Pumping Test
for the
Watchtower Educational Center
Patterson, New York

Prepared for the
Watchtower Bible and Tract Society
July 28,1988

Prepared by:

C A Rich Consultants, Inc.
404 Glen Cove Avenue
Sea Cliff, New York 11579

CA RICH CONSULTANTS, INC.

Certified Ground-Water and Environmental Specialists

July 28, 1988

WATCHTOWER
Bible and Tract Society of New York, Inc.
25 Columbia Heights
Brooklyn, NY 11201

Attention: Mr. Robert Pollock

RE: Pumping Test Report
<u>Watchtower Educational Center</u>

Dear Mr. Pollock:

We are pleased to transmit herewith two copies of our Pumping Test Report for the Watchtower Educational Center in Patterson, New York. This report summarizes the quantitative and qualitative results of an extended pumping test performed on six bedrock test wells during the week of June 12, 1988.

Results indicate that four out of the six tested wells are suitable for permanent potable water supply purposes with a safe sustained yield of 179 gallons per minute (gpm). Combining these wells with Well No. 1 (purposely excluded) produces a system capacity having a safe yield of **272,000** gallons per day (gpd). This amount is 100,000 gpd in excess of the Project daily demand of 165,000 gpd. However, the need to demonstrate the availability of twice daily demand with the best well out of service requires proving an additional 50 gpm.

The report recommends continued exploratory drilling with one or more cased and screened wells completed in the unconsolidated sand and gravel deposits west of Route 22. The addition of a screened and developed well will complete the drilling portion of the groundwater exploration and development program.

Mr. Robert Pollock
July 28, 1988
Page Two

If you have any questions or require additional report copies, please do not hesitate to contact us.

Respectfully submitted,

CA RICH CONSULTANTS, INC.

Rita C. Lindsay, Hydrogeologist

Charles A. Rich, CPG, President

AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS
CERTIFICATE NUMBER
4433
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attachments

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1.0 EXECUTIVE SUMMARY

This report describes the activities and findings of CA Rich Consultants, Inc., relative to the ground water resource assessment and pumping test for the Watchtower Bible and Tract Society of New York, Inc.

The objective of this study is to assess the availability of ground water resources for the proposed Watchtower Educational Center in sufficient quantity to satisfy the proposed project demand and water-taking permit requirements of the New York State Department of Environmental Conservation, the New York State Department of Health and the Putnam County Health Department. A pumping test has been performed by CA Rich Consultants, Inc. to determine the safe yield of the existing on-site well system and to establish whether or not there would be any significant impact to neighboring off-site wells.

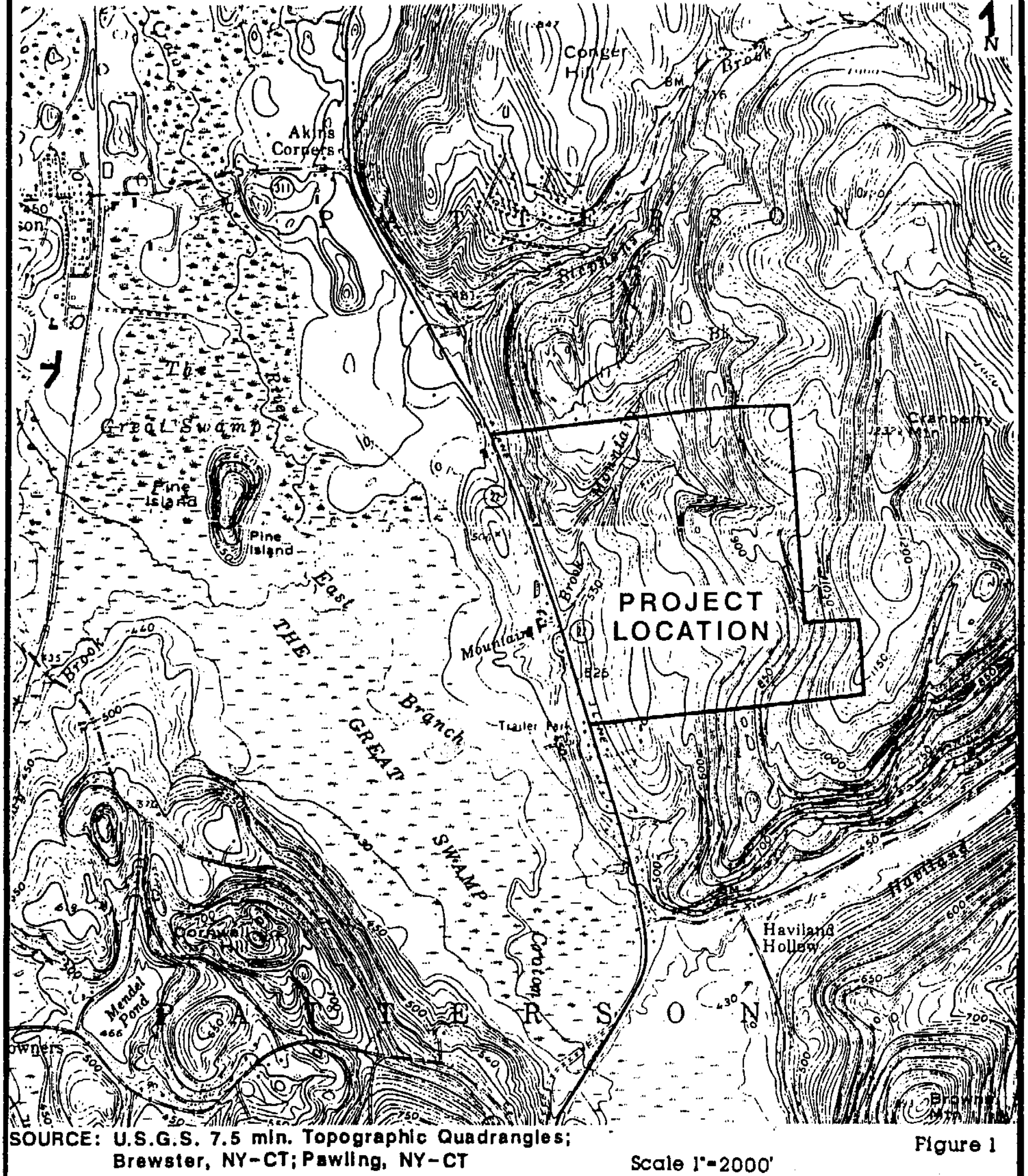
Six wells were pump tested and of these, four have been confirmed to provide a safe sustained yield of 179 gallons per minute (gpm), the equivalent of 257,760 gallons per day (gpd). Analytical testing has shown this groundwater to be suitable for potable supply.

Further groundwater exploration within the unconsolidated deposits in property area west of Route 22 is ongoing by CA Rich Consultants, Inc. Installation and pump testing of a sand and gravel well is planned to fully satisfy the established daily demand for the proposed Watchtower Educational Center.

2.0 INTRODUCTION AND BACKGROUND

2.1 General

Watchtower plans construction of a complex of buildings for an educational facility and hotel on a 374-acre tract of land (hereinafter referred to as the site) situated along Route 22 in Patterson, N.Y. (see Figure 1).



SOURCE: U.S.G.S. 7.5 min. Topographic Quadrangles; Brewster, NY-CT; Pawling, NY-CT

Scale 1"=2000'

Figure 1

CA RICH CONSULTANTS, INC.

Certified Ground-Water and Environmental Specialists

Location of Proposed Watchtower Educational Center

The proposed facility is to include seven buildings, a 149 unit hotel, and an educational center consisting of a group of buildings surrounding a central courtyard. The project water demand, as developed in the D.E.I.S. (Laurent Engineering Associates 1987), is calculated to be 165,000 gpd. As stipulated by the New York State Department of Health and New York State Department of Environmental Conservation guidelines, twice this demand or 330,000 gpd should be demonstrated on a sustained basis (stabilized pumping water level), with the most productive well out of service.

2.2 Geology

The eastern portion of the Watchtower property (east of Route 22) is underlain by unconsolidated glacial deposits comprised of sand, silt, gravel and clay. These deposits rest upon pelitic schist and amphibolite bedrock of the Manhattan Formation. Steep slopes, fields and sporadic rock outcrops dominate this area.

Directly west of Route 22, the bedrock underlying the Watchtower property consists of Stockbridge Marble which is less resistant to physical and chemical weathering than the Manhattan Formation and therefore forms a low-lying area. Overlying the bedrock in this area are unconsolidated glacial deposits comprised of stratified drift which are believed to possess significant water-bearing potential.

2.3 Groundwater Availability

Groundwater occurs within the saturated portion of the unconsolidated deposits and within the underlying fractured bedrock both west and east of Route 22. The areal distribution of the unconsolidated deposits in the eastern portion of the property is limited and fractured bedrock represents the principle source of groundwater to wells supplying the Watchtower Facility.

Primary porosity and permeability of the bedrock is negligible. Consequently, the quantity of groundwater available to the on-site wells is controlled by the geometry and density of intercepted, water-bearing joints and fractures within the bedrock aquifer.

3.Ø PUMPING TEST DESCRIPTION

3.1 General

A network of six pumping wells, two on-site observation wells and eleven off-site observation wells was established for the June 13th pumping test (See Figure 2 for well locations). Drawdown and recovery data were collected at each of the pumping wells and two on-site observation wells. Baseline water level measurements were taken in the off-site observation wells one week prior to the start up of the pump test, and periodically during the pumpage of the on-site wells. Water levels were measured using Sinco, Inc. electronic water level indicators. Observation wells W-1 and W-B were monitored throughout the test using installed Stevens automatic water level recorders. A record of water level measurements is given in Appendix I.

3.2 Pumping Well Network

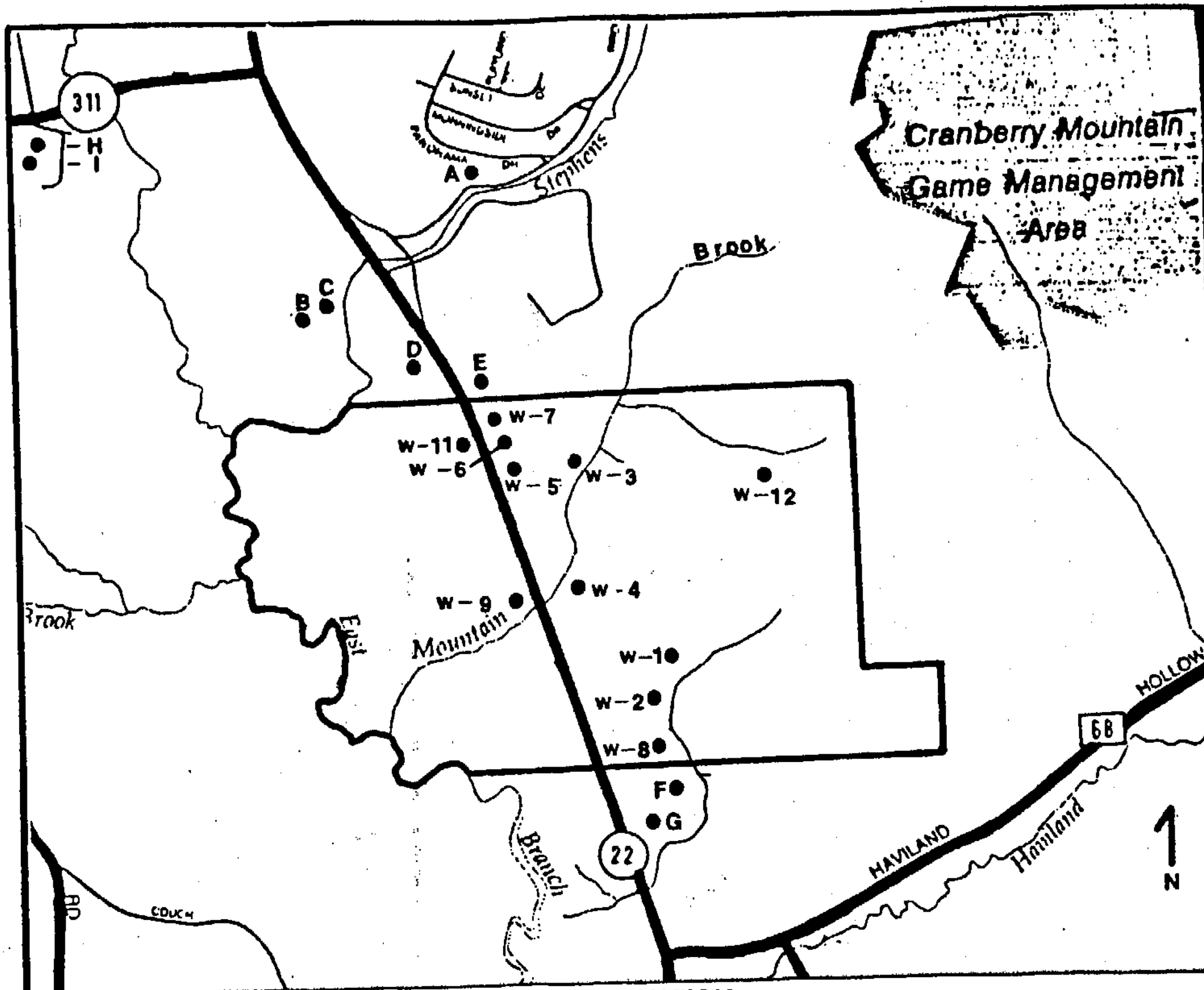
The on-site pumping well network consists of the following six wells: W-2, W-3, W-4, W-5, W-6, and W-7.

The W-2 well was pumped at a rate of 25 gpm for the first 45 hours of the pump test, at which time the rate was increased to 65 gpm due to lower than expected yield in W-5 and W-7. Following 86 hours of pumpage, the water level in W-2 was measured at 79.18 feet. For the final 8 hours of pumpage, measured drawdown in W-2 averaged Ø.27ft/hour. This well reached 75 % recovery in 19 hours.

The W-3 well was pumped at 3Ø gpm for approximately 4Ø hours. Significant drawdown forced a decrease in pumping rate to 24 gpm. A stabilized pumping water level was achieved after 99 hours at this rate of discharge. Full water level recovery was attained within 1 hour of pump shut down.

A pumping rate of 4Ø gpm was established at the onset of the test for W-4. Thirty two hours into the test the pumping rate of Well 4 was increased to 6Ø gpm. After 93 hours of pumpage, depth to water in W-4 was recorded at 232.65 feet. For the final 8 hours of pumpage measured drawdown averaged Ø.37ft/hour. Seventy-five percent recovery of W-4 was reached within 8 hours.

Pumpage of W-5 at 4Ø gpm resulted in significant drawdown after 12 hours. This rate then decreased steadily for 67 hours until the pump was shut off. Recovery data was collected, however, the rate of recovery was influenced by the continued pumping of adjacent wells.



EXPLANATION

Off-site Observation Wells

A: Alpine Hills #3
B: Birch Hills #5
C: Birch Hills #6
D: Pizza King
E: Magdi's Diner
F: Berkshire Nursery
G: Noletti Bakery
H: Rosebud A
I: Rosebud C

On-site Pumping Wells

W-2 W-4 W-6
W-3 W-5 W-7

On-site Observation Wells

W-1 W-11
W-8 W-12
W-9

Approximate Scale

0 2000 Feet

Figure 2

CA RICH CONSULTANTS, INC.

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WELL LOCATIONS
June 1988 Pump Test
Watchtower Educational Center
Patterson, NY

The W-6 well was pumped at a rate of 50 gpm for 48 hours. This rate was then increased to 80 gpm. Excessive drawdown occurred and forced a shutdown 65 hours into the test. After 7 hours of well recovery, pumping of W-6 resumed at an adjusted rate of 30 gpm with wells W-5 and W-7 taken off line. W-6 exhibited stable flow for the remaining 24 hours of the test and was shut down after a total of 89 pumping hours. Recovery measurements were recorded for 48 hours and a 75% recovery was achieved.

The W-7 well was pumped at 45 gpm for 24 hours. However, significant impact to the neighboring shallow well servicing the Magdi's Diner was observed after approximately 24 hours. Consequently, the pumping rate of W-7 was decreased to 25 gpm. The well was shut down 24 hours later due to excessive drawdown.

3.3 Observation Well Network

The observation well network includes eleven (11) off-site and two (2) on-site wells. The network was established for the purpose of identifying any significant interference effects due to on-site pumpage. The wells were chosen based upon area hydrogeology, previous pump testing results in 1985, accessibility and owner permission.

Two on-site wells W-1 and W-8 were not pumped during the test, but were included as observation wells for measurement of drawdown and recovery in direct response to pumpage of nearby well W-2. Well W-1 (located 500 feet to the northwest of W-2) was previously tested in conjunction with W-2 in March, 1985 and exhibits a safe sustained yield of 75 gpm. The drawdown in W-1 was 47 feet during the test, and a 70% recovery was observed within 19 hours.

Observation well W-8 is located 330 feet south of W-2. Pumping of W-2 caused a total drawdown of 54.2 feet in W-8. Seventy-four percent recovery was reached in after 19 hours.

The off-site observation well network is comprised of two Watchtower farmhouse wells, one Patterson Water District well and eight privately owned wells. One week prior to commencement of the pumping test (June 7th through 10th) baseline measurements were collected from all of these wells to compare the normal range of water level fluctuation with those measured during on-site pumped withdrawals.

4.0 INTERPRETATION OF RESULTS

4.1 Aquifer Analysis

The objective of pumping test analysis is to ascertain values of the aquifer's characteristics or hydraulic properties. These properties are useful for determination of well behavior or prediction of a future well's behavior. The three primary aquifer characteristics applicable to the Watchtower test are transmissivity, coefficient of storage and specific capacity. These terms are defined below:

** Transmissivity is a measure of the aquifers ability to transmit groundwater to a well. It is defined as the volume of water that will pass through (horizontally), a one-foot wide section extending the entire thickness of the aquifer in one day under a unit hydraulic gradient of 1:1 and it is measured in gallons per day per foot (gpd/ft).

** Coefficient of storage is dimensionless and defined as the volume of groundwater released from a vertical rectangular prism with a surface area (horizontal) of one square foot that extends through the entire aquifer when the head in the aquifer is lowered one foot.

** Specific Capacity is the ratio of a well's yield to the drawdown of water level. This value is measured in gpm/ft.

The Cooper-Jacob Method of aquifer analysis was performed on the six pumping wells and two on-site observation wells. Transmissivities and storage coefficients were calculated using initial pumping rates for drawdown, and final pumping rates for recovery. Semilogarithmic plots of drawdown and recovery data on a per well basis are given in Appendix II.

4.2 Aquifer Properties

Transmissivity values, obtained through the analysis of pumping well data, were used to estimate aquifer conditions in the site area. The objective of these analyses, along with specific capacity estimates for each well, is to obtain values of the aquifer's hydraulic properties, which in turn can be used to calculate optimum well yields.

Transmissivity (T) values for the aquifer underlying the site area ranged from 20 to 667 gpd/ft. The bedrock beneath the southernmost portion of the Watchtower property (location of wells W-1, W-2 and W-8) appears to have the greatest water-bearing potential displaying T values of approximately 500 gpd/ft.

Transmissivity values, derived from analysis of data collected from wells located in the northern portion of the site (wells W-3, W-5, W-6 and W-7), reveal a less transmissive bedrock aquifer in this area. However, wells W-3 and W-6 are both capable of producing a reliable and sustainable supply of groundwater for the Project.

Specific Capacity data derived from observed response during pumping ranges from 0.08 to 1.14 gpm/ft with W-1 being the most productive on-site well tested to date. From these data it is again apparent that the bedrock aquifer underlying the southern portion of the site is relatively more productive.

The storage coefficients derived for on-site observation wells W-1 and W-8 are .0000241 and .0000332 respectively. Storage coefficient values less than 0.003 are common for confined aquifers.

The depth of each well, initial and final pumping test discharge rates, stabilized drawdown level, and specific capacity and transmissivity values for Wells 1 through 8 are summarized on Table 1.

TABLE 1

WATCHTOWER FARMS PUMPING TEST
WELL DETAILS AND CALCULATIONS
Patterson, New York*

Well	Well Depth (ft)	Initial Pumping Rate (gpm)	Final Pumping Rate (gpm)	Stabilized Drawdown (ft)	Specific Capacity (gpm/ft)	Transmissivity (gpd/ft)	
						pumping	recovery
Well-1	350	NA	NA	NA	NA	571	594
Well-2	365	25	65	57	1.14	571	424
Well-3	450	30	24	300	0.08	27	19
Well-4	450	40	60	218	0.28	229	463
Well-5	420	40	off	NA	NA	219	---
Well-6	400	50	30	92	0.54	190	114
Well-7	460	45	off	NA	NA	201	---
Well-8	--	NA	NA	NA	NA	667	594
Total		230	179				

* 96 Hour Pumping Test, June 13-17, 1988

4.3 Observation Well Network

Six of the thirteen observation wells displayed a response due to on-site pumpage. Noletti's Bakery, the southernmost observation well exhibited water level decline of approximately 5 feet below normal following the increase of the pumping rate in W-2 from 25 gpm to 65 gpm. The Berkshire Nursery displayed a drawdown of approximately 13 feet below normal during the same interval of pumpage.

The northern farmhouse well (W-9) and the well servicing Magdi's Diner were flowing prior to the pump test but exhibited drawdown effects of greater than 50 feet during the pumping period. The Watchtower Society upgraded the water supply system servicing Magdi's Diner via the installation of a submersible pump at a depth of 80 feet (in place of the original shallow jet pump) and also had the Magdi's Diner well raised two feet above ground level.

Wells W-1 and W-8 displayed declines in water level similar to the pumping wells with a significant slope increase after 2000 minutes of pumpage. Hydrographs for the observation wells are presented in Appendix III.

4.4 WATER QUALITY

Prior to termination of the pumping test groundwater samples were collected from wells W-2, W-3, W-4 and W-6 and hand delivered under chain of custody control to State certified Envirotest Laboratories for chemical analysis. Analytical parameters included New York State Part 5 Drinking Water constituents (primary and secondary), volatile organics, and radioactivity (gross alpha, gross beta, Radium 226 and Radium 228). Results are presented in Appendix IV.

The laboratory results indicate that groundwater derived from the four wells tested exhibit concentrations of the New York State Sanitary Code, Part 5 primary, secondary and radiological parameters below the maximum prescribed contaminant levels (MCL) . No volatile organic compounds were detected in the four water samples analyzed using EPA Method 624.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

1) A total sustained yield of 179 gpm was demonstrated through simultaneous pumpage of Wells W-2, W-3, W-4 and W-6.

2) The wells serving Noletti's Bakery and the Berkshire Nursery exhibited drawdown due to on-site pumpage (see section 4.2). However, this drawdown is considered to be insignificant in consideration of the available water column above the pumps in each of these wells, and the extended period of groundwater withdrawal associated with the pumping test.

3) The well servicing Magdi's Diner was significantly impacted due to simultaneous pumping at wells W-5, W-6, and W-7. This well was mechanically upgraded as discussed in section 4.2 to prevent any additional significant drawdown.

4) Based on analytical results of water quality, groundwater derived from wells W-2, W-3, W-4 and W-6 is suitable for potable supply.

5.2 RECOMMENDATIONS

1) We recommend that a program of additional groundwater exploration and development be implemented. This program should include the installation and testing of one or more additional wells in the unconsolidated glacial deposits underlying the Watchtower property west of Route 22.

