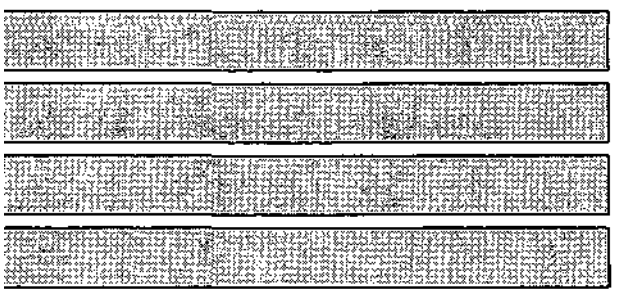
Contract Report 616

Ground-Water Investigation in the Cache River Valley, Alexander County, Illinois

by
Ellis W. Sanderson and Adrian P. Visocky
Office of Ground-Water Resource Evaluation & Management

Prepared for
South Water, Inc.

May 1997



Illinois State Water Survey
Hydrology Division
Champaign, Illinois

A Division of the Illinois Department of Natural Resources

GROUND-WATER INVESTIGATION IN THE CACHE RIVER VALLEY, ALEXANDER COUNTY, ILLINOIS

by

Ellis W. Sanderson, P.E., Senior Engineer
Adrian P. Visocky, P.E., Senior Hydrologist

Prepared for SouthWater, Inc.

May 1997

Illinois State Water Survey
Hydrology Division
2204 Griffith Drive
Champaign, IL 61820

ISSN 0733-3927

CONTENTS

APPENDICES

GROUND-WATER INVESTIGATION IN THE CACHE RIVER VALLEY, ALEXANDER COUNTY, ILLINOIS

by
Ellis W. Sanderson, P.E., Senior Engineer
Adrian P. Visocky, P.E., Senior Hydrologist

INTRODUCTION

SouthWater, Inc., seeks to own and operate a water utility to serve many of the residential, commercial, and industrial customers of rural Alexander and Pulaski Counties, Illinois; the municipalities of Pulaski, McClure, East Cape Girardeau, Dongola, and Ullin; and the Central Alexander County Public Water District.

In May 1995, SouthWater, Inc., contracted with Speth Plumbing, Inc., for test drilling to determine aquifer thickness and texture at a reasonably convenient location in the proposed service area. One 6-inch diameter test well (TW 1-95) was drilled in Alexander County at NE¼, NE¼, Section 15, T. 15 S., R.2 W. The test well confirmed the presence of a thick section of sand-and-gravel aquifer that offered promise for developing the desired water supply source.

This investigation was conducted jointly for SouthWater, Inc., by the Illinois State Water Survey; Clarida Engineering Company, Inc.; and Beanland Drilling Company, Inc. A contract was awarded in January 1996, to Beanland Drilling Company, Inc., Anna, Illinois, to construct a test/production well and four observation wells to evaluate the ground-water resources available and the possible withdrawal rate from an individual production well and well field tapping the sand-and-gravel aquifer associated with the Cache River Valley lowland area.

ACKNOWLEDGMENTS

Special thanks go to Robert D. Olson, Associate Hydrologist, for his assistance with the field work during the step test and the aquifer test. Water samples collected by Water Survey staff during the tests were analyzed by the Survey's Analytical and Water Treatment Services laboratory under the supervision of Loretta Skowron.

We appreciate the opportunity to work with Mr. Glenn Clarida, Clarida Engineering Company, Inc., and Mr. Ron Beanland, Beanland Drilling Company, Inc. Their competence and experience allowed the planned test to proceed in an efficient manner. Finally, Mr. Larry Lovell, Vice-President, SouthWater, Inc., and its Trustees, were professional in their approach to this project and expedited its accomplishment.

We also acknowledge the assistance of Pamela Lovett (word processing of the reproducible copy of this report), Eva Kingston (editing of the manuscript), and Linda Hascall (preparation of graphics).

SUMMARY OF 1995 TESTING

In May, 1995, South Water, Inc., contracted with Speth Plumbing, Inc., Allendale, Illinois, to construct a 6-inch test well (TW 1-95) for the purposes of 1) confirming the thickness and texture of the extensive sand-and-gravel aquifer associated with the lowlands of the Cache River valley, and 2) enabling the collection of water samples for chemical analysis. Test Well 1-95 was located about 1100 feet south of the NE corner, Section 15, T. 15 S., R.2 W., Alexander County (see figure 1). Construction features of TW 1-95 and the driller's log of the formations penetrated are included in appendix A.

Test well 1-95 was test pumped for a period of 12 hours on June 13-14, 1995. Ground-water-level data were collected by Speth Plumbing and are included in appendix B. Three water samples were collected during the test pumping period after about 2, 6, and 12 hours. The analyses of these three water samples (see appendix C) showed the water to have a low iron content, less than 0.3 milligrams per liter (mg/1). The low iron content, not typical of the ground water in this area, raised the question as to whether this condition would persist over time if the site were developed with production wells. Although this could not be accurately predicted or determined for the long-term future, further effort to evaluate the ground-water quality was deemed worthwhile because this could impact the design of the water treatment plant.

South Water, Inc., then contracted with Speth Plumbing to furnish and install a pump in TW 1-95 and to operate the pump for a period of about 30 days. The well pump was installed during the last week of July 1995. Pumping commenced on July 27, 1995, and continued until 2:50 p.m., September 1, 1995. During this test pumping six water samples were collected on July 27, August 2, August 10, August 15, August 23, and September 1,1995, and submitted to the Water Survey laboratory for analysis. These analyses are also included in appendix C. They showed very minor changes in the quality of the ground water during the test pumping period.

INVESTIGATIVE METHODS AND PROCEDURES

Testing Program

Objective

The principal objective of this investigation was to estimate the potential for ground-water resource development in the vicinity of the initial test well (1-95). A development potential of at least 1 to 2 million gallons per day (mgd) was desired. The target area for this investigation was in the NE¼, NE¼, Section 15, T.15 S., R.2 W., Alexander County. One high-capacity test well and three observation wells were drilled at this site to conduct an aquifer test to evaluate the yield of the sand-and-gravel aquifer and to design a well field (see figure 2).

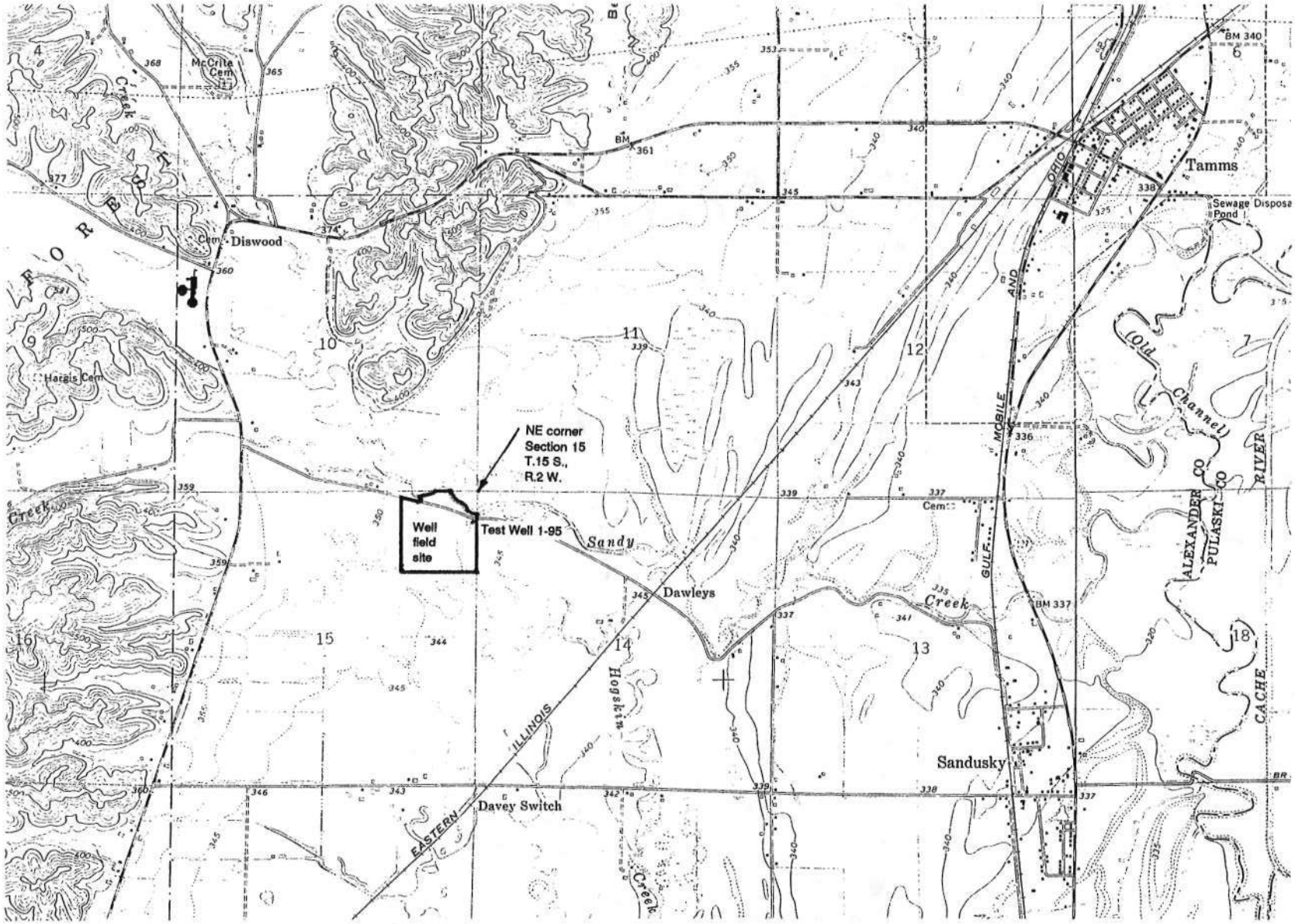


Figure 1. Well field site and location of Test Well 1-95

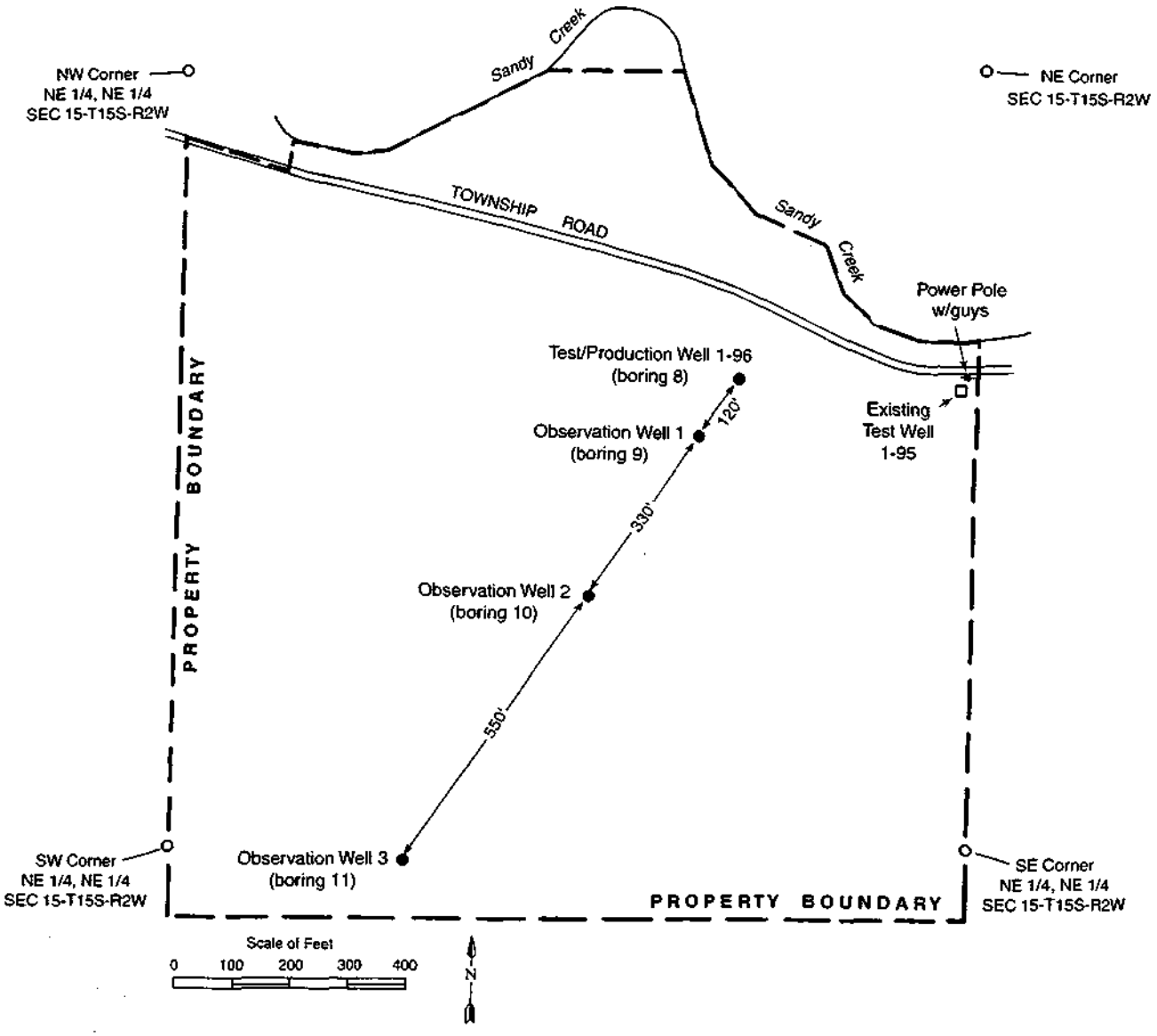


Figure 2. Location of Test/Production Well 1-96
and Observation Wells for aquifer

Description of Site

The proposed well field site is a 40-acre parcel of land located adjacent to Sandy Creek about 2 miles southwest of Tamms. The site is in the broad lowlands of the Cache River about 3,000 feet east from the base of the bluffs bordering the lowlands. Directly west of the site, the adjacent hills are bisected by the valleys of Wolf Creek, West Branch, Sandy Creek, and Jim Branch, which exit the hill area into the lowlands as Sandy Creek. Sandy Creek and the north line, Section 15, form the north boundary of the parcel of land.

The high-capacity Test/Production Well 1-96 drilled near the northeast corner of the site and the three observation wells confirmed the thick sand-and-gravel aquifer generally about 85 feet thick and overlain by about 30 to 40 feet of clay. A test hole drilled near the northwest corner of the well field site showed only a thin layer of sand-and-gravel aquifer immediately above the bedrock surface.

Design of Tests

The available information suggested that the sand-and-gravel aquifer, probably associated with the preglacial buried bedrock valley, was extensive and likely could support the development of a water supply of 2 mgd or more. About 5 miles south of the site at the Horseshoe Lake Conservation Area, the Department of Natural Resources maintains several high-capacity wells for the purpose of flooding low-lying area in the fall for wildlife management. In addition, a number of irrigation wells are present in the area from Sandusky to Olive Branch.

To achieve the objective of evaluating the potential yield of the sand-and-gravel aquifer to a well field, the study focused on conducting an aquifer test on a test pumping well for 48 hours. The aquifer test would consist of pumping the test well at a constant, uninterrupted rate for the test period while observing ground-water levels in the pumping test well and in three observation wells.

Prior to the aquifer test, a step test was planned for the pumping test well to help determine an appropriate pumping rate for the 48-hour aquifer test and to estimate the hydraulic efficiency of the test well. The aquifer response during the step test would help determine a pumping rate that could be sustained for the desired 48-hour constant-rate aquifer test, but at the same time stress the aquifer system sufficiently to provide meaningful data for analysis. For this investigation, the primary purpose of the step test was to collect data to determine the well-loss coefficient of the test well to enable calculation of the portion of observed drawdown attributable to well inefficiencies. Well loss, described in more detail below, is an additional component of observed drawdown in pumping wells that can significantly reduce sustainable yields. The step test would consist of pumping the test well at increasing increments of the full rate for about 30 minutes at each rate. During the test, ground-water levels would be observed in the pumping test well and in observation wells as convenient.

Evaluation Methodology for Step Tests

Well Loss

When a well is pumped, water is removed from storage within the aquifer, causing water levels to decline over time in the vicinity of the well. This effect, referred to as drawdown, is most pronounced at the pumped well and gradually diminishes at increasing distances away from the well. Drawdown is the distance that the water level declines from its nonpumping stage and, under ideal conditions, is a function of pumping rate, time, and the aquifer's hydraulic properties. Aquifer boundaries, spatial variation in aquifer thickness or hydraulic properties, interference from nearby wells, and partial-penetration conditions all can affect observed drawdowns at both pumping and observation wells. On the other hand, well loss or the additional drawdown inside the pumped well due to turbulent flow of water into and inside the well is a measure of the hydraulic efficiency of the pumping well only, reflecting the unique flow geometry of the borehole, well screen, and pump placement.

Because of well loss, the observed drawdown in a pumped well is usually greater than that in the aquifer formation outside the borehole. In addition to considerations of flow geometry, as noted above, the amount of well loss can also depend on the materials used (screen openings, gravel-pack size distribution, drilling fluids, etc.) and the care taken in constructing and developing the well using mechanical and hydraulic means to remove drilling fluids from the borehole. Some well loss is natural because of the physical blocking of the aquifer interstices caused by the well screen and the disturbance of aquifer material around the borehole during construction. However, an improperly designed well and/or ineffective well construction and development techniques can result in unacceptable well losses. In addition, well losses often reflect a deterioration in the condition of an existing well, especially if they are observed to increase over time.

Well loss is a function of pumping rate but ideally not of time. It is associated with changes in flow velocity in the immediate vicinity of the well, resistance to flow through the well screen, and changes in flow path and velocity inside the well, all of which cause the flow to change from laminar to turbulent in form. Head losses under turbulent conditions are nonlinear; that is, drawdowns increase more rapidly with increases in pumping rate than under laminar conditions, as discussed below.

While it is possible to have turbulent flow within the aquifer and laminar flow within a pumping well, under near-ideal conditions the observed drawdown (s_o) in a pumping well is made up of two components: the formation loss (s_a), resulting from laminar flow head loss within the aquifer; and well loss (s_w), resulting from the turbulent flow of water into and inside the well, as shown in equation 1.

$$s_o = s_a + s_w \tag{1}$$

Jacob (1947) devised a technique for separating the well losses from the formation losses, assuming that all formation losses are laminar and all well losses are turbulent. These

components of theoretical drawdown, s, in the pumped well are expressed as being proportional to pumping rate, Q, in the following manner:

$$s = BQ + CQ^2 \quad (2)$$

where B is the formation-loss coefficient at the well-aquifer interface per unit discharge, and C is the well-loss coefficient. For convenience, s is expressed in feet and Q in cubic feet per second (ftVsec). Thus, the well-loss coefficient C has the units $secVft^5$.

Rorabaugh (1953) suggested that the well-loss component be expressed as CQ^n, where n is a constant greater than 1. He thus expressed the drawdown as:

$$s = BQ + CQ^n \quad (3)$$

To evaluate the well-loss component of the total drawdown, one must know the well-loss coefficient (if using equation 2) or both the coefficient and the exponent (if using equation 3). This analysis requires a controlled pumping test, called a step-drawdown test (described below), in which total drawdown is systematically measured while pumping rates are varied in a stepwise manner.

Methodology for Determining Well Loss

If Jacob's equation is used to express drawdown, then the coefficients B and C must be determined. A graphical procedure can be employed after first modifying equation 2 as:

$$s/Q = B + CQ \quad (4)$$

After this modification, a plot of s_o/Q versus Q can be prepared on arithmetic graph paper from data collected during a step drawdown test, with the observed drawdown, s_o, substituted for s. The slope of a line fitted to these data is equal to C, while the y-intercept is equal to B, as shown in figure 3. If the data do not fall within a straight line, but instead curve concavely upward, the curvature of the plotted data indicates that the second-order relationship between Q and s_o is not valid, and the Rorabaugh method of analysis usually is appropriate.

Occasionally the data plot of s_o/Q versus Q may yield a straight-line fit with essentially zero slope or with a negative slope, or the data may be too scattered to allow a reasonable fit to be made at all. In these instances, the well-loss parameters are immeasurable. There are four possible explanations: 1) turbulent well loss was negligible for the range of pumping rates used during the test; 2) inadequate data collection or test methods were employed during the test; 3) the hydraulic condition of the well was unstable, as is the case during well development; or 4) the contribution of water from the aquifer was not uniform along the entire length of the well screen over the range of pumping rates, as might occur due to the pump setting in relationship to the screen or to vertical heterogeneity of the aquifer materials.

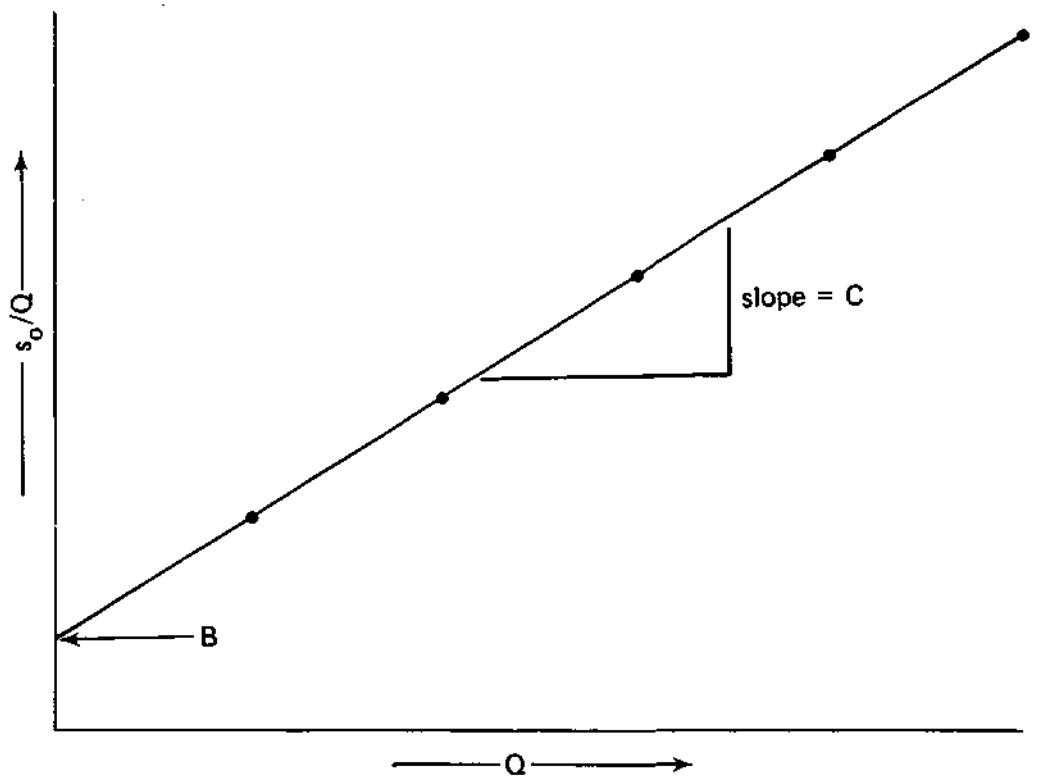


Figure 3. Graphical solution of Jacob's equation for well-loss coefficient, C

Step-Test Procedure

The primary objective of a step-drawdown test (or step test) is the determination of the well-loss coefficient (and exponent, if using Rorabaugh's method). With this information, the turbulent well-loss portion of drawdown for any pumping rate of interest can be estimated. During the test, the discharge rate is successively increased or decreased over the previous rate, in approximately equal increments, in order to facilitate the data analysis. Each pumping period at a given rate is called a step, and all steps are of equal duration. Generally, the pumping rates increase from step to step, but the test also can be conducted by decreasing the pumping rates. During each step, the pumping rate is held constant. If data are collected manually, water-level measurements are made every minute for the first six minutes, every two minutes for the next ten minutes, and then every four to five minutes thereafter until the end of the step.

Schematically, the relationship between time and water level resembles that shown for a five-step test in figure 4. Incremental drawdowns for each step (shown as Δs_i) are measured as the distance between the extrapolated water levels from the previous step and the final water level of the current step. For step 1, the nonpumping water-level trend prior to the start of the test is extrapolated, and Δs_1 is measured from this datum. All data extrapolations should be performed on semilog graph paper for the most accurate results. For the purpose of plotting s_o/Q versus Q, values of observed drawdown s_o are equal to the sum of Δs_i for a given step. Thus, for step 3, $s_o = \Delta s_1 + \Delta s_2 + \Delta s_3$.

Evaluation Methodology for Aquifer Tests

Analysis

The capacity of a formation to transmit ground water is expressed by the **transmissivity,** which is the rate of flow of water, in gpd, through a one-foot-wide vertical strip of the aquifer extending the full saturated thickness under a hydraulic gradient of 100 percent (one foot per foot) at the prevailing water temperature. Transmissivity is the product of the saturated thickness of the aquifer and the **hydraulic conductivity,** which is the rate of flow of water, in gpd, through a cross-sectional area of one square foot of the aquifer under a hydraulic gradient of 100 percent at the prevailing water temperature.

The storage properties of an aquifer are expressed by the **storage coefficient,** the volume of water released from storage per unit surface area of the aquifer per unit change in the water level. This parameter is dimensionless.

The hydraulic properties of an aquifer may be determined by means of an aquifer test, where the effect of pumping a well at a known constant rate is measured in the pumped well and at observation wells that penetrate the aquifer at various distances from the pumped well. Graphs of drawdown (the lowering of water levels in the wells) versus time after pumping starts and/or drawdown versus distance from the pumped well are used to solve equations that express the relation between the transmissivity, storage coefficient, pumping rate, and drawdown. Where appropriate, drawdown data must be adjusted to account for conditions that affect the observed

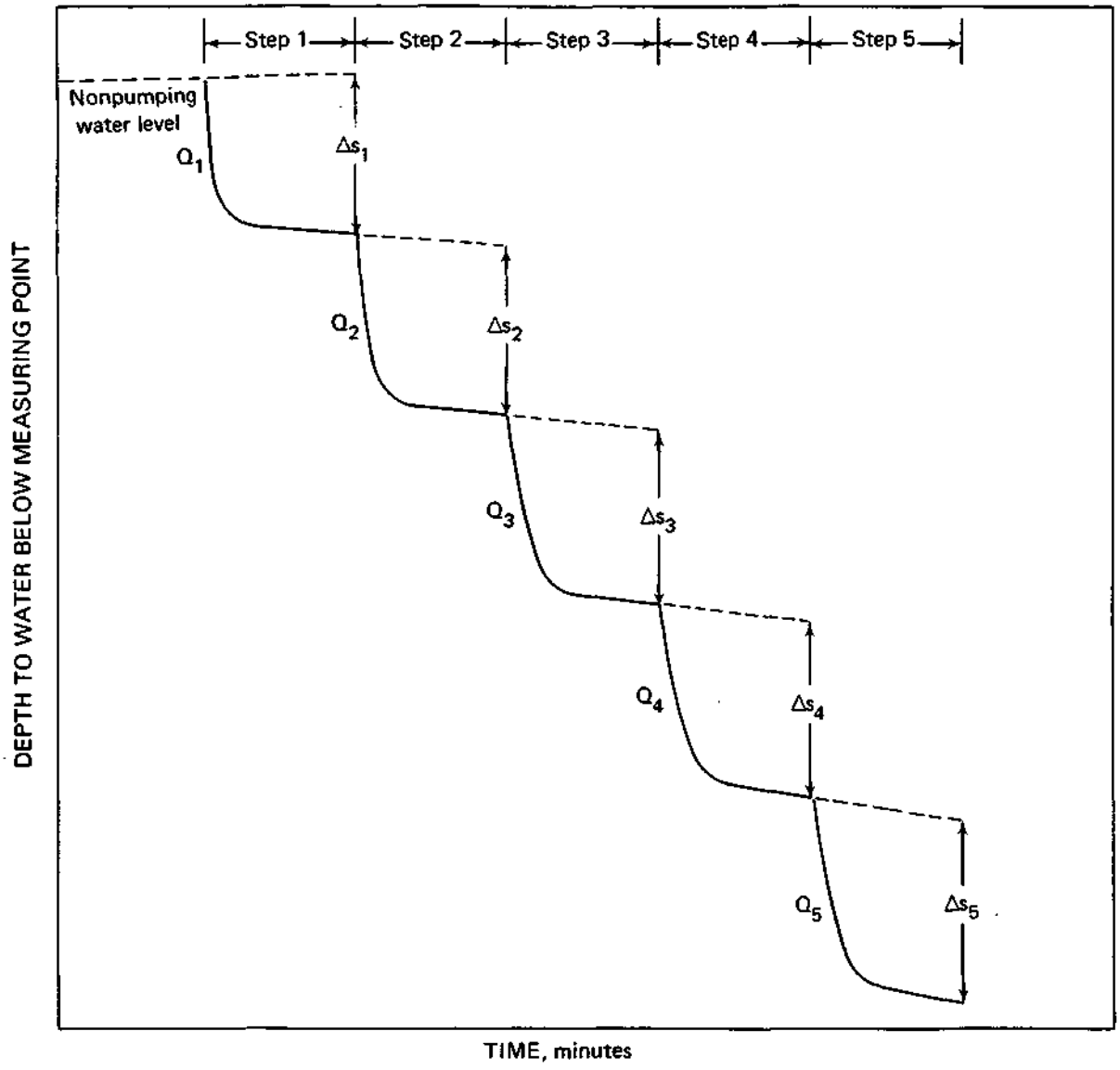


Figure 4. Relationship between time and water-level during a five step drawdown test

rate of drawdown, such as variations in pumping rate, barometric pressure fluctuations, pumping in nearby wells, aquifer boundaries, leakage, significant dewatering (see later discussion of water-table conditions), or a partially penetrating pumped well. The two most common methods of analysis for field data under nonleaky artesian conditions—the type-curve method and the Jacob straight-line method—are described below.

