

File
with:

W-2013-0693

Hahn jr, Norman A - DNR

From: Andy Jacque <AJacque@tcengineers.net>
Sent: Thursday, January 23, 2014 9:35 AM
To: Hahn jr, Norman A - DNR
Cc: Tim Kingman; Troy Simonar
Subject: Test Well for Well 8 in Rhinelander
Attachments: Well 8 Test Well map V2.pdf

Norm,

Attached is a revised test well location map. Location 1 is the location shown in the well site investigation. We are requesting approval to move the test well to Location 2 for the following reasons:

1. The location is better from a layout perspective. The easement and subsequent fence around it won't stick into the existing airport property.
2. It is further away from the runway, a potential contaminant source.
3. It is located out of an apparent fill section created by grading the airport runway.

Please let me know if you have any questions or concerns.

Regards,

Andy

Andrew D. Jacque, Ph.D., P.E.
ajacque@tcengineers.net
Town & Country Engineering, Inc.
5225 Verona Road, Building 3
Madison, WI 53711
Phone: (608) 273-3350
Direct Dial: (608) 310-1070
Cell: (608) 219-6770
Fax: (608) 273-3381

W-5013-0993



EW fence line

Location 1

89° 29' 40.444444 W

45° 37' 40.444444 N

EW fence line

Location 2
89° 29' 40.444444 W
45° 37' 40.444444 N
EW fence line

Location 3
89° 29' 11.422222 W
45° 37' 23.777778 N
EW fence line

EW fence line

Google earth

Hahn jr, Norman A - DNR

From: Hahn jr, Norman A - DNR
Sent: Thursday, January 23, 2014 9:51 AM
To: Anderson, Ian K - DNR
Cc: Dobbins, William G - DNR; Hahn jr, Norman A - DNR
Subject: FW: Test Well for Well 8 in Rhinelander
Attachments: Well 8 Test Well map V2.pdf

Hello Ian. Please see me to discuss relocated site No. 2 for City of Rhinelander well No. 8. You/I approved site No. 1 but they now want to stay out of the airport property and the fill that is there. You can ignore site No. 3 (for the time being at least).

Thanks.

 Norman A. Hahn, Jr., P.E.

Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources
PO Box 7921
Madison WI 53707

(☎) phone: (608) 267-7661

(☎) fax: (608) 267-7650

(✉) e-mail: norman.hahnjr@wisconsin.gov

Fill out this customer survey -- <https://www.surveymonkey.com/s/WDNRWater>

From: Andy Jacque [<mailto:AJacque@tcengineers.net>]
Sent: Thursday, January 23, 2014 9:35 AM
To: Hahn jr, Norman A - DNR
Cc: Tim Kingman; Troy Simonar
Subject: Test Well for Well 8 in Rhinelander

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2. It is further away from the runway, a potential contaminant source.
3. It is located out of an apparent fill section created by grading the airport runway.

Please let me know if you have any questions or concerns.

Regards,

Andy

Andrew D. Jacque, Ph.D., P.E.
ajacque@tcengineers.net
Town & Country Engineering, Inc.
5225 Verona Road, Building 3

Hahn jr, Norman A - DNR

From: Hahn jr, Norman A - DNR
Sent: Thursday, January 23, 2014 11:57 AM
To: Andy Jacque (AJacque@tcengineers.net); tkingman@rhinelanderutilities.org; troy.simonar@ctwcorp.com; Eugene Laschinger (Gene@tcengineers.net)
Cc: Dobbins, William G - DNR; Hahn jr, Norman A - DNR; Anderson, Ian K - DNR
Subject: FW: Revised location - Rhinelander Well #8

Thank you Andy for sending me the revised City of Rhinelander well siting information. Location No. 2 is acceptable to the Department for the construction of the test well and if it is successful and with prior Department approval, the final well. Please see the capture zone modeling recommendation from Ian Anderson below.

As you and I discussed, the higher elevation of Location No. 2 versus the elevation of the well No. 7 installation needs to be taken into account so that positive pressure will always be maintained in the connecting water main from well No. 8 to the well No. 7 pumpstation.

Location No. 3 has not been reviewed or approved by the Department.

Sincerely,

 *Norman A. Hahn, Jr., P.E.*

Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources
PO Box 7921
Madison WI 53707
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(☎) fax: (608) 267-7650
(✉) e-mail: norman.hahnjr@wisconsin.gov

Fill out this customer survey -- <https://www.surveymonkey.com/s/WDNRWater>


From: Anderson, Ian K - DNR
Sent: Thursday, January 23, 2014 11:14 AM
To: Hahn jr, Norman A - DNR
Subject: Revised location - Rhinelander Well #8

Norm,

I have reviewed the revised location for Rhinelander Well #8, referred to as Location 2 in the map you sent. The coordinates of the location were specified as 45°37'39.23"N, 89°29'11.51"W, located 55' off the east fence line and 65' off the north fence line.

This location is approximately 130 feet southwest of the original proposed location. As such, it does not significantly alter the analysis of my NR 820 review, that predicts no significant impact to any water resources (see Jan 10, 2014 memo for details). I would recommend that the City's consultant re-run their capture zone modeling in order to verify that the new location yields a similar result as the original location.

Thank you,
Ian

 *Ian Anderson*

Hydrogeologist

Water Use Section

Bureau of Drinking Water & Groundwater

Wisconsin Department of Natural Resources

(☎) phone: (608) 266-2432

(☎) fax: (608) 267-7650

(✉) e-mail: ian.anderson@wisconsin.gov

Fill out this customer survey –

<https://www.surveymonkey.com/s/WDNRWater>

Hahn jr, Norman A - DNR

From: Tim Kingman <tkingman@rhinelanderutilities.org>
Sent: Friday, January 24, 2014 1:19 PM
To: Hahn jr, Norman A - DNR; Andy Jacque
Cc: Eugene Laschinger; Dobbins, William G - DNR; Witthuhn, James K - DNR; Wagner, Mary E - DNR
Subject: RE: Well 8 Rhinelander

Yes, the City does have wellhead protection ordinance and plan (will plan to amend for new well accordingly).

TimK

From: Hahn jr, Norman A - DNR [<mailto:Norman.Hahnjr@wisconsin.gov>]
Sent: Friday, January 24, 2014 12:08 PM
To: Andy Jacque
Cc: Tim Kingman; Eugene Laschinger; Dobbins, William G - DNR; Witthuhn, James K - DNR; Wagner, Mary E - DNR; Hahn jr, Norman A - DNR
Subject: RE: Well 8 Rhinelander

Hello Andy. Your list looks good. I added a few comments below.

Sincerely,

 Norman A. Hahn, Jr., P.E.

Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources
PO Box 7921
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(✉) e-mail: norman.hahnjr@wisconsin.gov

Fill out this customer survey -- <https://www.surveymonkey.com/s/WDNRWater>

From: Andy Jacque [<mailto:AJacque@tcengineers.net>]
Sent: Friday, January 24, 2014 11:47 AM
To: Hahn jr, Norman A - DNR
Cc: Tim Kingman; Eugene Laschinger
Subject: Well 8 Rhinelander

Norm,

I would like to make sure we have the i's dotted and t's crossed for the review and approval of the Well 8 project Rhinelander. Is the following list complete from the DNR's perspective review and approval?

Submittal of test well data: pumping, water quality and monitoring well (and test well construction report)
Submittal of engineering report (including an assessment of any drawdown impacts from the test pumping/monitoring work)

- Submittal of plan and specifications for well and well house modifications, including
 - Chemical feed
 - Well pump (and pitless unit)
 - Water main from satellite well to well house

Submittal of final water quality data and pumping data from final well (and the final well construction report, any final well monitoring work performed if necessary)

Submittal of well head protection plan; contaminant use inventory

Submittal of resolution or Owner approval letter for WHPP (I can't remember back to the management plan for well No. 7: Does the City have a wellhead protection ordinance? If so, it will need to be modified to incorporate well No. 8)

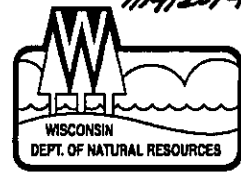
Would you like the engineering report ahead of the Plans and Specifications? (Yes but after the test well pumping/monitoring work and evaluation.)

Please let me know if I have missed anything. We are intending to bid the final well in early March. It looks like we may have a break in the weather to drill the well at the end of next week (fingers crossed).

Regards,

Andy

Andrew D. Jacque, Ph.D., P.E.
ajacque@tcengineers.net
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5225 Verona Road, Building 3
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Phone: (608) 273-3350
Direct Dial: (608) 310-1070
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Fax: (608) 273-3391



January 14, 2014

BLAINE OBORN ADMINISTRATOR
CITY OF RHINELANDER
135 S STEVENS STREET
RHINELANDER WI 54501

Project Number: W-2013-0693
PWSID#: 74401261
DNR Region: NOR
County: ONEIDA

SUBJECT: WELL SITE INVESTIGATION REPORT APPROVAL.

Dear Mr. Oborn:

The Wisconsin Department of Natural Resources, Division of Water, Bureau of Drinking Water and Groundwater, is conditioning approving a Well Site Investigation Report for proposed well No. 8. Information of sufficient detail to meet the requirements of s. NR 811.09 (3), Wis. Adm. Code, was submitted.

Water system name: City of Rhinelander

Date received: 12/19/13, with revisions or additions received on 01/02/14, 1/3/14 & 01/09/14

Professional Engineer: Dr. Andrew D. Jacque

Engineering firm: Town & Country Engineering, Inc., Madison

Regional DNR contact: Bill Dobbins, Rhinelander, 715-365-8923

Project description: A Well Site Investigation Report was submitted for proposed well No. 8. A test well will be constructed, that if successful, will be converted into well No. 8. The Well Site Investigation Report is being approved by the Department subject to the conditions below.

Well site: Well No. 8 will be centered on a minimum 100-foot by 100-foot parcel of City/County owned airport property that will be covered by a 99-year easement granted to the City. The primary well site will be located approximately 500 feet northwest of well No. 7. The alternate well site will be located approximately 500 feet east of well No. 7. The well sites are located at the north dead end of South Fox Ranch Road in Section 10, T36N, R8E, Town of Crescent (east part), Oneida County. The primary well site is located in the NW ¼ of the NW ¼ of Section 10. The alternate well site is located in the NE ¼ of the NW ¼ of Section 10.

The nearest neighboring municipal well is located approximately 18 miles to the southwest at the City of Tomahawk. It is not believed that the proposed well will have an adverse effect on any nearby wells owned by a water utility. If there is an actual adverse effect caused by the proposed well to nearby utility wells, or any other wells, the injured party may seek relief under the reasonableness of use tests set forth in State of Wisconsin v. Michels Pipeline Construction, Inc., 63, Wis. 2nd, 278 (1974).

Test well: A test well will be constructed at the primary well site. If the primary well site is not successful, a second test well may be constructed at the alternate well site. If the test well is successful, it will be converted into the final well. Eight-inch well casing will be installed through drift material to an expected depth of approximately 80 feet. If preliminarily successful, a telescoping well screen will be installed inside the 8-inch casing and the casing pulled back to approximately 60 feet to expose the

W-2013-0623

1/28/13

well screen to the formation. A temporary submersible pump will be installed in the well and the well pumped at a rate of approximately 250 gallons per minute (gpm) or as practical. If the test well is successful, water collected from the well will be sampled and analyzed for water quality. The laboratory water quality data should be submitted to the Department for review prior to or along with the submittal to the Department of the plans and specifications for the final well. Notification should be given to Bill Dobbins within 48 hours of beginning construction of the test well and within 48 hours of pumping the test well in case he deems it necessary to be present during the test well construction work or the subsequent test pumping work.

The City will monitor water levels in well No. 7 and the existing monitoring well in the southwest corner of the well No. 7 well site property during the pumping of the test well. The City will also monitor water levels in the test well and the existing monitoring well during the pumping of well No. 7. The results of the water level monitoring work along with a summary of the water level monitoring work should be submitted to the Department for review prior to or along with the submittal to the Department of the plans and specifications for the construction of the final well.

If the test well is converted into the final well, specifications documenting the methods and materials to be used for the temporary abandonment of the test well must be submitted to the Department for review and the subsequent written approval of the Department obtained prior to temporarily abandoning the well.

Final well construction: The construction of final well No. 8 is not being approved at this time. The final well should be constructed with a minimum of 60 feet of grouted well casing if possible.

Chapter NR820 review: Both the primary and the alternate well sites have been reviewed using the criteria of ch. NR820, Wis. Adm. Code. Based on the review, the Department does not believe that a proposed well at either site will have an adverse impact on the water resources protected under s. 281.34, Statutes.

High capacity well fee: The required \$500 high capacity well construction fee must be submitted to the Department along with the submittal of the plans and specifications for the construction of well No. 8.

Well No. 8, pumphouse, pump and connecting water main: The construction and installation of the well No. 8 pumphouse, pump and connecting water main is not being approved by the Department at this time. It is anticipated that the well No. 8 pump will be rated between 400 and 600 gallons per minute. The well No. 8 pump discharge piping will be brought into the nearby well No. 7 pumphouse where it will be connected to the well No. 7 pump discharge piping that discharges into the distribution system. The ground storage reservoir located at the pumphouse has never been placed in service.

Variances being issued to Chapter NR 811, Wis. Adm. Code: None.

Approval conditions related to Chapter NR 811, Wis. Adm. Code:

1. A Wisconsin Well Construction Report shall be submitted to the Department for the test well(s) within 30 days of completing the test well construction and test pumping work for each test well constructed. (s. NR811.12 (3), Wis. Adm. Code)
2. Plans and specifications for the construction of well No. 8 shall be submitted to the Department for review and the subsequent written approval of the Department obtained prior to starting construction of the well. (s. NR11.08 (2), Wis. Adm. Code)

3. Specifications documenting the methods and materials for the temporary abandonment of any test well to be constructed into a final well shall be submitted to the Department for review and the subsequent written approval of the Department obtained prior to temporarily abandoning the well. (s. NR811.12 (21) (c), Wis. Adm. Code)
4. Unless converted into the final well, any test well(s) shall be permanently abandoned in accordance with s. NR811.13, Wis. Adm. Code, within 60 days of placing well No. 8 in service. A completed DNR Well Abandonment Report Form shall be submitted to the Department for each abandoned well within 30 days of completing the well abandonment. (s. NR811.13 (1), Wis. Adm. Code)
5. The City shall have obtained the easement for the well site prior to starting construction of the final well. (s. NR811.12 (5) (b), Wis. Adm. Code)

Approval conditions related to other Department requirements: None.

- ✓ **Approval constraints:** The project was reviewed in accordance with ss. 281.34 and 281.41, Statutes for compliance with Chapters NR 108, NR 811 and NR 820, Wis. Adm. Code and is hereby approved in accordance with ss. 281.34 and 281.41, Statutes subject to the conditions listed above. This approval is valid for two years from the date of approval. If construction or installation of the improvements has not commenced within two years the approval shall become void and a new application must be made and approval obtained prior to commencing construction or installation.

This approval is based upon the representation that the plans submitted to the Department are complete and accurately represent the project being approved. Any approval of plans that do not fairly represent the project because they are incomplete, inaccurate, or of insufficient scope and detail is voidable at the option of the Department.

Be advised that this project may require permits or approvals from other federal, state or local authorities. For example: a certificate of authority from the Public Service Commission of Wisconsin, under Wis. Stats. 196.49 and Wis. Adm. Code, ch. PSC 184, may be required.

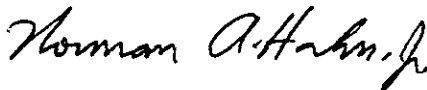
Appeal rights: If you believe that you have a right to challenge this decision, you should know that the Wisconsin Statutes and administrative rules establish time periods within which requests to review Department decisions must be filed. To request a contested case hearing pursuant to s. 227.42, Wis. Stats., you have 30 days after the decision is mailed, or otherwise served by the Department, to serve a petition for hearing on the Secretary of the Department of Natural Resources. Requests for contested case hearings must be made in accordance with ch. NR 2, Wis. Adm. Code. Filing a request for a contested case hearing does not extend the 30 day period for filing a petition for judicial review. For judicial review of a decision pursuant to ss. 227.52 and 227.53, Wis. Stats., you must file your petition with the appropriate circuit court and serve the petition on the Department within 30 days after the decision is mailed. A petition for judicial review must name the Department of Natural Resources as the respondent.

Recommendations: The following recommendations are based on staff review of the project. The owner is not required to implement the recommendations in order to comply with the approval.

1. It is recommended that notification be given to Bill Dobbins within 48 hours of beginning construction of any test well and within 48 hours of pumping any test well in case he deems it necessary to be present during the test well construction work or the subsequent test pumping work.

2. It is recommended that the test well water be sampled for all of the inorganic, volatile organic, synthetic organic and radionuclide water quality parameters required for new municipal wells and the lab results submitted to the Department for review prior to or along with the submittal to the Department of the plans and specifications for the final well.
3. It is recommended that the results of the water level monitoring work along with a summary of the water level monitoring work be submitted to the Department for review prior to or along with the submittal to the Department of the plans and specifications for the construction of the final well.
4. It is recommended that the City demonstrate that any final well No. 8 constructed on the site will be able to be pumped simultaneously with well No. 7 without causing significant drawdown at either well, before the final decision is made to construct a final well on the site. If two wells on the site cannot effectively be pumped together, it is recommended that the City investigate and pursue construction of a well at a different location.

STATE OF WISCONSIN
DEPARTMENT OF NATURAL RESOURCES
For the Secretary

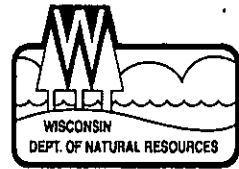


Norman A. Hahn, Jr., P.E.
Public Water Engineering Section
Bureau of Drinking Water and Groundwater
norman.hahnjr@wisconsin.gov
608-267-7661

cc: Tim Kingman – City of Rhinelander (e-mail only)
Andy Jacque – Town & Country Engineering, Inc., Madison (e-mail only)
Bill Dobbins - DNR, Rhinelander (e-mail only)
Ian Anderson – DNR, Madison, DG/5 (e-mail only)
Mary E. Wagner – DNR, Madison, CF/2 (e-mail only)
Jim Witthuhn – DNR, Madison, DG/5 (e-mail only)
Peter Feneht – PSC, Madison (e-mail only)
Norman Hahn – DNR, Madison, DG/5, Plan reviewer

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
101 S. Webster Street
Box 7921
Madison WI 53707-7921

Scott Walker, Governor
Cathy Stepp, Secretary
Telephone 608-266-2621
FAX 608-267-3579
TTY Access via relay - 711



December 20, 2013

BLAINE OBORN ADMINISTRATOR
CITY OF RHINELANDER
135 S STEVENS STREET
RHINELANDER WI 54501

Acknowledgement of Receipt

The Department has received the following plan submittal and request for Department approval in accordance with s. 281.41 Statutes. If you have questions regarding the status of the project review, please contact the listed review engineer.

DATE RECEIVED: 12/19/2013

OWNER: CITY OF RHINELANDER

SUBMITTING ENGINEER: ANDREW D. JACQUE

PROJECT TYPE: Engineering Report

PROJECT DESCRIPTION: A well site investigation report was submitted for proposed well No. 8 at the City of Rhinelander.

DNR PROJECT NUMBER: W-2013-0693

DNR REGION: Northern

DNR REVIEWER: Norman A. Hahn, Jr., P.E.

(608) 267-7661

FAX: (608) 267-7650

E-MAIL: norman.hahnjr@wisconsin.gov

Copy To:

ANDREW JACQUE PE
TOWN & COUNTRY ENGINEERING, INC.
5225 VERONA ROAD BUILDING 3
MADISON WI 53711

December 17, 2013

Mr. Lee Boushon, P.E. Section Chief
Drinking Water Systems Section
Wisconsin Department of Natural Resources
101 South Webster Street
P.O. Box 7921
Madison, WI 53707-7921

RECEIVED-DNR
DEC 19 2013
DRINKING WATER & GW

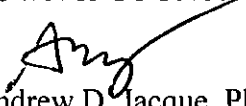
Subject: Well Site Investigation Report
New Well No. 8 – City of Rhinelander, Wisconsin

Dear Mr. Boushon:

Attached for your review and approval is a well site investigation report for a new well in the City of Rhinelander. Because of the granite bedrock in the Rhinelander area, wells of sufficient capacity and quality characteristics to act as public water supplies are difficult to find. For many years the City has had an ongoing program of geophysical exploration and test well drilling in an attempt to locate potential sites for future well development. The site at which this new well is proposed was found under this program. At this site, test wells were constructed in 1986 and 1987, and Well No. 7 was constructed in 2008. Data from the test wells is included in this report.

If you have any questions about the well site or the project intended by the City, please feel free to contact me at your convenience.

Very truly yours,
TOWN & COUNTRY ENGINEERING, INC.


Andrew D. Jacque, Ph.D., P.E.
Senior Engineer

cc: Mr. Tim Kingman, P.E., Water and Sewer Superintendent, City of Rhinelander
(135 South Stevens Street, Rhinelander, WI 54501)

Mr. Blaine Oborn, City Administrator, City of Rhinelander (135 South Stevens
Street, Rhinelander, WI 54501)

ADJ:sai

J:\JOB#\S\Rhinelande\RI-88-11-Well No 8 Well Site Report\08 Specs & Reports\Site Report\Site Report DNR Letter.docx

Hahn jr, Norman A - DNR

From: Hahn jr, Norman A - DNR
Sent: Tuesday, January 14, 2014 8:57 AM
To: tkingman@rhinelanderutilities.org; Andy Jacque (AJacque@tcengineers.net); Dobbins, William G - DNR; Anderson, Ian K - DNR; Wagner, Mary E - DNR; Witthuhn, James K - DNR; Feneht, Peter - PSC
Cc: Hahn jr, Norman A - DNR
Subject: City of Rhinelander well No. 8 well site investigation report DNR approval letter FYI.
Attachments: 20140114084952547.pdf

Hello. The original letter will be mailed out to the City.

Andy, please forward a copy of the attached letter to the well driller. Thank you.

Sincerely,

Norman A. Hahn, Jr., P.E.
Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources PO Box 7921 Madison WI 53707
phone: (608) 267-7661
fax: (608) 267-7650
e-mail: norman.hahnjr@wisconsin.gov

Hahn jr, Norman A - DNR

From: Hahn jr, Norman A - DNR.
Sent: Tuesday, January 14, 2014 8:36 AM
To: tkingman@rhinelanderutilities.org; Andy Jacque (AJacque@tcengineers.net)
Cc: Hahn jr, Norman A - DNR
Subject: Four lab forms for use with the City of Rhinelander test well as needed.
Attachments: 20140114083136601.pdf

Hello. I am hoping to be able to send out the well site approval letter today.

Sincerely,

Norman A. Hahn, Jr., P.E.
Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources PO Box 7921 Madison WI 53707
phone: - (608) 267-7661
fax: (608) 267-7650
e-mail: norman.hahnjr@wisconsin.gov

DATE: January 10, 2014

FILE REF:

TO: Norm Hahn – DG/5

FROM: Ian Anderson – DG/5 IA

SUBJECT: City of Rhinelander Proposed Well Site, Well #8 – Review of Protected Water Resources

Norm – I have completed a protected water resources review of the potential well sites proposed on behalf of the City of Rhinelander. In accordance with s. 281.34, Stats., and Ch. NR 820, I have reviewed the proposed locations to determine if a well located at the Proposed Well site or the Alternate Well site could result in potential adverse impacts to trout streams, outstanding or exceptional resource waters or springs (1 cfs, 80% of the year) or any other waters of the state.

The Proposed Well site and the Alternate Well site are both located on the southwest end of the City, located in S10 T36N R8E, Oneida County and are situated in the Mississippi River Basin. The Proposed Well site is in the NW ¼ NW ¼ of Section 10 and the Alternate site is located in the NE ¼ NW ¼ of Section 10. The Proposed Well site is 500 feet northwest of Well 7 and coordinates are approximately 45° 37.674'N, 89° 29.192'W and the Alternate Well site is 500 feet east of Well 7 and coordinates are approximately 45° 37.634'N, 89° 28.969'W. The well is proposed to be about 80 feet deep and would be completed in sand and gravel with a 20 foot screen. The intended pumping capacity will be 600 gallons per minute with an average daily use of 216,000 gpd. Well #8 is intended to supplement the existing system in order to meet increased demand and will be operated for about 6 hours per day, on average.

The nearest trout stream to either well site is Heal Creek, located in Section 10, T36N R8E. The stream is a Class 2 trout stream and is located about 4400 feet southeast of the Proposed Well and 3600 feet southeast of the Alternate Well site. Heal Creek receives groundwater input from several small spring seeps and likely input of diffuse lateral groundwater discharge from surrounding wetlands. A flow system of this type is not likely to be impacted by a pumping at the magnitude and distance proposed. The nearest outstanding or exceptional resource water is Radke Creek, which is located approximately 4.0 miles south of the Proposed site and 3.9 miles south of the Alternate site in Section 27 T36N R8E and it is designated as an exceptional resource water.

In conducting a review of the topographic map of the area and other information, I determined there are no springs (1 cfs) within two miles of the proposed well location. Both well sites are located about 500 feet from mapped wetlands. However, the hydrogeology of the site suggests that the wetlands should not be affected by pumping from the sand and gravel due to the presence of a silt and clay at a depth of 40-75 feet. There are private wells located about 900 feet southeast of the Proposed site and 400 feet southwest of the Alternate well site, that are not anticipated to be significantly impacted, based on a drawdown analysis.

The nearest lake is Hoist Lake, which is located about 1500 feet southeast of the Proposed Well site and about 1200 feet south of the Alternate Well site. Based upon the lower hydraulic conductivity of silt and clay in the vicinity, and analysis by Town & Country Engineering Inc. (Well Site Investigation Report, December 2013), Hoist Lake is not likely to be significantly impacted by Well 8, especially if the Proposed Well site is selected. The other lakes (Round Lake and two small unnamed lakes) that are likely sources of water for the well, are not likely to be significantly impacted since no single lake would be the

sole source of water. There are no other significant water resources in close proximity to the proposed well.

I did not identify any potential contaminant sources that were not mentioned in the Well Site Investigation Report.

I would recommend selecting the Proposed Well site, because it is further from the nearby private wells, and according to the capture zone analysis by Town & Country Engineering, spreads the impact to more lakes, thus decreasing impact to individual lakes. I also recommend monitoring water levels in Well 7 and the existing monitoring well during the pump test of Well 8 in order to validate modeled outcomes and confirm the minimal well interference predicted by both Town & Country and myself.