2) Based on the excessive drawdown observed in the Magdi's Diner well, it is suggested that wells W-5 and W-7 not be included in the well network for the proposed project and that well W-7, the northernmost on-site well, be preserved for future water level monitoring purposes.

3) Pumping demand on wells W-3, W-4, and W-6 should not exceed the final sustained yields of 24, 60 and 30 gpm respectively, and the combined rate of wells W-1 and W-2 should not exceed 75 gpm as indicated by our initial investigation (CA Rich, 1985).

4) The Watchtower Educational Center will have two (2) separate centers of well pumpage, situated in the northern and southern portions of the property on the eastern side of Route 22. To manage the system properly in order to minimize pumping stress and prolong system reliability, we advise that groundwater supply pumped from these wells be withdrawn on a proportional and rotational basis. Continued

pumped withdrawals from only one or two wells within either pumping center for any extended period should be avoided.

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BIBLIOGRAPHY

Garber, Murray, 1985, Effects of Increased Pumpage on a Fractured-Bedrock Aquifer System in Central Orange County, New York: U. S. Geologic Water-Resources Investigations Report 84-4348.

GeoEnvironmental/CA Rich Consultants, Inc., 1985, Pumping Test Analysis for the Proposed Watchtower Project in Patterson, New York.

Laurent Engineering Associates, 1987, Draft Environmental Impact Statement for Watchtower Educational Center and Patterson Inn.

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Groundwater Supply Assessment
Watchtower Educational Center
Paterson, New York

November 1988

Prepared for:

Watchtower Bible and Tract Society
25 Columbia Heights
Brooklyn, New York 11201

Prepared by:

C A Rich Consultants, Inc.
404 Glen Cove Avenue
Sea Cliff, New York 11579

CA RICH CONSULTANTS, INC.

Certified Ground-Water and Environmental Specialists

November 10, 1988

Watchtower
25 Columbia Heights
Brooklyn, New York 11201

Attn: Mr. Robert Pollock

Re: Groundwater Supply Assessment
Watchtower Educational Center
Paterson, New York

Dear Bob:

Attached is our report entitled, "Groundwater Supply Assessment, Watchtower Educational Center, Paterson, New York." The testing performed for this project indicates that the combined bedrock/sand and gravel well system is capable of sustaining a yield of 240 gpm and that all of the wells in the system are in compliance with the New York State Sanitary Code, Part 5.

If you have any questions regarding this report, please do not hesitate to contact our office.

Respectfully submitted,

C A RICH CONSULTANTS, INC.

Eric A. Weinstock, CPG
Project Manager

EAW:mg

404 Glen Cove Avenue, Sea Cliff, New York 11579 • Tel. 516/674-3889 FAX 516/674-3901 • P.O. Box 324, Cranford, New Jersey 07016

EXECUTIVE SUMMARY

This report describes the activities and findings of CA Rich Consultants, Inc. (CA Rich) concerning a follow-up groundwater resource assessment and two pumping tests performed for the Watchtower Bible and Tract Society of New York, Inc. (Watchtower).

The objective of this study is to assess the availability of groundwater resources for the proposed Watchtower Educational Center. This report demonstrates that such resources are of sufficient quantity and quality to satisfy the water-taking permit requirements of the New York State Department of Environmental Conservation, the New York State Department of Health and the Putnam County Health Department. The pumping tests were supervised by C A Rich Consultants, Inc. to determine the sustainable yield of the existing on-site well system and to establish whether or not there would be any significant impact to neighboring off-site wells.

As a result of the two tests, a groundwater supply well system comprised of both a bedrock well network and sand and gravel well network have been developed. Individual pumping tests of the bedrock and sand and gravel well networks resulted in yields of 90 gallons per minute (gpm) and 150 gpm or a total of 240 gpm with the best bedrock well out of service. This represents a combined yield of 10 gpm in excess of twice the average daily demand of 230 gpm.

Based on the demonstrated well yields and water quality test results, C A Rich finds that all of the supply wells in the combined bedrock/sand and gravel system are useful for sustained withdrawals and are in compliance with the NYS Sanitary Code, Part 5.

1.0 INTRODUCTION

1.1 General

Watchtower plans construction of a complex of buildings for an educational facility and hotel on a 374-acre tract of land (hereinafter referred to as the Site) situated along Route 22 in Patterson, N.Y. (see Figure 1).

The proposed facility is to include seven buildings, a 149 unit hotel, and an educational center consisting of a group of buildings surrounding a central courtyard. The project water demand, as developed in the DEIS (Laurent Engineering Associates 1987), is calculated to be 165,000 gpd. As stipulated by the New York State Department of Health and New York State Department of Environmental Conservation guidelines, twice this demand or 330,000 gpd (230 gpm), must be demonstrated on a sustained basis (stabilized pumping water level) with the most productive bedrock well out of service.

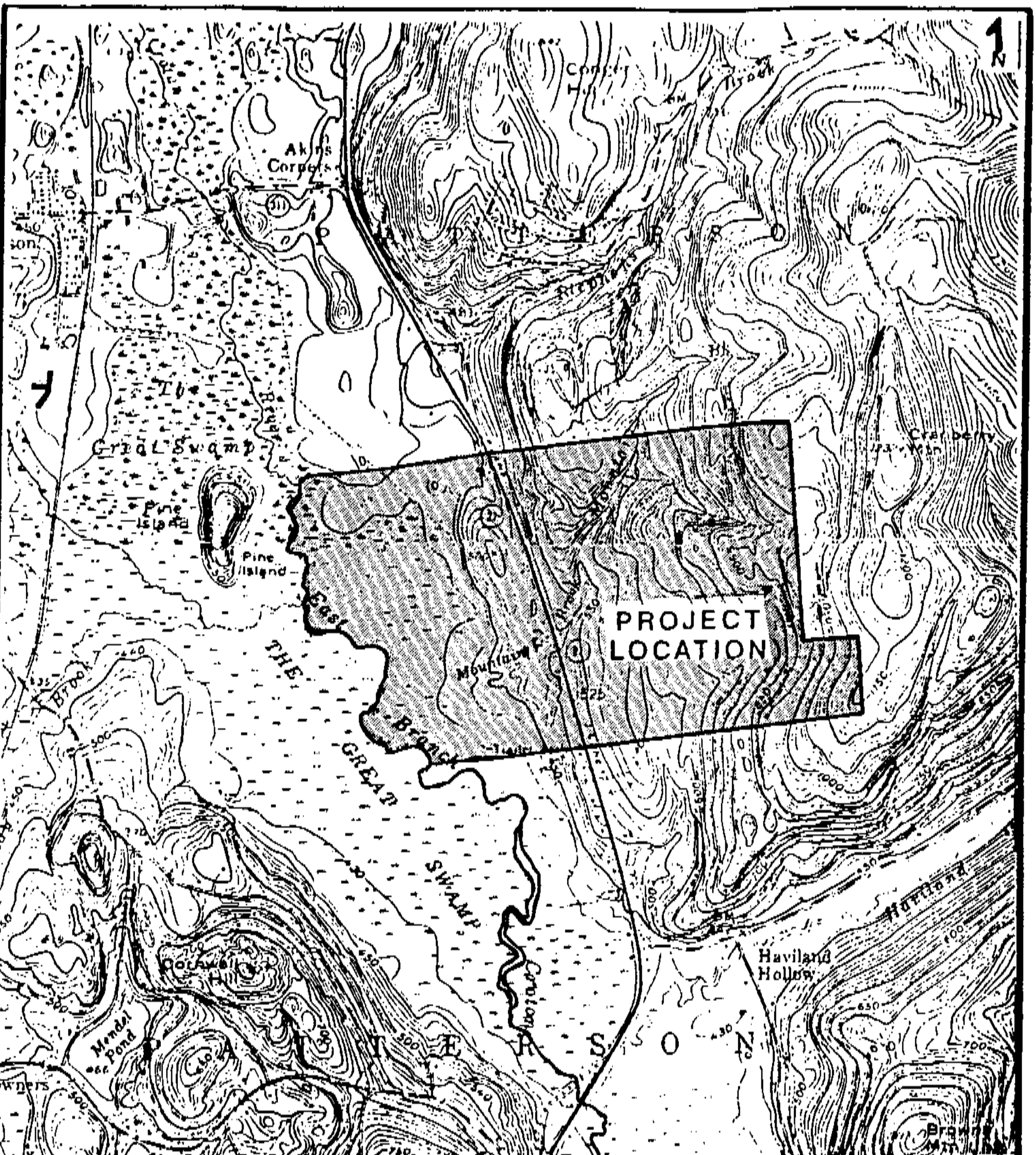
1.2 Geology

The eastern portion of the Watchtower property (east of Route 22) is underlain by a thin veneer of unconsolidated glacial deposits comprised of sand, silt, gravel and clay. These deposits rest upon pelitic schist and amphibolite gneiss bedrock of the Manhattan Formation (Fisher, et al, 1970). Steep slopes, fields actively used by the Watchtower Farms and sporadic rock outcrops dominate this area.

Directly west of Route 22, the bedrock underlying the Watchtower property consists of Stockbridge Marble which is less resistant to physical and chemical weathering than the Manhattan Formation and has therefore formed a low-lying valley. Overlying the bedrock in this area is a buried glacial valley. Borings performed in this section of the property indicate that directly above the bedrock is 10 to 20 feet of fine to coarse sand and gravel. Above this is approximately 50 to 60 feet of poorly consolidated silt and clay. Boring logs of the two sand and gravel wells installed west of Route 22 for this project are included in Appendix I.

1.3 Groundwater Availability

Groundwater occurs within the saturated portion of the unconsolidated deposits west of Route 22 and within the underlying fractured bedrock both west and east of Route 22. The areal distribution and thickness of the unconsolidated deposits in the eastern portion of the property is limited. Here fractured bedrock represents the principle source of groundwater to on-site wells.



SOURCE: U.S.G.S. 7.5 min. Topographic Quadrangles; Brewster, NY-CT; Pawling, NY-CT

Scale 1"-2000'

Figure 1

CA RICH CONSULTANTS, INC.

Certified Ground-Water and Environmental Specialists

Location of Proposed Watchtower Educational Center Patterson, N.Y.

Primary porosity and permeability of the bedrock is negligible. Consequently, the quantity of groundwater available to the on-site wells is controlled by the geometry and density of intercepted, water-bearing joints and fractures within the bedrock aquifer.

The glacial sand and gravel unit located on the western portion of the property represents the most productive source of groundwater on the Site. Wells drilled in this location provide significant yields of water with a minimal drawdown of the water table.

2.0 Background

2.1 Installation of Bedrock Wells

A total of eleven (11) exploratory supply wells were installed on the Watchtower Farms property. Beginning in 1985, six-inch diameter exploratory wells were drilled at numerous locations both east and west of Route 22 using the air-rotary method with a downhole hammer. The wells were all cased with steel pipe to a depth of approximately 40 to 50 feet and completed at depths from 350 to 460 feet. The location of the bedrock wells is illustrated in Figure 2 and well construction details are presented in Appendix I.

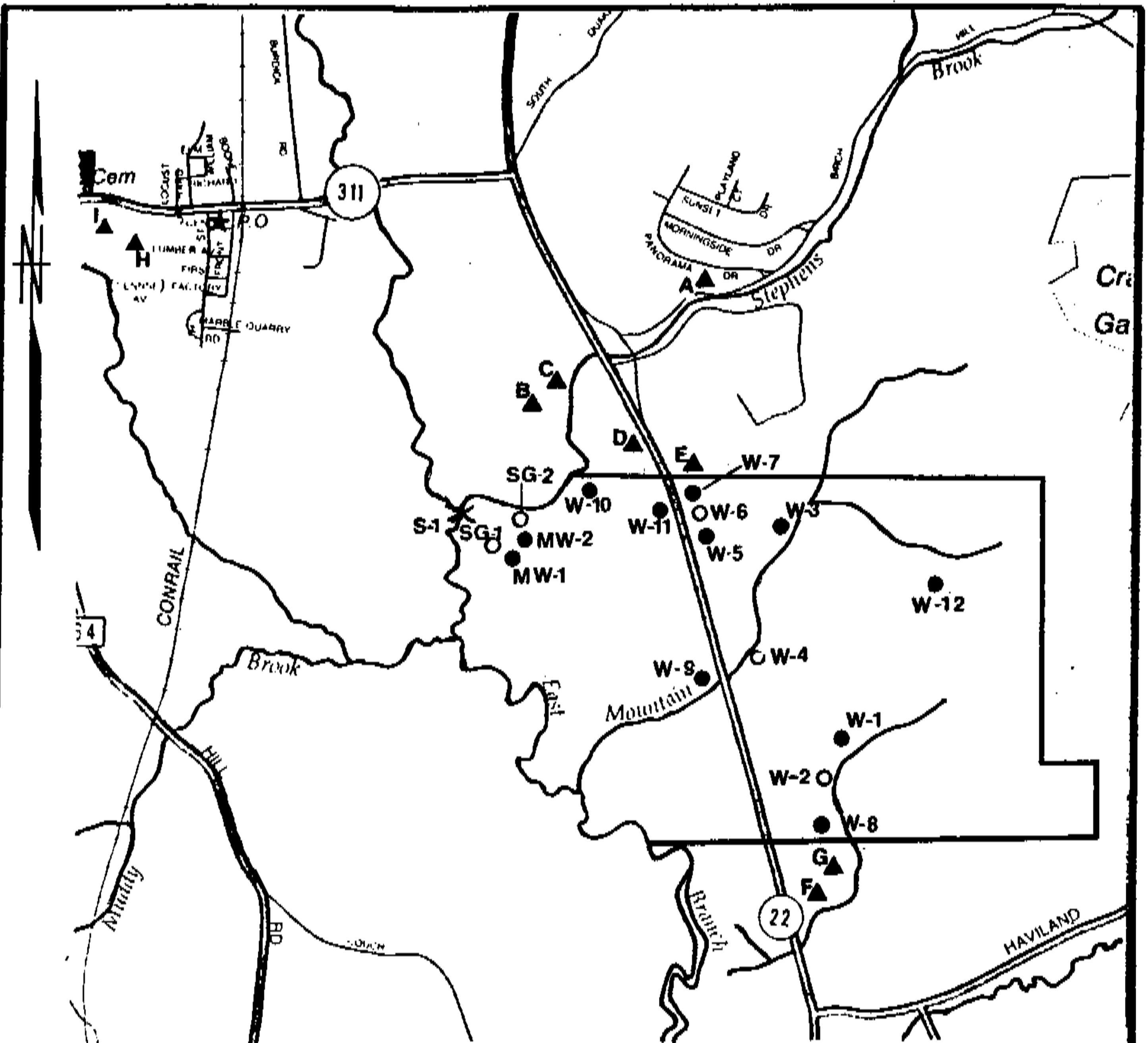
2.2 Installation of Sand and Gravel Wells

On August 17 through September 23, 1988, drilling activities were performed on the western portion of the Watchtower property for the installation of 2 six-inch diameter sand and gravel supply wells and 2 two-inch diameter observation wells. The wells were installed by Boyd Artesian Well, Inc. of Carmel, New York using the cable-tool method (supply wells) and the hollow stem auger method (observation wells). The supply wells are designated SG-1 and SG-2 and installed to depths of 73 feet and 80 feet, respectively. The observation wells are designated MW-1 and MW-2 and installed to the same horizon as the supply wells. The location of the sand and gravel well network is illustrated in Figure 2 and well construction information is presented in Appendix I.

3.0 PUMPING TEST DESCRIPTION

3.1 Bedrock Well Network

The bedrock well network for the June 1988 long-term pumping test included Watchtower wells W-2, W-3, W-4, W-5, W-6 and W-7. These wells are located along Route 22 and their locations are presented in Figure 2.



EXPLANATION

● ON-SITE OBSERVATION WELL

▲ OFF-SITE OBSERVATION WELL

○ PROPOSED SUPPLY WELL

x STREAM LEVEL GAUGE

APPROXIMATE SCALE

0 2000'

FIGURE 2

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ON AND OFF SITE WELL
LOCATION MAP
WATCHTOWER EDUCATIONAL CENTER
PATTERSON, N.Y.

TABLE 1

INDEX OF OFF-SITE OBSERVATION WELLS
WATCHTOWER PUMPING TEST
PATTERSON, NEW YORK

WELL DESIGNATION	LOCATION
A	Alpine Acres
B	Birch Hills #1
C	Birch Hills #2
D	Pizza King
E	Magdi's Diner
F	Noletti Bakery
G	Berkshire Nursery
H	Rosebud Well A
I	Rosebud Well C

Drawdown and recovery data were collected from each of the pumping wells throughout the course of the test. These data were collected from two on-site bedrock wells which were not pumped as part of the June test. On-site test wells W-1 and W-8 (located 500 feet to the northeast and 330 feet to the south of W-2, respectively) were used as observation wells throughout the test. Drawdown and recovery plots for on-site pumping and observation wells are presented in Appendix III.

The discharge rates for the three pumping wells were adjusted throughout the 96-hour test as described below:

- W-2 was pumped at a rate of 25 gpm for 45 hours at which time the rate was increased to 65 gpm and remained at this level for the rest of the test.

- W-4 was pumped at a rate of 40 gpm for the first 32 hours of the test. The rate was then increased to 60 gpm for the remainder of the test.

- W-6 was pumped at a rate of 50 gpm for 48 hours. The discharge was then increased to 80 gpm. Excessive drawdown forced a shutdown of W-6 at 65 hours into the test. Pumpage was resumed 8 hours later at a rate of 30 gpm and remained at this rate for the remainder of the test.

- Wells W-3, W-5 and W-7 were initially pumped at rates of 30, 40 and 45 gpm, respectively. Due to excessive declines in the water level and deceases in yield, these three wells were subsequently omitted from the bedrock network.

Water levels in nine off-site wells were monitored during the June test for the purposes of identifying any significant interference effects in response to on-site pumpage. Baseline readings were taken in the off-site observation wells every day during the week prior to start-up in order to develop an off-site, non-pumping water level data base for comparison purposes. Locations of the off-site observation wells are shown on Figure 2 and individual off-site well designation is given in Table 1. Hydrographs of the water level information from the observation wells included in the June pumping test are presented in Appendix V.

3.2 Sand and Gravel Well Network

On October 3 through 7, the two recently-installed sand and gravel wells, SG-1 and SG-2 were pump tested. Pumping of SG-1 commenced at 2:02 pm on Monday, October 3rd and continued until 12:50 pm on Friday, October 7th; a total duration of approximately 95 hours. On Thursday, October 6th at 11:00 am, pumping of well SG-2 commenced in combination with pumpage of SG-1. SG-2 was shut down in conjunction with SG-1 resulting in a total pumping duration of approximately 26 hours for SG-2. Each of the sand and gravel wells were pumped at a rate of 75 gpm throughout the test.

Drawdown and recovery data were collected from the two pumping wells as well as the two on-site sand and gravel observation wells, MW-1 and MW-2. These data are presented in the form of semi-logarithmic time-drawdown plots in Appendix III.

Water levels in 12 bedrock observation wells were measured during the test to assess possible interference from on-site pumpage. The observation well network included five on-site wells designated W-4, W-6, W-9, W-10 and W-11, as well as seven off-site wells designated A, B, C, D, E, H, and I. Baseline water levels in the designated observation well network were established from periodic measurements collected two weeks prior to the test and continuing up until commencement of on-site pumpage. A stream gauging station was set up on the East Branch of the Croton River near the two sand and gravel pumping wells to assess any potential impact of pumpage upon surface water levels. Observation well and stream gauging water levels measured in connection with the October test are depicted on hydrographs in Appendix V.

4.0 INTERPRETATION OF RESULTS

4.1 Bedrock Well Network

4.1.1 Pumping Test Analysis

The Cooper-Jacob Method (1946) of aquifer analysis was performed on the three pumping rock wells and the two on-site observation rock wells. Transmissivities, storage coefficients and specific capacities were calculated using initial pumping rates for drawdown and final pumping rates for recovery. Semi-logarithmic plots of drawdown and recovery for the bedrock wells are presented in Appendix III along with definitions of the aquifer characteristics discussed in this section.

Transmissivity (T) and specific capacity values obtained through pumping and on-site well data analysis were used to estimate aquifer conditions beneath the Watchtower Site. These data, as well as well depth, stabilized drawdown, and pumping rate for the Watchtower bedrock well network are appended on Table 2.

Analysis of pumping test data indicates that the bedrock underlying the southern portion of the site (area of W-1, W-2 and W-8) appears to possess the greatest water-transmitting potential. Here, test data exhibits transmissivity values between 400 and 600 gallons per day per foot (gpd/ft). Well W-2 has the highest specific capacity value, 1.14 gpm/foot, of all the bedrock wells.

Six of the thirteen observation wells displayed an observable response to on-site pumpage. Noletti's Bakery, the southernmost observation well, exhibited water level decline of approximately 5 feet below normal following the increase of the pumping rate in W-2 from 25 gpm to 65 gpm. The Berkshire Nursery displayed a drawdown of approximately 13 feet below normal during the same interval of pumpage.

TABLE 2

SUMMARY OF PUMPING TEST RESULTS
COOPER - JACOB METHOD (1946)
BEDROCK WELL NETWORK

WELL NO.	DEPTH (FEET)	PUMPING RATES (GPM) INITIAL	PUMPING RATES (GPM) FINAL	STABILIZED DRAWDOWN (FT)	TRANSMISSIVITY (GPD PER FT) PUMPING	TRANSMISSIVITY (GPD PER FT) RECOVERY	SPECIFIC CAPACITY (GPM PER FT)	INCLUDED IN FINAL SYSTEM
W-1	350	--	--	--	571	594	--	NO
W-2	365	25	65	57	571	424	1.14	YES
W-3	450	30	24	300	--	--	0.08	NO
W-4	450	30	60	218	229	463	0.28	YES
W-5	420	30	OFF	--	--	--	--	NO
W-6	400	50	30	92	190	114	0.54	YES
W-7	460	45	OFF	--	--	--	--	NO
W-8	--	--	--	--	667	594	--	NO

The northern farmhouse well (W-9) and the well servicing Magdi's Diner were flowing prior to the pump test but exhibited drawdown effects of greater than 50 feet during the pumping period. The Watchtower Society upgraded the water supply system servicing Magdi's Diner by installing a submersible pump to a depth of 80 feet (in place of the original shallow jet pump) and by also raising the well casing two feet above ground level to prevent possible entry of surface runoff.

Recharge to the bedrock aquifer occurs through direct precipitation at the ground surface and from flow from adjacent fractures.

4.1.2 Water Quality

Prior to the termination of the June pumping test, well-water samples were collected from pumping wells W-2, W-4 and W-6. The samples were packaged in laboratory-issued sample containers, labelled accordingly to field designation, and hand-delivered under full chain-of-custody control to State Certified Envirotest Laboratories, Inc. in Newburgh, N.Y. for chemical analysis. Analysis included New York State Sanitary Code primary and secondary Part 5 drinking water constituents, volatile organics and radioactivity (gross alpha, gross beta, radium 226 and radium 228). Original laboratory results are included in Appendix VI.

None of the samples exhibited concentrations of New York State Sanitary Code Part 5 primary, secondary or radiological parameters at or above the maximum prescribed contaminant levels. No concentrations of volatile organic compounds at or above laboratory detection limits were observed in the samples collected from any of the wells.