Type-Curve Method

Theis (1935) introduced an analogy between the nonsteady flow of ground water and heat conduction. The nonequilibrium formula—popularly known as the Theis equation—describes radial flow toward a well pumping from an artesian aquifer as:

$$s = \frac{Q}{4\pi T}W(u) \tag{5}$$

or in commonly used units,

$$s = \frac{114.6Q}{T}W(u) \tag{6}$$

where:

$$W(u) = \int_u^\infty \frac{e^{-u}}{u}du = -0.5772 + \ln u + u - \frac{u^2}{2\cdot 2!} + \frac{u^3}{3\cdot 3!} - \frac{u^4}{4\cdot 4!} + \cdots \tag{7}$$

and

$$u = \frac{2693r^2S}{Tt} \tag{8}$$

where:

s = drawdown at distance r from the pumped well, in feet
Q = well discharge, in gpm
T = transmissivity, in gpd/ft
r = distance from pumped well to observation point, in feet
S = storage coefficient, decimal fraction
t = time since pumping began, in minutes

W(u), referred to as the **well function for nonleaky artesian aquifers,** has been extensively tabulated.

Theis devised a graphical procedure using superposition to solve for the aquifer properties, T and S, using equations 6 and 8, but inverting equation 8:

$$s = \frac{114.6Q}{T}W(u) \quad (9)$$

and

$$\frac{1}{u} = \frac{Tt}{2693r^2S} \quad (10)$$

Expanding the logarithm of both sides of these equations yields:

$$\log s = \log \left[\frac{114.6Q}{T}\right] + \log W(u) \quad (11)$$

and

$$\log \frac{1}{u} = \log \left[\frac{T}{2693r^2S}\right] + \log t \quad (12)$$

In equation 11 the term log [114.6Q/T] is a constant for a given pumping rate (hence, the need for a constant pumping rate during tests), so log s is directly related to log W(u). Also, in equation 12 the term log [T/2693r^2S] is a constant for a given distance r (a selected observation well), so log 1/u is directly related to log t. Thus,

$$\log s \propto \log W(u)$$

and

$$\log t \propto \log 1/u$$

From these relationships, one can construct a plot of the well function W(u) versus 1/u on log-log graph paper (figure 5). Such a plot of a mathematical function is called a **type curve.** Likewise, one can plot on identical log-log paper a plot of drawdown s versus time t from the data collected at each observation well.

The type curve is then superimposed over the field-data plot, keeping the corresponding ordinate and abscissa axes parallel, until a best fit is obtained. A convenient match point is chosen on the two graphs (usually one that includes the convenient type-curve match point of W(u) = 1 and 1/u = 10). The corresponding coordinates of W(u), 1/u, s, and t are then substituted into equations 6 and 8 to solve for T and S.

In the same manner, one could make a type curve of W(u) versus u, noting the relationship between s versus W(u) and between u and r^2. For an aquifer test in which several observation wells were used, one could fit the new type curve to a field-data plot of s versus r^2 for a given time, and follow the same procedure of fitting the type curve to the field-data plot and selecting a match point.

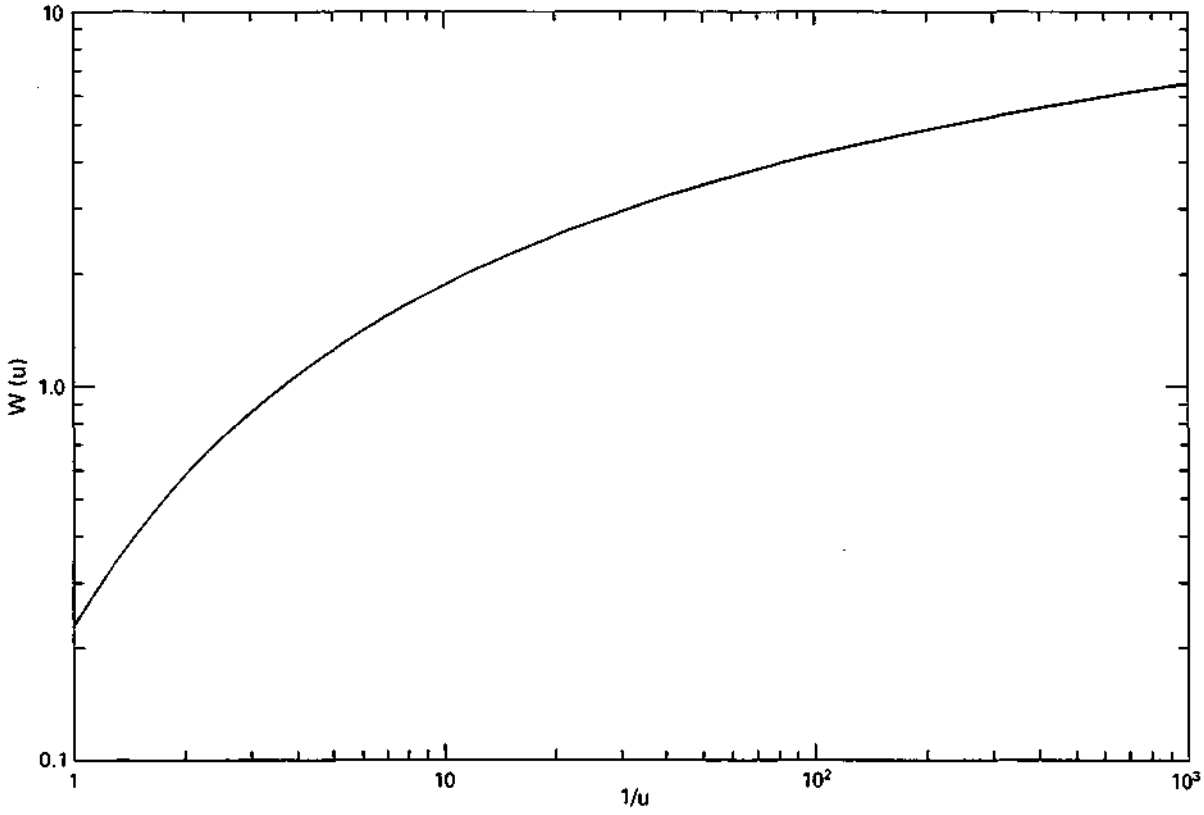


Figure 5. Nonleaky artesian type curve

Jacob Straight-Line Method

A popular graphical method derived from the Theis method by Cooper and Jacob (1946) is referred to as the **modified nonleaky artesian formula,** or simply the **Jacob straight-line method.** The method is based on the fact that when values of u are small (less than, say, 0.01), the sum of the series terms in equation 7 beyond In u becomes insignificant. An examination of the terms in equation 8 shows that u becomes small when r becomes small (close-in observation wells) or t becomes large (long pumping periods).

When $u < 0.01$, field-data plots of drawdown versus log time on semilog paper will yield a straight line. The straight-line portion of the s versus t plot is extrapolated to its intersection with the zero-drawdown axis. The slope of the straight line (drawdown per log cycle) is used to solve for the transmissivity, and the zero-drawdown intercept is used to solve for the storage coefficient. Expressions for these computations derived by Cooper and Jacob (1946) are:

$$T = \frac{264Q}{\Delta s} \tag{13}$$

and

$$S = \frac{Tt_0}{4790r^2} \tag{14}$$

where:

T = transmissivity, in gpd/ft
Q = well discharge, in gpm
AS = drawdown difference per log cycle, in feet
S = storage coefficient
t_o = intersection of straight-line slope with zero-drawdown axis, in minutes
r = distance from pumped well to observation point, in feet

The method can be extended also to plots of drawdown versus distance for given time values. Field-data plots of drawdown versus log distance on semilog paper will yield a straight line in the region where $u < 0.01$. The straight-line portion of the graph is extrapolated to its intersection with the zero-drawdown axis. The slope of the straight line is used to solve for T, and the zero-drawdown intercept is used to solve for S, using the following expressions:

$$T = \frac{528Q}{\Delta s} \tag{15}$$

and

$$S = \frac{Tt}{4790r_0^2} \tag{16}$$

where:

r_o = intersection of straight-line slope with zero-drawdown axis, in feet, and all other terms are as defined above.

The Jacob straight-line method is popular because of its simplicity; however, its use is restricted to field data that satisfy the "u-criterion" of $u < 0.01$. Deviation from a straight line becomes appreciable when u exceeds about 0.02 (Walton, 1962). The method should be used to supplement, rather than supersede, the type-curve method.

Water-Table Conditions

The methods described in the previous section pertain to artesian aquifer conditions; however, the formulas can also be applied to the results of aquifer tests made under water-table (unconfined) conditions. These formulas were developed in part based on the assumptions that the coefficient of storage is constant and that water is released from storage instantaneously with a decline in water levels. Under water-table conditions, water is derived largely from storage by the gravity drainage of the interstices in the portion of the aquifer dewatered by the pumping. The gravity drainage of water through stratified sediments is not immediate, and the nonsteady flow of water towards a well in an unconfined aquifer is characterized by slow drainage in interstices.

Gravity drainage of interstices decreases the saturated thickness and, therefore, the transmissivity of the aquifer. Under water-table conditions, it is necessary to compensate for observed values of drawdown by the decrease in saturated thickness before the data can be used to determine the hydraulic properties of the aquifer. The following equation derived by Jacob (1944) is used to adjust drawdown data for decreases in transmissivity:

$$s' = s-(s^2/2m) \qquad (17)$$

where:

s' = drawdown that would occur in an equivalent artesian aquifer
s = observed drawdown under water-table conditions
m = initial saturated thickness of aquifer

The effects of gravity drainage also present challenging problems for the analysis of data because of the fact that the field data deviate from the ideal upon which the Theis and Jacob methods are based. Several methods of data analysis have been presented by researchers, including Boulton (1963) and Neuman (1975). Neuman's method is designed for assessing anisotropic conditions. Prickett (1965) presented an application of the Boulton method that is useful for conditions under which anisotropy is not considered to be significant or critical to an assessment of the aquifer.

WELL AND AQUIFER TEST RESULTS

Test/Production Well 1-96

The pumping test well, Test/Production Well 1-96, was finished at a depth of 125 feet. The borehole was drilled 32 inches in diameter and the well was built with 20-inch-diameter steel casing and stainless steel well screen. A 45-foot-long 80-slot (0.080-inch) well screen was placed between depths of 80 and 125 feet. Northern No. 2 gravel pack was placed in the annulus between the depths of about 74 and 125 feet. The well screen slot size and grain size of the gravel pack were recommended by the Water Survey based on procedures described by Smith (1954). A graded sand was placed between depths of about 22 and 74 feet, and cement grout was placed from land surface to a depth of 22 feet. Three observation wells, OW 1, 2, and 3, were drilled approximately 120 feet, 450 feet, and 1001 feet southwest of the Test/Production Well 1-96, respectively (see appendix D for construction details and appendix E for aquifer sample sieve data). Two wells (OW 1 and 2) were completed with 2-inch-diameter PVC casing and 40 feet of well screen. One well (OW 3) was completed with 4-inch-diameter PVC casing and 40 feet of well screen.

Aquifer Tests

A 48-hour aquifer test was conducted using Test/Production Well 1-96 and four observation wells. Water levels in TW 1-95, located about 376 feet east, were observed in addition to the three observation wells completed for the aquifer test.

Test Protocol

Beanland Drilling Company, Inc., furnished and installed pumping equipment in the test/production well and discharge piping. Three types of equipment were used to measure discharge rate, water levels, and to record the data. Equipment was furnished and installed by the Water Survey.

The step test was conducted on April 25, 1996, and the 48-hour aquifer test was conducted on April 30-May 2, 1996. Pumped ground water was conducted from the well head in a plastic-lined ditch to a natural drainage way to Sandy Creek. A valve at the well head was used to control the pumping rates, and the Water Survey 8-inch orifice tube was used to measure discharge rates. Ground-water-level measuring equipment included InSitu Hermit data logging equipment and pressure transmitters in each well, supplemented with electric dropline measurements.

Step Test

The step test began at a rate of about 1350 gpm and increased in approximately 100-gpm increments. Ideally, a minimum of three steps is necessary for analysis, and five steps are desirable. For this test, six 30-minute steps were conducted at rates of about 1350, 1430,1555,

1655,1755, and 1850 gpm. Observed ground-water-level data for the step test are included in appendix F.

Step-Test Results

Data collected during the step test conducted on April 25 were analyzed using the Jacob step-test methodology described earlier. The results of the analysis indicate that Test/Production Well 1-96 had a very low well-loss coefficient of approximately 0.01 sec^2/ft^5. Since drawdown due to well loss is proportional to the square of the pumping rate, even with relatively high pumping rates (1500 to 1800 gpm), only about 1.2 to 1.5 percent of the observed drawdown in the well was due to well loss.

48-Hour Aquifer Test

The 48-hour aquifer test was conducted on April 30-May 2, 1996, observing ground-water levels in Test/Production Well 1-96 and in OW 1, OW 2, OW 3, and TW 1-95. In addition, a barometric pressure transducer was used to record barometric pressure. Pumping at Test/Production Well 1-96 commenced at 9:20 a.m. on April 30 and ended at 10:00 a.m. on May 2, for a pumping period of 2920 minutes. An average discharge rate of about 1776 gpm was maintained throughout the test. At the completion of pumping, water-level recovery was measured for 100 minutes. Observed ground-water-level data for the 48-hour aquifer test are included in appendix G. Analyses of water samples collected on April 25 during the step test and on May 2 during the aquifer test are included in appendix H.

48-Hour Aquifer Test Results

The aquifer test data did not show the effects of the known barrier boundary (the bluffs) northwest and southwest of the well field site. This may be due to changes in the storage coefficient at the pumped well and/or that the sand-and-gravel aquifer may in fact extend in bands up the valleys of Wolf Creek, West Branch, Sandy Creek, and Jim Branch immediately west of the site. No adjustments to the collected data were made because of the influence of barometric pressure changes, which can influence ground-water-level changes in some cases. The average of these hourly data show a range in barometric pressure of only about 33.8 to 34.4 feet of water (29.77 to 30.40 in Hg) during the aquifer test period (see appendix G). These barometric changes were judged small enough to have little or no effect on the collected ground-water-level data as observations of barometric pressure and ground-water levels in Test Well 1-95 from May 2 to May 21 following the aquifer test did not suggest a strong influence of barometric pressure on ground-water levels at this site (see appendix I). Time-drawdown graphs of the data were then constructed and analyzed, using the Type-Curve (Boulton/Prickett) and Straight-Line (Jacob) methodologies. The time-drawdown graph of observed water level data for Test Well 1-95 and the type curve match is shown in figure 6 to illustrate the analysis.

Analysis of the data collected from Test/Production Well 1-96 and the observation wells indicated the transmissivity of the sand and gravel aquifer at the time of the test ranged from about 245,200 gpd/ft to 267,900 gpd/ft as shown in table 1, and averaged about 258,700 gpd/ft.

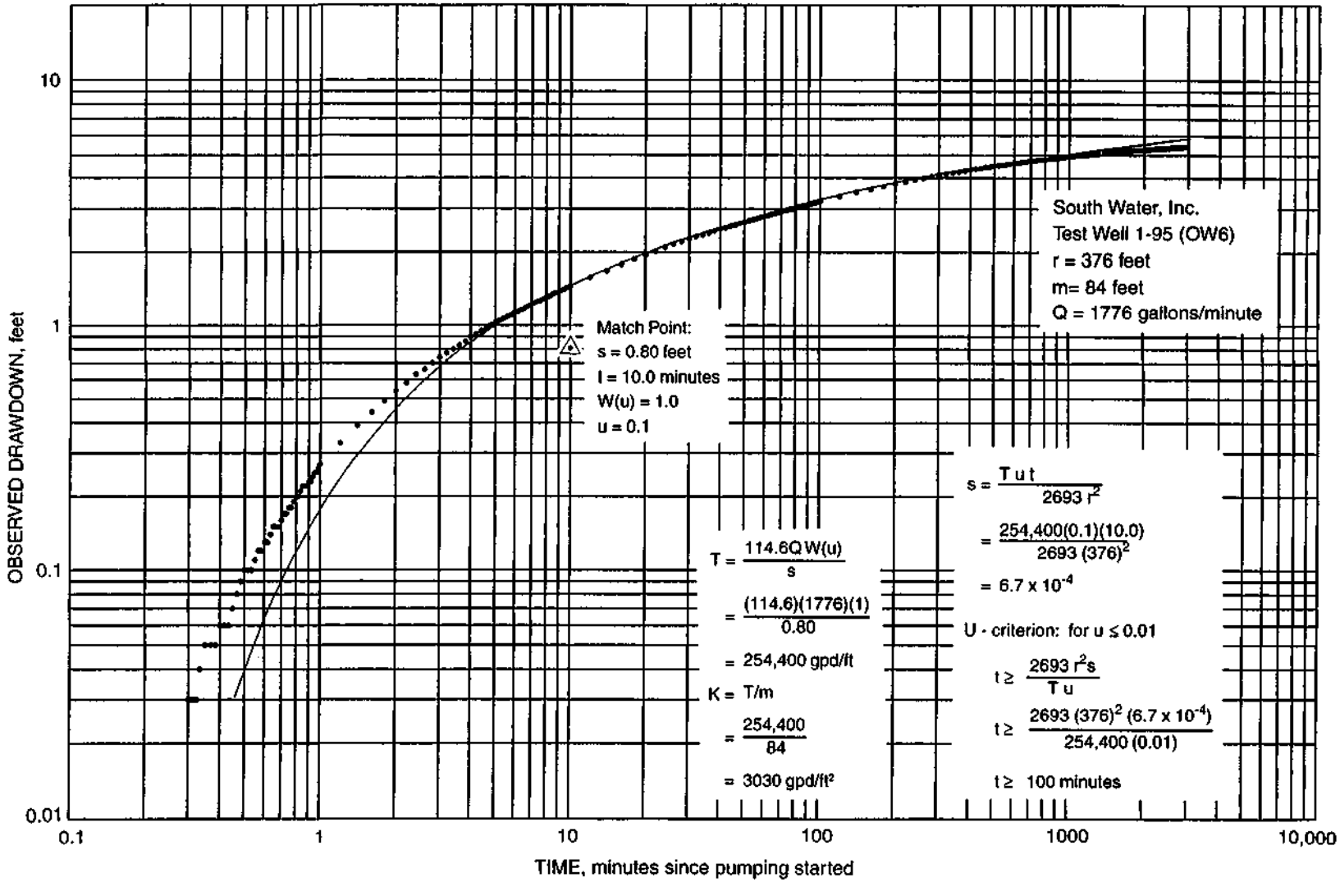


Figure 6. Type curve of Test Well 1-95 observed water level data

(hydraulic conductivity of about 3100 gpd/ft^2). The storage coefficient of the aquifer ranged from about 2.5 x 10^{-4} to 2.24 x 10^{-3}, indicative of artesian conditions. None of the observation well data indicated the presence of the aquifer boundary during the test period. Data from the pumping test well showed variations in ground-water levels due to fluctuations in the pumping rate.

Table 1. Results of 48-Hour Aquifer Test, Test/Production Well 1-96

	Straight-Line Method			*Type-Curve Method*		
Well	*T* (gpd/ft)	*K* (gpd/ft^2)	*S*	*T* (gpd/ft)	*K* (gpd/ft^2)	*S*
T/PW 1-96	263,400	2,990	-	-	-	-
OW 1	246,800	2,625	0.00229	245,200	2,610	0.00224
TW 1-95	253,400	3,000	0.00067	254,400	3,030	0.00067
OW 2	264,900	3,580	0.00093	264,300	3,570	0.00084
OW 3	267,900	3,080	0.00025	267,800	3,080	0.00028

Note: T/PW = Test/Production Well, T = transmissivity, K = hydraulic conductivity, and S = storage coefficient

With this information, a theoretical idealized model of the aquifer conditions in the vicinity of Test/Production Well 1-96 was hypothesized. The aquifer model was a semi-infinite aquifer extending north, east, and south beyond the cone of depression. A barrier boundary was assumed to be located about 3000 feet northwest of the well field site. While ostensibly conservative, this assumption is reasonably consistent with the known regional extent of the sand-and-gravel aquifer system associated with the Cache River bottomlands, and does not reduce the yield of a well field to less than the desired quantity.

The yield of a shallow sand-and-gravel aquifer also must take into account effects on ground-water levels by extended drought conditions. In this case, there are no data available to indicate how much natural decline in ground-water levels might occur during these periods. Experience with other similar areas indicates that ground-water levels during drought periods may be about 5 feet lower than at the time of the aquifer test. These lowered ground-water levels have the effect of reducing the available drawdown in production wells.

Thus the model aquifer consisted of the following elements: 1) a transmissivity of about 258,700 gpd/ft, 2) a specific yield of 6.1 x 10^{-4}, and 3) a barrier boundary at a distance of about 3000 feet northwest of the well field.

Using the hydraulic properties of the model aquifer, a theoretical distance-drawdown graph was constructed to estimate the effects of the assumed boundary and the mutual drawdown interference effects between production wells. Allowance was made for dewatering up to 50 percent of the saturated thickness of the aquifer at the production well sites by adjusting drawdowns for the decrease in transmissivity.

Based on the assumptions and conditions described above, the idealized model aquifer, and resulting calculations of drawdown and interference effects, it appears that a well field yield of about 3,200 gpm (4.6 mgd) is feasible from two production wells (1600 gpm each) spaced at about 500 feet in a line trending northeast-southwest across the 40-acre property owned by the water company. Each production well may be equipped with about 35-45 feet of well screen and the well pump intake positioned no lower than the top of the well screen. For reliable supply at the maximum yield rate, a standby production well also should be considered. It should be located in the established northeast-southwest line, about 500 feet from the other production wells.

CONCLUSION

This ground-water investigation in the bottomlands of the Cache River valley was encouraging, with the discovery that the sand-and-gravel aquifer had a much greater hydraulic conductivity than estimated. Field testing conducted at the test site in Section 15, T.15 S., R.2 W., Alexander County, and subsequent analysis of data have confirmed early thoughts regarding the yield capability of the extensive sand-and-gravel aquifer system associated with the present Cache River valley. This investigation has shown that it is possible to develop the shallow sand-and-gravel aquifer associated with the Cache River bottomlands as a source of large quantities of ground water to meet the present and future needs of the region to be served by SouthWater, Inc.

SELECTED REFERENCES

Boulton, N.S., 1963. *Analysis of data from nonequilibrium pumping tests allowing for delayed yield from storage.* Proceeding of the Institution of Civil Engineers, 26(6693):469-482.

Cooper, H. H., Jr., and C. E. Jacob. 1946. *A generalized graphical method for evaluating formation constants and summarizing well field history.* Trans. Am. Geophys. Union, 27(4):526-534.

Jacob, C. E. 1944. *Notes on determining permeability by pumping tests under water-table conditions.* Unpublished U.S. Geological Survey mimeo.

Jacob, C. E. 1947. *Drawdown tests to determine effective radius of artesian well.* Transactions, American Society of Civil Engineers, 112:1047-1070.

Neuman, S.P., 1975. *Analysis of pumping test data from anisotropic, unconfined aquifers, considering delayed gravity response.* Water Resources Res., 11:329-342.

Prickett, T.A., 1965. *Type-curve solution to aquifer tests under water-table conditions.* Ground Water, 3(3):5-14.

Rorabaugh, M.I., 1953. *Graphical and theoretical analysis of step-drawdown test of artesian wells.* Proceedings, American Society of Civil Engineers, v. 79(362), 23p.

Smith, H. F., 1954. *Gravel packing water wells.* Illinois State Water Survey Circular 44.

Theis, C. V. 1935. *The relation between the lowering of piezometric surface and the rate and duration of discharge of a well using ground-water storage.* Trans. Am. Geophys. Union, 16th Annual Meeting, pt. 2.

Walton, W. C. 1962. *Selected analytical methods for well and aquifer evaluation.* Illinois State Water Survey Bulletin 49.

Appendix A.

Test Well 1-95 Information

SOUTHWATER, INC. TEST WELL 1-95
ALEXANDER COUNTY, ILLINOIS
by
Speth Plumbing, Inc.

Well Owner:	SouthWater, Inc.
Well Location:	Approximately 540 feet South and 25 feet West of the NE/corner, Section 15, T.15 S., R.2 W., Alexander County, Illinois
Date Well Completed:	April, 1995
Dates of Water Quality /Production Tests:	June 13-14, 1995; July 27 - September 1, 1995
Aquifer:	Sand and Gravel

PUMPED TEST WELL DATA

Well No.:	Test Well 1-95
Depth:	144 feet
Drilling Contractor:	Speth Plumbing, Inc., Allendale, IL
Formation Samples:	to ISGS
Drilling Method:	Straight rotary
Hole Record:	10-inch; 0-144½ feet
Casing Record:	6-inch PVC; +1.8-124½ feet
Screen Record:	6-inch PVC; 124½-144½ feet; 0.050-inch slot (50 slot); 20-feet long
Annulus and Gravel Pack Record:	Northern gravel pack
Ground Elevation:	347.16 feet above mean sea level (msl)
Measuring Point:	Top of well casing (TOC), 1.80 feet above land surface (lsd)
Elevation Top of Casing:	348.96 feet above msl
Nonpumping Water Level:	20.08 feet below TOC, 6:30 p.m. June 13, 1995
Measuring Equipment:	Dropline
Test Pump and Power:	Berkeley Model 6TP7.5-175 6-inch submersible turbine w/ 7½ hp 460v Franklin motor, commercial power
Test Pump Setting:	NA
Date Water Samples Collected:	8:30 p.m. June 13; 12:20 p.m. June 14; 6:30 a.m. June 14; July 27; August 2; August 10, August 15, August 23, September 1, 1995
Temperature of Water:	58°F, June 13, 1995

SOUTHWATER, INC.
TEST WELL 1-95

DRILLERS LOG

Formation	From *(feet)*	To *(feet)*
Light brown topsoil - little clay	0	10
Dark brown loam - more clay content	10	20
Dark brown loam - higher clay content but sandy	20	30
Blue gray clay - little sand	30	40
Blue gray clay - increasing sand	40	50
Gray, very fine sand, lots of clay, still muddy	50	55
Same, more sand	55	60
Same, fine to medium sand	60	65
Coarser sand, fine gravel	65	70
Coarse sand and fine gravel mix	70	80
Coarse sand and fine to medium gravel mix	80	85
Medium gravel and sand mix	85	135
Coarser gravel	135	144
Limestone	144	144½

Appendix B.