Based on the proposed well construction, the local geology and hydrology, and the abundance and diffuse nature of water in the area, it is my determination that a well located at the proposed site will not result in adverse impacts to any of these water resources. Please contact me if you need anything else.

cc: Judy Gifford – DG/5.(email only)

Transient Drawdown Analysis for Evaluating Potential Impacts to a Municipal Well From a Single Extraction Well in an Unconfined Aquifer

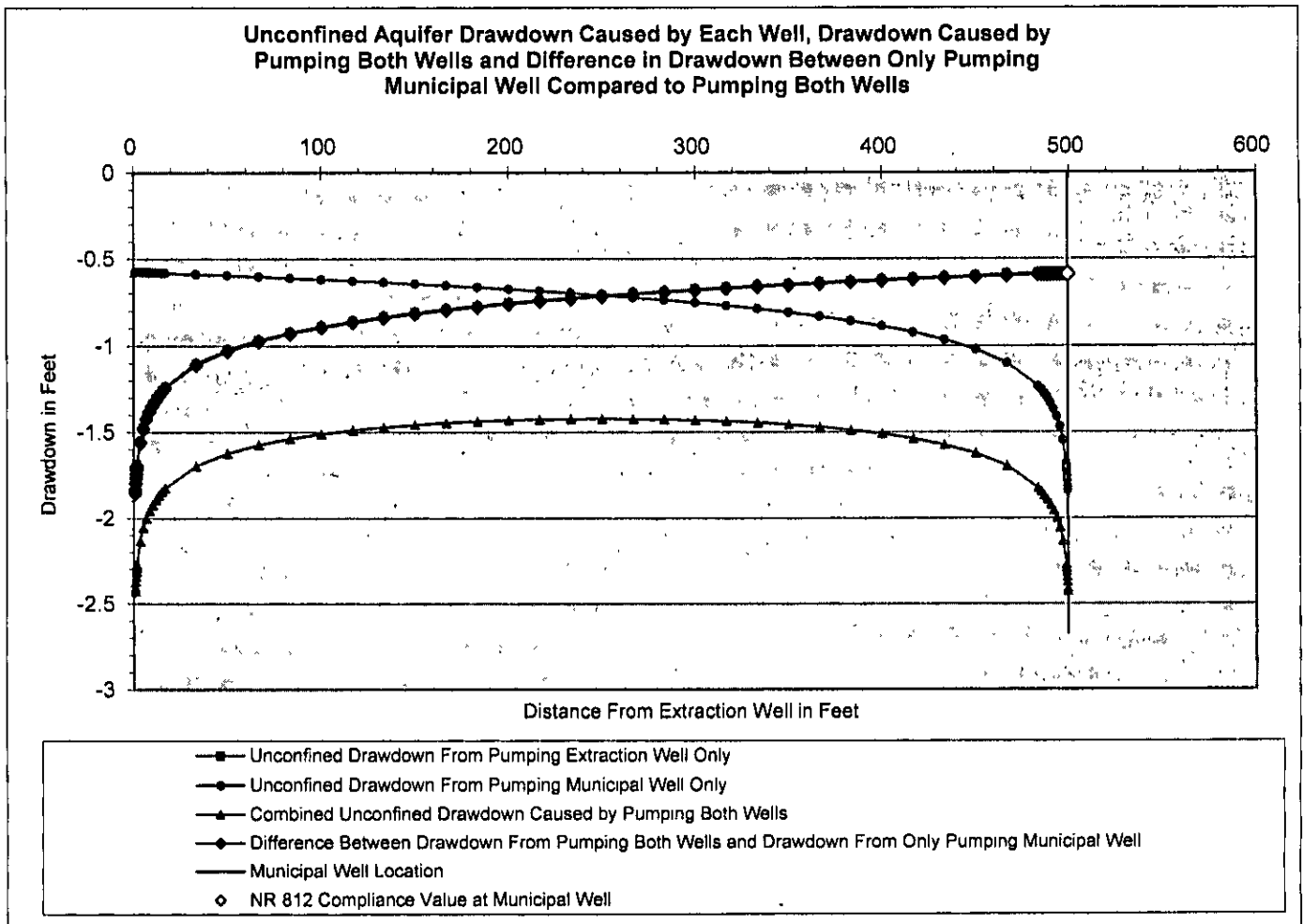
Spreadsheet Template by George Mickelson, WDNR, Version 2.7

Project Name = Rhinelander 8
 Date and Time of Analysis = 03-Jan-14 12:48 PM
 Hydraulic Conductivity = 300.00 feet/day or 2,244.00 gpd/feet²
 Static Aquifer Thickness = 80.00 feet
 Storage Coefficient = 0.2000000 unitless or 2.00E-01
 Extraction Well Pumping Rate = 150.00 gpm
 Extraction Well Diameter = 18.00 inches
 Extraction Well Time of Pumping = 365.00 days
 Municipal Well Pumping Rate = 150.00 gpm average
 Municipal Well Diameter = 18.00 inches
 Municipal Well Time of Pumping = 365.00 days
 Distance Between Wells = 500.00 feet

	At Location of Extraction Well	At Location of Municipal Well	
Unconfined Drawdown From Pumping Municipal Well Only =	0.57 feet	1.84 feet	
Unconfined Drawdown From Pumping Extraction Well Only =	1.84 feet	0.57 feet	
Unconfined Drawdown From Pumping Both Wells =	2.43 feet	2.43 feet	<i>Best case</i>

Difference Between Drawdown Caused by Pumping Both Wells and Drawdown Caused by Pumping Municipal Well Only (NR 812 Compliance Value) = **0.59 feet**

Note: Estimated drawdown in a well assumes a 100 percent efficient fully penetrating well with no seepage face.



Transient Drawdown Analysis for Evaluating Potential Impacts to a Municipal Well From a Single Extraction Well in an Unconfined Aquifer

Spreadsheet Template by George Mickelson, WDNR, Version 2.7

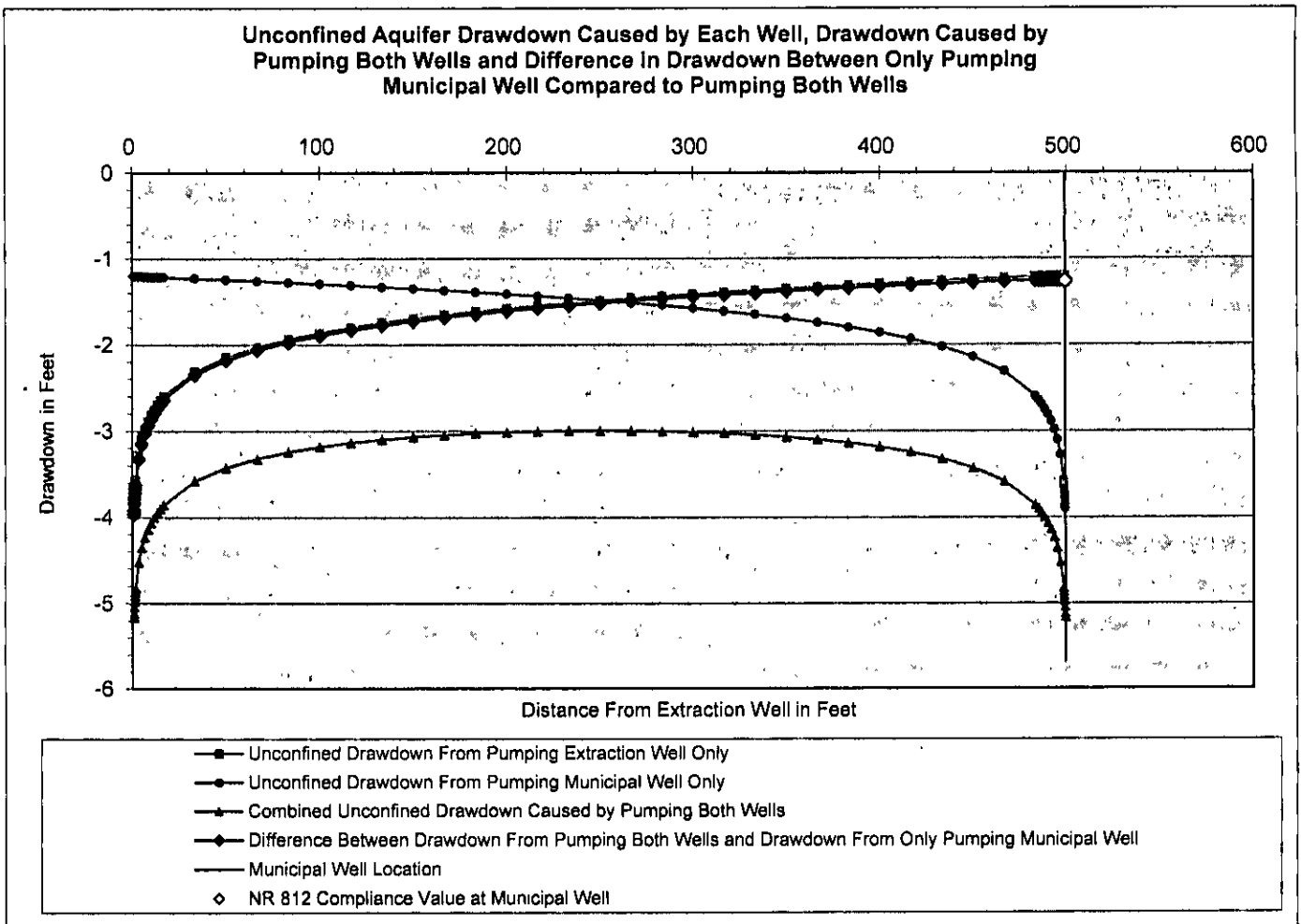
Project Name = Rhinelander 8
 Date and Time of Analysis = 03-Jan-14 1:00 PM
 Hydraulic Conductivity = 143.00 feet/day or 1,069.64 gpd/feet²
 Static Aquifer Thickness = 80.00 feet
 Storage Coefficient = 0.1000000 unitless or 1.00E-01
 Extraction Well Pumping Rate = 150.00 gpm
 Extraction Well Diameter = 18.00 inches
 Extraction Well Time of Pumping = 365.00 days
 Municipal Well Pumping Rate = 150.00 gpm average
 Municipal Well Diameter = 18.00 inches
 Municipal Well Time of Pumping = 365.00 days
 Distance Between Wells = 500.00 feet

	At Location of Extraction Well	At Location of Municipal Well
Unconfined Drawdown From Pumping Municipal Well Only =	1.20 feet	3.90 feet
Unconfined Drawdown From Pumping Extraction Well Only =	3.90 feet	1.20 feet
Unconfined Drawdown From Pumping Both Wells =	5.16 feet	5.16 feet

Worst case

Difference Between Drawdown Caused by Pumping Both Wells and Drawdown Caused by Pumping Municipal Well Only (NR 812 Compliance Value) = **-1.26 feet**

Note: Estimated drawdown in a well assumes a 100 percent efficient fully penetrating well with no seepage face.



High Capacity Well Application Record of Locational Criteria Review

Reviewed by Anderson Date Received 12-19-13 Date Reviewed _____
 Project Name Rhinelanders Well # 8 File # 44-9-2
 County Oneida - Crescent Major Basin MRB / LSB / LMB

Identify Wells (name, PWS ID, WUWN)	Municipal Well #8		
PLSS	_____ 1/4 of <u>NW</u> 1/4	_____ 1/4 of _____ 1/4	_____ 1/4 of _____ 1/4
	Sec <u>10</u> G Lot.	Sec _____ G Lot.	Sec _____ G Lot.
	T <u>36</u> N, R <u>8</u> E/W	T _____ N, R _____ E/W	T _____ N, R _____ E/W
Latitude DD MM SS.SS	_____ . _____ "	_____ . _____ "	_____ . _____ "
Longitude	_____ . _____ "	_____ . _____ "	_____ . _____ "
Latitude DD MM.MMMM	_____ . _____ "	_____ . _____ "	_____ . _____ "
Longitude	_____ . _____ "	_____ . _____ "	_____ . _____ "
DISTANCES			
Trout Stream	<u>4400</u> <input checked="" type="checkbox"/> / mi	_____ ft / mi	_____ ft / mi
Class	<u>II</u>		
Name	<u>Heal Creek</u>		
ORW or <input checked="" type="checkbox"/> ERW	Circle one <u>4.0</u> ft / <input checked="" type="checkbox"/> mi	_____ ft / mi	_____ ft / mi
Name	<u>Radke Creek</u>		
Spring (1cfs)	<u>72</u> ft / <input checked="" type="checkbox"/> mi	_____ ft / mi	_____ ft / mi
USGS List ?	Y / N	Y / N	Y / N
Upper Term Non-Ephemeral creek	Y / N	Y / N	Y / N
Protected ?	Y / N / UKN	Y / N / UKN	Y / N / UKN
Comments on spring	<u>No left springs in 2 mi</u>		
General			
GMA Drawdown >150	<u>SE / NE / <input checked="" type="checkbox"/> no</u>	SE / NE / no	SE / NE / no
Water Loss amt	<u>95% < 2 mgd</u>		
Restriction ?			
Location tolerance ft			
Approval Status			
Any further analysis Warranted on any of the above?			
Nearest Public Utility			
Name	<u>Rhinelanders #7 W851</u>		
Direction from Well			
Distance from Well	<u>500</u> <input checked="" type="checkbox"/> / mi	_____ ft / mi	_____ ft / mi
Potential Contaminants - <u>None additional to those in Site Investigation Report</u>			
Landfills/GWUR	Y / <input checked="" type="checkbox"/> N	Y / N	Y / N
Deed Restrictions?			
Special Casing?	Y / <input checked="" type="checkbox"/> N	Y / N	Y / N
Dual Aquifer?	Y / <input checked="" type="checkbox"/> N	Y / N	Y / N
NHI Species in Area <u>Large-flowered ground-cherry, Water shrew</u>			

Any G50 - 0.5cfs Heal Creek cold trans.
 Nearest: Stream 4400 ft SE Lake 1500 ft SE Wetland 500 ft SE Spring 4400 ft SE Private Well 900 ft
 Any other items to note: Haist Lake - 11ac no flow data
Deep seepage ~0.4cfs based on stream flow

Hahn jr, Norman A - DNR

From: Andy Jacque <AJacque@tcengineers.net>
Sent: Friday, December 20, 2013 10:13 AM
To: Hahn jr, Norman A - DNR
Subject: Re: City of Rhinelander well No. 8 well site investigation report acknowledgement of receipt FYI.

Will do.

Sent from my U.S. Cellular® Android-powered device

-----Original message-----

From: "Hahn jr, Norman A - DNR" <Norman.Hahnjr@wisconsin.gov>
To: Andy Jacque <AJacque@tcengineers.net>, "tkingman@rhinelanderutilities.org" <tkingman@rhinelanderutilities.org>
Cc: "Dobbins, William G - DNR" <William.Dobbins@wisconsin.gov>, "Hahn jr, Norman A - DNR" <Norman.Hahnjr@wisconsin.gov>
Sent: Fri, Dec 20, 2013 16:11:54 GMT+00:00
Subject: City of Rhinelander well No. 8 well site investigation report acknowledgement of receipt FYI.

Hello Andy. I have attached the acknowledgement of receipt letter FYI. Please send another copy of the report directly to Bill Dobbins at our Rhinelander office.

Sincerely,

Norman A. Hahn, Jr., P.E.
Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources
PO Box 7921
Madison WI 53707
phone: (608) 267-7661
fax: (608) 267-7650
e-mail: norman.hahnjr@wisconsin.gov

Hahn jr, Norman A - DNR

From: Hahn jr, Norman A - DNR
Sent: Monday, December 23, 2013 2:04 PM
To: tkingman@rhinelanderutilities.org; Andy Jacque (AJacque@tcengineers.net); Eugene Laschinger (Gene@tcengineers.net); Dobbins, William G - DNR; Anderson, Ian K - DNR
Cc: Hahn jr, Norman A - DNR
Subject: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.
Attachments: 20131223135822369.pdf; Rhinelanderwell8sitesurveymemo.docx

Hello. I have attached my memo in PDF and WORD versions.

Sincerely,

Norman A. Hahn, Jr., P.E.
Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources PO Box 7921 Madison WI 53707
phone: (608) 267-7661
fax: (608) 267-7650
e-mail: norman.hahnjr@wisconsin.gov

DATE: December 23, 2013 FILE REF: W-2013-0693

TO: Andy Jacque, P.E. – Town & Country Engineering, Inc., Madison (e-mail only)

FROM: Norm Hahn – DNR, Public Water Engineering Section, Madison
NH.

SUBJECT: Department plan review comments on the Well Site Investigation Report received on December 19, 2013, for the City of Rhinelander well No. 8. The report proposes a primary well site and a nearby alternate well site.

Hello Andy. Please respond to the following plan review issues so that I can complete my review of the proposed well site(s). I appreciate your cooperation. Call me as necessary at 608-267-7661.

1. I have given the necessary information from the submitted report to Ian Anderson of our Water Use Section (608-266-2432) so that he can perform a ch. NR820, Wis. Adm. Code, review of the two well sites regarding their location in relation to any nearby sensitive surface water bodies. I will need Ian's written approval before I can complete my review.
2. What is planned regarding test well construction, pumping, water quality sampling and area groundwater monitoring for each well site to be investigated?
3. If the test well is successful, will it be converted into the final well or will a separate well be constructed near the test well?
4. It is noted that on page 5 of the report, a 10 year recharge area is used for the two well sites. Although use of a 10-year capture zone is perfectly acceptable, it is noted that for the future Wellhead Protection Plan for well No. 8, s. NR811.12 (6) (e), Wis. Adm. Code, states "The well head protection area shall encompass, at a minimum, that portion of the recharge area equivalent to a 5 year time of travel to the well". It is recommended that to be consistent, that either a 10 year or 5 year time of travel or both, be shown/used in both documents.
5. How is it planned to normally operate well Nos. 7 and 8 in relation to each other?
6. Any future well site must be provided with a year-round access road.
7. Have the groundwater drawdown impacts of pumping well No. 7 ever been monitored and assessed as was recommended by the Department in the Department's May 27, 2008 approval letter, number W-2008-0257? If so, please submit a summary of the assessment and address any additional impacts that pumping well No. 8 in addition to well No. 7 may create.
8. It is recommended that the future Wellhead Protection Area to be designated for well No. 8 include a circle around the well with a minimum radius of 1,200 feet.
9. You indicated that you will be sending a hard copy of the report to Bill Dobbins for his review and comment. I will need Bill's input before I can complete my review.
10. Is the ground storage reservoir at well No. 7 currently in use or not? If not, will it be placed into service as a part of placing well No. 8 into service?

CC: Tim Kingman – City of Rhinelander (e-mail only)
Bill Dobbins – DNR, Rhinelander (e-mail only)
Ian Anderson – DNR, Madison (e-mail only)

Hahn jr, Norman A - DNR

From: Andy Jacque <AJacque@tcengineers.net>
Sent: Thursday, January 02, 2014 5:05 PM
To: Hahn jr, Norman A - DNR; tkingman@rhinelanderutilities.org; Eugene Laschinger; Dobbins, William G - DNR; Anderson, Ian K - DNR
Subject: RE: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Hi Norm,

The following is in response to your memo dated December 23, 2013. I will formalize this response into a letter once you have incorporated comments from Ian Anderson and Bill Dobbins. I have included your comment/question before each response.

1. I have given the necessary information from the submitted report to Ian Anderson of our Water Use Section (608-266-2432) so that he can perform a ch. NR820, Wis. Adm. Code, review of the two well sites regarding their location in relation to any nearby sensitive surface water bodies. I will need Ian's written approval before I can complete my review.

Okay.

2. What is planned regarding test well construction, pumping, water quality sampling and area groundwater monitoring for each well site to be investigated?

It is our intent to sink an 8" diameter exploratory well to determine general water availability. If the well has sufficient yield, it would be converted to a test well with a 40-slot screen. The well would be developed and pumped to determine water quality and quantity. Water level monitoring would be performed in Well 7 during the test pumping of the Well 8 test well. We would drill the alternate location first as it appears to be the better location hydraulically.

3. If the test well is successful, will it be converted into the final well or will a separate well be constructed near the test well?

It is our intent to remove the test well and construct a final well in its place. The well screen would be pulled and the well filled with chlorinated pea gravel to allow casing removal with a Barber rig. In anticipation of this, cuttings will be characterized every foot in the vicinity of the screened interval during test well drilling.

4. It is noted that on page 5 of the report, a 10 year recharge area is used for the two well sites. Although use of a 10-year capture zone is perfectly acceptable, it is noted that for the future Wellhead Protection Plan for well No. 8, s. NR811.12 (6) (e), Wis. Adm. Code, states "The well head protection area shall encompass, at a minimum, that portion of the recharge area equivalent to a 5 year time of travel to the well". It is recommended that to be consistent, that either a 10 year or 5 year time of travel or both, be shown/used in both documents.

Okay.

5. How is it planned to normally operate well Nos. 7 and 8 in relation to each other?

Analysis of test pumping data for Well 7 suggests the potential for little interference with Well 8, particularly if Well 8 is located to the northwest. If test pumping data supports this, the wells would be run either individually or in tandem, depending upon the water system needs. Well 7 has piping connections installed for the connection of Well 8 for chemical addition; new chemical addition equipment and metering would be needed in the existing well house.

6. Any future well site must be provided with a year-round access road.

The road to Well 8 would extend from Well 7. The fence around Well 7 would be modified and extended to encompass Well 8.

7. Have the groundwater drawdown impacts of pumping well No. 7 ever been monitored and assessed as was recommended by the Department in the Department's May 27, 2008 approval letter, number W-2008-0257? If so, please submit a summary of the assessment and address any additional impacts that pumping well No. 8 in addition to well No. 7 may create.

According to the City, they have not been monitored.

8. It is recommended that the future Wellhead Protection Area to be designated for well No. 8 include a circle around the well with a minimum radius of 1,200 feet.

Okay.

9. You indicated that you will be sending a hard copy of the report to Bill Dobbins for his review and comment. I will need Bill's input before I can complete my review.

Okay; copy was sent.

10. Is the ground storage reservoir at well No. 7 currently in use or not? If not, will it be placed into service as a part of placing well No. 8 into service?

The ground reservoir is currently not in use. An evaluation will be performed to determine whether it will be needed with the connection of Well 8.

Please let me know if you have any questions or need further clarification. It is our intent to move forward with test well construction ASAP, pending DNR approval.

Regards,

Andy
Andrew D. Jacque, Ph.D., P.E.
ajacque@tcengineers.net
Town & Country Engineering, Inc.
5225 Verona Road, Building 3
Madison, WI 53711
Phone: (608) 273-3350
Direct Dial: (608) 310-1070
Cell: (608) 219-6770
Fax: (608) 273-3391

-----Original Message-----

From: Hahn jr, Norman A - DNR [mailto:Norman.Hahnjr@wisconsin.gov]

Sent: Monday, December 23, 2013 2:04 PM

To: tkingman@rhinelanderutilities.org; Andy Jacque; Eugene Laschinger; Dobbins, William G - DNR; Anderson, Ian K - DNR

Cc: Hahn jr, Norman A - DNR

Subject: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Hello. I have attached my memo in PDF and WORD versions.

Sincerely,

Norman A. Hahn, Jr., P.E.

Water Supply Engineer

Public Water Engineering Section

Bureau of Drinking Water & Groundwater

Wisconsin Department of Natural Resources PO Box 7921 Madison WI 53707

phone: (608) 267-7661

fax: (608) 267-7650

e-mail: norman.hahnjr@wisconsin.gov

Hahn jr, Norman A - DNR

From: Hahn jr, Norman A - DNR
Sent: Friday, January 03, 2014 11:23 AM
To: Dobbins, William G - DNR
Cc: Hahn jr, Norman A - DNR
Subject: RE: Proposed City of Rhinelander well No. 8.

Thanks for the comments Bill. I don't think Rhinelander is listening to our concerns. I will speak with Lee about this (again) next week.

Thanks,
Norm



Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources
PO Box 7921
Madison WI 53707
(☎) phone: (608) 267-7661
(☎) fax: (608) 267-7650
(✉) e-mail: norman.hahnjr@wisconsin.gov

It is recommended that unless the City can demonstrate that wells 7 and 8 can be successfully pumped simultaneously for significant duration of time, that the City consider constructing well No. 8 on the eastern side of the City at some other location.

Water level in the It is recommended that the monitoring well located to the SW of the well No. 7 pump house also be monitored during the pumping of the test well.

Fill out this customer survey -- <https://www.surveymonkey.com/s/WDNRWater>

From: Dobbins, William G - DNR
Sent: Friday, January 03, 2014 11:16 AM
To: Hahn jr, Norman A - DNR
Cc: Anderson, Ian K - DNR; Pauli, Mark D - DNR
Subject: RE: Proposed City of Rhinelander well No. 8.

Norm,

Below are my comments in relation to the Well Site Investigation Report - Well No. 8 (Satellite Well to Well No. 7):

1. Site 8 Well location in relation to the water system – What Rhinelander's water distribution system doesn't need is another water source on the far southwest side. With all their water coming from the south and southwest side, they have a hard time maintaining a chlorine residual in the northeast and the flow pattern would have to be much better with a source in the northeast. Although the search for this balanced new

well site might be extensive and costly; in the long run it might provide the City with a much better source.

2. Site 8 Well location in relation to Well #7 – I have many communities with 2 wells in close proximity to each other, but in all these cases these wells are more of a backup to the other well, than jointly pumping independent wells, as Wells #7 and #8 would be. If they need the water from both of these wells, as they say, what really is their hydraulic effect on each other? In Well #7 the difference between static and pumping levels is now 30 feet, how will this change? Can the setup at Well #7 really handle the flow and treatment of Well #8 with the minimum upgrading they imply?
3. Site 8 Well location in relation to potential contamination sources – The majority of the area surrounding this well site is; airport, woodland, wetland and surface water. There are a few homes on septic systems within 800 to 1400 feet and four businesses on Highway 8 and South Fox Ranch Road. These businesses are light industrial facilities that are fairly new (they would not have a long previous history of bad handling of chemicals or waste). The “radiation” site just to the north of the airport on Forest Service land was a former experiment using above ground, ionizing radiation (no elemental radiation used) and there would be no residual effects.
4. Site 8 Well location in relation to ground and surface water – What will be the real effect of both these wells on the surrounding wetlands, springs and surface water? In the Report the pretty little groundwater model maps aren’t the real world. If anybody perceived the future need for another well in this area, they could have studied monitoring wells and surface water in the area of Well #7 and got a real idea on what the effects of Well #8 would be. If the private wells on South Fox Ranch Road fail, will Rhinelander supply water to these homes at no cost and without annexation?

Any question Norm or Ian – give me a call.

Bill

William G. Dobbins, P.E.

Regional Drinking Water Engineer

Wisconsin DNR

107 Sutliff Ave.

Rhinelander, WI 54501

phone: (715) 365-8923

fax: (715) 365-8932

e-mail: william.dobbins@wisconsin.gov

Customer Service is Important to Us. How Are We Doing?

<https://www.surveymonkey.com/s/WDNRwater>

WI Drinking Water & Groundwater Information on the web: <http://www.dnr.state.wi.us/org/water/dwg/>

Follow the DNR on Twitter: <http://www.twitter.com/WDNR>

Find the DNR on Facebook: <http://www.facebook.com/WIDNR>

Watch the DNR on YouTube: <http://www.youtube.com/WIDNRTV>

From: Hahn jr, Norman A - DNR
Sent: Friday, January 03, 2014 8:26 AM
To: Dobbins, William G - DNR
Cc: Anderson, Ian K - DNR; Hahn jr, Norman A - DNR
Subject: Proposed City of Rhinelander well No. 8.

Happy New Year Bill. Can you give me an approximate date by which you can give me any comments you may have on the proposed City of Rhinelander well No. 8 well site(s)?

Thanks,
Norm

 *Norman A. Hahn, Jr., P.E.*

Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources
PO Box 7921
Madison WI 53707
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(✉) e-mail: norman.hahnjr@wisconsin.gov

Fill out this customer survey -- <https://www.surveymonkey.com/s/WDNRWater>

Hahn jr, Norman A - DNR

From: Hahn jr, Norman A - DNR
Sent: Friday, January 03, 2014 9:12 AM
To: Andy Jacque; tkingman@rhinelanderutilities.org; Eugene Laschinger; Dobbins, William G - DNR; Anderson, Ian K - DNR
Cc: Hahn jr, Norman A - DNR
Subject: RE: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Hello Andy. Thank you for the responses to my questions and comments. They are satisfactory. I will get back you once I have received responses back from Bill and Ian. I have spoken with both of them in the past two days and expect to get their comments soon.

Sincerely,
Norm

Norman A. Hahn, Jr., P.E.
Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources PO Box 7921 Madison WI 53707
phone: (608) 267-7661
fax: (608) 267-7650
e-mail: norman.hahnjr@wisconsin.gov

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Sent: Thursday, January 02, 2014 5:05 PM
To: Hahn jr, Norman A - DNR; tkingman@rhinelanderutilities.org; Eugene Laschinger; Dobbins, William G - DNR; Anderson, Ian K - DNR
Subject: RE: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

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Please let me know if you have any questions or need further clarification. It is our intent to move forward with test well construction ASAP, pending DNR approval.

Regards,

Andy
Andrew D. Jacque, Ph.D., P.E.
ajacque@tcengineers.net
Town & Country Engineering, Inc.
5225 Verona Road, Building 3
Madison, WI 53711
Phone: (608) 273-3350
Direct Dial: (608) 310-1070
Cell: (608) 219-6770
Fax: (608) 273-3391

-----Original Message-----

From: Hahn jr, Norman A - DNR [mailto:Norman.Hahnjr@wisconsin.gov]
Sent: Monday, December 23, 2013 2:04 PM
To: tkingman@rhinelanderutilities.org; Andy Jacque; Eugene Laschinger; Dobbins, William G - DNR; Anderson, Ian K - DNR
Cc: Hahn jr, Norman A - DNR
Subject: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Hello. I have attached my memo in PDF and WORD versions.