4.2 Sand and Gravel Well Network

4.2.1 Pumping Test Analysis

An analysis of the sand and gravel aquifer's transmissivity (T) and Storativity (S) was performed by plotting the drawdown recorded in wells MW-1, MW-2 and SG-2 in response to the pumping of well SG-1. Plots of the drawdown (s) versus the time divided by the distance to the pump well squared (t/r^2) were constructed on 3 x 5 cycle logarithmic graph paper and are included in Appendix IV. These plots are very useful in that they allow the drawdown data to be compared to the standard Theis type curves as well as to a series of additional well function type curves developed by the United States Geological Survey (Lohman, 1979). Based upon the geologic framework -- 50 feet of loosely packed silt and clay over 10 to 20 feet of sand and gravel -- and the shape of plotted drawdown data, the plots were analyzed using the "leaky" confined aquifer method developed by Hantush and Jacob (1955), Cooper (1963) and presented in Lohman (1979).

By overlaying the plots of the drawdown data over the type curves presented in Appendix IV, it is clear that the graphs deviate significantly from the standard Theis curve and that vertical leakage from the overlying silt and clay unit has occurred. Using this method, it was possible to calculate not only the transmissivity and storativity of the aquifer, but also the permeability of the overlying clay unit. A summary of aquifer analytical results is included on Table 3 below.

TABLE 3

SUMMARY OF PUMPING TEST RESULTS
HANTUSH-JACOB METHOD (1955)
STANDARD GRAVEL WELL NETWORK

Well #	Transmissivity (gpd/ft)	Storativity	Hydraulic Conductivity of Confining Unit (cm/sec)	Specific Capacity (gpm/ft)
MW-1	10,000	8.2×10^{-4}	3.5×10^{-3}	—
MW-2	12,000	1.0×10^{-3}	3.1×10^{-4}	--
SG-1	—	—	—	3.75
SG-2	29,000	6.6×10^{-3}	8.0×10^{-6}	2.5

Notes: (1) Well Construction Details are included in Appendix I.

(2) Calculations of aquifer transmissivity and storativity are included in Appendix IV.

Water levels were monitored in 12 bedrock wells adjacent to the buried glacial valley prior to and during the pumping test. The stage of the East Branch of the Croton River was also monitored. Of the 12 wells monitored, a response was only detected in two wells, W-10 and W-D. The latter well is owned by Pizza King. Well W-10 (which has no permanent pump installed) is located approximately 200 feet northeast of well SG-2. This well dropped approximately two feet as a result of the pumping test. The Pizza King well also dropped approximately two feet, however, this is probably due to the pump cycling on and off in the well and not to the pump test in the sand and gravel aquifer. The stream gauge indicated a fluctuation of approximately 0.4 feet over the course of the test.

Recharge to the sand and gravel aquifer occurs through seepage from the overlying silt and clay unit, from the adjacent bedrock fractures and to a lesser degree, from the East Branch of the Croton River.

4.3 Water Quality

Shortly before the termination of the test, groundwater samples were collected from wells SG-1 and SG-2 and hand-delivered under chain-of-custody control to State-Certified Envirotest Laboratories, Inc. Analysis included New York State Sanitary Code Part 5 primary, secondary and radioactivity parameters plus the Target Compound List (TCL) which includes volatile organics, semi-volatile organics and metals.

The results of these analyses, presented in Appendix VI, indicate that the sand and gravel wells are in compliance with the NYS Sanitary Code, Part 5. Additionally, no organic compounds were detected using EPA methods 624 and 625.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

1. A total sustained yield of 240 gpm has been demonstrated for the Project with the best bedrock well out of service. This represents a yield of 10 gpm in excess of twice the average daily demand of 230 gpm.

2. The planned water supply system consists of two separate well networks: a bedrock well network capable of sustaining a combined well yield 90 gpm with the best well out-of-service and a sand and gravel well network capable of sustaining a combined yield of 150 gpm.

3. Based on the analytical results of the bedrock well network (wells W-2, W-4 and W-6) and the sand and gravel well network (wells SG-1 and SG-2), the groundwater supply system developed for this project is in compliance with the New York State Sanitary Code. In addition, no volatile organic compounds were detected in the bedrock wells using EPA Method 624. The samples from the sand and gravel wells revealed no detections of organics using EPA methods 624 and 625.

4. Based on the limited drawdown and sustainable pumping water levels of wells SG-1 and SG-2, the sand and gravel aquifer west of Route 22 can support additional water supply wells, if required.

5. The wells serving Noletti's Bakery and the Berkshire Nursery exhibited drawdown due to pumpage of the bedrock well network. This drawdown, is considered insignificant in consideration of the available water column above the pumps in each of these wells, and the extended period of groundwater withdrawal associated with the bedrock pumping test.

6. The well servicing Magdi's Diner was significantly impacted due to simultaneous pumping at the nearby Wells W-5, W-6 and W-7 during the bedrock well field pumping test. This well was mechanically upgraded as discussed in Section 4.0 to preserve a sufficient water supply to the Diner.

7. No significant water level impacts to the representative wells neighboring the Site were recorded during the sand and gravel well network pumping test.

5.2 Recommendations

1. Based on the excessive drawdown observed in the Magdi's Diner well, it is suggested that well W-6 not be pumped at rates greater than 30 gpm and that W-7, the northernmost on-site well, be preserved only for future water level monitoring purposes.

2. C A Rich further recommends that each well incorporated in the final system have a dedicated well head protection zone (sanitary easement) of no less than 100 feet and preferably 200 feet in radius.

3. The bedrock wells should not be pumped at rates beyond those demonstrated to be sustainable in this report and should have low-level shut-off switches installed 10 feet above the intake settings of the pump.

6.0 REFERENCES

Cooper, H.H., Jr. and Jacob, C.E., 1946, A Generalized graphical method for evaluating formation constants and summarizing well-field history: Am. Geophys. Union Trans., V. 27, No. 4, p. 526-534.

Fisher, D.W., Isachen, Y.W., and Rickard, L.V., 1970, Geologic Map of New York, Lower Hudson Street, NYS Museum, Map & Chart Series 15.

Hantush, M.S. and Jacob, C.E., 1955, Non-steady radial flow in an infinite leaky aquifer: Am. Geophys. Union Trans., V. 36, No. 1, p. 95-100.

Laurent Engineering Associates, 1987, Draft Environmental Impact Statement for the Watchtower Educational Center and Patterson Inn.

Lohman, S.W., 1979, Ground-Water Hydraulics, U.S.G.S. Professional Paper 708.

Rich, C.A., 1985, Pumping Test Analysis, Wells 1 and 2, Watchtower Educational Center, Patterson, New York.

Theis, C.V., 1935, The relation between the lowering of the piezometric surface and the rate and duration of discharge of a well using ground-water storage: Am. Geophys. Union Trans., V. 16, p.519-524.

EXCERPTS FROM
GROUNDWATER SUPPLY ANALYSIS
WATCHTOWER EDUCATIONAL CENTER
PATTERSON, NEW YORK

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August 12, 1996

WELL AND GEOLOGY DATA
DRAFT REPORT
PW:PWA August 13, 1996

INTRODUCTION

Approximately 2 weeks were spent in analyzing the water supplies for the Watchtower Education Center located in Patterson, New York. This was between August 3 and 17, 1996.

A report submitted in November 1988 by C.A. Rich Consultants, Inc., covering the Ground Water Assessment, Watchtower Education Center, Patterson, New York, was analyzed. This report deals with the geology of the region, and analyses of water wells drilled, and their subsequent pump test results.

The purpose of this report is to summarize all of the pertinent geological and hydrological information garnered to date, and recommend future procedures to monitor the water supplies for Watchtower Education Center.

GEOLOGY

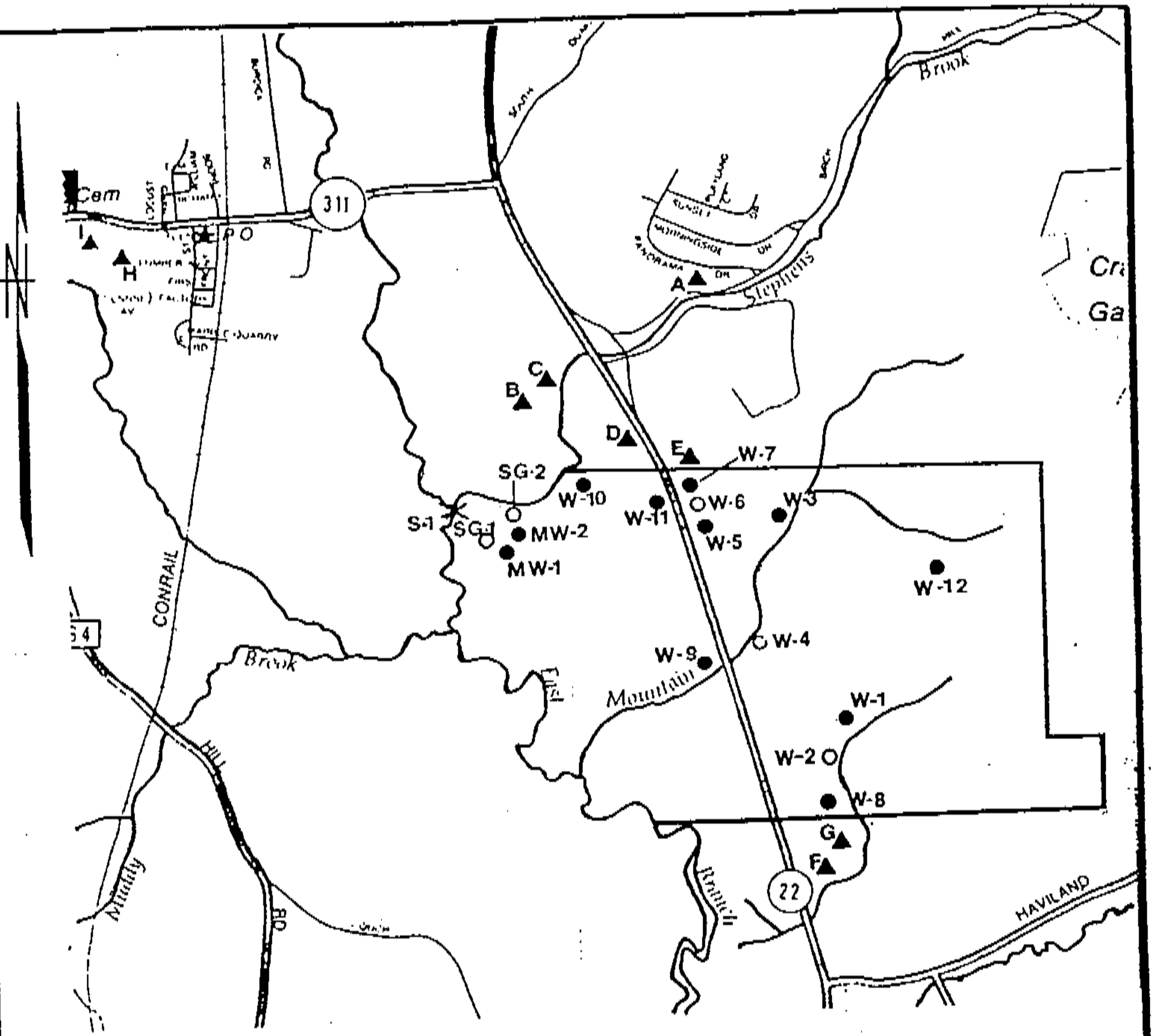
According to C.A. Rich Consultants, Inc., the geology of the Watchtower property is described as follows:

"The eastern portion of the Watchtower property (east of Route 22) is underlain by unconsolidated glacial deposits comprised of sand, silt, gravel, and clay. These deposits rest upon pelitic schist and amphibolite bedrock of the Manhattan Formation. Steep slopes, fields, and sporadic rock outcrops dominate this area. Directly west of Route 22, the bedrock underlying the Watchtower property consists of Stockbridge marble which is less resistant to physical and chemical weathering than the Manhattan formation, and has therefore formed a low-laying valley.

Overlying the bedrock in this area is a buried glacial valley. Borings performed in this section of the property indicate that directly above the bedrock is 10 to 20 feet of fine to coarse sand and gravel. Above this is approximately 50 to 60 feet of poorly consolidated (poorly sorted) silt and clay." This information was obtained from well logs of the two sand wells installed west of Route 22.

AQUIFER PARAMETERS

Two different well types; that is, producing from different aquifer types, are present within the Watchtower property at Patterson, New York (see Well Location Map). The first of these are wells drilled into the metamorphic rocks of the Manhattan Formation(Gneisses and Schists); the second aquifer type is the unconsolidated sands and gravels of glacial deposits overlying the marble (another metamorphic rock type consisting primarily of calcium carbonate) of the Stockbridge formation (see Well Location Map).



EXPLANATION

● ON-SITE OBSERVATION WELL

▲ OFF-SITE OBSERVATION WELL

○ PROPOSED SUPPLY WELL

X STREAM LEVEL GAUGE

APPROXIMATE SCALE

0 — 2000'

FIGURE 2

CA RICH CONSULTANTS, INC.

Certified Ground-Water and Environmental Specialists

ON AND OFF SITE WELL
LOCATION MAP
WATCHTOWER EDUCATIONAL CENTER
PATTERSON, N.Y.

The wells drilled into the Manhattan formation will be referred to as bedrock wells, as described in the C.A. Rich, Consultants report.

Water occurs in the Manhattan formation in secondary fractures: "Primary porosity and permeability is negligible. Consequently, the quantity of groundwater available to the on-site wells is controlled by the geometry (fracture patterns) and rock density of intercepted, water-bearing joints and fractures within the bedrock aquifers."

Eleven bedrock wells were drilled, and only 3 were finally used to supply water to the Watchtower Facility. The data shown on Table 2, taken from the C.A. Rich report, shows the depths and aquifer characteristics derived from drilling and pump testing of 8 of the wells. The other wells were used as observation wells, necessary for aquifer analyses.

As can be seen from the results of pump testing, typical low yielding wells are the only type one can expect in this aquifer type. Bedrock, composed of these types of metamorphic rocks, can produce only from secondary fracturing. Normally, the fractures are few and far between. Fracturing becomes less and less at depth.

Transmissivity and specific capacity rates shown in Table 2 are very low. Transmissivity is defined as the quantity of flow through a porous material. In this case, it is defined as the quantity, in gallons of groundwater per day, through a vertical width of one foot times the thickness of the aquifer with a groundwater able slope or gradient of 45 degrees or 100 percent. In wells 2, 4, and 6, they average only 335 gpd/ft. In groundwater parlance, this means that an assured groundwater source from these wells is not very reliable. This would be true, especially during a prolonged period of drought. Also a low specific capacity has been measured. This is defined as the pumping yield of a well expressed as gallons per minute per foot of drawdown. The average specific capacities of the 3 wells are only about 0.65 gallons per minute per foot of drawdown. That is to say one would have a total drawdown of 100 feet to produce 65 gallons per minute from each of the wells. This is normally considered excessive and would require an expensive pumping system, especially power for pumping (See Table 2).

By overlaying the plots of the drawdown data over the type curves presented in Appendix IV, it is clear that the graphs deviate significantly from the standard Theis curve and that vertical leakage from the overlying silt and clay unit has occurred. Using this method, it was possible to calculate not only the transmissivity and storativity of the aquifer, but also the permeability of the overlying clay unit. A summary of aquifer analytical results is included in Table 3 below.

TABLE 2

SUMMARY OF PUMPING TEST RESULTS
COOPER – JACOB METHOD (1946)
BEDROCK WELL NETWORK

WELL NO.	DEPTH (FEET)	PUMPING RATES INITIAL	(GPM) FINAL	STABILIZED DRAWDOWN (FT)	TRANSMISSIVITY (GPD PER FT) PUMPING	RECOVERY	SPECIFIC CAPACITY (GPM PER FT)	INCLUDED IN FINAL SYSTEM
W-1	350	--	--	--	571	594	--	NO
W-2	365	25	65	57	571	424	1.14	YES
W-3	450	30	24	300	--	--	0.00	NO
W-4	450	30	60	218	229	463	0.28	YES
W-5	420	30	OFF	--	--	--	--	NO
W-6	400	50	30	92	190	114	0.54	YES
W-7	460	45	OFF	--	--	--	--	NO
W-8	--	--	--	--	667	594	--	NO

TABLE 3

SUMMARY OF PUMPING TESTS RESULTS
HANTOSH-JACOB METHOD (1955)
STANDARD GRAVEL WELL NETWORK

Well #	Transmissivity (gpd/ft)	Storativity	Hydraulic Conductivity of Confining Unit (cm/sec)	Specific Capacity (gpm/ft)
MW-1	10,000	8.2×10^{-4}	3.5×10^{-3}	—
MW-2	12,000	1.0×10^{-3}	3.1×10^{-4}	—
SG-1	—	—	—	3.75
SG-2	29,000	6.6×10^{-3}	8.0×10^{-6}	2.5

Another factor to reckon with is what is referred to as storativity, or the coefficient of storage. This is defined as the amount of liquid (in this case, groundwater) that would drain by gravity from one cubic unit of aquifer material. Figures shown in Table 2, show only 0.01 to 0.001. A figure of 0.15 is common for a good aquifer. This points out the unreliable characteristics of most fractured aquifers, especially those existing in the bedrock of the Watchtower Facility in Patterson, New York.

The two "sand" wells, referred to as SG-1 and SG-2 in the C.A. Rich report, were drilled on the western portion of the Watchtower Property, west of Route 22. The material making up this aquifer, as stated above, is unconsolidated deposits of sand and gravel overlain by a thick sequence of relatively impervious silts and clays, (called aquitards or aquicludes) all derived from glacial deposits. Table 3 of the Rich report shows the calculated aquifer parameters of Wells SG-1 & 2 and MW-1 & 2. The latter two wells are 2-inch observation wells used to calculate the parameters. One can note the differences in the transmissivities between the sand and gravel wells and those of the bedrock wells. The column called "Hydraulic Conductivity of Confining Unit" shows that overlying silts and clays existing in the area have extremely low permeabilities (very low transmissivities). This condition usually results in an artesian condition though in this case, a non-flowing one. The underlying sand and gravel aquifer is completely saturated and is under some pressure. This is shown by the very low storativity figures derived from the pumping data. C.A. Rich referred to the condition existing at this location as a "leaky Aquifer Condition," that is, whenever the pressure is reduced by pumping in the sand and gravel aquifer, the water existing in the overlying silts and clays would begin to migrate to the lower pressure caused by the pumping, or they would leak downwards.

Considering the much higher yields, the higher transmissivities, and the total volume of the sand and gravel aquifer, it is fairly obvious that this would be the preferred source of water for the Watchtower property. It would also be much less affected by droughts, especially since the recharge to the aquifers is from a different source and much larger area than those of the bedrock aquifers.

STATIC WATER LEVELS

Some information is available on the fluctuation of the regional water table in both the bedrock and sand-gravel aquifer. Depths to water have been measured fairly continuously since October 1993. These are shown on the included well chart. Also the original depth to water, dated June 1988 is also shown.

The bedrock wells static water levels are complicated by the fact that frequently the measurements were made during pumping or shortly after pumping stopped. This would not give a true static reading since it usually takes 2 to 3 days for a water level to recover to its original level.

From observing the well chart, it appears that some areas of the bedrock aquifer are in a state of overdraft; that is, more groundwater is being taken from the aquifer than is being recharged from rainfall. Well #1, no longer is use, had an original static water level of 49 feet below ground level. On September 1, 1995, it was measured to be 112 feet below ground level.

This has been a substantial drop of 63 feet in a 7-year period. Whereas Well #6 has only dropped 7 feet in 7 years.

The sand wells are not in an overdraft condition. Well #SW-1, which had an original piezometric (pressure) head of 3.6 feet below ground level (October 1988) was measured to be 9.5 feet on September 10, 1994. Other measurements with greater depths were made during pumping. SW-2 had an original piezometric head of 4.8 feet (October 1988) and was last measured to be 8 feet on October 22, 1994. Piezometric water levels can vary greatly at times.

WELL YIELDS

It appears that well yields have remained fairly constant in both the bedrock and sand wells. The attached well history shows bedrock wells 2, 4 & 6 are fairly constant as are the sand wells. However, just the yields, by themselves, do not tell the whole story. A more meaningful measurement is the specific capacity of the well. As stated above the specific capacity can be obtained by measuring the yield and then measuring the drawdown at the same time. Care must be taken that the drawdown in the pumped well has stabilized. A simple calculation will give the specific capacity in gallons per minute per foot of drawdown. Example, if a well is pumping at a stable rate of 50 gallons per minute (GPM) and a stabilized drawdown of 10 feet is measured, the specific capability would be 50 gpm divided by 10 feet, or 5 gpm per foot, written as 5 gpm/ft.

WELL PROBLEMS

Well #1 in the bedrock has only been used as a source of water for construction. No well permit was ever attained for commercial use of the well. A large decline in the static level has occurred.

Well #6 has an iron problem, most likely due to iron-fixation bacteria. Anaerobic bacteria is present in all aquifers, and why they (the bacteria) begin to produce Fe_2O_3, which oxidizes to Fe_3O_4, when exposed to air, is beyond my expertise. This, however, is common. It can be treated by slugging the well with high dosages of chlorine. This is usually a continuing maintenance requirement.

Well #4 has a corrosion problem caused by connecting two dissimilar metals together. Why this is happening only in this well and not others with similar hookups is not known. Cathodic protection may solve the problem.

CONCLUSIONS

Watchtower Property – Patterson, New York

1. The bedrock wells are not a long-term reliable source of water. This is because of the nature of the Manhattan metamorphic rocks with their poor transmissivity and low storativity factors together with their small recharge areas. Wells drilled into this formation will produce low yields and most likely dry up during severe drought conditions.

2. Since 3 wells are already in use within the Manhattan formation (Wells 2, 4, & 6) and pumps are already installed, continue using them.

3. The sand wells, SG-1 and SG-22, are significantly better and more reliable than those of the bedrock. Well #SG-2 had a calculated transmissivity (T) of 29,000 gallons per day per foot (gpd/ft). Also, the specific capacity was measured to be 2.5 gpm/ft and well #SG-1 was 3.75 gpm/ft.

   Both wells produce from what is referred to as "leaky aquifers" (see above) and both are artesian, but not flowing.

   The sand wells have a significantly larger recharge area than do the bedrock wells and the storage of groundwater within the aquifers are much greater than those of the bedrock. This is important since the sand wells would not be affected nearly as much by drought conditions.

4. It appears from all of the well test data that reliable, long-term supplies of groundwater is available for the Watchtower Property at Patterson, New York. Additional wells should be drilled within the sand and gravel aquifers, without danger of overdraft conditions, providing the water requirements for the Watchtower property do not significantly rise.

RECOMMENDATIONS

1. As stated above, continue using the bedrock wells, since the wells area already equipped with the pumps and distribution pipes.

2. Monitor the wells on a quarterly basis (every three months) to measure the yield, in gpm, after at least 16 hours of continuous pumping and the yield is stabilized.

3. At the same time as the yield is measured, measure the drawdown during pumping. (Distance to water during pumping.)

4. After exactly 16 hours after the well is shut off, measure the recovery (distance to water) of the well. It is important to make sure that this is always the same number of exact hours. For instance, if the yield and drawdown are measured at 4:00 p.m. and then the pump is stopped, the recovery must be measured at exactly 8:00 a.m. the next day. This will give a standard base for comparisons. Again, this should be done on a quarterly basis for each pumping well.