Test Well 1-95
Water-Level Measurements, June 13-14, 1995

Ground - Water Investigation in the Cache River Valley for South Water, Inc.
Test Well 1-95 11 Water Quality/ Production Test: June 13-14, 1995
by
Speth Plumbing, Inc

Date/ Hour	Elapsed Time *(min)*	Depth to water *(ft)*	Draw-down *(ft)*	Pumping Rate *(gpm)*	Remarks
06/13/95					
06:30 PM		20.02			Pump ON
06:31PM	1	32.08	12.06	225	
06:32 PM	2	32.12	12.10	225	
06:33 PM	3	32.16	12.14	225	
0634 PM	4	32.20	12.18	225	
06:35 PM	5	32.72	12.20	225	
06:36 PM	6	32.22	12.20	225	
0637 PM	7	32.22	12.20	225	
0638 PM	8	32.24	12.22	225	
0639 PM	9	32.24	12.22	225	
06:40 PM	10	32.24	12.22	225	
06:42 PM	12	32.28	12.26	225	
06:44 PM	14	32.28	12.26	225	
06:46 PM	16	32.30	12.28	225	
06:48 PM	18	32.30	12.28	225	
06:50 PM	20	32.32	12.30	225	
06:52 PM	22	32.34	12.32	225	
06:54 PM	24	32.38	12.36	225	
06:56 PM	26	32.38	12.36	225	
06:58 PM	28	32.38	12.36	225	
07:00 PM	30	32.38	12.36	225	
07:05 PM	35	32.38	1236	225	
07:10 PM	40	32.40	12.38	225	
07:15 PM	45	32.42	12.40	225	
0720 PM	50	32.44	12.42	225	
0725 PM	55	32.44	12.42	225	
07:30 PM	60	32.46	12.44	225	
07:35 PM	65	32.46	12.44	225	
07:40 PM	70	32.46	12.44	225	
07:45 PM	75	32.46	12.44	225	
07:50 PM	80	32.46	12.44	225	
07:55 PM	85	32.46	12.44	225	
08:00 PM	90	32.48	12.46	225	
08:05 PM	95				Water temperature
08:10 PM	100	32.48	12.46	225	= 58°F
0820 PM	110	32.48	12.46	225	
08:30 PM	120	32.50	12.48	225	Collected water sample
08:40 PM	130	32.50	12.48	225	
08:50 PM	140	32.50	12.48	225	
09:00 PM	150	32.50	12.48	225	
0920 PM	170	32.50	12.48	225	
09:40 PM	190	32.54	12.52	225	
10:00 PM	210	32.54	12.52	225	
1020 PM	230	32.54	12.52	225	
10:40 PM	250	32.55	12.53	225	
11:00 PM	270	32.54	12.52	225	
1120 PM	290	32.54	12.52	225	
11:40 PM	310	32.54	12.52	225	
06/14/95					
12:00 AM	330	32.55	12.53	225	
1220 AM	350	32.54	12.52	225	Collected water sample
12:40 AM	370	32.54	12.52	225	
01:00 AM	390	32.54	12.52	225	
02:00 AM	450	32.54	12.52	225	
03:00 AM	510	32.58	12.56	225	
04:00 AM	570	32.60	12.58	225	
05:00 AM	630	32.60	12.58	225	

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Test Well 1-95 l l Water Quality / Production Test: June 13-14,1995
by
Speth Plumbing, Inc

Date/ Hour	Elapsed Time *(win)*	Depth to water *(ft)*	Draw-down *(ft)*	Pumping Rate *(gpm)*	Remarks
06:00 AM	690	32.60	12.58	225	
0630 AM	720	32.60	12.58	225	Collected water sample Pump OFF
0631AM	1	20.62			Recovery
06:32 AM	2	20.60			
0633 AM	3	20.60			
0634 AM	4	20.58			
0635 AM	5	20.56			
0636 AM	6	20.55			
06:37 AM	7	20.54			
0638 AM	8	20.52			
0639 AM	9	20.52			
06:40 AM	10	20.50			
06:42 AM	12	20.49			
06:44 AM	14	20.48			
06:46 AM	16	20.47			
06:48 AM	18	20.46			
06:50 AM	20	20.45			
06:55 AM	25	20.43			
07:00 AM	30	20.42			
07:05 AM	35	20.40			
07:10 AM	40	2039			
07:15 AM	45	2037			
0720 AM	50	2037			
0725 AM	55	20.36			
07:30 AM	60	20.36			
07:40 AM	70	20.34			
07:50 AM	80	20.33			
08:00 AM	90	20.33			
08:10 AM	100	20.32			
0820 AM	110	20.32			
0830 AM	120	20.31			End of Test

Following are water level recovery data collected by Speth Plumbing following pumping during the period July 27 — September 1,1995, for water quality testing

09/01/95					
02:50 PM	0	38.58			Pump OFF
02:51 PM	1	24.75			
02:52 PM	2	24.63			
02:53 PM	3	24 .58			
02:54 PM	4	24.58			
02:55 PM	5	24.56			
02:56 PM	6	24.56			
02:57 PM	7	24.54			
02:58 PM	8	24.52			
02:59 PM	9	24.52			
03:00 PM	10	24.52			
03:02 PM	12	24.48			
03:04 PM	14	24.48			
03:06 PM	16	24.46			
03:08 PM	18	24.46			
03:10 PM	20	24.44			
03:12 PM	22	24.44			
03:14 PM	24	24.42			
03:16 PM	26	24.42			
03:18 PM	28	24.40			
03:20 PM	30	24.40			
03:55 PM	65	2425			End of measurements

Appendix C.

Test Well 1-95
Chemical Analyses of Water Samples, June-September, 1995

Illinois State Water Survey
Chemistry Division
2004 griffith drive
Champaign, Illinois 61820-7495
Telephone (217) 333-9321
Telefax (217) 333-6540

WATER SAMPLE DATA
LABORATORY SAMPLE NUMBER: 228791

SOURCE: TEST HOLE NO. 1
OWNER: SOUTHWATER REGIONAL WATER SYSTEM
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 06/13/1995 DATE RECEIVED: 06/16/1995
WELL DEPTH (Ft.): 144.5 TEMPERATURE REPORTED (F): 58
TREATMENT: NONE
COMMENTS: SAMPLE COLLECTED 2 HOURS INTO PUMP TEST AT 225 GPM.

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.01	Fluoride (F):	0.2
Manganese (Mn):	0.03	Chloride (Cl):	3.5
Calcium (Ca):	60.6	Sulfate (S04):	2.3
Magnesium (Mg):	21.7	Nitrate (N03-N):	< 0.02
Sodium (Na):	7.3		
Barium (Ba):	0.03		
Boron (B):	< 0.13		
Chromium (Cr) :	0.008		
Copper (Cu):	< 0.01		
Nickel (Ni):	< 0.031		
Zinc (Zn):	0.02		
Turbidity(Lab, NTU):	0.38	Alkalinity (CaC03):	266
Color (PCU):	< 5	Hardness (as CaC03):	240
pH (Lab):	7.7	Total Dissolved Minerals:	262
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Analyst: Lauren F. Sievers
Assistant Chemist

A Division of the
Illinois Department of Energy and Natural Resources

Illinois State Water Survey

Chemistry Division

2204 Griffith Drive
Champaign. Illinois 61820-7495
Telephone (217) 333-9321
Telefax (217) 333-6540

WATER SAMPLE DATA

LABORATORY SAMPLE NUMBER: 228792

SOURCE: TEST HOLE NO. 1
OWNER: SOUTHWATER REGIONAL WATER SYSTEM
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 06/14/1995 DATE RECEIVED: 06/16/1995
WELL DEPTH (Ft.): 144.5 TEMPERATURE REPORTED (F): 58
TREATMENT: NONE
COMMENTS: SAMPLE COLLECTED 6 HOURS INTO PUMP TEST AT 225 GPM.

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.01	Fluoride (F):	0.2
Manganese (Mn):	0.03	Chloride (CI):	3.5
Calcium (Ca):	61.4	Sulfate (S04):	2.2
Magnesium (Mg):	21.9	Nitrate (N03-N):	< 0.02
Sodium (Na):	7.4		
Barium (Ba):	0.03		
Beryllium (Be):	< 0.003		
Boron (B):	< 0.13		
Chromium (Cr):	< 0.007		
Copper (Cu):	< 0.01		
Nickel (Ni):	< 0.031		
Zinc (Zn):	< 0.02		
Turbidity(Lab, NTU):	0.31	Alkalinity (CaC03):	267
Color (PCU):	< 5	Hardness (as CaC03):	243
pH (Lab):	7.9	Total Dissolved Minerals:	267
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Analyst: Lauren F. Sievers
Assistant Chemist

A Division of the
Illinois Department of Energy and Natural Resources

Illinois State Water Survey

Chemistry Division
2204Griffith Drive
Champaign, lll.no.s 61820-7495
Telephone (217) 333-9321
Telefax (217) 333-6540

WATER SAMPLE DATA
LABORATORY SAMPLE NUMBER: 228793

SOURCE: TEST HOLE NO. 1
OWNER: SOUTHWATER REGIONAL WATER SYSTEM
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 06/14/1995 DATE RECEIVED: 06/16/1995
WELL DEPTH (Ft.): 144.5 TEMPERATURE REPORTED (F): ND
TREATMENT: NONE
COMMENTS: SAMPLE COLLECTED 12 HOURS INTO PUMP TEST AT 225 GPM.

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.01	Fluoride (F):	0.1
Manganese (Mn):	0.03	Chloride (Cl):	3.6
Calcium (Ca):	61.0	Sulfate (S04):	2.3
Magnesium (Mg):	21.8	Nitrate (N03-N):	< 0.02
Sodium (Na):	7.3		
Barium (Ba) :	0.03		
Beryllium (Be):	< 0.003		
Boron (B):	< 0.13		
Chromium (Cr):	< 0.007		
Copper (Cu):	< 0.01		
Nickel (Ni):	< 0.031		
Zinc (Zn):	< 0.02		
Turbidity(Lab, NTU):	0.21	Alkalinity (CaC03):	268
Color (PCU):	< 5	Hardness (as CaC03):	241
pH (Lab):	7.7	Total Dissolved Minerals:	262
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Lauren F. Sievers

Analyst: Lauren F. Sievers
Assistant Chemist

A Division of the
Illinois Department of Energy and Natural Resources

Illinois State Water Survey

Chemistry Division
2204 Griffith Drive
Champaign, Illinois 61820-7495
Telephone (217) 333-9321
Telefax (217) 333-6540

WATER SAMPLE DATA
LABORATORY SAMPLE NUMBER: 228858

SOURCE: TEST HOLE NO. 1
OWNER: SOUTHWATER REGIONAL WATER SYSTEM
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 07/27/1995 DATE RECEIVED: 07/31/1995
WELL DEPTH (Ft.): 144.5 TEMPERATURE REPORTED (F): ND
TREATMENT: NONE
COMMENTS: NONE

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.10	Fluoride (F):	0.1
Manganese (Mn):	0.05	Chloride (Cl):	4.9
Calcium (Ca):	75.2	Sulfate (S04):	4.1
Magnesium (Mg):	24.2	Nitrate (N03-N):	< 0.02
Sodium (Na):	8.2		
Barium (Ba):	0.04		
Beryllium (Be):	< 0.003		
Boron (B):	< 0.13		
Chromium (Cr):	< 0.007		
Copper (Cu):	< 0.01		
Nickel (Ni):	< 0.031		
Zinc (Zn):	< 0.02		
Turbidity(Lab, NTU):	0.25	Alkalinity (CaC03):	274
Color (PCU):	< 5	Hardness (as CaC03):	287
pH (Lab):	7.9	Total Dissolved Minerals:	361
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Analyst: Lauren F. Sievers
Assistant Chemist

Illinois State Water Survey

Chemistry Division
2204 Griffith Drive
Champaign, Illinois 61820-7495
Telephone (217) 333-9321
Telefax (217) 333-6540

WATER SAMPLE DATA
LABORATORY SAMPLE NUMBER: 228871

SOURCE: TEST HOLE NO. 1
OWNER: SOUTHWATER REGIONAL WATER SYSTEM
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 08/02/1995 DATE RECEIVED: 08/03/1995
WELL DEPTH (Ft.): 144.5 TEMPERATURE REPORTED (F): ND
TREATMENT: NONE
COMMENTS: NONE

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.02	Fluoride (F):	0.1
Manganese (Mn):	0.04	Chloride (Cl):	3.7
Calcium (Ca):	66.2	Sulfate (S04):	3.6
Magnesium (Mg):	22.1	Nitrate (N03-N):	< 0.02
Sodium (Na):	7.7		
Barium (Ba):	0.03		
Beryllium (Be):	< 0.003		
Boron (B):	< 0.13		
Chromium (Cr):	< 0.007		
Copper (Cu):	< 0.01		
Nickel (Ni):	< 0.031		
Zinc (Zn):	< 0.02		
Turbidity(Lab, NTU):	0.16	Alkalinity (CaC03):	264
Color (PCU):	< 5	Hardness (as CaC03):	256
pH (Lab):	8.0	Total Dissolved Minerals:	274
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Analyst: Lauren F. Sievers
Assistant Chemist

Illinois State Water Survey

Chemistry Division
2204 Griffith Drive
Champaign, Illinois 61820-7495
Telephone (217) 333-9321
Telefax (217) 333-6540

WATER SAMPLE DATA
LABORATORY SAMPLE NUMBER: 228910

SOURCE: TEST HOLE NO. 1
OWNER: SOUTHWATER REGIONAL WATER SYSTEM
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 08/10/1995 DATE RECEIVED: 08/14/1995
WELL DEPTH (Ft.): 144.5 TEMPERATURE REPORTED (F): ND
TREATMENT: NONE
COMMENTS: NONE

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.12	Fluoride (F):	0.2
Manganese (Mn):	0.04	Chloride (Cl):	3.8
Calcium (Ca):	66.8	Sulfate (S04):	2.3
Magnesium (Mg):	22.3	Nitrate (N03-N):	< 0.02
Sodium (Na):	7.7		
Barium (Ba):	0.03		
Beryllium (Be):	< 0.003		
Boron (B):	< 0.13		
Chromium (Cr):	< 0.007		
Copper (Cu):	< 0.01		
Nickel (Ni):	< 0.031		
Zinc (Zn):	0.03		
Turbidity(Lab, NTU):	0.16	Alkalinity (CaC03):	269
Color (PCU):	6	Hardness (as CaC03):	258
pH (Lab):	7.8	Total Dissolved Minerals:	264
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Analyst: Lauren F. Sievers
Assistant Chemist

Illinois State Water Survey

Chemistry Division
2204 Griffith Drive
Champaign, Illinois 61820-7495
Telephone (217) 333-9321
Telefax (217) 333-6540

WATER SAMPLE DATA
LABORATORY SAMPLE NUMBER: 228917

SOURCE: TEST HOLE NO. 1
OWNER: SOUTHWATER REGIONAL WATER SYSTEM
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 08/15/1995 DATE RECEIVED: 08/16/1995
WELL DEPTH (Ft.): 144.5 TEMPERATURE REPORTED (F): ND
TREATMENT: NONE
COMMENTS: NONE

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.28	Fluoride (F):	0.2
Manganese (Mn):	0.04	Chloride (Cl):	3.8
Calcium (Ca):	65.4	Sulfate (S04):	2.4
Magnesium (Mg):	21.9	Nitrate (N03-N):	< 0.02
Sodium (Na):	7.6		
Barium (Ba):	0.03		
Beryllium (Be):	< 0.003		
Boron (B):	< 0.13		
Chromium (Cr):	< 0.007		
Copper (Cu):	0.05		
Nickel (Ni):	< 0.031		
Zinc (Zn):	0.05		
Turbidity(Lab, NTU):	1.15	Alkalinity (CaC03):	278
Color (PCU):	< 5	Hardness (as CaC03):	252
pH (Lab):	7.9	Total Dissolved Minerals:	262
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Analyst: Lauren F. Sievers
Assistant Chemist

Illinois State Water Survey

Chemistry Division
2204 Griffith Drive
Champaign, Illinois 61820-7495
Telephone (217) 333-9321
Telefax (217) 333-6540

WATER SAMPLE DATA
LABORATORY SAMPLE NUMBER: 228934

SOURCE: TEST HOLE NO. 1
OWNER: SOUTHWATER REGIONAL WATER SYSTEM
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 08/23/1995 DATE RECEIVED: 08/24/1995
WELL DEPTH (Ft.): 144.5 TEMPERATURE REPORTED (F): ND
TREATMENT: NONE
COMMENTS: NONE

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.02	Fluoride (F):	0.2
Manganese (Mn):	0.04	Chloride (Cl):	3.4
Calcium (Ca):	67.7	Sulfate (S04):	2.1
Magnesium (Mg):	22.6	Nitrate (N03-N):	< 0.02
Sodium (Na):	7.8		
Barium (Ba):	0.04		
Beryllium (Be):	< 0.003		
Boron (B):	< 0.13		
Chromium (Cr):	< 0.007		
Copper (Cu):	< 0.01		
Nickel (Ni):	< 0.031		
Zinc (Zn):	0.03		
Turbidity(Lab, NTU):	0.12	Alkalinity (CaC03):	280
Color (PCU):	5	Hardness (as CaC03):	262
pH (Lab):	8.2	Total Dissolved Minerals:	257
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Analyst: Lauren F. Sievers
Assistant Chemist

Illinois State Water Survey

Chemistry Division
2204 Griffith Drive
Champaign, Illinois 61820-7495
Telephone (217) 333-9321
Telefax (217) 333-6540

WATER SAMPLE DATA
LABORATORY SAMPLE NUMBER: 228963

SOURCE: TEST HOLE NO. 1
OWNER: SOUTHWATER REGIONAL WATER SYSTEM
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 09/01/1995 DATE RECEIVED: 09/05/1995
WELL DEPTH (Ft.): 144.5 TEMPERATURE REPORTED (F): ND
TREATMENT: NONE
COMMENTS: NONE

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.06	Fluoride (F):	0.2
Manganese (Mn):	0.04	Chloride (Cl):	3.3
Calcium (Ca):	66.3	Sulfate (S04):	2.0
Magnesium (Mg):	22.0	Nitrate (N03-N):	0.05
Sodium (Na):	7.8		
Barium (Ba):	0.03		
Beryllium (Be):	< 0.003		
Boron (B):	< 0.13		
Chromium (Cr):	< 0.007		
Copper (Cu):	< 0.01		
Nickel (Ni):	< 0.031		
Zinc (Zn):	0.12		
Turbidity(Lab, NTU):	0.12	Alkalinity (CaC03):	278
Color (PCU):	< 5	Hardness (as CaC03):	256
pH (Lab):	7.5	Total Dissolved Minerals:	263
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Analyst: Lauren F. Sievers
Assistant Chemist

Appendix D.

Test/Production Well 1-96
and Observation Well Information

SOUTHWATER, INCTEST/PRODUCTION WELL 1-96
ALEXANDER COUNTY, ILLINOIS
by
Beanland Drilling Company, Inc.
Illinois State Water Survey

Well Owner:	South Water, Inc.
Well Location:	Approximately 514 feet South and 400 feet West of the NE/corner, Section 15, T.15 S., R.2 W., Alexander County, Illinois
Date Well Completed:	April, 1996
Date of Step Test:	April 25, 1996
Length of Step Test:	6 30-minute steps
Date of 48-Hr Aquifer Test:	April 30 - May 2, 1996
No. of Observation Wells:	4
Aquifer:	Sand and Gravel

PUMPED TEST WELL DATA

Well No.:	Test Well 1-96
Depth:	125 feet
Drilling Contractor:	Beanland Drilling Company, Anna, IL
Formation Samples:	
Drilling Method:	Reverse rotary
Hole Record:	32-inch, 0-125 feet
Casing Record:	20-inch, +2.0-80 feet
Screen Record:	20-inch PS Cook SS, 80-125 feet, 0.080-inch slot (80 slot), 45-feet long
Annulus and Gravel Pack Record:	Cement grout, 0-22 ft; Graded sand, 22-74 ft; Northern Gravel No. 2, 74-125 feet
Ground Elevation at Well:	345.68 feet above mean sea level (msl)
Measuring Point:	Top of well casing (TOC), 2.03 feet above land surface (lsd)
Elevation Top of Well Casing:	347.71 feet above msl
Nonpumping Water Level:	22.52 feet below TOC, 9:20 a.m. April 30, 1996
Measuring Equipment:	Solinst dropline, InSitu Hermit logger w/ 30-psi pressure transmitter, SWS 8-inch orifice tube with plate 6
Test Pump and Power:	Submersible turbine w/ commercial power
Test Pump Setting:	Approximately 65 feet
Time Water Sample Collected:	11:25 a.m., April 30 and 8:35 a.m., May 2, 1996
Temperature of Water:	57.2 °F

SOUTHWATER, INC.
TEST/PRODUCTION WELL 1-96

DRILLERS LOG
(Boring No. 8)

Formation	From *(feet)*	To *(feet)*
Yellow clay	0	18
Silty yellow clay	18	20
Yellow clay	20	28
Gray sand	28	28.5
Gray clay	28.5	31
Coarse gray sand	31	38
Gray clay	38	39
Coarse gray sand	39	43
Fine to medium gray sand	43	61
Gray clay w/ sand streaks	61	65
Fine gray sand w/ clay streaks	65	79
Very coarse sand w/ small gravel	79	95
Gravel w/ coarse sand Small clay streaks @ 97 feet	95	126
Fine Yellowish sand w/ clay streaks	126	127
Chert	127	128

OBSERVATION WELL NO. 1 DATA
(Boring No. 9)

Site:	Cache River Valley
Observation Well No.:	1
Drilling Contractor:	Beanland Drilling Company
Depth:	116 feet
Hole Record:	5-inch; 0-126 feet
Casing Record:	2-inch PVC; +3.8-76 feet
Screen Record:	2-inch PVC; 76-116 feet; 0.020-inch slot (20 slot); 40-feet long
Annulus and Gravel Pack Record:	Bentonite grout, 0-60 feet; Graded sand, 60-126 feet
Measuring Equipment:	Solinst dropline, InSitu Hermit logger w/ 20-psi pressure transmitter
Ground Elevation:	346.02 feet above mean sea level (msl)
Measuring Point:	Top of well casing, 3.70 feet above land surface (lsd)
Elevation Top of Well Casing:	349.79 feet above msl
Nonpumping Water Level:	24.32 feet below TOC, 9:20 a.m. April 30, 1996
Distance and Direction from Pumped Well:	120 feet Southwest of Test/Production Well 1-96

Remarks:

DRILLERS LOG

Formation	From *(feet)*	To *(feet)*
Yellow clay	0	25
Fine yellow sand	25	26
Yellow clay	26	27
Gray clay	27	28
Fine to medium gray sand	28	68
Fine to medium gray sand w/ thin gray clay streaks	68	73
Coarse sand to small gravel	73	126
Chert	126	

OBSERVATION WELL NO. 2 DATA
(Boring No. 10)

Site:	Cache River Valley
Observation Well No.:	2
Drilling Contractor:	Beanland Drilling Company
Depth:	99 feet
Hole Record:	5-inch; 0-109 feet
Casing Record:	2-inch PVC; +3.0-59 feet
Screen Record:	2-inch PVC; 59-99 feet; 0.020-inch slot (20 slot); 40-feet long
Annulus and Gravel Pack Record:	Bentonite grout, 0-50 feet; Graded sand, 50-109 feet.
Measuring Equipment:	Solinst dropline, InSitu Hermit logger w/ 10-psi pressure transmitter
Ground Elevation:	346.26 feet above mean sea level (msl)
Measuring Point:	Top of well casing (TOC), 3.01 feet above land surface (lsd)
Elevation Top of Casing:	349.27 feet above msl
Nonpumping Water Level:	23.45 feet below TOC, 9:20 a.m. April 30, 1996
Distance and Direction from Pumped Well:	450.3 feet Southwest of Test/Production Well 1-96

Remarks:

DRILLERS LOG

Formation	From *(feet)*	To *(feet)*
Yellow clay	0	28
Gray clay	28	32
Medium gray sand	32	72
Gray clay streak @ 42 ft		
Fine gray sand @ 45 ft		
Gray clay w/ gray sand @ 63 ft		
Coarse gravel and gray clay mixed	72	75
Very coarse yellow sand with small gravel	75	80
Coarse brown sand w/ small gravel	80	85
Gravel w/ very coarse sand	85	106
Chert	106	109

OBSERVATION WELL NO. 3 DATA
(Boring No. 11)

Site:	Cache River Valley
Observation Well No.:	3
Drilling Contractor:	Beanland Drilling Company
Depth:	109 feet
Hole Record:	6.5-inch; 0-119 feet
Casing Record:	4-inch PVC; +1.5-69 feet
Screen Record:	4-inch PVC; 69-109 feet; 0.020-inch slot (20 slot); 40-feet long
Annulus and Gravel Pack Record:	Bentonite grout, 0-55 feet; Graded sand, 55-119 feet
Measuring Equipment:	Solinst dropline, InSitu Hermit logger w/ 10-psi pressure transmitter
Ground Elevation:	347.31 feet above mean sea level (msl)
Measuring Point:	Top of well casing (TOC), 0.98 feet above land surface (lsd)
Elevation Top of Casing:	348.79 feet above msl
Nonpumping Water Level:	23.16 feet below TOC, 9:20 am April 30, 1996
Distance and Direction from Pumped Well:	1001.1 feet Southwest of Test/Production Well 1-96

Remarks:

DRILLERS LOG

Formation	From *(feet)*	To *(feet)*
Clay	0	30
Gray sand	30	36
Gray clay w/ sand streaks	36	58
Gray sand fine to medium	58	61
Gray clay w/ sand streaks	61	80
Coarse gray sand w/ small gravel	80	98
Coarse brown sand w/ large gravel	98	117
Chert	117	119

TEST WELL NO. 1-95 DATA

Site:	Cache River Valley
Observation Well No.:	Test Well 1-95 (OW 6-in)
Drilling Contractor:	Speth Plumbing, Inc.
Depth:	144 feet
Hole Record:	10-inch; 0-144½ feet
Casing Record:	6-inch PVC; + 1.8-124½ feet
Screen Record:	6-inch PVC; 124½-144½ feet; 0.050-inch slot (50 slot); 20-feet long
Annulus and Gravel Pack Record:	Northern gravel pack
Measuring Equipment:	Solinst dropline, InSitu Hermit logger w/ 20-psi pressure transmitter
Ground Elevation:	347.16 feet above mean sea level (msl)
Measuring Point:	Top of well casing (TOC), 1.80 feet above land surface (lsd)
Elevation Top of Casing:	348.96 feet above msl
Nonpumping Water Level:	23.11 feet below TOC, 9:20 a.m. April 30, 1996
Distance and Direction from Pumped Well:	376.3 feet East of Test/Production Well 1-96

Remarks: A 2-inch observation well is present about 8 feet west of Test Well 1-95. It was drilled by SIU graduate students studying the Cache River bottomlands. During the aquifer test on Test Well 1-96, it was found to be plugged.

DRILLERS LOG

Formation	From *(feet)*	To *(feet)*
Light brown topsoil - little clay	0	10
Dark brown loam - more clay content	10	20
Dark brown loam - higher clay content but sandy	20	30
Blue gray clay - little sand	30	40
Blue gray clay - increasing sand	40	50
Gray, very fine sand, lots of clay, still muddy	50	55
Same, more sand	55	60
Same, fine to medium sand	60	65
Coarser sand, fine gravel	65	70
Coarse sand and fine gravel mix	70	80
Coarse sand and fine to medium gravel mix	80	85
Medium gravel and sand mix	85	135
Coarser gravel	135	144
Limestone	144	144V2

Appendix E.