Sincerely,

Norman A. Hahn, Jr., P.E.
Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources PO Box 7921 Madison WI 53707
phone: (608) 267-7661
fax: (608) 267-7650
e-mail: norman.hahnjr@wisconsin.gov

Hahn jr, Norman A - DNR

From: Andy Jacque <AJacque@tcengineers.net>
Sent: Thursday, January 09, 2014 2:52 PM
To: Anderson, Ian K - DNR; Hahn jr, Norman A - DNR; Dobbins, William G - DNR
Cc: Tim Kingman; Eugene Laschinger; Troy Simonar
Subject: RE: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Norm,

To reiterate what was indicated below, we will monitor water levels in Well 7 and the existing monitoring well while test pumping the Well 8 test well. We will also monitor water levels in the Well 8 test well and existing monitoring well while pumping Well 7. Pending pump test results, we may do a simultaneous test with both Well 7 and the Well 8 test well operating. If this is performed, water levels in the existing monitoring well would be monitored.

Please let me know if you need any additional information.

Regards,

Andy
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Madison, WI 53711
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Cell: (608) 219-6770
Fax: (608) 273-3391

-----Original Message-----

From: Andy Jacque
Sent: Wednesday, January 08, 2014 4:29 PM
To: 'Anderson, Ian K - DNR'; Hahn jr, Norman A - DNR
Cc: Tim Kingman; Eugene Laschinger
Subject: RE: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Hi Ian,

You are correct on the first account. The six hour number is a yearly average for the first few years of operation; the well would likely be pumped at up to 12 hours per day on average during the design year. We will know if simultaneous pumping of Well 7 and Well 8 is possible after test pumping the test well. We will also monitor the existing monitoring well and Well 7 during test pumping of the test well.

On your second question, yes, the groundwater surface was created based on the surface water elevations obtained from Google Earth. In the model, the water table generally agreed with the water level in Well 7 (I think there was about a one foot difference).

I am not aware of any monitoring at Hoist Lake. The modeling, based on actual data from test pumping Well 7, suggests water is obtained from a seam of high hydraulic conductivity material at the base of the aquifer. Because of this, the model suggests that Hoist Lake is not impacted. Data from Well 7 shows the presence of silt seams, which would also suggest minimal impact on Hoist Lake. However, taking a conservative approach and assuming a lower hydraulic conductivity, the lake may be impacted.

Andy

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-----Original Message-----

From: Anderson, Ian K - DNR [mailto:ian.Anderson@wisconsin.gov]

Sent: Wednesday, January 08, 2014 4:02 PM

To: Andy Jacque; Hahn jr, Norman A - DNR

Cc: Tim Kingman; Eugenie Laschinger

Subject: RE: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo
FYI:

Hi Andy,

I would like a little clarification on Norm's comment #5 below regarding pump operation scheduling. My interpretation of your reply is that if aquifer productivity supports it, the City plans to pump well 7 and well 8 at 650gpm and 600pgm, respectively, for 6 hours a day. Is this accurate?

I am also interested in details about Figures 4-8 in the Well Site Investigation Report dated December 19, 2013. It appears that elevations from surface water were used to create the potentiometric surface. Were any other factors, such as static water levels in Well 7, taken into account?

I have moderate concern for impact to Hoist Lake resultant from the operation of Wells 7 and 8 in conjunction. Is there a record of water levels in Hoist Lake before and after the installation of Well 7, or any other indicator that the well is not impacting the lake?

Thank you,
Ian

Ian Anderson

Hydrogeologist
Water Use Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources
() phone: (608) 266-2432
() fax: (608) 267-7650
() e-mail: ian.anderson@wisconsin.gov

Fill out this customer survey -
<https://www.surveymonkey.com/s/WDNRWater>

-----Original Message-----

From: Andy Jacque [mailto:AJacque@tcengineers.net]
Sent: Tuesday, January 07, 2014 8:00 AM
To: Hahn jr, Norman A - DNR
Cc: Anderson, Ian K - DNR; Tim Kingman; Eugene Laschinger
Subject: RE: City of Rhineland well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Hi Norm,

The test well will be about 80 feet deep. Casing will be set at 60 feet with 20 feet of 0.040 slot stainless steel screen. We will test a natural pack well, but final well could be a gravel pack.

Andy
Andrew D. Jacque, Ph.D., P.E.
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Fax: (608) 273-3391

-----Original Message-----

From: Hahn jr, Norman A - DNR [mailto:Norman.Hahnjr@wisconsin.gov]
Sent: Tuesday, January 07, 2014 7:53 AM
To: Andy Jacque
Cc: Anderson, Ian K - DNR; Hahn jr, Norman A - DNR
Subject: RE: City of Rhineland well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Hello Andy. I need Ian Anderson's ch. NR820 review and OK before I can approve the well site.

Can you give me the anticipated total depth for the test well and how many feet of well screen is anticipated to be exposed? Otherwise, I have enough information to approve the test well construction knowing that if successful, it will be converted into the final well under a future approval.

Sincerely,

Norman A. Hahn, Jr., P.E.
Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources PO Box 7921 Madison WI 53707
phone: (608) 267-7661
fax: (608) 267-7650
e-mail: norman.hahnjr@wisconsin.gov

-----Original Message-----

From: Andy Jacque [mailto:AJacque@tcengineers.net]
Sent: Monday, January 06, 2014 4:55 PM
To: Hahn jr, Norman A - DNR
Subject: RE: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Norm,

Thank you.

For drilling a test well, do we need DNR approval of the design because we will be using the same hole for the final well? We will not be converting the well, rather pulling and enlarging it.

Attached is our proposed schedule for the project. Please let me know if you have any concerns with it.

Andy

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Fax: (608) 273-3391

-----Original Message-----

From: Hahn jr, Norman A - DNR [mailto:Norman.Hahnjr@wisconsin.gov]
Sent: Friday, January 03, 2014 9:12 AM
To: Andy Jacque; tkingman@rhinelanderutilities.org; Eugene Laschinger; Dobbins, William G - DNR; Anderson, Ian K - DNR
Cc: Hahn jr, Norman A - DNR
Subject: RE: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Hello Andy: Thank you for the responses to my questions and comments. They are satisfactory. I will get back you once I have received responses back from Bill and Ian. I have spoken with both of them in the past two days and expect to get their comments soon.

Sincerely,
Norm

Norman A. Hahn, Jr., P.E.
Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources PO Box 7921 Madison WI 53707
phone: (608) 267-7661
fax: (608) 267-7650
e-mail: norman.hahnjr@wisconsin.gov

Fill out this customer survey -- <https://www.surveymonkey.com/s/WDNRWater>

-----Original Message-----

From: Andy Jacque [mailto:AJacque@tcengineers.net]

Sent: Thursday, January 02, 2014 5:05 PM

To: Hahn jr, Norman A - DNR; tkingman@rhinelanderutilities.org; Eugene Laschinger; Dobbins, William G - DNR; Anderson, Ian K - DNR

Subject: RE: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Hi Norm,

The following is in response to your memo dated December 23, 2013. I will formalize this response into a letter once you have incorporated comments from Ian Anderson and Bill Dobbins. I have included your comment/question before each response.

1. I have given the necessary information from the submitted report to Ian Anderson of our Water Use Section (608-266-2432) so that he can perform a ch. NR820, Wis. Adm. Code, review of the two well sites regarding their location in relation to any nearby sensitive surface water bodies. I will need Ian's written approval before I can complete my review.

Okay.

2. What is planned regarding test well construction, pumping, water quality sampling and area groundwater monitoring for each well site to be investigated?

It is our intent to sink an 8" diameter exploratory well to determine general water availability. If the well has sufficient yield, it would be converted to a test well with a 40-slot screen. The well would be developed and pumped to determine water quality and quantity. Water level monitoring would be performed in Well 7 during the test pumping of the Well 8 test well. We would drill the alternate location first as it appears to be the better location hydraulically.

3. If the test well is successful, will it be converted into the final well or will a separate well be constructed near the test well?

It is our intent to remove the test well and construct a final well in its place. The well screen would be pulled and the well filled with chlorinated pea gravel to allow casing removal with a Barber rig. In anticipation of this, cuttings will be characterized every foot in the vicinity of the screened interval during test well drilling.

4. It is noted that on page 5 of the report, a 10 year recharge area is used for the two well sites. Although use of a 10-year capture zone is perfectly acceptable, it is noted that for the future Wellhead Protection Plan for well No. 8, s. NR811.12 (6) (e), Wis. Adm. Code, states "The well head protection area shall encompass, at a minimum, that portion of the recharge area equivalent to a 5 year time of travel to the well". It is recommended that to be consistent, that either a 10 year or 5 year time of travel or both, be shown/used in both documents.

Okay.

5. How is it planned to normally operate well Nos. 7 and 8 in relation to each other?

Analysis of test pumping data for Well 7 suggests the potential for little interference with Well 8, particularly if Well 8 is located to the northwest. If test pumping data supports this, the wells would be run either individually or in tandem, depending upon the water system needs. Well 7 has piping connections installed for the connection of Well 8 for chemical addition; new chemical addition equipment and metering would be needed in the existing well house.

6. Any future well site must be provided with a year-round access road.

The road to Well 8 would extend from Well 7. The fence around Well 7 would be modified and extended to encompass Well 8.

7. Have the groundwater drawdown impacts of pumping well No. 7 ever been monitored and assessed as was recommended by the Department in the Department's May 27, 2008 approval letter, number W-2008-0257? If so, please submit a summary of the assessment and address any additional impacts that pumping well No. 8 in addition to well No. 7 may create.

According to the City, they have not been monitored.

8. It is recommended that the future Wellhead Protection Area to be designated for well No. 8 include a circle around the well with a minimum radius of 1,200 feet.

Okay.

9. You indicated that you will be sending a hard copy of the report to Bill Dobbins for his review and comment. I will need Bill's input before I can complete my review.

Okay; copy was sent.

10. Is the ground storage reservoir at well No. 7 currently in use or not? If not, will it be placed into service as a part of placing well No. 8 into service?

The ground reservoir is currently not in use. An evaluation will be performed to determine whether it will be needed with the connection of Well 8.

Please let me know if you have any questions or need further clarification. It is our intent to move forward with test well construction ASAP, pending DNR approval.

Regards,

Andy
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Fax: (608) 273-3391

-----Original Message-----

From: Hahn jr, Norman A - DNR [mailto:Norman.Hahnjr@wisconsin.gov]
Sent: Monday, December 23, 2013 2:04 PM
To: tkingman@rhinelanderutilities.org; Andy Jacque; Eugene Laschinger; Dobbins, William G - DNR; Anderson, Ian K - DNR
Cc: Hahn jr, Norman A - DNR
Subject: City of Rhinelander well No. 8 Well Site Investigation Report DNR plan review memo FYI.

Hello. I have attached my memo in PDF and WORD versions.

Sincerely,

Norman A. Hahn, Jr., P.E.
Water Supply Engineer
Public Water Engineering Section
Bureau of Drinking Water & Groundwater
Wisconsin Department of Natural Resources PO Box 7921 Madison WI 53707
phone: (608) 267-7661
fax: (608) 267-7650
e-mail: norman.hahnjr@wisconsin.gov

Hahn jr, Norman A - DNR

From: Andy Jacque <AJacque@tcengineers.net>
Sent: Friday, January 10, 2014 3:23 PM
To: Hahn jr, Norman A - DNR
Subject: RE: City of Rhinelander well 4 & 5 recirculation lines.

250 gpm.

Andy
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ajacque@tcengineers.net
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Cell: (608) 219-6770
Fax: (608) 273-3391

-----Original Message-----

From: Hahn jr, Norman A - DNR [<mailto:Norman.Hahnjr@wisconsin.gov>]
Sent: Friday, January 10, 2014 3:22 PM
To: Andy Jacque
Subject: RE: City of Rhinelander well 4 & 5 recirculation lines.

OK. Thanks.

I have ch. NR820 OK from Ian. Can you give me an expected gpm pumping rate for the well No. 8 test well?

Thanks,
Norm 267-7661

-----Original Message-----

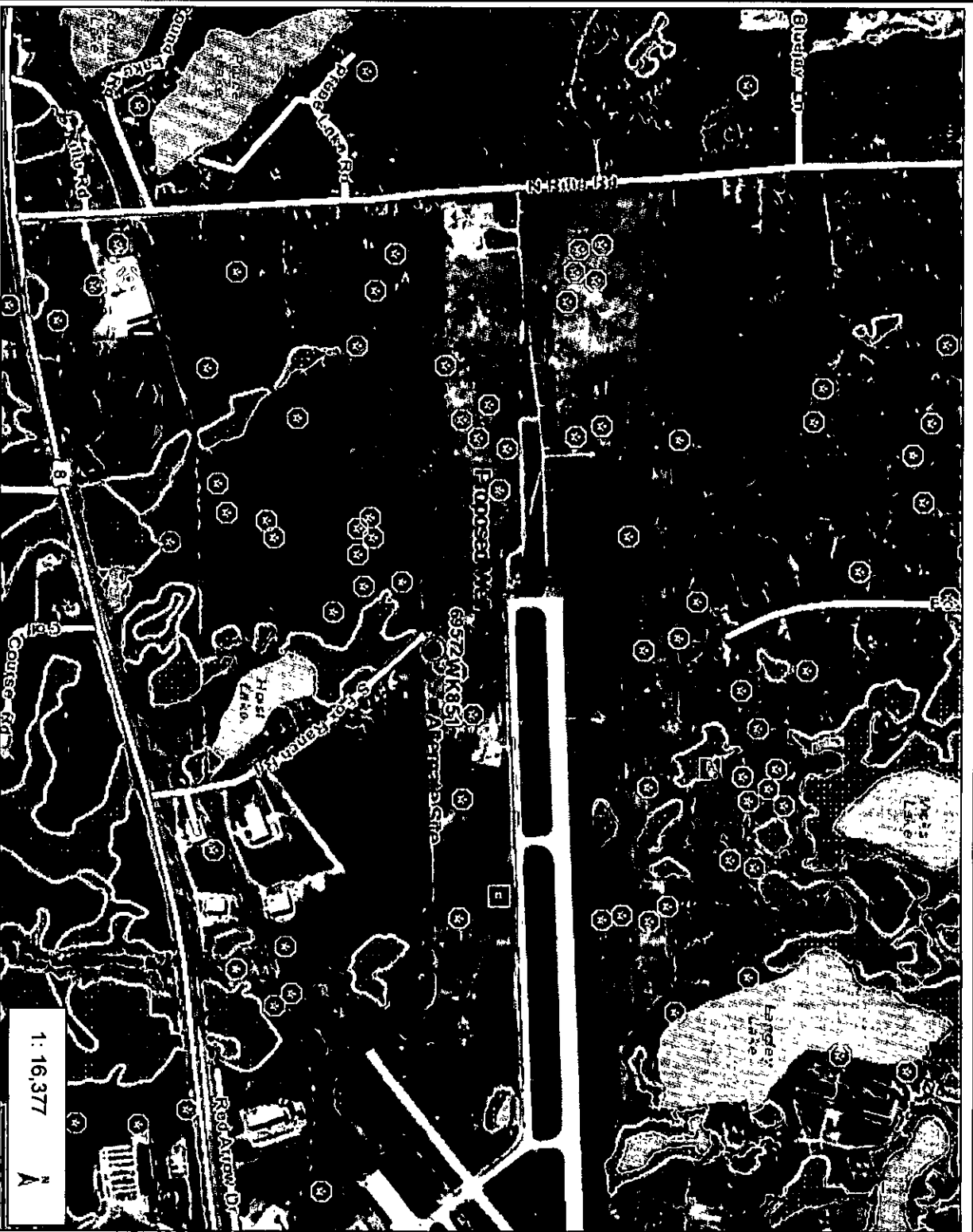
From: Andy Jacque [<mailto:AJacque@tcengineers.net>]
Sent: Friday, January 10, 2014 3:11 PM
To: Hahn jr, Norman A - DNR
Subject: RE: City of Rhinelander well 4 & 5 recirculation lines.

Norm?

I spoke with Tim. He is fine with the testing requirements. He indicated that they would like to put in 3/4" pipe and would prefer a recycle rate of 10 gpm. Sorry for the confusion.



City of Rhinelander Municipal Well #8 - Oneida Cty S10 T36N R8E

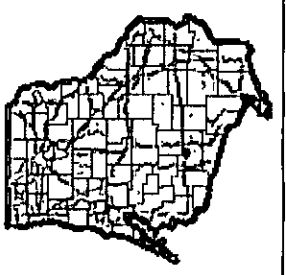


0.5 0 0.25 0.5 Miles

NAD_1983_HARN_Wisconsin_TM
Map created: 1/13/2014

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1:16,377



Legend

- Active HICAP Well
- Municipal Well
- Spring - CFS >= 1.0
- Spring - 1.0 > CFS >= 0.25
- Spring - 0.25 > CFS
- Trout Stream Lines
 - Class 1
 - Class 2
 - Class 3
- Trout Spring Ponds
 - Class 1
 - Class 2
 - Class 3
- OERW Streams
 - Exceptional
 - Outstanding
- OERW Lakes
 - Exceptional
 - Outstanding
- Wetland Class Points
 - ▲ Dammed pond
 - Excavated pond
 - Filled excavated pond
 - ▲ Filled/dammed wetland
 - Wetland too small to delineate
- Wetland Class Areas

The specific locations of public drinking water wells, surface water intakes, and assessment areas are sensitive information protected by security measures implemented by the DNR. To prevent misuse, access to this sensitive information must be limited, and any public dissemination requires prior Department approval. Any public requests for release of this sensitive information should be directed to Lee Boushion, (608) 266-0857. Lee.Boushion@dnr.wisconsin.gov



Rhinelanders Well 8



1:8,104



0.3
0
0.13
0.3 Miles

NAD_1983_HARN_Wisconsin_TM
Map created: 1/8/2014

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Legend

- Active HICAP Well
- Municipal Well
- Spring - CFS >= 1.0
- Spring - 1.0 > CFS >= 0.25
- Spring - 0.25 > CFS
- Trout Stream Lines
 - Class 1
 - Class 2
 - Class 3
- Trout Spring Ponds
 - Class 1
 - Class 2
 - Class 3
- OERW Streams
 - Exceptional
 - Outstanding
- OERW Lakes
 - Exceptional
 - Outstanding
- Major Basins
- County
- Rivers and Streams
- Open Water
- 2010 Air Photos (MROC)

The specific locations of public drinking water wells, surface water intakes, and assessment areas are sensitive information protected by security measures implemented by the DNR. To prevent misuse, access to this sensitive information must be limited, and any public dissemination requires prior Department approval. Any public requests for release of this sensitive information should be directed to Lee Boushon, (800) 266-0857. Lee.Boushon@Wisconsin.gov

CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: July 31, 2007

FILE REF:

TO: Norm Hahn - DG/2

FROM: Larry Lynch - DG/2

608-267-7553

SUBJECT: City of Rhinelander Proposed Well Location - Review of Protected Water Resources

I have completed a protected water resources review of the potential well site proposed for the City of Rhinelander. In accordance with s. 281.34, Stats., I have reviewed the proposed well location to determine if the well could result in potential adverse impacts to trout streams, outstanding or exceptional resource waters or springs (1 cfs, 80% of the year). The proposed well site is located in the Town of Crescent, Oneida County, NW ¼ NW ¼, Section 10 T36N R8E.

The nearest trout stream to the proposed well site is Heal Creek, located in the SE1/4 Section 10 T36N R8E. The stream is a Class 2 trout stream and is located about 3800 feet southeast of the proposed well site. The nearest outstanding or exceptional resource water is the Wisconsin River, an exceptional resource water located in Section 34 T36N R8E. The location of the proposed well is about 3.9 miles north of the river. Given these distances, the proposed well is not within a groundwater protection area, as defined in s. 281.34, Stats.

Based on review of topographic maps, air photos and data compiled by the Wisconsin Wildlife Federation, there appears to be a spring located at the headwaters of Heal Creek, the trout stream mentioned above. I have not been able to locate specific information concerning flow in the spring, but from what I have reviewed I believe it is close to the 1 cfs threshold. Thus, this could be a spring that is considered "protected" under s. 281.34, Stats., and proposed NR 820. Additional field investigation is needed to determine if this is a spring, for regulatory purposes. Specifically, details concerning the nature of the spring and site-specific flow information are necessary.

If this is a spring that meets the statutory criteria, the department must determine whether the proposed well will result in significant environmental impact on a spring and may require that the applicant submit an environmental impact report concerning the proposed well. Further, after conducting an environmental review, the department may approve a proposed well that is predicted to result in significant environmental impacts on a spring if 1) the applicant demonstrates that there are no other reasonable alternatives to the proposed location; and 2) the department includes conditions in the approval to ensure that the environmental impact is balanced by the public benefits of the well.

Depending on the outcome of the field investigation, additional information may be needed in order to evaluate the siting process and the suitability of alternative well sites and also to evaluate the extent of potential impacts as a result of the well. Given that this could be a spring under the definition contained in the statutes and proposed rule, I conducted several preliminary analyses of the potential impact of the proposed well on the spring. My analyses indicate that the area around the spring could experience a decline in the groundwater level of 0.5 to 1.5 feet. This magnitude of groundwater drawdown could be significant and would likely warrant further evaluation.

Feel free to contact me if you need any additional information.

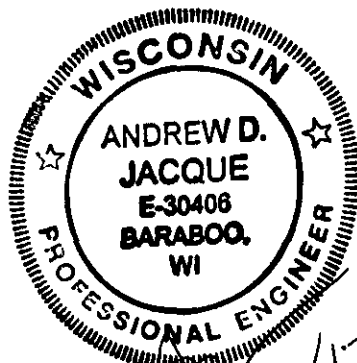


**WELL SITE INVESTIGATION REPORT
Well No. 8
(Satellite Well to Well No. 7)**

City of Rhinelander, Wisconsin

December 2013

RECEIVED-DNR
DEC 19 2013
DRINKING WATER & GW

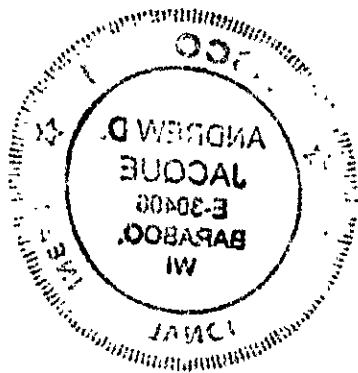


APR 17/13

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tce@tcengineers.net

1971
1972



WELL SITE INVESTIGATION REPORT
Well No. 8
(Satellite Well to Well No. 7)

City of Rhinelander, Wisconsin

December 2013

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APPENDICES

Appendix A -	Excerpts from September 1986 – Water Supply System Study (Foth & Van Dyke)	
Appendix B -	Excerpts from April 14, 1987 – Update of Groundwater Investigation (Foth & Van Dyke)	

a) Proposed Well Site

The proposed site for Well No. 8 is shown in Figure 1. Two sites for Well No. 8 are shown relative to Well No. 7; 500 feet east (proposed Well 8) and 500 feet northwest (alternate proposed Well No. 8). The intent is to drill Well No. 8 on the existing airport property and connect it to the treatment tank at Well No. 7. Two sites are shown to allow flexibility in locating a suitable source (quality and quantity). Pending test pumping results, the final well location will be described in an easement, similar to the approach used for Well No. 7.

b) Regional Flood Elevation

The elevation of the nearest floodplain is approximately 1550 feet USGS. The approximate site elevation is 1590 feet. The nearest defined floodplain is more than a mile away. A copy of the applicable floodplain map is shown in Figure 2.

c) Past and Present Uses of the Proposed Site

The proposed well site and property northward are presently zoned for airport use. However, the runways and the terminal are nearly 0.75 miles away. The site is covered with grasses and has been undisturbed for many years.

Two parcels several hundred feet to the south are used for residential development. The land about 0.33 to 0.50 miles to the south is used for industry.

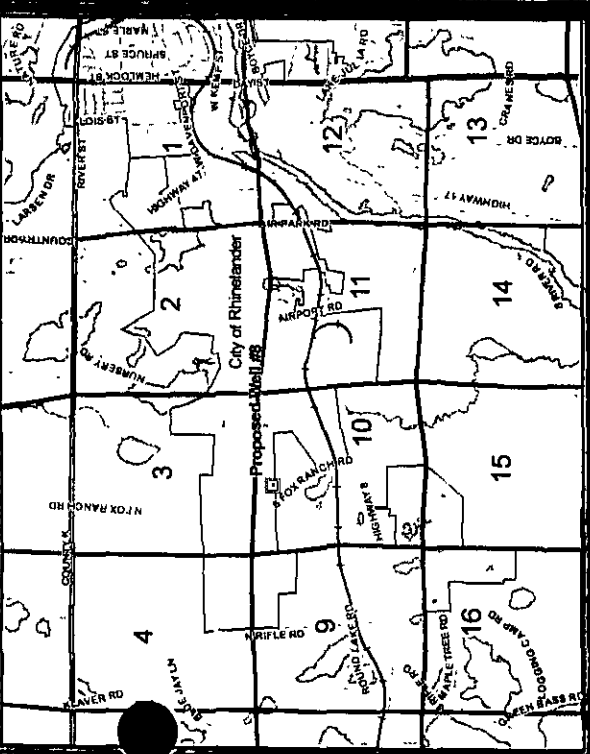
d) Potential Contamination Sources Within ½ Mile of the Well Location

Residential parcels with private wells and septic waste disposal systems are located about 800 and 1400 feet southeast of the proposed well site. Otherwise, the next closest potential contaminant sources identified are industrial parcels located about 0.50 miles south of the proposed well site. A railroad track is located to the south of the proposed well. Because the proposed well site is on City/County airport property, an airport runway is in the vicinity. However, the airport terminal and equipment facilities are located about 0.75 miles to the east. A site to the north of the airport is labeled as "radiation field". This site was a U.S. Forest Service research site where the effects of airborne radiation on trees were studied. This site is not believed to represent high potential for radioactivity contamination. See attached Potential Contamination Use Map, Figure 3.

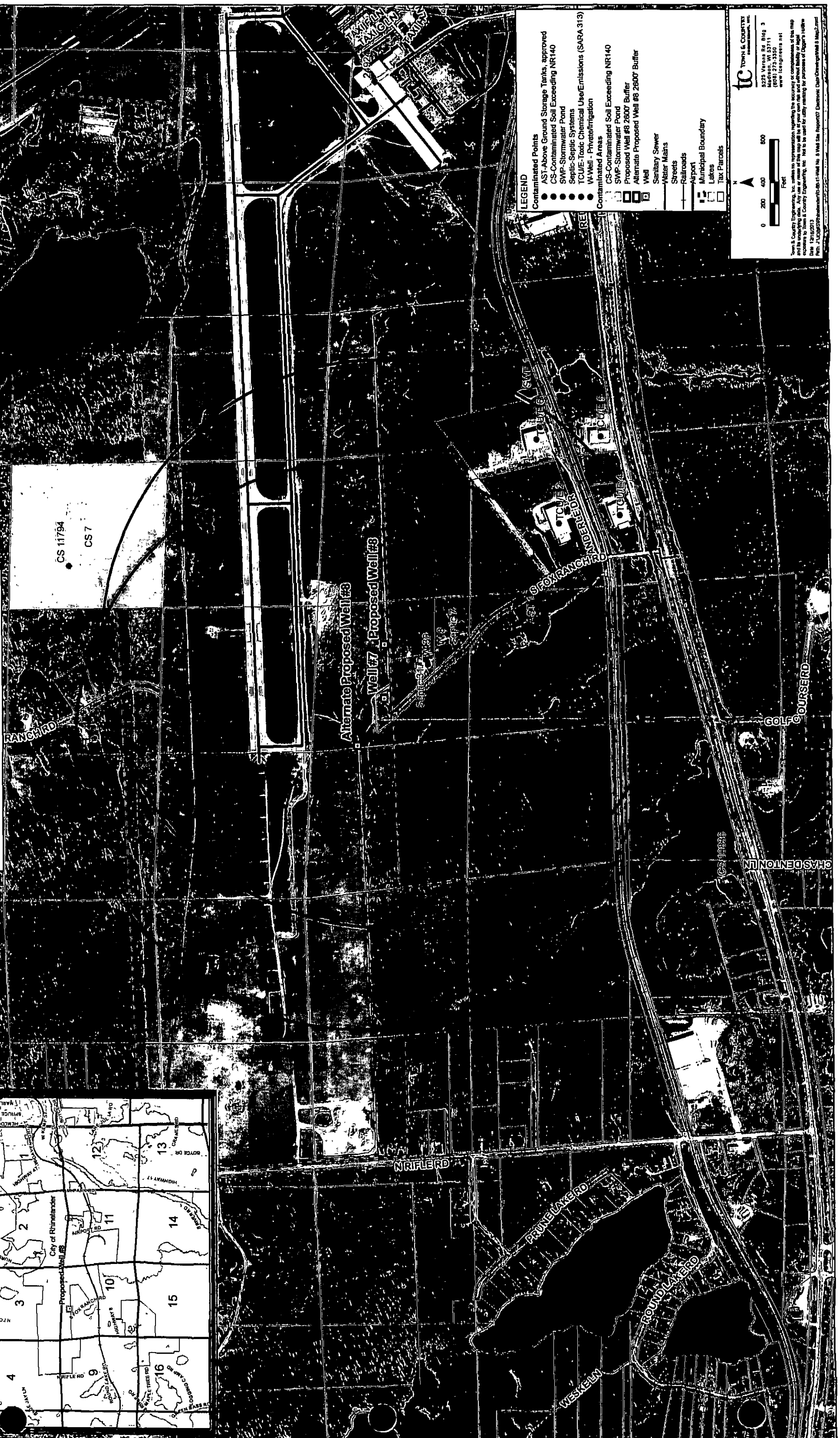
e) Proposed Final Well Capacity

600 gallons per minute (gpm) is the goal; however, a capacity as low as 400 gpm would be acceptable.