5. Calculate the specific capacity for each pumping well on a quarterly basis (see above).

6. Plot hydrographs for yields, drawdowns, static water levels, and specific capacities. This can be done by plotting the four functions on graph paper on the Y axis (vertical) and against time on the X axis (horizontal). This will be done quarterly. Connect each point to make the hydrograph.

7. Measure the total $CaCO_3$ contents of each well on a semi-annual basis. Plot results against time.

8. If new wells are to be drilled in the sand and gravel aquifers, consider gravel packing the wells. Even though this is more expensive, the yields will be greater, the drawdowns less, and the life expectancy of the wells will be extended considerably. Details of this procedure can be found in the book entitled, "Groundwater and Wells" published by Johnson Filtration Systems, Inc., St. Paul, Minnesota 55112. Third printing 1989 on pages 476-483.

9. Whenever a new pump is installed or an old one is removed and reinstalled on any producing well, attach a one-half inch, open-ended galvanized pipe to the pump column, with the bottom of the pipe anchored about one foot above the pump intake. The top of the one-half inch column should be about a foot above ground level and anchored so as to keep it steady. This will be used to measure static water levels and drawdowns with an electric water level indicator. This is a much more accurate method than an air line, and easier to perform. The 1/2-inch pipe can be in 20 feet sections and connected by threaded couplings so that they can be added or removed during installation.

10. Survey elevations of each of the bedrock and sand wells to the measuring points of the wells. This will usually be where the attachment to the airline is. This data will then be used to construct a groundwater contour map so as to determine the direction of flow of both aquifers, and to determine if the two aquifers are hydraulically connected.

WELL HISTORY

WATCHTOWER EDUCATIONAL CENTER

STATIC LEVEL (LET WELL SET 12 HOURS BEFORE TESTING)

	WELL 1	WELL 2		WELL 4		WELL 6		WELL S1		WELL S2		NOTES
DATE	LEVEL	LEVEL	GPM	LEVEL	GPM	LEVEL	GPM	LEVEL	GPM	LEVEL	GPM	
10-93	67							10'		8'		
12-93									82		82	
6-94	94					24		9'		8'		
8-94										10.5 →		w/ S1 RUNNING
9-94	86					30		9.5		8.5		
10-94								9		8		
8-95	99					24			80		81	
10-95	112					30			80		79	
1-96									82		80	
5-96									82		80	
7-96									82		80	
6-88	49	25		18		23		3.6		4.8		

wellhist.doc

NOTES: All levels are distance from ground level to water level

WELL HISTORY

WATCHTOWER EDUCATIONAL CENTER

	WELL	2	WELL	4	WELL	6	WELL	SW1	WELL	SW2	NOTES
DATE	LEVEL	GPM	LEVEL	GPM	LEVEL	GPM	LEVEL	GPM	LEVEL	GPM	
9-27-95		55		50		60		80		79	
11-22-95		59		41		60		80		80	
12-22-95		59		41		60		82		80	
1-22-96		58		36		60		82		80	
2-28-96		59		34		62		81		80	
3-28-96		59	PULLED/NEW PIPE			62		82		80	
4-24-96		58	NOT WORKING			60		80		80	
5-10-96		60	OUT OF SERVICE			62		82		80	
6-28-96	—	—	START UP AFTER [illegible]	62 57 *	—	—	—	—	—	—	
6-29-96	—	—	ALL DAY AVE	51	—	—	—	—	—	—	clean strainer
7-2-96		64		—		82		82		80	
7-24-96		59		53		61		82		80	

wellhist.doc

NOTES: All levels are distance from ground level to water level

Record whether pump is off or running

* Well #4 INSTALLED 6-28-96
- NEW 2" GALVANIZED PIPE
- NEW S.S. CABLE
- NEW WIRE 10 G. instead of 8 G.
- NEW LEVEL 370' to bottom of pump
- 363' to bottom of tube
- 7 ½ HP MOTOR
- 13 stages PUMP

STANLEY M. REMINGTON
Hydrogeologist and Hydrologist

FIELDS of SPECIAL COMPETENCE	Groundwater Hydrology Surface Water Hydrology On-Farm Water Management
EDUCATION	AA/Civil Engineering/John Muir College/1949 BS/Geology/University of California, Los Angeles/1952 Graduate Courses/Hydrology/San Jose State University/1959-1960 USGS Short Course/Hydrology/University of Arizona/1965
REGISTRATIONS	Registered Geologist #1056 – California Certified Engineering Geologist #EG 424 – Calif.
PUBLICATIONS	Groundwater Occurrences in Jordan, 1963, Food and Agricultural Organization, United Nations The Geology and Groundwater of 500 sq. kms of Southern, West Jordan, 1967, Natural Resources Authority, Got. of Jordan Quantitative Analyses of the Aquifers of the Burami Area, Sultinate of Oman, 1986, Dept. of Water, Government of Oman
YEARS OF EXPERIENCE	35 Years

PROFESSIONAL EXPERIENCE

July 1990 to Present

Member of a citizens' committee to investigate the possible contamination of the City of St. Charles, Missouri, well field by volatile organic compounds and PCB's. Named to the committee by the Mayor of St. Charles. The team is investigating groundwater and chemical data provided by the Environmental Protection Agency and a local engineering firm. Evaluated several reports on the contamination and made recommendations for further field studies. Now awaiting the completion of the studies by the EPA.

February 1989 to Present

Under contract with the St. Charles County to work with the Department of Energy, Department of Natural Resources, State of Missouri, and EPA on a CERCLA (Superfund) project at Weldon Spring Missouri to sample groundwater, perform chemical analyses by subcontract, review technical data submitted concerning the project, review and prepare technical comments of documents regarding environmental issues, submit monthly reports, represent St. Charles County at information meetings, public hearings and as liaison on environmental issues. This is for the

St. Charles County well field at Weldon Spring, which supplies drinking water to about 60,000 residents. The well field is in danger of radioactive and semi-volatile compound contamination.

March 1988 to Present

Chief Hydrology Consultant to the St. Charles Countians Against Hazardous Wastes, Inc. Duties involve giving advice to the SCCAHW on the eventual chemical and radioactive contamination of the Weldon Springs well field in St. Charles County, Missouri. Interpreting reports submitted to St. Charles County in regards to a well monitoring program designed to detect both radiologic and chemical contamination, speaking to citizen groups concerned over contamination of water resources in general throughout St. Charles County, working and attending meetings with consultants and professionals within Missouri, e.g., U.S. Department of Energy, U.S. Environmental Protection Agency, Untied States Geological Survey, and various engineering companies involved in the cleanup of radioactive and chemical wastes in raffinate pits and an open quarry dump at Weldon Springs, working with a local college and the St. Charles County Commission on establishing an eventual repository for quality water resources data in St. Charles County.

1985 to 1986 Consultant to Tetra Tech International District Chief, Public Authority for Water Resources, for Buraimi District, Sultanate of Oman. Conducted a one-year groundwater quantitative study within the Greater Buraimi area and supervised in setting up a groundwater model in one of the groundwater systems. Published two reports on the results of the study.

1983 Groundwater Consultant with USAID in Somalia for one-month assignment to evaluate the Comprehensive Groundwater Project under contract to Louis Berger International and Roscoe Moss companies. Acted as team head for three persons to evaluate progress of an exploratory phase of a $4.5 million, three-year groundwater exploration and development project for the government of Somalia. Personally evaluated the drilling and hydrogeological elements of the project and supervised the socioeconomic phases. Submitted final report including recommendations.

1980 to 1982 Hydrologist on a two-year contract with the Jordan Valley Authority to assist the Hydrology Division to explore the groundwater potential for the eastern escarpment of the Jordan Valley and the ground and surface waters of Wadi Araba. Was original proponent of the $7.5 million project and wrote a project paper. Duties involved the supervision of Jordanian professionals in the drilling of 14 exploratory wells in the Jordan Valley escarpments to depths ranging from 700 to 1250 meters, grouting, pump testing, well designs, computing aquifer parameters, establishing stream gauging, meteorological stations, and drilling 54 shallow exploratory wells in Wadi Araba. Also supervised bi-weekly seminars in hydrology subjects.

1981 Groundwater Consultant to Oman for ten-day assignment to evaluate an ongoing country-wide groundwater project and to make recommendations for revisions to the program wherever required.

1980 Irrigation Engineer and Team Leader on three-month assignment to conduct a feasibility study for the Asian Development Bank for a $13 million, on-farm water project in the Punjab and Northwest Frontier, Provinces of Pakistan.

Supervised a team of four professionals to select areas of Pakistan to initiate a five-year, on-farm water management project and ascertain the feasibility of such a project. Worked with several Pakistani government agencies and personnel. Recommended various watercourse designs and land leveling techniques; calculated benefit/cost ratios, etc.; and submitted a final feasibility report to the ADB.

1977 to 1979 On worldwide basis, worked as Hydrologist on consulting assignments for all USAID Missions and foreign governments requesting services. Duties involved writing proposals, conducting training seminars, conducting ground and surface water assessments, advising on water availability for irrigation and domestic uses.

1975 to 1977 Hydrologist to USAID Mission in Pakistan Loan Committee Chairman on a $22.5 million loan for a five-year, on-farm management project. Duties involved working with provincial government officials on land leveling and irrigation watercourse construction projects, supervising a Soil Conservation Service (USDA) team, training local personnel, supervising a Colorado State University contract for agricultural extension, and related activities.

1970 to 1975 Hydrologist and General Consultant to USAID Missions worldwide. Duties involved short-term consulting services to USAID and foreign governments requesting services, writing proposals for hydrologic (surface and groundwater) projects, monitoring ongoing projects and foreign government water resource agencies, and conducting qualitative and quantitative analyses for both surface and groundwater schemes in several countries.

1967 to 1970 Near – East South Asia (NESA) Regional Hydraulic Engineering Advisor (Water Resources, USAID) headquartered in Delhi, India. Advised all USAID Missions on matters pertaining to the exploration, assessment, and development of water resources. Duties included evaluating water resource organizations of the NESA countries; providing consulting services in ground and surface water; recommending technical and administrative changes within existing water institutions; advising American Embassy and USAID officials on the technical and legal aspects of water problems; drafting proposals for investigation, production, and conservation of water resource programs; coordinating USAID activities in water resources with other bilateral and multilateral agencies engaged in similar activities; working with agricultural personnel in matters of irrigation and water management; monitoring continuing and completed USAID financed loan and grant projects in ground and surface water investigations and evaluating their effects; and other related activities.

1961 to 1967 Groundwater Advisor (USAID), Natural Resources Authority of the Kingdom of Jordan, Amman, Jordan. Involved in advising and training of Jordanian groundwater personnel in all phases of the exploration, assessment, and development of groundwater. Duties were those of Acting Chief of the Groundwater Division for two years, setting up geological mapping, well drilling and testing, and exploration and assessment programs; monitoring and supervising geological contract mapping of both USAID and other bilateral AID-financed programs; coordinating all bilateral and multilateral aid in geological mapping and groundwater studies; personally mapping 500 square kilometers (scale 1/25,000) of an area in the southern part of West Jordan; publishing work stressing the relationship between permeability and geological structures in karstic aquifers; setting up domestic and U.S. training programs in coordination with the University of Arizona; advising the surface water division on all phases of stream gauging and data collection and interpretation; and setting standards for publication of reports.

1958 to 1960 District Hydrologist, Santa Clara Valley Water Conservation District, San Jose, California. In charge of all hydrographic analyses, groundwater and geological studies, and annual cloud seeding analysis. Duties included collecting and interpreting stream flow data, conducting evaporation studies, analyzing percolation data, determining aquifer parameters, supervising personnel in hydrographic duties, designing stream gauging structures, providing water news data to local news media, lecturing and conducting tours of the District's facilities for school groups, working with consulting engineering representatives on specific contracts, and related activities.

1956 to 1958 Field Geologist, Ralph M. Parsons Co., Jeddah, Saudi Arabia. One of a team of five under contract for the purpose of setting up a Division of Water for the Ministry of Agriculture. Duties included reconnaissance and detailed geological mapping, selecting water well drilling sites, being in charge of well drilling for the western half of the country, training local technical personnel in geological and groundwater activities, advising and aiding in the planning of water systems for villages, and writing technical reports.

1952 to 1956 Assistant Civil Engineer, Los Angeles County Flood Control District, Los Angeles, California. Involved in the planning, construction, and maintenance of a water pressure barrier to prevent seawater infiltration into freshwater aquifers in the Los Angeles Basin at Manhattan Beach, California. Duties included logging wells, drawing geological cross sections, constructing isopach maps, conducting conductivity surveys on water wells, supervising development and redevelopment of recharge wells, analyzing groundwater for its chemical constituents, supervising personnel in hydrographic functions, writing technical reports, and assisting in the supervision of a sewage reclamation project for use as recharge water.

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PLAINVIEW, NEW YORK
11803

Letter of Transmittal

To:	Robert S. May **Watchtower Bible and Tract Society of New York, Inc.** 900 Red Mills Road Wallkill, NY 12589-3223 Richard Eldred **Watchtower Bible and Tract Society of New York, Inc.** 100 Watchtower Drive Patterson, NY 12563-3710
From:	Eric Weinstock and Richard Izzo
Date:	January 26, 2010
Subject:	Hydrogeologic Analysis Report, Watchtower Educational Center, Patterson, NY
cc:	

The attached report is being submitted to you for your review, approval and use. As this report will be incorporated into another document, we will not forward it to any agencies unless directed to by Watchtower.

Please do not hesitate to call our office if you have any questions.

CA RICH ENVIRONMENTAL SPECIALISTS

e-mail: eweinstock@carichinc.com
website: www.carichinc.com

HYDROGEOLOGIC ANALYSIS

WATCHTOWER EDUCATIONAL CENTER
TOWN OF PATTERSON, NY

January 2010

Prepared For:

WATCHTOWER BIBLE AND TRACT SOCIETY OF NEW YORK, INC.
100 Watchtower Drive
Patterson, NY 12563-3710

Prepared by:

CA RICH CONSULTANTS, INC.
17 Dupont Street
Plainview, NY 11803

January 26, 2010

Robert S. May
WATCHTOWER BIBLE AND TRACT SOCIETY OF NEW YORK, INC.
900 Red Mills Road
Wallkill, NY 12589-3223

Richard Eldred
WATCHTOWER BIBLE AND TRACT SOCIETY OF NEW YORK, INC.
100 Watchtower Drive
Patterson, NY 12563-3710

Re: **Hydrogeologic Analysis**
Watchtower Educational Center,
Patterson, NY

Gentlemen:

CA RICH CONSULTANTS, INC. (CA RICH) is pleased to provide this Report entitled: Hydrogeologic Analysis for the above-captioned Watchtower Educational Center and surrounding environs.

Should you have any questions, please do not hesitate to contact us.

Respectfully submitted,

CA RICH CONSULTANTS, INC.

Richard J. Izzo, CPG 9644
Associate

Eric A. Weinstock, CPG, CGWP
Vice President

RJI:EAW:tk
Attachments

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Figure

1. Property and Subwatershed Boundary

Table

1. Estimated Water Usage Within the Watchtower Subwatershed Area

Appendix

A. Well Inventory

1.0 INTRODUCTION

1.1 General

CA RICH CONSULTANTS, INC. ("CA RICH") of Plainview, NY presents the following Hydrogeologic Report summarizing an analysis of existing water resources, groundwater availability, and water supply potential for the Watchtower Educational Center and surrounding environs.

1.2 Purpose and Objectives

The purpose and objectives of this Hydrogeologic Analysis Report are fourfold: 1) review certain subsurface conditions prevailing within the effective subwatershed surrounding the Property, 2) derive a preliminary generalized hydrologic water balance for the subwatershed, 3) assess and understand pre-existing pumpage and water sources at and in proximity to the Property, and 4) support the continued development of the on-site water supply system to meet the water demand of the Watchtower Educational Center on a safe-sustained basis without causing detrimental impacts to any neighboring water users.

1.3 Site Description

The Watchtower Educational Center property (also called the 'Property' and/or 'Site') comprises 709.32 acres of contiguous land located along Route 22 in the Town of Patterson, NY. The Property is improved with a 152-unit hotel and Educational Center. There are a variety of other improvements such as various support facilities, several pre-existing detached homes, farmland, and open space.

1.4 On-site Water Demand

According to Watchtower's existing Water Supply Permit (Permit No. 3-3724-0045/1-0, WSA #8240), current on-site water supply is authorized to average 165,000 gallons per day (gpd). On-site water demand is met by an inter-connected system of on-site bedrock and sand & gravel wells.

The pre-existing permitted on-site well network currently consists of three bedrock wells designated W-2, W-4, and W-6 with permitted pumping capacities of 65, 60, and 30 gallons per minute (gpm) respectively. In addition, the existing well network includes two permitted sand and gravel wells designated SG-1 and SG-2 which are each permitted at 75 gpm.

Two new sand and gravel wells were installed in early 2009. These are designated SG-3 (PC Permit TW-05-08) and SG-4 (PC Permit TW-04-08) and are 49 and 53 feet in depth, respectively. The wells were installed using the cable-tool drilling method and are constructed with 8-inch steel casing and 6-inch telescoping stainless steel screens set at 38-48 feet in well SG-3 and 42-52 feet in well SG-4.

Both wells were constructed with natural sand packs and were developed via pumping and surging following their installation. In addition, the two new wells along with the five pre-existing wells were pump tested in October 2009. The pumping test was performed over a 73-hour period and included the concurrent pumping of the seven wells along with requisite pre-test baseline and post test recovery measurements in accordance with NYSDEC guidelines (NYSDEC TOGS 3.2.1). The results of the test indicate that the seven on-site wells can safely provide the required on-site water resources without detrimental inter-well interference affects to on-site or surrounding off-site wells. (CA RICH 2009).

2.0 TOPOGRAPHY & GEOLOGY

2.1 Topography

United States Geologic Survey topographic quadrangle maps (USGS 1958 Brewster & Pawling) and local site-specific surveys indicate that Site lands range in elevation from 1,140 ft. above mean sea level (MSL) (a.k.a. National Geodetic Vertical Datum of 1929) in the extreme southeast corner of the Property down to 430 feet above mean sea level along the western Property boundary formed by the east Branch Croton River providing an overall topographic relief site-wide of about 710 feet. Most of the western lower-lying half of the Property (West or Route 22) within the East Branch Croton River valley is relatively flat (having 0 to 5 percent slopes) with the upland areas having between 10 percent and 20 percent slopes. A map detailing the topography of the Property is included as Figure 1.

2.2 Geology

2.2.1 Surficial Geology

The surficial geology within at the Watchtower Educational Center property and its immediate environs, is primarily composed of unconsolidated sediments of Recent and Pleistocene age. However, the nature and thickness of these deposits varies considerably between the two portions of the Site which are generally bisected by north-south trending Route 22. According to a published New York State Geological Survey (NYSGS) Map (Cadwell 1989), the upland; eastern portion of the Site's surficial geology is characterized by a thin veneer of glacial sediments, which are chiefly characterized as glacial till (an unstratified, poorly-sorted, mixture of clay, silt, sand, gravel, cobbles & boulders). On-site test/production well installation confirmed the presence of till in the western portion of the Site (CA RICH 1985).

To the west of Route 22, within the low-lying East Branch Croton River stream valley, the unconsolidated surficial sediments are mapped as Recent age swamp deposits described as peat-muck and organic silts. These materials are shown to be surrounded (and underlain) by Pleistocene age glacial kame deposits which may include kames, eskers, kame terraces and/or kame deltas which are formed adjacent to ice sheets and are characterized as coarse to fine gravel and/or sand. The presence of this surficial stratigraphic sequence has been confirmed during test boring/test well development (CA RICH 1988 & 2009). Test boring/well installation activities in the western portion of the Site have identified the mapped swamp deposits comprising silts and clays within the upper 50 to 60 feet below land surface. Underlying these materials is approximately 10 to 20 feet of relatively well sorted sand and gravel deposits which coincide with the NYSGS mapped kame sequence.

Till is considered a poor aquifer material as the unstratified nature of the materials does not afford the primary permeability and uniform porosity characteristics preferred to produce sustainable yields of ground water to wells. However, certain till deposits have been found sufficient for lower yield applications such as certain single-family residential domestic wells. Conversely, glacial outwash or kame/esker deposits are considered an excellent aquifer material where present in sufficient thickness and lateral extent. Fully-saturated, stratified sand & gravel glacial outwash deposits are capable of producing reliably higher yields to properly designed, screened-and-cased wells. It is these deposits which form the sand and gravel aquifer underlying the western portion of the Site.

2.2.2 Bedrock Geology

The buried bedrock underlying the Property is characterized as Lower Ordovician Age crystalline metamorphic rocks. The bedrock underlying the glacial till deposits in the eastern portion of the Property is characterized as peletic schist and amphibolite gneiss bedrock of the Manhattan Formation.

The bedrock underlying the swamp and glacial deposits in the western portion of the Property is characterized as Stockbridge Marble (Fisher, et al 1970). The Stockbridge Marble is much less resistant to physical and chemical weathering as compared with the Manhattan Schist. This difference in weathering corresponds to the structural and topographic differences between the two halves of the Property.

The bedrock beneath the Property does not exhibit the primary permeability and porosity features attributable to unconsolidated sands & gravels. Instead, the occurrence and abundance of groundwater resources within this bedrock is largely dependent upon the presence, size, concentration, and interconnection of saturated secondary permeability features including structurally-controlled faults, joints and fractures within the rock.

Some smaller bedrock fracture systems are often highly localized. These may occasionally be reflected on the natural land surface by pronounced topographic features. Larger groups of fractures or potential faults or fault zones may be interconnected and indicative of regional structural bedrock lineaments that tend to traverse a much larger regional area (as much as several thousands of feet in length). Lineaments, when known, usually characterize areas of a series of mappable faults trending in a preferred compass orientation that correlate with each other.

Review of topographic information and aerial photography, as well as inspection of selected bedrock outcrops in the area was used to locate the active bedrock production wells primarily located within the eastern portion of the Site (CA RICH 1985).

3.0 HYDROGEOLOGY

3.1 Surface Water

The East Branch Croton River is the principal southward-flowing perennial stream flowing proximal to the Property and comprises the western Property boundary. The East Branch Croton River is a direct tributary to the East Branch Croton Reservoir (a protected NY City water supply source) located approximately seven miles south-southeast of the Watchtower Educational Center. There are three second-order tributary streams flowing roughly northeast to southwest through some portion of the Site that discharge into the East Branch Croton River. These streams generally drain the highland areas to the northeast into the stream valley to the southwest. The northernmost is Stephens Brook which originates well to the north of the northern Property boundary and flows through the extreme northwest corner of the Site. Centrally, within the Site is Mountain Brook, originating approximately 2,000 feet to the north of the Site and flows through the central portion of the Property. Mountain Brook is the permitted receiving waters for Watchtower's treated wastewater effluent. The southernmost stream flowing across the Site is a small unnamed tributary to the East Branch Croton River which originates within the southeastern portion of the Site and flows southwest and eventually south of the southern Property boundary.

A hydrologic budget (water balance) has been developed to identify any potentially significant impacts to existing water resources caused by on-site groundwater withdrawals. To develop the hydrologic budget, the study area has been defined as those lands comprising the immediate or "effective" local subwatershed area surrounding the Site. This area has been delineated by CA RICH hydrogeologists and is referred herein as the Watchtower Subwatershed Area (WSA). The WSA, approximately 4.55 square miles in size, is situated within the larger regional East Branch Croton River drainage basin. The approximate extent and configuration of the WSA is shown on Figure 1.