Sieve Data for Aquifer Samples from Test Well 1-95 and Test/Production Well 1-96

Appendix E. Sieve Data for Aquifer Samples

SouthWater, Inc

Test Well 1-95
Drilled by Speth Plumbing, Inc.
Drilled June 1995
Samples sieved by Holcomb Foundation Engineering Company, August 1995

Depth	*Sample*	*U.S. Sieves, # / opening size, in mm*										
(ft)	*Weight*	*3/8"*	*#5*	*#10*	*#16*	*#20*	*#30*	*#40*	*#60*	*#80*	*#100*	*#200*
	(g)	*951*	*4.00*	*2.00*	*1.18*	*0.850*	*0.600*	*0.425*	*0.250*	*0.177*	*0.149*	*0.075*
		(Cumulative Percent Retained)										
70 - 75	474.6	0.0	4.4	23.5	58.1	78.9	89.1	94.2	97.7	98.3	98.4	98.7
75-80	475.2		15.4	38.7	55.6	64.5	71.6	81.5	94.2	96.6	973	98.1
80-85	632.5	0.0	8.7	28.8	53.9	66.9	743	813	93.7	96.8	97.5	98.4
85-90	740.2	0.0	1.6	14.6	35.9	59.2	82.0	94.7	98.0	98.5	98.6	98.9
90-95	755	0.0	2.5	8.6	24.8	43.9	71.6	92.6	97.9	98.6	98.8	99.1
95-100	767.5	0.0	0.0	4.2	23.6	49.4	80.7	96.3	99.0	99.2	99.2	993
100-105	807.8	0.0	0.2	2.9	20.1	44.8	76.0	95.6	99.5	99.6	99.7	99.7
105-110	559.4	0.0	1.8	5.7	16.4	41.0	73.5	94.4	99.1	99.3	99.4	99.4
110-115	746.9	0.0	0.8	4.0	12.1	25.0	473	81.6	98.4	99.2	993	99.4
115-120	821.2		3.7	8.0	14.6	25.6	47.0	80.7	98.4	99.1	99.3	99.4
120-125	556.2		12.2	16.4	26.0	36.8	54.8	75.7	97.7	99.1	99.3	99.4
125- 130	514	0.0	7.1	32.6	61.6	77.3	88.3	96.3	99.4	99.5	99.6	99.7
130-135	5333	0.0	12.6	34.5	58.4	76.4	893	96.4	98.8	99.2	99.2	99.4
135-140	529.4		30.9	69.6	87.9	93.9	96.7	97.9	98.6	98.8	98.9	99.1
140-144	429.8		38.7	76.5	91.6	93.9	95.4	96.8	98.0	98.4	98.6	99.0

Test/Production Well 1-96 (Boring No. 8)
Drilled by Beanland Drilling Company, Inc.
Drilled February 1996 (Boring No 8/Well drilled April 1996)
Samples sieved by Illinois State Geological Survey, March 1996

Depth	*Sample*	*U.S. Sieves, #/opening size, in mm*									
(ft)	*Weight*	*5/16"*	*#5*	*#10*	*#18*	*#25*	*#35*	*#45*	*#60*	*#80*	*#170*	*PAN*
	(g)	*8.00*	*4.00*	*2.00*	*1.00*	*0.710*	*0.500*	*0355*	*0.250*	*0.177*	*0.088*	
		(Cumulative Percent Retained)										
75-80	121.00		1.33	9.38	26.65	42.88	61.69	84.38	9331	95.74	97.69	99.94
85- 90	121.33		338	12.72	31.40	50.61	7331	92.95	9838	99.47	99.70	99.98
90- 95	126.00		4.60	8.63	16.16	28.20	48.87	72.53	94.64	99.14	99.69	99.92
100-105	142.98	4.95	22.92	42.12	62.77	80.61	91.98	96.45	98.18	99.68	99.88	99.99
110- 115	125.80	1.93	12.77	26.19	39.79	53.59	68.02	81.83	91.94	99.21	99.68	99.89
115- 120	145.60	0.57	12.32	25.04	37.73	51.97	68.15	83.98	93.25	99.41	99.69	99.95

Test/Production Well 1-96
Graded Sand, placed in annulus from 22 to 74 feet
Samples sieved by Illinois State Geological Survey, April 1996

Sample	*U.S. Sieves, # / opening size, in mm*								
Weight	*#10*	*#18*	*#25*	*#35*	*#45*	*#60*	*#120*	*#230*	*PAN*
(g)	*2.00*	*1.00*	*0.710*	*0.500*	*0355*	*0.250*	*0.125*	*0.063*	
	(Cumulative Percent Retained)								
139.06	10.09	23.88	41.41	62.36	83.37	94.59	99.73	99.81	99.83

Test/Production Well 1-96
Northern Gravel Company, Well Pack No. 2, placed in annulus from 74 to 125 feet
Samples sieved by Illinois State Geological Survey, April 1996

Sample	*U.S. Sieves, #/opening size, in mm*									
Weight	*#4*	*#5*	*#6*	*#7*	*#8*	*#10*	*#14*	*#16*	*#18*	*PAN*
(g)	*4.75*	*4.00*	*335*	*2.80*	*236*	*2.00*	*1.40*	*1.19*	*1.00*	
	(Cumulative Percent Retained)									
160.36	0.00	9.19	37.03	65.88	82.15	91.81	98.97	99.58	99.71	99.95

Appendix F.

Test/Production Well 1-96
Step Test Water-Level Measurements, April 25,1996

Ground—Water Investigation in the Cache River Valley for SouthWater, Inc.
Test/Production Well 1-96 || Step Test: April 25, 1996

Date/ Hour	Elapsed Time *(min)*	Depth to water *(ft)*	Piez head *(ft)*	Pumping Rate *(gpm)*	Remarks
04/25/96					
0822 AM	0	22.72			Solinst dropline
0836 AM	0	46.41			Transmitter head
08:45 AM	0	22.71			Data logging started
08:46 AM	1	22.71			Water level trend
08:47 AM	2	22.71			
08:48 AM	3	22.71			
08:49 AM	4	22.71			
08:50 AM	5	22.70			
08:51 AM	6	22.70			
08:52 AM	7	22.70			
08:53 AM	8	22.71			
08:54 AM	9	22.71			
0855 AM	10	22.71			
08:56 AM	11	22.71			
0857 AM	12	22.70			
0858 AM	13	22.70			
0859 AM	14	22.70			
09:00 AM	15	22.70			
09:01AM	16	22.70			
09:02 AM	17	22.70			
09:03 AM	18	22.70			
09:04 AM	19	22.70			
09:05 AM	20	22.70			
09:06 AM	21	22.70			
09:07 AM	22	22.70			
09:08 AM	23	22.70			
09:09 AM	24	22.69			
09:10 AM	0	22.69			Pump ON
09:11AM	1	27.84			Stepl
09:12 AM	2	29.03	2.03	1345	Piez readings erratic;
09:13 AM	3	29.77	2.10	1355	+/-0.1 ft fluctuation
09:14 AM	4	29.82			
09:15 AM	5	29.49	2.08	1350	
09:16 AM	6	3024	2.05	1350	
09:17 AM	7	29.99	2.06	1350	
09:18 AM	8	29.71			
09:19 AM	9	29.66	2.05	1350	
0920 AM	10	30.32			
0921AM	11	29.92			
0922 AM	12	30.62			
0923 AM	13	30.41			
0924 AM	14	30.66			
0925 AM	15	30.57	2.07	1350	
0926 AM	16	30.70			
0927 AM	17	31.31			
0928 AM	18	3122			
0929 AM	19	30.85			
09:30 AM	20	31.39			
09:31 AM	21	31.00			
09:32 AM	22	31.07			
09:33 AM	23	31.65	2.06	1350	
09:34 AM	24	31.10			
09:35 AM	25	31.52			
09:36 AM	26	31.10			
09:37 AM	27	30.80			
09:38 AM	28	31.88			
09:39 AM	29	31.62			
09:40 AM	30	3125	2.06	1350	Increase rate

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Test/Production Well 1-96 || Step Test: April 25,1996

Date/ Hour	Elapsed Time *(min)*	Depth to water *(ft)*	Piez head *(ft)*	Pumping Rate *(gpm)*	Remarks
09:41AM	1	31.80			Step 2
09:42 AM	2	31.49			Piez readings still erratic
09:43 AM	3	31.65	2.36	1450	
09:44 AM	4	31.72			
09:45 AM	5	31.66			
09:46 AM	6	31.70			
09:47 AM	7	32.12			
09:48 AM	8	31.66	2.35	1450	
09:49 AM	9	32.10			
09:50 AM	10	31.94			
09:51 AM	11	32.48			
09:52 AM	12	32.03			
09:53 AM	13	32.16			
09:54 AM	14	31.44	2.33	1445	
09:55 AM	15	32.55			
09:56 AM	16	32.07			
09:57 AM	17	32.30			
09:58 AM	18	32.68			
09:59 AM	19	33.08	2.33	1445	
10:00 AM	20	3220			
10:01 AM	21	31.60			
10:02 AM	22	32.33			
10:03 AM	23	32.16			
10:04 AM	24	3237			
10:05 AM	25	32.44			
10:06 AM	26	32.33			
10:07 AM	27	32.53			
10:08 AM	28	3224	2.30	1430	
10:09 AM	29	32.58			
10:10 AM	30	32.31	2.30	1430	Increase rate
10:11AM	1	32.84			Step 3
10:12 AM	2	32.49	2.74	1555	Piez readings still erratic
10:13 AM	3	3325			
10:14 AM	4	32.60			
10:15 AM	5	33.58			
10:16 AM	6	33.76			
10:17 AM	7	33.42	2.74	1555	
10:18 AM	8	32.97			
10:19 AM	9	33.67			
1020 AM	10	33.49			
1021 AM	11	33.52			
1022 AM	12	33.64			
1023 AM	13	33.12			
1024 AM	14	33.06			
1025 AM	15	3327			
1026 AM	16	33.54	2.73	1555	
1027 AM	17	33.02			
1028 AM	18	33.10			
1029 AM	19	33.42			
10:30 AM	20	3324			
10:31 AM	21	33.52			
1032 AM	22	33.59	2.74	1555	
10:33 AM	23	33.09			
10:34 AM	24	33.69			
1035 AM	25	33.49			
10:36 AM	26	3325			
10:37 AM	27	33.18			
10:38 AM	28	33.46	2.74	1555	
1039 AM	29	33.45			
10:40 AM	30	33.85	2.74	1555	Increase rate

Ground-Water Investigation in the Cache River Valley for SouthWater, Inc.
Test/Production Well 1-96 || Step Test: April 25,1996

Date/ Hour	Elapsed Time *(mm)*	Depth to water *(ft)*	Piez head *(ft)*	Pumping Rate *(gpm)*	Remarks
10:41AM	1	33.45	3.12	1655	Step 4
10:42 AM	2	34.18			Piez readings still erratic
10:43 AM	3	33.77			
10:44 AM	4	34.45	3.12	1655	
10:45AM	5	33.91			
10:46 AM	6	34.03			
10:47AM	7	34.15			
10:48AM	8	34.61			
10:49AM	9	33.91			
10:50 AM	10	33.95			
10:51AM	11	33.67			
10:52 AM	12	34.34	3.12	1655	
10:53 AM	13	33.86			
10:54 AM	14	34.07			
10:55 AM	15	34.25			
10:56 AM	16	34.22			
10:57 AM	17	34.25			
10:58AM	18	34.10			
10:59 AM	19	34.32			
11:00 AM	20	33.78			
11:01AM	21	34.10			
11:02 AM	22	3420			
11:03 AM	23	3420			
11:04 AM	24	33.98			
11:05AM	25	34.13	3.12	1655	
11:06AM	26	34.52			
11:07 AM	27	34.02			
11:08AM	28	34.18			
11:09AM	29	33.93			
11:10 AM	30	34.11	3.12	1655	Increase rate
11:11AM	1	34.59	3.51	1755	Step 5
11:12 AM	2	34.92			Piez readings still erratic
11:13AM	3	35.10			
11:14 AM	4	34.77			
11:15 AM	5	34.86			
11:16AM	6	35.44	3.51	1755	
11:17 AM	7	34.83			
11:18 AM	8	34.73			
11:19AM	9	34.61			
1120 AM	10	34.92			
1121AM	11	34.75			
1122 AM	12	34.60	3.51	1755	
1123AM	13	34.90			
1124 AM	14	34.97			
1125 AM	15	35.21			
1126 AM	16	34.85	3.52	1755	
1127 AM	17	35.09			
11:28 AM	18	34.43			
1129 AM	19	34.93			
11:30 AM	20	35.09			
11:31AM	21	34.92			
11:32 AM	22	34.79	3.51	1755	
11:33 AM	23	35.05			
11:34 AM	24	35.00			
11:35 AM	25	34.90			
11:36 AM	26	35.44			
11:37 AM	27	35.03			
11:38 AM	28	34.98	3.51	1755	
11:39 AM	29	3520			

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Test/Production Well 1-96 11 Step Test: April 25,1996

Date/ Hour	Elapsed Time *(mitt)*	Depth to water *(ft)*	Piez head *(ft)*	Pumping Rate *(gpm)*	Remarks
11:40 AM	30	35.31	3.51	1755	Increase rate
11:41AM	1	35.72			Step 6
11:42 AM	2	35.42	3.85	1850	Piezreadings still erratic
11:43AM	3	35.62			
11:44AM	4	35.61			
11:45 AM	5	35.82			
11:46AM	6	35.47	3.86	1850	
11:47 AM	7	35.80			
11:48 AM	8	3524			
11:49 AM	9	35.73			
11:50AM	10	35.57			
11:51 AM	11	36.02			
11:52 AM	12	35.53	3.85	1850	
11:33 AM	13	35.87			
11:54 AM	14	35.77			
11:55 AM	15	35.94			
11:56 AM	16	35.54	3.85	1850	
11:37 AM	17	34.86			
11:58 AM	18	35.98			
1139 AM	19	35.65			
12:00 PM	20	36.53	3.85	1850	
12:01 PM	21	35.74			
12:02 PM	22	35.62			
12:03 PM	23	35.68			
12:04 PM	24	35.67			
12:05 PM	25	35.58			
12:06 PM	26	35.63	3.85	1850	
12:07 PM	27	35.46			
12:08 PM	28	35.68			
12:09 PM	29	35.57			
12:10 PM	30	35.50	3.85	1850	End of Step Test

Appendix G.

Test/Production Well 1-96
48-Hour Aquifer Test: Water-Level Measurements,
April 30-May 2, 1996

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time (min)	Test Well 1-96 Depth to water (ft)	Test Well 1-96 Observed Drwdwn (ft)	Observation Well 1 Depth to water (ft)	Observation Well 1 Observed Drwdwn (ft)	Observation Well 2 Depth to water (ft)	Observation Well 2 Observed Drwdwn (ft)	Observation Well 3 Depth to water (ft)	Observation Well 3 Observed Drwdwn (ft)	Test Well 1-95 Depth to water (ft)	Test Well 1-95 Observed Drwdwn (ft)	Approx Barometric pressure (psia)	Piez head (ft)	Pumping rate (gpm)	Remarks
04/25/96															
12:52 PM										24.67					Measured d/w
12:57 PM										22.89					Transmitter head
02:52 PM		23.31													Measured d/w
03:01 PM		38.21													Transmitter head
03:03 PM				25.09											Measured d/w
03:05 PM				29.82											Transmitter head
03:06 PM						24.23									Measured d/w
03:06 PM						22.45									Transmitter head
03:20 PM								24.10							Measured d/w
03:24 PM								10.08							Transmitter head
04:00 PM	0	22.99		24.99		24.11		24.10		23.81		14.27			Logging started
05:00 PM	60	22.85		24.90		24.04		24.03		23.71		14.26			Water Fevels recovering
06:00 PM	120	22.74		24.83		23.97		23.96		23.65		14.26			from step test
07:00 PM	180	22.68		24.78		23.93		23.90		23.60		14.26			
08:00 PM	240	22.58		24.75		23.89		23.86		23.56		14.28			
09.00 PM	300	22.56		24.70		23.85		23.79		23.52		14.31			
10:00 PM	360	22.52		24.68		23.82		23.79		23.49		14.29			
11:00 PM	420	22.49		24.66		23.81		23.77		23.47		14.29			
04/26/96															
12:00 AM	480	22.47		24.64		23.79		23.75		23.46		14.29			
01:00 AM	540	22.42		24.62		23.77		23.72		23.44		14.29			
02:00 AM	600	22.38		24.61		23.76		23.71		23.42		14.28			
03:00 AM	660	22.36		24.60		23.75		23.69		23.41		14.27			
04:00 AM	720	22.34		24.59		23.74		23.68		23.40		14.27			
05:00 AM	780	22.30		24.58		23.73		23.67		23.39		14.27			
06:00 AM	840	22.27		24.57		23.73		23.67		23.39		14.28			
07:00 AM	900	22.25		24.57		23.73		23.66		23.38		14.29			Water level trend
08:00 AM	960	22.25		24.57		23.72		23.70		23.38		14.28			
09:00 AM	1020	22.24		24.57		23.72		23.71		23.37		14.29			
10:00 AM	1080	22.25		24.57		23.73		23.64		23.39		14.36			
11:00 AM	1140	22.24		24.57		23.74		23.66		23.39		14.38			
12:00 PM	1200	22.24		24.58		23.74		23.64		23.39		14.41			
01:00 PM	1260	22.23		24.57		23.74		23.65		23.39		14.41			
02:00 PM	1320	22.23		24.57		23.75		23.63		23.40		14.44			
03:00 PM	1380	22.24		24.58		23.75		23.63		23.40		14.44			
04:00 PM	1440	22.26		24.58		23.75		23.63		23.40		14.45			
05:00 PM	1500	22.24		24.59		23.75		23.62		23.40		14.47			
06:00 PM	1560	22.22		24.59		23.75		23.62		23.40		14.47			
07:00 PM	1620	22.26		24.59		23.75		23.61		23.40		14.47			
08:00 PM	1680	22.24		24.58		23.76		23.61		23.40		14.47			
09:00 PM	1740	22.24		24.59		23.76		23.61		23.40		14.49			
10:00 PM	1800	22.24		24.59		23.76		23.62		23.40		14.49			
11:00 PM	1860	22.24		24.59		23.76		23.63		23.41		14.49			
04/27/96															
12:00 AM	1920	22.24		24.59		23.76		23.63		23.40		14.49			
01:00 AM	1980	22.24		24.59		23.76		23.62		23.40		14.48			
02:00 AM	2040	22.23		24.59		23.76		23.63		23.40		14.48			
03:00 AM	2100	22.24		24.59		23.76		23.63		23.40		14.48			
04:00 AM	2160	22.23		24.59		23.76		23.64		23.40		14.47			
05:00 AM	2220	22.23		24.59		23.76		23.66		23.40		14.47			
06:00 AM	2280	22.23		24.59		23.76		23.66		23.40		14.48			
07:00 AM	2340	22.24		24.59		23.76		23.69		23.40		14.47			
08:00 AM	2400	22.24		24.59		23.76		23.77		23.40		14.46			

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time (mitt)	Test Well 1-96 Depth to water (ft)	Test Well 1-96 Observed Drwdwn (ft)	Observation Well 1 Depth to water (ft)	Observation Well 1 Observed Drwdwn (ft)	Observation Well 2 Depth to water (ft)	Observation Well 2 Observed Drwdwn (ft)	Observation Well 3 Depth to water (ft)	Observation Well 3 Observed Drwdwn (ft)	Test Well 1-95 Depth to water (ft)	Test Well 1-95 Observed Drwdwn (ft)	Approx Barometric pressure (psia)	Piez head (ft)	Pumping rate (gpm)	Remarks
09:00 AM	2460	22.24		24.59		23.76		23.72		23.40		14.49			
10.00 AM	2520	22.25		24.59		23.76		23.70		23.41		14.53			
11:00 AM	2580	22.24		24.59		23.76		23.69		23.41		14.55			
12:00 PM	2640	22.28		24.59		23.77		23.67		23.41		14.55			
01:00 PM	2700	22.21		24.59		23.76		23.65		23.40		14.56			
02:00 PM	2760	22.23		24.58		23.76		23.63		23.40		14.56			
03:00 PM	2820	22.18		24.57		23.75		23.60		23.39		14.57			
04:00 PM	2880	22.20		24.57		23.75		23.60		23.39		14.55			
05:00 PM	2940	22.21		24.57		23.75		23.62		23.39		14.53			
06:00 PM	3000	22.20		24.57		23.74		23.60		23.39		14.52			
07:00 PM	3060	22.19		24.56		23.74		23.59		23.38		14.51			
08:00 PM	3120	22.20		24.56		23.74		23.59		23.38		14.51			
09:00 PM	3180	22.19		24.57		23.74		23.60		23.38		14.51			
10:00 PM	3240	22.20		24.57		23.74		23.61		23.38		14.52			
11:00 PM	3300	22.20		24.57		23.74		23.61		23.38		14.52			
04/28/96															
12:00 AM	3360	22.19		24.56		23.74		23.61		23.37		14.50			
01:00 AM	3420	22.19		24.56		23.74		23.61		23.37		14.49			
02:00 AM	3480	22.18		24.55		23.73		23.60		23.37		14.47			
03:00 AM	3540	22.18		24.54		23.72		23.59		23.36		14.47			
04:00 AM	3600	22.17		24.54		23.72		23.59		23.35		14.46			
05:00 AM	3660	22.17		24.54		23.71		23.58		23.35		14.45			
06:00 AM	3720	22.17		24.53		23.71		23.57		23.35		14.44			
07:00 AM	3780	22.15		24.52		23.69		23.55		23.34		14.44			
08:00 AM	3840	22.15		24.52		23.69		23.56		23.34		14.44			
09:00 AM	3900	22.14		24.52		23.69		23.56		23.33		14.44			
10:00 AM	3960	22.14		24.52		23.69		23.56		23.32		14.43			
11:00 AM	4020	22.14		24.51		23.68		23.55		23.32		14.44			
12:00 PM	4080	22.13		24.51		23.68		23.55		23.32		14.43			
01:00 PM	4140	22.13		24.50		23.67		23.55		23.31		14.43			
02:00 PM	4200	22.11		24.49		23.66		23.53		23.30		14.42			
03:00 PM	4260	22.11		24.49		23.65		23.53		23.29		14.40			
04:00 PM	4320	22.10		24.48		23.65		23.52		23.29		14.40			
05:00 PM	4380	22.09		24.47		23.64		23.52		23.29		14.39			
06:00 PM	4440	22.08		24.47		23.64		23.51		23.28		14.38			
07:00 PM	4500	22.08		24.46		23.63		23.50		23.27		14.39			
08:00 PM	4560	22.08		24.46		23.63		23.50		23.27		14.38			
09:00 PM	4620	22.07		24.46		23.63		23.50		23.27		14.38			
10:00 PM	4680	22.06		24.45		23.62		23.49		23.26		14.36			
11:00 PM	4740	22.05		24.45		23.61		23.49		23.25		14.35			
04/29/96															
12:00 AM	4800	22.04		24.44		23.60		23.48		23.25		14.38			
01:00 AM	4860	22.03		24.42		23.59		23.46		23.23		14.37			
02:00 AM	4920	22.02		24.41		23.58		23.46		23.22		14.38			
03:00 AM	4980	22.01		24.39		23.56		23.44		23.20		14.35			
04:00 AM	5040	21.98		24.37		23.54		23.43		23.18		14.36			
05:00 AM	5100	21.96		24.36		23.53		23.43		23.17		14.36			
06:00 AM	5160	21.95		24.34		23.51		23.39		23.15		14.37			
07:00 AM	5220	21.95		24.35		23.51		23.38		23.15		14.40			
08:00 AM	5280	21.97		24.36		23.53		23.39		23.17		14.41			
09:00 AM	5340	21.99		24.38		23.54		23.41		23.18		14.41			
10:00 AM	5400	22.00		24.39		23.55		23.42		23.20		14.42			
11:00 AM	5460	22.00		24.40		23.56		23.42		23.20		14.42			
12:00 PM	5520	22.00		24.39		23.55		23.42		23.19		14.39			

Ground-Water Investigation in the Cache River Valley for SouthWater, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time (win)	Test Well 1-96 Depth to water (ft)	Test Well 1-96 Observed Drwdwn (ft)	Observation Well 1 Depth to water (ft)	Observation Well 1 Observed Drwdwn (ft)	Observation Well 2 Depth to water (ft)	Observation Well 2 Observed Drwdwn (ft)	Observation Well 3 Depth to water (ft)	Observation Well 3 Observed Drwdwn (ft)	Test Well 1-95 Depth to water (ft)	Test Well 1-95 Observed Drwdwn (ft)	Approx Barometric pressure (psia)	Piez head (ft)	Pumping rate (gpm)	Remarks
01:00 PM	5580	21.98		24.38		23.54		23.41		23.18		14.40			
02:00 PM	5640	21.98		24.37		23.53		23.41		23.17		14.39			
03:00 PM	5700	21.97		24.36		23.53		23.39		23.17		14.39			
04:00 PM	5760	21.95		24.36		23.51		23.38		23.16		14.39			
05:00 PM	5820	21.93		24.35		23.50		23.38		23.15		14.39			
06:00 PM	5880	21.94		24.34		23.50		23.36		23.14		14.40			
07:00 PM	5940	21.93		24.33		23.49		23.36		23.14		14.41			
08:00 PM	6000	21.94		24.34		23.50		23.36		23.14		14.42			
09:00 PM	6060	21.93		24.34		23.50		23.36		23.14		14.42			
10.00 PM	6120	21.93		24.34		23.50		23.36		23.14		14.42			
11:00 PM	6180	21.93		24.34		23.49		23.36		23.13		14.42			
04/30/96															
12:00 AM	6240	21.92		24.33		23.49		23.36		23.13		14.43			
01:00 AM	6300	21.92		24.32		23.48		23.35		23.13		14.43			
02:00 AM	6360	21.91		24.32		23.48		23.34		23.12		14.42			
03:00 AM	6420	21.90		24.31		23.47		23.34		23.11		14.42			
04:00 AM	6480	21.89		24.30		23.46		23.33		23.10		14.42			
05:00 AM	6540	21.88		24.30		23.45		23.32		23.10		14.42			
06:00 AM	6600	21.88		24.29		23.45		23.32		23.10		14.43			
07:00 AM	6660	21.89		24.29		23.45		23.33		23.10		14.43			
08:00 AM	6720	21.88		24.30		23.45		23.37		23.10		14.44			
08:29 AM	6749									23.10					Measured d/w
08:36 AM	6756	22.53													Measured d/w
08:38 AM	6758			24.32											Measured d/w
08:40 AM	6760					23.46									Measured d/w
08:43 AM	6763							23.38							Measured d/w
09:00 AM	6780					23.45				23.10		14.40			
09:20 AM	0	22.51		24.32		23.45		23.31		23.11		14.32			Pump ON
	0.008	22.52	0.00	24.34	0.02	23.45	0.00								Valve was preset
	0.017	22.52	0.00	24.33	0.01	23.45	0.00	23.20	0.04	23.11	-0.00	14.36			after step test
	0.025	22.52	0.00	24.31	-0.01	23.46	0.01								
	0.033	22.52	0.00	24.32	0.00	23.45	0.00	23.18	0.02	23.11	-0.00	14.36			
	0.042	22.52	0.00	24.33	0.01	23.46	0.01								
	0.050	22.52	0.00	24.33	0.01	23.46	0.01	23.17	0.01	23.11	-0.00	14.37			
	0.058	22.52	0.00	24.32	0.00	23.46	0.01								
	0.067	28.02	5.50	24.33	0.01	23.46	0.01	23.16	0.00	23.11	0.00	14.37			
	0.075	24.76	2.24	24.33	0.01	23.46	0.01								
	0.083	25.58	3.06	24.33	0.01	23.46	0.01	23.16	-0.00	23.11	-0.00	14.37			
	0.092	24.28	1.76	24.32	0.00	23.46	0.01								
	0.100	25.61	3.09	24.34	0.02	23.46	0.01	23.16	-0.00	23.11	0.00	14.37			
	0.108	26.07	3.55	24.35	0.03	23.46	0.01								
	0.117	26.76	4.23	24.36	0.04	23.46	0.01	23.16	-0.00	23.11	0.00	14.37			
	0.125	27.56	5.04	24.37	0.05	23.46	0.01								
	0.133	28.14	5.62	24.38	0.06	23.46	0.01	23.16	-0.00	23.12	0.01	14.37			
	0.142	27.86	5.34	24.41	0.09	23.46	0.01								
	0.150	28.24	5.72	24.42	0.10	23.46	0.01	23.15	-0.01	23.12	0.01	14.37			
	0.158	28.49	5.97	24.45	0.13	23.46	0.01								
	0.167	29.22	6.70	24.46	0.14	23.46	0.01	23.15	-0.01	23.11	0.00	14.37			
	0.175	29.00	6.48	24.49	0.17	23.46	0.01								
	0.183	28.68	6.16	24.51	0.19	23.46	0.01	23.15	-0.01	23.12	0.01	14.37			
	0.192	29.22	6.70	24.55	0.23	23.47	0.02								
	0.200	28.92	6.40	24.57	0.25	23.47	0.02	23.15	-0.01	23.12	0.01	14.37			
	0.208	29.55	7.03	24.59	0.27	23.47	0.02								
	0.217	29.42	6.90	24.62	0.30	23.47	0.02	23.15	-0.01	23.13	0.01	14.37			