OVERVIEW MAP T36N-R8E



**FIGURE NO. 1
PROPOSED WELL NO. 8
LOCATION MAP**



LEGEND

Contaminated Points

- AST-Above Ground Storage Tanks, approved
- CS-Contaminated Soil Exceeding NR140
- SWP-Stormwater Pond
- Septic-Septic Systems
- TCUE-Toxic Chemical Use/Emissions (SARA 313)
- W-Well - Private/Irrigation

Contaminated Areas

- CS-Contaminated Soil Exceeding NR140
- SWP-Stormwater Pond
- Proposed Well #8 2600' Buffer
- Alternate Proposed Well #8 2600' Buffer
- Well

Sanitary Sewer

- Water Mains
- Streets
- Railroads
- Airport

Municipal Boundary

- Lakes
- Tax Parcels

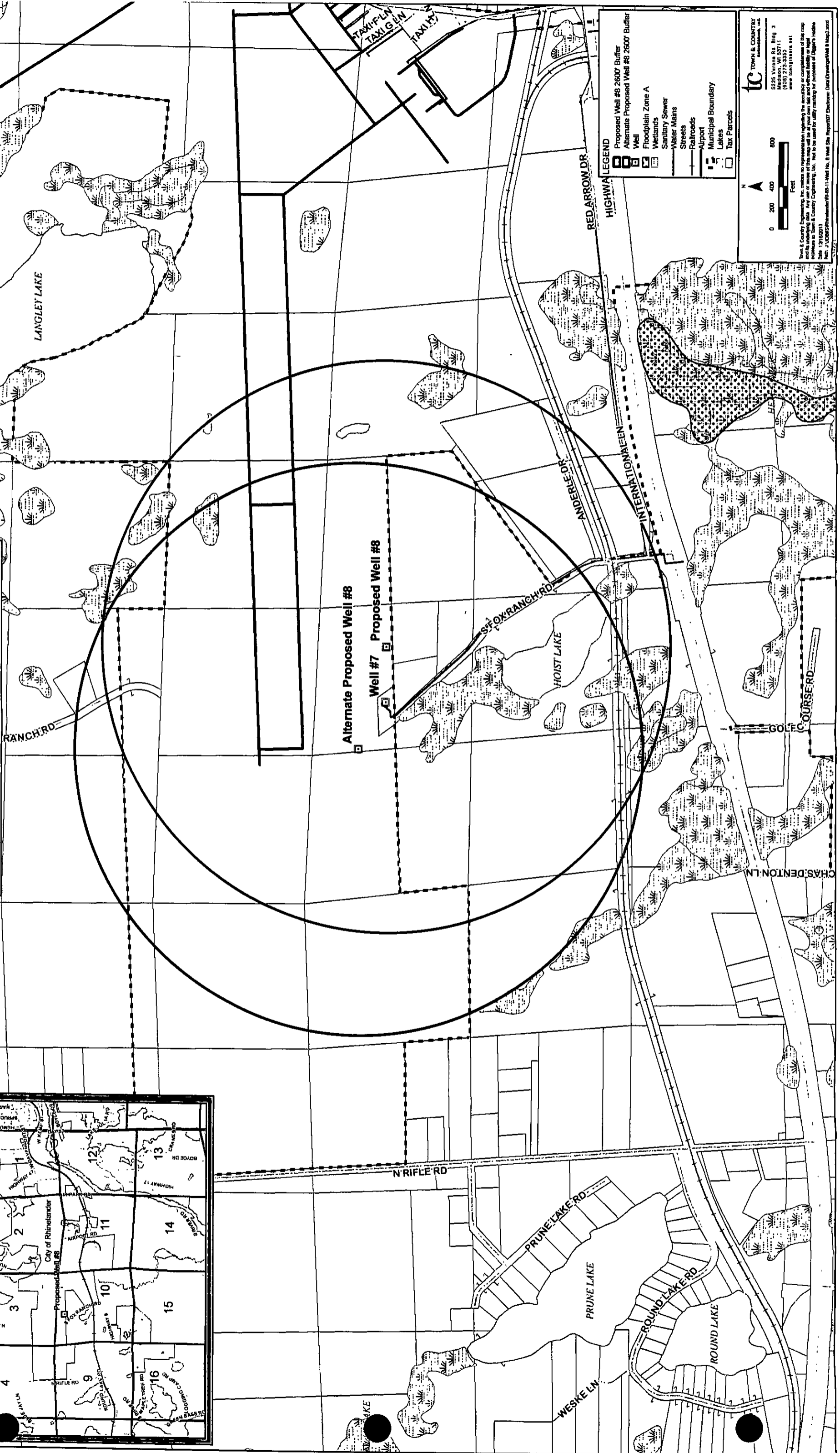
TC TOWN & COUNTRY ENGINEERS, INC.

5225 Verona Rd. Bldg 3
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www.tcengineers.net

Scale: 0 200 400 800 Feet

Town & Country Engineering, Inc. makes no representation regarding the accuracy or completeness of this map. The map is provided for informational purposes only and should not be used for any purpose for which it was not intended. Date: 12/16/2013. File: J:\L008\SR\1008-11-Well No. 8 Well Site Report\07 Electronic Data\DrawingWell 8 Map2.dwg

FIGURE NO. 2 PROPOSED WELL NO. 8 FLOODPLAIN AND WETLANDS



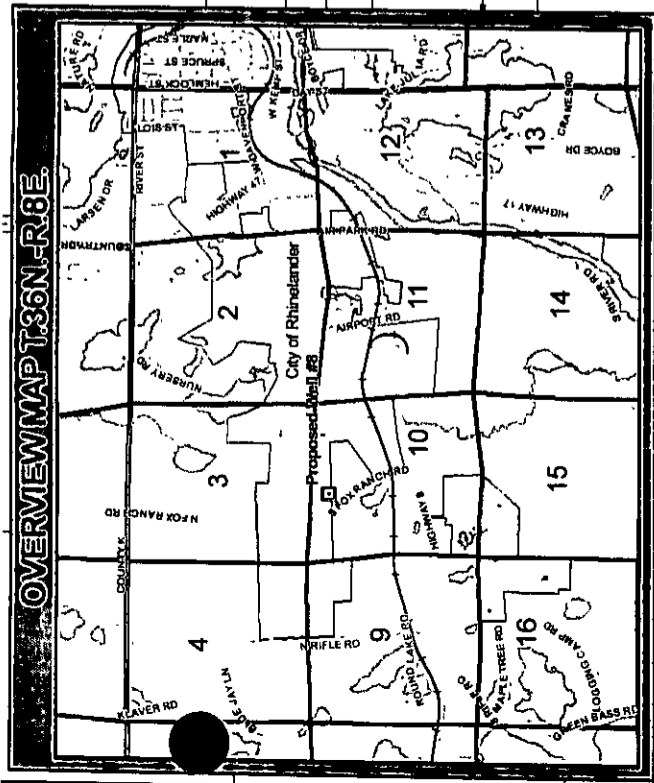
HIGHWAY LEGEND

- Proposed Well #8 2600' Buffer
- Alternate Proposed Well #8 2600' Buffer
- Well
- Floodplain Zone A
- Wetlands
- Sanitary Sewer
- Water Mains
- Streets
- Railroads
- Airport
- Municipal Boundary
- Lakes
- Tax Parcels

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 www.townandcountryinc.com

Scale: 0 200 400 800 Feet

Town & Country Engineering, Inc. makes no representation regarding the accuracy or completeness of this map and the underlying data. Any use or reuse of this map will be at your own risk and without liability or warranty. Date: 12/18/2013. No. 13-00253 (Revised) 10-11-Well No. 8 Well Site Report/07 Electronic Data Drawing/Well 8 Map2.dwg



f) Direction of Groundwater Flow

Based upon the surface elevation of lakes in the area, the groundwater flow at the proposed well site is believed to be northeasterly, which is shown in Figure 4. The groundwater divide is believed to be about two miles north-northwest of the proposed well site.

g) Recharge Area for the Well

The recharge area is expected to extend to the southwest of the proposed well site. Because of uncertainty in aquifer properties, capture zones for the proposed and alternate Well 8 locations were determined using two different hydraulic conductivity values. Figure 5 and Figure 6 show the 10-year capture zones for the proposed and alternate Well No. 8 locations respectively based on a hydraulic conductivity value of 1100 feet/day (determine by analysis of pumping data). Figure 7 and Figure 8 show the 10-year capture zones for the proposed and alternate Well No. 8 locations respectively based on a hydraulic conductivity value of 110 feet/day (10% of determined value). These figures represent the predicted capture zone of a municipal well pumped about 6 hours per day at 600 gpm (no recharge) using WhAEM, an analytical groundwater flow model. The hydraulic conductivity value was determined by analysis of pumping data from the Well No. 7 test well using AQETSOLV.

about 5 year?

consider > 6 hours in the future? Use 12?

h) Zone of Influence Calculations

The anticipated cone of depression, assuming 30 days of continuous pumping at 600 gpm with no recharge, was calculated utilizing the modified Theis nonequilibrium equation. This equation is described on page 219 of "Ground Water and Wells" Second Edition, Fletcher G. Driscoll. The Theis equation is used to estimate the proposed well zone of influence as follows:

$$s = \frac{264Q}{T} \log \frac{0.3Tt}{r^2S}$$

where:

- s = drawdown, in feet, at any point in the vicinity of a well discharging at a constant rate
- Q = pumping rate, in gallons per minute (gpm)
- T = coefficient of transmissivity of the aquifer, in gallons per day per foot (gpd/ft)
- t = time since pumping started, in days
- r = distance, in feet, from the center of a pumped well to a point where the drawdown is measured
- S = coefficient of storage (dimensionless)

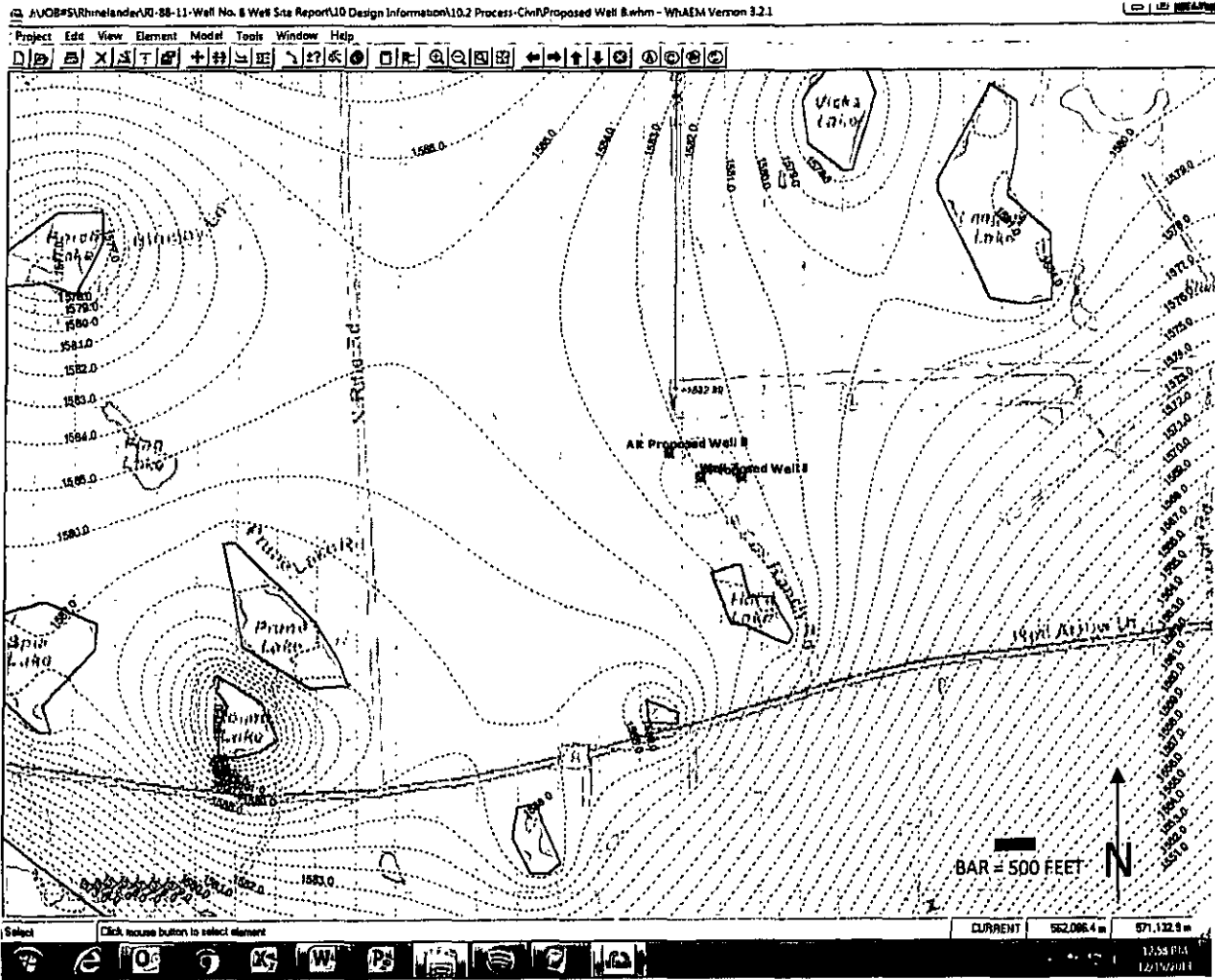


Figure 4. Map showing base aquifer conditions using WhAEM Version 3.2.1. Map is from Wisconsin DNR Surface Water Data Viewer with water surface elevations from Google Earth.

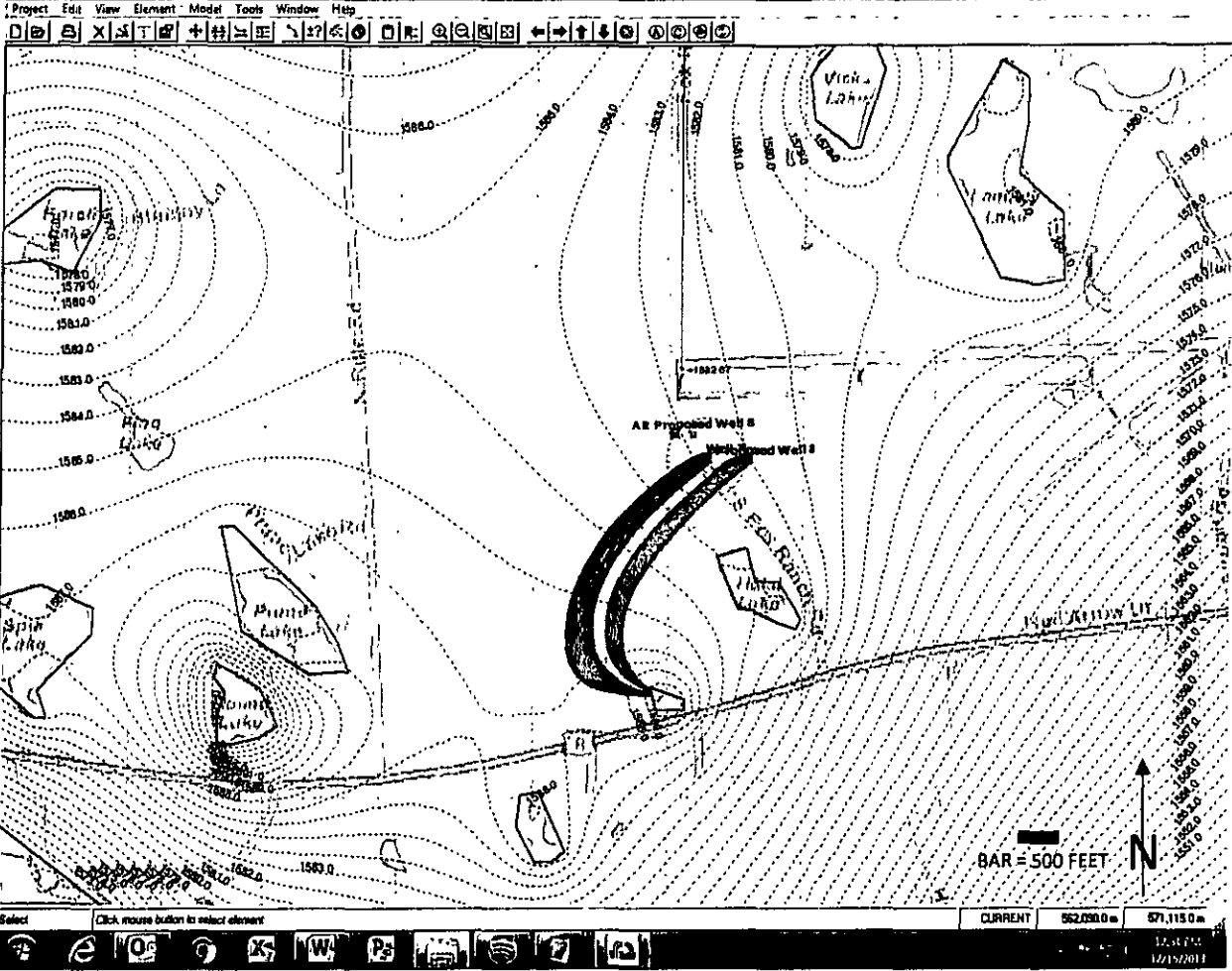


Figure 5. Capture zone analysis results for Well 7 and Proposed Well 8 based on 10 year travel time, $K=1100$ ft/day, and $Q=155$ gpm (600 gpm pumping rate pumping an average of 6 hours per day). Hydraulic conductivity based on analysis of testing pumping for Well 7 test well using AQETSOLV software.

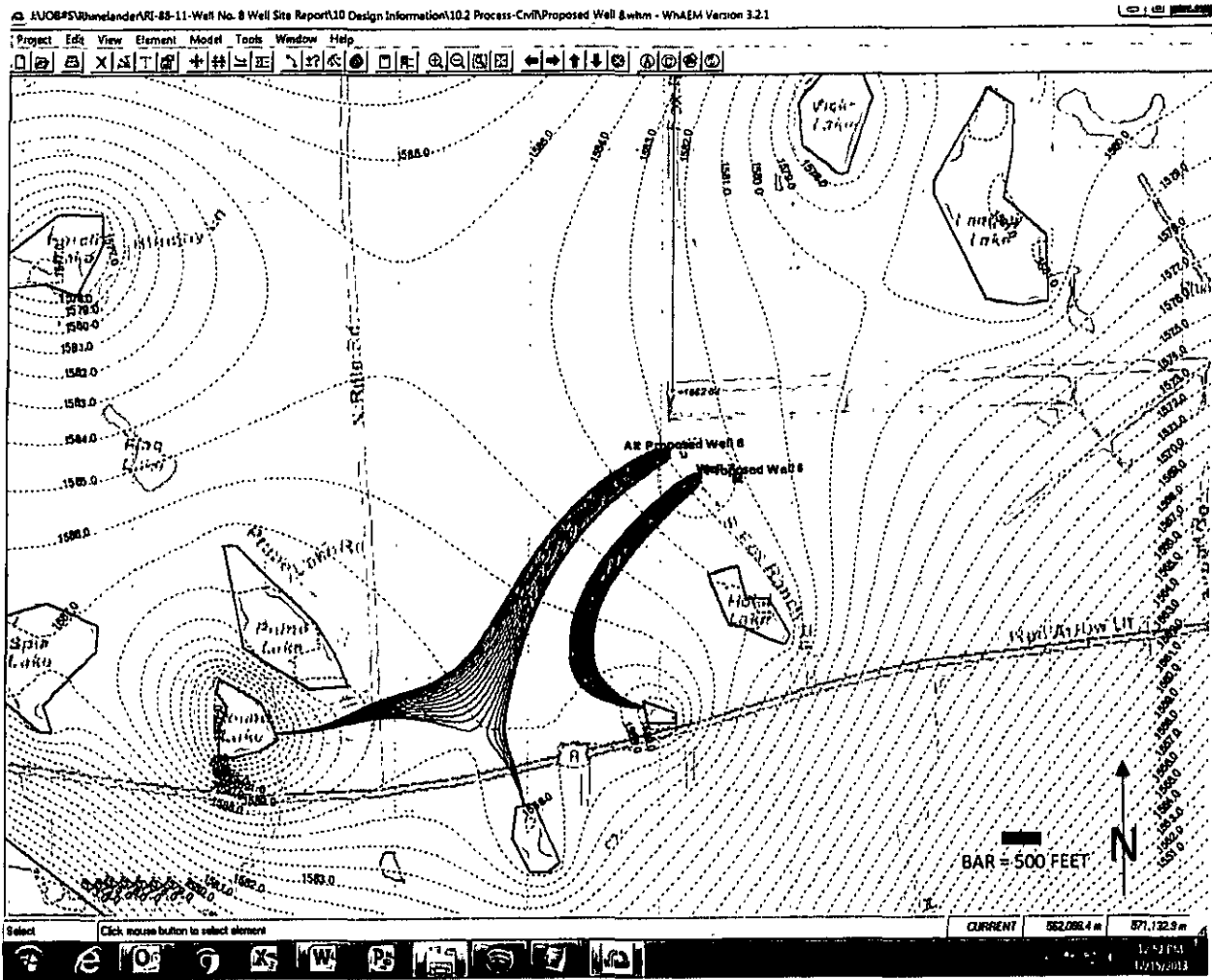


Figure 6. Capture zone analysis results for Well 7 and Alternate Proposed Well 8 based on 10 year travel time, $K=1100$ ft/day, and $Q=155$ gpm (600 gpm pumping rate pumping an average of 6 hours per day). Hydraulic conductivity based on analysis of testing pumping for Well 7 test well using AQETSOLV software.

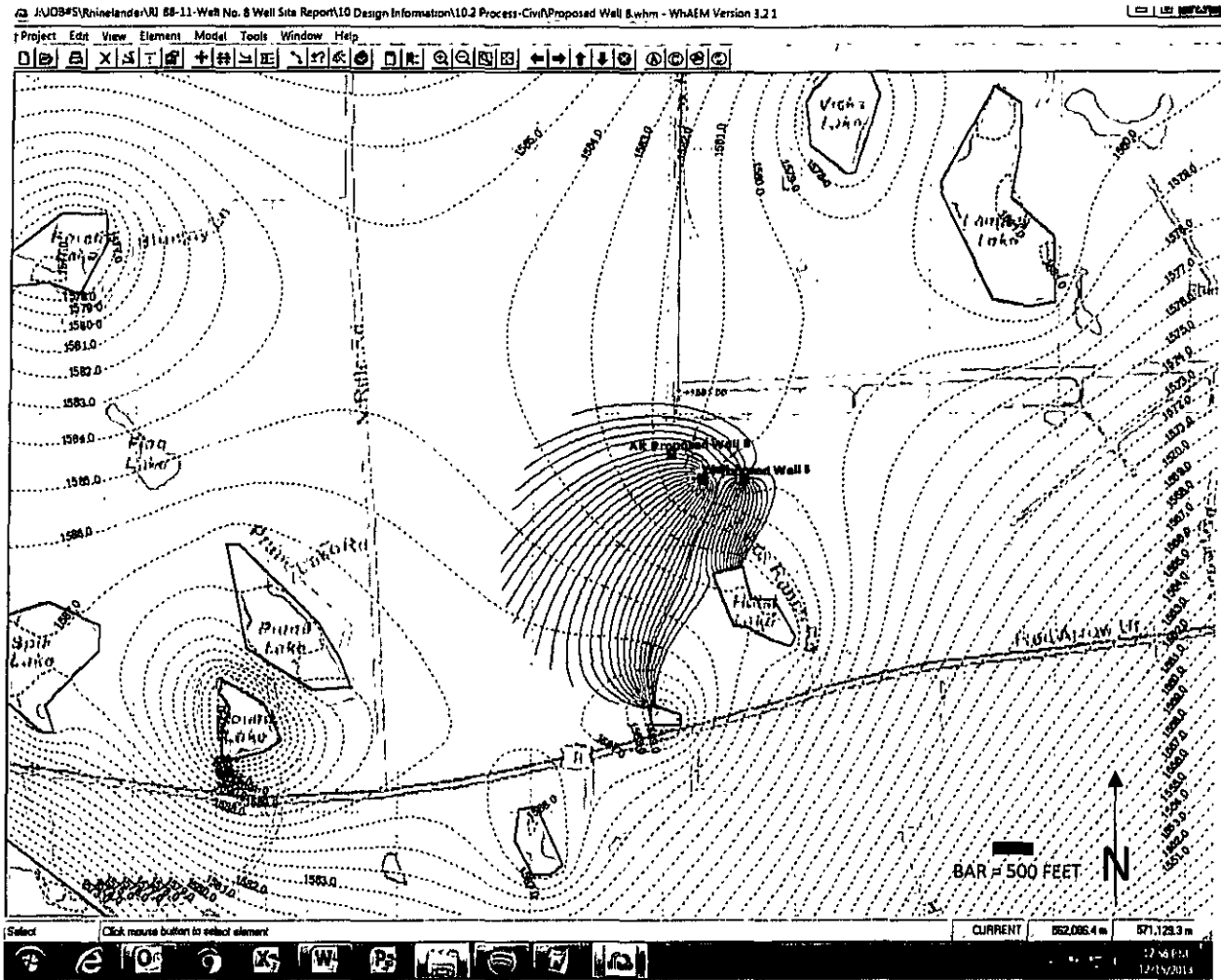


Figure 7. Capture zone analysis results for Well 7 and Proposed Well 8 based on 10 year travel time, $K=110$ ft/day, and $Q=155$ gpm (600 gpm pumping rate pumping an average of 6 hours per day). Hydraulic conductivity used was 10% of value obtained from analysis of testing pumping for Well 7 test well using AQETSOLV software.