3.2 Ground Water

Available groundwater resources occur within two subsurface systems. The uppermost system (as described in Section 2.2.1) occurs as saturated and permeable portions of any surficial unconsolidated outwash and till deposits, where present. The second deeper and thicker, fractured bedrock system consists of saturated portions of interconnected fractures, faults and joint plane systems occurring within the underlying competent bedrock. Where stratified drift occurs upon (over) underlying fractured bedrock, the two 'aquifers' may or may not be in hydrologic communication.

The storage capacity of a fractured bedrock aquifer system varies and it is difficult to predict long-term safe sustained well yields. The converse is true with wells drilled into sufficient thicknesses of stratified drift (outwash). Throughout Putnam County, bedrock well yields have historically been measured to vary from a low of 2-10 gallons per minute (gpm) up to as much as 120 gpm (Grossman 1957). Recent (past 20 years) groundwater exploration and testing directly within the Property produced bedrock wells with yields ranging from 30 to 65 gpm.

Historical sand & gravel well yields throughout Putnam County, have been reported to vary from a low of less than 1 gpm up to as much as 450 gpm (Grossman 1957). Recent (past 20 years) groundwater exploration and testing directly within the Watchtower Property produced sand & gravel wells with yields ranging from 75 to 200 gpm.

3.3 Groundwater Flow

The water table represents the uppermost, unconfined surface of fully-saturated aquifer materials. A potentiometric surface represents aquifer water levels under confined or artesian conditions. The elevation of this surface is dependent upon the water-transmitting properties of the aquifer materials, their thicknesses and areal extent, and the location of natural recharge and discharge points. The configuration of this surface, once mapped, can be used to determine the horizontal or lateral direction and rate, or groundwater velocity, of shallow groundwater flow under natural conditions.

Groundwater flow paths within the deeper fractured bedrock aquifer, unlike flow within the shallower unconsolidated glacial deposits, are controlled by the occurrence, density, geometry and frequency of interconnected fully or partially-saturated bedrock fractures, indicative of secondary permeability and porosity characteristics. Because fractures within the buried bedrock are not fully-saturated uniformly, the direction of flow in this type of hydrogeologic environment is often difficult to predict locally. However, flow typically follows paths of least resistance such as zones of greatest fracture faulting or joint density.

Based upon the local topography, the predominant directional trend of major bedrock fractures occurring appear to be roughly north/south coinciding with the East Branch Croton River valley with smaller localized fractures appearing to trend predominately in a northeast/southwest direction. This apparent fracture orientation has been documented within Putnam County in other studies (Grossman 1957). Unless there are influencing circumstances such as a zone of groundwater capture caused by a large scale pumping center, it is presumed that the natural direction of deeper groundwater flow conforms to the geologic trend of the bedrock fracture system.

3.4 Aquifer Recharge Areas

Recharge to a stratified drift aquifer generally comes from rainfall directly over the aquifer itself. The streams and wetland areas within the WSA represent areas of groundwater discharge, surface water impoundments, or areas of low infiltration.

A stream that receives groundwater underflow is referred to as a 'gaining stream'. The four streams within and proximal to the Site could act to recharge the aquifer if sustained groundwater pumpage exceeds groundwater underflow into the stream (base flow), thus changing the stream from a gaining stream (i.e. one that captures groundwater discharge) into a losing stream (one that contributes to groundwater recharge). This phenomenon may impact streamflow stage during periods of lower than average rainfall.

The locations of bedrock aquifer recharge areas are generally not as clearly defined. On-site, bedrock aquifer recharge areas are commonly associated with areas of fractured bedrock outcrop as well as the higher elevation areas of the property that may be indicative of shallow or near surface bedrock occurrences. Exposed bedrock outcrop areas are most likely localized sources of rainwater infiltration down into the bedrock aquifer.

4.0 HYDROLOGIC BUDGET

4.1 Water Resources

The overall circulation of water from the earth's surface and groundwater up through the atmosphere, and returned back down to the earth as precipitation, and finally back to either continental surface water and/or groundwater, denotes the hydrologic cycle. An estimate of the amount of water entering or leaving the groundwater reservoir within the subwatershed and the amount stored in the reservoir is an indication of the total amount of groundwater that is available. In general terms, of the total precipitation which falls on a specific subwatershed in this region, approximately half is consumed through the joint processes of evaporation and transpiration (plant uptake). This joint process is referred to as *evapotranspiration*. The remaining portion is generally divided between surface runoff (to lakes and wetland areas) and groundwater recharge.

Natural hydrologic systems are normally in a state of equilibrium. Therefore, for the purposes of calculating the hydrologic budget for the Watchtower Subwatershed Area, we assume that groundwater recharge is balanced by an equal amount of groundwater discharge. Consequently, any approximation of the amount of water recharging the stratified drift and/or fractured bedrock aquifer on-site is directly proportional to the percentage of precipitation represented by groundwater recharge as expressed in the following equation:

$$P = Rs + Rg + ET$$

where:

P = annual precipitation

Rs = direct surface runoff

Rg = groundwater recharge

ET = evapotranspiration

The hydrologic budget for the 4.55-square mile WSA, based upon reasonably available reference data and our professional experience in this area of New York State, is summarized below:

	INCHES/YEAR	GALLONS PER DAY (gpd)
ANNUAL PRECIPITATION (P)	51	11,047,828
ANNUAL RUNOFF	25.5	5,523,914
Groundwater Recharge (Rg)	8	1,732,993
Surface Water Runoff (Rs)	17.5	3,790,921
ANNUAL EVAPOTRANSPIRATION (ET)	25.5	5,523,914

These numerical values are based upon a mean annual precipitation of approximately 51 inches over a period of 30 years as measured by the National Oceanic and Atmospheric Administration (NOAA) at their climatologic measurement station in Yorktown Heights, NY approximately 20 miles to the southwest of the WSA (NOAA 2002)). Half of the reported precipitation is lost, chiefly, through the process of evapotranspiration.

Existing studies indicate that recharge within areas similar to the WSA may range from 7 inches up to as much as 21 inches annually (Chazen 2004, Rich & Maslansky 1984). We conservatively use a recharge estimate within the WSA of eight inches based upon the relatively steep slopes and relatively thin overburden in the eastern upland areas of the subwatershed as well as the relative thickness of the unconsolidated sediments and small topographic relief in the western river valley. Thus, the total estimated groundwater recharge within the WSA is approximately 632 million gallons per year (mgy) or around 1.73 million gallons per day (mgd) for the approximately 4.55-square mile subwatershed. This estimate is conservative in that it considers periods over 30 years of both above average as well as below average rainfall (periods of drought).

It is noted that there is a small planned increase in impervious area of 10.4 acres within the WSA. This represents a 0.36% increase in impervious area within the 4.55 square-mile subwatershed. This increase is negligible when considering the size of the subwatershed. In addition, as discussed above, the annual recharge estimate utilized herein has intentionally been selected at a conservatively low rate of 8” (as compared with other similar studies) to ensure that reasonable addition of impervious areas within the WSA will not significantly impact the findings of this study.

4.2 Water Usage

4.2.1 On-site

Groundwater resources for the Educational Center are pumped from the five permitted on-site supply wells (W-2, 4 & 6 and SG-1 & 2). The resulting wastewater is treated within Watchtower’s on-site treatment plant and discharged to Mountain Brook which flows to the southwest eventually discharging into the Croton Reservoir System. In 2008, Watchtower pumped and utilized a total of 35,457,196 gallons from the on-site well network, 31,716,000 gallons of which was treated and discharged to Mountain Brook. The remaining 3,741,196 gallons is reportedly attributable to system losses, evaporation and irrigation. In addition, separate bedrock wells serving eight on-site private residences referred to as Houses A-H are reported to have pumped an additional 537,330 gallons with wastewater treated via on-site septic systems.

The total groundwater usage by Watchtower in 2008 was 35,994,526 gallons (or around 36 million gallons). The water disposed of via surface water and the associated system losses, etc. is considered to represent 100% consumptive loss. That is, the water is taken out of the aquifer system and none of it is recharged back. Water disposed of via septic systems is conservatively considered only 25% consumptive loss as at least 75% of it is recharged back to the aquifer. As such, the total consumptive loss for the watchtower Educational Center Site for 2008 is estimated to be around 35.5 million gallons. This is roughly 5.6% of the total recharge for the WSA as estimated in Section 4.1.

Although Watchtower's total groundwater usage in 2008 was around 36 million gallons (less than 100,000 gpd), Watchtower's NYSDEC Water Supply Permit allows pumpage of up to 165,000 gpd or around 60.2 mgy. It is understood that Watchtower has no current or planned future need to pump this much water. However, for a "worst case" analysis, we will assume that Watchtower uses all of the water it has been allocated in its water supply permit. If we further assume this permitted supply to represent 98% consumptive loss (roughly the same ratio as the actual usage in 2008), it would equate to a potential consumptive loss figure of around 59 mgy. This is roughly 9% of the total recharge for the WSA as estimated in Section 4.1.

4.2.2. Existing off-site Water Supply Systems

Off site groundwater usage is divided between commercial/retail usage and community/private residential supply. An inventory of off-site wells within 2,000 feet of on-site pumping wells was provided by Watchtower (Appendix A). Water use estimates for the identified off-site users were prepared based upon personal discussions (where available and responsive) or utilization of standard flow criteria for Putnam County (PCDH 1987) as well as other resources as detailed on Table 1.

As shown on Table 1, the estimated groundwater usage within the WSA surrounding the Watchtower Property is estimated to be approximately 123,751 gpd. Of this figure, around 56,500 gpd is attributed to Berkshire Nursery and 26,301 gpd is attributed to Thunder Ridge. All of the water usage at Berkshire Nursery will be conservatively considered total consumptive loss via irrigation. 85% of the Thunder Ridge usage (around 22,000 gpd) will be conservatively considered consumptive loss to evaporation and runoff and the remaining 15% will be applied to groundwater Recharge. Subtracting the water usage by Thunder Ridge and Berkshire Nursery from the estimated 123,751 gpd leaves 40,950 gpd. This figure represents users who rely on septic systems for wastewater disposal and, as such, only 25% of this water (around 10,238 gpd) is considered consumptive loss. The total off-site consumptive loss is then estimated by adding the consumptive loss of Berkshire Nursery (56,500 gpd), the consumptive loss from Thunder Ridge (22,000 gpd) and the consumptive loss from all of the other off-site users (10,238 gpd) which totals around 88,738 gpd or 32 million gallons per year (mgy).

This figure, added to the actual 2008 consumptive loss from the Watchtower Educational Center of approximately 35.5 mgy totals around 67.5 mgy and represents roughly 11% of the estimated annual groundwater recharge within the WSA of 632 mgy (see Section 4.1 above). Based upon the above calculations, it may be conservatively assumed that as much as 89% of the estimated groundwater recharge, roughly 1.5 mgd, remains unutilized.

Once again a “worst case” analysis was included. The total estimated off-site consumptive loss figure of 32 mgy added to Watchtower’s total permitted consumptive loss estimate of 59 mgy (corresponding to the total permitted water usage figure for Watchtower of 165,000 gpd) yields a total potential water usage figure within the WSA of 91 mgy. This represents around 14% of the estimate groundwater recharge for the WSA, leaving as much as 86% of the estimated groundwater resources unutilized.

5.0 FINDINGS & CONCLUSIONS

1. Hydrogeologic conditions and on-site water resource development activities indicate the presence of two separate aquifer systems: fractured bedrock and unconsolidated valley-fill sand & gravel deposits. On-site wells have recently (October 2009) been tested in accordance with County and State Regulations to demonstrate the safe sustained yield from both the fractured bedrock and sand & gravel aquifer.

2. The Watchtower Educational Center property is situated within a 4.55 sq. mi. subwatershed referred to herein as the Watchtower Subwatershed Area (WSA). Natural groundwater recharge within this subwatershed averages 1.73 million gallons per day (mgd). The Watchtower Educational Center's 97,000 gpd water usage figure for 2008 represents approximately 5.6 % of this recharge volume (leaving a balance of 94.4%). Other users in the WSA account for an additional 5% or so, leaving approximately 89% of the Water resources unutilized. In actuality, Watchtower uses less than 100,000 gpd of the available water resources in the WSA. For the purposes of this Report, a "worst case" analysis was used. If we assume that Watchtower uses all of their permitted supply of 165,000 gpd (which they never have in the past), their groundwater usage would approximate 9% of the total recharge volume (leaving a balance of 91%). Subtracting the 5% for the other users within the WSA leaves a total of 86% of the estimated groundwater resources unutilized. As such, the on-site independent water system utilizing groundwater resources may continue to be utilized without the threat of adverse impacts to the subwatershed. Further development within the WSA should proceed gradually in a systematic fashion, subject to incremental review, to avoid adversely impacting area water usage.

6.0 REFERENCES

CA RICH, (1985), Pumping Test Analysis, Wells 1 and 2, Watchtower Education Center, Patterson, New York.

CA RICH, (1988), Groundwater Supply Assessment, Watchtower Education Center, Patterson, New York.

CA RICH, (2009), Aquifer Mapping & Test Borings Report, Watchtower Educational Center, Patterson, New York.

CA RICH. (2009) Pumping Test Report, Watchtower Educational Center, Patterson, NY

Chazen Companies (2004) Putnam County Groundwater Protection and Utilization Plan

Cadwell, D.H. (1989), Surficial Geologic Map of New York, Lower Hudson Sheet, New York State Museum – Geological Survey, Map and Chart Series No. 40.

Fisher, D.W. et. al, (1970), Geologic Map of New York, Lower Hudson Sheet, New York State Museum and Science Service, Map and Chart Series No. 15.

Rich C. and Maslansky S. (1984) Groundwater Availability in Putnam County, NY, A Preliminary Evaluation

Grossman I. G. (1957) The Groundwater Resources of Putnam County, NY

USGS Brewster Quadrangle, New York, Putnam County, 1958 (photo-revised 1984) 7.5 Minute Series (Topographic)

USGS Pawling Quadrangle, New York, Putnam County, 1958 (photo-revised 1971) 7.5 Minute Series (Topographic)

Dunne, T. and Leopold, L. 1978. Water in Environmental Planning. W.H. Freeman & Co.

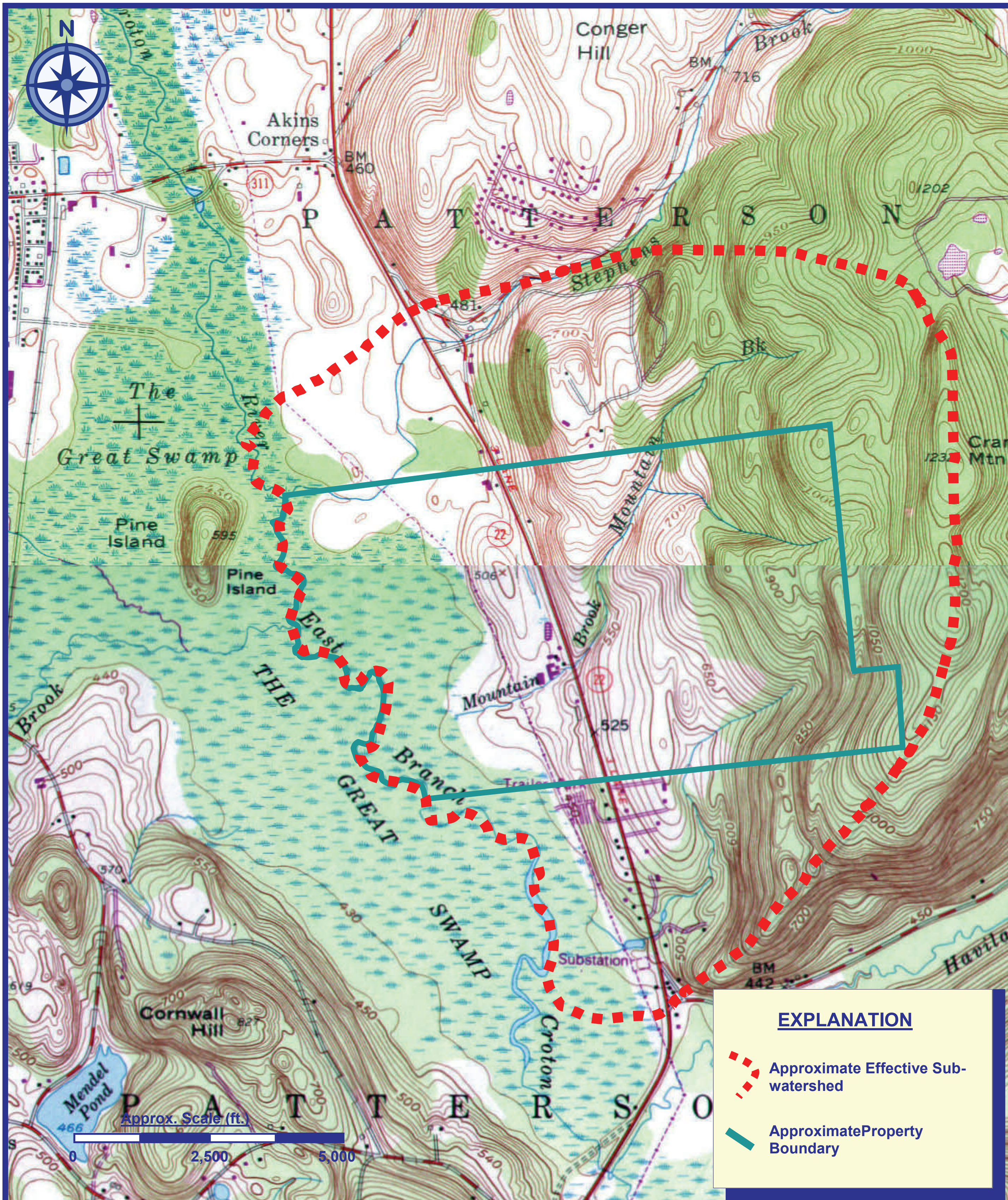
NYSDEC; 2005; Appendix 190, TOGS 3.2.1: Recommended Pump Test Procedures for Water Supply Applications

NOAA, 2002, Monthly Station Normals of Temperature, Precipitation, and Heating and Cooling Degree Days 1971-2000, 30 New York

Putnam County Department of Health (1987) Required Design Flows

Ohio State University Extension (2004) Nurseries Leading the Charge in Environmental Stewardship

FIGURE



CaRICH ENVIRONMENTAL SPECIALISTS

Approximate Subwatershed Boundary	Figure: 1	Drawn by: RJI
Watchtower Educational Center Patterson, NY	Date: 5-5-09	Approved by: EAW

TABLE

Table 1

Estimated Water Usage Within the Watchtower Subwatershed Area

Groundwater User	Number of Units		Unit Rates		Estimated Average Daily Usage (gpd)
Wooded Hills MHP	33	Mobile Homes @	400	gpd/home*	13,200
Berkshire Nursery	226,000	Sq. ft. of Nursery @	0.25	gpd/sq.ft.**	56,500
Clancy Syst. Moving & Storage	60,000	Sq. ft. of Commercial Space @	0.125	gpd/sq.ft*.	7,500
Pharma LP	50,000	Sq. ft. of Commercial Space @	0.125	gpd/sq.ft.*	6,250
NE Equine	40,000	Sq. ft. of Clinical/Office Space @	0.125	gpd/sq.ft*.	5,000
Thunder Ridge Ski Area	30	Acres of snow making @	80,000	gal./acre per 8" snow event*** x 4 snowmaking events/season ÷ 365 days/year	26,301
Additional Private Residential and Commercial Users	15	Users @	600	gpd/user*	9,000
Estimated Total					**123,751**

*Source : Putnam County DOH 1987
** Ohio State University Extension
*** Source:Lake Effect Snowmaking.com, Seven Oaks Recreation.com

CaRICH ENVIRONMENTAL SPECIALISTS

APPENDIX

APPENDIX A

Well Inventory

Property within 2,000 feet of Production Well W-2 in South, East, West Direction
and within 2,000 feet of W-6/SG-2 in North, East, West Direction

PROPERTIES WITH WELLS WITHIN 2,000 FEET OF WEC PRODUCTION WELLS
Some Properties With Bedrock Wells
WATCHTOWER PROPOSED PUMPING TEST
PATTERSON, NEW YORK

Five WEC Production Wells	Location	Well Type	DEC Permitted Pump Rate	
1) Watchtower 14.1-53 W-2	By South Loop Road	Bedrock – 365 ft. depth	65-gpm based upon 6/1988 96-hr. test	Draws from **south bedrock aquifer**
2) Watchtower 14.-1-53 W-4	500-ft east of RT 22	Bedrock – 450 ft. depth **north aquifer**	60-gpm based upon 6/1988 96-hr. test	Also observation well for 10/88 S&G pump test
3) Watchtower 14.-1-53 W-6	100-ft. East of B House	Bedrock – 400 ft. depth **north aquifer**	30-gpm based upon 6/1988 96-hr. test	Also observation well for 10/88 S&G pump test
4) Watchtower 14.-1-15 SG-1 2741-2891 RT 22	2,350-Ft. West of RT 22	well –73 ft. depth	75-gpm based upon 10/1988 95-hr. test	Draws from **sand gravel aquifer west of RT 22**
5) Watchtower 14.-1-15 SG-2 2741-2891 RT 22	2,000-Ft. West of RT 22	well -80 ft. depth	75-gpm based upon 10/1988 pumpage during final 26-hr of 95-hr. test of SG-2	Draws from **sand gravel aquifer west of RT 22**
Proposed Additional Production Wells from Sand Gravel Aquifer	To be included within current permitted Water Supply			To allow greater management of water resource
Watchtower 14.-1-15 **TW-4-08 [SG-4]**	250-ft. east of SG-1	Sand/Gravel Aquifer to 55-ft. depth	2009 Test well	Will receive a 72-hour pump test in 2009
Watchtower 14.-1-15 **TW-5-08 [SG-3]**	250-ft. east of SG-1	Sand Gravel Aquifer to 50-ft. depth	2009 Test Well	Will receive a 72-hour pump test in 2009
Onsite Watchtower ObservationWells within 2000-ft. of W-2	**South Bedrock Aquifer along unnamed Brook**			
W-1	Front of E RES – 500-ft. NE of W-2	Bedrock – 350 ft. depth	June 1988 Drawdown 47-ft. by W-2	

			pumping @ 65 gpm	
W-8	Near Berkshire P/L – 330-ft. south of W-2	Bedrock -	Drawdown 54.2 ft. by W-2 pumping @ 65 gpm	
14.19-1-14 Watchtower 2721 RT 22	1150-ft. southwest single family H residence	Bedrock well	Not used as observation well	Address: 900 Red Mills RD, Wallkill, NY 12589
Off-site Wells drawing from **South Bedrock Aquifer** within 2000 feet of WEC well W-2 used as representative observation wells				
F: Berkshire Nursery 14.19-1-15 Carmine &Nina Lopane 2714 RT 22, Patterson, NY 12563	800-ft. south of W-2 Retail Nursery Greenhouse	1988 - Bedrock well – 380-ft. depth 2000 –Bedrock well behind greenhouse near RT 22	4/11/2000 Berkshire Nursery installed additional well 50% funded by Watchtower. Adequate water available.	Observation well in June1988 pump test. Drawdown of 13-ft. by W-2 pumping at 65 gpm for 41-hr. of 95-hr. test
G: Nolletti Bakery 14.19-1-18 Albert Nolletti Cheerie Nolletti 2680 RT 22	1,450-ft. south of W-2 Small building Bakery now unoccupied / active cell phone tower	Bedrock - actual pumping of W-2 @ 65 gpm currently averages 6-hr./day and ultimately 9 hours / day. Therefore does not affect Nolletti's well.	Observation Well in June 1988 Drawdown 5-ft. by W-2 pumping at 65 gpm for 41-hr. of 95-hr. test	Mailing: Albert Nolletti, 31 Country view RD, Millerton, NY 12546 / Cheerie Nolletti PO Box 110 Patterson, NY 12563
Other Properties on South Bedrock Aquifer within 2,000 feet of W-2 not used as observation wells				