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time	Test Well 1 - % Depth to water	Observed Drwdwn	Observation Well 1 Depth to water	Observed Drwdwn	Observation Well 2 Depth to water	Observed Drwdwn	Observation Well 3 Depth to water	Observed Drwdwn	Test Well 1-95 Depth to water	Observed Drwdwn	Approx Barometric pressure	Piez head	Pumping rate	Remarks
	(min)	*(ft)*	*(ft)*	*(ft)*	*(ft)*	*(ft)*	*(ft)*	*(ft)*	*(ft)*	*(ft)*	*(ft)*	*(psia)*	*(ft)*	*(gpm)*	
	0.225	29.61	7.09	24.65	0.33	23.47	0.02								
	0.233	29.81	7.29	24.67	0.35	23.47	0.02	23.15	-0.01	23.13	0.01	14.37			
	0.242	29.64	7.12	24.69	0.37	23.47	0.02								
	0.250	29.80	7.28	24.71	0.39	23.48	0.02	23.15	-0.01	23.13	0.02	14.37			
	0.258	29.80	7.28	24.73	0.41	23.48	0.02								
	0.267	29.99	7.47	24.74	0.42	23.48	0.02	23.15	-0.01	23.13	0.02	14.37			
	0.275	30.24	7.72	24.76	0.44	23.48	0.02								
	0.283	30.16	7.64	24.77	0.45	23.48	0.03	23.15	-0.01	23.14	0.03	14.37			
	0.292	30.11	7.59	24.79	0.47	23.48	0.03								
	0.300	30.00	7.48	24.80	0.48	23.49	0.03	23.15	-0.01	23.14	0.03	14.37			
	0.308	30.06	7.54	24.81	0.49	23.49	0.03	23.15	-0.01	23.14	0.03	14.37			
	0.317	30.41	7.89	24.82	0.50	23.49	0.04	23.16	-0.00	23.14	0.03	14.37			
	0.325	30.45	7.93	24.84	0.51	23.49	0.04	23.16	-0.00	23.14	0.03	14.37			
	0.333	30.00	7.48	24.85	0.53	23.49	0.04	23.16	-0.00	23.15	0.04	14.37			
	0.350	29.89	7.37	24.88	0.56	23.49	0.04	23.29	0.13	23.16	0.05	14.33			
	0.367	29.99	7.47	24.90	0.58	23.50	0.05	23.31	0.15	23.16	0.05	14.33			
	0.383	30.76	8.24	24.93	0.61	23.51	0.06	23.32	0.16	23.16	0.05	14.33			
	0.400	30.10	7.58	24.96	0.64	23.51	0.06	23.32	0.16	23.17	0.06	14.32			
	0.417	30.45	7.93	24.97	0.65	23.52	0.07	23.33	0.17	23.18	0.06	14.32			
	0.433	29.88	7.36	24.99	0.67	23.52	0.07	23.33	0.17	23.18	0.06	14.32			
	0.450	30.30	7.78	25.01	0.69	23.53	0.08	23.34	0.17	23.18	0.07	14.32			
	0.467	30.09	7.57	25.02	0.70	23.53	0.08	23.34	0.18	23.19	0.08	14.32			
	0.483	30.42	7.90	25.04	0.72	23.54	0.08	23.34	0.18	23.20	0.09	14.32			
	0.500	30.39	7.87	25.06	0.74	23.54	0.09	23.35	0.18	23.21	0.10	14.32			
	0.517	30.75	8.23	25.07	0.75	23.54	0.09	23.35	0.19	23.21	0.10	14.32			
	0.533	30.67	8.15	25.09	0.77	23.55	0.10	23.35	0.19	23.21	0.10	14.32			
	0.550	30.95	8.43	25.11	0.79	23.55	0.10	23.35	0.19	23.22	0.11	14.32			
	0.567	30.73	8.21	25.12	0.80	23.56	0.11	23.35	0.19	23.23	0.12	14.32			
	0.583	30.82	8.30	25.14	0.82	23.57	0.12	23.36	0.20	23.23	0.12	14.32			
	0.600	30.55	8.03	25.15	0.83	23.57	0.12	23.36	0.20	23.24	0.13	14.32			
	0.617	30.91	8.39	25.16	0.84	23.57	0.12	23.36	0.20	23.24	0.13	14.32			
	0.633	30.91	8.39	25.18	0.85	23.58	0.13	23.36	0.20	23.25	0.14	14.32			
	0.650	30.37	7.85	25.19	0.87	23.58	0.13	23.37	0.21	23.26	0.15	14.32			
	0.667	30.63	8.11	25.20	0.88	23.59	0.14	23.37	0.21	23.26	0.15	14.32			
	0.683	30.57	8.05	25.21	0.89	23.59	0.14	23.37	0.21	23.26	0.15	14.32			
	0.700	30.60	8.08	25.23	0.91	23.60	0.15	23.37	0.21	23.27	0.16	14.32			
	0.717	30.58	8.06	25.24	0.92	23.60	0.15	23.37	0.21	23.28	0.17	14.32			
	0.733	30.40	7.88	25.25	0.93	23.61	0.16	23.38	0.22	23.28	0.17	14.32			
	0.750	31.26	8.73	25.26	0.94	23.61	0.16	23.38	0.22	23.29	0.18	14.32			
	0.767	30.90	8.38	25.27	0.95	23.62	0.17	23.38	0.22	23.30	0.18	14.32			
	0.783	31.20	8.68	25.28	0.96	23.62	0.17	23.38	0.22	23.30	0.19	14.32			
	0.800	30.74	8.22	25.29	0.97	23.63	0.18	23.39	0.23	23.31	0.20	14.32			
	0.817	30.86	8.34	25.29	0.97	23.63	0.18	23.39	0.23	23.31	0.20	14.32			
	0.833	30.77	8.25	25.31	0.99	23.64	0.19	23.39	0.23	23.32	0.21	14.32			
	0.850	30.85	8.33	25.32	1.00	23.64	0.19	23.40	0.24	23.33	0.22	14.32			
	0.867	30.18	7.66	25.33	1.01	23.64	0.19	23.40	0.24	23.33	0.22	14.32			
	0.883	31.04	8.52	25.33	1.01	23.65	0.19	23.40	0.24	23.33	0.22	14.32			
	0.900	30.43	7.91	25.34	1.02	23.65	0.20	23.40	0.24	23.34	0.23	14.32			
	0.917	30.64	8.12	25.36	1.04	23.65	0.20	23.41	0.25	23.35	0.23	14.32			
	0.933	30.91	8.39	25.36	1.04	23.66	0.21	23.41	0.25	23.35	0.24	14.32			
	0.950	30.71	8.19	25.37	1.05	23.66	0.21	23.41	0.25	23.36	0.25	14.32			
	0.967	31.13	8.61	25.38	1.06	23.67	0.22	23.41	0.25	23.36	0.25	14.32			
	0.983	30.93	8.41	25.38	1.06	23.67	0.22	23.41	0.25	23.37	0.26	14.32			
09:21AM	1.00	30.73	8.21	25.40	1.08	23.68	0.23	23.42	0.26	23.38	0.27	14.32	3.70	1800	Piez readings erratic;

Ground-Water Investigation in the Cache River Valley for SouthWater, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time (min)	Test Well 1-96 Depth to water (ft)	Test Well 1-96 Observed Drwdwn (ft)	Observation Well 1 Depth to water (ft)	Observation Well 1 Observed Drwdwn (ft)	Observation Well 2 Depth to water (ft)	Observation Well 2 Observed Drwdwn (ft)	Observation Well 3 Depth to water (ft)	Observation Well 3 Observed Drwdwn (ft)	Test Well 1-95 Depth to water (ft)	Test Well 1-95 Observed Drwdwn (ft)	Approx Barometric pressure (psia)	Piez head (ft)	Pumping rate (gpm)	Remarks
	1.20	31.03	8.51	25.51	1.19	23.73	0.28	23.46	0.30	23.44	0.33	14.30			+/-0.1 ft fluctuation
	1.40	31.00	8.48	25.59	1.27	23.76	0.31	23.49	0.33	23.50	0.39	14.30			
	1.60	30.93	8.41	25.65	1.33	23.81	0.35	23.52	0.36	23.55	0.44	14.30			
	1.80	31.65	9.13	25.71	1.39	23.84	0.39	23.55	0.39	23.60	0.49	14.30			
09:22 AM	2.00	31.55	9.03	25.77	1.45	23.88	0.43	23.58	0.42	23.65	0.54	14.30	3.70	1800	
	2.20	31.53	9.01	25.82	1.50	23.91	0.46	23.60	0.44	23.69	0.58	14.30			
	2.40	31.30	8.78	25.87	1.55	23.94	0.49	23.62	0.46	23.74	0.63	14.30			
	2.60	31.68	9.16	25.91	1.59	23.97	0.52	23.65	0.49	23.77	0.66	14.30			
	2.80	31.34	8.82	25.95	1.63	23.99	0.54	23.67	0.51	23.81	0.70	14.30			
09:23 AM	3.00	31.45	8.93	25.99	1.67	24.02	0.57	23.69	0.53	23.85	0.74	14.30	3.68	1800	
	3.20	31.95	9.43	26.03	1.71	24.04	0.59	23.71	0.55	23.88	0.77	14.30			
	3.40	31.70	9.18	26.06	1.74	24.07	0.62	23.73	0.57	23.91	0.80	14.30			
	3.60	31.66	9.14	26.09	1.77	24.09	0.64	23.75	0.59	23.94	0.83	14.30			
	3.80	31.47	8.95	26.13	1.81	24.12	0.67	23.77	0.61	23.98	0.86	14.30			
09:24 AM	4.00	31.48	8.96	26.16	1.84	24.14	0.68	23.79	0.63	24.01	0.90	14.30	3.66	1796	
	4.20	31.21	8.69	26.19	1.87	24.15	0.70	23.81	0.65	24.03	0.92	14.30			
	4.40	31.78	9.26	26.21	1.89	24.17	0.72	23.82	0.66	24.06	0.95	14.30			
	4.60	31.75	9.23	26.24	1.92	24.19	0.74	23.84	0.68	24.08	0.97	14.30			
	4.80	32.08	9.56	26.27	1.95	24.21	0.76	23.86	0.70	24.11	1.00	14.30			
09:25 AM	5.00	31.78	9.26	26.29	1.97	24.23	0.78	23.87	0.71	24.13	1.02	14.30	3.66	1796	
	5.20	31.57	9.05	26.32	2.00	24.25	0.80	23.89	0.73	24.16	1.05	14.30			
	5.40	31.77	9.24	26.34	2.02	24.26	0.81	23.90	0.74	24.18	1.07	14.30			
	5.60	31.78	9.26	26.36	2.04	24.28	0.83	23.92	0.76	24.20	1.09	14.30			
	5.80	31.83	9.31	26.38	2.06	24.29	0.84	23.93	0.77	24.22	1.11	14.30			
09:26 AM	6.00	32.31	9.79	26.41	2.09	24.31	0.85	23.94	0.78	24.25	1.14	14.30	3.65	1793	
	6.20	31.84	9.32	26.43	2.11	24.32	0.87	23.96	0.80	24.26	1.15	14.30			
	6.40	32.06	9.54	26.45	2.13	24.33	0.88	23.97	0.81	24.28	1.17	14.30			
	6.60	31.99	9.47	26.46	2.14	24.35	0.90	23.98	0.82	24.30	1.19	14.30			
	6.80	32.02	9.50	26.48	2.16	24.36	0.91	24.00	0.84	24.32	1.21	14.30			
09:27 AM	7.00	31.70	9.18	26.51	2.19	24.37	0.92	24.01	0.85	24.34	1.23	14.30			
	7.20	32.12	9.60	26.52	2.20	24.38	0.93	24.02	0.86	24.36	1.25	14.30			
	7.40	31.78	9.26	26.54	2.22	24.40	0.95	24.04	0.88	24.38	1.27	14.30			
	7.60	31.97	9.45	26.55	2.23	24.41	0.96	24.05	0.89	24.39	1.28	14.30			
	7.80	31.96	9.44	26.57	2.25	24.43	0.97	24.06	0.90	24.41	1.30	14.30			
09:28 AM	8.00	32.00	9.48	26.59	2.27	24.44	0.99	24.07	0.91	24.42	1.31	14.30	3.65	1793	
	8.20	32.14	9.62	26.61	2.29	24.45	1.00	24.08	0.92	24.44	1.33	14.30			
	8.40	31.76	9.24	26.62	2.30	24.46	1.01	24.09	0.93	24.46	1.35	14.30			
	8.60	32.13	9.61	26.63	2.31	24.48	1.02	24.10	0.94	24.48	1.37	14.30			
	8.80	32.36	9.84	26.65	2.33	24.49	1.04	24.11	0.95	24.49	1.38	14.30			
09:29 AM	9.00	32.49	9.97	26.67	2.35	24.50	1.05	24.12	0.96	24.50	1.39	14.30			
	9.20	32.43	9.91	26.68	2.36	24.51	1.06	24.14	0.98	24.52	1.41	14.30			
	9.40	32.12	9.60	26.70	2.38	24.52	1.07	24.15	0.99	24.54	1.42	14.30			
	9.60	32.26	9.74	26.71	2.39	24.53	1.08	24.16	1.00	24.55	1.44	14.30			
	9.80	32.56	10.04	26.72	2.40	24.54	1.09	24.16	1.00	24.56	1.45	14.31			
09:30 AM	10	32.23	9.71	26.73	2.41	24.55	1.10	24.17	1.01	24.57	1.46	14.31	3.65	1793	
09:32 AM	12	32.31	9.79	26.86	2.54	24.65	1.19	24.24	1.08	24.70	1.59	14.32	3.65	1793	
09:34 AM	14	32.67	10.15	26.97	2.65	24.73	1.28	24.33	1.17	24.81	1.69	14.34			
09:36 AM	16	32.31	9.79	27.06	2.74	24.82	1.36	24.41	1.25	24.90	1.79	14.33			
09:38 AM	18	32.99	10.47	27.14	2.82	24.88	1.43	24.45	1.29	24.99	1.88	14.35	3.65	1793	
09:40 AM	20	32.20	9.68	27.22	2.90	24.94	1.49	24.48	1.32	25.06	1.95	14.36			
09:42 AM	22	32.69	10.17	27.29	2.97	25.00	1.55	24.51	1.35	25.13	2.02	14.38			
09:44 AM	24	32.52	10.00	27.35	3.03	25.05	1.60	24.55	1.39	25.20	2.09	14.39			
09:46 AM	26	32.61	10.09	27.41	3.09	25.10	1.65	24.57	1.41	25.26	2.15	14.40			
09:48 AM	28	33.00	10.48	27.46	3.14	25.15	1.70	24.61	1.45	25.32	2.21	14.41			

Ground-Water Investigation in the Cache River Valley for SouthWater, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time (min)	Test Well 1-96 Depth to water (ft)	Test Well 1-96 Observed Drwdwn (ft)	Observation Well 1 Depth to water (ft)	Observation Well 1 Observed Drwdwn (ft)	Observation Well 2 Depth to water (ft)	Observation Well 2 Observed Drwdwn (ft)	Observation Well 3 Depth to water (ft)	Observation Well 3 Observed Drwdwn (ft)	Test Well 1-95 Depth to water (ft)	Test Well 1-95 Observed Drwdwn (ft)	Approx Barometric pressure (psia)	Piez head (ft)	Pumping rate (gpm)	Remarks
09:50 AM	30	33.26	10.74	27.51	3.19	25.20	1.74	24.64	1.48	25.37	2.26	14.42	3.65	1793	
09:52 AM	32	33.22	10.70	27.56	3.24	25.24	1.79	24.68	1.52	25.42	2.31	14.42			
09:54 AM	34	33.45	10.93	27.61	3.29	25.28	1.83	24.71	1.55	25.46	2.35	14.43			
09:56 AM	36	33.08	10.56	27.66	3.34	25.32	1.87	24.75	1.59	25.50	2.39	14.43			
09:58 AM	38	33.54	11.02	27.70	3.38	25.36	1.90	24.78	1.62	25.55	2.44	14.43			
10:00 AM	40	33.64	11.12	27.74	3.42	25.40	1.95	24.81	1.65	25.59	2.48	14.44	3.65	1793	
10.02 AM	42	33.20	10.68	27.78	3.46	25.42	1.97	24.83	1.67	25.62	2.51	14.44			
10.04 AM	44	33.19	10.67	27.82	3.50	25.46	2.01	24.86	1.70	25.66	2.55	14.44			
10:06 AM	46	33.49	10.97	27.85	3.53	25.50	2.05	24.90	1.74	25.69	2.58	14.44			
10:08AM	48	32.96	10.44	27.88	3.56	25.52	2.07	24.92	1.76	25.73	2.62	14.45			
10.10 AM	50	33.62	11.10	27.92	3.60	25.55	2.10	24.95	1.79	25.76	2.65	14.45	3.63	1788	
10:12 AM	52	33.23	10.71	27.94	3.62	25.58	2.13	24.97	1.81	25.79	2.68	14.45			
10:14 AM	54	33.09	10.57	27.98	3.66	25.61	2.16	24.99	1.83	25.82	2.71	14.46			
10:16 AM	56	33.91	11.39	28.00	3.68	25.63	2.18	25.02	1.86	25.85	2.74	14.46			
10:18 AM	58	33.01	10.49	28.03	3.71	25.66	2.21	25.04	1.88	25.88	2.77	14.46			
10:20 AM	60	33.52	11.00	28.06	3.74	25.69	2.24	25.06	1.90	25.91	2.80	14.47	3.63	1788	
10:22 AM	62	33.88	11.36	28.09	3.77	25.71	2.26	25.08	1.92	25.93	2.82	14.47			
10:24 AM	64	33.57	11.05	28.11	3.79	25.74	2.29	25.10	1.94	25.96	2.85	14.47			
10:26 AM	66	33.40	10.88	28.14	3.82	25.76	2.31	25.12	1.96	25.99	2.88	14.48			
10:28 AM	68	33.91	11.39	28.16	3.84	25.77	2.32	25.14	1.98	26.01	2.90	14.48			
10:30 AM	70	33.36	10.84	28.18	3.86	25.80	2.35	25.16	2.00	26.04	2.93	14.48			
10:32 AM	72	33.67	11.15	28.21	3.89	25.82	2.37	25.18	2.02	26.06	2.95	14.48			
10:34 AM	74	33.62	11.10	28.23	3.91	25.84	2.39	25.20	2.04	26.08	2.97	14.49			
10:36 AM	76	33.82	11.30	28.26	3.93	25.86	2.41	25.22	2.06	26.10	2.99	14.49			
10:38 AM	78	34.24	11.72	28.27	3.95	25.89	2.44	25.23	2.07	26.12	3.00	14.49			
10:40 AM	80	33.59	11.07	28.30	3.98	25.90	2.45	25.25	2.09	26.15	3.04	14.49	3.62	1786	
10:42 AM	82	34.26	11.74	28.31	3.99	25.92	2.47	25.27	2.11	26.17	3.06	14.49			
10:44 AM	84	33.36	10.84	28.33	4.01	25.94	2.49	25.29	2.13	26.18	3.07	14.50			
10:46 AM	86	34.30	11.78	28.35	4.03	25.95	2.50	25.30	2.14	26.20	3.09	14.50			
10:48 AM	88	33.96	11.44	28.38	4.06	25.98	2.53	25.32	2.16	26.22	3.10	14.50			
10:50 AM	90	34.30	11.78	28.39	4.07	25.99	2.54	25.34	2.18	26.23	3.12	14.50			
10:52 AM	92	34.22	11.70	28.41	4.09	26.01	2.56	25.36	2.20	26.26	3.15	14.50			
1054 AM	94	34.08	11.56	28.42	4.10	26.03	2.57	25.37	2.21	26.27	3.16	14.50			
10:56 AM	96	33.77	11.25	28.44	4.12	26.05	2.60	25.39	2.23	26.29	3.18	14.50			
10:58 AM	98	34.20	11.68	28.46	4.14	26.06	2.61	25.41	2.25	26.31	3.20	14.50			
11:00 AM	100	34.06	11.54	28.48	4.16	26.08	2.63	25.43	2.27	26.32	3.21	14.50	3.62	1786	
11:20 AM	120	34.48	11.96	28.63	4.31	26.22	2.77	25.58	2.42	26.47	3.36	14.49	3.62	1786	
11:25 AM	125														Water sample collected;
11:40 AM	140	34.58	12.06	28.75	4.43	26.34	2.89	25.72	2.56	26.61	3.50	14.48			T= 57.2°F
12:00 PM	160	34.37	11.85	28.87	4.55	26.47	3.01	25.84	2.68	26.71	3.60	14.47	3.62	1786	
12:20 PM	180	34.90	12.38	28.97	4.65	26.56	3.11	25.95	2.79	26.81	3.70	14.46	3.60	1781	
12:40 PM	200	34.57	12.05	29.05	4.73	26.62	3.17	26.01	2.85	26.89	3.78	14.47	3.60	1781	
01:00 PM	220	34.80	12.28	29.12	4.80	26.70	3.25	26.09	2.93	26.97	3.86	14.47			
01:20 PM	240	34.33	11.81	29.19	4.87	26.76	3.31	26.18	3.02	27.04	3.93	14.45			
01:40 PM	260	34.96	12.44	29.26	4.94	26.82	3.37	26.25	3.09	27.10	3.99	14.45			
02:00 PM	280	34.68	12.16	29.32	5.00	26.90	3.45	26.33	3.17	27.17	4.06	14.43			
02:10 PM	290												3.58	1776	
02:20 PM	300	34.99	12.47	29.37	5.05	26.95	3.50	26.37	3.21	27.22	4.11	14.45			
02:40 PM	320	35.25	12.73	29.42	5.10	27.00	3.55	26.41	3.25	27.27	4.16	14.45	3.58	1776	
03:00 PM	340	34.92	12.40	29.46	5.14	27.04	3.59	26.44	3.28	27.31	4.20	14.46	3.58	1776	
03:20 PM	360	34.82	12.30	29.51	5.19	27.09	3.64	26.48	3.32	27.36	4.24	14.46	3.58	1776	
03:40 PM	380	34.66	12.14	29.55	5.23	27.11	3.66	26.53	3.37	27.39	4.28	14.45	3.58	1776	
04:00 PM	400	35.78	13.26	29.59	5.27	27.16	3.71	26.56	3.40	27.43	4.32	14.46	3.58	1776	
04:20 PM	420	35.01	12.49	29.62	5.30	27.19	3.74	26.59	3.43	27.47	4.36	14.46	3.58	1776	

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time (win)	Test Well 1-% Depth to water (ft)	Test Well 1-% Observed Drwdwn (ft)	Observation Well 1 Depth to water (ft)	Observation Well 1 Observed Drwdwn (ft)	Observation Well 2 Depth to water (ft)	Observation Well 2 Observed Drwdwn (ft)	Observation Well 3 Depth to water (ft)	Observation Well 3 Observed Drwdwn (ft)	Test Well 1-95 Depth to water (ft)	Test Well 1-95 Observed Drwdwn (ft)	Approx Barometric pressure (psia)	Piez head (ft)	Pumping rate (gpm)	Remarks
04:40 PM	440	34.63	12.11	29.71	5.39	27.23	3.78	26.60	3.44	27.49	4.38	14.48	3.58	1776	
05:00 PM	460	34.92	12.40	29.75	5.43	27.26	3.81	26.62	3.46	27.54	4.43	14.48	3.58	1776	Piez rdgs still erratic;
05:20 PM	480	35.47	12.95	29.78	5.46	27.29	3.84	26.66	3.50	27.56	4.45	14.47	3.58	1776	+/- 0.1 ft fluctuation
05:40 PM	500	35.32	12.80	29.81	5.49	27.31	3.86	26.70	3.54	27.59	4.48	14.47			
06:00 PM	520	35.37	12.85	29.84	5.52	27.35	3.89	26.73	3.57	27.61	4.50	14.46	3.58	1776	
06:20 PM	540	35.43	12.91	29.87	5.55	27.38	3.93	26.75	3.59	27.63	4.52	14.46	3.58	1776	
06:40 PM	560	35.40	12.88	29.89	5.57	27.41	3.96	26.78	3.62	27.66	4.55	14.45	3.58	1776	
07:00 PM	580	35.07	12.55	29.92	5.60	27.43	3.98	26.81	3.65	27.69	4.58	14.45	3.58	1776	
07:20 PM	600	34.99	12.47	29.94	5.62	27.45	4.00	26.83	3.67	27.71	4.60	14.45	3.58	1776	
07:40 PM	620	35.55	13.03	29.96	5.64	27.47	4.02	26.86	3.70	27.73	4.62	14.44	3.58	1776	
08:00 PM	640	35.45	12.93	29.98	5.66	27.49	4.04	26.88	3.72	27.75	4.64	14.44	3.58	1776	
08:20 PM	660	35.84	13.32	30.01	5.69	27.52	4.07	26.90	3.74	27.77	4.66	14.44			
08:40 PM	680	35.34	12.82	30.03	5.71	27.54	4.09	26.93	3.77	27.80	4.69	14.45			
09:00 PM	700	35.44	12.92	30.05	5.73	27.56	4.11	26.95	3.79	27.81	4.70	14.44	3.58	1776	
09:20 PM	720	35.81	13.29	30.07	5.75	27.58	4.13	26.97	3.81	27.83	4.72	14.44			
09:40 PM	740	35.83	13.31	30.09	5.77	27.60	4.15	26.99	3.83	27.85	4.74	14.44			
10:00 PM	760	35.70	13.18	30.11	5.79	27.62	4.17	27.02	3.85	27.87	4.76	14.44	3.58	1776	
10:20 PM	780	35.27	12.75	30.13	5.81	27.63	4.18	27.03	3.87	27.89	4.78	14.43			
10:40 PM	800	35.46	12.94	30.14	5.82	27.65	4.20	27.05	3.89	27.90	4.79	14.43			
11:00 PM	820	35.57	13.04	30.15	5.83	27.67	4.22	27.07	3.91	27.92	4.81	14.43	3.58	1776	
11:20 PM	840	35.93	13.41	30.17	5.85	27.69	4.23	27.08	3.92	27.93	4.82	14.42			
11:40 PM	860	35.76	13.24	30.19	5.87	27.69	4.24	27.09	3.93	27.95	4.84	14.41			
05/01/96															
12:00 AM	880	35.48	12.96	30.20	5.88	27.71	4.26	27.11	3.95	27.96	4.85	14.42	3.58	1776	
12:20 AM	900	36.07	13.55	30.22	5.90	27.73	4.28	27.13	3.97	27.97	4.86	14.42			
12:40 AM	920	35.93	13.41	30.23	5.91	27.74	4.29	27.14	3.98	27.98	4.87	14.42			
01:00 AM	940	36.32	13.80	30.25	5.93	27.75	4.30	27.16	4.00	28.00	4.89	14.42	3.58	1776	
01:20 AM	960	35.81	13.29	30.26	5.94	27.76	4.31	27.17	4.01	28.01	4.90	14.41			
01:40 AM	980	35.65	13.13	30.27	5.95	27.78	4.33	27.18	4.02	28.02	4.91	14.42			
02:00 AM	1000	35.42	12.90	30.28	5.96	27.79	4.34	27.19	4.03	28.04	4.92	14.42	3.58	1776	
02:20 AM	1020	35.78	13.26	30.29	5.97	27.80	4.35	27.20	4.04	28.04	4.93	14.42			
02:40 AM	1040	36.30	13.78	30.30	5.98	27.81	4.36	27.21	4.05	28.05	4.94	14.43			
03:00 AM	1060	36.39	13.87	30.31	5.99	27.83	4.38	27.22	4.06	28.07	4.96	14.44	3.58	1776	
03:20 AM	1080	35.75	13.23	30.32	6.00	27.84	4.38	27.23	4.07	28.08	4.97	14.44			
03:40 AM	1100	36.59	14.07	30.33	6.01	27.85	4.39	27.24	4.08	28.08	4.97	14.43			
04:00 AM	1120	35.54	13.02	30.34	6.02	27.85	4.40	27.25	4.09	28.09	4.98	14.44	3.58	1776	
04:20 AM	1140	35.71	13.19	30.34	6.02	27.86	4.41	27.25	4.09	28.10	4.99	14.43			
04:40 AM	1160	36.01	13.49	30.35	6.03	27.87	4.42	27.26	4.10	28.11	5.00	14.43			
05:00 AM	1180	36.18	13.66	30.36	6.04	27.88	4.43	27.27	4.11	28.12	5.01	14.43	3.58	1776	
05:20 AM	1200	35.85	13.33	30.37	6.05	27.89	4.44	27.28	4.12	28.13	5.02	14.43			
05:40 AM	1220	34.90	12.38	30.38	6.06	27.90	4.45	27.29	4.13	28.14	5.03	14.42			
06:00 AM	1240	36.61	14.09	30.39	6.07	27.91	4.46	27.30	4.14	28.15	5.04	14.42	3.58	1776	
06:20 AM	1260	35.95	13.43	30.40	6.08	27.92	4.47	27.31	4.15	28.15	5.04	14.42			
06:40 AM	1280	36.03	13.51	30.41	6.09	27.93	4.48	27.33	4.17	28.17	5.06	14.42			
07:00 AM	1300	35.41	12.89	30.42	6.10	27.94	4.49	27.34	4.18	28.17	5.06	14.42	3.58	1776	
07:20 AM	1320	36.01	13.49	30.43	6.11	27.95	4.50	27.35	4.19	28.18	5.07	14.43			
07:40 AM	1340	36.68	14.16	30.44	6.12	27.96	4.51	27.36	4.20	28.19	5.08	14.43			
08:00 AM	1360	35.89	13.37	30.45	6.13	27.97	4.52	27.37	4.21	28.21	5.09	14.44	3.58	1776	Piez rdgs still erratic;
08:20 AM	1380	35.82	13.30	30.46	6.14	27.98	4.53	27.39	4.23	28.22	5.11	14.44			+/-0.1 ft fluctuation
08:40 AM	1400	36.28	13.76	30.46	6.14	27.99	4.54	27.39	4.23	28.22	5.11	14.44			
09:00 AM	1420	35.99	13.47	30.47	6.15	28.00	4.55	27.40	4.24	28.23	5.12	14.45	3.58	1776	
09:20 AM	1440	36.01	13.49	30.48	6.16	28.01	4.55	27.41	4.25	28.24	5.13	14.45			
09:40 AM	1460	34.79	12.27	30.49	6.17	28.02	4.57	27.42	4.26	28.25	5.14	14.46			
10:00 AM	1480	36.00	13.48	30.49	6.17	28.03	4.58	27.43	4.27	28.26	5.14	14.46	3.58	1776	