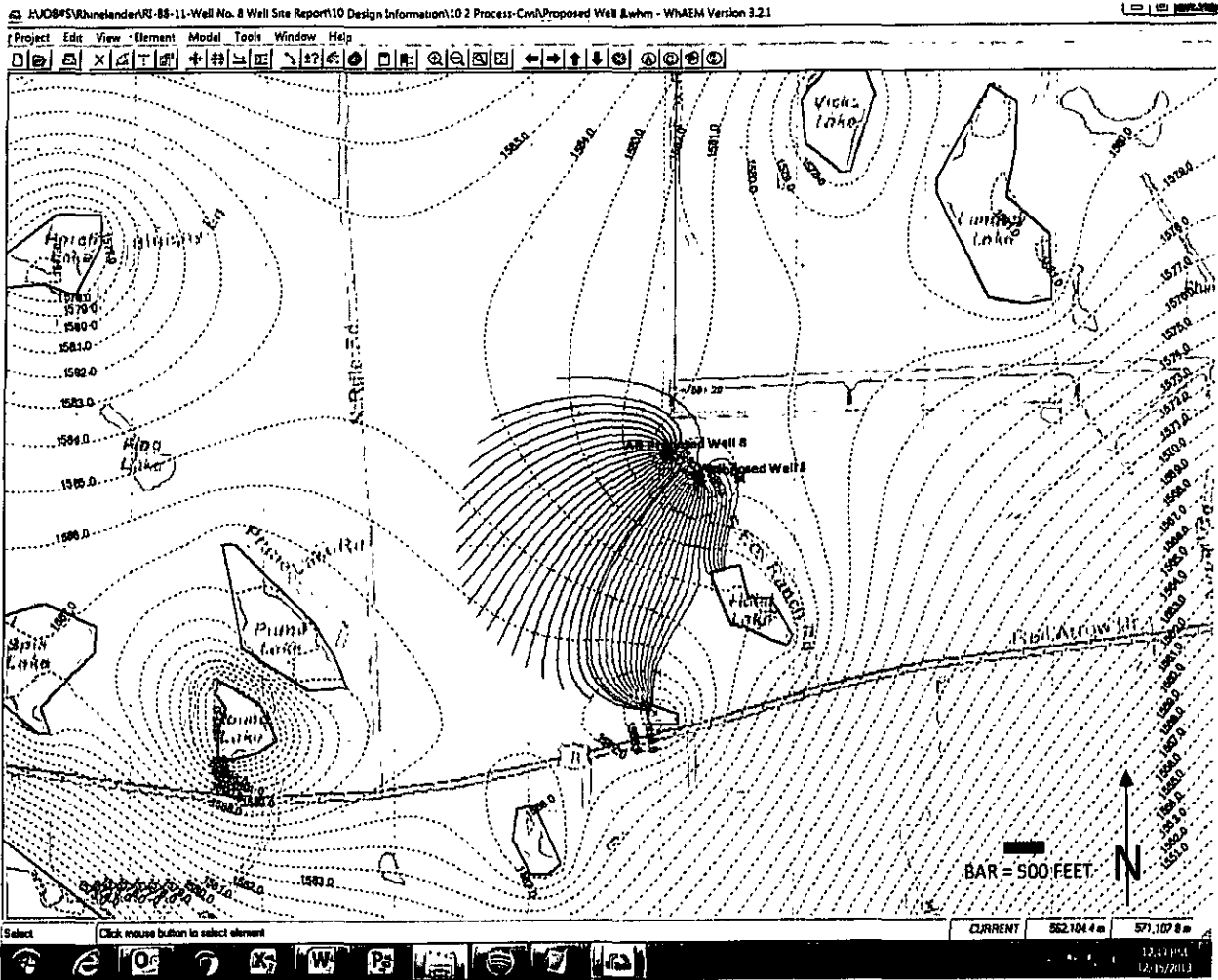


Figure 8. Capture zone analysis results for Well 7 and Alternate Proposed Well 8 based on 10 year travel time, $K=110$ ft/day, and $Q=155$ gpm (600 gpm pumping rate pumping an average of 6 hours per day). Hydraulic conductivity used was 10% of value obtained from analysis of testing pumping for Well 7 test well using AQETSOLV software.

The estimate of zone of influence was based upon an 11,500 gpd/ft coefficient of transmissivity estimate from the Well No. 7 test well. To solve the equation the following values were utilized:

s = 1 foot
Q = 600 gpm. This is the desired volume for the new well
T = 11,500 gpd/ft.
T = 30 days
r = distance in feet from center of pumped well to point of analysis
S = 0.20, this value is the estimated coefficient of storage for coarse grained material in an unconfined aquifer (Reference Page 737)

Utilizing the above information, the calculated zone of influence from the center of the pumping well for 30 days of continuous pumping is 661 feet. If a smaller coefficient of storage, for example 0.10, is assumed, the radius (r) becomes 935 feet.

Recommend 1,200 WHP pipe?

i) Wetlands

The proposed well site is located at the west edge of the Rhinelander airport property. There are several small wetlands in the vicinity of the well site. A larger wetland, which is immediately adjacent to Hoist Lake, begins about 600 feet from the proposed well sites. A copy of the DNR wetlands inventory map of the area is shown on Figure 2).

Any monitoring of wells? monitoring well?

j) Aquifer to be Used

The well will be completed in an unconsolidated formation above granite bedrock. Granite is expected to be encountered at a depth of about eighty feet based on experience at Well No. 7.

k) Well Location

City of Rhinelander. NW ¼, NW ¼, Section 10, Township 36 North, Range 8 East. Section numbers are shown on the Location Map, Figure 1.

l) Boundaries of the Site and Location of the Well on the Site

The City/County own the airport property, which is the proposed location for Well No. 8. The closest property line is located 100 feet to the south. The proposed well site will be separated from the rest of the City/County property by land survey and covered by a 99-year easement. The minimum easement size will be 100-foot by 100-foot, with the well located in the middle of the easement.

m) Topography of the Site

The site is relatively flat. A detailed site topographical map has not been prepared. The site will be graded so that all drainage is away from the well.

n) Results from Previous Test Wells

In past years, a program of electrical resistivity profile lines, electrical resistivity depth sounds and seismic refraction soundings were performed in and around the City of Rhinelander in an attempt to identify favorable test well locations. Based upon this information, fourteen test wells were drilled. Of these fourteen test wells, only five were deemed promising enough to warrant test pumping. Of these five which were test pumped, two (numbers 9 and 14), both in the vicinity of the intersection of Fox Ranch Road with the southern boundary of the airport property, west of the City, were found to have production suitable for permanent well development. At the time of the test well drilling program the nearest water main was located far from the site. Since that time, industrial development west of the City has brought the water main much closer to the site, making development of a new water supply source much more economically feasible. The site of Test Well No. 9, on the airport property, was chosen for Well No. 7, which was drilled in 2008. Well No. 7 was constructed to allow the addition of a satellite well, which will be Well No. 8. Copies of excerpts from the 1986 report are included as an appendix to this well site investigation report.

o) Final Well Construction Details

Well No. 8 will be a gravel pack well, drilled to a depth of approximately 80 feet. The upper borehole will be 30 inches in diameter and held open with a 30-inch diameter temporary casing, which will be pulled during the grouting process. An 18-inch diameter casing with a 20-foot long screen will be installed to the bottom of the hole. A 24-inch diameter casing will be suspended over the eighteen inch diameter casing with screen for installation of the gravel pack; gravel will be placed around and to the top of the screen (60 feet below the surface). A bentonite seal will be placed between the 18-inch and 24-inch casings. The annular space between the formation and the 24-inch diameter casing will be grouted to the surface to provide a sanitary seal.

p) Anticipated Annual Volume of Water to Be Withdrawn and Compatibility with the Existing Water Supply Facilities

It is anticipated that Well No. 8 will pump, on average, about 6 hours per day, which equates to about 216,000 gallons per day.

Well No. 8 will be of the same type as the other wells in the Rhinelander water system. The close proximity to Well No. 7 is not anticipated to cause a problem; test pumping of the test well for Well No. 7 showed a drawdown after 72 hours of

How many hours does well 7 pump?

pumping of 6.72 feet and 3.95 feet in the near monitoring well (25 feet north) and far monitoring well (100 feet west) respectively. Little interference is expected with a separation distance of 500 feet based on modeling in WhAEM.

q) Location and Data from Any Piezometers

None. See Appendix for additional hydrogeologic investigation data.

r) Summary Evaluation, Need for Possible Water Treatment

The City of Rhinelander has three sources of water supply, the Well 4 – Well 5 complex, the output from which is treated in a single chlorine contact tank, Well 6, and Well 7. The City has seen steady growth in water demand, necessitating the need for a new well.

vague?

Bedrock in the vicinity of Rhinelander has been characterized as dioritic intrusive rock; granite intrusive rock and metavolcanic rock. These forms of bedrock do not transmit water freely. Groundwater supplies in the vicinity of the City are derived almost exclusively from glacial drift. The City has conducted several geophysical and test well drilling programs over the years to find an area of glacial drift/outwash which holds sufficient water for a municipal well. Only one site with significant potential has been discovered. This report covers that site.

Well No. 7, constructed in 2008, and test wells constructed in 1986 and 1987, indicate that an 80-foot deep gravel pack well can be constructed at this location. The well is expected to produce 600 gallons per minute. Water from Well No. 7 was acidic, and low in alkalinity, iron and manganese. The raw water from Well No. 8 is expected to be corrosive, requiring chemical addition to alter its corrosivity. Well No. 8 will discharge to the treatment tank at Well No. 7 where facilities exist for treatment. Chlorine would be fed to disinfect the water. No iron/manganese removal treatment or softening is anticipated to be necessary.

- How ^{well 8} to be operated in relation to well No. 7?
- why not a well on the NE, E, SE side of the City?
- Test well (1) / construction details?
- How close to well 8 were the previous test wells?
- Recommend additional investigation / test well work in other parts of the City?

Appendix A

**Excerpts from September 1986 –
Water Supply System Study
(Foth & Van Dyke)**

VIII. GROUNDWATER EXPLORATION - 1986

This section is a review of data obtained by test well drilling and geophysical work during this year in an additional effort to find sites suitable for the construction of more water supply wells. This has been an ongoing program for a number of years. A previous report presented the data obtained from test well work carried out in 1983. At that time, nine (9) test wells were drilled in the western portion of the City and in the general area of Well No. 2. No production wells were developed as a result of that work.

A. Test Well Drilling

This year, to date, fourteen (14) test wells have been drilled by the Rhinelander Well Drilling Company. Data regarding this drilling work is shown on Table No. 2 and the locations are indicated on Figure No. 3. The majority of these test wells were located in the vicinity of the Rhinelander-Oneida County Airport to the west of the City. There are two (2) exceptions, however. Test Well No. 5-86 is located at the site of Test Well No. 1-83. The latest test well here is eight (8) inch rather than six (6) inch which allows for the installation of a larger test pump. The results were not favorable, however. The other exception is Test Well 7-86 which was drilled to the south of Production Well No. 5.

Five (5) of the fourteen (14) test wells were deemed to be worthy of test pumping. All of these, except for No. 5-86, are located at the western edge of the airport. The depths of these four (4) test wells (No.'s 3, 4, 9 and 14) range from 75 to 84 feet. Of these four (4), No.'s 9 and 14 were the most promising and provided the greatest volume of water with the least drawdown. (Test pumping data is included in Appendix B.) Based on this data, this area looks most favorable for the construction of a permanent well or wells. Before this step is taken, however, a more thorough aquifer testing program must be carried out to insure that the volume of water which can be developed is adequate and that the quality is acceptable.

NOT IN TO B/G/ME!

TABLE NO. 2

CITY OF RHINELANDER

1986 TEST WELLS

Test Well No.	Location	Depth (ft)	Test Pumped	Comments
1	Airport - East	90	No	
2	Airport - Southeast	51	No	
3	Airport - West	75	Yes	195 gpm - 3 hr test
4	Airport - West	82	Yes	256 gpm - 8 hr test
5	Lois St. North of Well 2	85	Yes	200 gpm - Less than 1 hr
6	Airport South Hwy. 8	73	No	
7	South of Well 5	72	No	
8	Airport - West	52	No	
9	Airport - West	80	Yes	319 gpm - 12 hr test
10	Airport - West	82	No	
11	Airport - West	72	No	
12	Airport - West	72	No	
13	Airport - West	65	No	
14	Airport - West	84	Yes	312 gpm - 24 hr test



500,000 GAL
ELEV. TANK

17

CITY OF
RHINELANDER

RHINELANDER - ON
AIRPORT

8

- 10 ●
- 11 ●
- 12 ●
- 3 ●
- 4 ●
- 9 ●
- 13 ●
- 14 ●
- 8 ●

PELICAN
RIVER

WELL NO. 4

7

1986 TEST WELL LOCATIONS

Foth & Van Dyke
Engineering/Architectural Division

2737 S. Ridge Road
P. O. Box 19012
Green Bay, Wisconsin 54307-9012
414/497-2500

COUNTY Oneida		CHECK (✓) ONE: <input type="checkbox"/> Town <input type="checkbox"/> Village <input type="checkbox"/> City		Name	
2. LOCATION OR - Grid or Street No. Street or Road Name		Section Township, Range		3. NAME <input type="checkbox"/> OWNER <input type="checkbox"/> AGENT AT TIME OF DRILLING CHECK (A) ONE City of Rhinelander	
AND - If available subdivision name, lot & block No.		ADDRESS Test Hole #14		POST OFFICE ZIP CODE	
4. Distance in feet from well to nearest: (Record answer in appropriate block)		Building		Sanitary Bldg. Drain	
				Sanitary Bldg. Sewer	
				Floor Drain Connected To:	
				Storm Bldg. Drain	
				Storm Bldg. Sewer	
Street Sewer		Other Sewers		Foundation Drain Connected to:	
San. Storm C.I. Other		Sewer Clearwater Dr. Sewage Sump Clearwater Sump		Sewage Sump C.I. Other	
Privy		Pet Waste Pit		Pit: Nonconforming Existing Well Pump Tank	
				Subsurface Pumproom Nonconforming Existing	
				Barn Gutter	
				Animal Barn Pen	
				Animal Yard	
				Silo With Pit	
				Glass Lined Storage Facility	
				Silo w/o Pit	
				Earthen Silage Storage Trench Or Pit	
				Earthen Manure Hopper or Retention or Pneumatic Tank	
Temporary Manure Stack or Platform		Watertight Liquid Manure Tank or Basin		Manure Pressure Pipe	
				Subsurface Gasoline or Oil Tank	
				Waste Pond or Land Disposal Unit (Specify Type)	
				Manure Storage Basin Concrete Floor Only Concrete Floor and Partial Concrete Walls	
				Other (Describe)	
5. Well is intended to supply water for: Test well				9. FORMATIONS	
6. DRILLHOLE				Kind From (ft.) To (ft.)	
Dia. (in.) From (ft.) To (ft.) Dia. (in.) From (ft.) To (ft.)				Caving Sand & clay Surface 20	
8 Surface 80				Sand & gravel-40 slot 20 65	
				Medium & large sand 65 80	
7. CASING, LINER, CURBING AND SCREEN				Sand & clay 80 84	
Material, Weight, Specification				Bedrock 84 -	
Dia. (in.) Mfg. & Method of Assembly From (ft.) To (ft.)					
8 8 Surface 55					
6 Stainless screen					
6' 12 slot					
5' 20 slot					
6' 25 slot					
6' 15 slot					
8. GROUT OR OTHER SEALING MATERIAL				10. TYPE OF DRILLING MACHINE USED	
Kind From (ft.) To (ft.)				<input type="checkbox"/> Cable Tool <input type="checkbox"/> Rotary-hammer w/drilling mud & air <input type="checkbox"/> Jetting with	
Surface				<input type="checkbox"/> Rotary air w/drilling mud <input checked="" type="checkbox"/> Rotary-hammer & air <input type="checkbox"/> Air	
				<input type="checkbox"/> Rotary w/drilling mud <input type="checkbox"/> Reverse Rotary <input type="checkbox"/> Water	
				Well construction completed on June 25 19 86	
11. MISCELLANEOUS DATA				Well is terminated _____ inches <input checked="" type="checkbox"/> above final grade <input type="checkbox"/> below	
Yield Test: _____ Hrs. at _____ GPM				Well disinfected upon completion <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
Depth from surface to normal water level _____ Ft.				Well sealed watertight upon completion <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
Depth of water level when pumping _____ Ft. Stabilized <input type="checkbox"/> Yes <input type="checkbox"/> No					
Water sample sent to _____ laboratory on _____ 19____					

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature

Business Name and Complete Mailing Address

Registered Well Driller

Foth & Van Dyke Engineers/Architects

2737 S. Ridge Road P. O. Box 19072 Green Bay, Wisconsin 54307-9012 414/497-2500

PUMP TEST OF WELL

DATE March 6, 1986

WELL NO. TW-3-86 OWNER City of Rhineland LOCATION 550 feet south of west end of taxiway "B" near fence corner
 DIA. ORIFICE 6" X 4" STATIC LEVEL 20 FT. IN. WELL DEPTH 85 FEET

DRILLED BY Rhineland Well Drilling LENGTH OF AIRLINE FT. DIRECT READING LEVEL INDICATOR

PUMP SETTING TO DISCHARGE NOZZLE FT. TO TAIL PIPE FT. TESTED BY Dean Funk / Ray Weber

Reading Number	Time	Altitude GA. in Feet	Inches on Orifice	G.P.M.	Top of screen @ 64'			Specific Capacity	FE	HARDNESS	Water Appearance: Clear, Cloudy, Murky, Muddy, Sandy, Temp., Odor
					Pumping Level	in Feet	Drawdown				
Start	8:57										
	9:15		9	195	58	38	5.1				Red Murky
	9:30		9	195	58	38	5.1	Trace			Clear, No Sand
	10:00		9	195	58	38	5.1		4 Grains		" " "
	10:30		8.5	190	58	38	5.0				" " "
	11:00		8.5	190	58	38	5.0				" " "
	11:30		8.5	190	58	38	5.0				" " "
	12:00		8.5	190	58	38	5.0				" " "
RECOVERY											
				30 SECS	26						
				1 MIN	21.5						

Foth & Van Dyke

Engineers/Architects

2737 S. Ridge Road P. O. Box 19012 Green Bay, Wisconsin 54307-9012 414/497-2500

PUMP TEST OF WELL

DATE April 3, 1986

WELL NO. TW-4-86 OWNER City of Rhineland LOCATION North end of Fox Ranch Road
 DIA. ORIFICE 6" X 4" STATIC LEVEL 6 FT. 6 1/2 IN. WELL DEPTH 82 FEET
 DRILLED BY Rhineland Well Drilling LENGTH OF AIRLINE FT. x FT. DIRECT READING LEVEL INDICATOR
 PUMP SETTING TO DISCHARGE NOZZLE FT. TO TAIL PIPE FT. TESTED BY Dean Funk / Ray Weber

WE-11-86 located 335' southwest of TW-3-86

Reading Number	Time	Altitude GA. in Feet	Inches on Orifice	G.P.M.	Pumping Level 6'-6 1/2"	Drawdown in Feet	Specific Capacity D =	Sand Point TW-10-86 D = 550	Water Appearance: Clear, Cloudy, Murky, Muddy, Sandy, Temp., Odor
Start	10:15				6.54			19'-10 1/2"	
	10:30		10	206	41.5				
	10:40		15 1/2	256	51.0		5.4		
	10:45		15 1/2	256	53.0	47	5.4		
	11:00		15 1/2	254	53.0	47	5.4		
	11:30		15 1/2	254	53.0	47	5.4		
	12:00		15 1/2	254	53.0	47	5.4		
	12:30		15 1/2	254	53.0	47	5.4		
	1:00		15 1/2	254	53.0	47	5.4		
	1:30		15 1/2	254	53.0	47	5.4	20'-2"	
	2:00		15 1/2	254	53.0	47	5.4		
	2:30		15 1/2	254	53.0	47	5.4	20'-2"	RECOVERY
	3:00		15 1/2	254	53.0	47	5.4		
	3:30		15 1/2	254	53.0	47	5.4	20'-2"	30 SECS 15
	4:00		15 1/2	254	53.0	47	5.4		
	4:30		15 1/2	254	53.0	47	5.4	20'-2"	1 MIN 7.6
	5:00		15 1/2	254	53.0	47	5.4		
	5:30		15 1/2	254	53.0	47	5.4	20'-2 1/2"	
	6:00		15 1/2	254	53.0	47	5.4		

NOTE:
 White Copy - Division's Copy
 Green Copy - Driller's Copy
 Yellow Copy - Owner's Copy

COUNTY		CHECK (✓) ONE:				Name	
		<input type="checkbox"/> Town		<input type="checkbox"/> Village		<input type="checkbox"/> City	
2. LOCATION		1/4 Section or Gov't. Lot		Section Township Range		3. NAME <input type="checkbox"/> OWNER <input type="checkbox"/> AGENT AT TIME OF DRILLING CHECK (✓) ONE	
OR - Grid or Street No. Street or Road Name		ADDRESS				City of Rhinelander	
AND - If available subdivision name, lot & block No.		POST OFFICE				Test Hole #3	
4. Distance in feet from well to nearest: (Record answer in appropriate block)		Building		Sanitary Bldg. Drain		Sanitary Bldg. Sewer	
		C.I. Other		C.I. Other		Floor Drain Connected To: C.I. Sewer Other Sewer	
		Storm Bldg. Drain		Storm Bldg. Sewer		Storm Bldg. San	
		C.I. Other		C.I. Other		C.I. Other	
Street Sewer		Other Sewers		Foundation Drain Connected to		Sewage Sump	
San. Storm C.I. Other		Sewer Clearwater Dr.		Sewage Sump Clearwater Sump		Clearwater Sump Septic Tank Holding Tank	
Privy		Pet Waste Pit		Pit: Nonconforming Existing		Subsurface Pumproom	
				Well Pump		Nonconforming Existing	
						Barn Gutter Animal Barn Pen Animal Yard Silo With Pit Glass Lined Storage Facility Silo w/o Pit Earthen Silage Storage Trench Or Pit Earthen Manure Retention or Pneumatic Tank	
Temporary Manure Stack or Platform		Watertight Liquid Manure Tank or Basin		Manure Pressure Pipe		Subsurface Gasoline or Oil Tank	
						Waste Pond or Land Disposal Unit (Specify Type)	
						Manure Storage Basin Concrete Floor Only Concrete Floor and Partial Concrete Walls Other (Describe)	
5. Well is intended to supply water for:				9. FORMATIONS			
				Kind From (ft.) To (ft.)			
6. DRILLHOLE				Sand & Clay Surface 25			
Dia. (in.)		From (ft.)		To (ft.)			
6		Surface		75		Clay, Sand, Gravel (Grey) 25 75	
7. CASING, LINER, CURBING AND SCREEN							
Material, Weight, Specification							
Dia. (in.)		Mfg. & Method of Assembly		From (ft.)		To (ft.)	
6		Steel Casing		Surface		75	
8. GROUT OR OTHER SEALING MATERIAL				10. TYPE OF DRILLING MACHINE USED			
Kind		From (ft.)		To (ft.)		<input type="checkbox"/> Cable Tool <input type="checkbox"/> Rotary-hammer w/drilling mud & air <input type="checkbox"/> Jetting with <input type="checkbox"/> Rotary-air w/drilling mud <input checked="" type="checkbox"/> Rotary-hammer & air <input type="checkbox"/> Air <input type="checkbox"/> Rotary-w/drilling mud <input type="checkbox"/> Reverse Rotary <input type="checkbox"/> Water	
		Surface					
11. MISCELLANEOUS DATA				Well construction completed on <u>March 3</u> 19 <u>86</u>			
Yield Test: _____ Hrs. at _____ GPM		Well is terminated _____ inches		<input type="checkbox"/> above final grade		<input type="checkbox"/> below	
Depth from surface to normal water level _____ Ft.		Well disinfected upon completion		<input type="checkbox"/> Yes <input type="checkbox"/> No			
Depth of water level when pumping _____ Ft. Stabilized <input type="checkbox"/> Yes <input type="checkbox"/> No		Well sealed watertight upon completion		<input type="checkbox"/> Yes <input type="checkbox"/> No			
Water sample sent to _____ laboratory on _____ 19____							
Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.							
Signature				Business Name and Complete Mailing Address			

1. COUNTY Oneida		CHECK (✓) ONE: <input checked="" type="checkbox"/> Town <input type="checkbox"/> Village <input type="checkbox"/> City			Name Crescent		
2. LOCATION OR - Grid or Street No. Street or Road Name AND - If available subdivision name, lot & block No.		Section	Township	Range	3. NAME <input type="checkbox"/> OWNER <input type="checkbox"/> AGENT AT TIME OF DRILLING CHECK (A) C City of Rhinelander ADDRESS Test Hole # 4 1986 POST OFFICE ZIP CODE		
4. Distance in feet from well to nearest: (Record answer in appropriate block)		Building	Sanitary Bldg. Drain C.I. Other		Sanitary Bldg. Sewer C.I. Other		
Street Sewer		Other Sewers		Foundation Drain Connected to:		Sewage Absorption Unit	
San.	Storm	C.I.	Other	Sewer	Sewage Sump	Clearwater Sump	Septic Tank
Clearwater Dr.	Clearwater Sump	C.I.	Other	Sewage Sump	Clearwater Sump	Sewage Sump	Septic Tank
Holding Tank	Sewage Absorption Unit	Manure Hopp. Retention or Pnuematic Tank	Sewage Pit	Sewage Bed	Sewage Trench	Sewage Trench	Sewage Trench
Privy	Pet Waste Pit	Pit: Nonconforming Existing	Well	Pump	Subsurface Pumphoom	Barn Gutter	Animal Barn Pen
Animal Yard	Silo With Pit	Glass Lined Storage Facility	Silo w/o Pit	Earthen Silage Storage Or Pit	Earthen Storage Trench	Earthen Manure Retention	Earthen Manure Retention
Temporary Manure Stack or Platform	Watertight Liquid Manure Tank or Basin	Manure Pressure Pipe	Subsurface Gasoline or Oil Tank	Waste Pond or Land Disposal Unit (Specify Type)	Manure Storage Basin	Concrete Floor Only	Concrete Floor and Partial Concrete Walls
Other (Describe)	Other (Describe)	Other (Describe)	Other (Describe)	Other (Describe)	Other (Describe)	Other (Describe)	Other (Describe)
5. Well is intended to supply water for:				9. FORMATIONS			
6. DRILLHOLE				Kind		From (ft.)	To (ft.)
Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)	Surface	20
8	Surface	32				sand & gravel	
						medium sand	20
						fine sand & clay	70
						large sand &	73
							82
7. CASING, LINER, CURBING AND SCREEN				10. TYPE OF DRILLING MACHINE USED			
Dia. (in.)	Material, Weight, Specification	Mfg. & Method of Assembly	From (ft.)	To (ft.)	Kind	From (ft.)	To (ft.)
8			Surface	60	All materials removed when finished testing.		
6	s.s. screen	15 slot	59	67	<input type="checkbox"/> Cable Tool <input type="checkbox"/> Rotary-hammer w/drilling mud & air <input type="checkbox"/> Rotary-air w/drilling mud <input checked="" type="checkbox"/> Rotary-hammer & air <input type="checkbox"/> Rotary-w/drilling mud <input type="checkbox"/> Reverse Rotary		
6		12 slot	67	73	<input type="checkbox"/> Jetting with Air <input type="checkbox"/> Jetting with Water		
		20 slot	73	82			
8. GROUT OR OTHER SEALING MATERIAL				Well construction completed on April 2 198			
Kind	From (ft.)	To (ft.)	Kind	From (ft.)	To (ft.)	Well is terminated	inches
	Surface					<input type="checkbox"/> above final grade <input type="checkbox"/> below final grade	
11. MISCELLANEOUS DATA				Well disinfected upon completion			
Yield Test: 7.5	Hrs. at 245	GPM	Depth from surface to normal water level 5	Ft.	Well sealed watertight upon completion	<input type="checkbox"/> Yes <input type="checkbox"/> No	
			Depth of water level when pumping 53	Ft.	Stabilized <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	<input type="checkbox"/> Yes <input type="checkbox"/> No	
Water sample sent to _____ laboratory on _____ 19__				Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.			
Signature				Business Name and Complete Mailing Address			
Registered Well Driller							

1. COUNTY
Oneida

CHECK (✓) ONE:
 Town Village City **Name** Airport

2. LOCATION
 OR - Grid or Street No. Street or Road Name
 AND - If available subdivision name, lot & block No.

3. NAME OWNER AGENT AT TIME OF DRILLING CHECK (✓) ONE:
City of Oneida

ADDRESS
Test Well # 9 1986

POST OFFICE **ZIP CODE**

4. Distance in feet from well to nearest: (Record answer in appropriate block)

Building		Sanitary Bldg. Drain		Sanitary Bldg. Sewer		Floor Drain Connected to:		Storm Bldg. Drain		Storm Bldg. Sewer	
C.I.	Other	C.I.	Other	C.I.	Other	C.I. Sewer	Other Sewer	C.I.	Other	C.I.	Other

Street Sewer: San., Storm, C.I., Other
 Other Sewers: C.I., Other
 Foundation Drain Connected to: Sewer, Sewage Sump, Clearwater Dr., Clearwater Sump
 Sewage Sump: C.I., Other
 Clearwater Sump
 Clearwater Dr.
 Holding Tank
 Septic Tank
 Sewage Absorption Unit: Seepage Pit, Seepage Bed, Seepage Trench
 Manure Hopper or Retention or Pneumatic Tank

Privy: Pit: Nonconforming Existing, Well, Pump, Tank
 Subsurface Pumproom: Nonconforming Existing
 Barn Gutter
 Animal Barn Pen
 Animal Yard
 Silo With Pit
 Glass Lined Storage Facility
 Silo w/o Pit
 Earthen Silage Storage Trench Or Pit
 Earthen Manure Basin

Temporary Manure Stack or Platform
 Watertight Liquid Manure Tank or Basin
 Manure Pressure Pipe
 Subsurface Gasoline or Oil Tank
 Waste Pond or Land Disposal Unit (Specify Type)
 Manure Storage Basin: Concrete Floor Only, Concrete Floor and Partial Concrete Walls
 Other (Describe)

5. Well is intended to supply water for:

6. DRILLHOLE

Dia. (in.)	From (ft.)	To (ft.)	Dia. (in.)	From (ft.)	To (ft.)	Kind	From (ft.)	To (ft.)
8	Surface	30				sand, gravel, & boulders	Surface	40
						sand & gravel (medium sand to large gravel)	40	60

7. CASING, LINER, CURBING AND SCREEN
Material, Weight, Specification
Mfg. & Method of Assembly

Dia. (in.)	From (ft.)	To (ft.)
8	Surface	51
6	51	71
6	71	80
All materials removed from site after test completed. <i>INCORRECT 8/6/86 PIPES ETC STILL IN WELL</i>		

8. GROUT OR OTHER SEALING MATERIAL

Kind	From (ft.)	To (ft.)
	Surface	

9. FORMATIONS

10. TYPE OF DRILLING MACHINE USED

Cable Tool
 Rotary-air w/drilling mud
 Rotary-w/drilling mud

Rotary-hammer w/drilling mud & air
 Rotary-hammer & air
 Reverse Rotary

Jetting with
 Air
 Water

Well construction completed on April 21 1986 19__

11. MISCELLANEOUS DATA

Yield Test: 12 Hrs. at 312 GPM
 Well is terminated _____ inches above below final grade

Depth from surface to normal water level 8 Ft. Well disinfected upon completion Yes No

Depth of water level when pumping 30 Ft. Stabilized Yes No Well sealed watertight upon completion Yes No

Water sample sent to _____ laboratory on _____ 19__

Your opinion concerning other pollution hazards, information concerning difficulties encountered, and data relating to nearby wells, screens, seals, method of finishing the well, amount of cement used in grouting, blasting, etc., should be given on reverse side.