Property within 2,000 feet of Production Well W-2 in South, East, West Direction
and within 2,000 feet of W-6/SG-2 in North, East, West Direction

14.-1-55 Carmine & Nina Lopane 39 Lopane DR	650-ft. southeast of W-2 single family residential	Bedrock well		Mailing: Carmine & Nina Lopane 2714 RT 22 Patterson, NY 12563
14.19-1-16 Carmine & Nina Lopane, 3-27 Lopane Drive, Patterson, NY 12563	950-ft. south Commercial small storage building / nursery stock	Bedrock well		Mailing: Carmine & Nina Lopane 2714 RT 22 Patterson, NY 12563
14.19-1-3 Charles Brightly 2665 RT 22	2,000-ft. southwest converted residence	Bedrock well		Address 19 Drapeau RD New Milford, CT 06776
14.19-1-4 Charles Olson 2671 RT 22 Patterson, NY 12563	1,900-ft. southwest commercial sign business	Bedrock well		
14.19-1-5 Robert De Lorenzo 2679 RT 22 Patterson, NY 12563	1700-ft. southwest two family residence	Bedrock well		
14.19-1-7 22 North Realty Corp. 2693 RT 22 Patterson, NY 12563	1500-ft. southwest Restaurant	Bedrock well		
14.19-1-8 Partnership Third Garden Park Limited 1-37 Wooded Hills Park Ln.	1400-ft. southwest Manufactured Housing Park	Bedrock well		Address: PO Box 4401 Stamford, CT 06907
14.19-1-9 C.B. Neubauer 2705 RT 22	1300-ft. southwest two family residence	Bedrock well		Address: 350 Haviland Hollow RD Patterson, NY 12563
14.19-1-10 John W. Neubauer 2713 RT 22	1250-ft. southwest single family	Bedrock well		Address: 350 Haviland Hollow RD

	residence			Patterson, NY 12563
14.19-1-12 John and Christine Neubauer 2717 Rt 22	1200-ft. southwest AVP Office Supplies	Bedrock well		Address: 360 Haviland Hollow RD Patterson, NY 12563
14.19-1-17 Centrum Properties LLC, 2682-2684 RT 22 Patterson, NY 12563	1100-ft. south 2-family residential	Bedrock well		
14.19-1-20 2656 RT 22 LLC 2656 RT 22 Patterson, NY 12563	1800-ft south single family residential	Bedrock well		
14.19-1-21 DGF Properties, LLC 2644 RT 22 Patterson, NY 12563	1700-ft. south mini self storage / residential	Bedrock well		
14.19-1-22 Macal Development Corp. 2648 RT 22	1500-ft. south mini self storage / residential	Bedrock well		Mailing: Macal Development Corp., 256 Holmes RD., Holmes, NY 12531
North Bedrock Aquifer along Mountain Brook	**And Separate Sand / Gravel Aquifer west of RT 22**			
Watchtower Wells currently used for individual houses or exploration in 1985-88 / 2009				note TW-4-08, TW-5-08 to be included in 72-hour 2009 pump test
Watchtower 14.-1-53 W-5	300-ft. south of W-6	Bedrock – 420 ft. depth –		June1988 observation well for 96-hr. pump test
Watchtower 14.-1-53 W-7	300-ft. north of W-6	Bedrock		June 1988 observation well for 96-hr.

Property within 2,000 feet of Production Well W-2 in South, East, West Direction
and within 2,000 feet of W-6/SG-2 in North, East, West Direction

				pump test
Watchtower 14.-1-15 W-9 E House 2741-2891 RT 22	850-ft. southwest of W-4	Bedrock Draws from north bedrock aquifer	Drawdown 50 ft. by W-4,6 pumping @ 60, 50 gpm respectively.	Onsite observation well for 06/88 96-hour pump test / 10/88 S&G pump test
Watchtower 14.-1-15 W-10	200-ft. NE of SG-1	Sand / Gravel	2-ft. drawdown by simultaneous of SG 1&2	Onsite observation well for October 1988 S&G 95-hour pump test
Watchtower 14.-1-15 W-11 A House 2741-2891 RT 22	700-ft. northwest of W-6; serves single house	Bedrock - Draws from north bedrock aquifer		Onsite observation well for 06/88 96-hour pump test / 10/88 S&G pump test
Watchtower 14.-1-53 W-12	1,750-ft. NE of W-4	Bedrock		Observation well for 06/88 96-hr. pump test
Watchtower 14.-1-15 MW-2	200-ft. SE of SG-2	Sand / Gravel aquifer to 80-ft depth		Observation well for 10/88 95-hr. S&G pump test
Watchtower 14.-1-15 MW-1	200-ft. NE of SG-1	Sand / Gravel aquifer to 73-ft depth		Observation well for 10/88 95-hr. S&G pump test
Watchtower 14.-1-15 G House 2741-2891 RT 22	900-ft. southwest of W-4	Bedrock Draws from north bedrock aquifer		
Offsite Wells within 2000-ft. of W-6 / SG-1				
14.-1-30 **B: Birch Hills #5** in 1988 Now: Clancy Properties	1,600-ft. NW of W-6 Moving & storage	Bedrock	observation well for 06/88 96-hour pump test / 10/88 S&G pump test	Mailing: Clancy Properties LLC PO Box 291 Patterson, NY 12563
14.-1-30 **C: Birch Hills #6**	1,700-ft. NW of W-6	Bedrock	observation well for 06/88	Mailing: Clancy

in 1988 Now: Clancy Properties	Moving & storage		96-hour pump test / 10/88 S&G pump test	Properties LLC PO Box 291 Patterson, NY 12563
14.-1-27 **D: Pizza King** in 1988 now: Bradley Cook LLC 2933 RT 22 Patterson, NY 12563	1,200-ft. NW of W-6 Equestrian Care	Bedrock		observation well for 06/88 96-hour pump test / 10/88 S&G pump test
14.-1-52 **E: Magdi's Diner** in 1988 now King's Pizza Owner Operator: Muluka LLC 2908 RT 22 Patterson, NY 12563	650-ft. NW of W-6	Bedrock Actual pumping of W-6 @ 30 gpm currently averages 6-hr./day and ultimately 9 hours / day. Therefore does not affect King's Pizza.	Drawdown 50-ft. by simultaneous pumping of W-5, W-6, W-7 at 135 gpm for 24-hrs. W-5, 7 then only used for observation well. No affect by W-6 @ 30 gpm	observation well for 06/88 96-hour pump test / 10/88 S&G pump test
14.-1-3 Angela Dell 2905 RT 22 Patterson, NY 12563	1200-ft. northwest of W-6 1900-ft. east of SG-1 Single family home	Bedrock well		
14.-1-43 JRS Pharma LP 2981 RT 22, Patterson, NY, 12563	2000-ft. northeast of SG-1 / 3400-ft. northwest of W-6 Office Bldg.	Bedrock well		
14.-1-50 Patterson Center, LLC 26-32 Thunder Ridge RD	2400-ft. north of W-6 Ski Area	Bedrock Well		Mailing: Patterson Center, LLC, PO Box 10, Carmel, NY 10512

Aquifer Mapping & Test Borings

Watchtower Educational Center
Patterson, New York

May 2008

Prepared for:

Watchtower Bible and Tract Society of New York, Inc.
100 Watchtower Drive
Patterson, NY 12563-3710

Attention: Mr. Robert May

Prepared by:

CA RICH CONSULTANTS, INC.
17 Dupont Street
Plainview, New York 11803

CA RICH
ENVIRONMENTAL SPECIALISTS

e-mail: eweinstock@carichinc.com

May 28, 2008

Phone: 845-306-3717
Fax: 845-306-3710
e-mail: rsmay@jw.org

Robert S. May
Watchtower Bible and Tract Society of New York, Inc.
100 Watchtower Drive
Patterson, NY 12563-3710

Re: **Aquifer Mapping & Test Borings**
Watchtower Educational Center, Patterson, NY
CA RICH Job Code: Watchtower/Patterson/Additional Wells

Dear Mr. May:

CA RICH Consultants, Inc. (CA RICH) is pleased to provide you with this progress report regarding the recent test borings and mapping of the sand and gravel aquifer below the northwest portion of the Watchtower Educational Center (WEC).

Understanding of the Current Situation

It is our understanding that WEC currently has a water allocation permit with the New York state Department of Environmental Conservation (NYSDEC). Permit number WSA 8240 was issued for 165,000 gallons per day (gpd) based on a site-wide pump test performed at this property in 1988. The current well network consists of three bedrock wells and two sand & gravel wells. At this time, we understand that WEC wishes to add two additional sand & gravel wells to serve as a backup to their water supply well network. To achieve this, CA RICH performed a test boring program described herein to determine the extent of the known sand and gravel aquifer below WEC property. This program was focused on areas outside of the NYSDEC's 100-foot wetlands setback for purposes of locating potential drill sites for two new supply wells.

Summary of Work

On April 30, 2008, CA RICH Field Technician Michael Yager and subcontracted Connecticut Test Borings (CTB) personnel attended the mandatory WEC orientation meeting prior to the start of this project. Upon completion of the orientation, CA RICH and CTB setup at the first of five test boring locations in the northwest portion of the WEC property. These test boring locations, illustrated on Figure 1, were marked, mapped and cleared of utilities by Watchtower personnel. Each test boring was advanced to depth using CTB's Geoprobe™ 7720 DT direct push drill rig and soil samples were collected continuously at five foot intervals from the ground surface to the bedrock surface. The samples from each boring location were classified and collected; and a boring log was prepared for each of the respective boring locations. A copy of each boring log -- identified as WTB-1, WTB-2, WTB-3, WTB-4 & WTB-5 -- are attached. CA RICH selected and submitted a soil sample from three of the five test borings to Universal Testing Laboratories for grain size distribution analysis. The test boring location and sample interval submitted for analysis included WTB-1 (43-48ft), WTB-2 (35-40ft) and WTB-3 (30-32ft). The results are attached to this report.

Upon completion, test borings WTB-1, WTB-2, WTB-3 and WTB-4 were converted into observation wells using 1-inch diameter PVC pipe and well screen. These will be used to monitor water levels in the future and during a pump test planned during a later phase of this project. Well construction diagrams are included in the appendices.

The boring logs indicate that there is a substantial aquifer in the western portion of the study area. Borings WTB-1 and WTB-2 encountered 30 feet or more of aquifer material above the marble bedrock. The bedrock surface rises significantly in elevation from west to east decreasing the thickness of the aquifer. At one of the eastern test boring locations, WTB-4, the thickness of the aquifer was measured to be approximately 10 feet.

The results of the grain size analysis indicate that the aquifer materials from the selected test borings [WTB-1 (43-48ft), WTB-2 (35-40ft) and WTB-3 (30-32ft)] have excellent water bearing potential. Approximately 45% to 50% of the samples were retained by the 1/8-inch sieve, which is 0.125 inches in diameter and correlates to coarse sand. Less than 2% of the samples passed the #200 sieve, which correlates to silt and clay.

Based upon the information developed during this field effort CA RICH prepared cross sections of the aquifer including potential locations for two additional sand and gravel supply wells (see Figures 2 & 3).

We recommend that specifications be prepared for the installation of two additional supply wells. A copy of this report should be also provided to drilling companies preparing bids to perform this work. If you have any questions regarding this Work Plan, please do not hesitate to call our office.

Respectfully,

CA RICH CONSULTANTS, INC.

Michael Yager

Michael Yager
Project Environmental Scientist

Eric Weinstock

Eric A. Weinstock, CPG
Vice President

Attachments

H:Projects/Watchtower/Aquifer Mapping Test Boring Prog Ltr

FIGURES

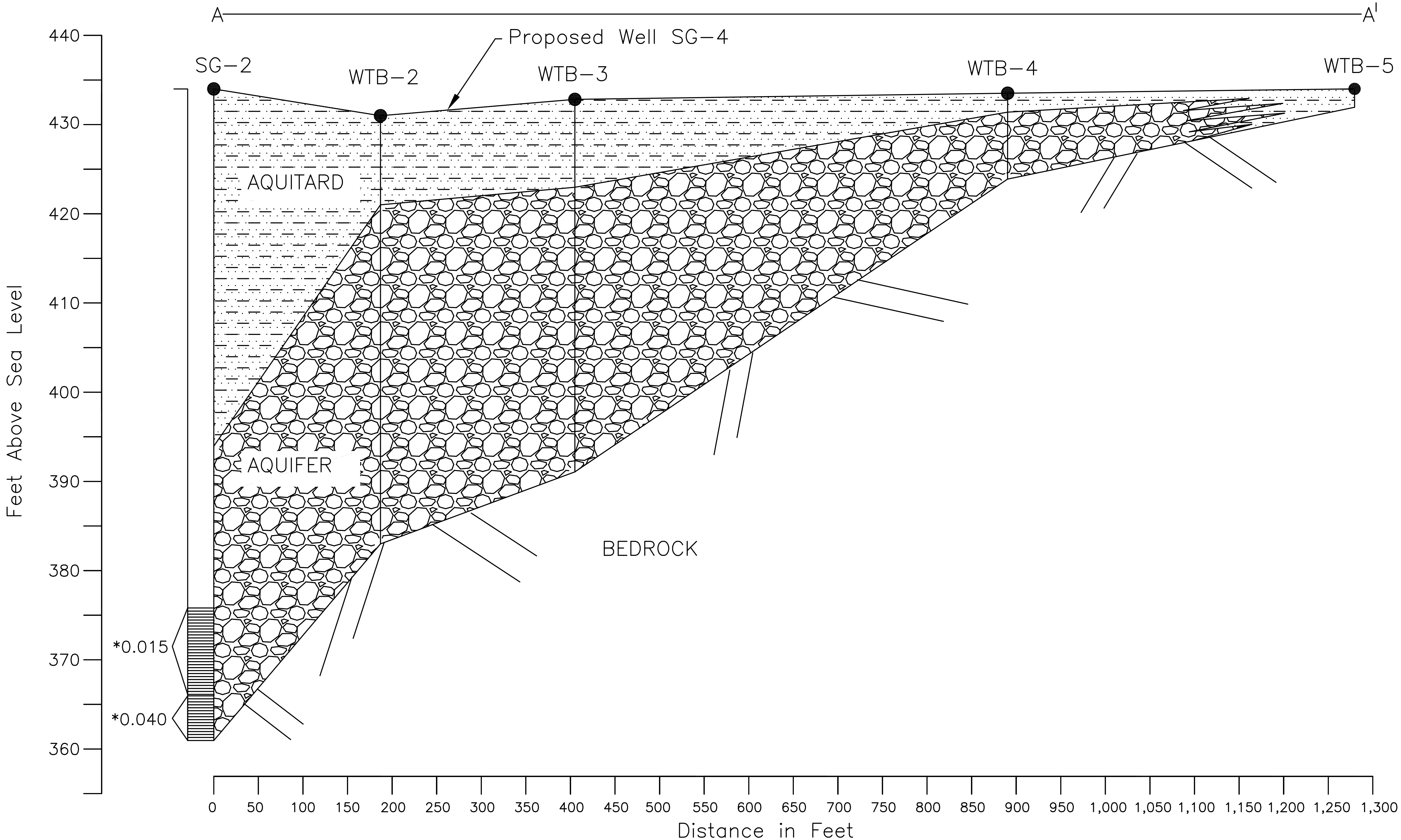
Legend

- Existing Water Well
- Test Boring
- Proposed Well
- A–A' Cross–Section
- B–B' Cross–Section
- 100' Wetlands Setback Contour

0 50 100 200
Graphic Scale in Feet

N

CA RICH CONSULTANTS, INC. Certified Ground–Water and Environmental Specialists 17 Dupont Street, Plainview, New York 11803		
TITLE: LOCATION OF EXISTING SAND & GRAVEL WELLS, APRIL 2008 TEST BORINGS AND CROSS–SECTIONS		DATE: 5/22/2008 SCALE: AS SHOWN
FIGURE: 1 DRAWING NO: 2008–7	Watchtower Bible & Tract Soc. of NY, Inc. Paterson, New York	DRAWN BY: J.T.C. APPR. BY: E.A.W.



Notes:
* = Screen slot size in inches

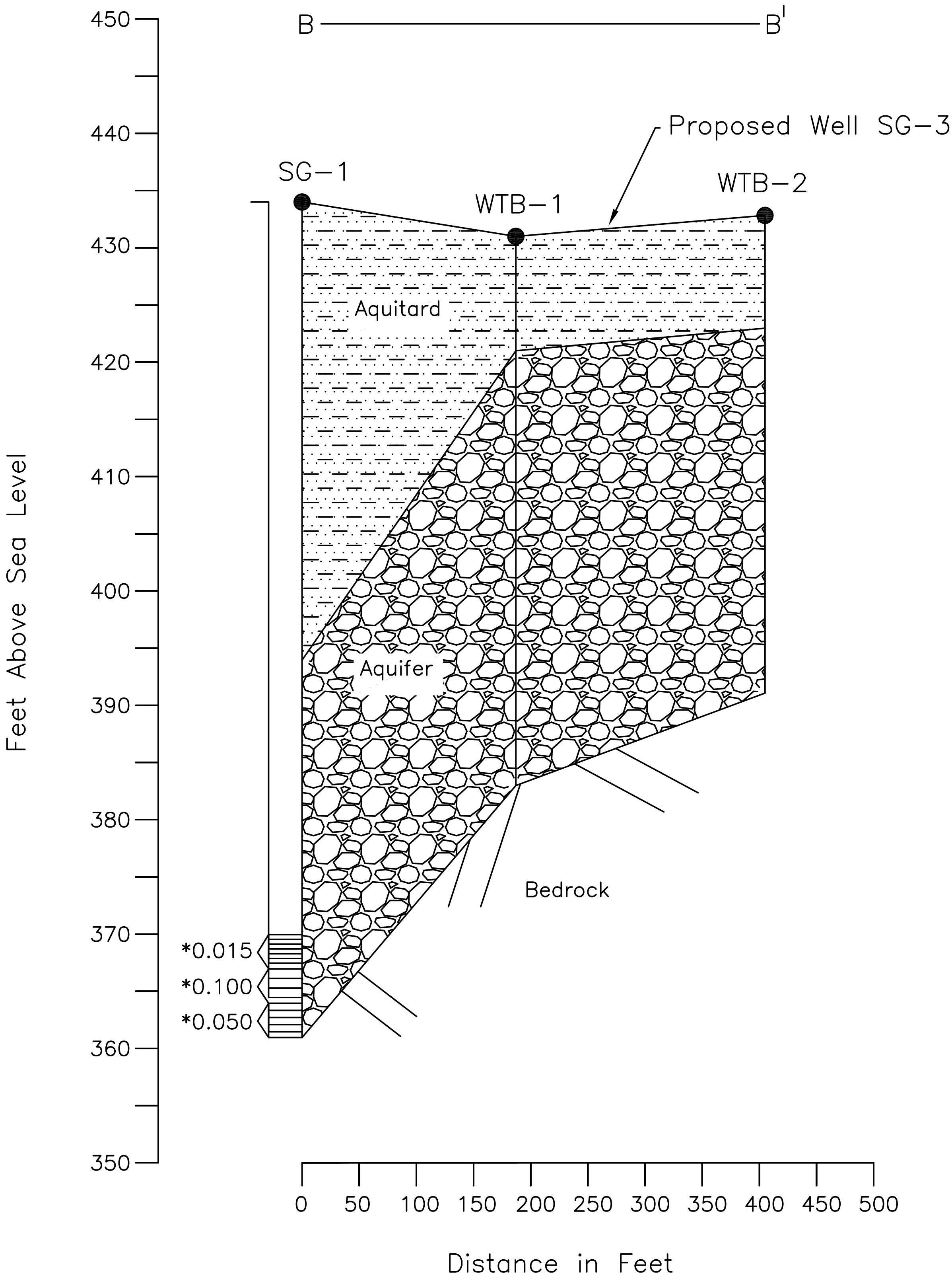
Cross-section drawn with a 10X vertical exaggeration

Sand, silt, and clay

Sand and gravel

Bedrock

CA RICH CONSULTANTS, INC. Certified Ground-Water and Environmental Specialists 17 Dupont Street, Plainview, New York 11803		
TITLE: CROSS-SECTION A-A'		DATE: 4/16/2008
		SCALE: AS SHOWN
FIGURE: 2	Watchtower Bible & Trac Society of NY, Inc. Paterson, NY	DRAWN BY: J.T.C.
DRAWING NO: 2008-2A		APPR. BY: E.A.W.



Notes:
* = Screen slot size in inches

Cross-section drawn with a 10X vertical exaggeration

Sand, silt, and clay

Sand and gravel

Bedrock

CA RICH CONSULTANTS, INC.

Certified Ground-Water and Environmental Specialists
17 Dupont Street, Plainview, New York 11803

TITLE: CROSS-SECTION B-B'		DATE: 5/19/2008
		SCALE: As Shown
FIGURE: 3	Watchtower Bible & Trac Society of NY, Inc. Paterson, NY	DRAWN BY: J.T.C.
DRAWING NO: 2008-1		APPR. BY: E.A.W.