Ground-Water Investigation in the Cache River Valley for SouthWater, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time (win)	Test Well 1-96 Depth to water (ft)	Test Well 1-96 Observed Drwdwn (ft)	Observation Well 1 Depth to water (ft)	Observation Well 1 Observed Drwdwn (ft)	Observation Well 2 Depth to water (ft)	Observation Well 2 Observed Drwdwn (ft)	Observation Well 3 Depth to water (ft)	Observation Well 3 Observed Drwdwn (ft)	Test Well 1-95 Depth to water (ft)	Test Well 1-95 Observed Drwdwn (ft)	Approx Barometric pressure (psia)	Piez head (ft)	Pumping rate (gpm)	Remarks
10:20 AM	1500	36.52	14.00	30.51	6.19	28.04	4.59	27.44	4.28	28.27	5.16	14.47			
10:40 AM	1520	36.96	14.44	30.52	6.20	28.04	4.59	27.44	4.28	28.27	5.16	14.48			
11:00 AM	1540	35.70	13.18	30.53	6.21	28.05	4.60	27.44	4.28	28.28	5.17	14.48	3.58	1776	
11:20 AM	1560	35.58	13.06	30.53	6.21	28.06	4.61	27.45	4.29	28.29	5.18	14.48			
11:40 AM	1580	35.71	13.19	30.54	6.22	28.07	4.62	27.47	4.31	28.29	5.18	14.48			
12:00 PM	1600	35.23	12.70	30.54	6.22	28.07	4.62	27.47	4.31	28.30	5.19	14.49	3.58	1776	
12:20 PM	1620	36.22	13.70	30.55	6.23	28.08	4.63	27.47	4.31	28.31	5.20	14.50			
12:40 PM	1640	35.58	13.06	30.56	6.24	28.09	4.64	27.48	4.32	28.32	5.21	14.50			
01:00 PM	1660	35.91	13.39	30.56	6.24	28.08	4.63	27.49	4.33	28.32	5.21	14.49	3.58	1776	
01:20 PM	1680	35.55	13.03	30.57	6.25	28.11	4.66	27.49	4.33	28.32	5.21	14.50			
01:40 PM	1700	35.93	13.41	30.58	6.26	28.11	4.66	27.49	4.33	28.32	5.21	14.50			
02:00 PM	1720	36.12	13.60	30.58	6.26	28.11	4.66	27.49	4.33	28.33	5.22	14.50	3.58	1776	
02:20 PM	1740	36.24	13.72	30.58	6.26	28.11	4.66	27.49	4.33	28.34	5.23	14.51			
02:40 PM	1760	35.90	13.38	30.59	6.27	28.13	4.67	27.50	4.34	28.34	5.23	14.51			
03:00 PM	1780	36.02	13.50	30.59	6.27	28.13	4.68	27.51	4.35	28.35	5.24	14.50	3.58	1776	
03:20 PM	1800	36.36	13.84	30.59	6.27	28.13	4.68	27.51	4.35	28.35	5.24	14.50			
03:40 PM	1820	35.96	13.44	30.59	6.27	28.13	4.68	27.52	4.36	28.36	5.25	14.50			
04:00 PM	1840	36.02	13.50	30.60	6.28	28.14	4.69	27.52	4.36	28.36	5.25	14.50	3.58	1776	
04:20 PM	1860	35.94	13.42	30.60	6.28	28.13	4.68	27.52	4.36	28.36	5.25	14.49			
04:40 PM	1880	35.41	12.89	30.60	6.28	28.14	4.69	27.53	4.37	28.36	5.25	14.49			
05:00 PM	1900	35.92	13.40	30.61	6.29	28.15	4.70	27.53	4.37	28.36	5.25	14.49	3.58	1776	
05:20 PM	1920	35.24	12.72	30.61	6.29	28.15	4.70	27.53	4.37	28.38	5.27	14.49			
05:40 PM	1940	35.71	13.19	30.61	6.29	28.15	4.70	27.53	4.37	28.38	5.27	14.49			
06:00 PM	1960	35.66	13.14	30.62	6.30	28.16	4.71	27.54	4.38	28.38	5.27	14.49	3.58	1776	
06:20 PM	1980	35.92	13.40	30.62	6.30	28.17	4.72	27.54	4.38	28.38	5.27	14.49			
06:40 PM	2000	35.87	13.35	30.62	6.30	28.17	4.72	27.54	4.38	28.38	5.27	14.49			
07:00 PM	2020	35.20	12.68	30.62	6.30	28.17	4.72	27.54	4.38	28.39	5.28	14.49	3.58	1776	
07:20 PM	2040	36.25	13.73	30.63	6.31	28.18	4.73	27.54	4.38	28.39	5.28	14.49			
07:40 PM	2060	35.39	12.87	30.63	6.31	28.18	4.73	27.55	4.39	28.39	5.28	14.49			
08:00 PM	2080	36.27	13.75	30.64	6.32	28.18	4.73	27.55	4.39	28.40	5.29	14.49	3.58	1776	
08:20 PM	2100	35.71	13.19	30.64	6.32	28.19	4.74	27.56	4.40	28.40	5.29	14.49			
08:40 PM	2120	35.72	13.20	30.64	6.32	28.20	4.75	27.56	4.40	28.41	5.30	14.49			
09:00 PM	2140	36.10	13.58	30.65	6.33	28.20	4.75	27.57	4.41	28.41	5.30	14.49	3.58	1776	
09:20 PM	2160	35.67	13.15	30.66	6.34	28.21	4.76	27.57	4.41	28.42	5.31	14.49			
09:40 PM	2180	36.23	13.71	30.66	6.34	28.21	4.76	27.58	4.42	28.43	5.31	14.49			
10:00 PM	2200	36.55	14.03	30.67	6.35	28.22	4.77	27.59	4.43	28.43	5.31	14.50	3.58	1776	
10:20 PM	2220	36.43	13.91	30.68	6.36	28.23	4.78	27.60	4.43	28.43	5.32	14.50			
10:40 PM	2240	35.79	13.27	30.68	6.36	28.23	4.78	27.60	4.44	28.44	5.33	14.50			
11:00 PM	2260	35.95	13.43	30.68	6.36	28.24	4.79	27.60	4.44	28.44	5.33	14.50	3.58	1776	
11:20 PM	2280	35.96	13.44	30.69	6.37	28.24	4.79	27.61	4.45	28.44	5.33	14.50			
11:40 PM	2300	35.77	13.25	30.69	6.37	28.24	4.79	27.61	4.45	28.45	5.34	14.50			
05/02/96															
12:00 AM	2320	36.61	14.09	30.70	6.38	28.25	4.80	27.61	4.45	28.45	5.34	14.49	3.58	1776	
12:20 AM	2340	36.94	14.42	30.70	6.38	28.25	4.80	27.62	4.46	28.45	5.34	14.49			
12:40 AM	2360	36.24	13.72	30.70	6.38	28.25	4.80	27.62	4.46	28.46	5.35	14.49			
01:00 AM	2380	35.60	13.08	30.71	6.39	28.26	4.81	27.62	4.46	28.46	5.35	14.49	3.58	1776	
01:20 AM	2400	36.28	13.76	30.70	6.38	28.26	4.81	27.63	4.47	28.46	5.35	14.48			
01:40 AM	2420	35.53	13.01	30.71	6.39	28.26	4.81	27.63	4.47	28.46	5.35	14.49			
02:00 AM	2440	36.59	14.07	30.71	6.39	28.27	4.82	27.63	4.47	28.46	5.35	14.49	3.58	1776	
02:20 AM	2460	36.10	13.58	30.71	6.39	28.27	4.82	27.63	4.47	28.47	5.36	14.48			
02:40 AM	2480	36.27	13.75	30.71	6.39	28.27	4.82	27.64	4.48	28.47	5.36	14.48			
03:00 AM	2500	35.96	13.44	30.71	6.39	28.27	4.82	27.64	4.48	28.47	5.36	14.48	3.58	1776	
03:20 AM	2520	35.59	13.07	30.72	6.40	28.27	4.82	27.64	4.48	28.47	5.36	14.48			
03:40 AM	2540	36.16	13.64	30.72	6.40	28.28	4.83	27.64	4.48	28.48	5.37	14.49			

Ground-Water Investigation in the Cache River Valley for SouthWater, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time (win)	Test Well 1-% Depth to water (ft)	Test Well 1-% Observed Drwdwn (ft)	Observation Well 1 Depth to water (ft)	Observation Well 1 Observed Drwdwn (ft)	Observation Well 2 Depth to water (ft)	Observation Well 2 Observed Drwdwn (ft)	Observation Well 3 Depth to water (ft)	Observation Well 3 Observed Drwdwn (ft)	Test Well 1-95 Depth to water (ft)	Test Well 1-95 Observed Drwdwn (ft)	Approx Barometric pressure (psia)	Piez head (ft)	Pumping rate (gpm)	Remarks
04:00 AM	2560	36.43	13.91	30.72	6.40	28.28	4.83	27.65	4.49	28.48	5.37	14.49	3.58	1776	
04:20 AM	2580	35.73	13.21	30.72	6.40	28.29	4.83	27.65	4.49	28.48	5.37	14.49			
04:40 AM	2600	35.75	13.23	30.73	6.41	28.29	4.83	27.65	4.49	28.48	5.37	14.48			
05:00 AM	2620	36.28	13.76	30.73	6.41	28.29	4.83	27.65	4.49	28.48	5.37	14.48	3.58	1776	
05:20 AM	2640	36.37	13.85	30.73	6.41	28.29	4.84	27.65	4.49	28.48	5.37	14.48			
05:40 AM	2660	36.32	13.80	30.73	6.41	28.29	4.84	27.65	4.49	28.48	5.37	14.48			
06:00 AM	2680	37.14	14.62	30.73	6.41	28.29	4.84	27.66	4.50	28.49	5.38	14.48	3.58	1776	
06:20 AM	2700	36.09	13.57	30.73	6.41	28.30	4.85	27.66	4.50	28.49	5.38	14.49			
06:40 AM	2720	36.09	13.57	30.73	6.41	28.30	4.85	27.66	4.50	28.49	5.38	14.48			
07:00 AM	2740	35.75	13.23	30.74	6.42	28.30	4.85	27.68	4.52	28.49	5.38	14.48	3.58	1776	
07:20 AM	2760	36.18	13.66	30.75	6.43	28.31	4.86	27.69	4.53	28.50	5.39	14.47			
07:40 AM	2780	36.44	13.92	30.75	6.43	28.31	4.86	27.70	4.54	28.50	5.39	14.47			
08:00 AM	2800	36.22	13.70	30.75	6.43	28.32	4.87	27.70	4.54	28.51	5.40	14.48	3.58	1776	Piez rdgs still erratic;
08:20 AM	2820	35.92	13.40	30.75	6.43	28.32	4.87	27.71	4.55	28.51	5.40	14.48			+ / - 0 1 ft fluctuation
08:35 AM	2835														Water sample collected; T= 57.2°F
08:37 AM	2837	36.18													Measured d/w
08:40 AM	2840	36.47	13.95	30.69	6.37	28.32	4.87	27.72	4.56	28.51	5.40	14.49			
08:41 AM	2841			30.71											Measured d/w
08:44 AM	2844					28.34									Measured d/w
08:49 AM	2849							27.71							Measured d/w
08:54 AM	2854									28.50					Measured d/w
09:00 AM	2860	36.54	14.02	30.70	6.38	28.32	4.87	27.86	4.70	28.52	5.41	14.38	3.58	1776	
09:20 AM	2880	36.73	14.21	30.70	6.38	28.33	4.88	27.83	4.67	28.53	5.42	14.43			
09:40 AM	2900	36.00	13.48	30.70	6.38	28.33	4.88	27.73	4.57	28.53	5.42	14.51			
10:00 AM	2920	34.13	11.61	30.70	6.38	28.34	4.88	27.71	4.55	28.53	5.42	14.53	3.58	1776	Pump OFF
	0.008	34.67		30.70		28.34									Water level recovery
	0.017	34.21		30.70		28.33		27.70		28.52		14.54			
	0.025	33.78		30.70		28.34									
	0.033	33.08		30.70		28.33		27.69		28.52		14.54			
	0.042	32.40		30.69		28.33									
	0.050	32.01		30.68		28.33		27.69		28.52		14.54			
	0.058	30.77		30.67		28.33									
	0.067	30.26		30.65		28.33		27.69		28.51		14.54			
	0.075	29.59		30.63		28.33									
	0.083	28.99		30.61		28.33		27.69		28.51		14.54			
	0.092	28.53		30.59		28.33									
	0.100	28.20		30.56		28.33		27.68		28.51		14.54			
	0.108	28.02		30.52		28.33									
	0.117	27.82		30.49		28.33		27.68		28.50		14.54			
	0.125	27.79		30.45		28.33									
	0.133	27.81		30.41		28.33		27.68		28.50		14.54			
	0.142	27.88		30.37		28.33									
	0.150	27.98		30.34		28.32		27.68		28.49		14.54			
	0.158	28.09		30.31		28.32									
	0.167	28.16		30.27		28.32		27.68		28.49		14.54			
	0.175	28.25		30.24		28.32									
	0.183	28.31		30.22		28.32		27.68		28.48		14.54			
	0.192	28.39		30.20		28.32									
	0.200	28.43		30.18		28.32		27.68		28.48		14.54			
	0.208	28.46		30.17		28.31									
	0.217	28.47		30.15		28.31		27.68		28.48		14.54			
	0.225	28.48		30.14		28.31									
	0.233	28.47		30.14		28.31		27.68		28.47		14.54			

Ground-Water Investigation in the Cache River Valley for SouthWater, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time (win)	Test Well 1-96 Depth to water (ft)	Test Well 1-96 Observed Drwdwn (ft)	Observation Well 1 Depth to water (ft)	Observation Well 1 Observed Drwdwn (ft)	Observation Well 2 Depth to water (ft)	Observation Well 2 Observed Drwdwn (ft)	Observation Well 3 Depth to water (ft)	Observation Well 3 Observed Drwdwn (ft)	Test Well 1-95 Depth to water (ft)	Test Well 1-95 Observed Drwdwn (ft)	Approx Barometric pressure (psia)	Piez head (ft)	Pumping rate (gpm)	Remarks
	0.242	28.45		30.13		28.30									
	0.250	28.43		30.12		28.30		27.68		28.46		14.54			
	0.258	28.41		30.11		28.30									
	0.267	28.40		30.10		28.30		27.68		28.46		14.54			
	0.275	28.40		30.09		28.29									
	0.283	28.39		30.08		28.29		27.67		28.46		14.54			
	0.292	28.39		30.07		28.29									
	0.300	28.39		30.06		28.29		27.67		28.45		14.54			
	0.308	28.39		30.05		28.29		27.67		28.44		14.54			
	0.317	28.38		30.04		28.28		27.67		28.44		14.54			
	0.325	28.38		30.02		28.28		27.67		28.44		14.54			
	0.333	28.37		30.01		28.28		27.67		28.43		14.54			
	0.350	28.34		29.99		28.27		27.70		28.43		14.53			
	0.367	28.32		29.98		28.27		27.70		28.42		14.53			
	0.383	28.30		29.97		28.26		27.70		28.42		14.53			
	0.400	28.29		29.95		28.26		27.70		28.41		14.53			
	0.417	28.28		29.93		28.25		27.70		28.40		14.53			
	0.433	28.27		29.92		28.25		27.70		28.39		14.53			
	0.450	28.25		29.91		28.24		27.70		28.39		14.53			
	0.467	28.23		29.89		28.24		27.70		28.39		14.53			
	0.483	28.21		29.88		28.23		27.69		28.38		14.53			
	0.500	28.19		29.87		28.23		27.69		28.37		14.53			
	0.517	28.18		29.85		28.22		27.69		28.36		14.53			
	0.533	28.17		29.84		28.22		27.69		28.36		14.53			
	0.550	28.16		29.83		28.21		27.69		28.36		14.53			
	0.567	28.15		29.82		28.21		27.69		28.35		14.53			
	0.583	28.14		29.80		28.20		27.68		28.34		14.53			
	0.600	28.13		29.80		28.20		27.68		28.34		14.53			
	0.617	28.11		29.78		28.19		27.68		28.33		14.53			
	0.633	28.10		29.77		28.19		27.68		28.32		14.53			
	0.650	28.09		29.76		28.18		27.68		28.32		14.53			
	0.667	28.08		29.75		28.18		27.68		28.31		14.53			
	0.683	28.07		29.74		28.18		27.67		28.31		14.53			
	0.700	28.06		29.73		28.17		27.67		28.30		14.53			
	0.717	28.04		29.72		28.17		27.67		28.29		14.53			
	0.733	28.03		29.71		28.17		27.67		28.29		14.53			
	0.750	28.02		29.70		28.16		27.67		28.29		14.53			
	0.767	28.01		29.69		28.16		27.66		28.28		14.53			
	0.783	28.01		29.68		28.15		27.66		28.27		14.53			
	0.800	27.99		29.68		28.15		27.66		28.27		14.53			
	0.817	27.98		29.66		28.14		27.66		28.26		14.53			
	0.833	27.97		29.66		28.14		27.66		28.26		14.53			
	0.850	27.97		29.65		28.13		27.66		28.25		14.53			
	0.867	27.96		29.64		28.13		27.65		28.24		14.53			
	0.883	27.95		29.63		28.13		27.65		28.24		14.53			
	0.900	27.94		29.62		28.12		27.65		28.23		14.53			
	0.917	27.94		29.61		28.12		27.65		28.23		14.53			
	0.933	27.92		29.61		28.11		27.65		28.22		14.53			
	0.950	27.91		29.60		28.11		27.64		28.22		14.53			
	0.967	27.90		29.59		28.11		27.64		28.21		14.53			
	0.983	27.90		29.58		28.10		27.64		28:21		14.53			
10:01AM	1.00	27.89		29.58		28.10		27.64		28.21		14.53			
	1.20	27.80		29.49		28.06		27.61		28.14		14.53			
	1.40	27.72		29.42		28.02		27.59		28.09		14.53			

Ground-Water Investigation in the Cache River Valley for SouthWater, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time (win)	Test Well 1-96 Depth to water (ft)	Test Well 1-96 Observed Drwdwn (ft)	Observation Well 1 Depth to water (ft)	Observation Well 1 Observed Drwdwn (ft)	Observation Well 2 Depth to water (ft)	Observation Well 2 Observed Drwdwn (ft)	Observation Well 3 Depth to water (ft)	Observation Well 3 Observed Drwdwn (ft)	Test Well 1-95 Depth to water (ft)	Test Well 1-95 Observed Drwdwn (ft)	Approx Barometric pressure (psia)	Piez head (ft)	Pumping rate (gpm)	Remarks
	1.60	27.65		29.35		27.98		27.56		28.04		14.53			
	1.80	27.60		29.29		27.94		27.54		27.99		14.53			
10:02 AM	2.00	27.54		29.24		27.91		27.51		27.95		14.53			
	2.20	27.49		29.19		27.88		27.49		27.90		14.53			
	2.40	27.45		29.14		27.85		27.47		27.86		14.53			
	2.60	27.40		29.10		27.82		27.44		27.82		14.53			
	2.80	27.35		29.05		27.79		27.42		27.78		14.53			
10:03 AM	3.00	27.31		29.02		27.77		27.40		27.76		14.53			
	3.20	27.27		28.99		27.74		27.38		27.72		14.53			
	3.40	27.23		28.95		27.72		27.36		27.69		14.53			
	3.60	27.19		28.92		27.70		27.34		27.66		14.53			
	3.80	27.15		28.88		27.68		27.32		27.63		14.53			
10:04 AM	4.00	27.11		28.86		27.66		27.30		27.60		14 53			
	4.20	27.07		28.83		27.64		27.28		27.58		14.53			
	4.40	27.03		28.80		27.61		27.27		27.54		14.53			
	4.60	26.99		28.78		27.59		27.25		27.52		14.53			
	4.80	26.96		28.75		27.58		27.23		27.50		14.53			
10:05 AM	5.00	26.93		28.73		27.56		27.22		27.47		14.53			
	5.20	26.90		28.70		27.55		27.20		27.46		14.53			
	5.40	26.88		28.68		27.52		27.19		27.43		14.54			
	5.60	26.86		28.66		27.51		27.17		27.41		14.54			
	5.80	26.83		28.64		27.50		27.15		27.39		14.54			
10:06 AM	6.00	26.81		28.61		27.48		27.14		27.37		14.54			
	6.20	26.79		28.60		27.46		27.13		27.35		14.54			
	6.40	26.77		28.58		27.45		27.11		27.32		14.54			
	6.60	26.76		28.56		27.44		27.10		27.31		14.54			
	6.80	26.76		28.54		27.42		27.08		27.29		14.54			
10:07 AM	7.00	26.75		28.52		27.41		27.07		27.27		14.54			
	7.20	26.74		28.51		27.40		27.06		27.26		14.54			
	7.40	26.72		28.49		27.39		27.04		27.24		14.54			
	7.60	26.70		28.47		27.38		27.03		27.23		14.54			
	7.80	26.68		28.46		27.36		27.02		27.20		14.54			
10:08 AM	8.00	26.67		28.44		27.35		27.01		27.19		14.54			
	8.20	26.65		28.43		27.34		26.99		27.18		14.54			
	8.40	26.64		28.41		27.32		26.98		27.16		14.54			
	8.60	26.63		28.39		27.31		26.97		27.14		14.54			
	8.80	26.61		28.38		27.30		26.96		27.13		14.54			
10:09 AM	9.00	26.59		28.36		27.28		26.95		27.12		14.54			
	9.20	26.58		28.35		27.27		26.93		27.10		14.54			
	9.40	26.56		28.34		27.26		26.92		27.09		14.54			
	9.60	26.55		28.33		27.25		26.91		27.08		14.54			
	9.80	26.54		28.31		27.24		26.90		27.06		14.54			
10:10 AM	10	26.54		28.30		27.23		26.89		27.05		14.54			
	12	26.39		28.17		27.13		26.78		26.93		14.55			
	14	26.28		28.07		27.04		26.69		26.82		14.55			
	16	26.18		27.98		26.97		26.61		26.73		14.55			
	18	26.10		27.90		26.90		26.54		26.65		14.56			
10:20 AM	20	26.04		27.82		26.84		26.47		26.58		14.56			
10:22 AM	22	25.97		27.76		26.78		26.41		26.51		14.56			
10:24 AM	24	25.92		27.70		26.72		26.35		26.45		14.56			
10:26 AM	26	25.84		27.64		26.68		26.30		26.39		14.56			
10:28 AM	28	25.77		27.58		26.62		26.25		26.34		14.56			
10:30 AM	30	25.73		27.53		26.58		26.20		26.29		14.56			
10:32 AM	32	25.73		27.49		26.54		26.16		26.25		14.57			

Ground-Water Investigation in the Cache River Valley for SouthWater, Inc.
Test/Production Well 1-96 11 48-hour Aquifer Test: April 30 - May 2,1996

Date/ Hour	Elapsed time *(alii)*	Test Well 1-96 Depth to water *(ft)*	Test Well 1-96 Observed Drwdwn *(ft)*	Observation Well 1 Depth to water *(ft)*	Observation Well 1 Observed Drwdwn *(ft)*	Observation Well 2 Depth to water *(ft)*	Observation Well 2 Observed Drwdwn *(ft)*	Observation Well 3 Depth to water *(ft)*	Observation Well 3 Observed Drwdwn *(ft)*	Test Well 1-95 Depth to water *(ft)*	Test Well 1-95 Observed Drwdwn *(ft)*	Approx Barometric pressure *(psia)*	Piez head *(ft)*	Pumping rate *(gpm)*	Remarks
10:34 AM	34	25.65		27.44		26.50		26.11		26.20		14.57			
10:36 AM	36	25.58		27.40		26.47		26.07		26.15		14.56			
10:38 AM	38	25.55		27.36		26.43		26.04		26.11		14.56			
10:40 AM	40	25.53		27.32		26.39		26.00		26.07		14.56			
10:42 AM	42	25.48		27.28		26.36		25.97		26.03		14.56			
10:44 AM	44	25.48		27.24		26.33		25.93		26.00		14.56			
10:46 AM	46	25.40		27.21		26.29		25.90		25.97		14.56			
10:48 AM	48	25.39		27.18		26.26		25.87		25.94		14.56			
10:50 AM	50	25.37		27.15		26.24		25.84		25.90		14.56			
10:52 AM	52	25.29		27.12		26.21		25.81		25.87		14.56			
10:54 AM	54	25.27		27.09		26.17		25.79		25.84		14.56			
10:56 AM	56	25.30		27.06		26.16		25.76		25.82		14.56			
10:58 AM	58	25.24		27.04		26.13		25.74		25.79		14.56			
11:00 AM	60	25.22		27.00		26.10		25.71		25.76		14.56			
11:02 AM	62	25.16		26.98		26.08		25.69		25.74		14.56			
11:04 AM	64	25.16		26.95		26.06		25.67		25.71		14.56			
11:06 AM	66	25.15		26.93		26.03		25.64		25.69		14.56			
11:08 AM	68	25.10		26.91		26.01		25.62		25.66		14.56			
11:10 AM	70	25.05		26.89		25.99		25.60		25.64		14.56			
11:12 AM	72	25.05		26.86		25.97		25.58		25.62		14.56			
11:14 AM	74	25.04		26.84		25.95		25.55		25.60		14.56			
11:16 AM	76	25.05		26.82		25.94		25.53		25.57		14.56			
11:18 AM	78	25.04		26.80		25.92		25.51		25.56		14.56			
11:20 AM	80	24.96		26.78		25.89		25.49		25.54		14.56			
11:22 AM	82	24.89		26.76		25.87		25.48		25.52		14.56			
11:24 AM	84	24.90		26.74		25.85		25.46		25.49		14.56			
11:26 AM	86	24.93		26.72		25.84		25.44		25.47		14.56			
11:28 AM	88	24.92		26.70		25.82		25.42		25.46		14.56			Moved barometer
11:30 AM	90	24.88		26.68		25.80		25.40		25.44					
11:32 AM	92	24.80		26.67		25.78		25.38		25.42					
11:34 AM	94	24.87		26.65		25.77		25.36		25.40					
11:36 AM	96	24.81		26.63		25.75		25.34		25.39					
11:38 AM	98	24.78		26.61		25.74		25.33		25.37					
11:40 AM	100	24.82		26.60		25.72		25.31		25.35					
12:00 PM	120	24.55		26.44		25.56		25.16							
12:20 PM	140	24.51		26.32		25.46		25.03							
12:40 PM	160	24.39		26.20		25.34									End of Test; all logging stopped

Appendix H.

Test/Production Well 1-96
Chemical Analyses of Water Samples, April-May, 1996

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

Illinois State Water Survey

Main Office • 2204 Griffith Drive • Champaign. IL 61820-7495 • *Tel (217) 333-2210 • Fax (217) 333-6540*
Peoria Office • P.O. Box 697 • Peoria. IL 61652-0697 • *Tel (309) 671-3196 • Fax (309) 671-3106*

SWS

June 10. 1996

Mr. Glenn Clarida
Clarida Engineering Co.
308 S. Court St.
P.O. Box 937
Marion, IL 62959

Dear Mr. Clarida:

We are enclosing a copy of each of the partial analyses made on samples of untreated water collected April 30 and May 2, 1996, from the 125 foot deep Test Well 1-96 in Alexander County.

The analyses show the samples to be moderately mineralized and moderately hard. The iron and manganese contents of the water are at a level which can result in some staining of porcelain and laundry.

The hardness in these samples is sufficient to cause the formation of a moderate amount of soft scale in boilers and hot water heaters and to consume a moderate amount of soap if used for washing or laundry.

None of the parameters tested appear unusual for Illinois ground water.

If we can be of further assistance, please let us hear from you.