Signature _____ Business Name and Complete Mailing Address _____
 Registered Well Driller

Layne-Northwest

Division of LAYNE-WESTERN COMPANY, INC.

W229 N5005 DuPlainville Road • Pewaukee, Wisconsin 53072 • 414/246-4646

June 12, 1986

Foth & Van Dyke
ATTN: Mr. Ray Webber
2737 S. Ridge Rd.
P.O. Box 19012
Green Bay, WI 54307-9012

RE: GEOPHYSICAL INVESTIGATIONS FOR THE CITY OF RHINELANDER

Dear Ray:

As you know on May 7 and 8, 1986 Layne-Northwest Company conducted 7 electrical resistivity profile lines, 5 electrical resistivity depth soundings, and 2 seismic refraction soundings in and around the City of Rhineland in an attempt to identify favorable test well locations.

Electrical resistivity was chosen since this geophysical method has the ability to determine the electric resistivity of Earth materials in place. The electrical resistivity of Earth materials is principally related to the conductivity of their pore fluid. In unsaturated sandy soils the principal pore fluid is air. For this reason unsaturated sandy soils tend to have very high electrical resistivities. In soils which are saturated with water the electrical resistivity measured tends to be that of the formation water. The electrical resistivity of natural formation fluids is principally determined by the concentrations of ions in the water. Fluids which are in clean sandy soils tend to have lower ionic concentrations, as a result saturated clean sands tend to be moderately to highly resistive. Fluids which are in soils that contain significant amount of silts or clays tend to have higher ionic concentrations due to the interaction of the natural fluids with the clay minerals present. For this reason saturated



WATER SUPPLY SERVICES

soils with higher clay or silt content tend to be lower in electric resistivity. It was felt that electrical resistivity would be useful in identifying areas which had a higher potential for the presence of clean sand and gravels.

Since there was little well control in some of the areas to be explored it was determined that it would be necessary to collect some seismic refraction data as well. The method of seismic refraction uses the principal of the distortion of sound waves as they cross the boundary between two materials having different sound conduction velocities. In most cases the strongest sound conduction velocity contrast occurs at the interface between the unconsolidated materials and the consolidated bedrock. It was Layne-Northwest's opinion that the method of seismic refraction should be able to determine a reasonably accurate estimate of the depth to bedrock in the survey areas.

The first area to be surveyed was an area west of the city airport. The map in the appendix of this report shows the study area. The city had three existing test wells, one of which (test well TW9-86) encountered noticeably better formation than the other two. It was the purpose of this study to identify the shape of the sand body and attempt to identify areas in which similar types of formation could be encountered.

Seven electrical resistivity profile lines were run in this area using a 40' electrode separation with the Wenner array. The data are presented on the map in the appendix of this report. The data indicates that the sand body is an irregularly shaped linear feature which trends slightly west of due north. Such a pattern suggests a melt water channel depositional environment. Channel deposits can be quite prolific aquifers, however they tend to be thin and meander quite a bit around a linear trend. Since they are generally thin and somewhat irregular in nature it can be difficult to exactly pinpoint the best test well location. Two electric resistivity depth soundings were conducted in the area and a test well site was recommended at the second depth sounding location. The formation encountered by this test well and by

another test well drilled along this trend where not of the same quality as the formations encountered at test well No. TW9-86. This data suggests that the sand body is a narrow, meandering, irregular feature and additional test well locations may be difficult to find. The possibility of using some type of inexpensive soil boring technique should be considered before additional test well locations are chosen in this area. In addition an extended pumping test of test well TW9-86 should be considered to ensure that the aquifer is of sufficient lateral extent and receives sufficient recharge to sustain a high capacity water well for a prolonged period of time.

The second area to be surveyed was in a gravel pit near City of Rhinelander well No. 5. A prolific sand and gravel aquifer is known to exist at this well site. Electrical resistivity depth sounding R-3 was run near this well for comparison to other resistivity depth soundings. Resistivity depth sounding R-3 indicated a layer of approximately 10' to 15' of highly resistive dry sandy soil above a layer of saturated clean sand and gravel which extended to bedrock which was at a depth of about 70' to 80'.

The third area to be surveyed was in a remote area near Timothy Lane. Electrical resistivity depth sounding No. R-4 was run at this location. The data indicated a surface layer about 9' to 10' thick of extremely resistive dry sand. Below this layer was a layer of saturated, relatively clean formation extending to bedrock which was at a depth of approximately 40'. Seismic line S-1 was run in this area to confirm the shallow bedrock depths. The data indicated a depth to bedrock of approximately 30'. Due to the relatively thin layer of saturated material present in this area it does not appear that a test well would be warranted.

Seismic line S-2 was run in the Harmony Hills Trailer Court. The seismic data was of poor quality but indicated a shallow (approximately 30') bedrock depth. Later conversations with a local well driller indicated that the depth to rock may in fact be closer to 100'. The driller reported that the area contains

many extremely large boulders. It is probable that sound waves refracting off these boulders may have given a false bedrock reading. It is probably not possible to determine an accurate bedrock depth using seismic refraction in this area due to the presence of these boulders. Based on the erroneous seismic data no additional work was done in this area. It is possible that this area may be worth some further investigation using methods other than seismic refraction.

Electrical resistivity depth sounding R-5 was conducted near the Sunrise Plaza Shopping Center on Highway 8. Two wells in the immediate area indicated that the bedrock depth was greater than about 115'. Depth sounding R-5 showed a layer of approximately 40' of extremely resistive sandy material. The depth to water was probably not accurately detected by this depth sounding. Below this was an approximately 100' thick layer of less resistive material, probably indicating saturated sand. The data from R-5 indicated a depth to bedrock of approximately 120' to 140'. This area appears to have the potential for the presence of clean saturated formation. However, as you pointed out, there are some water quality concerns in the area. If a test well were to be drilled in this area it is suggested that an extended range pumping test be conducted in order to address the long term water quality considerations.

Most of the area surveyed were characterized by a surface layer of dry, very sandy soil. This layer presented problems in terms of electrode contact resistance. This high electrode contact resistance probably reduced the effective resolution of the electrical resistivity method and may have caused some anomalous readings. However, it is Layne-Northwest's opinion that the data collected is still substantially correct but should be viewed more from a qualitative rather than a quantitative frame of reference. If additional geophysical work is conducted in the Rhinelander area more attention should be given to methods to reduce the electrode contact resistance such as preparation of electrode plants with salt water. Better well control information should be used to prevent erroneous interpretation of geophysical data due to atypical

Foth & Van Dyke
June 12, 1986
Page 5

geologic conditions such as occurred in the Harmony Hills Trailer Court.

The area around the airport still appears promising but more subsurface information is necessary before any predictions of the capacity of this area can be made. Some type of boring program should be instituted to confirm the trend of the sand body. It is Layne-Northwest's opinion that it is likely that the sand body will trend substantially similar to the electrical resistivity trend shown on the enclosed map though the body of cleanest sand may be patchy and discontinuous in nature.

Layne-Northwest appreciates the opportunity to work with Foth & Van Dyke on this project. We would like to thank you for your assistance and insight as well as for the input from Roger Freund. As you know, Rhinelander is a challenging area from a water supply standpoint. Layne-Northwest feels that some difficulties in any exploration program in this area are to be expected but we feel that your objective of a new high capacity water well of 1,000 gpm or more in the Rhinelander area is an obtainable goal. Please feel free to contact me if you should require any more information pertaining to this matter.

Respectfully submitted,

LAYNE-NORTHWEST Div. of
Layne-Western Co., Inc.

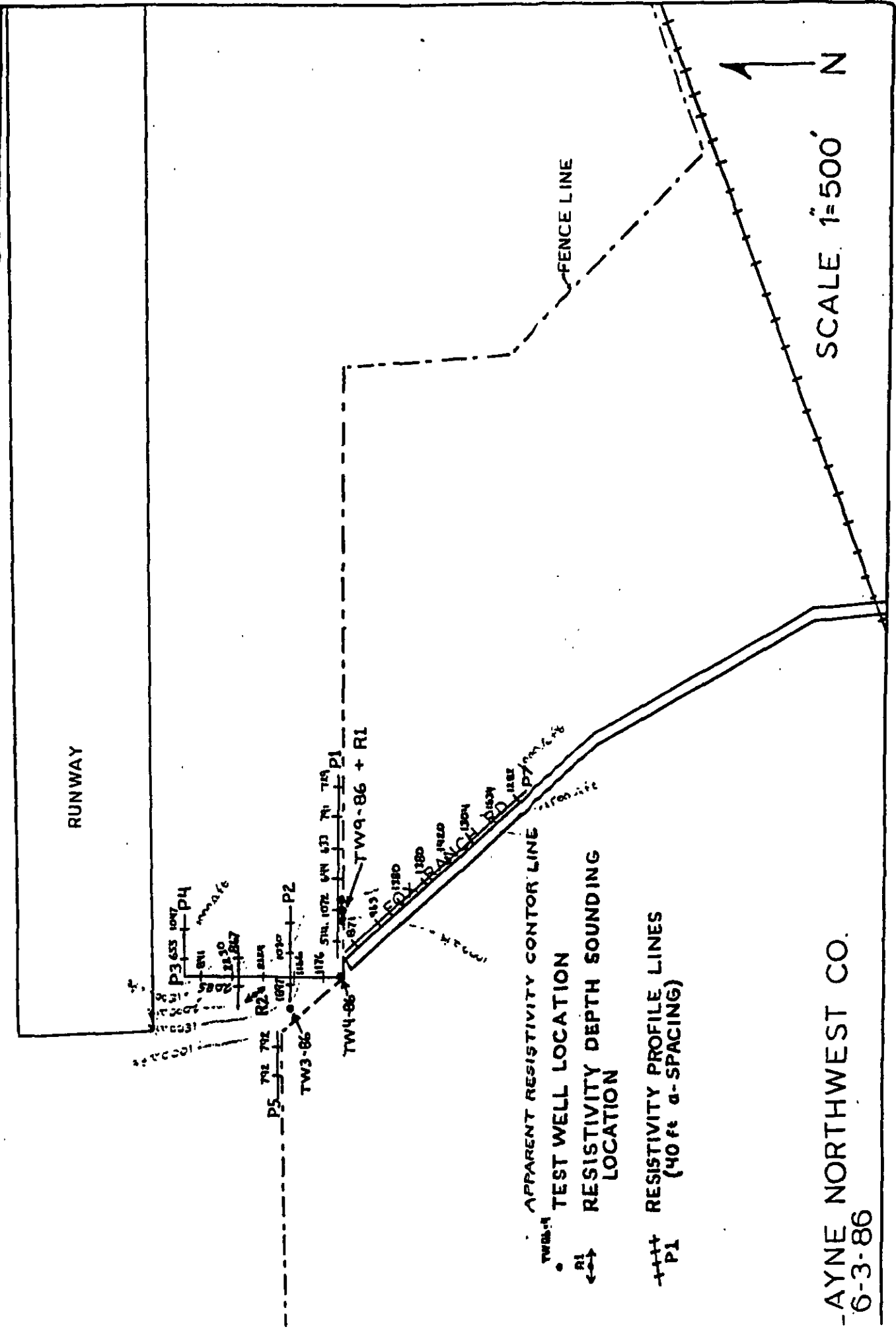


Mr. John R. Jansen
Hydrogeophysicist

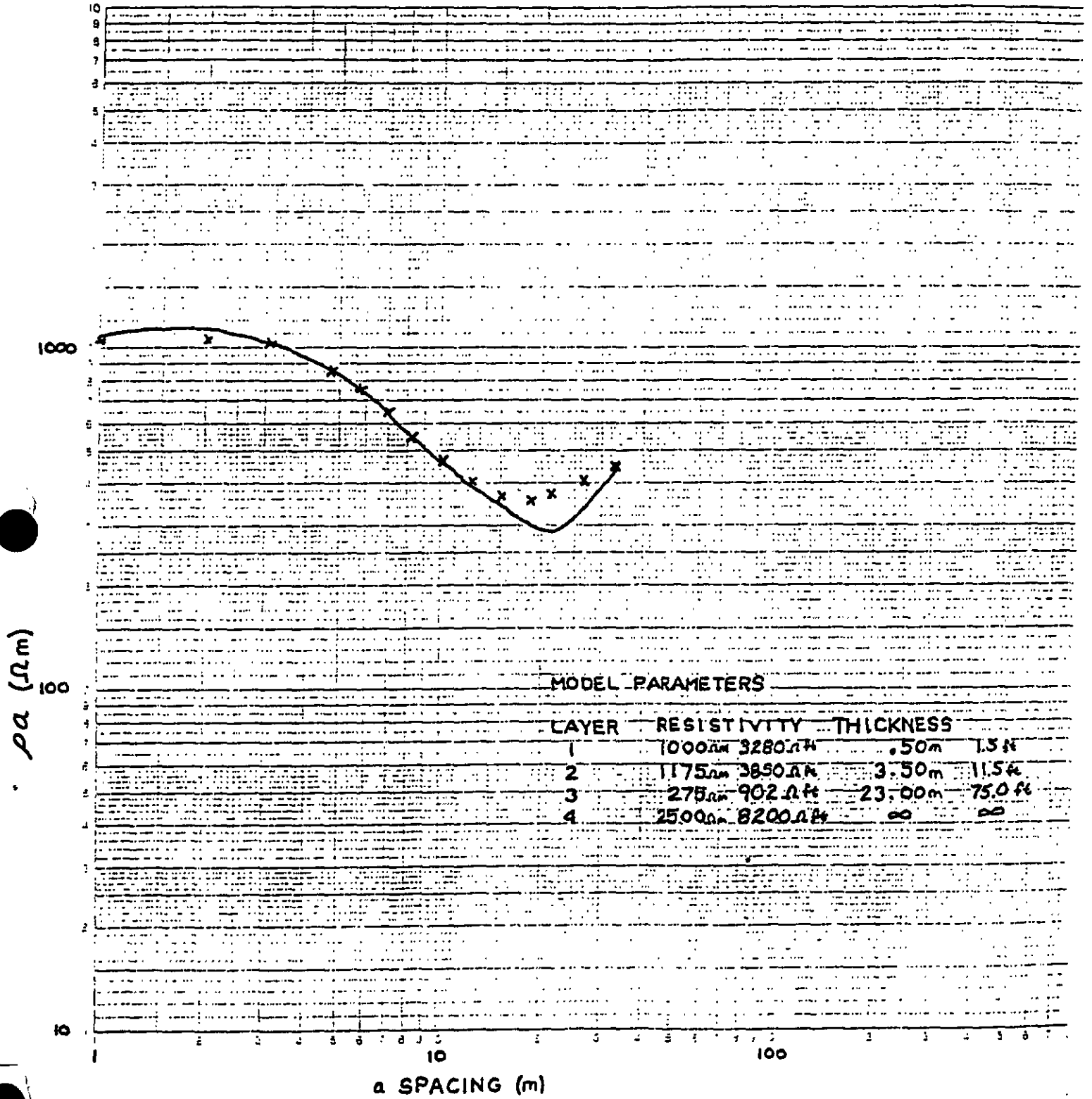
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Enc.

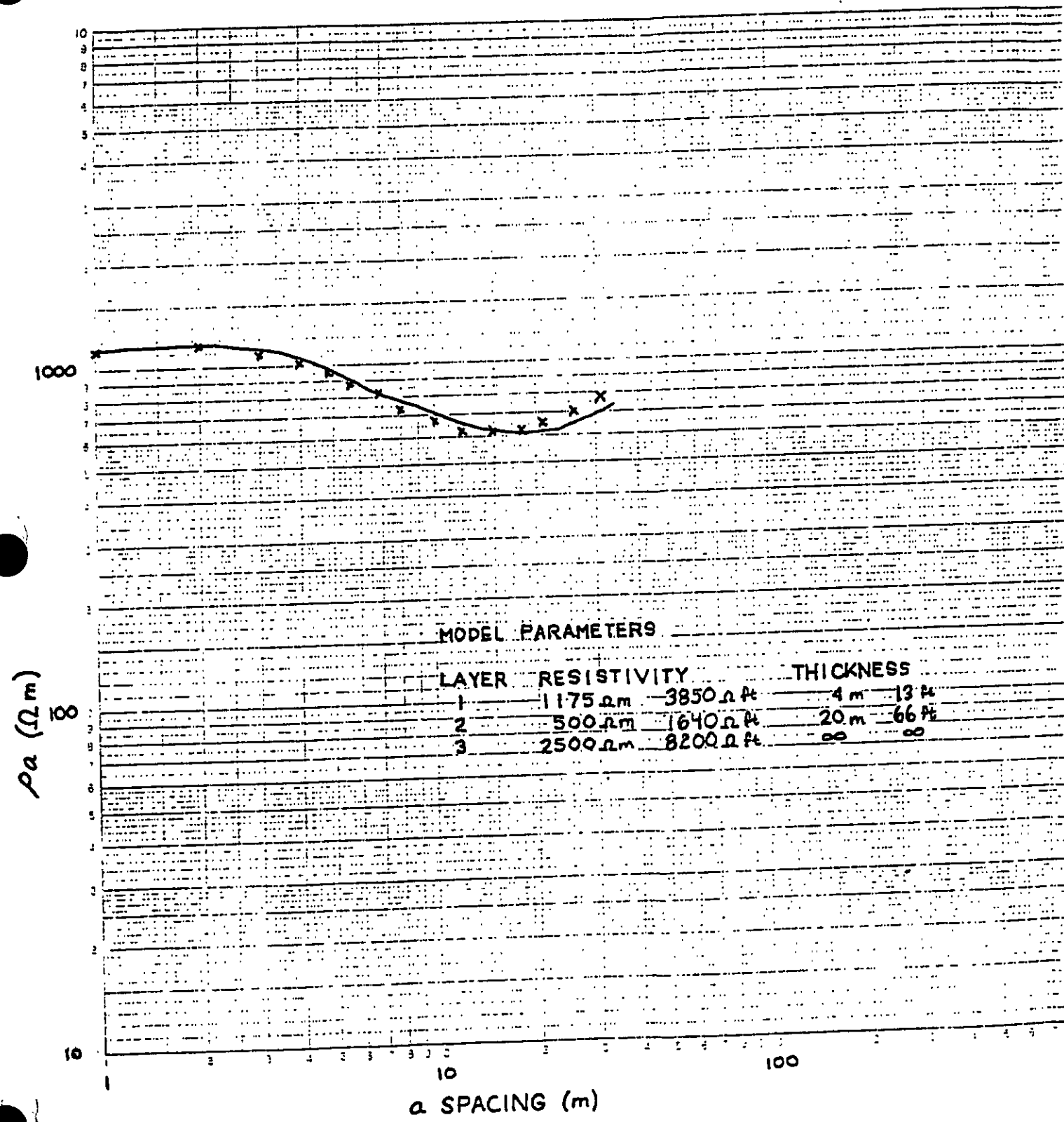
APPARENT RESISTIVITY CONTOUR MAP RHINELANDER, WI AIRPORT AREA



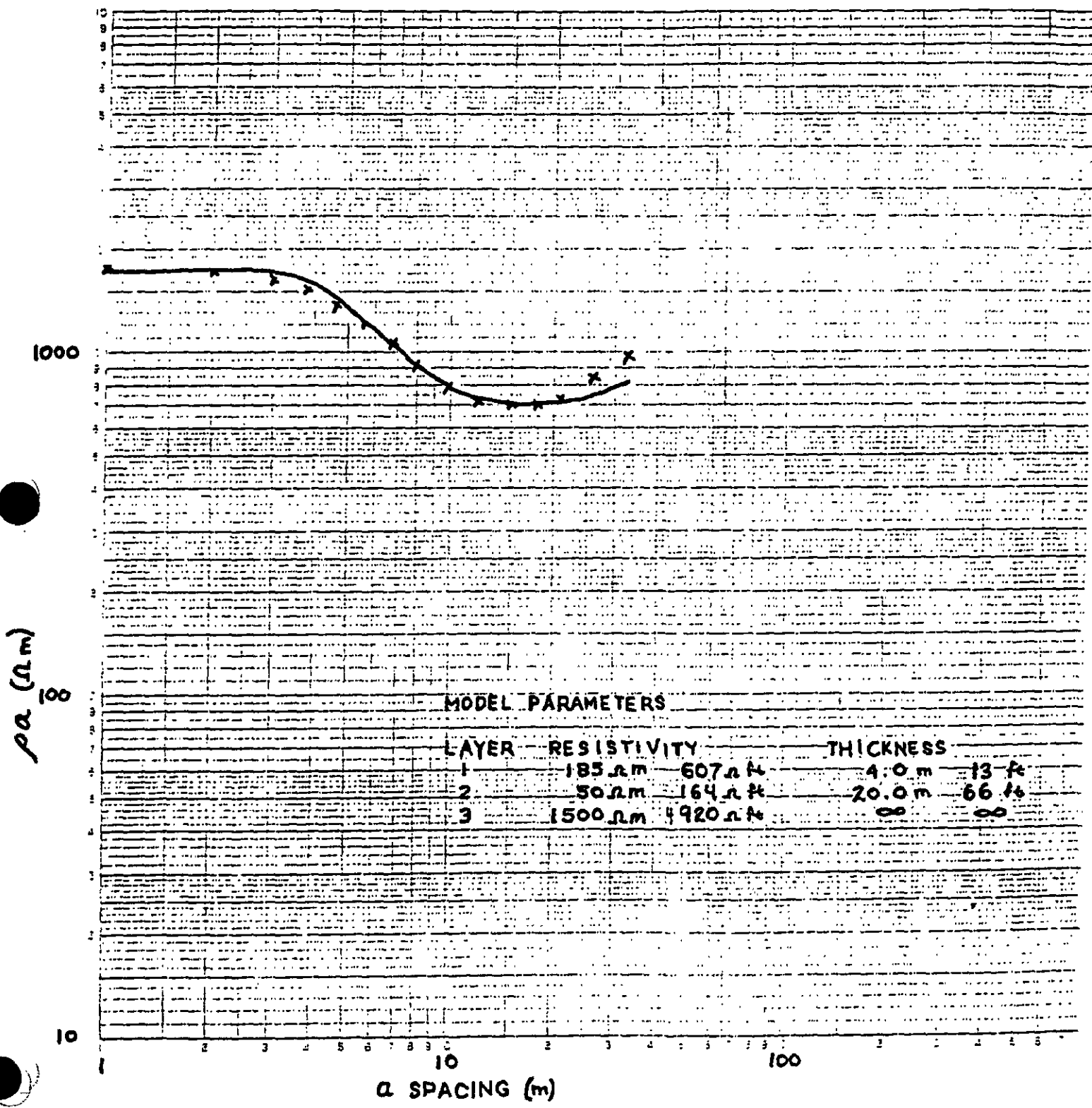
R 1



R 2



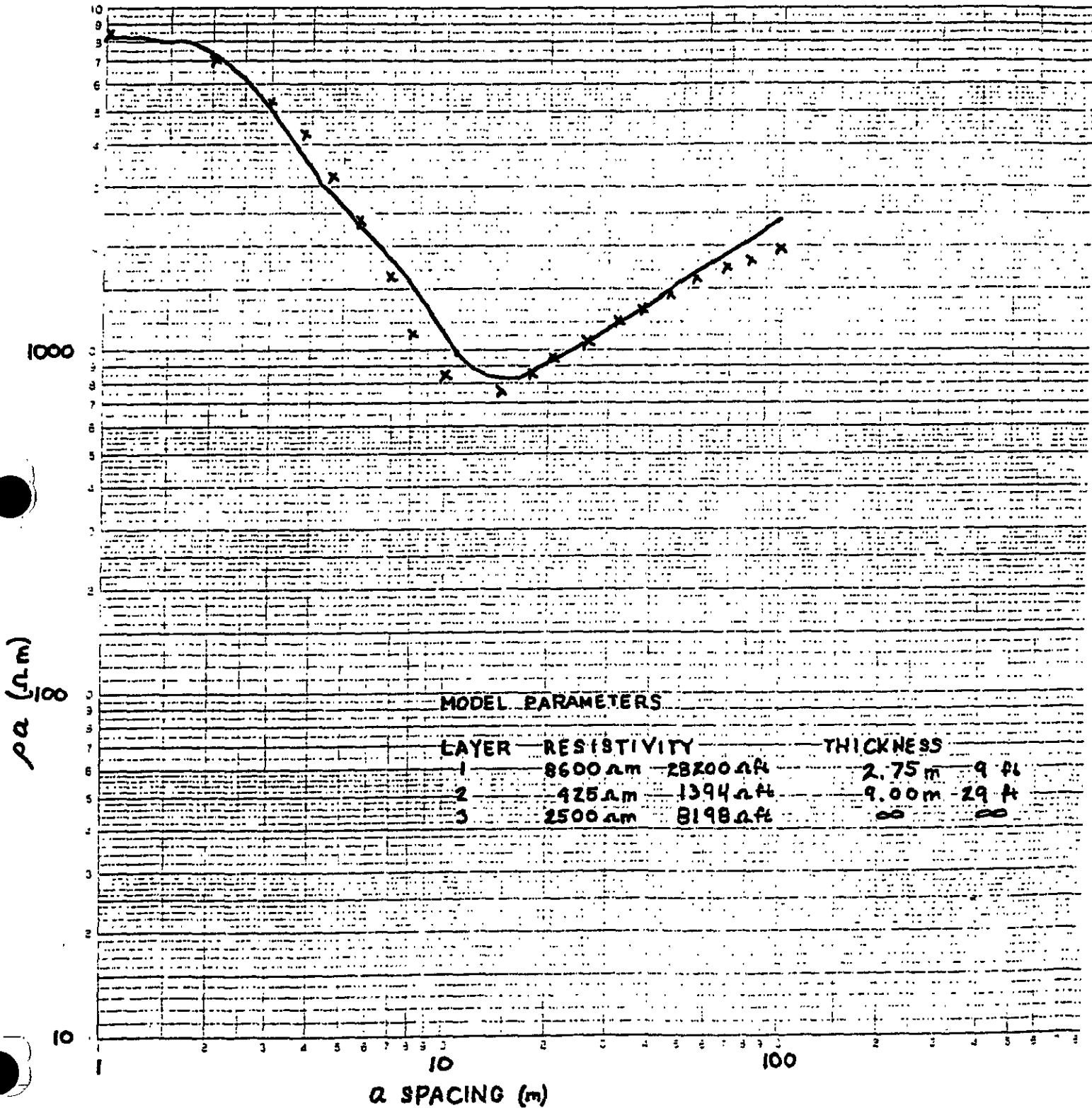
R 3



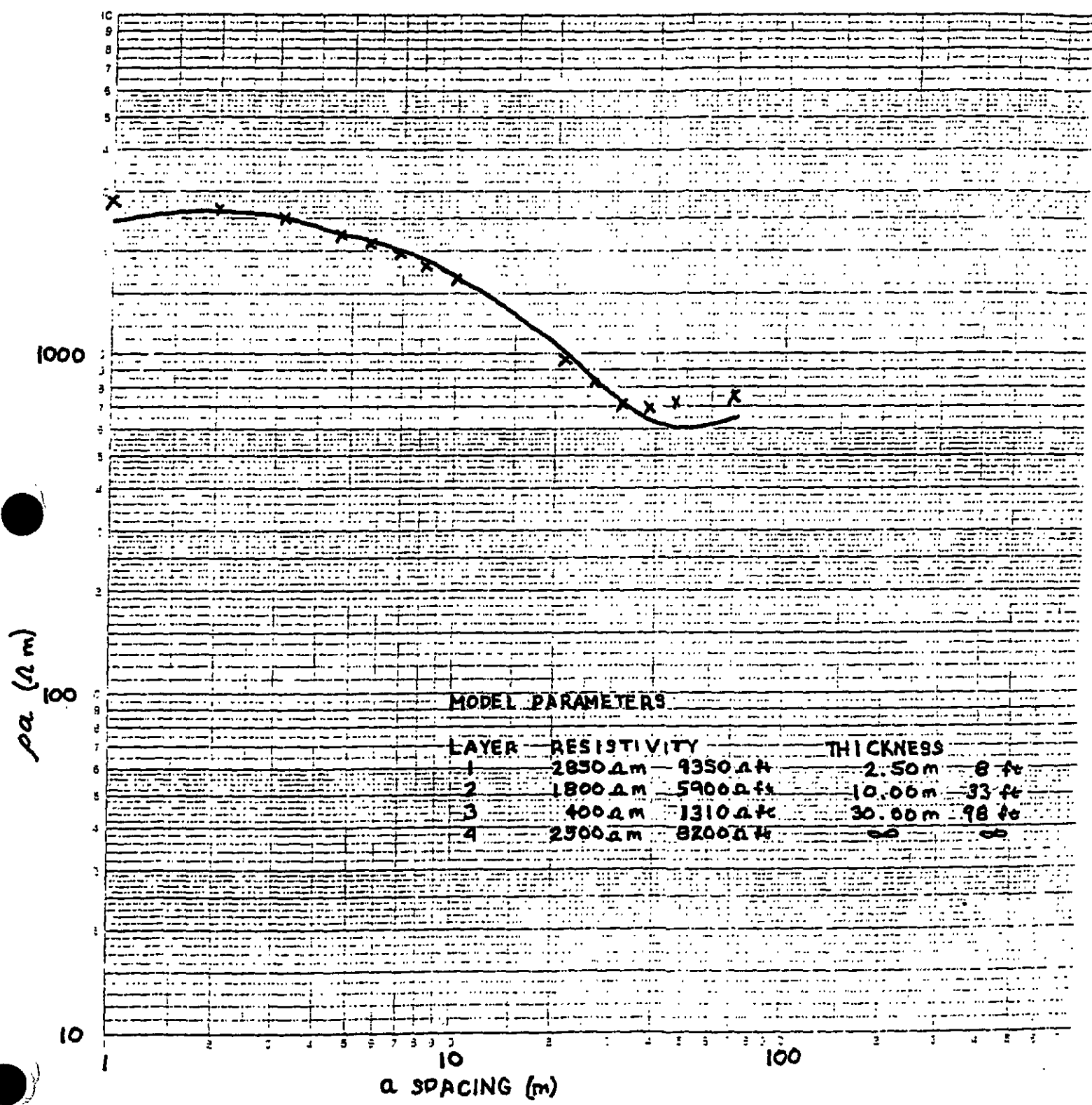
MODEL PARAMETERS

LAYER	RESISTIVITY	THICKNESS
1	185 Ωm 607 Ωft	4.0 m 13 ft
2	50 Ωm 164 Ωft	20.0 m 66 ft
3	1500 Ωm 4920 Ωft	∞ ∞