GRAIN SIZE ANALYSIS

UNIVERSAL TESTING & INSPECTION SERVICES

CLIENT: RICH CONSULTANTS INC DATE: 5/21/2008

PROJECT: WATCHTOWER/PATTERSON/TASK2 TECHNICIAN: GARY

SAMPLE TYPE: SOIL SAMPLE ID: WTB-1 (43-48 ft)

START WEIGHT: MOISTURE:

WASH WEIGHT:

DIFFERENCE: PASSING #200:

SIEVE SIZE	WEIGHT GRAMS	% RETAINED	% PASSING	Diameter in inches
(1/8")	289.8	45.1	54.9	0.125
#8	32.0	5.0	49.9	0.0937
#10	16.2	2.5	47.4	0.0787
(#16)	66.3	10.3	37.0	0.0469
#20	26.3	4.1	32.9	0.0331
(#30)	40.8	6.4	26.6	0.0234
(#40)	46.8	7.3	19.3	0.0165
(#50)	46.8	7.3	12.0	0.0117
#200	69.9	10.9	1.1	0.0029
PAN	7.3	1.1		
TOTAL	642.2	100.0		

UNIVERSAL TESTING & INSPECTION SERVICES

CLIENT:	RICH CONSULTANTS INC	DATE:	5/21/2008
PROJECT:	WATCHTOWER/PATTERSON/TASK2	TECHNICIAN:	GARY
SAMPLE TYPE:	SOIL	SAMPLE ID:	WTB-2 (35-40 ft)

START WEIGHT:	MOISTURE:
WASH WEIGHT:	
DIFFERENCE:	PASSING #200:

SIEVE SIZE	WEIGHT GRAMS	% RETAINED	% PASSING	Diameter in inches
(1/8")	273.6	50.2	49.8	0.125
#8	11.5	2.1	47.7	0.0937
#10	15.9	2.9	44.8	0.0787
(#16)	48.2	8.8	36.0	0.0469
#20	12.6	2.3	33.7	0.0331
(#30)	26.3	4.8	28.8	0.0234
(#40)	66.8	12.3	16.6	0.0165
(#50)	36.3	6.7	9.9	0.0117
#200	44.3	8.1	1.8	0.0029
PAN	9.8	1.8		
TOTAL	545.3	100.0		

UNIVERSAL TESTING & INSPECTION SERVICES

CLIENT:	RICH CONSULTANTS INC	DATE:	5/21/2008
PROJECT:	WATCHTOWER/PATTERSON/TASK2	TECHNICIAN:	GARY
SAMPLE TYPE:	SOIL	SAMPLE ID:	WTB-3 (30-32.5 ft)

START WEIGHT:	MOISTURE:
WASH WEIGHT:	
DIFFERENCE:	PASSING #200:

SIEVE SIZE	WEIGHT GRAMS	% RETAINED	% PASSING	Diameter in inches
(1/8")	313.0	46.1	53.9	0.125
#8	19.0	2.8	51.1	0.0937
#10	19.3	2.8	48.3	0.0787
(#16)	53.1	7.8	40.5	0.0469
#20	31.2	4.6	35.9	0.0331
(#30)	54.3	8.0	27.9	0.0234
(#40)	12.2	1.8	26.1	0.0165
(#50)	82.1	12.1	14.0	0.0117
#200	84.2	12.4	1.6	0.0029
PAN	10.9	1.6		
TOTAL	679.3	100.0		

BORING LOGS
AND
WELL CONSTRUCTION DIRGRAMS

CA RICH Consultants, Inc.

Boring Number WTB-1

17 Dupont Street, Plainview, New York 11803

BORING LOG

Project Name	Site	Date & Time Started:	5/1/2008	
Watchtower	Patterson, NY	Date & Time Completed:	5/1/2008	
Drilling Company: Connecticut Test Borings	Foreman: Christian Deangelis	Sampler(s): Michael Yager	Sampler Hammer: NA	Drop: NA
Drilling Equipment: Geoprobe 7720 DT	Method: Direct Push	Elevation & Datum: NA	Completion Depth: 48-Feet	Rock Depth: 48
Bit Size(s): 5-Feet	Core Barrel(s): 1.25 & 3.25 inch	Geologist(s): Michael Yager		

DEPTH (ft below grade)	SAMPLES Sample Number	Sample Interval (feet)	Recovery (feet)	Sieve Analysis	SOIL DESCRIPTION	REMARKS
	LOCATION: WTB-1				SURFACE DESCRIPTION: Open Field/Pasture - Grass	
0	1	0-5	2	No	Dark brown/brown sandy clayey silt to a peat layer to grey/tan fine sand/organic sediment at tip	Water encountered at approximately 5 feet.
5	2	5-10	3	No	Grey/tan fine sand/organic sediment to tan silty fine sand w/ some gravel	
10	3	10-15	3	No	Medium to coarse grey/tan sand with gravel and some fine silty sand	Bottom of aquitard/top of aquifer at approximately 10 feet.
15	4	15-20	4	No	Grey/tan fine medium and coarse sands with some gravel and silt	
20	5	20-25	4	No	Grey/tan fine medium and coarse sands with gravel and some silt	
25	6	25-30	2	No	Grey/tan medium and coarse sand with gravel and some fine sand	
30	7	30-35	3	No	Grey/tan fine medium sand with some coarse sand and gravel	
35	8	35-40	0	N/A	* No Recovery *	
40	9	40-45	1	No	Coarse gravel with some coarse sand and silt	Bottom of aquifer at approximately 47 feet.
45	10	43-48	5	Yes	Grey/tan medium/coarse sand with gravel and some silt Bedrock at 48 feet - Marble	1st attempt - Refusal encountered at 47 feet with no recovery. 2nd attempt - Drive down to 43 feet and begin sampling. Refusal at 48 feet.
50						

Signature: Michael Yager

Date: 5/8/2008

CA RICH Consultants, Inc.

17 Dupont Street, Plainview, New York 11803

Boring Number WTB-2

BORING LOG

Project Name: Watchtower	Site: Patterson, NY	Date & Time Started: 5/1/2008 Date & Time Completed: 5/1/2008		
Drilling Company: Connecticut Test Borings	Foreman: Christian Deangelis	Sampler(s): Michael Yager	Sampler Hammer: NA	Drop: NA
Drilling Equipment: Geoprobe 7720 DT	Method: Direct Push	Elevation & Datum: NA	Completion Depth: 42-Feet	Rock Depth: 42
Bit Size(s): 5-Feet	Core Barrel(s): 1.25 & 3.25 inch	Geologist(s): Michael Yager		

DEPTH (ft below grade)	Sample Number	Sample Interval (feet)	Recovery (feet)	Sieve Analysis	SOIL DESCRIPTION	REMARKS
	LOCATION: WTB-2				SURFACE DESCRIPTION: Open Field/Pasture - Grass	
0	1	0-5	2.5	No	Top soil to brown silty sandy clay with some gravel	Water encountered at approximately 4 feet.
5	2	5-10	3	No	Grey/tan fine/medium sand w/ some coarse sand and gravel w/ some silt	
10	3	10-15	2.5	No	Grey/tan fine/medium sand w/ some coarse sand and gravel w/ some silt (coarse gravel lense at 12-12.5 feet)	Bottom of aquitard/top of aquifer at approximately 10 feet.
15	4	15-20	3	No	Grey/tan fine medium and coarse sands with some gravel w/ trace silt	
20	5	20-25	2	No	Grey/tan medium/coarse sands with gravel and some fine sand and trace silt	
25	6	25-30	2.5	No	Grey/tan medium and coarse sand with gravel and trace silt	
30	7	30-35	2	No	Grey/tan medium/coarse sand w/ some fine sand and gravel	
35	8	35-40	0	Yes	Grey/tan medium/coarse sand and gravel w/ some fine sand and trace silt	
40	9	40-42	1	No	Grey/tan medium/coarse sand and gravel Bedrock at 42 feet - Marble	Bottom of aquifer at approximately 41 feet. Refusal at approximately 42 feet.
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Signature: *Michael Yager* Date: 5/8/2008

CA RICH Consultants, Inc.

Boring Number **WTB-3**

17 Dupont Street, Plainview, New York 11803

BORING LOG

Project Name: **Watchtower**	Site: **Patterson, NY**	Date & Time Started: 4/30/2008 Date & Time Completed: 4/30/2008		
Drilling Company: Connecticut Test Borings	Foreman: Christian Deangelis	Sampler(s): Michael Yager	Sampler Hammer: NA	Drop: NA
Drilling Equipment: Geoprobe 7720 DT	Method: Direct Push	Elevation & Datum: NA	Completion Depth: 32-Feet	Rock Depth: 32
Bit Size(s): 5-Feet	Core Barrel(s): 1.25 & 3.25 inch	Geologist(s): Michael Yager		

DEPTH (ft below grade)	SAMPLES: Sample Number	Sample Interval (feet)	Recovery (feet)	Sieve Analysis	SOIL DESCRIPTION	REMARKS
	LOCATION: **WTB-3**				SURFACE DESCRIPTION: Open Field/Pasture - Grass	
0	1	0-5	4	No	Top soil to brown sandy silty clay	Water encountered at approximately 4.5 feet.
5	2	5-10	5	No	Tan/brown fine silty sand 5 ft to 7.5 ft Grey sandy silty clay 7.5 ft to 10 ft	
10	3	10-15	5	No	Grey medium/coarse sand w/ some gravel and trace silt	Bottom of aquitard/top of aquifer at approximately 10 feet.
15	4	15-20	4	No	Grey coarse sand and gravel 15 ft to 18.5 ft Grey silty fine sand with clay and some gravel	
20	5	20-25	4	No	Grey/tan medium/coarse sand and gravel with some silt and clay Silt/clay lense at 21 ft to 22 ft	
25	6	25-30	5	No	Grey/tan medium and coarse sand with gravel and trace silt	
30	7	30-32	2	Yes	Grey/tan coarse sand and gravel Tan fine silty sand (weathered rock) w/ some gravel Bedrock at 32 feet - Marble	Bottom of aquifer at approximately 30 feet. Refusal at approximately 32 feet.
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Page 1 of 1 Signature: *Michael Yager* Date: 5/8/2008

CA RICH Consultants, Inc.

Boring Number **WTB-4**

17 Dupont Street, Plainview, New York 11803

BORING LOG

Project Name: **Watchtower**	Site: **Patterson, NY**	Date & Time Started: **4/30/2008** Date & Time Completed: **4/30/2008**	
Drilling Company: Connecticut Test Borings	Foreman: Christian Deangelis	Sampler(s): Michael Yager	Sampler Hammer: NA / Drop: NA
Drilling Equipment: Geoprobe 7720 DT	Method: Direct Push	Elevation & Datum: NA	Completion Depth: 12-Feet / Rock Depth: 12
Bit Size(s): 5-Feet	Core Barrel(s): 3.25 inch	Geologist(s): Michael Yager	

DEPTH (ft below grade)	SAMPLES: Sample Number	Sample Interval (feet)	Recovery (feet)	Sieve Analysis	SOIL DESCRIPTION	REMARKS
	LOCATION: WTB-4				SURFACE DESCRIPTION: Open Field/Pasture - Grass	
0	1	0-5	3	No	Top soil to brown silty sandy clay w/ some gravel Brown medium/coarse sand and gravel with some fine sand and silt - 4-5 feet	Water encountered at approximately 3 feet Bottom of aquitard/top of aquifer at approximately 4 feet.
5	2	5-10	3	No	Brown/tan/orange coarse sand and gravel w/ some silt	
10	3	10-12	1.5	No	Grey/tan coarse sand and gravel with trace silt Tip of core - light tan fine silty sand (weathered rock) w/ some gravel Bedrock at 12 feet	Bottom of aquifer at approximately 11 feet. Refusal at approximately 12 feet.
15						
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25						
30						
35						
40						
45						
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Signature: Michael Yager

Date: 5/8/2008

CA RICH Consultants, Inc.

Boring Number **WTB-5**

17 Dupont Street, Plainview, New York 11803

BORING LOG

Project Name **Watchtower**	Site **Patterson, NY**	Date & Time Started: **4/30/2008** Date & Time Completed: **4/30/2008**	
Drilling Company Connecticut Test Borings	Foreman Christian Deangelis	Sampler(s) Michael Yager	Sampler Hammer: NA Drop: NA
Drilling Equipment Geoprobe 7720 DT	Method Direct Push	Elevation & Datum NA	Completion Depth: 9-Feet Rock Depth: 9
Bit Size(s) 5-Feet	Core Barrel(s) 3.25 inch	Geologist(s) Michael Yager	

DEPTH (ft below grade)	SAMPLES: Sample Number	Sample Interval (feet)	Recovery (feet)	Sieve Analysis	SOIL DESCRIPTION	REMARKS
	LOCATION: **WTB-5**				SURFACE DESCRIPTION: Open Field/Pasture - Grass	
0	1	0-5	2.5	No	Top soil to brown medium/fine silty sand w/ some coarse sand and gravel	
5	2	5-9	3	No	Tan/orange fine/silty sand (weathered rock) w/ some gravel Bedrock at 9 feet	Water encountered at approximately 7 feet. Refusal at approximately 9 feet.
10						
15						
20						
25						
30						
35						
40						
45						
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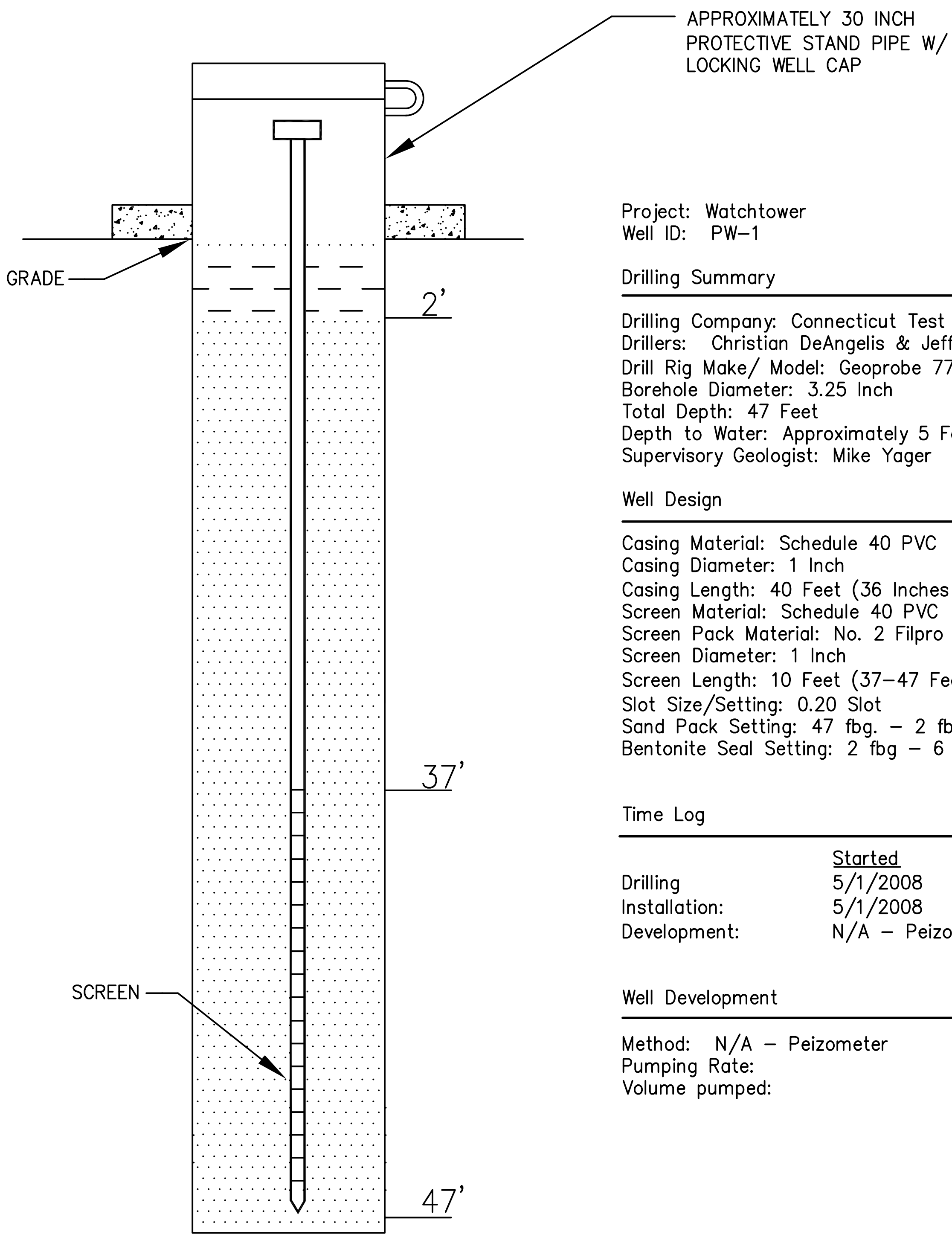
Signature: Michael Yager   Date: 5/8/2008



Project: Watchtower
Well ID: PW-1

Drilling Summary

Drilling Company: Connecticut Test Boring
Drillers: Christian DeAngelis & Jeff
Drill Rig Make/ Model: Geoprobe 7720 DT
Borehole Diameter: 3.25 Inch
Total Depth: 47 Feet
Depth to Water: Approximately 5 Feet
Supervisory Geologist: Mike Yager

Well Design

Casing Material: Schedule 40 PVC
Casing Diameter: 1 Inch
Casing Length: 40 Feet (36 Inches Above Grade to 37 fbg.)
Screen Material: Schedule 40 PVC
Screen Pack Material: No. 2 Filpro Morie Sand
Screen Diameter: 1 Inch
Screen Length: 10 Feet (37-47 Feet Below Grade)
Slot Size/Setting: 0.20 Slot
Sand Pack Setting: 47 fbg. - 2 fbg.
Bentonite Seal Setting: 2 fbg - 6 inches below grade

Time Log

	Started	Completed
Drilling	5/1/2008	5/1/2008
Installation:	5/1/2008	5/1/2008
Development:	N/A - Peizometer	

Well Development

Method: N/A - Peizometer
Pumping Rate:
Volume pumped:

LEGEND

BENTONITE SEAL

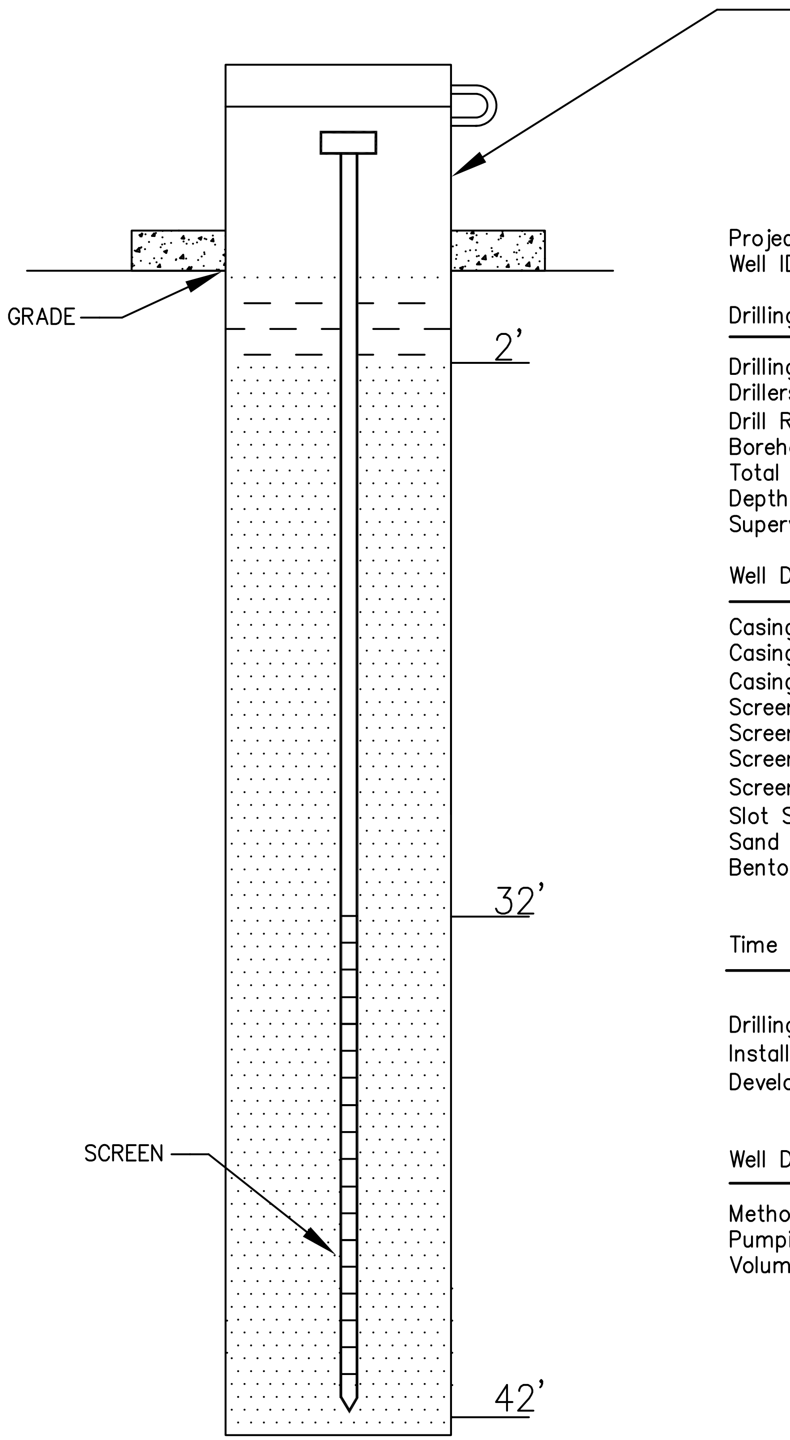
NO. 2 MORIE SAND

CONCRETE FORM

CA RICH CONSULTANTS, INC.

Certified Ground-Water and Environmental Specialists
17 Dupont Street, Plainview, NY 11803

TITLE: MONITORING WELL CONSTRUCTION DETAILS FOR PW-1		DATE: 5/21/2008
		SCALE: NTS
FIGURE: 1	Location: WATCHTOWER PATERSON, NEW YORK	DRAWN BY: J.T.C.
DRAWING NO: 2008-3		APPR. BY: E.A.W.



Project: Watchtower
Well ID: PW-2

Drilling Summary

Drilling Company: Connecticut Test Boring
Drillers: Christian DeAngelis & Jeff
Drill Rig Make/ Model: Geoprobe 7720 DT
Borehole Diameter: 3.25 Inch
Total Depth: 42 Feet
Depth to Water: Approximately 4 Feet
Supervisory Geologist: Mike Yager

Well Design

Casing Material: Schedule 40 PVC
Casing Diameter: 1 Inch
Casing Length: 35 Feet (36 Inches Above Grade to 32 fbg.)
Screen Material: Schedule 40 PVC
Screen Pack Material: No. 2 Filpro Morie Sand
Screen Diameter: 1 Inch
Screen Length: 10 Feet (32-42 Feet Below Grade)
Slot Size/Setting: 0.20 Slot
Sand Pack Setting: 32 fbg. - 2 fbg.
Bentonite Seal Setting: 2 fbg - 6 inches below grade

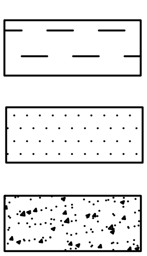
Time Log

	Started	Completed
Drilling	5/1/2008	5/1/2008
Installation:	5/1/2008	5/1/2008
Development:	N/A - Peizometer	

Well Development

Method: N/A - Peizometer
Pumping Rate:
Volume pumped:

LEGEND



BENTONITE SEAL

NO. 2 MORIE SAND

CONCRETE FORM

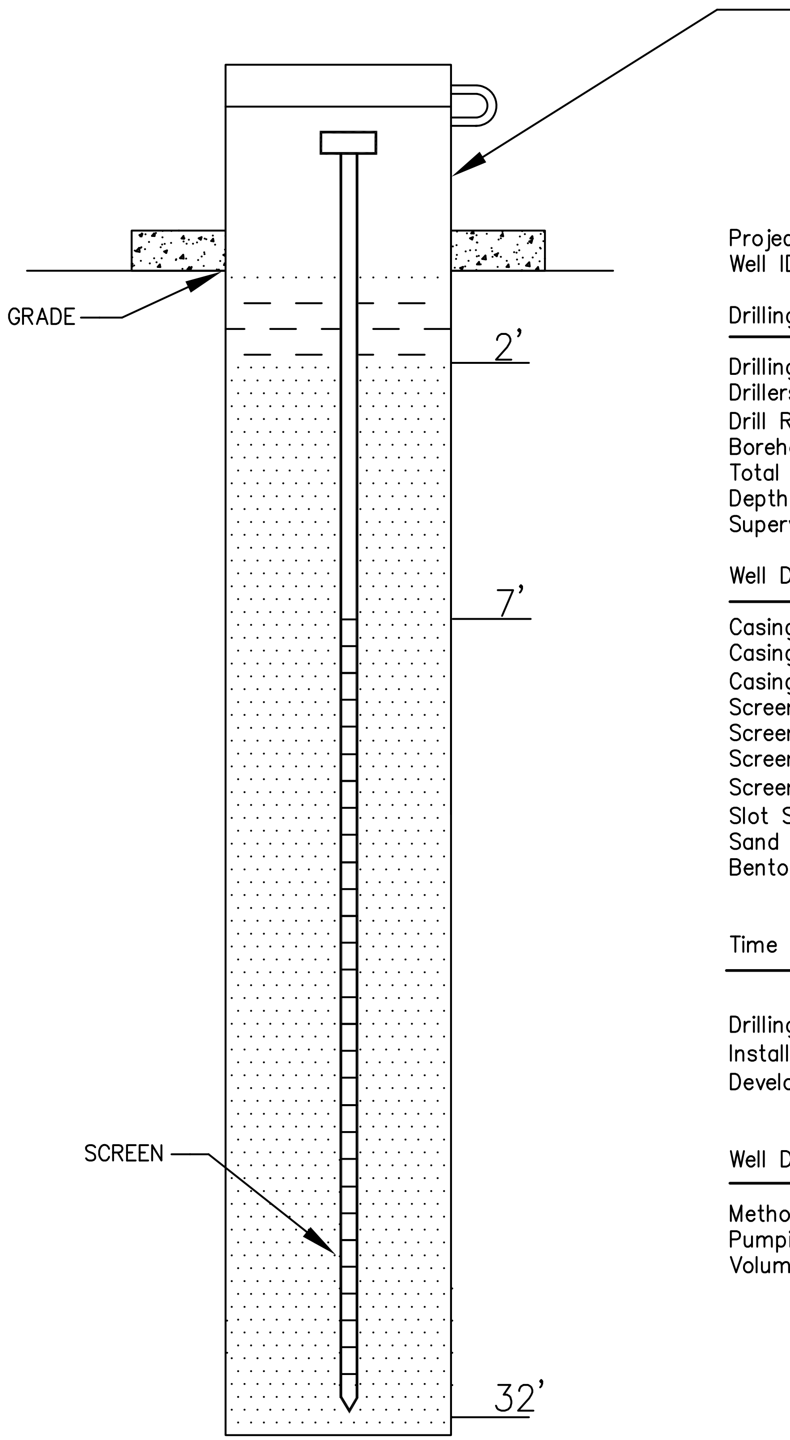
CA RICH CONSULTANTS, INC.

Certified Ground-Water and Environmental Specialists
17 Dupont Street, Plainview, NY 11803

TITLE:	DATE:
MONITORING WELL CONSTRUCTION DETAILS FOR PW-2	5/21/2008
	SCALE: NTS

FIGURE: 1	Location: WATCHTOWER PATERSON, NEW YORK	DRAWN BY: J.T.C.
DRAWING NO: 2008-4		APPR. BY: E.A.W.

APPROXIMATELY 30 INCH
PROTECTIVE STAND PIPE W/
LOCKING WELL CAP



Project: Watchtower
Well ID: PW-3

Drilling Summary

Drilling Company: Connecticut Test Boring
Drillers: Christian DeAngelis & Jeff
Drill Rig Make/ Model: Geoprobe 7720 DT
Borehole Diameter: 3.25 Inch
Total Depth: 32 Feet
Depth to Water: Approximately 4 Feet
Supervisory Geologist: Mike Yager

Well Design

Casing Material: Schedule 40 PVC
Casing Diameter: 1 Inch
Casing Length: 10 Feet (36 Inches Above Grade to 10 fbg.)
Screen Material: Schedule 40 PVC
Screen Pack Material: No. 2 Filpro Morie Sand
Screen Diameter: 1 Inch
Screen Length: 25 Feet (7–32 Feet Below Grade)
Slot Size/Setting: 0.20 Slot
Sand Pack Setting: 32 fbg. – 2 fbg.
Bentonite Seal Setting: 2 fbg – 6 inches below grade

Time Log

	Started	Completed
Drilling	4/30/2008	4/30/2008
Installation:	4/30/2008	4/30/2008
Development:	N/A – Peizometer	

Well Development

Method: N/A – Peizometer
Pumping Rate:
Volume pumped:

LEGEND

BENTONITE SEAL

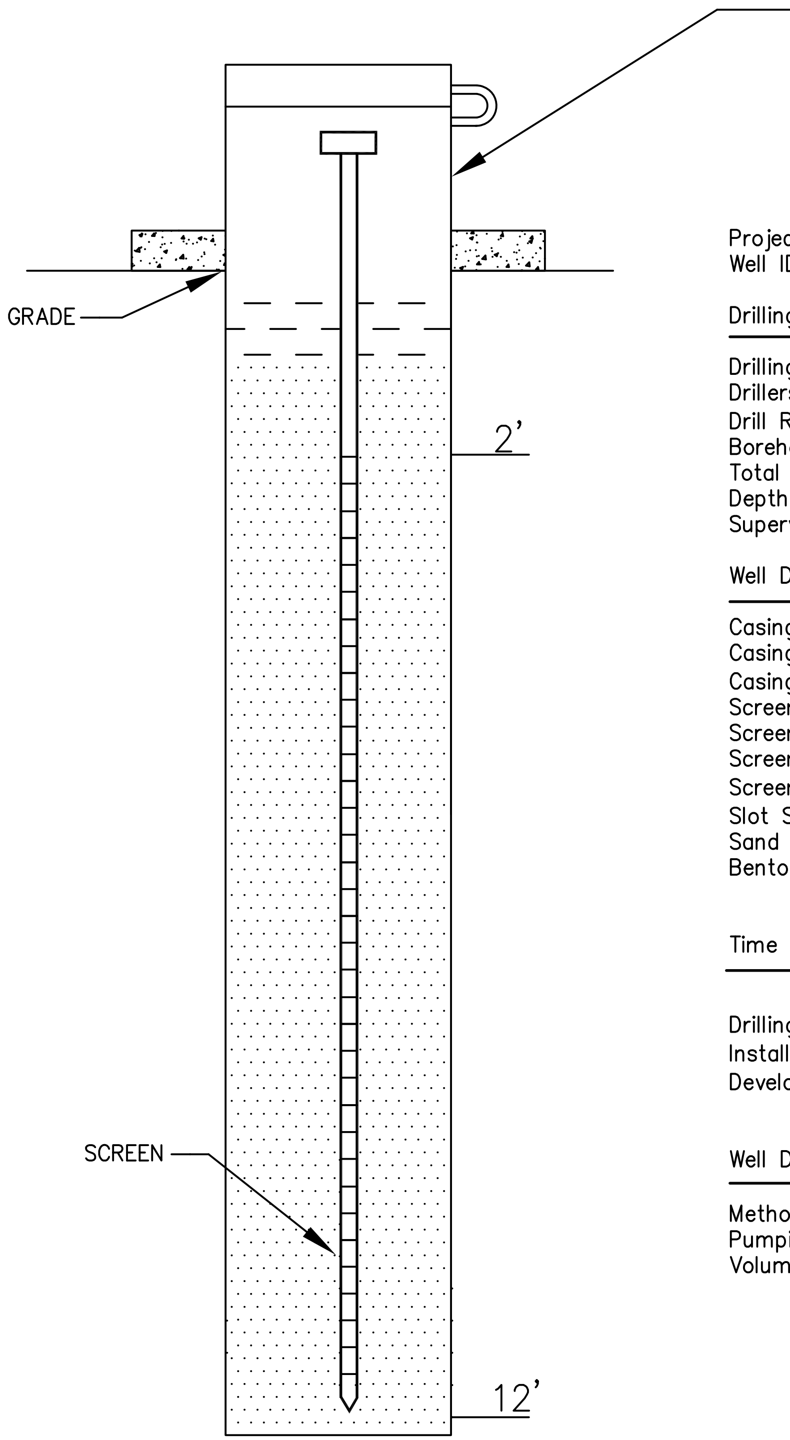
NO. 2 MORIE SAND

CONCRETE

CA RICH CONSULTANTS, INC.

Certified Ground–Water and Environmental Specialists
17 Dupont Street, Plainview, NY 11803

TITLE: MONITORING WELL CONSTRUCTION DETAILS FOR PW–3		DATE: 5/21/2008
		SCALE: NTS
FIGURE: 1	Location: WATCHTOWER PATERSON, NEW YORK	DRAWN BY: J.T.C.
DRAWING NO: 2008–5		APPR. BY: E.A.W.



Project: Watchtower
Well ID: PW–4

Drilling Summary

Drilling Company: Connecticut Test Boring
Drillers: Christian DeAngelis & Jeff
Drill Rig Make/ Model: Geoprobe 7720 DT
Borehole Diameter: 3.25 Inch
Total Depth: 12 Feet
Depth to Water: Approximately 3 Feet
Supervisory Geologist: Mike Yager

Well Design

Casing Material: Schedule 40 PVC
Casing Diameter: 1 Inch
Casing Length: 5 Feet (36 Inches Above Grade to 2 fbg.)
Screen Material: Schedule 40 PVC
Screen Pack Material: No. 2 Filpro Morie Sand
Screen Diameter: 1 Inch
Screen Length: 10 Feet (12–2 Feet Below Grade)
Slot Size/Setting: 0.20 Slot
Sand Pack Setting: 12 fbg. – 1 fbg.
Bentonite Seal Setting: 1 fbg – grade

Time Log

	Started	Completed
Drilling	4/30/2008	4/30/2008
Installation:	4/30/2008	4/30/2008
Development:	N/A – Peizometer	

Well Development

Method: N/A – Peizometer
Pumping Rate:
Volume pumped:

LEGEND

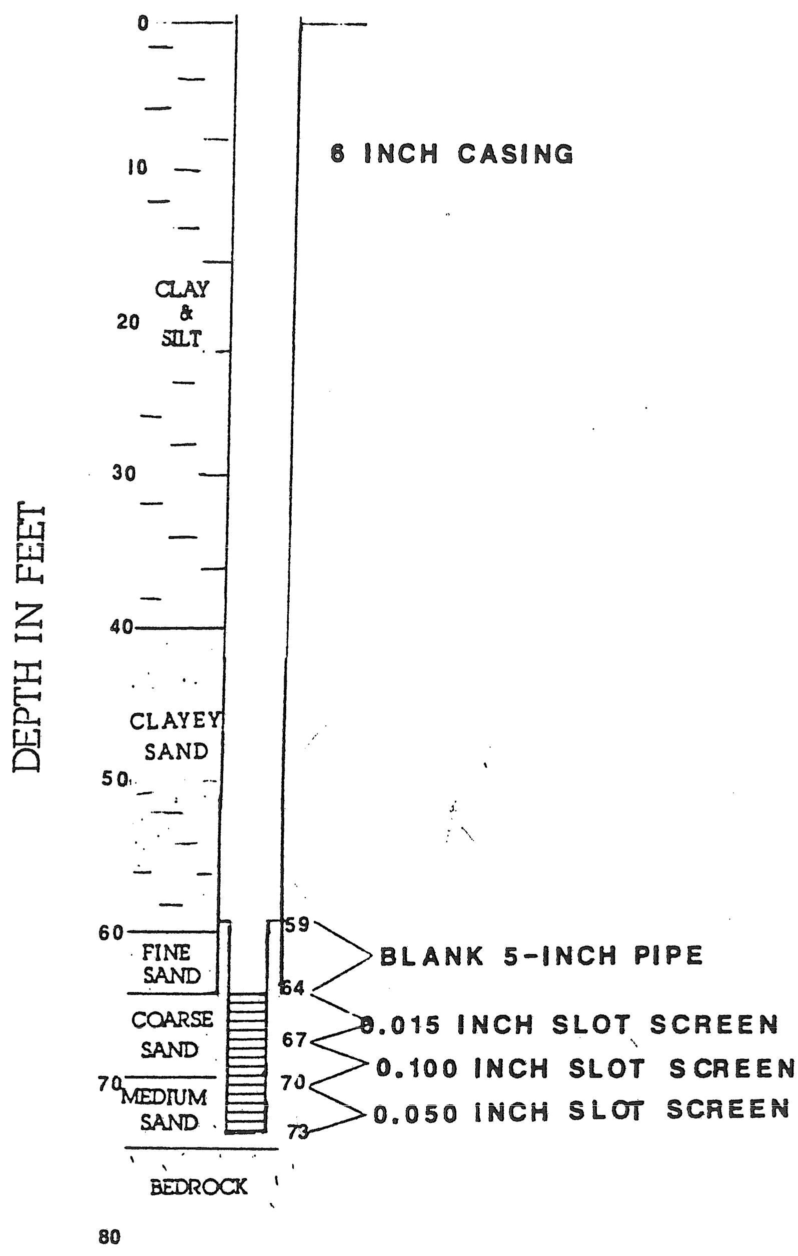
BENTONITE SEAL
NO. 2 MORIE SAND
CONCRETE FORM

CA RICH CONSULTANTS, INC.

Certified Ground–Water and Environmental Specialists
17 Dupont Street, Plainview, NY 11803

TITLE:	DATE:
MONITORING WELL CONSTRUCTION DETAILS FOR PW–4	5/21/2008
	SCALE: NTS
FIGURE: 1	Location: WATCHTOWER PATERSON, NEW YORK	DRAWN BY: J.T.C.
DRAWING NO: 2008–6		APPR. BY: E.A.W.

WATCHTOWER WELL SG-1

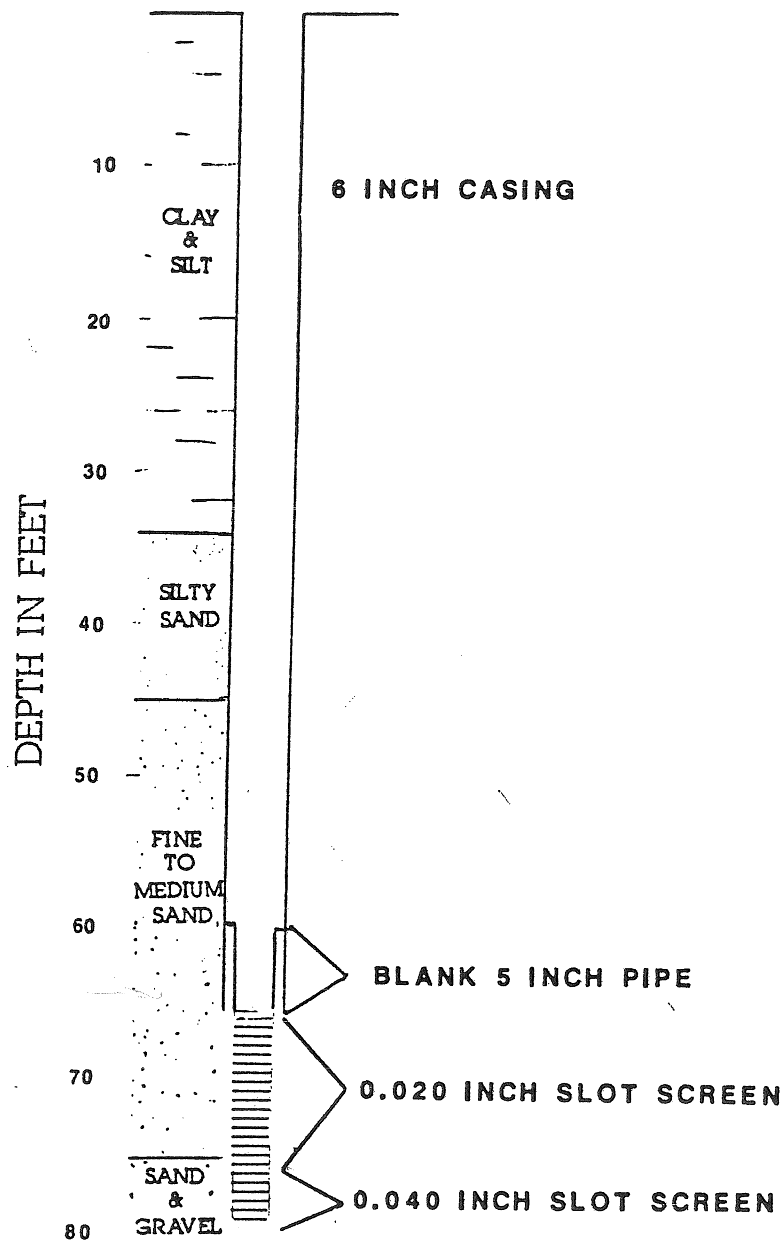


CA RICH CONSULTANTS, INC.

Certified Ground-Water and Environmental Specialists

Construction Diagram
Well SG-1
Watchtower Educational Center
Patterson, N.Y.

WATCHTOWER WELL SG-2



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Certified Ground-Water and Environmental Specialists

CONSTRUCTION DIAGRAM
WELL SG - 2
WATCHTOWER EDUCATIONAL CENTER
PATTERSON, N.Y.

e-mail: eweinstock@carichinc.com

July 2, 2008

Shawn Rogan, Chairman
Planning Board
Town of Patterson
P.O. Box 470
Patterson, NY 12563

Re: **Supporting Information Regarding the Placement of Two New Sand and Gravel Wells in Town of Patterson Designated Wetlands Watchtower Educational Center, Patterson, NY**
CA RICH Job Code: Watchtower/Patterson/Task 3

Dear Mr. Rogan:

CA RICH Consultants, Inc. (CA RICH) is providing you with this letter in support of the placement of two new water supply wells in the sand and gravel aquifer below the northwest portion of the Watchtower Educational Center (WEC). We understand that this area is a Town designated wetlands as per Section 154-18.E.3(b)[4] Patterson Wetlands Code, enacted in 1990. Based on our knowledge from work experience at the WEC, we believe that:

- There is no practicable alternative for this activity which is not currently a freshwater wetland or adjacent area;
- The proposed activity is reasonable and necessary;
- The proposed activity is compatible with the public health and welfare; and
- This activity will preserve, protect and conserve the freshwater wetlands and the benefits derived from them.

Understanding of the Current Situation

It is our understanding that WEC currently has a water allocation permit with the New York State Department of Environmental Conservation (NYSDEC). Permit number WSA 8240 was issued for 165,000 gallons per day (gpd) based on a site-wide pump test performed at this property in 1988. The current well network consists of three bedrock wells and two sand & gravel wells. At this time, we understand that WEC wishes to add two additional sand & gravel wells to serve as a backup to their water supply well network. However, they do not intend to pump beyond the 165,000 gpd allotment.

17 Dupont Street, Plainview, NY 11803 ■ Tel. 516.576.8844 ■ Fax. 516.576.0093 ■ www.carichinc.com

Summary of Groundwater Supply Investigation, Development and Rehabilitation Activities at WEC

November 1988 Groundwater Supply Assessment Study (Ref. 1) – This study documented the installation and testing of 11 bedrock wells and two sand and gravel wells installed on the WEC property between 1985 and 1988. Of the 11 bedrock wells, six had initial water production yields deemed to be suitable for water supply purposes. In June of 1988 a 96-hour site-wide pump test was performed that included these six wells. Due to excessive drawdown of the water level in the wells and decreases in water yield during the test, three of the six bedrock wells were judged to be unsuitable for use as water supply production wells. Based on this experience, we do not believe the bedrock aquifer at this property provides an adequate yield for the needs of the Center.

During August and September of 1988, two sand and gravel wells were installed in the unconsolidated sediments located below the northwestern portion of the WEC property. The wells were placed outside of the NYSDEC's 100-foot wetlands setback at that time. (In 1988, the Town of Patterson had not yet identified this area as a Town designated wetlands.) These wells were pump tested for 96-hours during October, 1988. Each well produced 75 gallons per minute (gpm) and was able to maintain these rates of production without excessive drawdown of the water level in the well or a decrease in yield.

August 2000 Rehabilitation of Sand and Gravel Well SG-2 (Ref. 2) – During the Summer of 1999, WEC reported that the pumping depth to water in sand & gravel well SG-2 had increased from approximately 32 feet below grade (when the well was initially installed) to 52 feet below grade. Inspection of the well indicated that the screens had been impacted by mineralization which occurred over years of pumping. A well rehabilitation effort was performed on well SG-2 during the Spring of 2000. This included standard well treatment techniques such as mechanical surging and chemical treatment. Upon completion of the rehabilitation effort, the well's improvement exceeded its initial capacity. This indicated that the sand and gravel wells could be rehabilitated after mineralization of the screens had occurred and that a program of periodic well treatment should be developed for the wells in this formation.

July 2007 Rehabilitation of Bedrock Supply Well W-4 – During the Spring of 2007, WEC reported an increase in the pumping depth to water in bedrock well W-4. Inspection of this well did not indicate that mineralization of the borehole had occurred. A rehabilitation effort similar to the one conducted on well SG-2 was performed on bedrock well W-4. However, the rehabilitation effort resulted in only minor improvements to the well's production capacity.

May 2008 Sand & Gravel Aquifer Mapping and Test Borings (Ref. 3) – In anticipation of future well maintenance efforts of the two existing sand and gravel wells, WEC decided to explore the feasibility of installing additional wells in this portion of the property. During the Spring of 2008, a series of five test borings were installed in the northwestern portion of the property. These five locations are all outside of the NYSDEC's 100-foot wetlands setback, but are within the Town designated wetlands. The boring program identified two proposed drill sites that were judged to have excellent potential for water production. The locations of these wells were selected to have a minimal impact on each other and on the two existing supply wells in the area.

Summary

Based on our experiences at the property, we recommend that the Town of Patterson allow WEC to install two sand and gravel wells in the Town designated wetlands located at the northwestern portion of the site. The rational for this recommendation is as follows:

1) There is no practicable alternative for this activity which is not currently a freshwater wetland or adjacent area. An extensive groundwater supply investigation performed between 1985 and 1988 confirmed that the bedrock aquifer alone is not a reliable water supply for the Center. The sand and gravel aquifer below the Town wetlands is the only viable alternative.

2) The proposed activity is reasonable and necessary. Our experience has shown that the sand & gravel wells have to be turned off periodically so that rehabilitation efforts can be performed on the screens. Adding wells to this portion of the property will decrease the amount of water pumped from any one well and will also allow wells to be taken out-of-service for routine maintenance.

3) The proposed activity is compatible with the public health and welfare. There are no negative impacts to public health or welfare posed by this activity.

4) This activity will preserve, protect and conserve the freshwater wetlands and the benefits derived from them. Drinking water wells require a wellhead protect area measuring 250 feet in radius. By allowing the installation of two additional wells in this portion of the property, the Town will essentially be ensuring the protection of these wetlands through the creation of wellhead projection areas. Since WEC does not intend to pump beyond their current 165,000 gpd water allotment, there should be no impact to the wetlands caused by the operation of these wells. Past experience has shown that the operation of existing wells SG-1 and SG-2 have not negatively impacted the wetlands in this area.

If you have any questions regarding this letter, please do not hesitate to call our office.

Respectfully,

CA RICH CONSULTANTS, INC.

Eric Weinstock

Eric A. Weinstock, CPG
Vice President

References

1. CA RICH (November, 1988) Groundwater Supply Assessment, Watchtower Educational Center, Patterson, NY.

2. CA RICH (August, 2000) Summary Report, Rehabilitation of Well SG-2, Patterson, NY.

3. CA RICH (May, 2008) Aquifer Mapping & Test Borings, Watchtower Educational Center, Patterson, NY.

cc: Robert S. May, Watchtower Bible and Tract Society of New York, Inc., Patterson, NY