Very truly yours,

Brian W. Kaiser

Brian W. Kaiser
Associate Chemist
217/333-9234

enclosures as stated

cc: Larry Lovell, Southwater, Inc.
Ron Beanland, Beanland Drilling Co.
Ellis Sanderson, ISWS

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Illinois State Water Survey

Main Office • 2204 Griffith Drive • Champaign. IL 61820-7495 • *Tel(217)333-2210'Fax(217) 333-6540*
Peoria Office • P.O. Box 697 • Peoria, IL 61652-0697 • *Tel (309) 671-3196' Fax (309) 671-3106*

SWS

WATER SAMPLE DATA
LABORATORY SAMPLE NUMBER: 229399

SOURCE: TEST/PRODUCTION WELL 1-96
OWNER: SOUTHWATER, INC.
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 04/30/1996 DATE RECEIVED: 05/03/1996
WELL DEPTH (Ft.): 125.0 TEMPERATURE REPORTED (F): 57.2
TREATMENT: NONE
COMMENTS: SAMPLE COLLECTED AFTER PUMPING 2.1 HRS. AT ABOUT 1780 GPM.

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.57	Fluoride (F):	0.2
Manganese (Mn):	0.19	Chloride (Cl):	3.4
Calcium (Ca):	64.0	Sulfate (S04):	1.7
Magnesium (Mg):	20.7	Nitrate (N03-N):	< 0.02
Sodium (Na):	7.5		
Barium (Ba):	0.04		
Beryllium (Be):	< 0.003		
Boron (B):	< 0.13		
Chromium (Cr):	< 0.007		
Copper (Cu):	< 0.01		
Nickel (Ni):	< 0.031		
Zinc (Zn):	< 0.02		
Turbidity(Lab, NTU):	3.48	Alkalinity (CaC03):	273
Color (PCU):	< 5	Hardness (as CaC03):	244
pH (Lab):	7.9	Total Dissolved Minerals:	268
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Analysts: Lauren F. Sievers BWC
Associate Chemist

Daniel L. Webb
Assistant Chemist

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Illinois State Water Survey

Main Office • 2204 Griffith Drive • Champaign. IL 61820-7495 • *Tel (217) 333-2210-Fax (217) 333-6540*

Peoria Office • P.O. Box 697 • Peoria IL 61652-0697 • *Tel (309) 671-3196 • Fax (309) 671-3106*

SWS

WATER SAMPLE DATA
LABORATORY SAMPLE NUMBER: 229400

SOURCE: TEST/PRODUCTION WELL 1-96
OWNER: SOUTHWATER, INC.
LOCATION: NORTHWEST OF SANDUSKY
COUNTY: ALEXANDER TOWNSHIP: 15S RANGE: 02W SECTION: 15.1H
DATE COLLECTED: 05/02/1996 DATE RECEIVED: 05/03/1996
WELL DEPTH (Ft.): 125.0 TEMPERATURE REPORTED (F): 57.2
TREATMENT: NONE
COMMENTS: SAMPLE COLLECTED AFTER PUMPING 47.25 HRS. AT ABOUT 1770 GPM.

PARAMETER:	mg/L	PARAMETER:	mg/L
Iron (Total Fe):	0.55	Fluoride (F):	0.2
Manqanese (Mn):	0.11	Chloride (Cl):	3.1
Calcium (Ca):	63.8	Sulfate (S04):	1.7
Magnesium (Mg):	20.5	Nitrate (N03-N):	< 0.02
Sodium (Na):	7.3		
Barium (Ba):	0.03		
Beryllium (Be):	< 0.003		
Boron (B):	< 0.13		
Chromium (Cr):	< 0.007		
Copper (Cu):	< 0.01		
Nickel (Ni):	< 0.031		
Zinc (Zn):	< 0.02		
TurbidityfLab, NTU):	4.13	Alkalinity (CaC03):	270
Color (PCU):	< 5	Hardness (as CaC03):	243
pH (Lab):	8.2	Total Dissolved Minerals:	270
Odor:	NONE		

< = Below detection limit (i.e. <1.0 = less than 1.0 mg/L)
mg/L = milligrams per liter mg/L x 0.0584 = grains per gallon
uS/cm = microsiemens per centimeter
ND = Not determined/Information not available

IEPA Certified Environmental Laboratory, Number 100202

Analysts: Lauren F. Sievers
Associate Chemist

Daniel L. Webb
Assistant Chemist

Appendix I.

Ground-Water Levels and Barometric Pressure Data, May 2 - 21, 1996

Ground—Water Investigation in the Cache River Valley for South Water, Inc.
Ground-Water Levels and Barometric Pressure Data, May 2-21,1996

Date/ Hour	Elapsed time *(mht)*	Approx Barometric pressure *(psia)*	Approx Barometric pressure *(ft of water)*	Test Well 1—95 *Depth to water *(ft)*	*Water Elevation *(ftmsl)*
	* Early ground-water levels recovering from aquifer test.				
05/02/96					
01:00 PM	0	14.55	33.56	*24.87	*324.03
02:00 PM	60	14.54	33.55	24.63	324.27
03:00 PM	120	14.53	33-53	24.44	324.46
04:00 PM	180	14.52	33.49	2429	324.61
05:00 PM	240	14.51	33.46	24.16	324.75
06:00 PM	300	14.51	33.46	24.05	324.85
07:00 PM	360	1451	33.46	23.96	324.94
08:00 PM	420	14.50	33.44	23.87	325.03
09:00 PM	480	14.50	33.44	23.80	325.10
10:00 PM	540	14.50	33.45	23.75	325.15
11:00 PM	600	14.50	33.45	23.69	325.21
05/03/96					
12:00 AM	660	14.49	33.42	23.64	32526
01:00 AM	720	14.50	33.44	23.59	32531
02:00 AM	780	14.50	33.44	23.55	325.35
03:00 AM	840	14.50	33.45	2351	32539
04:00 AM	900	14.51	33.46	23.48	325.43
05:00 AM	960	14.51	33.46	23.44	325.46
06:00 AM	1020	14.51	33.46	23.41	325.49
07:00 AM	1080	14.51	33.47	2338	325.52
08:00 AM	1140	14.53	33.51	23.36	325.54
09:00 AM	1200	14.54	3353	2334	325.56
10:00 AM	1260	14.54	3355	2332	325.58
11:00 AM	1320	14.54	3355	23.31	325.60
12:00 PM	1380	14.55	3357	2329	325.61
01:00 PM	1440	14.55	3356	2327	325.63
02:00 PM	1500	14.54	33.55	2325	325.65
03:00 PM	1560	14.53	33.53	2323	325.67
04:00 PM	1620	14.52	33.50	2320	325.70
05:00 PM	1680	14.51	33.47	23.19	325.72
06:00 PM	1740	14.50	33.45	23.16	325.74
07:00 PM	1800	14.50	33.44	23.14	325.76
08:00 PM	1860	14.49	33.42	23.12	325.78
09:00 PM	1920	14.49	33.41	23.11	325.79
10:00 PM	1980	14.49	33.43	23.10	325.80
11:00 PM	2040	14.50	33.44	23.09	325.81
05/04/96					
12:00 AM	2100	14.50	33.45	23.08	325.82
01:00 AM	2160	14.50	33.45	23.08	325.82
02:00 AM	2220	14.50	33.44	23.07	325.83
03:00 AM	2280	14.49	33.43	23.05	325.85
04:00 AM	2340	14.49	33.41	23.04	325.86
05:00 AM	2400	14.50	33.45	23.03	325.87
06:00 AM	2460	14.50	33.44	23.02	325.89
07:00 AM	2520	14.50	33.44	23.01	325.89
08:00 AM	2580	14.52	33.50	23.01	325.89
09:00 AM	2640	14.54	33.54	23.01	325.89
10:00 AM	2700	14.56	33.59	23.02	325.89
11:00 AM	2760	14.55	33.57	23.01	325.89
12:00 PM	2820	14.52	33.49	23.00	325.90
01:00 PM	2880	14.53	3352	23.00	325.90
02:00 PM	2940	14.54	3353	23.00	325.90
03:00 PM	3000	14.53	3352	22.98	325.92
04:00 PM	3060	14.53	3351	22.97	325.93
05:00 PM	3120	14.53	3351	22.97	325.94
06:00 PM	3180	14.53	3352	22.%	325.94
07:00 PM	3240	14.54	33.54	22.95	325.95
08:00 PM	3300	14.54	33.54	22.94	325.96
09:00 PM	3360	14.54	3355	22.94	325.96
10:00 PM	3420	14.55	3357	22.93	325.97
11:00 PM	3480	14.56	3358	22.93	325.97
05/05/96					
12:00 AM	3540	14.56	3358	22.93	325.97
01:00 AM	3600	14.55	3357	22.93	325.97
02:00 AM	3660	1455	3356	22.93	325.97
03:00 AM	3720	14.54	3354	22.92	325.98
04:00 AM	3780	1454	33.55	22.92	325.99
05:00 AM	3840	14.54	33.55	22.91	325.99
06:00 AM	3900	14.54	3355	22.90	326.00
07:00 AM	3960	14.55	33.55	22.90	326.00
08.00 AM	4020	14.55	33.55	22.90	326.00
09:00 AM	4080	1455	3356	22.90	326.00
10:00 AM	4140	1457	33.60	22.90	326.00

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Ground--Water Levels and Barometric Pressure Data., May 2 -- 21, 1996

Date/ Hour	Elapsed time *(min)*	Approx Barometric pressure *(psia)*	Approx Barometric pressure *(ft of water)*	TestWell 1-95 •Depth to water *(*)*	•Water Elevation *(ftmsl)*
11:00 AM	4200	14.57	33.60	22.90	326.00
12:00 PM	4260	14.57	33.61	22.90	326.00
01:00 PM	4320	14.56	3359	22.90	326.00
02:00 PM	4380	14.62	33.71	22.86	326.04
03:00 PM	4440	14.55	3355	22.85	326.05
04:00 PM	4500	14.52	33.49	22.83	326.07
05:00 PM	4560	1453	3352	22.83	326.07
06:00 PM	4620	14.55	3357	22.83	326.07
07:00 PM	4680	14.58	33.62	22.83	326.07
08:00 PM	4740	1457	33.62	22.83	326.07
09:00 PM	4800	1458	33.64	22.83	326.07
10:00 PM	4860	14.59	33.64	22.83	326.07
11:00 PM	4920	1459	33.65	22.83	326.07
05/06/96					
12:00 AM	4980	14.60	33.67	22.83	326.07
01:00 AM	5040	14.60	33.67	22.84	326.06
02:00 AM	5100	14.60	33.67	22.83	326.07
03:00 AM	5160	14.60	33.67	22.83	326.07
04:00 AM	5220	14.61	33.69	22.83	326.07
05:00 AM	5280	14.60	33.68	22.83	326.07
06:00 AM	5340	14.61	33.70	22.83	326.07
07:00 AM	5400	14.61	33.69	22.83	326.07
08:00 AM	5460	14.62	33.72	22.83	326.07
09:00 AM	5520	14.61	33.70	22.82	326.08
10:00 AM	5580	14.62	33.73	22.80	326.10
11:00 AM	5640	14.64	33.76	22.80	326.11
12:00 PM	5700	14.64	33.78	22.78	326.12
01:00 PM	5760	14.58	33.62	22.76	326.14
02:00 PM	5820	14.63	33.74	22.77	326.13
03:00 PM	5880	14.61	33.70	22.75	326.15
04:00 PM	5940	14.62	33.71	22.75	326.15
05:00 PM	6000	14.60	33.68	22.75	326.16
06:00 PM	6060	14.60	33.67	22.74	326.16
07:00 PM	6120	14.60	33.68	22.74	326.16
08:00 PM	6180	14.60	33.67	22.73	326.17
09:00 PM	6240	14.60	33.67	22.73	326.17
10:00 PM	6300	14.61	33.69	22.73	326.17
11:00 PM	6360	1459	33.65	22.71	326.19
05/07/96					
12:00 AM	6420	1459	33.66	22.71	326.19
01:00 AM	6480	14.60	33.67	22.71	326.19
02:00 AM	6540	14.60	33.67	22.70	32620
03:00 AM	6600	14.59	33.65	22.70	32620
04:00 AM	6660	1458	33.64	22.69	32621
05:00 AM	6720	1459	33.66	22.68	32622
06:00 AM	6780	14.59	33.65	22.68	32623
07:00 AM	6840	14.60	33.68	22.68	32623
08:00 AM	6900	14.61	33.70	22.68	326.23
09:00 AM	6960	14.61	33.69	22.67	32623
10:00 AM	7020	14.61	33.69	22.66	32624
11:00 AM	7080	14.61	33.71	22.66	32624
12:00 PM	7140	14.61	33.71	22.66	32624
01:00 PM	7200	14.61	33.71	22.66	32624
02:00 PM	7260	14.60	33.69	22.66	32624
03:00 PM	7320	14.60	33.68	22.65	32625
04:00 PM	7380	14.61	33.69	22.64	32626
05:00 PM	7440	14.61	33.71	22.65	32625
06:00 PM	7500	14.58	33.64	22.61	32629
07:00 PM	7560	1454	33.55	2258	326.32
08:00 PM	7620	1456	33.59	22.58	326.33
09:00 PM	7680	1459	33.64	2258	326.33
10:00 PM	7740	14.60	33.67	2258	326.33
11:00 PM	7800	14.59	33.66	22.58	32633
05/08/96					
12:00 AM	7860	14.58	33.63	22.56	326.34
01:00 AM	7920	1458	33.62	2256	326.34
02:00 AM	7980	1457	33.62	2256	326.34
03:00 AM	8040	1457	33.60	22.56	32634
04:00 AM	8100	14.57	33.60	22.55	32635
05:00 AM	8160	14.56	33.59	22.54	326.36
06:00 AM	8220	14.56	33.59	2254	32636
07:00 AM	8280	1457	33.61	2253	326.37
08:00 AM	8340	1459	33.65	2253	326.37
09:00 AM	8400	14.60	33.67	22.52	326.38
10:00 AM	8460	14.61	33.70	22.52	326.38

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Ground-Water Levels and Barometric Pressure Data, May 2 - 21,1996

Date/ Hour	Elapsed time *(min)*	Approx Barometric pressure *(psia)*	Approx Barometric pressure *(ft of water)*	Test Well 1-95 *Depth to water *(ft)*	*Water Elevation *(ftmsl)*
11:00 AM	8520	14.61	33.70	22.52	326.38
12:00 PM	8580	14.62	33.72	22.52	326.38
01:00 PM	8640	14.62	33.72	22.52	32638
02:00 PM	8700	14.62	33.71	22.52	326.38
03:00 PM	8760	14.61	33.69	2251	326.39
04:00 PM	8820	14.60	33.67	22.51	32639
05:00 PM	8880	14.59	33.64	22.50	326.40
06:00 PM	8940	14.58	33.64	22.49	326.41
07:00 PM	9000	1458	33.62	22.49	326.41
08:00 PM	9060	1458	33.62	22.48	326.42
09:00 PM	9120	1458	33.64	22.47	326.43
10:00 PM	9180	1458	33.64	22.47	326.43
11:00 PM	9240	1458	33.63	22.46	326.44
05/09/96					
12:00 AM	9300	14.58	33.63	22.46	326.45
01:00 AM	9360	14.58	33.62	22.45	326.45
02:00 AM	9420	1458	33.62	22.45	326.45
03:00 AM	9480	1458	33.64	22.45	326.45
04:00 AM	9540	1458	33.64	22.44	326.46
05:00 AM	9600	1459	33.65	22.44	326.46
06:00 AM	9660	1458	33.64	22.44	326.46
07:00 AM	9720	1459	33.66	22.44	326.46
08:00 AM	9780	14.61	33.69	22.44	326.46
09:00 AM	9840	14.62	33.73	22.44	326.46
10:00 AM	9900	14.63	33.75	22.44	326.46
11:00 AM	9960	14.64	33.76	22.44	326.46
12:00 PM	10020	14.64	33.77	22.44	326.46
01:00 PM	10080	14.64	33.77	22.43	326.47
02:00 PM	10140	14.64	33.76	22.44	326.46
03:00 PM	10200	14.63	33.74	22.42	326.48
04:00 PM	10260	14.62	33.73	22.42	326.48
05:00 PM	10320	14.62	33.72	22.42	326.48
06:00 PM	10380	14.61	33.69	22.41	326.49
07:00 PM	10440	14.60	33.67	22.41	32650
08:00 PM	10500	1459	33.65	22.40	32650
09:00 PM	10560	1458	33.64	22.39	32651
10:00 PM	10620	1458	33.64	22.39	32651
11:00 PM	10680	1457	33.62	2237	326.53
05/10/96					
12:00 AM	10740	1458	33.63	22.37	326.53
01:00 AM	10800	14.60	33.67	2235	32655
02:00 AM	10860	1458	33.64	22.36	32654
03:00 AM	10920	1458	33.63	22.35	326.55
04:00 AM	10980	1458	33.64	22.35	32655
05:00 AM	11040	1458	33.64	22.35	32655
06:00 AM	11100	1458	33.64	2235	32655
07:00AM	11160	14.60	33.68	2235	326.55
08:00 AM	11220	14.60	33.68	22.34	326.56
09:00AM	11280	14.61	33.70	22.34	326.56
10:00 AM	11340	14.62	33.72	22.34	32656
11:00 AM	11400	14.62	33.73	22.34	32656
12:00 PM	11460	14.62	33.73	22.32	32658
01:00 PM	11520	14.61	33.70	2232	32658
02:00 PM	11580	14.61	33.69	2230	326.60
03:00 PM	11640	14.60	33.67	22.31	32659
04:00 PM	11700	1458	33.64	22.30	326.60
05:00 PM	11760	14.58	33.62	2229	326.61
06:00 PM	11820	14.57	33.60	2229	326.61
07:00 PM	11880	14.55	3356	2228	326.62
08:00 PM	11940	1455	33.57	2227	326.63
09:00 PM	12000	1457	33.61	2226	326.64
10:00 PM	12060	1458	33.64	2226	326.64
11:00 PM	12120	14.58	33.62	2223	326.67
05/11/96					
12:00 AM	12180	1454	3354	2221	326.69
01:00 AM	12240	14.55	3356	2220	326.70
02:00 AM	12300	14.55	3356	22.18	326.72
03:00 AM	12360	1454	33.54	22.17	326.73
04:00 AM	12420	1455	3355	22.17	326.73
05:00 AM	12480	14.55	3356	22.17	326.74
06:00 AM	12540	14.56	33.59	22.17	326.73
07:00 AM	12600	14.58	33.62	22.17	326.73
08:00 AM	12660	14.59	33.65	22.18	326.72
09:00 AM	12720	14.60	33.67	22.18	326.72
10:00 AM	12780	14.61	33.71	22.18	326.72

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Ground-Water Levels and Barometric Pressure Data, May 2 - 21,1996

Date/ Hour	Elapsed time *(min)*	Approx Barometric pressure *(psia)*	Approx Barometric pressure *(ft ofwater)*	Test Well 1-95 *Depth to water *(ft)*	*Water Elevation *(ftmsl)*
11:00AM	12840	14.61	33.69	22.17	326.73
12:00 PM	12900	14.61	33.70	22.17	326.73
01:00 PM	12960	14.62	33.73	22.17	326.74
02:00 PM	13020	14.62	33.73	22.17	326.73
03:00 PM	13080	14.63	33.74	22.16	326.74
04:00 PM	13140	14.62	33.73	22.16	326.74
05:00 PM	13200	14.62	33.73	22.15	326.75
06:00 PM	13260	14.63	33.74	22.15	326.75
07:00 PM	13320	14.63	33.74	22.14	326.76
08:00 PM	13380	14.63	33.74	22.14	326.76
09:00 PM	13440	14.62	33.73	22.13	326.77
10:00 PM	13500	14.62	33.73	22.12	326.78
11:00 PM	13560	14.62	33.72	22.12	326.79
05A2/96					
12:00 AM	13620	14.62	33.72	22.11	326.79
01:00 AM	13680	14.62	33.72	22.10	326.80
02:00 AM	13740	14.62	33.71	22.09	326.81
03:00 AM	13800	14.61	33.71	22.08	326.82
04:00 AM	13860	14.61	33.71	22.07	326.83
05:00 AM	13920	14.62	33.71	22.07	326.84
06:00 AM	13980	14.62	33.72	22.06	326.84
07:00 AM	14040	14.63	33.74	22.05	326.85
08:00 AM	14100	14.65	33.79	22.05	326.85
09:00 AM	14160	14.66	33.81	22.05	326.85
10:00 AM	14220	14.65	33.80	22.05	326.85
11:00 AM	14280	14.66	33.81	22.04	326.86
12:00 PM	14340	14.66	33.82	22.03	326.87
01:00 PM	14400	14.65	33.80	22.02	326.88
02:00 PM	14460	14.65	33.79	22.01	326.89
03:00 PM	14520	14.64	33.78	22.00	326.90
04:00 PM	14580	14.64	33.76	21.99	326.91
05:00 PM	14640	14.62	33.72	21.98	326.92
06:00 PM	14700	14.62	33.72	21.96	326.94
07:00 PM	14760	14.61	33.71	21.96	326.94
08:00 PM	14820	14.61	33.71	21.95	326.95
09:00 PM	14880	14.62	33.72	21.95	326.96
10:00 PM	14940	14.62	33.73	21.94	326.96
11:00 PM	15000	14.63	33.74	21.93	326.97
05A3/96					
12:00 AM	15060	14.62	33.72	21.92	326.98
01:00 AM	15120	14.62	33.71	21.91	326.99
02:00 AM	15180	14.62	33.71	21.90	327.00
03:00 AM	15240	14.62	33.71	21.89	327.01
04:00 AM	15300	14.61	33.70	21.88	327.02
05:00 AM	15360	14.62	33.72	21.87	327.03
06:00 AM	15420	14.62	33.72	21.86	327.04
07:00 AM	15480	14.63	33.75	21.86	327.04
08:00 AM	15540	14.64	33.76	21.86	327.04
09:00 AM	15600	14.64	33.77	21.86	327.04
10:00 AM	15660	14.64	33.77	21.86	327.04
11:00AM	15720	14.65	33.79	21.85	327.06
12:00 PM	15780	14.65	33.79	21.84	327.06
01:00 PM	15840	14.65	33.79	21.84	327.06
02:00 PM	15900	14.64	33.78	21.83	327.07
03:00 PM	15960	14.64	33.77	21.81	327.09
04:00 PM	16020	14.64	33.77	21.81	327.09
05:00 PM	16080	14.64	33.77	21.80	327.10
06:00 PM	16140	14.64	33.77	21.79	327.11
07:00 PM	16200	14.64	33.76	21.78	327.12
08:00 PM	16260	14.64	33.76	21.78	327.13
09:00 PM	16320	14.64	33.76	21.78	327.13
10:00 PM	16380	14.64	33.76	21.76	327.14
11:00 PM	16440	14.64	33.76	21.76	327.14
05A4/96					
12:00 AM	16500	14.63	33.75	21.76	327.14
01:00 AM	16560	14.63	33.74	21.75	327.15
02:00 AM	16620	14.63	33.74	21.74	327.16
03:00 AM	16680	14.63	33.74	21.73	327.17
04:00 AM	16740	14.63	33.74	21.73	327.18
05:00 AM	16800	14.63	33.74	21.72	327.18
06:00 AM	16860	14.63	33.74	21.71	327.19
07:00 AM	16920	14.64	33.76	21.71	327.19
08:00 AM	16980	14.65	33.79	21.71	327.19
09:00 AM	17040	14.66	33.81	21.71	327.19
10:00 AM	17100	14.66	33.82	21.71	327.19

Ground-Water Investigation in the Cache River Valley for South Water, Inc.
Ground-Water Levels and Barometric Pressure Data, May 2 - 21,1996

Date/ Hour	Elapsed time *(min)*	Approx Barometric pressure *(psia)*	Approx Barometric pressure *([tot water)*	Test Well 1—95 *Depth to water *(ft)*	*Water Elevation *(ftmsl)*
11:00 AM	17160	14.66	33.82	21.71	327.19
12:00 PM	17220	14.65	33.79	21.70	327.20
01:00 PM	17280	14.63	33.75	21.69	327.21
02:00 PM	17340	14.62	33.72	21.68	32723
03:00 PM	17400	14.60	33.67	21.66	32724
04:00 PM	17460	14.58	33.62	21.64	32726
05:00 PM	17520	14.56	33.58	21.63	32727
06:00 PM	17580	14.54	33.55	21.62	32728
07:00 PM	17640	14.53	33.51	21.61	327.30
08:00 PM	17700	14.56	33.59	21.61	32730
09:00 PM	17760	14.57	33.62	21.60	327.30
10:00 PM	17820	14.54	33.54	21.58	327.32
11:00 PM	17880	14.54	33.54	21.57	32733
05/15/96					
12:00 AM	17940	14.55	33.56	21.56	32734
01:00 AM	18000	14.53	33.52	2154	327.36
02:00 AM	18060	14.52	33.49	21.54	327.36
03:00 AM	18120	1452	33.48	21.52	327.38
04:00 AM	18180	14.51	33.47	21.52	327.38
05:00 AM	18240	14.51	33.47	21.51	327.40
06:00 AM	18300	14.51	33.48	21.50	327.40
07:00 AM	18360	14.53	33.52	21.51	327.40
08:00 AM	18420	14.53	33.51	21.50	327.40
09:00 AM	18480	14.54	33.53	2151	327.40
10:00 AM	18540	1454	33.55	2150	327.40
11:00 AM	18600	14.55	3357	21.49	327.41
12:00 PM	18660	14.55	3355	21.49	327.41
01:00 PM	18720	1454	33.53	21.49	327.41
02:00 PM	18780	1454	33.53	21.47	327.43
03:00 PM	18840	1453	33.52	21.46	327.44
04:00 PM	18900	1453	33.52	21.45	327.45
05:00 PM	18960	14.52	33.50	21.44	327.46
06:00 PM	19020	14.52	33.50	21.43	327.47
07:00 PM	19080	14.53	33.51	21.42	327.48
08:00 PM	19140	1453	33.51	21.42	327.48
09:00 PM	19200	14.54	3354	21.42	327.48
10:00 PM	19260	14.54	33.55	21.42	327.48
11:00 PM	19320	14.54	33.55	21.41	327.49
05/16/96					
12:00 AM	19380	14.54	3355	21.40	327.50
01:00 AM	19440	1454	33.54	21.40	327.50
02:00 AM	19500	14.54	33.54	21.39	32751
03:00 AM	19560	1454	3354	21.39	32752
04:00 AM .	19620	1455	33.56	21.38	32752
05:00 AM	19680	1455	3357	21.37	327.53
06:00 AM	19740	14.56	33.58	21.37	327.53
07:00 AM	19800	14.57	33.60	21.36	327.54
08:00 AM	19860	14.58	33.62	21.36	32754
09:00 AM	19920	1458	33.63	21.36	32754
10:00 AM	19980	14.58	33.63	21.36	327.54
11:00 AM	20040	14.58	33.63	21.35	327.55
12:00 PM	20100	14.58	33.64	21.35	327.55
01:00 PM	20160	1457	33.61	21.35	327.55
02:00 PM	20220	14.56	3359	21.34	327.57
03:00 PM	20280	1457	33.60	21.33	32757
04:00 PM	20340	1456	3359	21.32	32758
05:00 PM	20400	14.54	3355	2130	327.60
06:00 PM	20460	14.54	3353	2129	327.61
07:00 PM	.20520	1453	33.52	21.28	327.62
08:00 PM	20580	14.53	33.52	2127	327.63
09:00 PM	20640	14.53	3351	2127	327.63
10:00 PM	20700	14.52	3350	2126	327.64
11:00 PM	20760	14.51	33.47	2126	327.64
05/17/96					
12:00 AM	20820	14.51	33.48	2125	327.65
01:00 AM	20880	14.51	33.47	2124	327.66
02:00 AM	20940	14.51	33.47	2123	327.67
03:00 AM	21000	14.51	33.46	2123	327.67
04:00 AM	21060	14.51	33.47	2122	327.68
05:00 AM	21120	1451	33.46	2122	327.69
06:00 AM	21180	14.51	33.47	2121	327.69
07:00 AM	21240	14.52	33.50	21.20	327.70
08:00 AM	21300	14.54	33.53	2120	327.70
09:00 AM	21360	1455	33.56	2121	327.69
10:00 AM	21420	14.55	3357	2120	327.70