R4



R 5



MODEL PARAMETERS

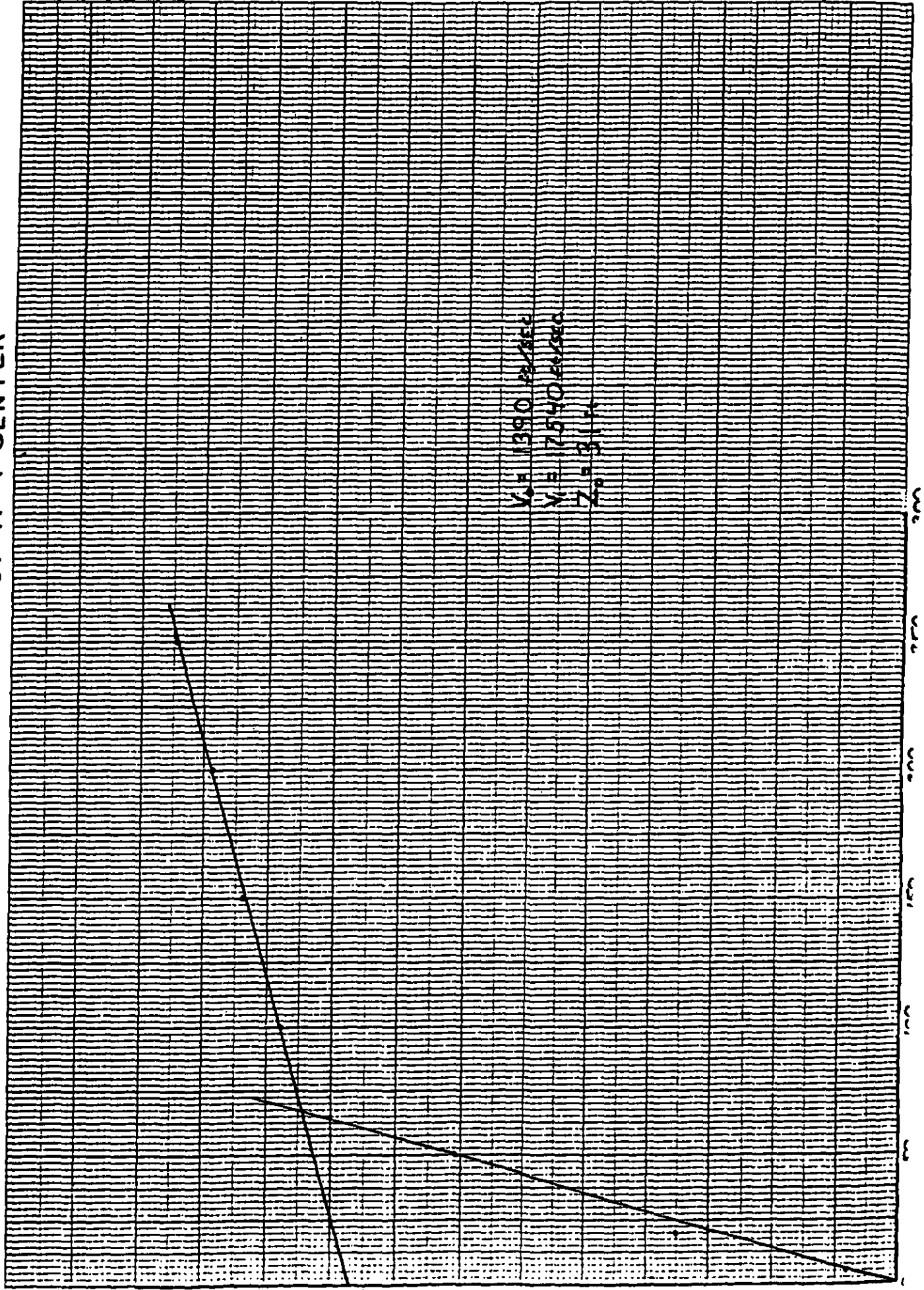
LAYER	RESISTIVITY	THICKNESS
1	2850 Ωm — 9350 Ωft	2.50m — 8 ft
2	1800 Ωm — 5900 Ωft	10.00m — 33 ft
3	400 Ωm — 1310 Ωft	30.00m — 98 ft
4	2500 Ωm — 8200 Ωft	∞ — ∞

Layne-Johnson

Division of LAYNE-WESTERN COMPANY, INC.

W229 N5005 DuPlainville Road • Pewaukee, Wisconsin 53072 • 414/248-4848

S1 PHONE 300 ft WEST OF R-4 CENTER

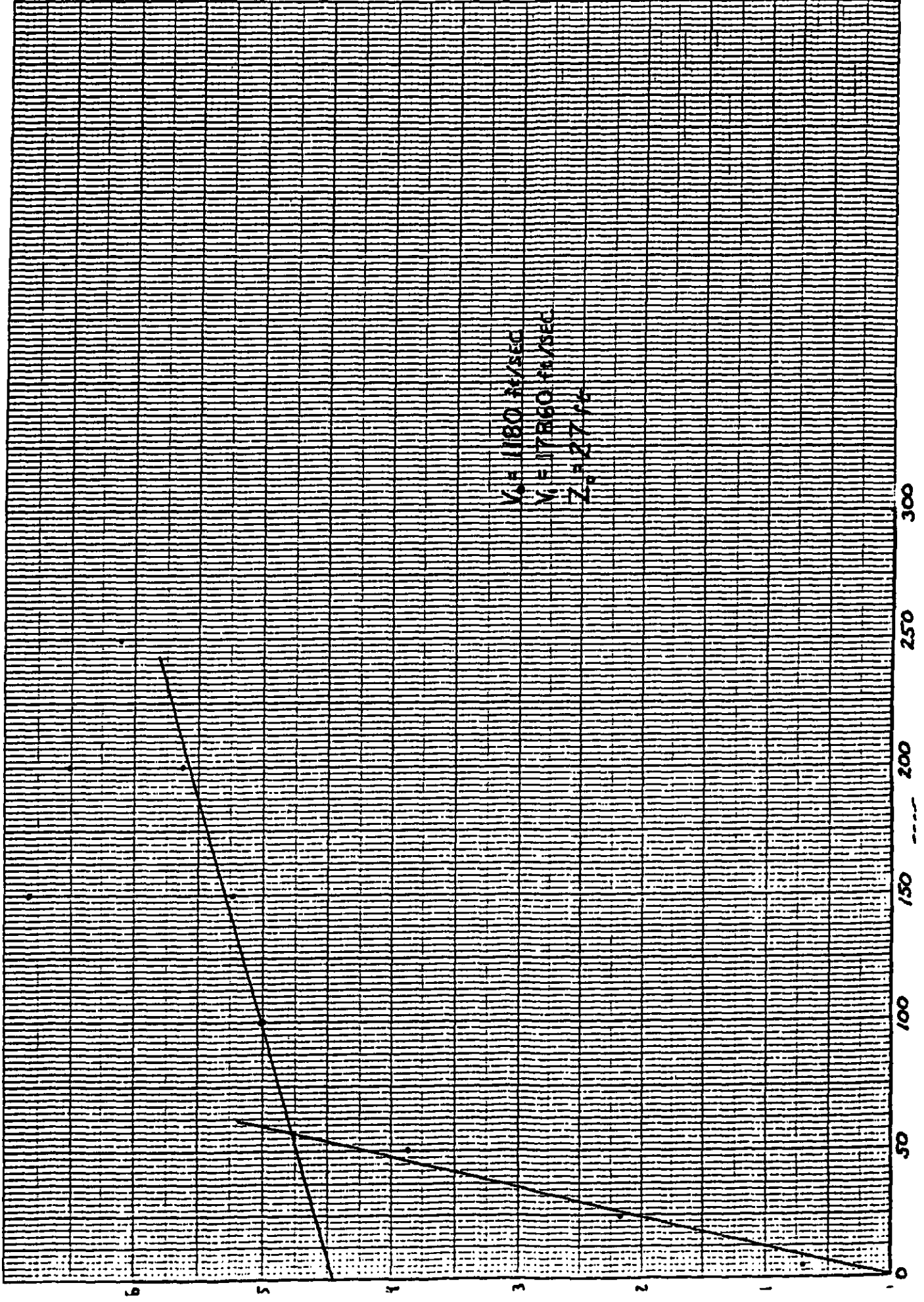


Layne-*Norinwest*

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S2 TRAILER COURT AREA



OFFSET WENNER SOUNDING R-1
 JOB RHINELANDER
 DATE 5/7/86
 NUMBER OF SPACINGS USED 6

SPACING	PA	PC	PD1	PD2	PB
.5000	467.0	450.0	284.0	311.0	17.59
1.000	235.0	235.0	176.1	173.1	15.35
2.000	125.5	118.4	84.50	100.7	7.020
4.000	47.40	45.10	36.60	39.10	2.360
8.000	13.32	12.63	10.24	11.74	.6950
16.00	4.650	4.390	3.240	3.330	.2950

SPACING	ADJUSTED READINGS					WENNER	
	RA	RB	RC	RD1	RD2	OFFSET	RESISTIVITY
.5000	467.2	17.57	449.7	284.0	311.0	297.5	934.6
1.000	242.4	14.86	227.5	176.1	173.1	174.6	1097.
1.500							1233.
2.000	125.4	7.022	118.4	84.50	100.7	92.60	1163.
3.000							1081.
4.000	47.42	2.358	45.07	36.60	39.10	37.85	951.2
6.000							744.7
8.000	13.32	.6948	12.62	10.24	11.74	10.99	552.4
12.00							412.7
16.00	4.667	.2938	4.373	3.240	3.330	3.285	330.2
24.00							351.3
32.00							437.7

SPACING	ERRORS		
	OBSERVED	OFFSET	LATERAL
.5000	-.1262	-9.075	
1.000	-6.331	1.718	-74.68
2.000	6.376	-17.49	-30.45
4.000	-.1264	-6.605	-36.32
8.000	-3.753	-13.64	-31.93
16.00	-.7498	-2.739	.1521

R.M.S. OBSERVATIONAL ERROR = 2.604
 R.M.S. OFFSET WENNER DIFFERENCE = 10.23
 R.M.S. LATERAL DIFFERENCE = 38.39

OFFSET WENNER SOUNDING R-2
 JOB RHINELANDER
 DATE 5/7/86
 NUMBER OF SPACINGS USED 7

SPACING	PA	PC	PDI	PD2	PB
.5000	508.0	483.0	388.0	339.0	25.30
1.000	258.0	245.0	187.2	183.5	13.93
2.000	115.6	108.5	99.50	84.10	7.850
4.000	53.90	51.90	46.50	37.50	2.020
8.000	19.26	18.46	16.18	15.28	.8110
16.00	8.890	8.609	6.640	5.610	.2800
32.00	5.260	4.900	3.480	3.610	.3700

SPACING	ADJUSTED READINGS					WENNER	
	RA	RB	RC	RD1	RD2	OFFSET	RESISTIVITY
.5000	508.1	25.29	482.8	388.0	339.0	363.5	1141.
1.000	258.4	13.90	244.5	187.2	183.5	185.3	1164.
1.500							1198.
2.000	115.9	7.824	108.1	99.50	84.10	91.80	1153.
3.000							1146.
4.000	53.91	2.019	51.89	46.50	37.50	42.00	1055.
6.000							869.3
8.000	19.26	.8107	18.45	16.18	15.28	15.73	790.6
12.00							732.7
16.00	8.889	.2800	8.609	6.640	5.610	6.125	615.7
24.00							649.0
32.00	5.264	.3696	4.895	3.480	3.610	3.545	712.7
48.00							968.8
64.00							1086.

SPACING	ERRORS		
	OBSERVED	OFFSET	LATERAL
.5000	-5.903	13.48	
1.000	-.3598	1.996	-28.94
2.000	-.6466	16.77	-29.95
4.000	-3.709	21.42	20.47
8.000	-5.709	5.721	-25.87
16.00	1.125	16.81	10.85
32.00	-.1899	-3.667	-40.14

R.M.S. OBSERVATIONAL ERROR = .2908
 R.M.S. OFFSET WENNER DIFFERENCE = 13.39
 R.M.S. LATERAL DIFFERENCE = 25.50

OFFSET WENNER SOUNDING R-3
 JOB RHINELANDER
 DATE 5/8/86
 NUMBER OF SPACINGS USED 6

SPACING	PA	PC	PD1	PD2	PB
.5000	635.0	583.0	435.0	614.0	53.50
1.000	388.0	374.0	261.0	290.0	13.49
2.000	20.10	192.8	135.0	143.0	9.000
4.000	81.80	77.80	65.30	62.90	4.110
8.000	19.68	18.41	13.70	23.20	1.356
16.00	9.950	9.149	6.640	7.760	.6910

SPACING	ADJUSTED READINGS					WENNER	
	RA	RB	RC	RD1	RD2	OFFSET	RESISTIVITY
.5000	635.7	53.43	582.3	435.0	614.0	524.5	1647.
1.000	387.7	13.49	374.2	261.0	290.0	275.5	1731.
1.500							1576.
2.000	36.55	1.630	34.92	135.0	143.0	139.0	1746.
3.000							1690.
4.000	81.85	4.107	77.74	65.30	62.90	64.10	1611.
6.000							1649.
8.000	19.72	1.353	18.36	13.70	23.20	18.45	927.3
12.00							759.3
16.00	9.895	.6948	9.200	6.640	7.760	7.200	723.8
24.00							745.2
32.00							804.4

SPACING	ERRORS		
	OBSERVED	OFFSET	LATERAL
.5000	-.2359	-34.12	
1.000	.1315	-10.52	57.53
2.000	-497.0	-5.755	-41.72
4.000	-.1343	3.744	-67.86
8.000	-.4360	-51.49	-48.50
16.00	1.101	-15.55	101.1

R.M.S. OBSERVATIONAL ERROR = 202.9
 R.M.S. OFFSET WENNER DIFFERENCE = 26.50
 R.M.S. LATERAL DIFFERENCE = 60.87

BISON INSTRUMENTS INC.

OFFSET WENNER SOUNDING R-4
 JOB RHINELANDER
 DATE 5/8/86
 NUMBER OF SPACINGS USED 8

SPACING	PA	PC	PD1	PD2	PB
.5000	3110.	2900.	2560.	1857.	207.0
1.000	1700.	1572.	1327.	1342.	129.1
2.000	692.0	657.0	597.0	590.0	37.10
4.000	143.4	137.3	128.1	142.5	5.920
8.000	40.20	38.90	33.90	29.70	1.270
16.00	10.92	9.990	8.070	8.689	.9680
32.00	9.370	8.890	5.560	6.600	.4800
64.00	6.930	6.420	4.250	5.070	.4350

SPACING	ADJUSTED READINGS					WENNER	
	RA	RB	RC	RD1	RD2	OFFSET	RESISTIVITY
.5000	3108.	207.0	2901.	2560.	1857.	2208.	6938.
1.000	1700.	129.0	1571.	1327.	1342.	1334.	8384.
1.500							8349.
2.000	693.0	37.04	656.0	597.0	590.0	593.5	7458.
3.000							5134.
4.000	143.3	5.923	137.3	128.1	142.5	135.3	3400.
6.000							1976.
8.000	40.18	1.270	38.91	33.90	29.70	31.80	1598.
12.00							1163.
16.00	10.93	.9663	9.972	8.070	8.689	8.379	842.3
24.00							1044.
32.00	9.370	.4800	8.890	5.560	6.600	6.080	1222.
48.00							1472.
64.00	6.892	.4373	6.454	4.250	5.070	4.660	1873.
96.00							2462.
128.0							2887.

SPACING	ERRORS		
	OBSERVED	OFFSET	LATERAL
.5000	9.650	31.83	
1.000	-6.468	-1.124	-3.634
2.000	-.3030	1.179	19.96
4.000	.1255	-10.64	6.134
8.000	7.465	13.20	87.42
16.00	-.3473	-7.387	-69.46
32.00	0.000	-17.10	47.02
64.00	1.088	-17.59	-20.60

R.M.S. OBSERVATIONAL ERROR = .4230
 R.M.S. OFFSET WENNER DIFFERENCE = 15.65
 R.M.S. LATERAL DIFFERENCE = 44.09

LAYNE WESTERN COMPANY, INC.

OFFSET WENNER SOUNDING R-5
 JOB RHINELANDER
 DATE 5/8/86
 NUMBER OF SPACINGS USED 7

SPACING	PA	PC	PD1	PD2	PB
.5000	621.0	592.0	415.0	332.0	26.00
1.000	522.0	489.0	392.0	395.0	25.00
2.000	258.0	234.0	221.0	202.0	24.00
4.000	114.1	106.0	97.90	88.20	8.630
8.000	47.60	44.70	36.00	41.70	3.200
16.00	13.18	12.45	12.99	11.88	.9610
32.00	4.460	4.290	3.170	3.800	.1825

SPACING	ADJUSTED READINGS					WENNER	
	RA	RB	RC	RD1	RD2	OFFSET	RESISTIVITY
.5000	619.4	26.06	593.4	415.0	332.0	373.5	1173.
1.000	517.9	25.19	492.7	392.0	395.0	393.5	2472.
1.500							2842.
2.000	258.0	24.00	234.0	221.0	202.0	211.5	2657.
3.000							2847.
4.000	114.3	8.610	105.7	97.90	88.20	93.05	2338.
6.000							1906.
8.000	47.74	3.189	44.55	36.00	41.70	38.85	1952.
12.00							1524.
16.00	13.29	.9526	12.34	12.99	11.88	12.43	1250.
24.00							862.9
32.00	4.466	.1822	4.283	3.170	3.800	3.485	700.7
48.00							534.1
64.00							642.5

SPACING	ERRORS		
	OBSERVED	OFFSET	LATERAL
.5000	.4842	22.22	
1.000	1.544	-.7623	-11.05
2.000	0.000	8.983	9.692
4.000	-.4634	10.42	51.63
8.000	-.6282	-14.67	33.33
16.00	-1.737	8.926	5.910
32.00	-.2798	-18.07	99.13

R.M.S. OBSERVATIONAL ERROR = .9507
 R.M.S. OFFSET WENNER DIFFERENCE = 13.65
 R.M.S. LATERAL DIFFERENCE = 44.49

Foth & Vair-Dyke

Engineers/Architects

2737 S. Ridge Road P. O. Box 19012 Green Bay, Wisconsin 54307-9012 414/497-2500

PUMP TEST OF WELL

DATE April 21, 1986

WELL NO. TW-9-86 OWNER City of Rhinelander LOCATION 120' east of TW-4-86 and 17 north of fence or 230' east of west fence corner post.
 DIA. ORIFICE 6" X 4" STATIC LEVEL 8 FT. 1 IN. WELL DEPTH 80 FEET

DRILLED BY Rhinelander Well Drilling LENGTH OF AIRLINE FT. TESTED BY Dean Funk / Ray Weber

PUMP SETTING TO DISCHARGE NOZZLE FT. TO TAIL PIPE FT. DIRECT READING LEVEL INDICATOR

Top of screen @ 51' - 29 feet

Reading Number	Time	Altitude GA. in Feet	Inches on Orifice	G.P.M.	Pumping Level	Drawdown in Feet	Specific Capacity	HARDNESS = 3 GRAINS FE = 0.1 PPM PH = 6.0	Water Appearance: Clear, Cloudy, Murky, Muddy, Sandy, Temp., Odor
Start	8:45 am				8'-1"				
	9:00		23	312	29'-6"	21.41	14.6		Cloudy - Little Sand
	9:15		23	312	29'-8"	21.58	14.5		Clear - No Sand
	9:30		23	312	29'-10"	21.75	14.3		" " "
	9:45		23	312	29'-11"	21.83	14.3		" " "
	10:00		23	312	29'-11½"	21.87	14.3		" " "
	10:30		23	312	30'-0"	21.91	14.2		" " "
	11:00		23	312	30'-6"	22.50	13.9		" " "
	11:30		23	312	30'-1"	22.0	14.2		" " "
	12:00		23	312	30'-1"	22.0	14.2		" " "
	12:30 pm		23	312	30'-1½"	22.04	14.2		" " "
	1:00		23	312	30'-2"	22.08	14.1		" " "
	1:30		23	312	30'-2"	22.08	14.1		" " "
	2:00		23	312	30'-2½"	22.12	14.1		" " "
	2:30		23	312	30'-3"	22.15	14.1		" " "
	3:00		23	312	30'-3½"	22.21	14.0		" " "
	3:30		23	312	30'-3½"	22.21	14.0		" " "
	4:00		23	312	30'-4"	22.25	14.0		" " "
	4:30		23	312	30'-4"	22.25	14.0		" " "
	5:00		23	312	30'-4½"	22.29	14.0		" " "
	5:30		23	312	30'-4½"	22.29	14.0		" " "
	6:00		23	312	30'-5"	22.33	14.0		" " "
	6:30		23	312	30'-5"	22.33	14.0		" " "
	7:00		23	312	30'-5"	22.33	14.0		" " "
	7:30		23	312	30'-5"	22.33	14.0		" " "

Foth & V. Dyke

Engineers/Architects

2737 S. Ridge Road P. O. Box 19012 Green Bay, Wisconsin 54307-9012 414/497-2500

PUMP TEST OF WELL

DATE July 21, 1986

WELL NO. TW-14-86 OWNER City of Rhineland LOCATION 390' south of TW-4-86 on James Ross Property - Fox Ranch Road

DIA. ORIFICE 6" X 4" STATIC LEVEL 11 FT. 7 IN. WELL DEPTH FEET

DRILLED BY Rhineland Well Drilling LENGTH OF AIRLINE FT. X DIRECT READING LEVEL INDICATOR

PUMP SETTING TO DISCHARGE NOZZLE 50 1/2 FT. TO TAIL PIPE FT. TESTED BY Cliff Nahles / Ray C. Weber

Reading Number	Time	Altitude GA. in Feet	Inches on Orifice	G.P.M.	Pumping Level	Drawdown in Feet	Specific Capacity	TW-9-86	Drawdown in TW-9-86	Water Appearance:
	8:22				11'-7"			7'-9 1/2"		Murky - Sand
	8:30		23	312	33'-10 1/2"	22.29	14	8'-9"	0.96	Clear - No Sand
	9:00		23	312	34'-3 1/2"	22.71	13.7	8'-9"	0.96	" " "
	9:30		23	312	34'-5"	22.85	13.7	8'-9 1/2"	1.00	" " "
	10:00		23	312	34'-5"	22.85	13.7	9'-1"	1.29	" " "
	10:30		23	312	34'-5 1/2"	22.88	13.7	9'-1"	1.29	" " "
	11:00		23	312	34'-6 1/2"	22.96	13.6	9'-1"	1.29	" " "
	11:30		23	312	34'-6 1/2"	22.96	13.6	8'-11 1/2"	1.15	" " "
	12:00		23	312	34'-6 1/2"	22.96	13.6	9'-0"	1.19	" " "
	12:30		23	312	34'-7"	23.00	13.6	9'-1"	1.28	" " "
	1:00		23	312	34'-7 1/2"	23.04	13.5	9'-1 1/2"	1.25	" " "
	1:30		23	312	34'-7 1/2"	23.04	13.5	9'-1"	1.28	" " "
	2:00		23	312	34'-7 1/2"	23.04	13.5	9'-2"	1.38	" " "
	2:30		23	312	34'-8"	23.08	13.5	9'-3"	1.46	" " "
	3:00		23	312	34'-8"	23.08	13.5	9'-3 1/2"	1.50	" " "
	3:30		23	312	34'-8 1/2"	23.12	13.5	9'-4"	1.54	" " "
	4:00		23	312	34'-8 1/2"	23.12	13.5	9'-4"	1.54	" " "
	4:30		23	312	34'-8 1/2"	23.12	13.5	9'-4 1/2"	1.58	" " "
	5:00		23	312	34'-8 1/2"	23.12	13.5	9'-4 1/2"	1.58	" " "
	5:30		23	312	34'-9"	23.15	13.5	9'-4 1/2"	1.58	" " "
	6:00		23	312	34'-9"	23.15	13.5	9'-4 1/2"	1.58	" " "
	6:30		23	312	34'-9"	23.15	13.5	9'-5"	1.62	" " "
	7:00		23	312	34'-9"	23.15	13.5	9'-5"	1.62	" " "
	7:30		23	312	34'-9 1/2"	23.19	13.5	9'-5 1/2"	1.66	" " "
	8:00		23	312	34'-9 1/2"	23.19	13.5	9'-5 1/2"	1.66	" " "
	8:30		23	312	34'-10"	23.25	13.4	9'-6"	1.71	" " "

Foth & Van Dyke

Engineers/Architects

2737 S. Ridge Road P. O. Box 19012 Green Bay, Wisconsin 54307-9012 414/497-2500

PUMP TEST OF WELL

DATE July 21, 1986

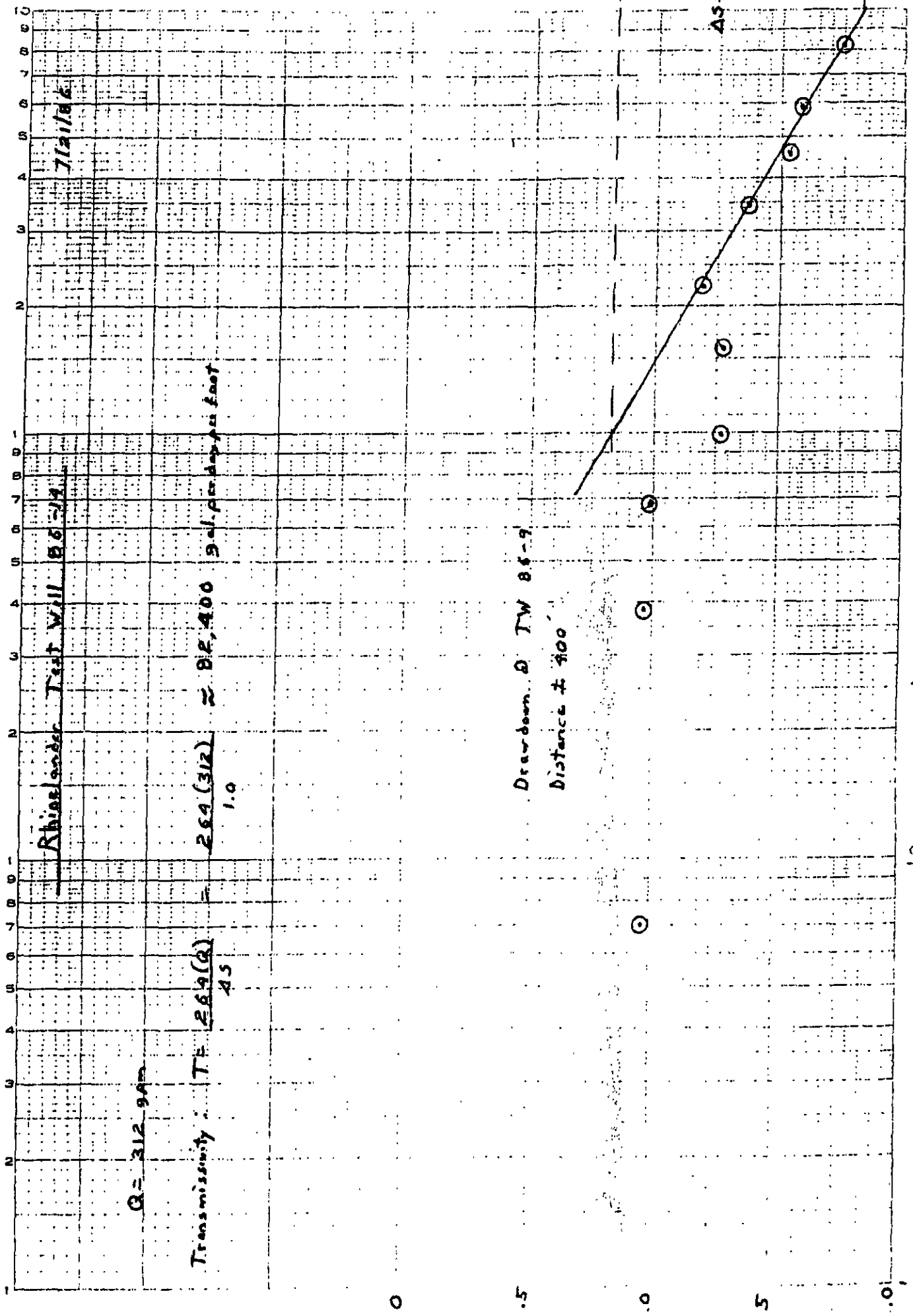
WELL NO. TW-14-86 OWNER City of Rhinelander LOCATION 390' south of TW-4-86 on James Ross Property - Fox Ranch Road

DIA. ORIFICE 6 " X 4 " STATIC LEVEL 11 FT. 7 IN. WELL DEPTH _____ FEET

DRILLED BY Rhinelander Well Drilling LENGTH OF AIRLINE _____ FT. X _____ DIRECT READING LEVEL INDICATOR

PUMP SETTING TO DISCHARGE NOZZLE _____ FT. TO TAIL PIPE _____ FT. TESTED BY Ray C. Weber

Reading Number	Time	Altitude GA. in Feet	Inches on Orifice	G.P.M.	Pumping Level	Drawdown in Feet	Specific Capacity	TW-9-83 Drawdown	TW-9-83 Drawdown	Water Appearance:
	9:00		23	312	34'-10"	23.25	13.4	9'-6"	1.71	Clear, Cloudy, Murky,
	9:30		23	312	34'-10"	23.25	13.4	9'-6½"	1.75	" " " "
	10:00		23	312	34'-10"	23.25	13.4	9'-6½"	1.75	" " " "
	10:30		23	312	34'-10½"	23.29	13.4	9'-6½"	1.75	" " " "
	11:00		23	312	34'-10½"	23.29	13.4	9'-6½"	1.75	" " " "
	11:30		23	312	34'-11"	23.33	13.4	9'-6½"	1.75	" " " "
	12:00		23	312	34'-11"	23.33	13.4	9'-6½"	1.75	" " " "
	12:30		23	312	34'-11"	23.33	13.4	9'-6½"	1.75	" " " "
	1:00		23	312	34'-11"	23.33	13.4	9'-6"	1.71	" " " "
	1:30		23	312	34'-11"	23.33	13.4	9'-5"	1.62	" " " "
	2:00		23	312	34'-11"	23.33	13.4	9'-5"	1.62	" " " "
	2:30		23	312	34'-11"	23.33	13.4	9'-4½"	1.58	" " " "
	3:00		23	312	34'-11"	23.33	13.4	9'-5"	1.62	" " " "
	3:30		23	312	34'-11½"	23.37	13.4	9'-5"	1.62	" " " "
	4:00		23	312	34'-11½"	23.37	13.4	9'-5½"	1.66	" " " "
	4:30		23	312	34'-11½"	23.37	13.4	9'-5½"	1.66	" " " "
	5:00		23	312	34'-11½"	23.37	13.4	9'-5½"	1.66	" " " "
	5:30		23	312	34'-11½"	23.37	13.4	9'-5½"	1.66	" " " "
	6:00		23	312	35'-0"	23.41	13.4	9'-5½"	1.66	" " " "
	6:30		23	312	35'-0"	23.41	13.4	9'-5½"	1.66	" " " "
	7:00		23	312	35'-0"	23.41	13.4	9'-5½"	1.66	" " " "
	7:30		23	312	35'-0"	23.41	13.4	9'-6"	1.71	" " " "
	8:00		23	312	35'-0"	23.41	13.4	9'-6"	1.71	" " " "
	8:30		23	312	35'-0"	23.41	13.4	9'-6"	1.71	" " " "



Appendix B

**Excerpts from April 14, 1987 –
Update of Groundwater
Investigation (Foth & Van Dyke)**

Test Well No. 17

Later in December of 1986 the next step was initiated. This was to obtain bids from contractors for drilling one or more larger diameter test wells in the vicinity of test wells No. 9 and No. 14 at the west edge of the airport. These were the only two of the eight test wells in this area that appeared to be favorable for well development. Specifications were prepared and bids received on January 26, 1987. Layne-Northwest Company of Schofield, Wisconsin was the low bidder.

The purpose of this phase of the investigation was to construct a larger test well (10 inch) that would be pumped at a higher rate than the smaller test wells. Observation wells (sand points) were also constructed at varying distances from the test well that could be used to measure the lowering of the water table during pumping.

Test well No. 17 was constructed to a depth of 80 feet with a 10 inch screen set between the depths of 55 feet and 80 feet. It was located five feet from test well No. 9 just inside of the airport fence. Construction of the test well and the three observation wells was completed the first week of March 1987. The attached pages from Layne-Northwest Company show the formations which were encountered. A general observation regarding the formations

encountered is that the coarser formations were higher up and that the material became finer with depth. At two of the observation wells the bottom formation was quite tight.

Test Pumping

On March 9, 1987 the test well was pumped. Personnel from the Rhinelander Water Utility, Foth & Van Dyke and Layne-Northwest were involved in taking water level measurements. The maximum output of the well was 550 gallons per minute which was somewhat less than was hoped for. The attached pump test data and sketch show the drawdown data at the test well and the observation points. The pump test was terminated after 24 hours because the drawdowns had very nearly stabilized. The drawdown data was used to graph and make calculations to determine the transmissivity and the storage coefficient which can assist in well analysis and design. Transmissivity is the thickness of an aquifer multiplied by the permeability and gives an indication of how productive an aquifer may be.

Water samples were taken during the test pumping and analyzed at the Foth & Van Dyke laboratory. A data sheet is attached.

Observations Regarding Test Well No. 17

Based on the data obtained during drilling and test pumping plus office analysis the following observations can be made:

1. The geologic formations which were penetrated at the four drill hole locations contained considerable fine to medium sand and not a great amount of coarse sand or gravel. Sieve analyses and sand curves were prepared by Layne-Northwest.
2. The calculated transmissivity value based on the distance-draw down method was from 50,000 to 60,000 gallons per day per foot. This is less than half the value for the aquifer in which wells No. 4 and No. 5 are developed.
3. The chemical water quality is good, but as is typical for groundwater in this area, the water is very soft and corrosive in nature.
4. It appears that a properly designed and constructed well at this location could produce approximately 800 gallons per minute. This is considerably less than the 1500 gallons per minute which was selected as the preliminary design criteria for the layouts in the September 1986 report.
5. Based on the drilling done in 1986 and in conjunction with test well No. 17, it does not look too favorable for the construction of more than two wells in the area at the west end of the airport. The sand formation found in test well No. 17 does not extend for a great distance according to the drill hole sampling data.

Conclusions

The data obtained from the testing and analysis of test well No. 17 indicates that this area does not appear to be suitable for the construction of wells that could replace the existing wells No. 4 and No. 5. One or two wells with a capacity of 800 gallons per minute each possibly could be developed, but in excess of two miles of watermain would be required to transmit the water into the City. The expense of this much watermain does not appear to be warranted for this volume of water unless there is the potential for development along Highway 8 and in the airport area.

Layne-Northwest

Division of LAYNE-WESTERN COMPANY, INC.

3200 Schofield Avenue • Schofield, WI 54476 • 715/359-4211

March 30, 1987

Foth & VanDyke
2737 South Ridge Road
Green Bay, WI 54307-9012

ATTENTION: Lowell Johnson, P.E.

SUBJECT: Test Drilling - City of Rhinelander

Dear Mr. Johnson:

To follow up our conversation we had on Friday, March 27, 1987, we wish to submit the following recommendations:

The average 50% size as determined from the sieve analyses from 50 to 80' shows 0.0156". The 50% size of #30 American Materials gravel pack is 0.056". This is slightly below the average of the actual formation samples. The 50% size of #20 gravel is 0.095". The #20 gravel pack seems to be too coarse to match the existing formation at the test well site.

We then recommend that #30 gravel pack from American Materials Corporation, Eau Claire, should be used for this particular location. The screen slot size would be 0.040".

We suggest that a large diameter drill hole be drilled at the site since the sand is slightly on the finer side. A large gravel envelope would help reduce the entrance velocity of the water through the screen and prevent unnecessary silting and plugging on the outside perimeter of the gravel pack or between the interface of the natural formation in the gravel pack. The attempt should be made to collect all the available groundwater possible by the pumping well with the least amount of drawdown. In our opinion, the formation sands at the test well site would merit a permanent well. The long range planning and the demand is something we are not familiar with and you will probably evaluate the economics of laying watermains out to this site.

A large diameter drill hole of at least 36" or more would certainly help in collecting the available groundwater in the area. In our opinion, a well of this size should be able to have an initial potential of around 700 to 800 gpm. However, for long range pumping periods and sustainable yields on a perennial basis, the well would probably level off around 600 to 700 gpm. We do not recommend that over 1 million gallons per day should be pumped from this particular area or within close proximity.



WATER SUPPLY SERVICES

March 30, 1987
Lowell Johnson, P.E.
Page 2

Please be advised that we stand ready to assist you in the event you decide to install a permanent well at the test well location, and we appreciate the cooperation that the City and Foth and VanDyke have provided for us in the test drilling of the test hole location.

Very truly yours,

LAYNE-NORTHWEST, Div. of
Layne-Western Co., Inc.


Harvey M. Stricker
Branch Manager - Hydrogeologist

HMS:kan

LAYNE - NORTHWEST COMPANY

"World's Largest Water Developers"

CITY OF RHINELANDER
TEST DRILLING T W-17

LOCATION: Southwest Corner of Rhinelanders City Airport (Close to Fence)

<u>Depth From-To</u>	<u>Formation Description</u>
0-15'	Fine to Medium Sand, Muddy, Gravel, With Large Cobbles
15-51'	Fine to Course Sand, Heavy Gravel, and Some Boulders, Formation was Tight, Had to Drill Because Formation Would Not Bail
51-77'	Medium to Brown Sand, Loose, Bailed Easy
77-79'	Fine to Brown Silty Sand, Quite Tight
79-80'	Fine to Medium Sand, Silty, Broken Granite

80' Total Depth.

NOTE: Had to drill last foot because of broken granite and small
boulders.

Set 25' of 10" nominal well screen as follows:

15' X .030" slot
10' X .025" slot

LAYNE - NORTHWEST COMPANY

"World's Largest Water Developers"

CITY OF RHINELANDER
MONITORING POINTS

Monitoring Point 50' South of Test Well.# 17

<u>Depth From-To</u>	<u>Formation Description</u>
0-55'	Fine to Course Sand, Gravel and Some Boulders
55-70'	Fine Silty Sand, Quite Muddy, Tight
70-80'	Fine Silty Muddy Sand, Very Tight

Set 5' X 1½" Sand Point to 80', Formation Too Tight - Would Not Take Water, Pulled Sand Point Back Up to 65' Where It Took Water.

Monitoring Point 150' South of Test Well.

0-55'	Fine To Medium With Some Course Sand
55-80'	Fine, Slightly Muddy To Course Sand

Set 1½" X 5' Sand Point to 80', Formation Too Tight - Pulled Point Back to 70' Where It Took Water.

Monitoring Point 50' East of Test Well.

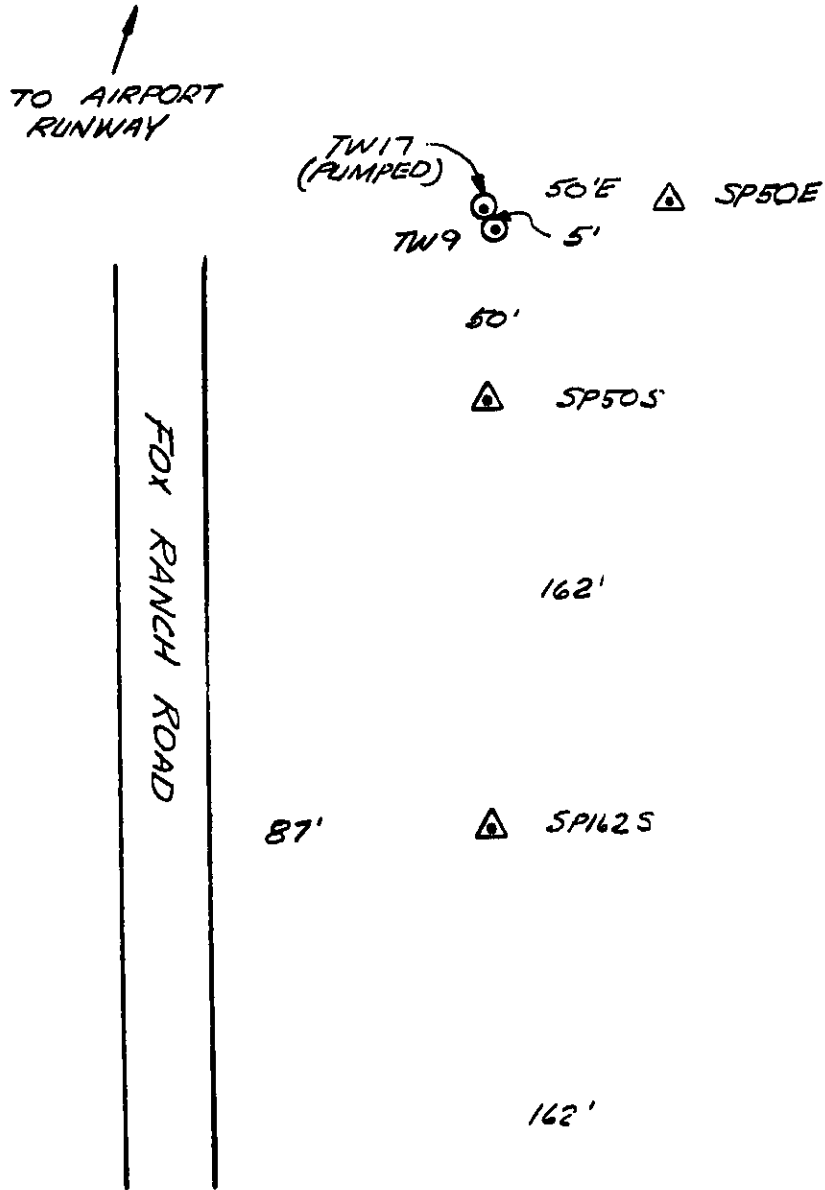
0-35'	Fine to Course Sand
35-55'	Fine to Course Sand and Some Gravel
55-80'	Fine to Course Sand, Gravel, Boulder

Set 5' Sand Point to 78'.

NOTE: Based on the formation sampling of the three monitoring holes, this monitoring hole showed the best formation compared to the other two. The best formation that was encountered in the area was at the test well site.

TEST WELL 17 AND OBSERVATION WELL LOCATIONS

SCALE: 1" = 50'



LEGEND

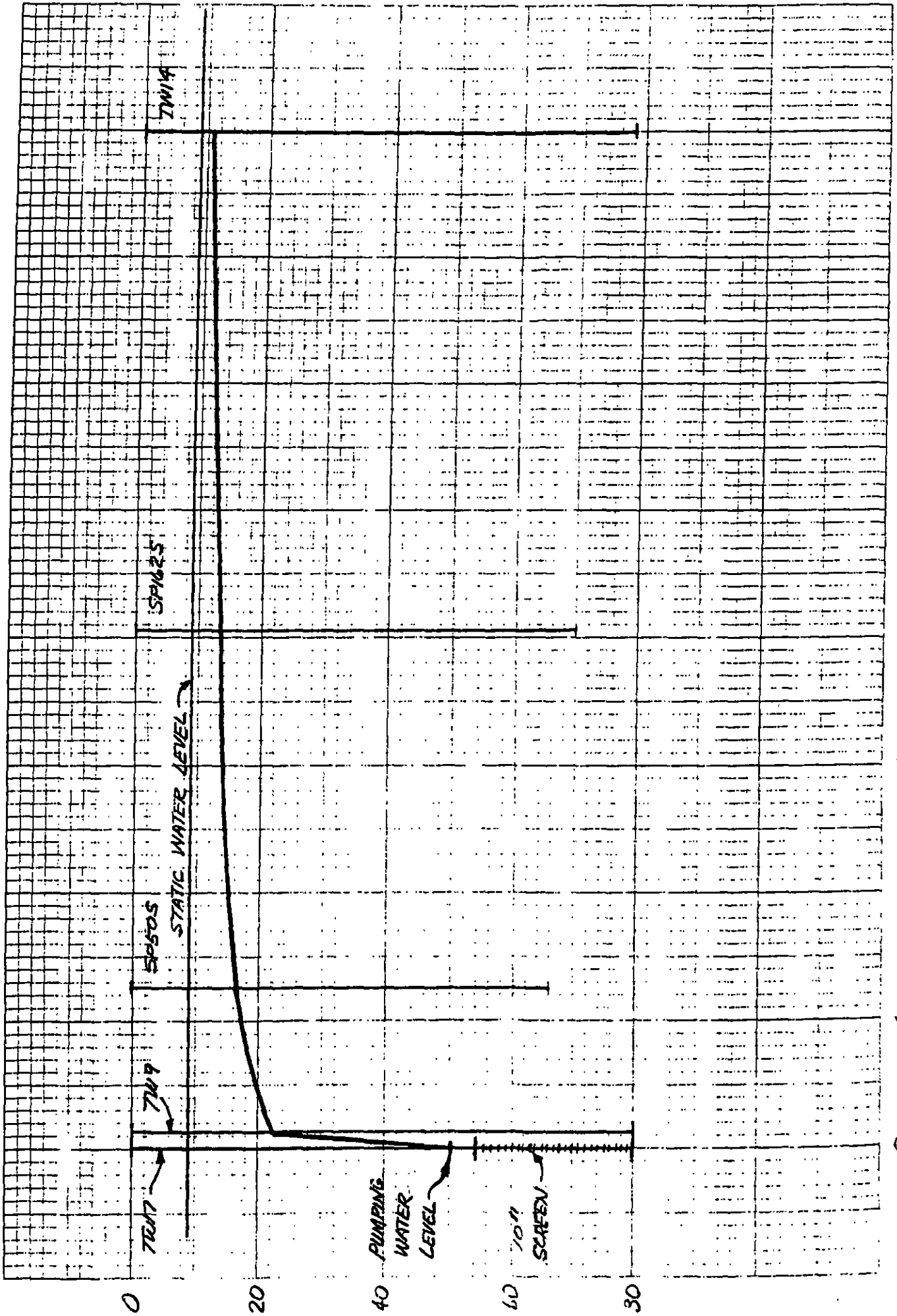
- ⊙ TEST WELL (TW)
- △ SAND POINT (SP)

⊙ TW14

320'

DRAWDOWN AFTER 1200 MINUTES OF PUMPING

RAINELANDER
MARCH 1987



0 40 80 120 160 200 240 280 320 360

•FOTH AND VAN DYKE
Engineers/Architects
2737 S. Ridge Road
P.O. Box 19012
Green Bay, Wisc. 54307-9012

LABORATORY ANALYSIS RESULTS

W.D.N.R. LAB CERT. NO. 405051240

Client City of Rhinelander Sampled By Ray Weber
Address P.O. Box 658 Scope I.D. 87R7
Rhinelander, WI 54501 Billing Line No. 2
Liaison L. Johnson
Name of Rep. Supply Order No.
Telephone No. (000) 000-0000 Result Sheet No. 35742.00

Sample I.D. Test Well
#17 (TW17)
Date Collected 3/10/87
Date Received 3/17/87

Parameters, units ----- Results -----

T. Alkalinity, mg/l	50	
Calcium, mg/l	12	Langelier Index at 50°F = (-)3.05
Chloride, mg/l	1	
T. Hardness, mg/l	40	
Manganese, mg/l	< 0.05	
Nitrate, mg/l	0.30	
pH, std. units	5.9	
Sodium, mg/l	3.5	
TDS, mg/l	64	
Sulfate, mg/l	9	
Iron, mg/l	< 0.10	

comments: Due to date received Nitrate, pH, and TDS holding times were exceeded.

Signed: *Samuel J. Berg* Date: 4/6/87

PUMP TEST OF WELL

DATE March 10, 1987

WELL NO. TWL7 OWNER City of Rhinelander 8/R6 LOCATION Airport - Fox Ranch Road

DIA. ORIFICE 6" X 4 7/8" STATIC LEVEL 8 FT. 10 1/2 IN. WELL DEPTH 80 FT. - Screen: 55-80 FEET

DRILLED BY Layne-Northwest LENGTH OF AIRLINE N/A FT. N/A DIRECT READING LEVEL INDICATOR

PUMP SETTING TO DISCHARGE NOZZLE - FT. TO TAIL PIPE 64 FT. TESTED BY D. HORNUNG, R. WEBER

Time	Elapsed Time Min.	Altitude GA. in Feet	Inches on Orifice	G.P.M.	Pumping Level Feet	Drawdown in Feet	Specific Capacity GPM/FT.	Water Appearance:
11:27	1							
A.M.	5		13.5	410	37.33	28.45	14.41	
	30							
	60		14.0	420	38.62	29.74	14.12	
	90							
1:20	120		14.0	420	38.75	29.87	14.06	
P.M.	130							
	135							
	150		25.5	560	48.00	39.12	14.31	
	163		25.5	560	48.54	39.66	14.12	
2:23	213		25.5	560	49.79	40.91	13.69	
	243		25.5	560	49.75	40.87	13.70	
	273		25.5	560	49.75	40.87	13.70	
4:20	303		25.5	560	49.88	41.00	13.66	
	333		25.5	560	49.88	41.00	13.66	
	363		25.5	560	49.92	41.04	13.64	
5:20	393		25.5	560	49.92	41.04	13.64	
	423		25.5	560	50.00	41.12	13.62	
6:20	453		25.5	560	50.04	41.16	13.60	
7:20	483		25.5	560	-	-	-	
	513		25.5	560	50.04	-	-	
8:20	543		25.5	560	50.04	-	-	
	573		25.5	560	50.08	41.20	13.59	
9:20	603		25.5	560	50.08	41.20	13.59	
	633		25.5	560	50.08	41.20	13.59	
10:20	663		25.5	560	50.08	41.20	13.59	

PUMP TEST OF WELL

DATE March 10, 1987

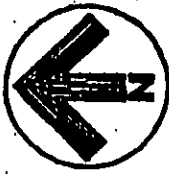
WELL NO. TW17 OWNER City of Rhinelander LOCATION _____

DIA. ORIFICE " X " STATIC LEVEL 8 FT. 10 1/2 IN. WELL DEPTH _____ FEET

DRILLED BY _____ LENGTH OF AIRLINE 8.875' FT. DIRECT READING LEVEL INDICATOR _____

PUMP SETTING TO DISCHARGE NOZZLE _____ FT. TO TAIL PIPE _____ FT. TESTED BY _____

Reading Time	Elapsed Time Min.	Altitude GA. in Feet	Inches on Orifice	G.P.M.	Pumping Level	Drawdown in Feet	Specific Capacity GPM/FT	Water Appearance:
10:50	693		25.0	550	50.25	41.37	13.29	Clear, Cloudy, Murky, Muddy, Sandy, Temp., Odor
	723		25.0	550	50.33	41.45	13.17	
11:50 PM	753		25.0	550	50.33	41.45	13.17	
	783		25.0	550	50.42	41.54	13.24	
12:50 AM	813		25.0	550	50.42	41.54	13.24	
	843		25.0	550	50.50	41.62	13.21	
1:50	873		25.0	550	50.50	41.62	13.21	
	903		25.0	550	50.50	41.62	13.21	
2:50	933		25.0	550	50.50	41.62	13.21	
	963		25.0	550	50.50	41.62	13.21	
3:50	993		25.0	550	50.50	41.62	13.21	
	1023		25.0	550	50.58	41.70	13.19	
4:50	1053		25.0	550	50.58	41.70	13.19	
	1083		25.0	550	50.66	41.78	13.16	
5:50	1113		25.0	550	50.66	41.78	13.16	
	1143		25.0	550	50.66	41.78	13.16	
6:50	1173		25.0	550	50.66	41.78	13.16	
	1203		25.0	550	50.66	41.78	13.16	
7:50	1233		25.0	550	50.75	41.87	13.13	
	1263		25.0	550	50.75	41.87	13.13	
8:50	1293		25.0	550	50.75	41.87	13.13	
	1323		25.0	550	50.75	41.87	13.13	
9:50	1353		25.0	550	50.75	41.87	13.13	
	1383		25.0	550	50.75	41.87	13.13	
10:50	1413		25.0	550	50.75	41.87	13.13	



SCALE
0 1000 2000'

500,000 GAL
ELEV. TANK

BOOM LAKE

300,000 GAL
ELEV. TANK

CITY OF
RHINELANDER

RHINELANDER - ONEIDA CO.
AIRPORT

17-1987

10 11 12 13 14
3 4 5 6 7 8

SOO LINE RR.

WISCONSIN RIVER

PELICAN RIVER

WELL NO. 5
WELL NO. 4

CTH "G"

16
15

1986 TEST WELL LOCATIONS

Foth & Van Dyke

Engineering/Architectural Division
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P. O. Box 19812
Green Bay, Wisconsin 54309-8912
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FIGURE NO. 6