Ground-Water Levels and Barometric Pressure Data, May 2 - 21,1996

Date/ Hour	Elapsed time *(tain)*	Approx Barometric pressure *(psia)*	Approx Barometric pressure *(ft of water)*	Test Well 1-95 *Depth to water *(ft)*	* Water Elevation *(ftmsl)*
11:00 AM	21480	14.56	33.59	21.21	327.69
12:00 PM	21540	14.56	33.58	21.20	327.70
01:00 PM	21600	14.56	33.58	2170	327.70
02:00 PM	21660	14.55	33.56	21.19	327.71
03:00 PM	21720	14.54	3334	21.18	327.72
04:00 PM	21780	14.33	33.53	21.18	327.72
05:00 PM	21840	14.53	3332	21.17	327.74
06:00 PM	21900	14.53	33.51	21.16	327.74
07:00 PM	21960	14.53	3332	21.15	327.75
08:00 PM	22020	14.32	33.50	21.14	327.76
09:00 PM	22080	14.33	33.51	21.13	327.77
10:00 PM	22140	14.33	3333	21.13	327.77
11:00 PM	22200	14.53	3333	21.12	327.78
05/18/96					
12:00 AM	22260	14.53	33.52	21.12	327.78
01:00AM	22320	1433	33.52	21.11	327.79
02:00 AM	22380	1433	3333	21.11	327.79
03:00 AM	22440	1433	3332	21.11	327.79
04:00 AM	22500	1434	3333	21.10	327.80
05:00 AM	22560	14.54	3333	21.10	327.80
06:00 AM	22620	14.56	3337	21.09	327.81
07:00 AM	22680	1437	33.61	21.09	327.81
08:00 AM	22740	1438	33.62	21.09	327.81
09:00 AM	22800	14.59	33.64	21.09	327.81
10:00 AM	22860	14.59	33.64	21.09	327.81
11:00AM	22920	14.58	33.63	21.10	327.80
12:00 PM	22980	14.58	33.63	21.09	327.81
01:00 PM	23040	1437	33.62	21.09	327.81
02:00 PM	23100	1437	33.61	21.08	327.82
03:00 PM	23160	1437	33.61	21.08	327.82
04:00 PM	23220	1436	3339	21.06	327.84
05:00 PM	23280	14.55	3337	21.06	327.84
06:00 PM	23340	14.55	33.56	21.05	327.85
07:00 PM	23400	1435	3335	21.04	327.86
08:00 PM	23460	1434	3335	21.03	327.87
09:00 PM	23520	1434	3335	21.03	327.87
10:00 PM	23580	1435	3336	21.02	327.88
11:00 PM	23640	1434	3333	21.02	327.88
05/19/96					
12:00 AM	23700	14.53	3332	21.01	327.89
01:00 AM	23760	1433	3332	21.01	327.89
02:00 AM	23820	1432	33.50	21.01	327.89
03:00 AM	23880	1432	33.48	21.01	327.89
04:00 AM	23940	1431	33.47	21.00	327.91
05:00 AM	24000	1432	33.49	20.99	327.91
06:00 AM	24060	1432	3330	20.99	327.91
07:00 AM	24120	1433	33.51	20.99	327.91
08:00 AM	24180	1434	3333	20.99	327.91
09:00 AM	24240	1434	3334	20.99	327.91
10:00 AM	24300	1434	3334	20.98	327.92
11:00 AM	24360	1434	3334	20.99	327.91
12:00 PM	24420	14.53	3332	20.99	327.91
01:00 PM	24480	1433	3331	20.98	327.92
02:00 PM	24540	14.52	33.49	20.98	327.92
03:00 PM	24600	1431	33.46	20.98	327.92
04:00 PM	24660	1430	33.45	20.98	327.92
05:00 PM	24720	14.49	33.43	20.97	327.93
06:00 PM	24780	14.49	33.42	20.96	327.94
07:00 PM	24840	14.48	3339	20.95	327.95
08:00 PM	24900	14.47	3338	20.94	327.96
09:00 PM	24960	14.48	33.40	20.94	327.%
10:00 PM	25020	14.48	33.40	20.94	327.96
11:00 PM	25080	14.49	33.42	20.93	327.97
05/20/96					
12:00 AM	25140	14.49	33.41	20.94	327.96
01:00 AM	25200	14.48	33.41	20.93	327.97
02:00 AM	25260	14.48	33.40	20.93	327.97
03:00 AM	25320	14.48	33.39	20.93	327.97
04:00 AM	25380	14.47	3338	20.93	327.97
05:00 AM	25440	14.46	3336	20.93	327.97
06:00 AM	25500	14.46	3336	20.92	327.98
07:00 AM	25560	14.47	3337	20.92	327.98
08:00 AM	25620	14.47	33.38	20.92	327.98
09:00 AM	25680	14.47	33.37	20.91	327.99
10:00 AM	25740	14.47	33.37	20.92	327.98

Ground—Water Investigation in the Cache River Valley for SouthWater, Inc.
Ground-Water Levels and Barometric Pressure Data, May 2 - 21,1996

Date/ Hour	Elapsed time *(min)*	Approx Barometric pressure *(psia)*	Approx Barometric pressure *(ft of water)*	Test Well 1—95 *Depth to water *(ft)*	*Water Elevation *(ftmsl)*
11:00 AM	25800	14.47	33.38	20.92	327.98
12:00 PM	25860	14.47	33.39	20.92	327.98
01:00 PM	25920	14.46	33.36	20.92	327.98
02:00 PM	25980	14.46	33.35	20.93	327.97
03:00 PM	26040	14.45	33.33	20.91	327.99
04:00 PM	26100	14.44	33.31	20.91	327.99
05:00 PM	26160	14.43	33.29	20.91	327.99
06:00 PM	26220	14.42	33.26	20.89	328.01
07:00 PM	26280	14.43	33.28	20.89	328.01
08:00 PM	26340	14.44	33.30	20.89	328.01
09:00 PM	26400	14.44	33.31	20.89	328.01
10:00 PM	26460	14.44	33.30	20.88	328.02
11:00 PM	26520	14.44	3330	20.88	328.02
05/21/96					
12:00 AM	26580	14.43	3329	20.88	328.02
01:00 AM	26640	14.44	3330	20.88	328.02
02:00 AM	26700	14.43	3329	20.88	328.02
03:00 AM	26760	14.43	3329	20.88	328.02
04:00 AM	26820	14.44	33.30	20.88	328.02
05:00 AM	26880	14.45	33.34	20.88	328.02
06:00 AM	26940	14.47	33.37	20.89	328.01
07:00 AM	27000	14.47	3337	20.88	328.02
08:00 AM	27060	14.48	33.40	20.89	328.01
09:00 AM	27120	14.49	33.42	20.89	328.01
10:00 AM	27180	14.50	33.44	20.91	327.99
11:00 AM	27240	14.50	33.45	20.91	327.99

Appendix J.

Correspondence:

June 23,1995: Water Qualify at Test Well 1-95

March 8, 1996: Design Recommendations for Test/Production Well 1-96

April 3, 1996: Description of Aquifer Samples for Test/Production Well 1-96

April 5, 1996: Use of Graded Sand in Test/Production Well 1-96

May 9, 1996: Results of the Step Test

May 20, 1996: Summary of Results of the Aquifer Test

June 23, 1996: Construction Features of Production Well 2

Illinois State Water Survey

Hydrology Division
2204 Griffith Drive
Champaign, Illinois 61820-7495
Telephone (217) 333-4300
Telefax (217) 333-6540

June 23, 1995

Mr. Glenn Clarida
Clarida Engineering Co.
308 South Court Street
P.O. Box 937
Marion, IL 62959

RE: Water Quality at Test Well for Southwater Regional Water System

Dear Mr. Clarida:

This letter is in response to your questions regarding what appears to be inordinately good water quality being produced by the test well for the Southwater Regional Water System in the NEVi, NE¼, NE¼ of Section 15, T15S, R2W, Alexander County. The well was drilled to a depth of 144.5 feet and ground water is developed from the sand and gravel deposits between 74 and 144.5 feet. Water samples were collected while pumping at 225 gpm after 2, 6, and 12 hours. Early analytical results indicate all three samples contained very low iron (0.10 ppm) and manganese (0.03 ppm), and moderate hardness (240 ppm).

Other wells in the area, such as the 98-foot deep Well No. 1 for the Central Alexander County Public Water District in Section 33, tend to show much poorer water quality with iron concentrations around 3 ppm and manganese up around 0.2 to 0.3 ppm. Similar results appear for wells drilled for the Horseshoe Lake Conservation Area located south of the Central Alexander County PWD well (see enclosed water analyses).

However, two wells at Tamms in the SE¼ of Section 1, T15S, R2W approximately 2 miles northeast of your site appear to have fairly good water, similar to the water produced by your test well (data enclosed). A call to the Tamms water operator, Bill Stiff, may be helpful (phone: 618/747-9247).

To help determine whether the water quality from the test well will remain good over the long term, a number of alternatives come to mind:

1. Continue pumping the test well, perhaps for several weeks if possible, and take additional samples. This may help to make judgments about future water quality but we can't be assured that changes in water quality will not occur once "full production" (2 mgd or more?) is extended over several years.
2. Go ahead with construction of one of the actual production wells, delay construction of the water treatment facility, and collect samples from the new well after it is completed. Here again, long-term pumping will help to give a better understanding of expected water quality. Water level measurements during such a long-term test will

A Division of the
Illinois Department of Energy and Natural Resources

also give a better understanding of the hydraulic behavior of the well and aquifer.

3. Sample a number of other wells in the area to see if a trend in ground-water quality can be determined. I am enclosing well records I found in our files for surrounding sections. As you suspected, most of the wells in the area are completed in the upper portions of the sand and gravel at depths around 70 to 80 feet. The Sandy Creek Church well in Section 10, however, is 100 feet deep and may be worth sampling. Certainly, the wells at Tamms suggest the water quality might be better than we expected. Like your test well, the Tamms wells are completed in the lower portions of the aquifer, from approximately 140 to 170 feet. Perhaps the water quality is better at depth, although I can't readily explain why. Note that the Central Alexander County PWD well is only 98 feet deep.

In summary, I agree with you that the water quality from your test well seems to be anomolous; yet, I can't discount the apparently good water quality at Tamms. I think longer-term pumping of either your test well or the production well after it is built will help give you the information you need.

If I can be of further assistance, please feel free to contact me again.

Sincerely,

H. Allen Wehrmann, P.E.
Director, Office of Ground-Water Quality
Telephone: 217-333-0493

cc: Sanderson

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

Illinois State Water Survey

Main Office • 2204 Griffith Drive • Champaign.'IL 61820-7495 • *Tel (217) 333-2210 - Fax (217) 333-6540*
Peoria Office • P.O. Box 697 • Peoria. IL 61652-0697 • *Tel (309) 671-3196-Fax (309) 671-3106*

SWS

March 8, 1996

Mr. Glenn Clarida
Clarida Engineering Co.
308 South Court Street
P.O. Box 937
Marion, IL 62959

Dear Mr. Clarida:

We understand that you seek suggestions on the design of a high-capacity production /test well for the South Water, Inc., water system. The well is to be located at the site of test hole (TH) 1-96 located approximately 400 feet West and 514 feet South of the NE corner, Section 15, T.15 S., R.2 W., Alexander County, Illinois. We understand the production/test well is to be designed for a pumping rate of 1500 to 1600 gallons per minute (gpm). Whether this pumping rate can be achieved depends on the hydraulic characteristics of the sand-and-gravel aquifer and the hydraulic efficiency of the production well.

The sieve analysis data for the samples from TH 1-96, the desired high-capacity production rate, and our well design criteria indicate that a gravel packed well design is warranted. Based on the grain size distribution of the sand-and-gravel aquifer sample from depths of 90 to 95 feet, a gravel pack with a grain size of about 1.5 to 2.5 mm would be ideal for this interval of the sand and gravel aquifer. However, all other intervals of the sand and gravel aquifer are more coarse grained and will allow for a larger grain-sized gravel pack. We suggest that if material from Northern Gravel Company is used their No. 2 material may be satisfactory. Our information indicates their No. 2 material is about 1.7 to 3.0 mm in size (this information should be verified directly from the company). For the interval from 90 to 95 feet the ratios of the 50 percent size of the aquifer (about 0.5 mm) to the size of the No. 2 gravel pack would be about 3.4 to 6.4. Our design practice calls for ratios of about 3 to 5. Because the remainder of the sand and gravel aquifer to be gravel packed is much more coarse-grained we believe the interval from 90 to 95 feet will not cause significant problems in developing and maintaining a sand-free water well.

A well screen with a slot size of 0.080-inch (80 slot) can be used with the No. 2 gravel pack from Northern Gravel Company. A 20-inch (or 24-inch) diameter well screen about 40 feet long set between depths of about 85 to 125 feet is suggested. A bore hole diameter of 32 to 36 inches is recommended for a 20-

inch diameter screen. This well screen should be satisfactory for a production rate of about 1600 gpm (about 1900 gpm if 24-inch diameter screen is used). Whether the sand and gravel aquifer has suitable hydraulic properties to permit this pumping rate is to be evaluated.

The No. 2 gravel pack may extend up the annulus to a depth of about 80 feet if desired. According to the driller's log of the formations, it appears that the material above this depth may be smaller in grain size and, conceivably, could migrate vertically through the recommended gravel pack. Care must be taken to fill this upper part of the annular space between the bore hole and the well casing with a selected material suitable to prevent vertical migration of this finer-grained material. For example, gravel pack material No. 0 from Northern Gravel Company is about 0.7 to 1.6 mm should be satisfactory for this purpose.

Alternately, a very conservative design allows for an ideal gravel pack with a grain size of about 1.5 to 2.5 mm as indicated by the sand and gravel interval from 90 to 95 feet. If material from Northern Gravel Company is used, our information suggests their No. 1 material is about 1.3 to 2.2 mm in size (this information should be verified directly from the company). A well screen with a slot size of 0.055-inch (55 slot) can be used with this gravel pack. The specified 24-inch diameter well screen about 40 feet long set between depths of about 85 to 125 feet can be used. A bore hole diameter of 36 to 42 inches is recommended. This well screen should be satisfactory for a production rate of about 1400 to 1500 gpm. Whether the sand and gravel aquifer has suitable hydraulic properties to permit this pumping rate is to be evaluated.

Please contact us when we can be of further assistance.

Very truly yours,

Ellis W. Sanderson, P.E.
Senior Engineer
Office of Ground-Water Resources
Evaluation and Management
Phone: (217) 333-0235

c: IEPA (2)
R. Brower, ISGS

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

ILLINOIS STATE GEOLOGICAL SURVEY

Natural Resources Building
615 East Peabody Drive
Champaign, IL 61820-6964
217/333-4747
FAX 217/244-7004

April 3, 1996

Mr. Ron Beanl and
Beanland Drilling Company, Inc.
P.O. Box 263
Anna, IL 62906

Dear Ron:

Re: SouthWater, Inc. Test Hole #1-96

Per your request in February, a sieve analysis was conducted on selected samples from SouthWater Test Hole #1-96 that were received at the Geological Survey February 23, 1996. This test site was shown on the faxed location map at a site situated 514 feet from the north line, 400 feet from the east line of Section 1, T. 15 S., R. 2 W., Alexander County, Illinois. Construction of a 2000 gpm water supply well is proposed for this site. Data sheets and graphic plots of the analyses are enclosed. A summary of the analysis results is included in this letter.

The Tamms 7-1/2 minute quadrangle map shows the land surface configuration of the site which is located toward the northwestern margin of the Cache River Valley. An elevation of 345 feet msl is contoured along the margin of the shallow drainageway lying about 50 feet east of the test hole.

A summary of the sieve analysis results is reported below as cumulative percent of sample retained on the designated mesh sieves. Invoice #09 is enclosed to cover the cost of running the sieve analysis in the ISGS Geotechnical Laboratory. Please send remittance as directed in the two boxes at the bottom of the invoice. The analysis results were sent to the State Water Survey to assist in developing a recommended design for the proposed water supply well.

The samples below a depth of 65 feet that were not sieved are briefly described in the following.

Description	Sample interval
Grayish tan fine to medium sand, little/some coarse sand; very silty, estimated median size approx. 0.012 - 0.017 inch	65- 70 ft
Grayish tan fine to medium sand, some coarse sand, little very coarse sand, silty; fragments of silt up to 3/4 inch; estimated median grain size approx. 0.015 - 0.020 inch	70- 75
Sample missing	75- 80
Grayish tan coarse to very coarse sand, some medium sand, little/ trace fine sand, some fine gravel, little medium gravel; estimated median grain size- 0.060 to 0.065 inch	80- 85
Greyish brown coarse to very coarse sand, some/little medium sand, little/some fine gravel, trace medium gravel; estimated median grain size- 0.060 - 0.065 inch	95-100
Grayish tan coarse sand to fine gravel, trace medium sand, some+ medium gravel, little/some coarse gravel; slightly silty (thin layers of fines present ?); estimated median grain size- 0.090 to 0.095 inch	105-110
Brownish very coarse sand to fine gravel, little coarse sand, trace medium sand, some medium gravel, little coarse gravel; estimated median grain size >0.125 inch	120-125
Brownish grey medium sand to coarse gravel, some fine sand; silty; many of the larger grains and pebbles have been broken by the drill bit	125-128

SouthWater, Inc. Test Hole #1-96
Approx. 514ft. from north line, 400 ft. from east line
Section 1, T. 15 S. , R. 2 W., Alexander County

Job No. 928							
Lab No.		10709	10710	10711	10712	10713	10713
Sample Depth		75-80'	85-90'	90-95'	100-105'	110-115'	115-120'
Sieve Mesh Size							
Inch	mm						
0.315	8.00	-	-	-	5.0%	1.9%	0.6%
0.157	4.00	1.3%	3.4	4.6%	22.9	12.8	12.3%
0.111	2.83		-	-	42.1	26.2	25.0
0.079	2.00	9.4	12.7	8.6	62.8	39.8	37.7
0.056	1.41	-	-	-	80.6	53.6	52.0
0.039	1.00	26.7	31.4	16.2	92.0	68.0	68.2
0.028	0.707	42.9	50.8	28.2	96.5	81.8	84.0
0.020	0.500	61.7	73.3	48.9	98.2	91.9	93.3
0.014	0.354	84.4	93.0	72.5	-	-	-
0.010	0.250	93.3	98.4	94.6	99.7	99.2	99.4
0.007	0.177	95.7	99.5	99.1	-	-	-
0.005	0.125	97.7	99.7	-	99.9	99.7	99.7
PAN		99.9	100.0	99.9	100.0	99.9	99.9

The finer grained materials reported in the depth interval of approximately 65 to 80 feet probably include both silt intermixed with the sand and also discrete layers of silt interbedded with the sand. The sand and sand and gravel horizons found below 80 feet appear capable of yielding a fairly large quantity of water to a production well. Close attention should be paid to the character of the sediments lying near and immediately above the top of the proposed placement of the well screen. Any significant deviation of the character of the materials in the production hole from those found in the test hole, may require some modification in well design to construct a well that yields a minimal quantity of fine material during well operation.

If there are any questions regarding this analysis or the geologic conditions in the vicinity of this test hole, please feel free to contact the State Geological Survey.

Sincerely yours,

Ross D. Brower RDB.
Staff Geologist
Groundwater Resources and Protection Section

RDB:ey

Enclosures:

cc: Mr. Ellis Sanderson, SWS
Mr. Glenn Clarida, Clarida Engineering
IEPA (2)

RDBltr04.016

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

Illinois State Water Survey

Main Office • 2204 Griffith Drive • Champaign. IL 61820-7495 • *Tel (217) 333-2210 • Fax (217) 333-6540*
Peoria Office • P.O. Box 697 • Peoria, IL..61652-0697 • *Tel (309) 671-3196- Fax (309) 671-3106*

SWS

April 5, 1996

Mr. Ron Beanland
Beanland Drilling Company, Inc.
P.O. Box 263
Anna, IL 62906

RE: South Water, Inc, Test/Production Well 1, Alexander County

Dear Mr. Beanland:

In our letter of March 8, 1996, we suggested that Northern Gravel well pack No. 0 be placed in the annulus opposite the natural formation above a depth of about 80 feet to help assure that the natural formation would not migrate vertically through the Northern Gravel well pack No. 2 below a depth of 80 feet. The sieve analysis data for the material that you propose to substitute for Northern Gravel well pack No. 0 should be satisfactory. The material is about 0.35 to 1.9 mm in size as compared to 0.7 to 1.6 mm for Northern No. 0. It appears to be very similar in size to the natural formation that is present at the well site between depths of about 75 to 95 feet. Final approval for this substitution should be from the consulting engineer Mr. Glenn Clarida.

Based on my conversation with you yesterday, and considering other work obligations that we have, I suggest that we tentatively plan on conducting the step test for the test/production Well 1 at South Water, Inc., on Thursday, April 25th, with Friday, April 26th, as an alternate date. We then will plan on conducting the 48-hour constant rate aquifer test during the following week of April 29th.

Please contact us when we can be of further assistance.

Very truly yours,

Ellis W. Sanderson

Ellis W. Sanderson, P.E.
Senior Engineer
Office of Ground-Water Resources
Evaluation and Management
Phone: (217) 333-0235

c: Glenn Clarida, Clarida Engineering Company

ILLINOIS DEPARTMENT OF NATURAL RESOURCES

Illinois State Water Survey

Main Office • 2204 Griffith Drive • Champaign. IL61820-7495 • *Tel(217)333-2210-Fax(217) 333-6540*
Peoria Office • P.O. Box 697 • Peoria, IL 61652-0697 • *Tel (309) 671-3196 • Fax (309) 671-3106*

SWS

May 9, 1996

Mr. Glenn Clarida
Clarida Engineering Company
308 South Court Street
P.O. Box 937
Marion, IL 62959

Dear Mr. Clarida:

We successfully conducted a step test and a 48-hour aquifer test on Test/Production Well 1-96 owned by SouthWater, Inc., on April 25 and April 30-May 2, 1996, respectively, in cooperation with Beanland Drilling Company. We are enclosing a preliminary copy of the data collected during those tests.

A preliminary analysis of the step test data suggests that Test/Production Well 1-96 is an efficient well, having a well loss value of only about 0.01 sec^2/ft^5, a low value. If the well is operated at the design rate of about 1600 gallons per minute (gpm), the amount of drawdown attributed to hydraulic inefficiency of the well is estimated to be only about 0.13 ft, or about 1.3 percent of the observed drawdown.

The analysis of the aquifer test data is now underway. We expect to have a preliminary report letter to you within 45 days (or earlier) as described in our agreement.

Very truly yours,

Ellis W: Sanderson, P.E.
Senior Engineer
Office of Ground-Water Resources
Evaluation and Management
Phone: (217) 333-0235

Enclosure as stated.

c: Beanland Drilling Company, Inc.

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

Illinois State Water Survey

Main Office -2204 Griffith Drive • Champaign. IL 61820-7495 • *Tel (217) 333-2210-Fax (217) 333-6540*
Peoria Office • P.O. Box 697 • Peoria. IL 61652-0697 • *Tel (309) 671-3196 • Fax (309) 671-3106*

SWS

May 20, 1996

Mr. Glenn Clarida
Clarida Engineering Company
308 South Court Street
P.O. Box 937
Marion, IL 62959

Dear Mr. Clarida:

We have completed our analysis of the data collected during the aquifer test on April 30-May 2, 1996, on SouthWater, Inc., Test/Production Well (PW) 1-96. This aquifer test was conducted with the capable assistance of Ron and Glenn Beanland, Beanland Drilling Company. PW 1-96 is 125 feet deep and finished in an extensive sand and gravel aquifer associated with the bottomlands of the Cache River. It is located approximately 514 ft South and 400 ft West of the NE corner, Section 15, T.15 N., R.2 W., Alexander County. A preliminary copy of the water level data collected during the test was previously sent to you with our letter dated May 9, 1996. That letter also reported the results of the step test conducted April 25, 1996, on PW 1-96.

Analysis of the data collected from PW 1-96, Observation Wells (OW) 1, 2, 3, and TW 1-95 (6-in) indicated the transmissivity of the sand and gravel aquifer at the time of the test averaged about 258,700 gpd/ft (hydraulic conductivity of about 3100 gpd/ft^2). The aquifer appeared to remain under artesian conditions during the test. Data from the observation wells (except OW 1) provided reasonably consistent values for the storage coefficient, averaging about 6.1×10^{-4}. None of the observation well data indicated the presence the aquifer boundary west of the site during the test period. Although the test data did not exhibit the effects of the barrier boundary, regional data make its presence known.

With this information, a theoretical idealized model of the aquifer conditions in the vicinity of PW 1-96 was hypothesized. The aquifer model was a semi-infinite aquifer bounded by one barrier boundary trending northeast-southwest about 3000 feet northwest of the well. The storage coefficient of 6.1×10^{-4} is small and under long-term pumping conditions may be greater. However, using this average value in the evaluation of well field yield is conservative and does not reduce the yield of a well field to less than the projected demands for the SouthWater water system.

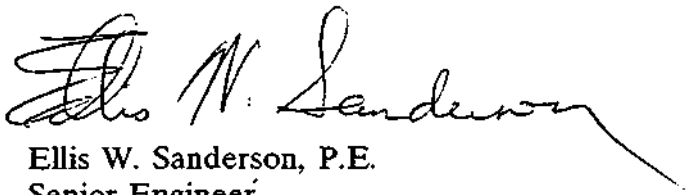
Thus the model aquifer consisted of the following elements: 1) A transmissivity of about 258,700 gpd/ft. 2) A storage coefficient of 6.1 x 10^{-4}. 3) A barrier boundary about 3000 feet northwest of the well field and parallel to the planned line of production wells. Allowance was made for dewatering up to 50 percent of the saturated thickness of the aquifer at the production well sites by adjusting drawdowns for the decrease in transmissivity.

Based on the assumptions and conditions described above, the idealized model aquifer, and resulting calculations of drawdown and interference effects, it appears that a well field yield of up to about 3200-gpm (4.6 mgd) is feasible from two production wells (1600-gpm each) spaced about 500 feet apart. Whether this yield can be sustained in the future may depend on the growth of supplemental agricultural irrigation in the area.

We understand that present plans are to use only one production well (1600-gpm) with a second production well for standby. Production Well 2 may be located either about 1000 feet southwest of Well 1-96 at the site of OW 3 or about 500 feet southwest of Well 1-96 (about 50 feet from OW 2). Production Well 2 should be equipped with about 40 feet of well screen and the well pump intake in both wells positioned no lower than the top of the well screen.

Please contact us if you have any questions regarding this matter.

Very truly yours,



Ellis W. Sanderson, P.E.
Senior Engineer
Office of Ground-Water Resources
Evaluation and Management
Phone: (217) 333-0235

cc: Mr. Larry Lovell, President, South Water, Inc.
Beanland Drilling Company
Adrian Visocky, ISWS
Gordon Dill, RDS
IEPA (2)

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

Illinois State Water Survey

Main Office • 2204 Griffith Drive • Champaign. IL61820-7495 • *Tel(217) 333-2210'Fax(217) 333-6540*
Peoria Office • P.O. Box 697 • Peoria. IL 61652-0697 • *Tel (309) 671-3196- Fax (309) 671-3106*

SWS

July 23, 1996

Mr. Glenn Clarida
Clarida Engineering Company
308 South Court Street
P.O. Box 937
Marion, IL 62959

Dear Mr. Clarida:

This is in response to your telefax of July 18, 1996, requesting suggestions for the well construction features of production Well 2 to be drilled for SouthWater, Inc., in the NE¼, NE¼, Section 15, T.15 N, R.2 W, Alexander County. You enclosed information indicating that Well 2 will be located near existing Observation Well 2 (Boring 10) that was used during the aquifer test with production Well 1-96. The driller's log of materials penetrated at Observation Well 2 indicates that the underlying bedrock surface elevation may be about 15-20 feet higher than at production Well 1-96.

We suggest that production Well 2 be constructed similar to Well 1-96. A 20-inch diameter casing and well screen in a 32-inch bore hole should be satisfactory. It is possible that the thickness and texture of the aquifer materials present and the elevation of the bedrock surface may limit the length of the 20-inch diameter well screen to about 30 feet. This 30-foot length of well screen, bottom placed at a depth of about 106 feet (or bedrock surface at the well site), will allow the desired pumping rate of about 1600 gpm if the slot size can be about 0.080-inch (80 slot) or larger. This depends on the grain size of the aquifer material and the selected gravel pack.

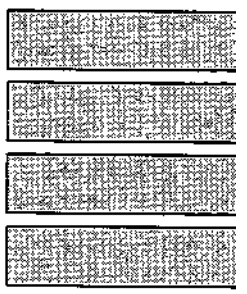
We agree that the final design of Well 2 must be based on formation samples collected from a test boring drilled at the site of Well 2.

Please contact us if you have any questions.

Very truly yours,

Ellis W. Sanderson

Ellis W. Sanderson, P.E.
Senior Engineer
Office of Ground-Water Resources
Evaluation and Management
Phone: (217) 333-0235




ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES