Wellhead Protection Plan for the City of New Brighton

Part I

Delineation of the Wellhead Protection Area (WHPA), Drinking Water Supply Management Area (DWSMA) and Assessments of Well and DWSMA Vulnerability

April 2010

I hereby certify that this plan, document, or report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Geologist under the laws of the state of Minnesota.

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Part I

Table of Contents

1.0 Introduction 1

2.0 Criteria for Wellhead Protection Area Delineation 2
- 2.1 Time of Travel 2
- 2.2 Aquifer Transmissivity 2
- 2.3 Daily Volume of Water Pumped 2
- 2.4 Conceptual Hydrogeologic Model 3
- 2.5 Sources of Water 5
- 2.6 Model Description 5
- 2.7 Groundwater Flow Field 7

3.0 Delineation of the Wellhead Protection Area 8
- 3.1 Porous Media Flow Evaluation 8
- 3.2 Sensitivity Analysis 8
- 3.3 Fracture Flow Evaluation 9
- 3.4 Other Groundwater Withdrawal 9
- 3.5 Surface Water Contribution Area 9

4.0 Delineation of the Drinking Water Supply Management Areas 11

5.0 Well Vulnerability Assessment 12

6.0 Drinking Water Supply Management Area Vulnerability Assessment 13

7.0 Supporting Data Files 15

8.0 References 16

Tables

Figures

Appendices

List of Tables

Table 1 Data Elements

Table 2 Annual and Projected Pumping Rates for New Brighton Wells

Table 3 Files Included on the Compact Disc

List of Figures

Figure 1 Bedrock Geology

Figure 2 Geologic Cross Section A-A'

Figure 3 Geologic Cross Section B-B'

Figure 4 Well Capture Zones

Figure 5 WHPA & DWSMA

Figure 6 Aquifer Vulnerability

List of Appendices

Appendix A Well Construction Records

Appendix B Aquifer Test Results

Appendix C Development of Groundwater Model

Appendix D Water Use

Appendix E MDH Well Vulnerability Assessments

Appendix F Summary of Fracture Flow Capture Zone Calculations

Appendix G L-Score Map

Appendix H Precipitation Data

1.0 Introduction

Wellhead protection areas (WHPAs) and a Drinking Water Supply Management Area (DWSMA) were delineated for the City of New Brighton (the City) This report summarizes the delineation of wellhead protection areas (WHPAs) and drinking water supply management area (DWSMA) for the City of New Brighton, Minnesota (the City) as required by the Wellhead Protection Rules.

The City has 11 municipal water supply wells including Well 3 (unique number 206793), Well 4 (unique number 206792), Well 5 (unique number 206796), Well 6 (unique number 206797), Well 8 (unique number 206795), Well 9 (unique number 206794), Well 10 (unique number 161432), Well 11 (unique number 509083), Well 12 (unique number 110485), Well 14 (unique number 554216) and Well 15 (unique number 582628). Four additional wells (1, 2, 7, and 13) have been abandoned. Wells 14 and 15 pump water from the Prairie du Chien Group aquifer. Wells 3 and 4 pump from both the Prairie du Chien Group aquifer and the Jordan Sandstone aquifer. Wells 5, 6, and 7 pump water from the Jordan Sandstone aquifer. Wells 8, 9, 10, 11, and 12 pump water from the Mt. Simon – Hinckley Sandstone aquifer. Well locations are shown on Figure 1 and well construction data are presented in Appendix A.

Data elements used in preparation of the report are presented in Table 1.

2.0 Criteria for Wellhead Protection Area Delineation

The following criteria were used to insure accurate delineation of the WHPA.

2.1 Time of Travel

A minimum ten-year time of travel criteria must be used to determine a WHPA so there is sufficient reaction time to remediate potential health impacts in the event of contamination of the aquifer. A time of travel of ten years was considered in this study. As required by the Wellhead Protection Rules, the one-year time of travel was also determined for each well addressed in this study.

2.2 Aquifer Transmissivity

Per discussions with Minnesota Department of Health (MDH) staff during the Pre-delineation Meeting (MDH, 2009a), aquifer transmissivities and hydraulic conductivity for the Prairie du Chien Group and Jordan Sandstone aquifers were determined from the results of aquifer tests in the area. The aquifer transmissivity of the Mt Simon Sandstone was determined using specific capacity tests for New Brighton Wells 8, 9, 10, 11, and 12.

New Brighton Wells 13, 14, and 15 are part of the hydraulic containment system for remedial action associated with the Twin Cities Army Ammunition Plant (TCAAP). As part of the design and implementation of the system, a number of aquifer pumping tests were performed at the containment wells (Montgomery Watson, 2000). Based on pumping tests conducted at New Brighton Wells 13, 14, and 15 the average hydraulic conductivity of the Prairie du Chien Group in the New Brighton area was determined to be 156 m/day (Appendix B).

Based on results from a nearby pumping test at Brooklyn Center Well 9 (Appendix B) the hydraulic conductivity of the Jordan Sandstone in the area is estimated to be 36 m/day.

Based on specific capacity tests, the hydraulic conductivity of the Mt. Simon Sandstone was determined to be 7.3 m/day (Appendix B).

2.3 Daily Volume of Water Pumped

Pumping data for the City of New Brighton, as reported on Minnesota Department of Natural Recourses water use reports (Appendix D), for 2004 through 2008 is summarized in Table 2. The

largest annual withdrawal for 2004-2008 was 1,485,500,000 gallons in 2006. The projected total withdrawal for 2014 is estimated to be 1,478,200,000 gallons (REFERENCE 2007 Water supply Plan). Projected pumping rates for 2014 were estimated for each well based on the percentage of the total volume that each well pumped from 2004-2008. The pumping rates used for each well in the delineation of the WHPA was the maximum of either the projected 2014 pumping rate, or those reported for 2004-2008. Table 2 summarizes the historical and projected distribution of the annual withdrawal among the New Brighton municipal wells and the pumping rates used for delineation of the WHPA.

2.4 Conceptual Hydrogeologic Model

The regional conceptual hydrogeologic model is described in detail in Metropolitan Council (2009). Information pertinent to the New Brighton area is summarized below.

All major aquifers and aquitards in the Twin Cities Metropolitan area were considered in this study and are included in the groundwater flow model. Hydrostratigraphic units were broken down as follows: Mt. Simon-Hinckley Sandstones aquifer, Eau Claire Formation confining unit, Ironton-Galesville Sandstones aquifer, Franconia Formation aquifer, St. Lawrence Formation confining unit, Jordan Sandstone aquifer, Prairie du Chien Group aquifer, St. Peter Sandstone aquifer, Quaternary Glacial Drift aquifer and aquitard. In the far southern part of New Brighton, the Platteville and Glenwood Formations are also present. However, these units are often unsaturated and therefore were not included in the groundwater flow model. In the groundwater flow model all units above the St. Peter Sandstone are grouped into one unit, usually referred to as the Quaternary Glacial Drift aquifer and aquitard.

Locations of two geologic cross sections through the study area are shown on Figure 1. Geologic cross section A-A' is a west to east cross section (Figure 2) and cross section B-B' is a south to north cross section (Figure 3).

Of most importance to this study is the lowermost hydrostratigraphic unit – the Mt Simon Sandstone – and the uppermost hydrostratigraphic units – Jordan Sandstone, Prairie Du Chien Group, and above. A number of extensive regional confining units are present between the Jordan Sandstone and the Mt Simon Sandstone (Runkel et al. 2003). The hydrostratigraphic units of importance for this study are described in more detail below.

Mt. Simon Sandstone

The Cambrian-aged Mt. Simon Sandstone consists of multiple beds of moderately-sorted to well-sorted quartz sandstone intermixed with thin beds of feldspathic sandstone, siltstone, and shale. The formation can be up to 350 feet thick in the Twin Cities metro area (Mossler and Tipping, 2000). The Mt Simon aquifer is the deepest aquifer in the Twin Cities and is underlain by low permeability Precambrian rocks. The Mt. Simon aquifer is primarily recharged along the periphery of the Hollandale Embayment where it subcrops (i.e. is the uppermost bedrock unit). In the New Brighton area, the Mt. Simon aquifer is overlain by the Eau Claire Formation which is a confining unit allowing little leakage from overlying aquifers.

Jordan Sandstone

The Cambrian-age Jordan Sandstone consists of several coarsening-upward sequences. The sequences consist of two distinguishable facies: (1) medium- to coarse-grained, cross bedded, friable quartz sandstone, and (2) a massive, very fine-grained, often bioturbated, feldspathic sandstone, with some siltstone and shale (Mossler and Tipping, 2000).

Prairie du Chien Group

The Ordovician-age Prairie du Chien Group contains the Shakopee Formation (upper portion of the Prairie du Chien Group) and the Oneota Dolomite (lower portion of the Prairie du Chien Group). The Shakopee Formation is a dolostone with interbedded, thin layers, of fine- to medium-grained quartz sandstone and shale. The Oneota Dolomite is commonly massive- to thick-bedded dolostone. The lower part of the Oneota Dolomite is often oolitic or sandy. Both formations are karsted in some areas and the upper contact may be rubbly (from pre-aerial exposure) (Mossler and Tipping, 2000).

St. Peter Sandstone

The upper part of the Ordovician-age St. Peter Sandstone is very fine- to medium-grained quartzose sandstone that generally is massive- to very thick-bedded. A lithofacies of shale and siltstone is present slightly below the midpoint of the formation. The lower part of the St. Peter Sandstone consists of fine- to very coarse-grained, well-cemented sandstone. The sandstone is interbedded with multicolored beds of mudstone, siltstone, and shale. The base of the unit is a major erosional contact (Mossler and Tipping, 2000).

Platteville and Glenwood Formations

The Platteville Formation is a fossiliferous limestone and dolomite. The Glenwood Formation is a blocky shale with thin stringers of fine- to coarse-grained quartz sandstone. (Mossler and Tipping, 2000).

2.5 Sources of Water

The two primary major sources of water to the Quaternary Glacial Drift aquifer are recharge from infiltration and seepage from surface water bodies. The primary source of water for the St. Peter Sandstone, Prairie du Chien Group, and Jordan Sandstone aquifer in the New Brighton area is leakage from adjoining aquifer units. The primary source of water for the Mt. Simon Sandstone aquifer is recharge along the periphery of the Twin Cities Basin, and to a much lesser extent, leakage from the Eau Claire Formation and focused leakage/recharge along deeply incised bedrock valleys. Discharge is to the major streams; the Mississippi and St. Croix Rivers. Pumping wells also remove water from the aquifer units.

2.6 Model Description

To accurately delineate the WHPA, it is necessary to assess how nearby wells, rivers, lakes, and variations in geologic conditions affect groundwater flow directions and velocities in the aquifer. The finite difference code MODFLOW-96 (McDonald and Harbaugh, 1988; Harbaugh and McDonald, 1996) was used for this study to simulate groundwater flow in the hydrostratigraphic units from the Quaternary aquifer down to the Mt. Simon Sandstone aquifer. MODFLOW is public domain software that is available at no cost from the United States Geological Survey. The pre- and post-processor Groundwater Vistas (ver. 5.37 Build 6) (Environmental Simulations, Inc., 2007) was used to create the data files and evaluate the results. A description of the MODFLOW groundwater model development is provided in Appendix C.

The base finite difference model used in this study is the Twin Cities Metropolitan Area Groundwater Flow Model, Version 2 (Metro Model 2) developed for Metropolitan Council Environmental Services by Barr Engineering Company (Metropolitan Council, 2009). This groundwater flow model is a nine-layer model and includes all major aquifer and aquitards in the Twin Cities area.

This model takes into account regional flow boundaries. The major flow boundaries near New Brighton are the Mississippi and St. Croix Rivers. Smaller streams and area lakes are also included in the model. These boundaries are represented in the model using the River Package (McDonald

and Harbaugh, 1988; Harbaugh and McDonald, 1996). In addition, high capacity pumping wells from the State Water Use Database System (SWUDS) area included in the model.

The Metro Model 2 (Metropolitan Council, 2009) was modified in the vicinity of New Brighton to better represent the local conditions. Changes made to the Metro Model for use in delineating the New Brighton WHPAs included:

- Refining the model grid around New Brighton municipal wells;
- Adjusting the extent of the St. Peter Sandstone based on updated bedrock geology from well logs in the area;
- Add in additional hydraulic head calibration targets in the New Brighton area based data associated with TCAAP studies (Wenck, 2006).
- Adjusting the hydraulic conductivity of the Prairie du Chien Group in the vicinity of New Brighton to 156 m/d to match the hydraulic conductivity determined from pumping tests at Well 13, 14 and 15 (Appendix B);
- Adjusting the hydraulic conductivity of the Jordan Sandstone in the New Brighton area to 36 m/d to match the hydraulic conductivity determined from the pumping tests at Brooklyn Center Well 9 (Appendix B);
- Adjusting the hydraulic conductivity of the Mt. Simon – Hinckley Sandstone Aquifer to 7.3 m/d to match the hydraulic conductivity determined from specific capacity tests from Wells 8, 9, 10, 11 and 12 (Appendix B);
- Updating porosity values to better reflect aquifer properties: Mt Simon – Hinckley Sandstones = 0.2; Jordan Sandstone = 0.2; Prairie du Chien Group = 0.056; St. Peter Sandstone = 0.283; Quaternary Sediments = 0.25 (Norvitch et al., 1974; Schwartz and Zhang, 2003);
- Adjusting the configuration of Rice Creek and nearby lakes to match the level of detail of the refined model grid;
- Changing the model cells representing the Mississippi River west of New Brighton from river cells to constant head cells. This change resulted in a reduction of the hydraulic head residuals in the vicinity of New Brighton. The conductance of the river cells for the Mississippi River west of New Brighton was too low, restricting flow and causing the simulated hydraulic head in the New Brighton area to be too high. This adjustment also allowed for a more stable solution during calibration (Appendix C).

After these revisions were made to the model a check on model calibration to hydraulic heads was made. It was determined that the model simulated hydraulic heads did not match the measured values accurately enough to delineate WHPAs. Additional model calibration was performed and is described in Appendix C.

Sensitivity of the model was also evaluated as discussed in Appendix C.

MODFLOW files for the calibrated local model are included on the data CD accompanying this report.

2.7 Groundwater Flow Field

Groundwater flow in the Quaternary aquifer and bedrock aquifers in the vicinity of New Brighton is to the west and southwest toward the Mississippi River. A groundwater flow divide exists east of New Brighton in Washington County. On the east side of this divide groundwater flows to the east to the St. Croix River. The ambient direction of groundwater flow was estimated based on piezometric and water table maps from the Ramsey County Geologic Atlas (Kanivetsky and Cleland, 1992a and Kanivetsky and Cleland, 1992b). This flow direction is consistent with the flow direction determined using the groundwater flow model in this study.

3.0 Delineation of the Wellhead Protection Area

Delineation of the WHPA for the New Brighton wells involved the evaluation of both porous media and fracture flow. First, the capture zones for each well were delineated based on porous media flow and then, because the Prairie du Chien exhibits both primary and secondary (i.e., fracture) porosity, the capture zones were also delineated according to the procedures described in the MDH guidance for WHPA delineations in fractured and solution-weathered bedrock (MDH, 2005). A composite WHPA was defined by combining the capture zones delineated using these two methods.

3.1 Porous Media Flow Evaluation

Using the recalibrated groundwater flow model, the WHPA for each of the New Brighton wells was delineated using the software program MODPATH (Pollock, 1994). A minimum of 1000 particles were distributed vertically surrounding the open interval of each well. These particles were tracked backwards in time for both 1 and 10 years. When viewed in plan view, the areas encompassed by the particle traces were then outlined as the one- and ten-year porous medium time of travel zones for each well.

3.2 Sensitivity Analysis

A sensitivity analysis was performed for the model using the auto sensitivity option in Ground Water Vistas. The model was most sensitive to the horizontal hydraulic conductivity (Kx) of the Prairie du Chien Group near New Brighton. Output from the sensitivity analysis is presented in Appendix C.

Multiple particle tracking simulations were conducted to account for uncertainty in the groundwater flow model. For these simulations, the hydraulic conductivity values for the most sensitive hydraulic conductivity zones (201 and 223) were adjusted. The calibrated hydraulic conductivity for zone 223 is 156 m/day. The hydraulic conductivity of zone 223 was adjusted to the maximum and minimum hydraulic conductivity as determined from the pumping tests at Wells 13, 14, and 15 (209 m/day and 121 m/day respectively). The calibrated hydraulic conductivity of zone 201 is 22.1 m/day. The hydraulic conductivity of zone 201was adjusted to 15 m/day and 30 m/day for the particle tracking simulations. The extent of the TCE plume originating from the TCAAP site was used as a check to confirm that the groundwater flow field remained consistent and matched measured values after altering the hydraulic conductivities. Particle traces from all simulations were combined to define a composite porous media flow capture zone as shown on Figure 4.

3.3 Fracture Flow Evaluation

Wells 5 and 6 are classified as being open solely to a porous media aquifer that is hydraulically connected to a fractured or solution-weathered bedrock aquifer. For these wells, delineation technique 4 in the MDH guidance document was followed (MDH, 2005). Wells 13, 14 and 15 are open to the Prairie Du Chien Group and delineation technique 2 in the MDH guidance document was followed. Wells 3 and 4 are open to both the Prairie du Chien Group and the Jordan sandstone. For these two wells delineation technique 3 in the MDH guidance document was followed.

Preliminary fixed-radius fracture-flow capture zones for the New Brighton wells were extended to account for overlap of capture zones of nearby municipal wells. There are additional pollution containment wells within the fixed radius capture zones for the New Brighton wells. However, these wells are screened in the Quaternary sediments and were therefore not considered for this analysis. The general procedure for accounting for overlapping capture volumes presented in MDH (2005) was followed except the areas of overlap were calculated using geometric functions within ArcGIS (ESRI, 2006) rather than using the short and long access of overlap. Calculation of overlap with ArcGIS allows for a more accurate redistribution of the shared volumes and allows for easier calculation when more than two wells overlap. The fixed-radius fracture-flow capture zones were extended upgradient based on the direction of groundwater flow based on the groundwater flow model. A summary of calculations used in the delineation of fracture flow capture zones is presented in Appendix F.

3.4 Other Groundwater Withdrawal

Potential interference from other high capacity wells in the area was incorporated by including wells from SWUDS in the groundwater flow model as described above. Average pumping rates for the last five years were used. Pumping from wells other than the City of New Brighton wells was not adjusted to address future use.

3.5 Surface Water Contribution Area

The capture zones as delineated for both porous media flow and fracture flow were combined to obtain a preliminary WHPA. The preliminary WHPA was then extended to include areas of higher topography from which surface runoff drains onto areas within the preliminary WHPA classified as having a high aquifer vulnerability (see below for discussion of aquifer vulnerability). A 10 meter cell-size digital elevation model (Metropolitan Council, 2001) was used to delineate the areas of

surface drainage. The capture zones for both porous media flow and fracture flow, along with the surface water contribution area, were combined to define the WHPA for the New Brighton wells (Figure 5). The composite 1-year time of travel zones comprise the emergency response management zones (Figure 5).

4.0 Delineation of the Drinking Water Supply Management Areas

The New Brighton DWSMA encompasses the WHPA with boundaries that correspond to geographically identifiable features (e.g., streets, parcel boundaries, quarter section lines). Parcel boundaries where used as much as possible in the delineation of the DWSMA. The DWSMA extends into the cities of Arden Hills, Columbia Heights, Fridley, Hilltop, Minneapolis, Mounds View, Roseville, Saint Anthony, and Shoreview. The DWSMA that encompasses the 10-year groundwater time of travel zones is shown on Figures 5.

A listing of property parcels within the DWSMA is included on the data CD as listed on Table 3.

5.0 Well Vulnerability Assessment

MDH evaluated the vulnerability of New Brighton's municipal wells to contamination from contaminants released at the surface. The evaluation parameters include geology, well construction, pumping rate, and water quality. Wells open to the Mt. Simon Sandstone (Wells 8, 9, 10, 11, and 12) are classified as being not vulnerable. Wells open to the Prairie du Chien Group and Jordan Sandstone are classified as being vulnerable due to the presence of volatile organic compounds (VOC) associated with contamination from the Twin Cities Army Ammunition Plant. Copies of the MDH well vulnerability scoring sheet for the New Brighton wells are presented in Appendix E.

6.0 Drinking Water Supply Management Area Vulnerability Assessment

As noted above, the City of New Brighton wells completed in the Prairie du Chien Group and Jordan Sandstone aquifers have been classified as vulnerable to contamination (Appendix E). The vulnerability of the Prairie du Chien Group and Jordan Sandstone aquifers within the DWSMA was assessed. The vulnerability of the Mt. Simon Sandstone aquifer was not assessed because all New Brighton wells screened within this aquifer have been classified as being not vulnerable. The vulnerability of the DWSMA associated with New Brighton wells screened in the Prairie du Chien Group and Jordan Sandstone aquifers was evaluated using geologic logs for wells located within and surrounding the DWSMA.

Geologic logs from wells located in the area were used to construct two cross sections. Locations of these cross sections are shown on Figure 1.

Geologic logs listed in the Minnesota Geological Survey (MGS) County Well Index for wells in the vicinity of the DWSMA were reviewed and "L scores" based on the thickness of low permeability units at each well location were assigned to each well. (See MnDNR (1991) for a discussion of how to determine L scores). These L scores were then interpolated to a continuous surface using the software SURFER (Golden Software, 2002). The interpolated L scores were then overlain on the DWSMA using ArcView (see Appendix G). Preliminary aquifer vulnerability zones were then delineated based on the L-score map, the geologic cross sections, bedrock geology map (Mossler and Tipping, 2000), surficial geology (Meyer, 2007) aquifer sensitivity from Twiss (1992).

The aquifer vulnerability in the area around Long Lake was manually adjusted to a moderate vulnerability after further review of the geologic logs and comparison of lake levels to the potentiometric surface in the Prairie du Chien aquifer indicated that a confining unit is present between the surficial water table and the source water aquifer. This interpretation is consistent with the aquifer sensitivity as presented in Twiss (1992).

New Brighton wells 3 and 4 are completed in the Prairie du Chien Group and Jordan Sandstone aquifers. These wells have a geologic sensitivity rating of very low as a result of thick confining units of glacial clay above the aquifer (MDH, 2009b). Wells 5 and 6 are completed in the Jordan Sandstone aquifer and have a geologic sensitivity rating of very low due to glacial clay and the presence of basal St. Peter Sandstone (MDH, 2009b). Wells 14 and 15 are completed in the Prairie du Chien group and have geologic sensitivity ratings of very low and medium respectively (MDH, 2009b).

The Quaternary geology of the New Brighton area is complex with some areas having thick sequences of clay till offering protection for the aquifer and other areas have only sand and gravel above the bedrock aquifer, offering little protection. The DWSMA is assigned a vulnerability ranging from “low” to “high” (Figure 6).

7.0 Supporting Data Files

Project-specific data files included on the compact disc are listed on Table 3.

The groundwater model can be reviewed using MODFLOW (Harbaugh and McDonald, 1996). MODPATH pathline files can be reviewed using MODPATH Version 3 (Pollock, 1994)

All coordinates in the modeling files are based on UTM NAD 83 Zone 15 N datum. Elevations are in meters above mean sea level (m MSL). Time units are days. Length units are meters.

GIS files are also listed in Table 3. Descriptions are self-explanatory and some additional information is available in the associated metadata. Shapefiles files are in UTM NAD 83 Zone 15 N datum.

8.0 References

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Table 1
Data Elements Used in Preparation of WHPP Part 1 Report

Precipitation
• Precipitation data are available from the Minnesota High Spatial Density Daily Observation Network. • A summary of precipitation data for station ID 218390 located in Arden Hills is shown in Appendix H
Geology
The following sources of geologic information were considered in delineation of the WHPA and DWSMA and assessment of aquifer vulnerability. • Geologic Atlas of Ramsey County, MN (Meyer and Swanson, 1992) • Surficial Geology of the Twin Cities Metropolitan Area (Meyer, 2007) • Bedrock geology and structure of the seven-county Twin Cities metropolitan area (Mossler and Tipping, 2000) • Hydrogeology of the Paleozoic bedrock in southeastern Minnesota (Runkel et al., 2003) • County Well Index (MDH, 2009) • Documentation describing development of the Metro Model 2 (Metropolitan Council, 2009) • Aquifer test data for the Prairie du Chien Group at Wells 13, 14, and 15 (Montgomery Watson, 2000; Appendix B) • Aquifer test data for the Jordan Sandstone from Brooklyn Center Well 9 (MDH, 2001; Appendix B) • Specific capacity test data for Wells 8, 9, 10, 11, and 12 (Appendix B)
Soils
• Maps of soils along with information on each soils hydrologic group (A, B, C, D) from the Natural Resources Conservation Service (NRCS) and Soil Survey Geographic Database (SSURGO) were used in the SWB recharge model to help define recharge rates used in the groundwater flow model (Metropolitan Council, 2009).
Water Resources
• Maps of public waters and major drainage ditches were used in development of the groundwater flow model (Metropolitan Council, 2009).
Land Use
• Land cover data from the USGS (2003) was used in the SWB recharge model (Metropolitan Council, 2009). • Parcels were used in delineating the DWSMA. A listing of parcels is included on the enclosed CD • Political boundaries are shown on Figures 1, 4, 5, and 6.
Public Utility Services
• Pumping rates for New Brighton's municipal wells for previous, current, and projected years are shown in Table 2. • Well construction records are shown in Appendix A. • Unaccounted for water is typically around 5% of total usage.

Table 1 (Continued)
Data Elements Used in Preparation of WHPP Part 1 Report

Surface Water Quantity
• Stream baseflow values were used in the original calibration of the Metro Model 2 (Metropolitan Council, 2009) • Permitted withdrawals of surface water as reported in the MN DNR SWUDS database were considered during delineation of the WHPA, DWSMA, and aquifer vulnerability • There are no known water-use conflicts related to surface water features.
Groundwater Quantity
• High capacity wells with water use permit records maintained by the Minnesota Department of Natural Resources (DNR) through the State Water Use Data System (SWUDS) were included in the groundwater flow model. Pumping rates for these wells were based on average reported water use from 1997 to 2007. There are currently no known conflicts related to well interference or groundwater withdrawal effects on surface water.
Surface and Groundwater Quality
• Surface water and groundwater quality data area collected regularly and submitted to the appropriate public agency (e.g. MDH, MPCA). No additional, unreported, data is known.

Table 2
Annual and Projected Pumping Rates for New Brighton Wells

		Total Annual Withdrawl (gal/yr)				
Unique Number	Well Name	2004	2005	2006	2007	2008
206789	1	0	0	0	0	0
206798	2	0	0	0	0	0
206793	3	109,600,000	50,000,000	88,200,000	96,600,000	51,960,000
206792	4	436,700,000	460,400,000	438,700,000	447,900,000	429,232,000
206796	5	8,300,000	12,800,000	17,900,000	24,600,000	91,451,000
206797	6	2,900,000	7,500,000	42,000,000	57,300,000	256,401,000
206791	7	0	0	0	0	0
206795	8	4,000,000	20,900,000	13,300,000	11,100,000	4,922,000
206794	9	0	0	0	0	0
161432	10	23,600,000	0	1,100,000	11,600,000	19,535,000
509083	11	15,700,000	29,400,000	19,500,000	11,300,000	4,485,000
110485	12	20,500,000	4,500,000	800,000	800,000	8,257,000
520931	13	100,000	0	0	0	0
554216	14	411,600,000	331,600,000	432,200,000	405,200,000	130,403,000
582628	15	431,500,000	449,200,000	431,800,000	418,600,000	432,928,000
	Totals	1,464,500,000	1,366,300,000	1,485,500,000	1,485,000,000	1,429,574,000

Source: New Brighton's MDNR Annual Appropriation Reports

		Percentage of Annual Withdrawl					
Unique Number	Well Name	2004	2005	2006	2007	2008	Average Annual % of Withdrawal
206789	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
206798	2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
206793	3	7.5%	3.7%	5.9%	6.5%	3.6%	5.4%
206792	4	29.8%	33.7%	29.5%	30.2%	30.0%	30.6%
206796	5	0.6%	0.9%	1.2%	1.7%	6.4%	2.2%
206797	6	0.2%	0.5%	2.8%	3.9%	17.9%	5.1%
206791	7	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
206795	8	0.3%	1.5%	0.9%	0.7%	0.3%	0.8%
206794	9	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
161432	10	1.6%	0.0%	0.1%	0.8%	1.4%	0.8%
509083	11	1.1%	2.2%	1.3%	0.8%	0.3%	1.1%
110485	12	1.4%	0.3%	0.1%	0.1%	0.6%	0.5%
520931	13	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
554216	14	28.1%	24.3%	29.1%	27.3%	9.1%	23.6%
582628	15	29.5%	32.9%	29.1%	28.2%	30.3%	30.0%

		Projected Water Use (2014)			Maximum Total Pumping for Model Input[4]		
Unique Number	Well Name	Total[1] (gal/yr)	% of Total Projected Water Use Well[2]	Projected Well Pumpage Based on %[3] (gal/yr)	gal/yr	gal/day	m^3/day
206789	1		0.0%	0	0	0	0
206798	2		0.0%	0	0	0	0
206793	3		3.6%	53,727,385	109,600,000	300,274	1,137
206792	4		30.0%	443,832,038	460,400,000	1,261,370	4,774
206796	5		6.4%	94,561,644	94,561,644	259,073	981
206797	6		17.9%	265,122,308	265,122,308	726,362	2,749
206791	7		0.0%	0	0	0	0
206795	8		0.3%	5,089,419	20,900,000	57,260	217
206794	9		0.0%	0	0	0	0
161432	10		1.4%	20,199,470	23,600,000	64,658	245
509083	11		0.3%	4,637,554	29,400,000	80,548	305
110485	12		0.6%	8,537,856	20,500,000	56,164	213
520931	13		0.0%	0	0	0	0
554216	14		9.1%	134,838,571	432,200,000	1,184,110	4,482
582628	15		30.3%	447,653,755	449,200,000	1,230,685	4,658
	Totals	1,478,200,000		1,478,200,000	1,905,483,952	5,220,504	19,760

[1] Projected 2014 water use based on New Brighton's 2007 Water Supply Plan

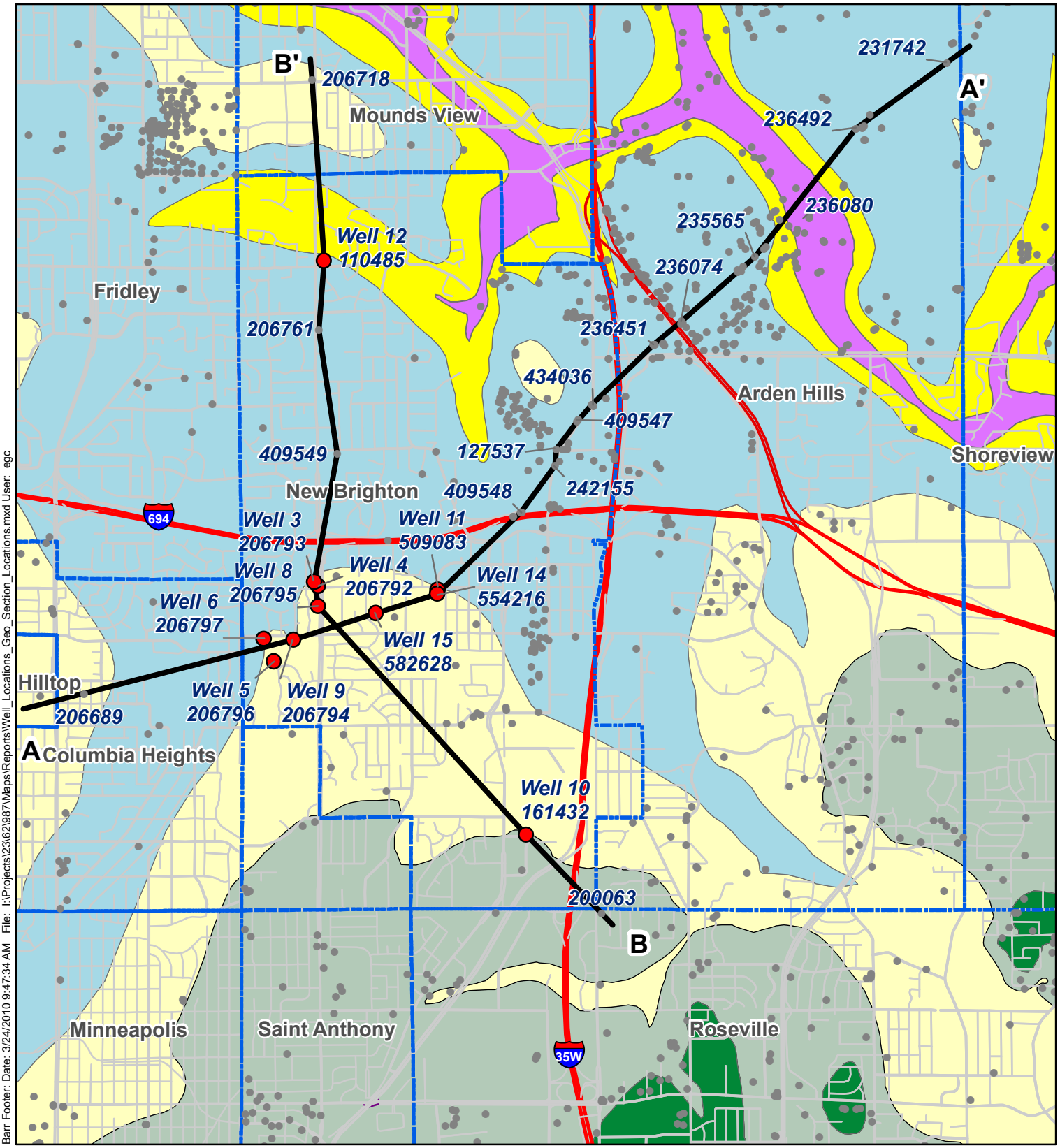
[2] Percentages for Wells 1 through 15 are based on the % of annual withdrawal for 2008.

[3] Estimated per well pumpage based on 2014 estimated water use and average % of annual withdrawal

[4] For each well, the greater of the estimated pumpage based on estimated 2014 water use and actual annual pumpage for 2004 through 2008,

Table 3
Files Included on the Compact Disc

Directory	File	Comments
\GIS_Data\1_yr_Fracture_Capture_Zones	1_yr_Fracture_Capture_Zone.*	1-year time of travel capture zones for fracture flow
\GIS_Data\1_Yr_Porous_Capture_Zones	1_yr_Porous_Capture_Zones.*	1-year time of travel capture zones for porous medium
\GIS_Data\10_yr_Fracture_Capture_Zone	10_yr_Fracture_Capture_Zone.*	10-year time of travel capture zone for fracture flow
\GIS_Data\10_yr_Porous_Capture_Zones	10_yr_Porous_Capture_Zone.*	10-year time of travel capture zone for porous medium
\GIS_Data\Aquifer_Vulnerability	Aq_vul.*	Aquifer vulnerability
\GIS_Data\DWSMA	New_Brighton_DWSMA.*	New Brighton DWSMA
\GIS_Data\L_Scores	L_Scores.*	L-Scores for wells in the area of North St. Paul
\GIS_Data\L_Scores\L_Score_Grid	L_Scores.*	Interpolated grid from L-scores at wells
\GIS_Data\Particle_Tracking	1_yr_particles.*	1-year time of travel particle tracks from groundwater flow model
\GIS_Data\Particle_Tracking	10_yr_particles.*	10-year time of travel particle tracks from groundwater flow model
\GIS_Data\Composite_1yr_Capture_Zones	Composite_1yr_Capture_Zones.*	Composite 1-year capture zones
\GIS_Data\Composite_10yr_WHPA	Composite_10yr_WHPA.*	New Brighton WHPA
\MODFLOW_Model	New_Brighton_WHPP.gwv	Groundwater Vistas file for the groundwater flow model
\MODFLOW_Model	New_Brighton_WHPP.*	Steady-state local groundwater flow model. Extensions described in McDonald and Harbaugh, 1988
	Parcels_in_DWSMA.xlsx	Spreadsheet of parcels that are within the DWSMA of New Brighton



Barr Footer: Date: 3/24/2010 9:47:34 AM File: I:\Projects\2362\987\Maps\Reports\Well_Locations_Geo_Section_Locations.mxd User: egc

Bedrock Units

- Decorah Shale
- Platteville-Glenwood Frms.
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence - Franconia Frms.

- New Brighton Well
- County Well Index Well
- Muncipal Boundary
- Cross Section Location

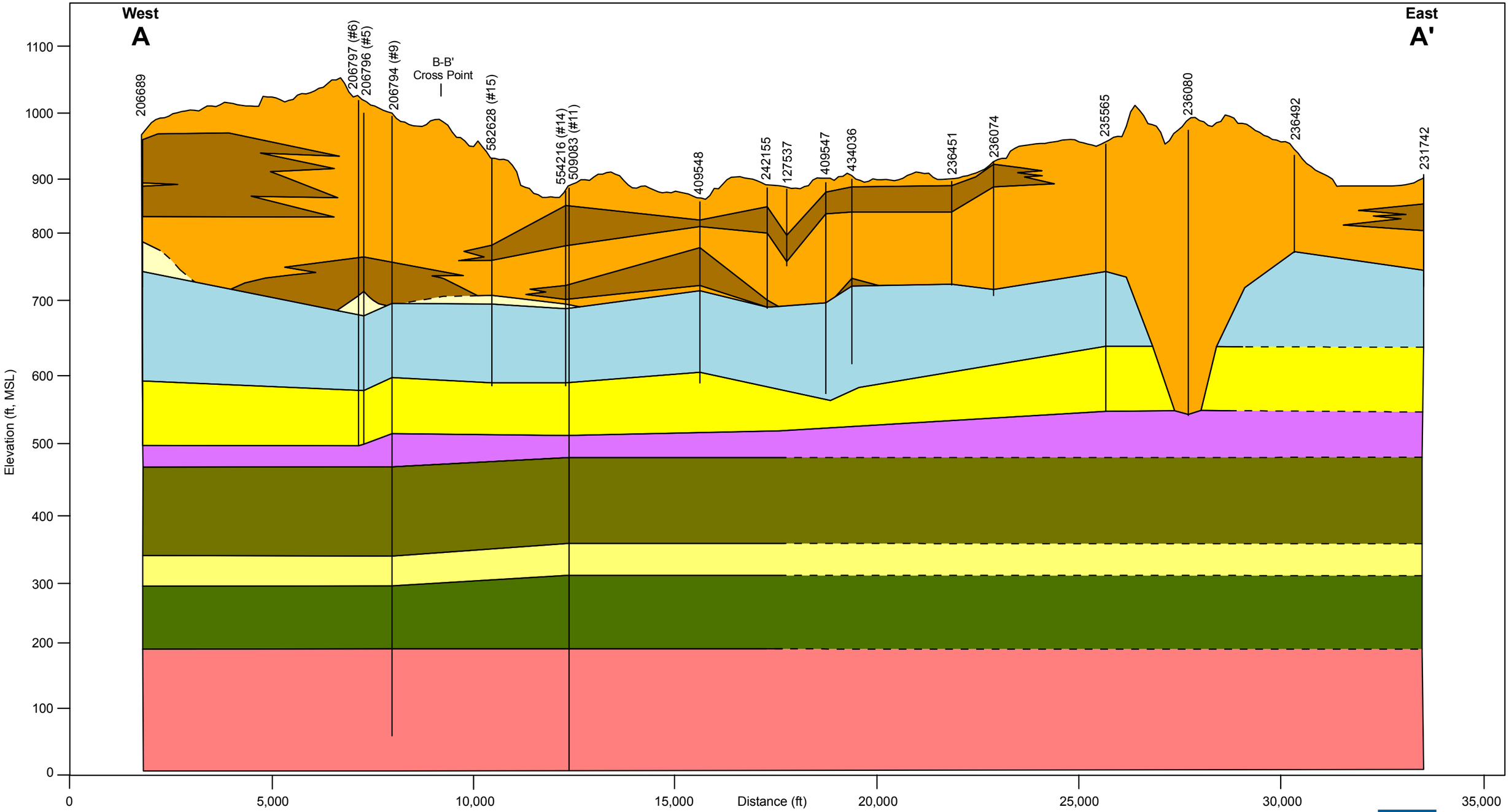
Miles 0 0.5

Kilometers 0 1

BARR

Figure 1

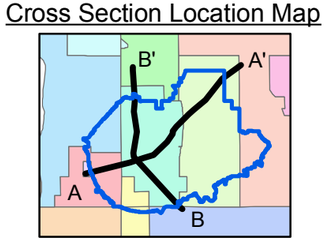
Bedrock Geology
WHPP Part 1
City of New Brighton
Ramsey County, MN



Lithology

- Sand & Gravel
- Clay Till
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Franconia Formation
- Ironton - Galesville Sandstones
- Eau Claire Formation
- Mt. Simon Sandstone

Cross Section Location Map



Notes

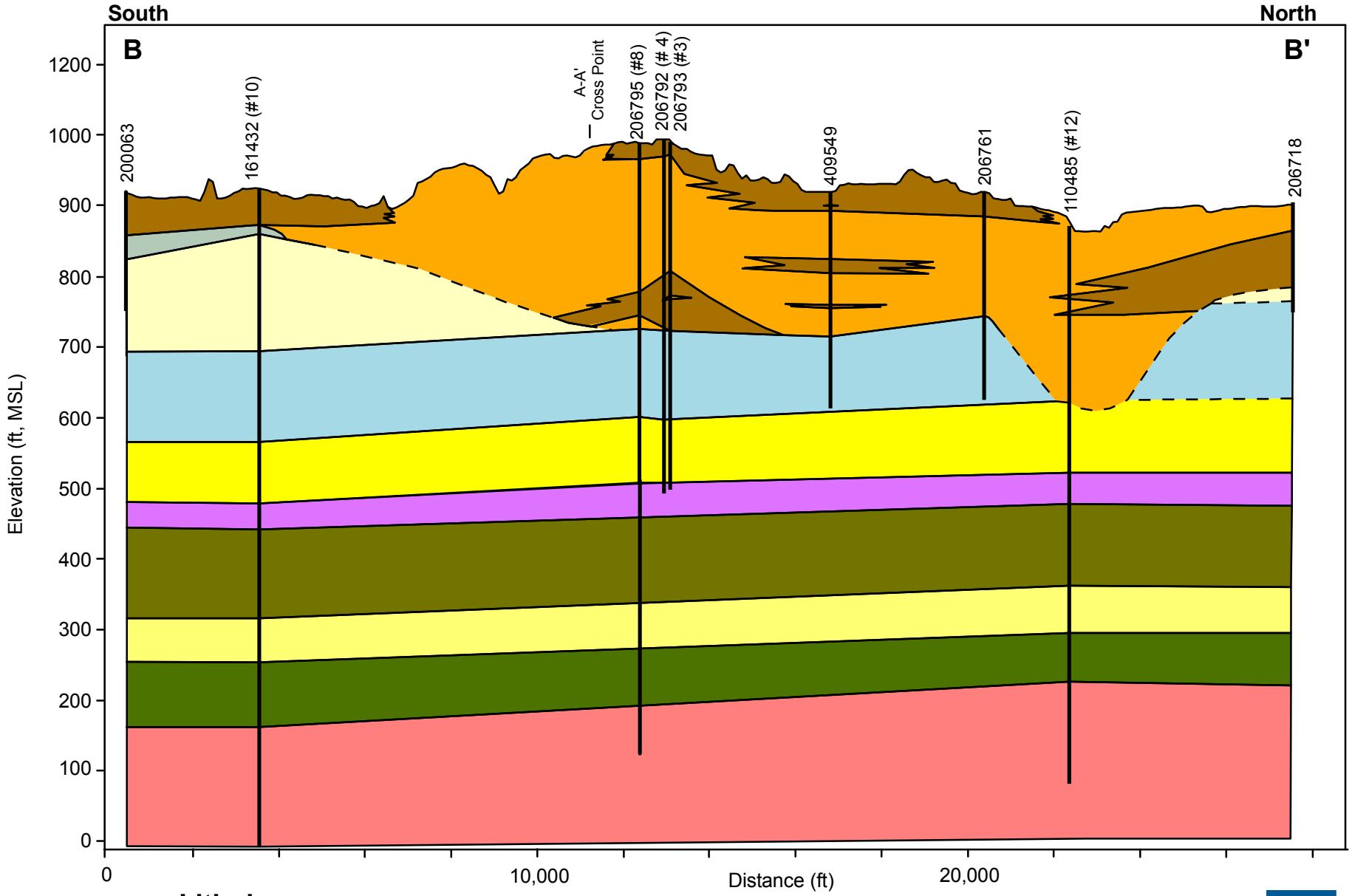
Dashed lines are inferred

BARR

Figure 2

Geologic Cross Section A-A'
WHPP Part 1
City of New Brighton
Ramsey County, MN

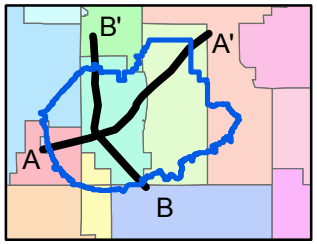
Barr Footer: Date: 3/24/2010 10:56:51 AM File: I:\Projects\23\62\987\Maps\Reports\Cross_Section_A_A.mxd User: egc



Lithology

- Sand & Gravel
- Clay Till
- Plateville & Glenwood Formation
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Franconia Formation
- Ironton - Galesville Sandstones
- Eau Claire Formation
- Mt. Simon Sandstone

Cross Section Location Map



Notes

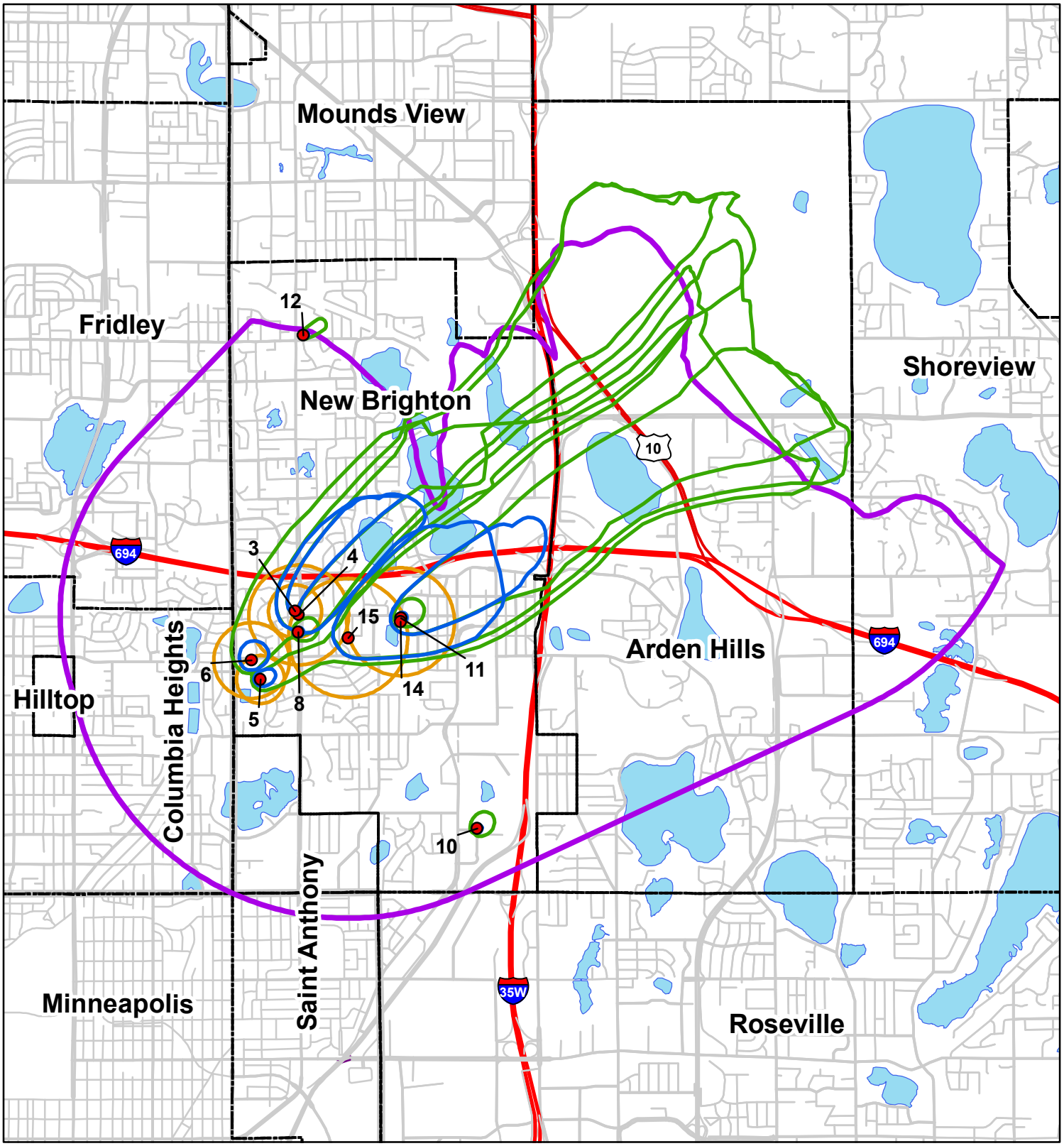
Dashed lines are inferred

BARR

Figure 3

Geologic Cross Section B-B'
WHPP Part 1
City of New Brighton
Ramsey County, MN

Barr Footer: Date: 3/24/2010 10:56:05 AM File: I:\Projects\23\62\987\Maps\Reports\Cross_Section_B_B.mxd User: egc



Barr Footer: Date: 3/24/2010 9:49:22 AM File: I:\Projects\23\62\987\Maps\Reports\Capture_Zones.mxd User: egc

- New Brighton Supply Well
- 1 Year Porous Media Capture Zone
- 10 Year Porous Media Capture Zone
- 1 Year Fracture Flow Capture Zone
- 10 Year Fracture Flow Capture Zone
- County Boundary
- Municipal Boundaries
- Water Body

N

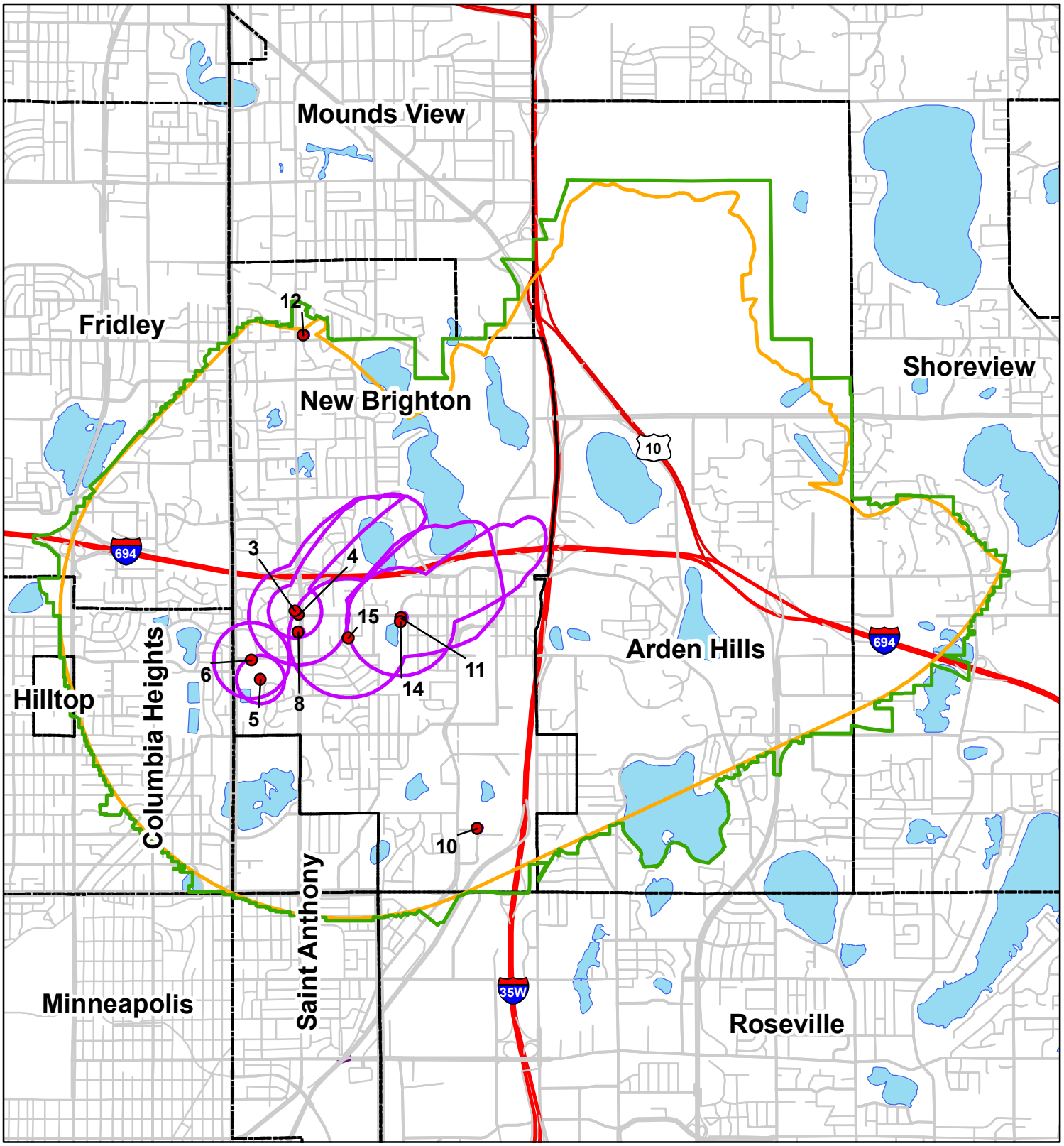
Miles
0 0.5 1

Kilometers
0 1 2

BARR

Figure 4

WELL CAPTURE ZONES
WHPP Part 1
City of New Brighton
Ramsey County, MN



Barr Footer: Date: 3/24/2010 9:58:33 AM File: I:\Projects\23\62\987\Maps\Reports\WHPA_and_DWSMA.mxd User: egc

New Brighton Supply Well
DWSMA
Composite 10 Year WHPA
Composite 1 Year Capture Zones
Municipal Boundaries
County Boundary
Water Body

N

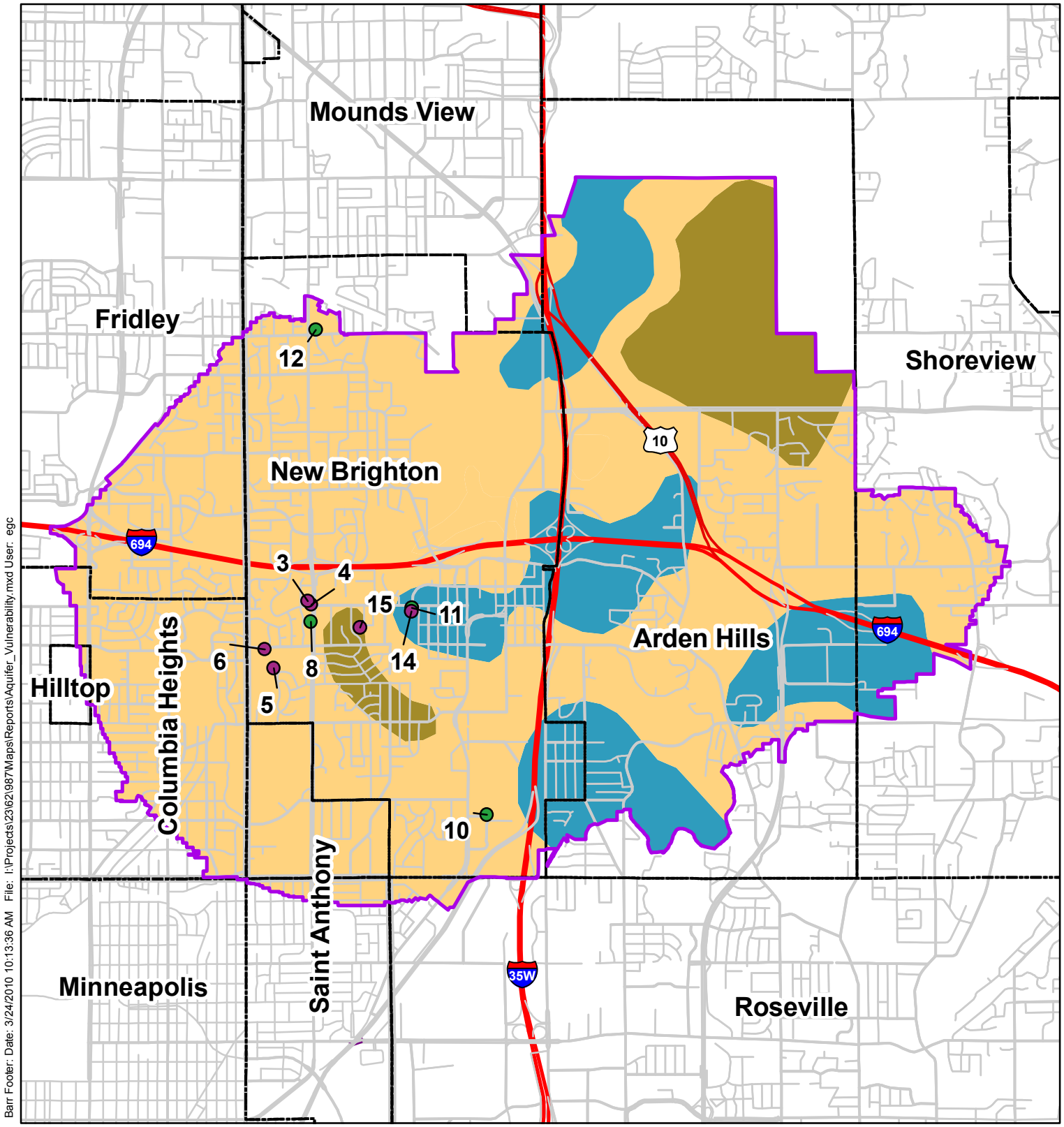
Miles
0 0.5 1

Kilometers
0 1 2

BARR

Figure 5

WHPA & DWSMA
WHPP Part 1
City of New Brighton
Ramsey County, MN



Barr Footer: Date: 3/24/2010 10:13:36 AM File: I:\Projects\23\62\987\Maps\Reports\Aquifer_Vulnerability.mxd User: egc

Aquifer Vulnerability

- High
- Low
- Moderate

New Brighton Well

- Not Vulnerable
- Vulnerable
- DWSMA
- Municipal Boundaries
- County Boundary

N

Miles
0 0.5 1

Kilometers
0 1 2

BARR

Figure 6

Aquifer Vulnerability
WHPP Part 1
City of New Brighton
Ramsey County, MN

Appendix A

Well Construction Records

Minnesota Unique Well No.

206789

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 06/05/2002
Received Date

Well Name NEW BRIGHTON 1

Township	Range	Dir	Section	Subsections	Elevation	Elevation Method
30	23	W	29	AACBBD	905 ft.	7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
358 ft.	358 ft.	

Drilling Method Cable Tool

Well Address
795 5TH AV NW
NEW BRIGHTON MN 55112

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Abandoned **Status** Sealed

Geological Material	Color	Hardness	From	To
DRIFT			0	188
DRIFT			188	192
SHAKOPEE ONEOTA			192	272
JORDAN			272	302
JORDAN			302	358

Casing Type Steel (black or low carbon) **Joint** No Information **Drive Shoe?** ☐ Yes ☐ No **Above/Below** ft.

Casing Diameter	Weight	Hole Diameter
8 in. to 193 ft.	lbs./ft.	

Open Hole from 193 ft. to 358 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
74 ft. from Land surface Date Measured 1984

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 250 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
GAMMA LOGGED 4-13-1984. WELL WAS ALSO TV.
IN BUILDING JUST S. OF FIRE BARN
ABANDONED 1984.

Grouting Information Well Grouted? ☐ Yes ☐ No

Located by: Minnesota Geological Survey
Method: Digitized - scale 1:24,000 or larger (Digitizing Table)
Unique Number Verification: Information from owner
Input Date: 01/01/1990
System: *UTM - Nad83, Zone15, Meters*
X: 484841 **Y:** 4989913

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☑ Not Installed Date Installed
Manufacturer's name Model number __ HP 10 Volts
Length of drop Pipe _ft. Capacity 250 g.p.m Type Turbine Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Borehole Geophysics Yes
First Bedrock Prairie Du Chien Group
Last Strat Jordan
Aquifer Prairie Du Chien-Jordan
Depth to Bedrock 188 ft.

Well Contractor Certification

Minnesota Department of Health	MDH	
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report **206789** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

206798

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 06/05/2002
Received Date

Well Name NEW BRIGHTON 2

Township	Range	Dir	Section	Subsections	Elevation	Elevation Method
30	23	W	29	AACBBD	905 ft.	7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
420 ft.	420 ft.	

Drilling Method Cable Tool

Well Address
795 5TH AV NW
NEW BRIGHTON MN 55112

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Abandoned **Status** Sealed

Geological Material	Color	Hardness	From	To
DRIFT			0	187
DRIFT			187	192
SHAKOPEE ONEOTA			192	272
JORDAN			272	302
JORDAN			302	392
JORDAN			392	420

Casing Type Steel (black or low carbon) **Joint** No Information **Drive Shoe?** ☐ Yes ☐ No **Above/Below** ft.

Casing Diameter	Weight	Hole Diameter
12 in. to 198 ft.	lbs./ft.	

Open Hole from 198 ft. to 420 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
74 ft. from Land surface Date Measured 1984

PUMPING LEVEL (below land surface)
ft. after hrs. pumping 700 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
GAMMA LOGGED 4-13-1984. WELL WAS ALSO TV.
WELL SEALED 1984.

Grouting Information Well Grouted? ☐ Yes ☐ No

Located by: Minnesota Geological Survey **Method:** Digitized - scale 1:24,000 or larger (Digitizing Table)

Unique Number Verification: Information from owner **Input Date:** 01/01/1990

System: *UTM - Nad83, Zone15, Meters* **X:** 484841 **Y:** 4989883

Nearest Known Source of Contamination
__feet __direction __type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Borehole Geophysics Yes
First Bedrock Prairie Du Chien Group
Last Strat St.Lawrence
Aquifer Multiple
Depth to Bedrock 187 ft.

Well Contractor Certification

Minnesota Department of Health	MDH	
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report **206798** Printed 10/30/2009 HE-01205-07

Minnesota Unique Well No.

206793

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 12/30/2004
Received Date

Well Name NEW BRIGHTON 3

Township	Range	Dir	Section	Subsections	Elevation	Elevation Method
30	23	W	30	BADDDB	991 ft.	Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
493 ft.	493 ft.	195501

Drilling Method Cable Tool

Well Address
700 SILVER LAKE RD
NEW BRIGHTON MN 55112

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Community Supply **PWS ID** 1620009 **Source** S01

Geological Material	Color	Hardness	From	To
CLAY			0	18
SAND			18	173
HARDPAN			173	183
SILTY CLAY	BROWN		183	218
SAND & GRAVEL			218	223
CLAY	BLUE		223	268
SHAKOPEE			268	393
SANDROCK			393	483
SANDROCK & SHALE			483	492
SHALE			492	493

Casing Type Steel (black or low carbon) **Joint** No Information **Drive Shoe?** ☐ Yes ☐ No **Above/Below** 0 ft.

Casing Diameter	Weight	Hole Diameter
24 in. to 272 ft.	lbs./ft.	23 in. to 286 ft.
16 in. to 286 ft.	lbs./ft.	16 in. to 493 ft.

Open Hole from 286 ft. to 493 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
163 ft. from Land surface Date Measured 01/00/1955

PUMPING LEVEL (below land surface)
174 ft. after hrs. pumping 800 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 286 ft. 0

Located by: Minnesota Geological Survey
Method: GPS Differentially Corrected
Unique Number Verification: Information from owner
Input Date: 07/27/1999
System: *UTM - Nad83, Zone15, Meters*
X: 482762 **Y:** 4989793

Nearest Known Source of Contamination
__feet __direction __type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☑ Not Installed Date Installed 00/00/1955
Manufacturer's name FAIRBANKS-MORSE Model number 5259 HP 80 Volts 440
Length of drop Pipe 204 ft. Capacity 800 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock Prairie Du Chien Group
Last Strat St.Lawrence
Aquifer Prairie Du Chien-Jordan
Depth to Bedrock 268 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Keys Well Co.	62012	KEMPER, R.

County Well Index Online Report **206793** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

206792

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 12/30/2004
Received Date

Well Name NEW BRIGHTON 4

Township Range Dir Section Subsections Elevation 993 **ft.**

30 23 W 30 BADDDC **Elevation Method** Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
500 **ft.**	500 **ft.**	195412

Drilling Method --

Well Address
700 SILVER LAKE RD
NEW BRIGHTON MN 55112

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Community Supply **PWS ID** 1620009 **Source** S02

Geological Material	Color	Hardness	From	To
CLAY			0	23
SAND GRAVEL & BOULDERS			23	25
HARDPAN			25	81
DIRTY SAND			81	139
SAND			139	188
HARDPAN			188	225
SAND			225	241
CLAY			241	247
SANDROCK			247	266
SHAKOPEE			266	396
SANDROCK			396	497
SANDROCK & SHALE			497	499
SHALE			499	500

Casing Type **Joint** No Information **Drive Shoe?** ☐ Yes ☐ No **Above/Below** 0 **ft.**

Casing Diameter			Weight	Hole Diameter		
24	in. to	268 ft.	lbs./ft.	16	in. to	500 ft.
16	in. to	269 ft.	lbs./ft.			

Open Hole from 269 ft. to 500 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
202 ft. from Land surface Date Measured 196105

PUMPING LEVEL (below land surface)
182 ft. after hrs. pumping 965 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☐ Yes ☐ No

Located by: Minnesota Geological Survey

Method: GPS Differentially Corrected

Unique Number Verification: Information from owner

Input Date: 07/27/1999

System: *UTM - Nad83, Zone15, Meters*

X: 482799 **Y:** 4989757

Nearest Known Source of Contamination
__feet __direction __type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☑ Not Installed Date Installed
Manufacturer's name FAIRBANKS-MORSE Model number 5258 HP 80 Volts 440
Length of drop Pipe 202 ft. Capacity 800 g.p.m Type Submersible Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock St.Peter
Last Strat St.Lawrence
Aquifer Prairie Du Chien-Jordan
Depth to Bedrock 247 **ft.**

Well Contractor Certification

Keys Well Co.	62012	KEMPER, R.
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report **206792** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

206796

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 12/30/2004
Received Date

Well Name NEW BRIGHTON 5

Township	Range	Dir	Section	Subsections	Elevation	Elevation Method
30	23	W	30	CBAABD	1001 ft.	Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
501 ft.	501 ft.	01/29/1963

Drilling Method Cable Tool

Well Address
3001 5TH ST NW
NEW BRIGHTON MN 55112

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Community Supply **PWS ID** 1620009 **Source** S03

Geological Material	Color	Hardness	From	To
SAND & GRAVEL			0	218
CLAY, SAND & GRAVEL			218	232
CLAY, STICKY	RED		232	242
CLAY, SAND & GRAVEL	YELLOW		242	270
ST. PETER SANDSTONE			270	307
SHAKOPEE ROCK			307	409
CREVICE AT ROCK			409	410
SHAKOPEE ROCK			410	414
CREVICE AT ROCK			414	416
SHAKOPEE ROCK			416	420
HIT JORDAN SANDSTONE			420	493
ST. LAWRENCE SANDSTONE			493	501

Casing Type Steel (black or low carbon) **Joint** No Information **Drive Shoe?** ☐ Yes ☐ No **Above/Below** 0 ft.

Casing Diameter	Weight	Hole Diameter
24 in. to 294 ft.	lbs./ft.	
16 in. to 430 ft.	lbs./ft.	

Open Hole from 430 ft. to 500 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
208 ft. from Land surface Date Measured 01/29/1963

PUMPING LEVEL (below land surface)
0 ft. after hrs. pumping 850 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Located by: Minnesota Geological Survey
Method: GPS Differentially Corrected
Unique Number Verification: Information from owner
Input Date: 07/27/1999
System: *UTM - Nad83, Zone15, Meters*
X: 482411 **Y:** 4989103

Grouting Information Well Grouted? ☑ Yes ☐ No

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Layne Well Co.	27010	HOLLEN, G.

First Bedrock St.Peter
Last Strat Jordan
Aquifer Jordan
Depth to Bedrock 270 ft.

County Well Index Online Report **206796** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

206797

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 12/30/2004
Received Date

Well Name NEW BRIGHTON 6

Township	Range	Dir	Section	Subsections	Elevation	Elevation Method
30	23	W	30	CBABAB	1020 ft.	Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
522 ft.	522 ft.	196105

Drilling Method Cable Tool

Well Address
3001 5TH ST NW
NEW BRIGHTON MN 55112

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Community Supply **PWS ID** 1620009 **Source** S04

Geological Material	Color	Hardness	From	To
CLAY			0	6
SAND			6	164
HARDPAN			164	254
SAND & CLAY			254	259
CLAY & SOME GRAVEL			259	299
SHAKOPEE			299	426
JORDAN			426	522
SHALE			522	522

Casing Type Steel (black or low carbon) **Joint** No Information **Drive Shoe?** ☐ Yes ☐ No **Above/Below** 0 **ft.**

Casing Diameter	Weight	Hole Diameter
24 in. to 303 ft.	lbs./ft.	16 in. to 522 ft.
16 in. to 447 ft.	lbs./ft.	

Open Hole from 447 ft. to 522 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
164 ft. from Land surface Date Measured 195412

PUMPING LEVEL (below land surface)
258 ft. after hrs. pumping 600 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
GWQ NO.0208.

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 447 ft. 32.5 yrds.

Located by: Minnesota Geological Survey

Method: GPS Differentially Corrected

Unique Number Verification: Information from owner

Input Date: 07/27/1999

System: *UTM - Nad83, Zone15, Meters*

X: 482321 **Y:** 4989295

Nearest Known Source of Contamination
__feet __direction __type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Keys Well Co.	62012	KEMPER, R.

First Bedrock Prairie Du Chien Group
Last Strat St.Lawrence

Aquifer Jordan
Depth to Bedrock 299 **ft.**

County Well Index Online Report **206797** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

206791

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 11/17/2008
Received Date

Well Name NEW BRIGHTON 7

Township	Range	Dir	Section	Subsections	Elevation	Elevation Method
30	23	W	29	CCDCDD	920 ft.	7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
437 ft.	437 ft.	09/25/1968

Drilling Method Cable Tool

Well Address
1300 13 AVE & CR E NW
MN

Drilling Fluid
--

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Abandoned **Status** Sealed

Geological Material	Color	Hardness	From	To
TO BE FILLED			0	7
CLAY & GRAVEL			7	62
SAND			62	126
HARDPAN			126	157
SANDROCK			157	176
SHALE			176	180
SANDROCK			180	195
SHALE & SANDROCK			195	220
SHAKOPEE			220	343
JORDAN SANDROCK			343	435
SANDROCK & SHALE			435	437

Casing Type Steel (black or low carbon) **Joint** No Information **Drive Shoe?** ☐ Yes ☐ No **Above/Below** ft.

Casing Diameter	Weight	Hole Diameter
24 in. to 173 ft.	lbs./ft.	16 in. to 437 ft.
16 in. to 361 ft.	lbs./ft.	

Open Hole from 361 ft. to 437 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
107.5 ft. from Land surface Date Measured 09/25/1968

PUMPING LEVEL (below land surface)
132.7 ft. after hrs. pumping 600 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
WELL SEALED 09-01-1997 BY 62012
ORIGINAL USE MU - MUNICIPAL

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 361 ft. 30 yrds.

Located by: Minnesota Geological Survey **Method:** Digitized - scale 1:24,000 or larger (Digitizing Table)

Unique Number Verification: Information from owner **Input Date:** 01/01/1990

System: *UTM - Nad83, Zone15, Meters* **X:** 483914 **Y:** 4988564

Nearest Known Source of Contamination
__feet __direction __type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Cuttings Yes
First Bedrock St.Peter
Last Strat St.Lawrence
Aquifer Jordan
Depth to Bedrock 157 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Keys Well Co.	62012	O'BRIEN, F.

County Well Index Online Report **206791** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

206795

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 12/30/2004
Received Date

Well Name NEW BRIGHTON 8

Township Range Dir Section Subsections Elevation 989 **ft.**

30 23 W 30 BDADAC **Elevation Method** Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
482 **ft.**	482 **ft.**	08/12/1970

Drilling Method Cable Tool

Well Address
600 SILVER LAKE RD
NEW BRIGHTON MN 55112

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Community Supply **PWS ID** 1620009 **Source** S06

Geological Material	Color	Hardness	From	To
CLAY			0	5
SAND & CLAY			5	23
SAND			23	158
SAND & CLAY			158	198
SAND & GRAVEL			198	214
CLAY			214	234
CLAY & SANDROCK			234	244
SAND & GRAVEL			244	263
SHAKOPEE			263	388
JORDAN			388	481
SHALE			481	482

Casing Type Steel (black or low carbon) **Joint** No Information **Drive Shoe?** ☐ Yes ☐ No **Above/Below** 0 **ft.**

Casing Diameter			Weight	Hole Diameter		
30	in. to	268 ft.	lbs./ft.	29	in. to	482 ft.
24	in. to	285 ft.	lbs./ft.			

Open Hole from 285 ft. to 482 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
165 ft. from Land surface Date Measured 08/12/1970

PUMPING LEVEL (below land surface)
173.3 ft. after hrs. pumping 1016 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 285 ft. 20 yrds.

Located by: Minnesota Geological Survey **Method:** GPS Differentially Corrected

Unique Number Verification: Information from owner **Input Date:** 07/27/1999

System: *UTM - Nad83, Zone15, Meters* **X:** 482797 **Y:** 4989581

Nearest Known Source of Contamination
__feet __direction __type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☑ Not Installed Date Installed
Manufacturer's name FAIRBANKS-MORSE/PEERLE Model number 365708
__ HP 200 Volts 460
Length of drop Pipe _ft. Capacity 1500 g.p.m Type Turbine Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Cuttings Yes
First Bedrock Prairie Du Chien Group **Aquifer** Prairie Du Chien-Jordan
Last Strat St.Lawrence **Depth to Bedrock** 263 **ft.**

Well Contractor Certification

Keys Well Co.	62012	O'BRIEN, F.
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report **206795** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

206794

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 12/30/2004
Received Date

Well Name NEW BRIGHTON 9

Township Range Dir Section Subsections Elevation 996 **ft.**

30 23 W 30 CABAAD **Elevation Method** Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
937 **ft.**	937 **ft.**	05/14/1971

Drilling Method Cable Tool

Well Address
2745 5TH ST NW
NEW BRIGHTON MN 55112

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Community Supply **PWS ID** 1620009 **Source** S07

Geological Material	Color	Hardness	From	To
SAND AND GRAVEL, CLAY			0	283
LIMESTONE			283	395
JORDAN SANDSTONE			395	468
ST. LAWRENCE			468	477
SHALEY SANDSTONE	GRY/WHT		477	480
SHALEY SANDSTONE	GRY/WHT		480	490
ST. LAWRENCE			490	495
SHALE	TAN		495	500
SHALE	LIGHT		500	525
SHALE	GREEN		525	530
FRANCONIA SOFTER	GRAY		530	540
FRANCONIA HARD	GRAY		540	560
SANDY SHALE	GREEN	M.SOFT	560	595
SHALE	YEL/BRN		595	600
SHALEY SANDSTONE	GRAY		600	650
SHALEY SANDSTONE	GREEN		650	660
SOFT SANDSTONE	LIGHT		660	663
SOFT SANDSTONE			663	665
SANDSTONE			665	685
SHALE	TAN/GRY		685	686
SHALE & SANDSTONE	GRAY		686	700
EAU CLAIRE SHALE	GRAY		700	710
EAU CLAIRE SHALE	GRAY		710	750
EAU CLAIRE SHALE	LIGHT		750	755
SHALE	GRN/TAN		755	765
MT. SIMON	WHITE		765	805
MT. SIMON	WHITE		805	885
MT. SIMON	WHITE		885	937

Casing Type Steel (black or low carbon) **Joint** No Information **Drive Shoe?** ☐ Yes ☐ No **Above/Below** 0 **ft.**

Casing Diameter	Weight	Hole Diameter
30 in. to 283 ft.	lbs./ft.	
24 in. to 326 ft.	lbs./ft.	

Open Hole from 782 ft. to 937 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
314 ft. from Land surface Date Measured 07/21/1982

PUMPING LEVEL (below land surface)
433 ft. after hrs. pumping 1000 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
DEEPENED IN 1982 BY E.H. RENNER & SONS ORIGINALY DRILLED BY LAYNE.
M.G.S. NO. 672. WELL ORIGINALLY DRILLED BY LAYNE MN. TO 476 FT.

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 325 ft. 35.5 yrds.
Grout Material: Neat Cement from 0 to 782 ft. 0

Located by: Minnesota Geological Survey
Method: GPS Differentially Corrected
Unique Number Verification: Information from owner
Input Date: 07/27/1999
System: *UTM - Nad83, Zone15, Meters*
X: 482583 **Y:** 4989290

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Cuttings Yes
First Bedrock Prairie Du Chien Group
Last Strat Mt.Simon
Aquifer Mt.Simon
Depth to Bedrock 283 **ft.**

Well Contractor Certification

Renner E.H. & Sons	02015	SIGAFOOS, G.
License Business Name	Lic. Or Reg. No.	Name of Driller

County Well Index Online Report **206794** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

161432

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 08/18/2009
Received Date

Well Name NEW BRIGHTON 10

Township	Range	Dir	Section	Subsections	Elevation	Elevation Method
30	23	W	32	DBBDAC	924 ft.	Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
931 ft.	931 ft.	10/11/1983

Drilling Method Cable Tool

Well Address
803 5TH ST NW
NEW BRIGHTON MN 55112

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Municipal

Geological Material	Color	Hardness	From	To
DRIFT	BROWN		0	51
PLATTEVILLE	GRAY	MEDIUM	51	58
PLATTEVILLE	GRAY	MEDIUM	58	64
PLATTEVILLE	GRAY	MEDIUM	64	70
ST. PETER	BROWN	SOFT	70	228
ST. PETER	BROWN	SOFT	228	230
SHAKOPEE ROOT VALLEY ONEOTA	BROWN	HARD	230	355
JORDAN	WHITE	SOFT	355	358
JORDAN	WHITE	SOFT	358	445
ST. LAWRENCE	GRAY	MEDIUM	445	448
ST. LAWRENCE	GRAY	MEDIUM	448	482
ST. LAWRENCE	GRAY	MEDIUM	482	485
FRANCONIA STICKY	GREEN		485	608
FRANCONIA STICKY	GREEN		608	615
IRONTON-GALESVILLE	BRN/WHT	SOFT	615	665
EAU CLAIRE STICKY	GRAY		665	670
EAU CLAIRE STICKY	GRAY		670	762
EAU CLAIRE STICKY	GRAY		762	765
MT. SIMON HINCKLEY	WHT/PNK	SOFT	765	931

Casing Type Steel (black or low carbon) **Joint** No Information **Drive Shoe?** ☑ Yes ☐ No **Above/Below** 2 ft.

Casing Diameter	Weight	Hole Diameter
30 in. to 51 ft.	lbs./ft.	29 in. to 447 ft.
24 in. to 447 ft.	lbs./ft.	23 in. to 779 ft.

Open Hole from 779 ft. to 931 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
282 ft. from Land surface Date Measured 10/11/1983

PUMPING LEVEL (below land surface)
382 ft. after hrs. pumping 1200 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
193 YARDS OF GROUT USED IN THE PROCESS.
M.G.S. NO. 1965. GAMMA LOGGED 3-30-1984.

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 447 ft. 0
Grout Material: Neat Cement from 0 to 779 ft. 0

Located by: Minnesota Geological Survey
Method: GPS Differentially Corrected
Unique Number Verification: Information from owner
Input Date: 07/27/1999
System: *UTM - Nad83, Zone15, Meters*
X: 484609 **Y:** 4987590

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Cuttings Yes **Borehole Geophysics** Yes
First Bedrock Platteville
Last Strat Mt.Simon
Aquifer Mt.Simon
Depth to Bedrock 51 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Bergerson-Caswell	27058	HENRICH, J.

County Well Index Online Report **161432** Printed 10/30/2009 HE-01205-07

Minnesota Unique Well No.

509083

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 05/30/1991
Update Date 12/30/2004
Received Date

Well Name NEW BRIGHTON 11

Township	Range	Dir	Section	Subsections	Elevation	Elevation Method
30	23	W	29	BCABBA	892 ft.	Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
950 ft.	950 ft.	03/24/1984

Drilling Method Cable Tool

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Community Supply **PWS ID** 1620009 **Source** S09

Casing Type Steel (black or low carbon) **Joint** Welded **Drive Shoe?** ☑ Yes ☐ No **Above/Below** 2 **ft.**

Geological Material	Color	Hardness	From	To
DRIFT	GRY/BRN	SOFT	0	165
DRIFT	GRY/BRN	SOFT	165	177
SANDSTONE ST. PETER	WHITE	MEDIUM	177	179
LIMEROCK SHAKOPEE	TAN	HARD	179	285
LIMEROCK SHAKOPEE	TAN	HARD	285	288
SANDROCK JORDAN	GRAY	MEDIUM	288	375
SANDROCK JORDAN	GRAY	MEDIUM	375	379
SHALE ST. LAWRENCE	GREEN	MEDIUM	379	412
SHALE & SANDSTONE FRANCONIA	GREEN	MEDIUM	412	418
SHALE & SANDSTONE FRANCONIA	GREEN	MEDIUM	418	541
SANDROCK IRONTON-GALESVILLE	GRAY	MEDIUM	541	545
SANDROCK IRONTON-GALESVILLE	GRAY	MEDIUM	545	590
SHALE EAU CLAIRE	GRAY	MEDIUM	590	610
SHALE EAU CLAIRE	GRAY	MEDIUM	610	678
SHALE EAU CLAIRE	GRAY	MEDIUM	678	698
SHALE & SANDSTONE EAU CLAIRE	GRAY	MEDIUM	698	710
SANDROCK MT. SIMON	GRAY	MEDIUM	710	950

Casing Diameter	Weight	Hole Diameter
30 in. to 168 ft.	lbs./ft.	29 in. to 385 ft.
24 in. to 395 ft.	lbs./ft.	23 in. to 950 ft.

Open Hole from 775 ft. to 950 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
248 ft. from Land surface Date Measured 03/24/1984

PUMPING LEVEL (below land surface)
300 ft. after hrs. pumping 700 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
GAMMALOGGED 4-18-1983 & 3-27-1985. M.G.S. NO. 1966.

Located by: Minnesota Geological Survey
Method: GPS Differentially Corrected
Unique Number Verification: Information from owner
Input Date: 07/27/1999
System: *UTM - Nad83, Zone15, Meters*
X: 483838 **Y:** 4989725

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement	from 0 to 395 ft.	0 bags
Grout Material: Neat Cement	from 0 to 775 ft.	0 bags

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☑ Not Installed Date Installed 00/00/1984
Manufacturer's name BERKELEY Model number S31736 HP 150 Volts 460
Length of drop Pipe 370 ft. Capacity 1000 g.p.m Type Turbine Material Steel (black or low carbon)

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Cuttings Yes **Borehole Geophysics** Yes
First Bedrock Prairie Du Chien Group
Last Strat Mt.Simon
Aquifer Mt.Simon
Depth to Bedrock 165 **ft.**

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Keys Well Co.	62012	SITTIG, R.

County Well Index Online Report **509083** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

110485

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 08/14/1991
Update Date 12/30/2004
Received Date

Well Name NEW BRIGHTON 12

Township	Range	Dir	Section	Subsections	Elevation	Elevation Method
30	23	W	18	ACCCCB	872 ft.	Calc from DEM (USGS 7.5 min or equiv.)

Well Depth	Depth Completed	Date Well Completed
790 ft.	790 ft.	05/00/1984

Drilling Method Cable Tool

Well Address

NEW BRIGHTON MN 55112

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Community Supply **PWS ID** 1620009 **Source** S10

Geological Material	Color	Hardness	From	To
GLACIAL DRIFT	BROWN		0	242
BROKEN LIMEROCK			242	251
BROKEN LIMEROCK			251	293
SANDSTONE	BROWN		293	308
SANDSTONE	TAN		308	345
SHALE	GRAY		345	350
SHALE	BLUE		350	365
LIMESTONE	RED		365	368
SHALE GRAY BLUE WHITE			368	394
SHALE GRAY BLUE WHITE			394	413
FRANCONIA			413	510
IRONTON-GALESVILLE			510	577
IRONTON-GALESVILLE			577	646
EAU CLAIRE SHALE			646	663
EAU CLAIRE SHALE			663	702
TRANSITION ZONE			702	718
MT. SIMON			718	742
HINCKLEY	BROWN		742	790

Casing Type Steel (black or low carbon) **Joint** Welded **Drive Shoe?** ☑ Yes ☐ No **Above/Below** 2 **ft.**

Casing Diameter	Weight	Hole Diameter
30 in. to 251 ft.	lbs./ft.	
24 in. to 372 ft.	lbs./ft.	

Open Hole from 730 ft. to 790 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
223 ft. from Land surface Date Measured 05/14/1984

PUMPING LEVEL (below land surface)
ft. after hrs. pumping g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☐ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
M.G.S. NO.2010. GAMMA LOGGED 11-11-83.

Located by: Minnesota Geological Survey

Method: GPS Differentially Corrected

Unique Number Verification: Information from owner

Input Date: 07/27/1999

System: *UTM - Nad83, Zone15, Meters*

X: 482847 **Y:** 4992590

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 730 ft. 58 yrds.

Nearest Known Source of Contamination
__feet __direction __type
Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP 0 Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☐ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

Cuttings Yes **Borehole Geophysics** Yes

First Bedrock Jordan

Last Strat Mt.Simon

Aquifer Mt.Simon

Depth to Bedrock 251 **ft.**

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Layne Well Co.	27010	HOLLEN, G.

County Well Index Online Report **110485** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

520931

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 01/14/1994
Update Date 04/11/2007
Received Date 01/04/1994

Well Name NEW BRIGHTON 13

Township Range Dir Section Subsections Elevation 902 **ft.**

30 23 W 29 ACCDDA **Elevation Method** 7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
320 **ft.**	320 **ft.**	05/14/1993

Drilling Method Cable Tool

Well Address
700 5TH ST NW
NEW BRIGHTON MN 55112
803 5TH AV NW

Geological Material	Color	Hardness	From	To
TOP SOIL	BLACK	SOFT	0	1
SAND (MEDIUM)	BROWN	MEDIUM	1	20
SANDY CLAY	GRAY	MEDIUM	20	40
CLAY	GRAY	MEDIUM	40	93
SANDY CLAY	GRAY	MEDIUM	93	112
SILTY CLAYEY SAND	RED	MEDIUM	112	145
GRAVEL LOOSE	RED/BRN		145	165
CLAY	GRAY	MEDIUM	165	178
GRAVEL	GRAY	MEDIUM	178	185
SANDY CLAY	RED	MEDIUM	185	195
SAND	RED	MEDIUM	195	198
LIMESTONE	TAN	HARD	198	320

Drilling Fluid --

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Recovery well

Casing Type Steel (black or low carbon) **Joint** Welded **Drive Shoe?** ☑ Yes ☐ No **Above/Below** 1 **ft.**

Casing Diameter	Weight	Hole Diameter
20 in. to 201 ft.	78.6 lbs./ft.	20 in. to 214 ft.
14 in. to 214 ft.	54.57 lbs./ft.	14 in. to 320 ft.

Open Hole from 214 ft. to 320 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
82 ft. from Land surface Date Measured 05/14/1993

PUMPING LEVEL (below land surface)
94 ft. after 72 hrs. pumping 1000 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
WELL ORIGINALLY USED FOR EXTRACTION (EXTRACTION WELL 1).

Located by: Minnesota Department of Health **Method:** GPS Differentially Corrected
Unique Number Verification: N/A **Input Date:** 07/27/1999
System: *UTM - Nad83, Zone15, Meters* **X:** 484591 **Y:** 4989373

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 214 ft. 20 yrds.

Nearest Known Source of Contamination
__feet __direction __type

Well disinfected upon completion? ☐ Yes ☑ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock Prairie Du Chien Group **Aquifer** Prairie Du Chien Group
Last Strat Prairie Du Chien Group **Depth to Bedrock** 198 **ft.**

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Bergerson-Caswell	27058	MANTHIE, D.

County Well Index Online Report **520931** Printed 10/30/2009 HE-01205-07

Minnesota Unique Well No.

554216

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 05/31/1996
Update Date 04/12/2007
Received Date

Well Name NEW BRIGHTON 14

Township	Range	Dir	Section	Subsections	Elevation	Elevation Method
30	23	W	29	BCABCB	883 ft.	7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
295 ft.	295 ft.	12/19/1995

Drilling Method Cable Tool

Well Address
7TH ST NW
NEW BRIGHTON MN 55112

Drilling Fluid Water

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Community Supply **PWS ID** 1620009 **Source** S12

Geological Material	Color	Hardness	From	To
SAND	BROWN	SOFT	0	22
CLAY	BLUE	SOFT	22	83
SAND & GRAVEL	BROWN	SOFT	83	110
SAND	BROWN	SOFT	110	143
CLAY	BROWN	SOFT	143	164
SAND & GRAVEL	TAN	SOFT	164	171
SANDSTONE	WHITE	MEDIUM	171	178
LIMESTONE	TAN	HARD	178	241
LIMESTONE	PINK	HARD	241	262
LIMESTONE	GRAY	HARD	262	290
SANDSTONE	TAN	MEDIUM	290	295

Casing Type Steel (black or low carbon) **Joint** Welded **Drive Shoe?** ☐ Yes ☐ No **Above/Below** ft.

Casing Diameter	Weight	Hole Diameter
24 in. to 171 ft.	94 lbs./ft.	23 in. to 188 ft.
18 in. to 188 ft.	70 lbs./ft.	17 in. to 295 ft.

Open Hole from 188 ft. to 295 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
62.4 ft. from Land surface Date Measured 12/12/1995

PUMPING LEVEL (below land surface)
64.5 ft. after 8 hrs. pumping 1290 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

NO REMARKS

Located by: Minnesota Department of Health **Method:** GPS SA On (averaged)
Unique Number Verification: N/A **Input Date:** 05/27/1999
System: *UTM - Nad83, Zone15, Meters* **X:** 483832 **Y:** 4989688

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 188 ft. 189 bags

Nearest Known Source of Contamination
150 feet N direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☐ No

First Bedrock St.Peter
Last Strat Jordan
Aquifer Prairie Du Chien Group
Depth to Bedrock 171 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Keys Well Co.	62012	SAMPSON, J.

County Well Index Online Report **554216** Printed 10/30/2009
HE-01205-07

Minnesota Unique Well No.

582628

County Ramsey
Quad New Brighton
Quad ID 119C

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 103I

Entry Date 06/25/1998
Update Date 04/12/2007
Received Date

Well Name NEW BRIGHTON 15

Township Range Dir Section Subsections Elevation 933 ft.

30 23 W 30 ADCBAB **Elevation Method** 7.5 minute topographic map (+/- 5 feet)

Well Depth	Depth Completed	Date Well Completed
345 ft.	345 ft.	09/00/1997

Drilling Method Cable Tool

Well Address
20TH AV NW
NEW BRIGHTON MN 55112

Drilling Fluid Water

Well Hydrofractured? ☐ Yes ☐ No
From Ft. to Ft.

Use Community Supply **PWS ID** 1620009 **Source** S13

Geological Material	Color	Hardness	From	To
SAND & GRAVEL	BROWN	SOFT	0	40
SAND	BROWN	SOFT	40	132
SAND, GRAVEL, CLAY	BROWN	SOFT	132	155
SAND-FINE	GRAY	SOFT	155	160
SHALE & GRAVEL	GRAY	SOFT	160	187
SAND & GRAVEL	BROWN	SOFT	187	208
SANDSTONE	TAN	MEDIUM	208	221
LIMESTONE	TAN	HARD	221	235
SANDSTONE	WHITE	MEDIUM	235	238
LIMESTONE	TAN	HARD	238	340
SANDSTONE	WHITE	MEDIUM	340	345

Casing Type Steel (black or low carbon) **Joint** Welded **Drive Shoe?** ☑ Yes ☐ No **Above/Below** ft.

Casing Diameter	Weight	Hole Diameter
24 in. to 223 ft.	94.62 lbs./ft.	24 in. to 253 ft.
18 in. to 253 ft.	70.59 lbs./ft.	17 in. to 345 ft.

Open Hole from 253 ft. to 345 ft.

Screen NO **Make** **Type**

Diameter	Slot/Gauze	Length	Set Between

Static Water Level
112 ft. from Land surface Date Measured 09/23/1997

PUMPING LEVEL (below land surface)
122 ft. after 24 hrs. pumping 1200 g.p.m.

Well Head Completion
Pitless adapter manufacturer Model
☐ Casing Protection ☑ 12 in. above grade
☐ At-grade (Environmental Wells and Borings ONLY)

REMARKS
M.G.S. NO. 3849.

Located by: Minnesota Department of Health **Method:** GPS SA On (averaged)
Unique Number Verification: N/A **Input Date:** 05/27/1999
System: *UTM - Nad83, Zone15, Meters* **X:** 483300 **Y:** 4989523

Grouting Information Well Grouted? ☑ Yes ☐ No

Grout Material: Neat Cement from 0 to 253 ft. 26.75 yrds.

Nearest Known Source of Contamination
75 feet North East direction Septic tank/drain field type
Well disinfected upon completion? ☑ Yes ☐ No

Pump ☐ Not Installed Date Installed
Manufacturer's name Model number __ HP _ Volts
Length of drop Pipe _ft. Capacity _g.p.m Type Material

Abandoned Wells Does property have any not in use and not sealed well(s)? ☐ Yes ☑ No

Variance Was a variance granted from the MDH for this well? ☐ Yes ☑ No

Cuttings Yes
First Bedrock St.Peter **Aquifer** Prairie Du Chien Group
Last Strat Jordan **Depth to Bedrock** 208 ft.

Well Contractor Certification

License Business Name	Lic. Or Reg. No.	Name of Driller
Keys Well Co.	62012	GALVIN, M.

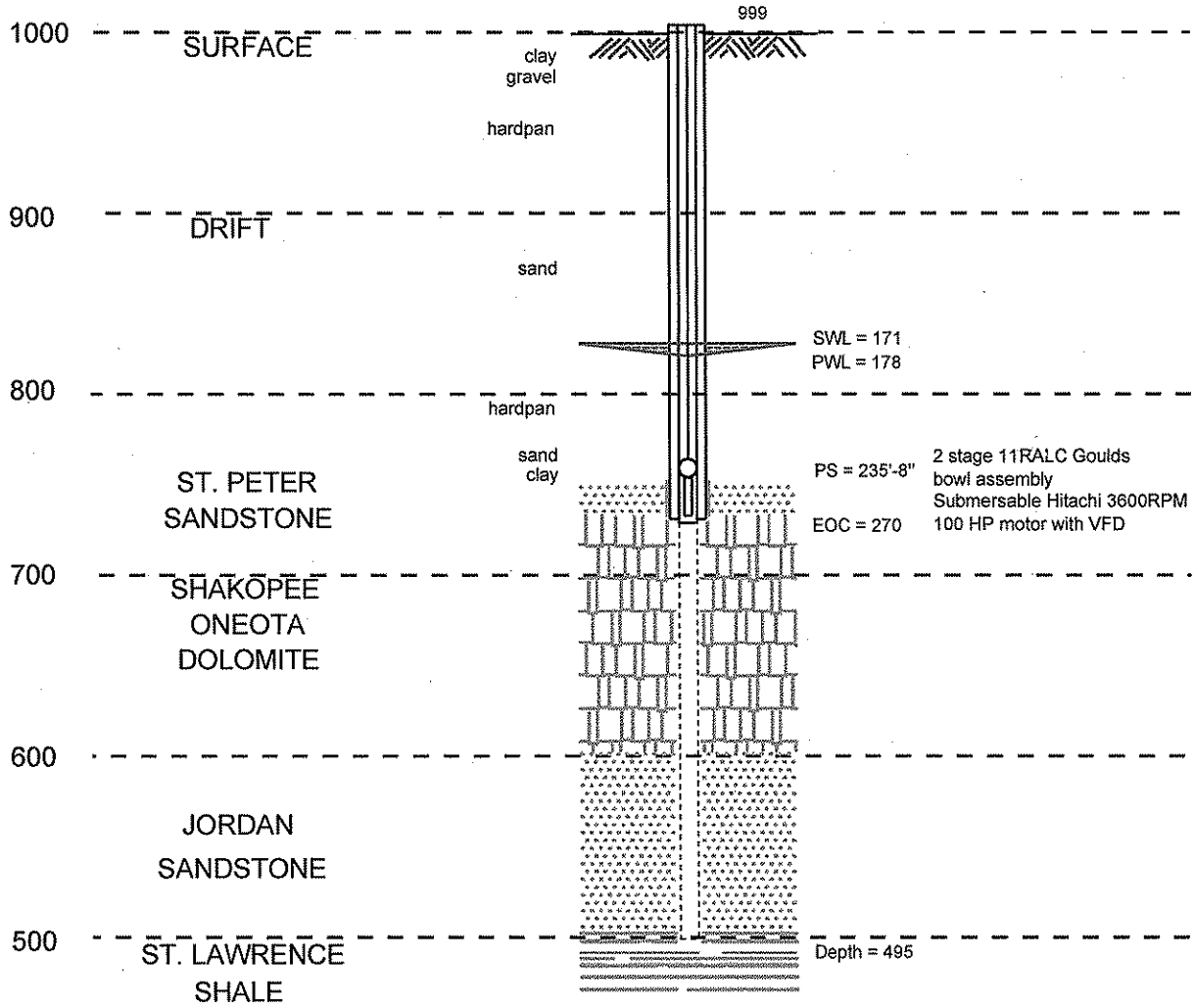
County Well Index Online Report **582628** Printed 10/30/2009
HE-01205-07

WELL 3

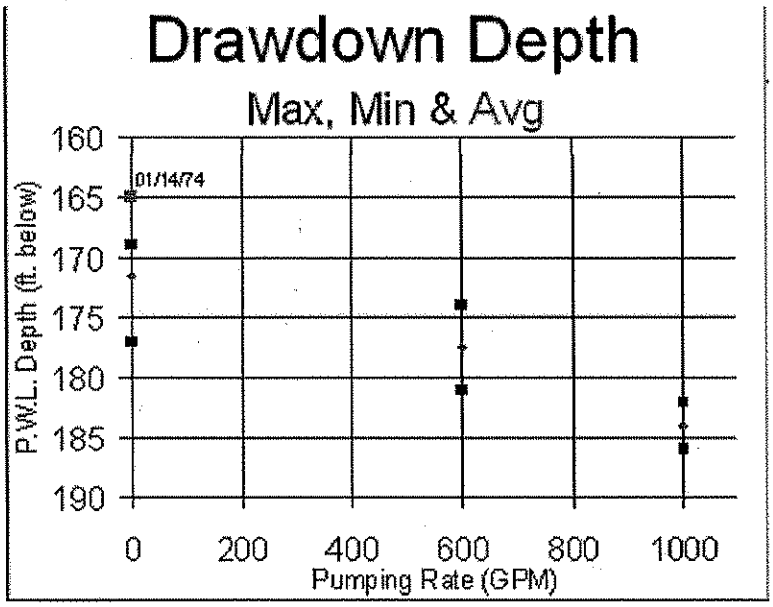
Address: 700 Siver Lake Road
DNR #: 206793
Excel meters: 0003471841 & 0000604387
Year installed: 1955

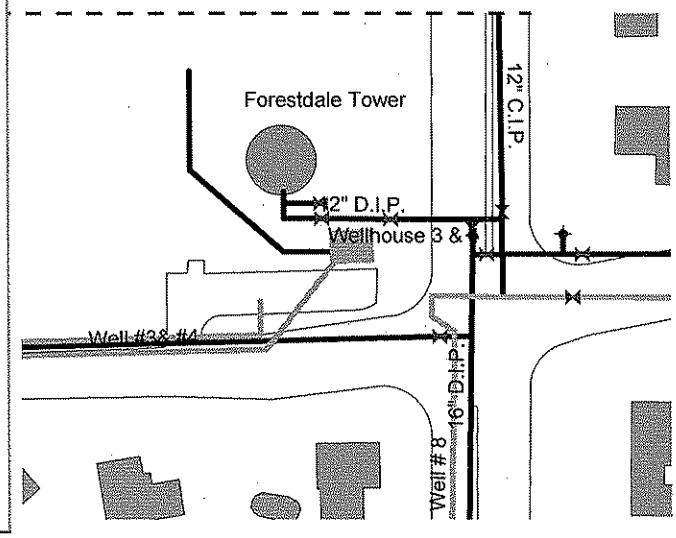
Casing size: 24"x16"
Capacity: 600 GPM
Remedial Target: 0 GPM
Priority: 2

MSE



EOC.....END OF CASING
PS.....PUMP SETTING
PWL.....PUMPING WATER LEVEL
SWL.....STATIC WATER LEVEL

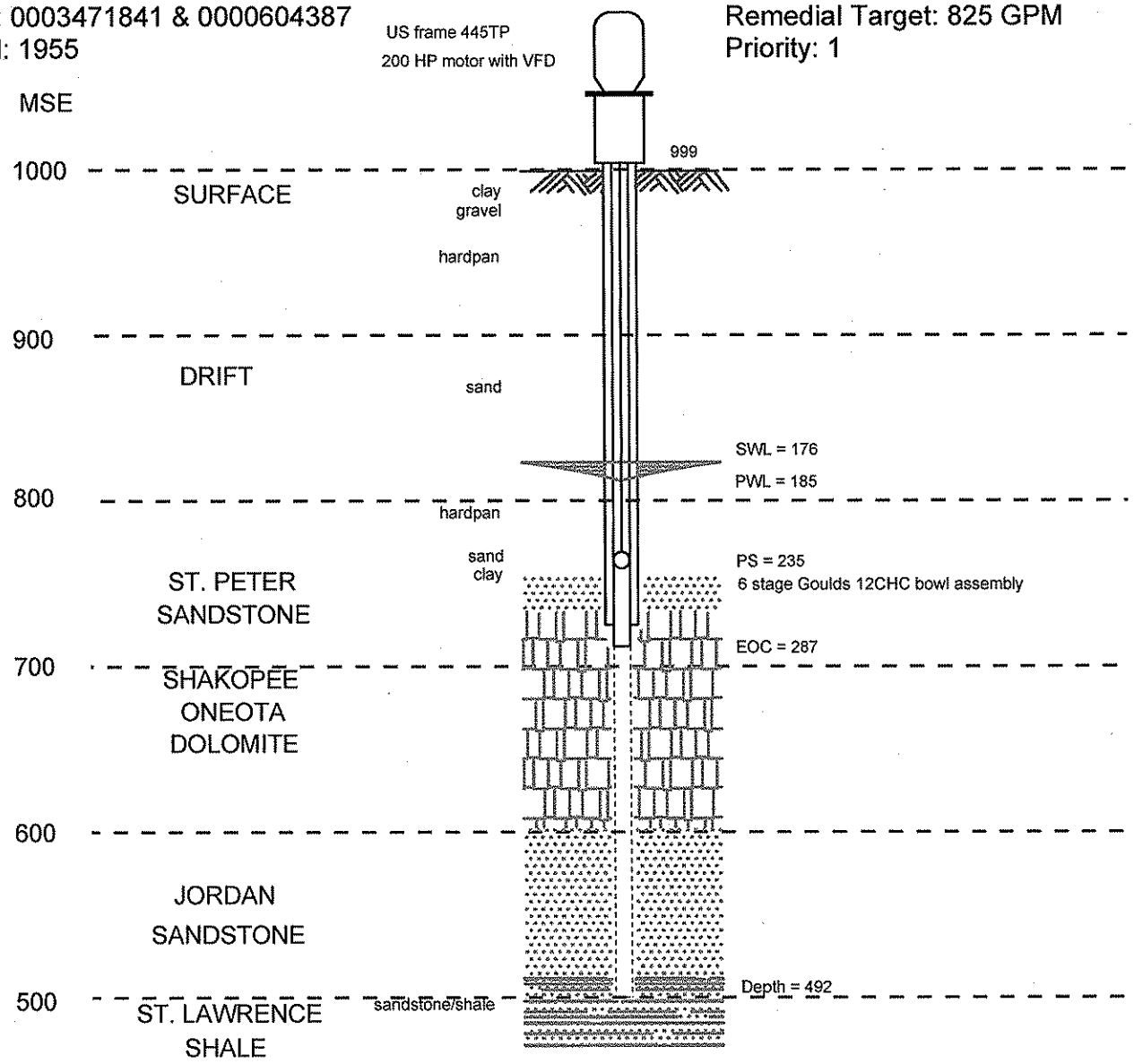




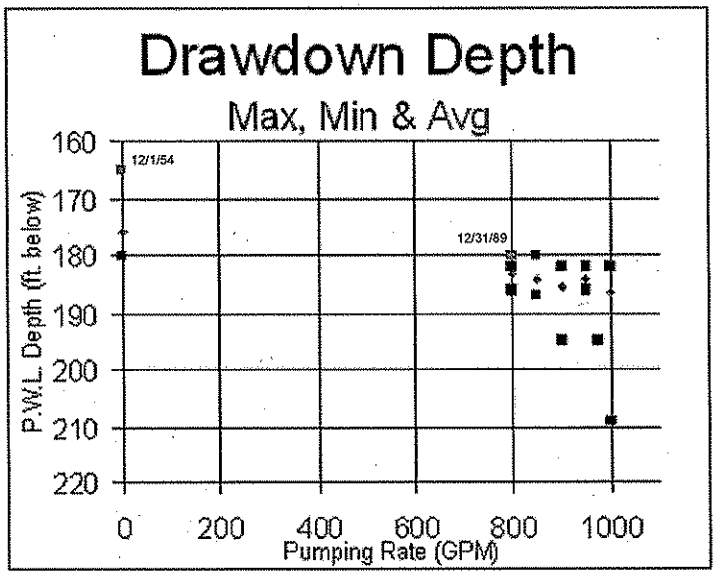
WELL 4

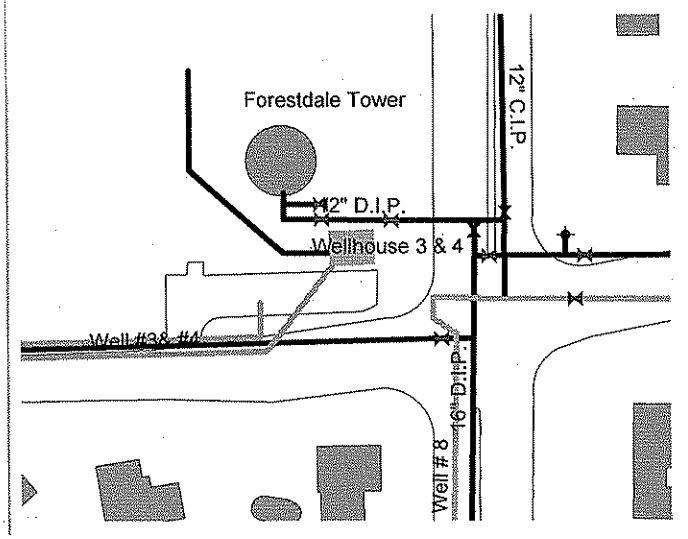
Address: 700 Siver Lake Road
DNR #: 206792
Excel meters: 0003471841 & 0000604387
Year installed: 1955

Casing size: 24"x16"
Capacity: 1100 GPM
Remedial Target: 825 GPM
Priority: 1



EOC.....END OF CASING
PS.....PUMP SETTING
PWL.....PUMPING WATER LEVEL
SWL.....STATIC WATER LEVEL

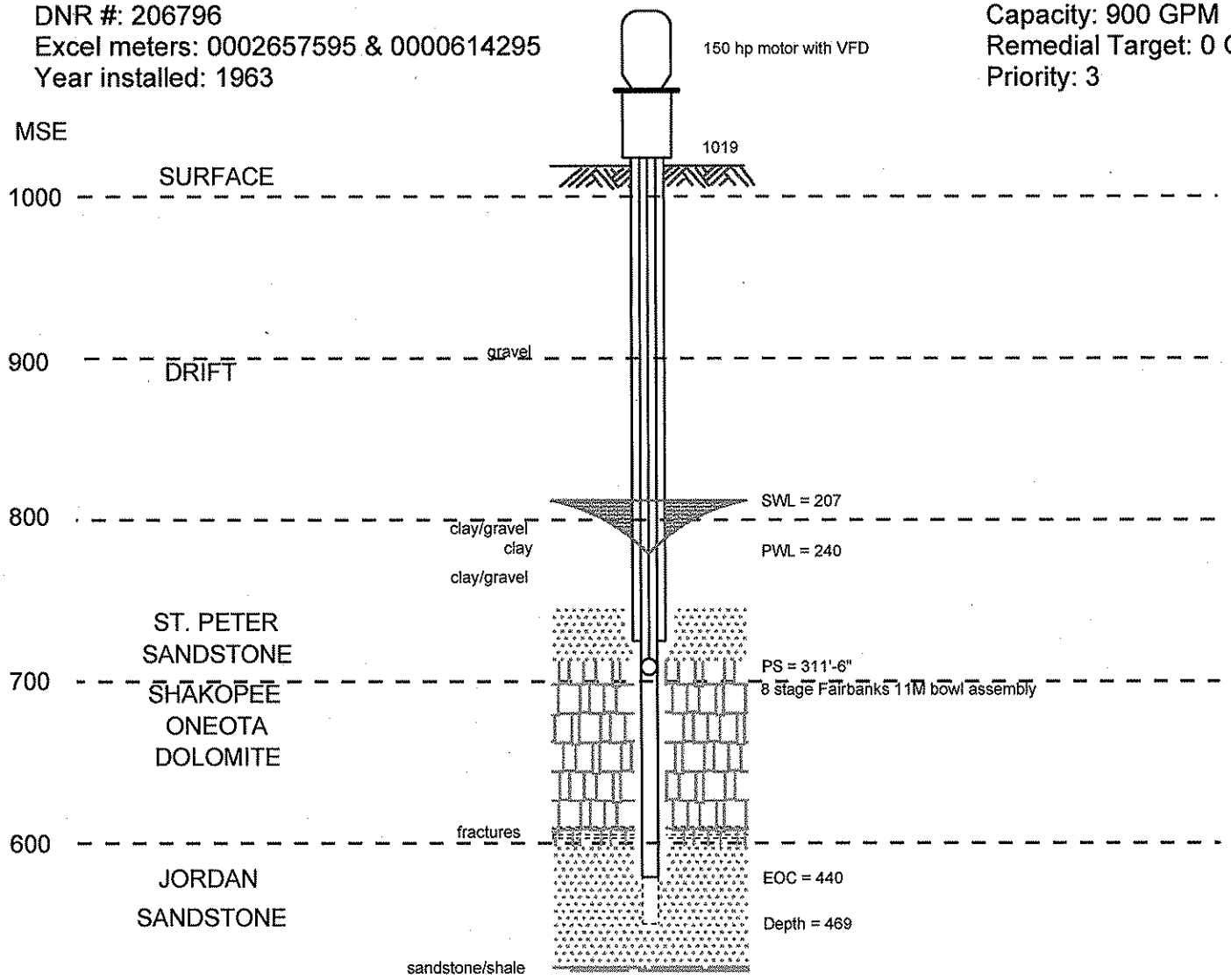




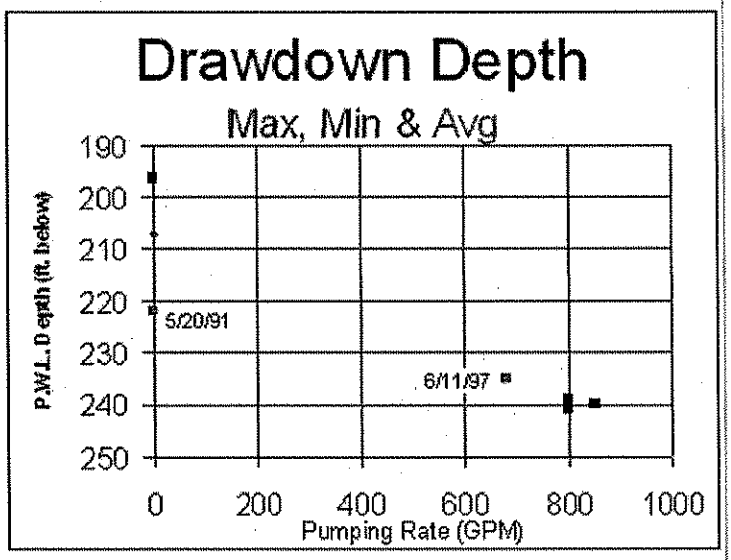
WELL 5

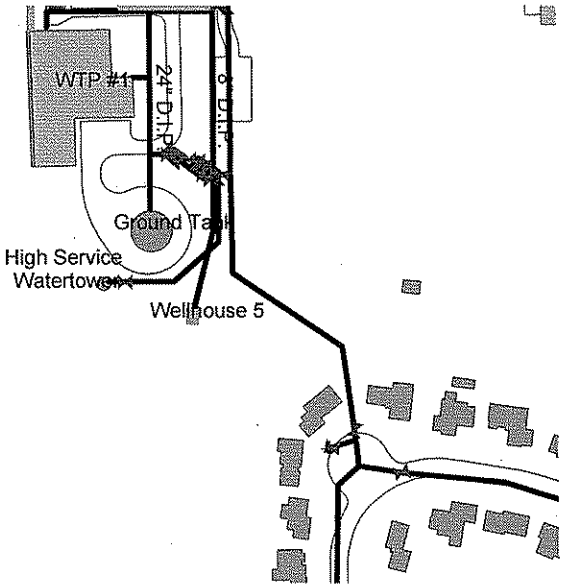
Address: 3001 5th Street NW
DNR #: 206796
Excel meters: 0002657595 & 0000614295
Year installed: 1963

Casing size: 24"x16"
Capacity: 900 GPM
Remedial Target: 0 GPM
Priority: 3



EOC.....END OF CASING
PS.....PUMP SETTING
PWL.....PUMPING WATER LEVEL
SWL.....STATIC WATER LEVEL

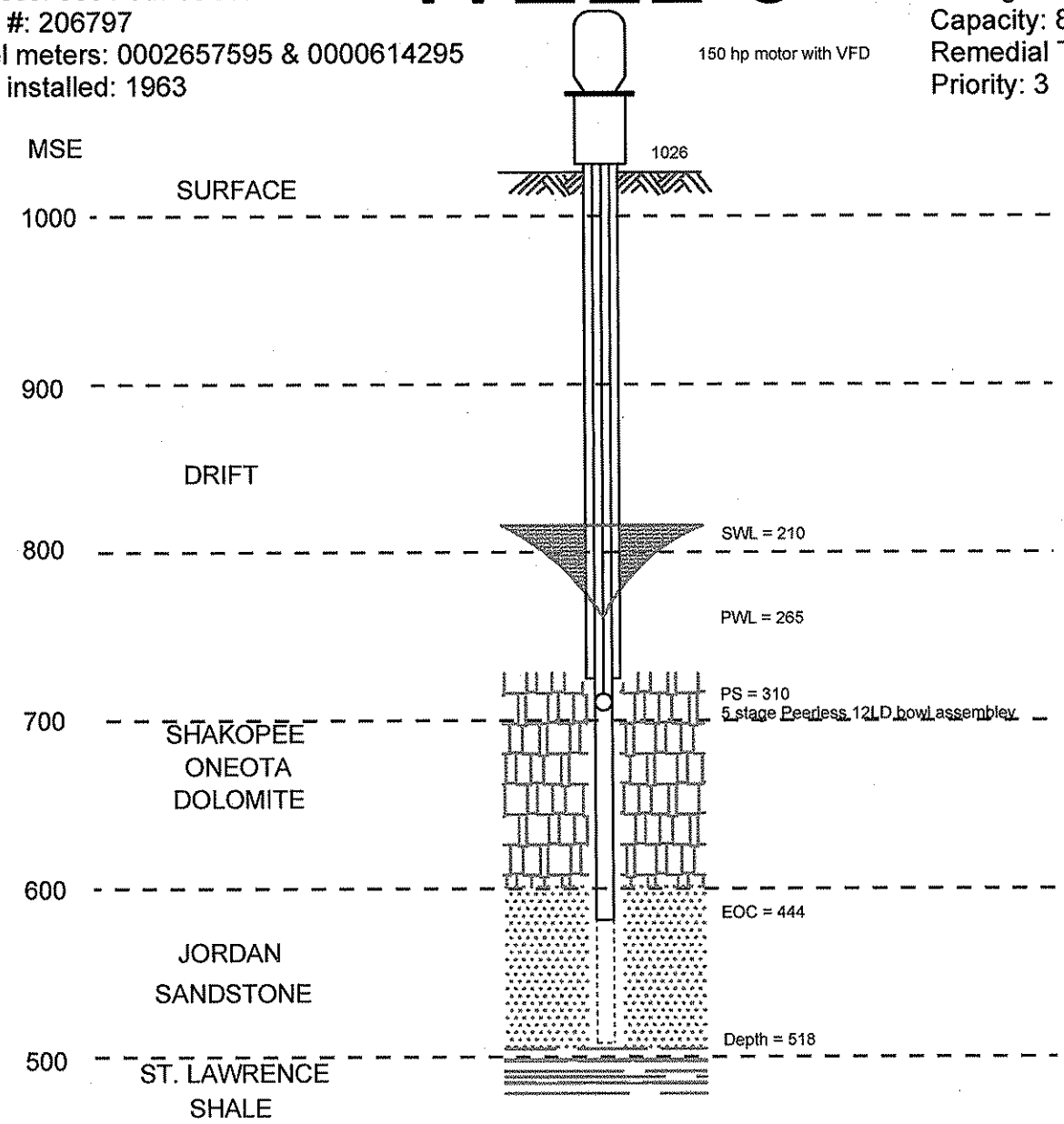




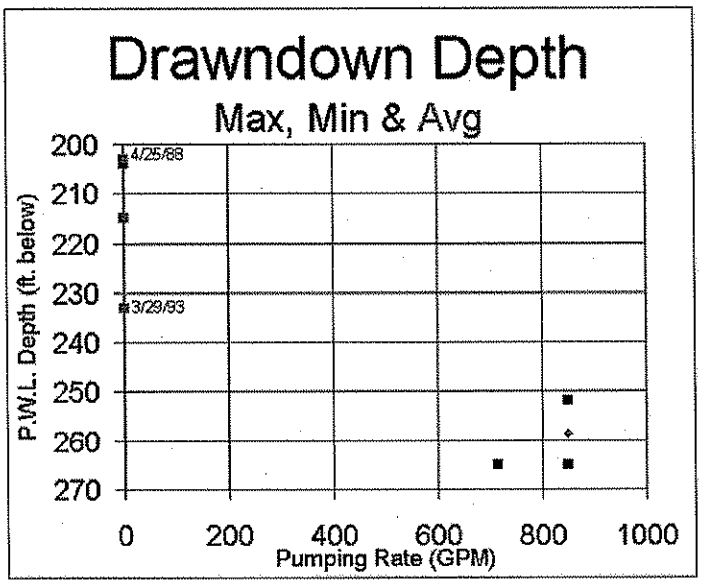
WELL 6

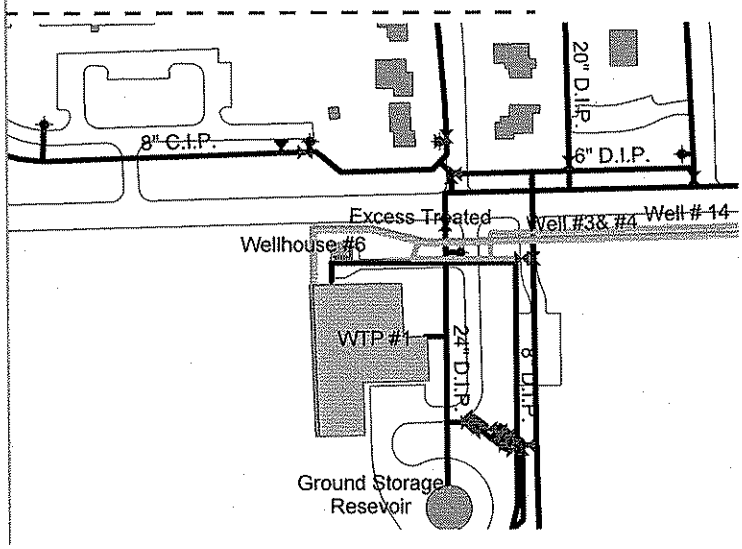
Address: 3001 5th Street NW
DNR #: 206797
Excel meters: 0002657595 & 0000614295
Year installed: 1963

Casing size: 24"x16"
Capacity: 850 GPM
Remedial Target: 0 GPM
Priority: 3



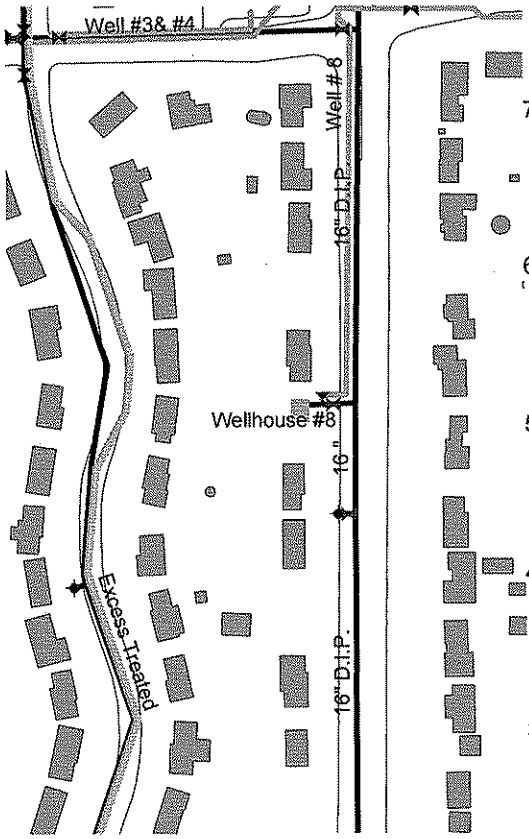
EOC.....END OF CASING
PS.....PUMP SETTING
PWL.....PUMPING WATER LEVEL
SWL.....STATIC WATER LEVEL

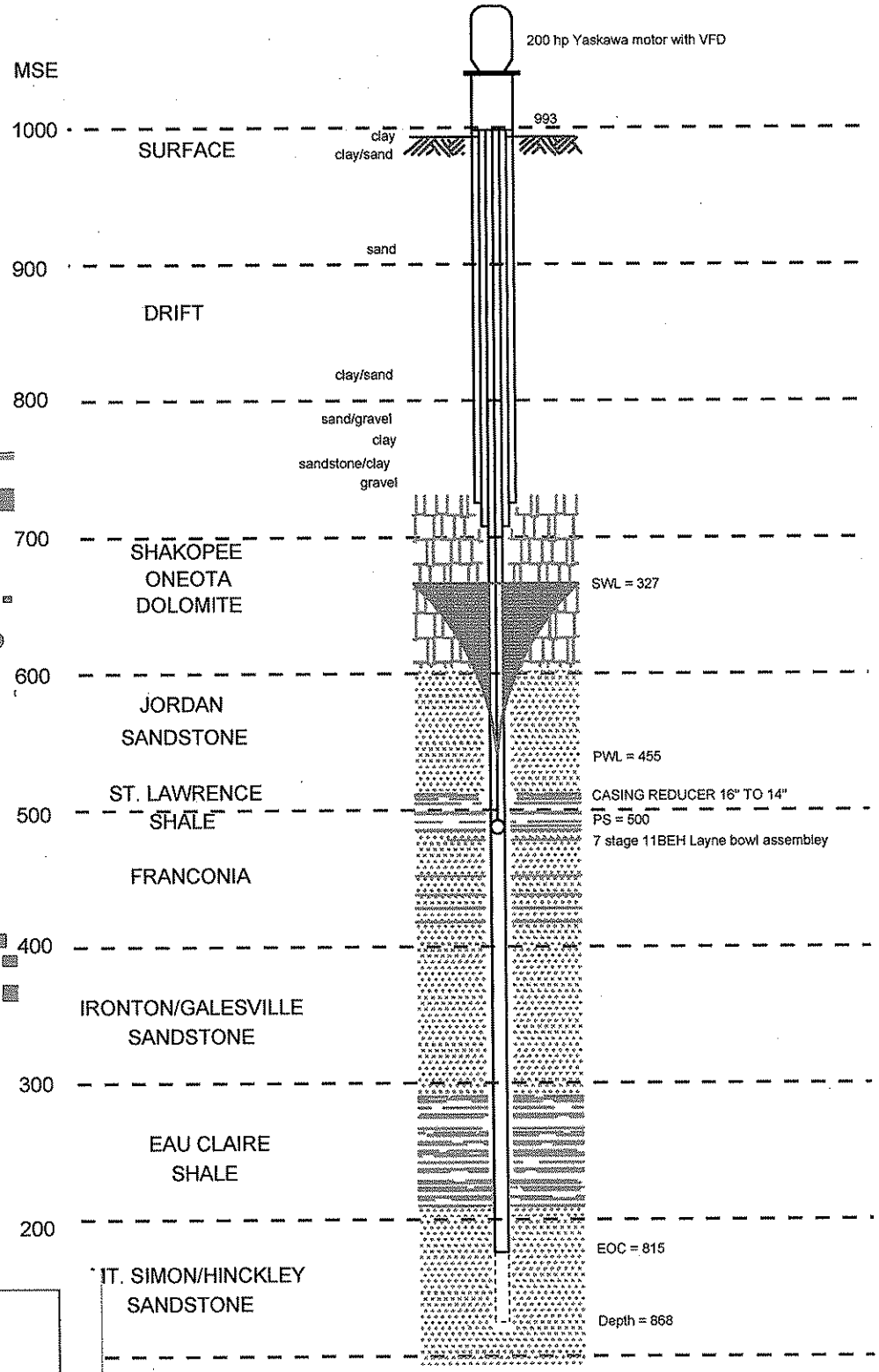




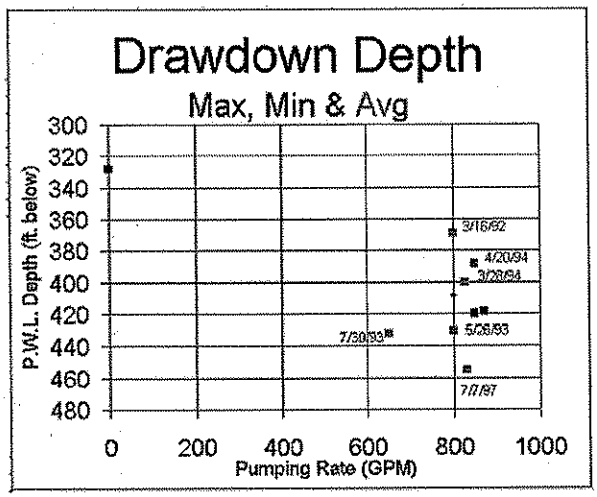
WELL 8

Casing size: 30"x24"x16"-14"
Capacity: 900 GPM
Remedial Target: 0 GPM
Priority: 4





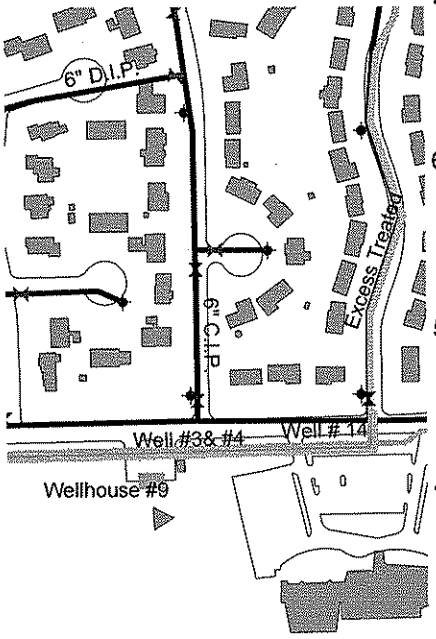
EOC.....END OF CASING
PS.....PUMP SETTING
PWL.....PUMPING WATER LEVEL
SWL.....STATIC WATER LEVEL

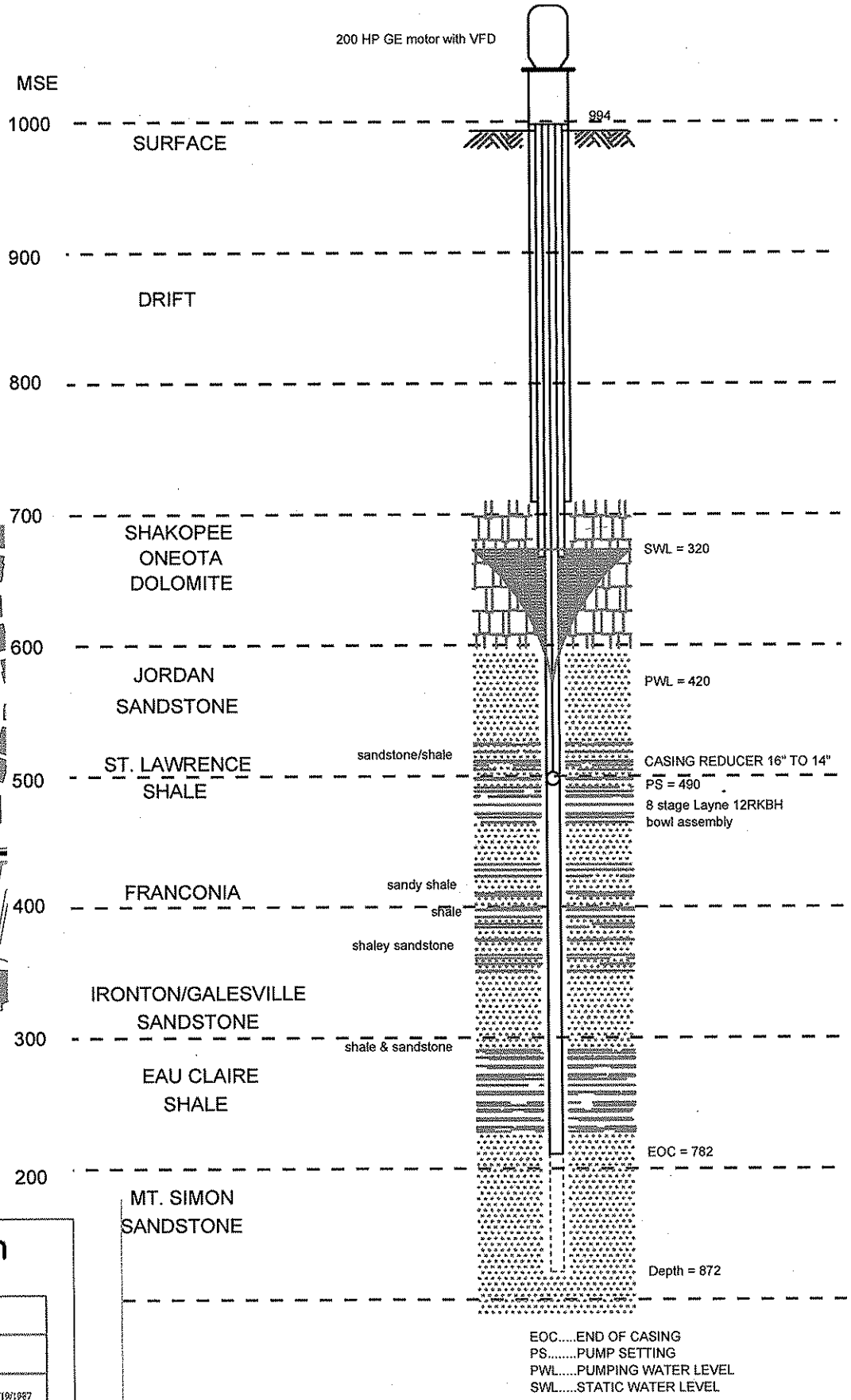


Address: 600 Siver Lake Road
DNR #: 206795
Excel meters: 0003450207 & 0000485194
Year installed: 1971, deepened in 1982

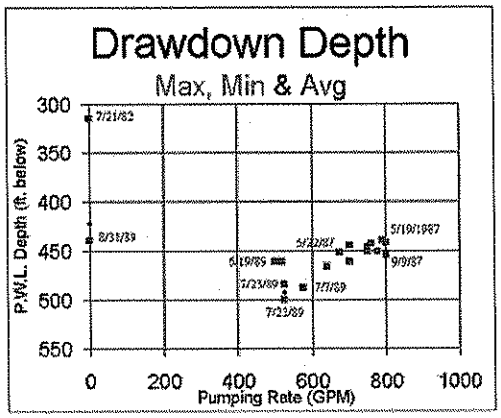
WELL 9

Casing size: 30"x24"x16"-14"
Capacity: 900 GPM
Remedial Target: 0 GPM
Priority: 4





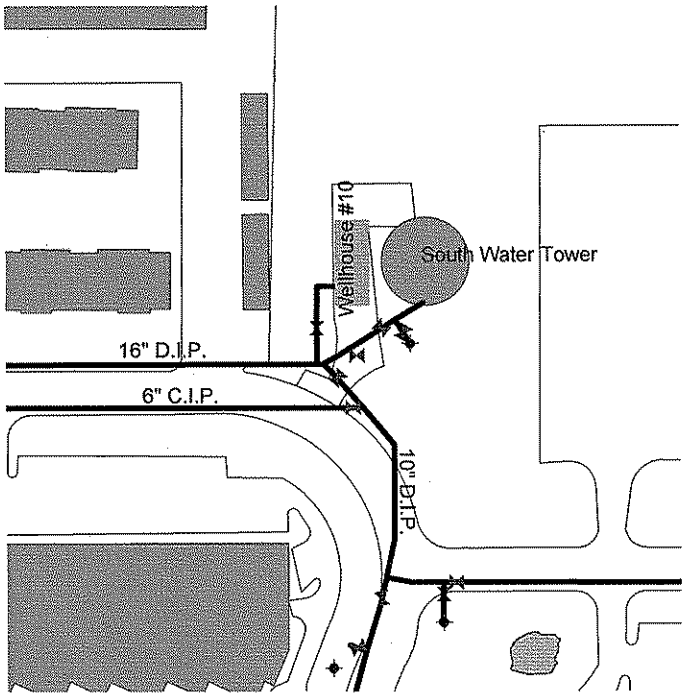
EOC.....END OF CASING
PS.....PUMP SETTING
PWL.....PUMPING WATER LEVEL
SWL.....STATIC WATER LEVEL

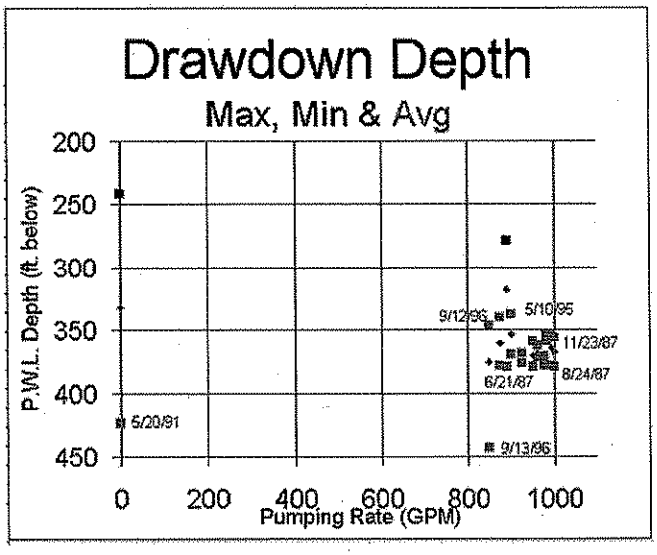


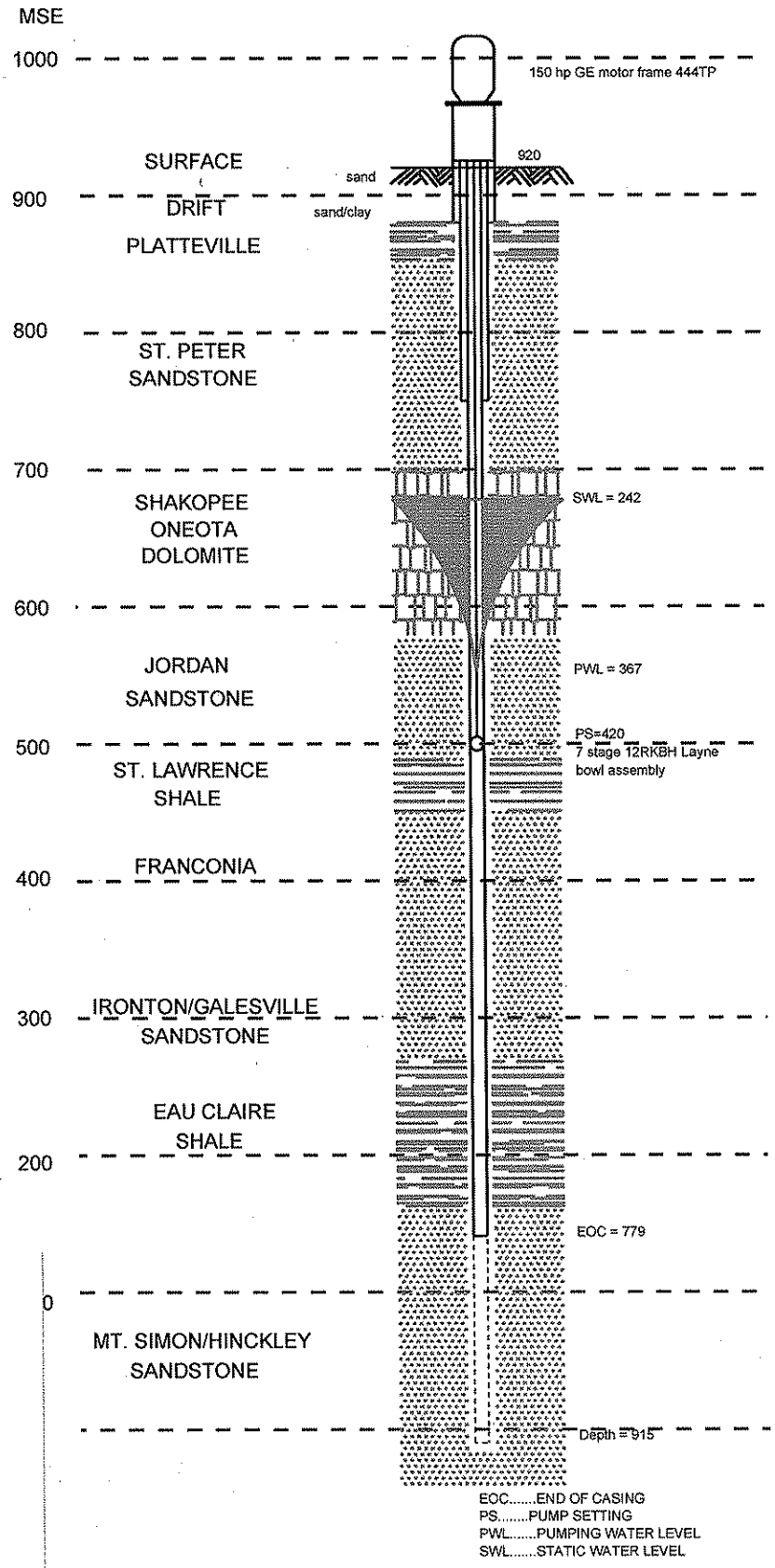
Address: 2745 5th Street NW
DNR #: 206794
Excel meters: 0003469596 & 0000537011
Year installed: 1971, Deepened in 1982

WELL 10

Casing size: 36"x24"x18"
Capacity: 900 GPM
Remedial Target: 0 GPM
Priority: 4



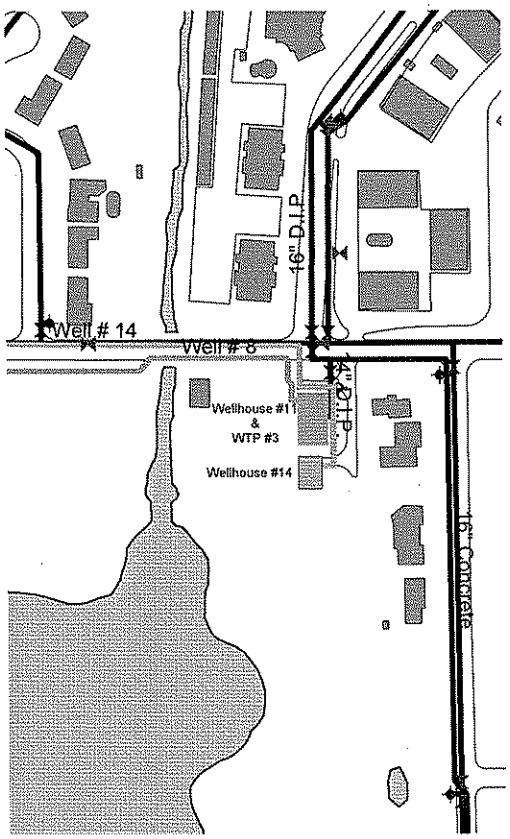


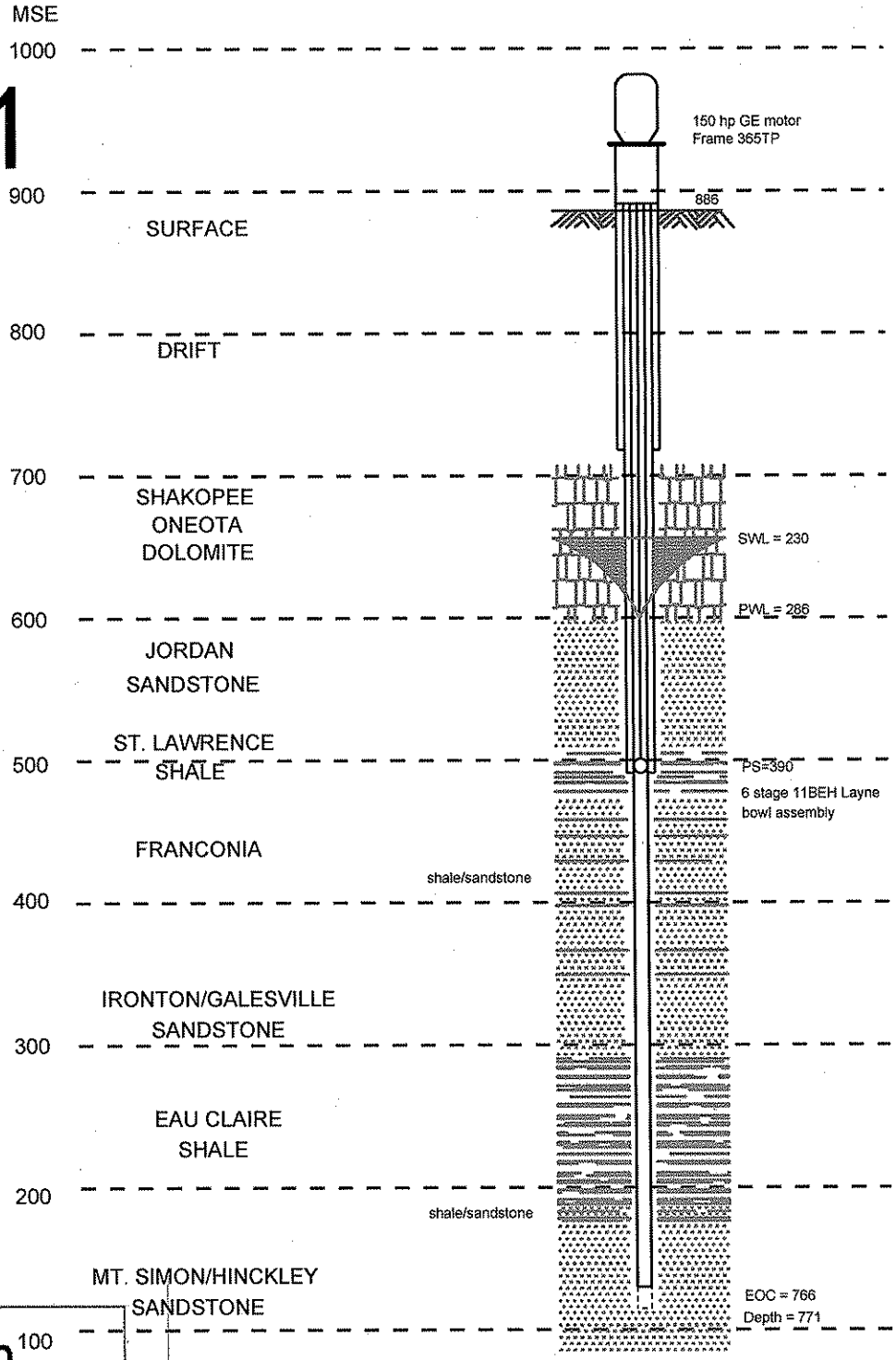


Address: 660 5th Street SW
DNR #: 161432
Excel meters: 0003577808 & 0000520619
Year installed: 1983

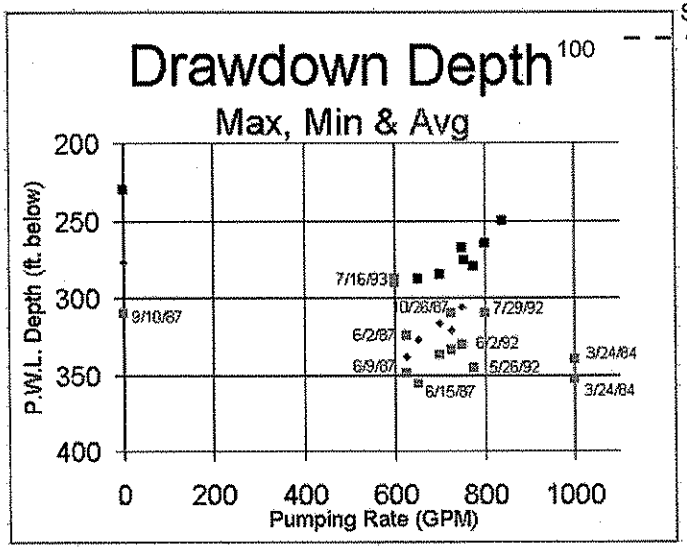
WELL 11

Casing size: 30"x24"x18"
Capacity: 1000 GPM
Remedial Target: 0 GPM
Priority: 4





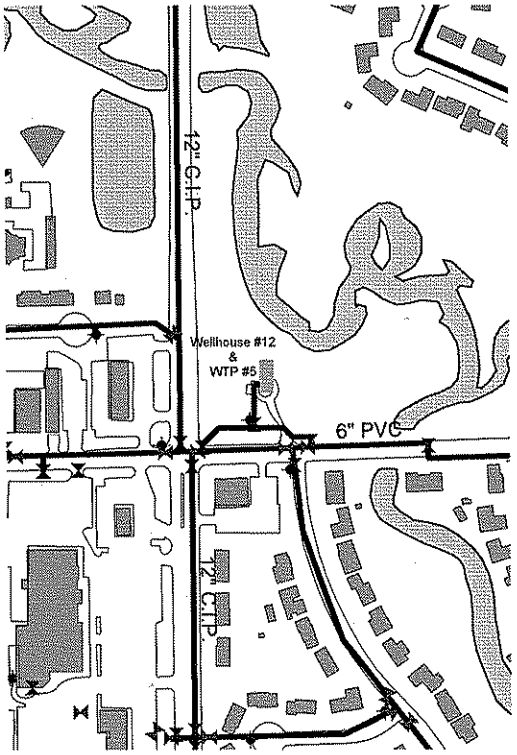
EOC.....END OF CASING
PS.....PUMP SETTING
PWL.....PUMPING WATER LEVEL
SWL.....STATIC WATER LEVEL

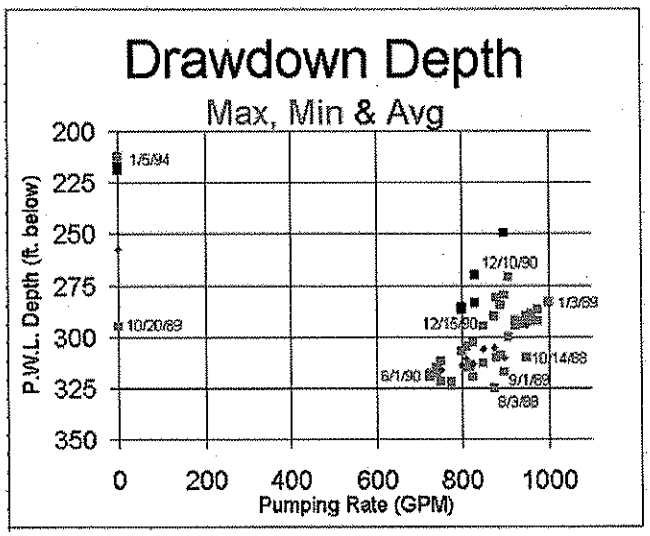


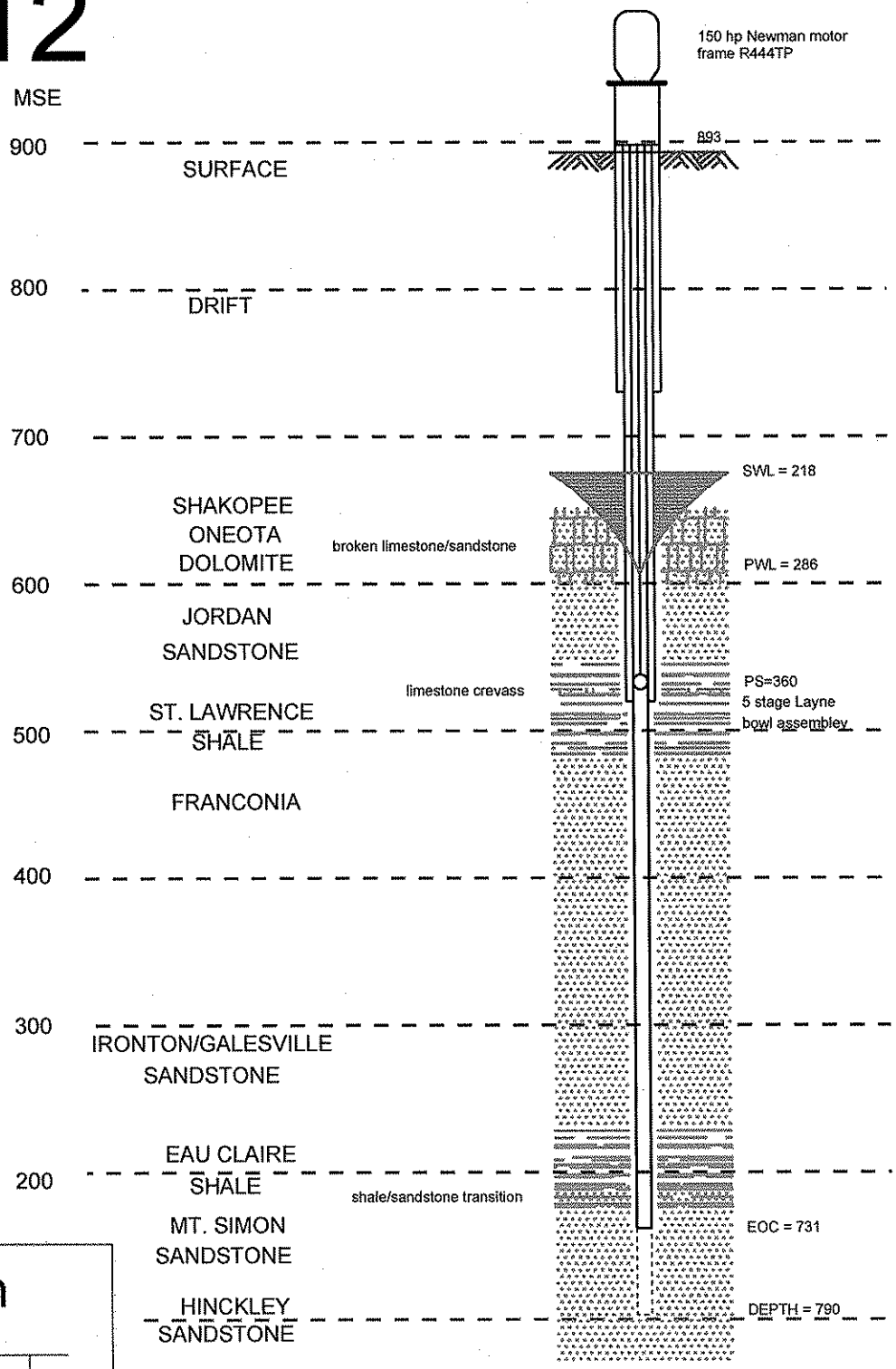
Address: 1375 7th Street NW
DNR #: 509083
Excel meters: 0003417644 & 0000501303
Year installed: 1984

WELL 12

Casing size: 30"x24"x16"
Capacity: 900 GPM
Remedial Target: 0 GPM
Priority: 4







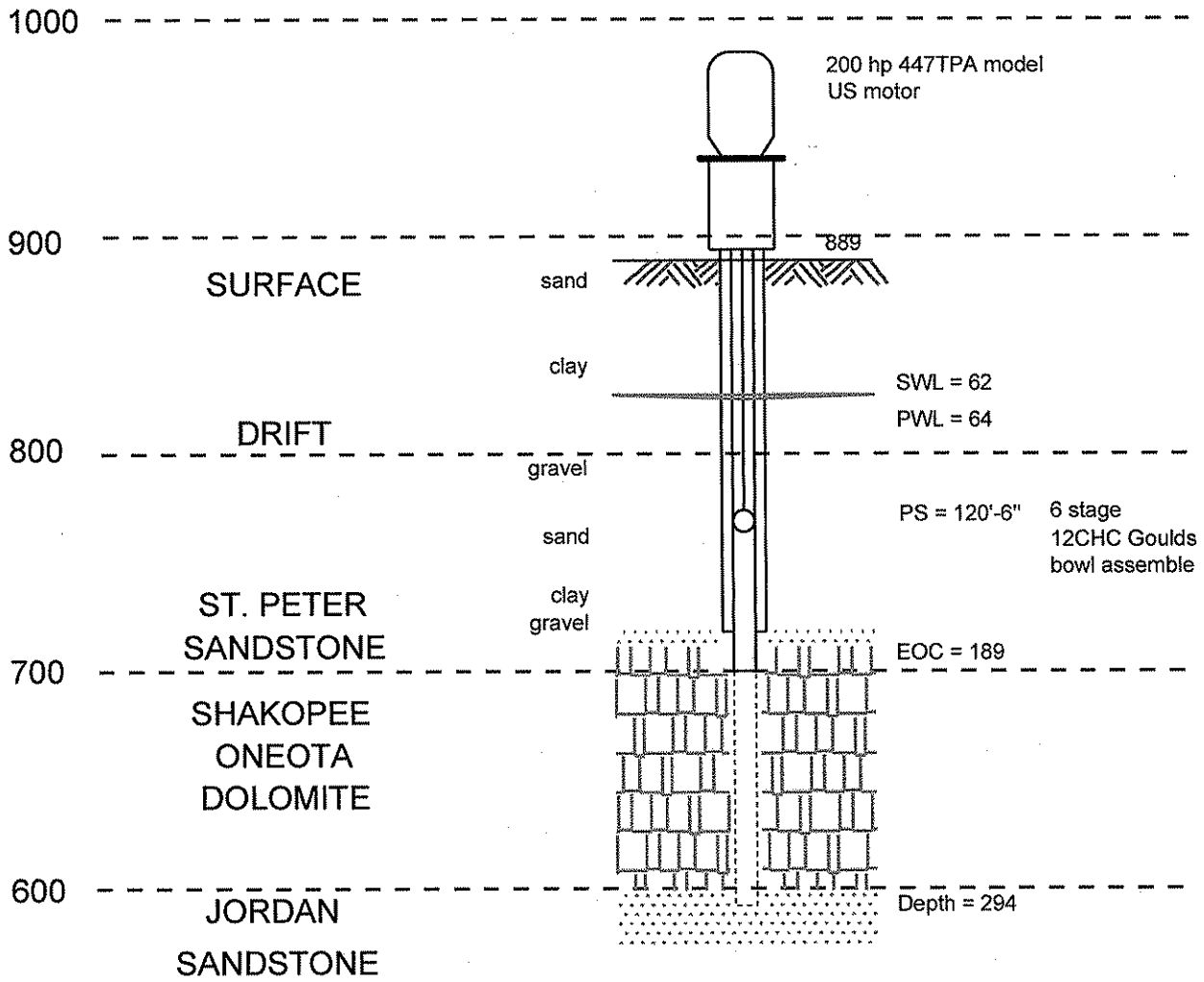
Address: 2400 Mississippi Street
DNR #: 110485
Excel meters: 0003444084 & 000105376
Year installed: 1984

WELL 14

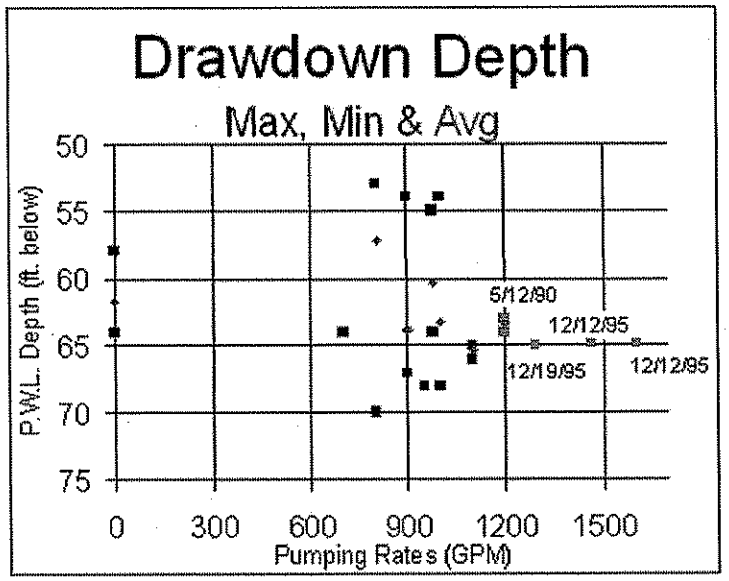
MSE

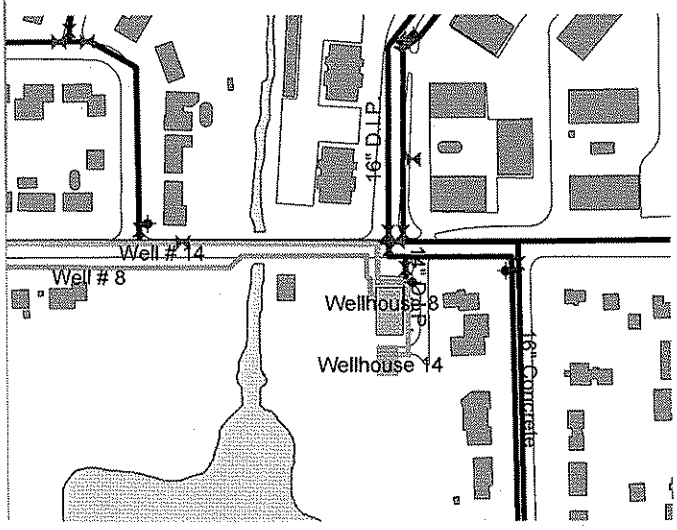
Address: 1377 7th Street NW
DNR #: 554216
Excel meters: 0002629189
Year installed: 1995

Casing size: 24"x18"
Capacity: 1200 GPM
Remedial Target: 687.5 GPM
Priority: 1



EOC.....END OF CASING
PS.....PUMP SETTING
PWL.....PUMPING WATER LEVEL
SWL.....STATIC WATER LEVEL

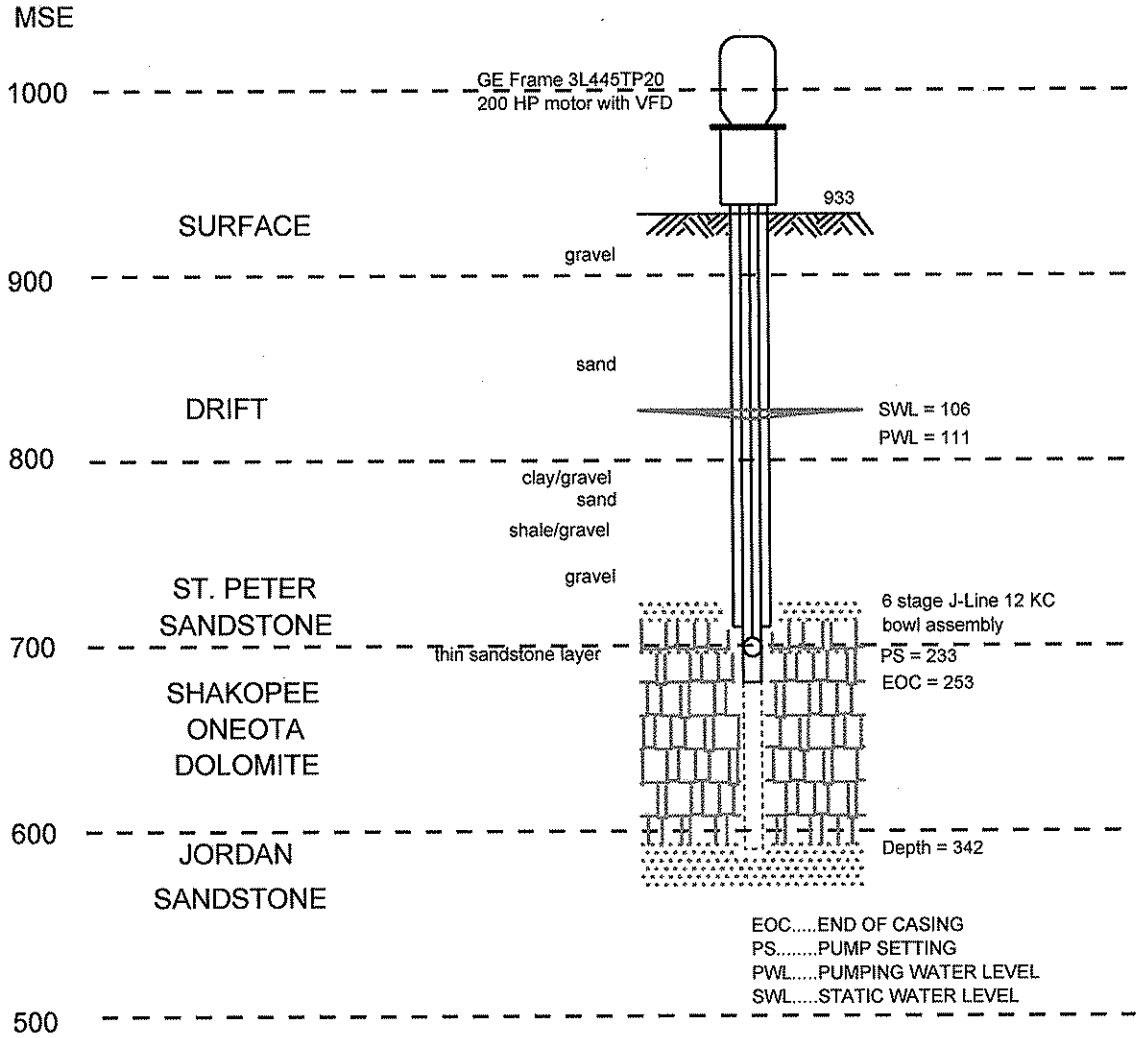


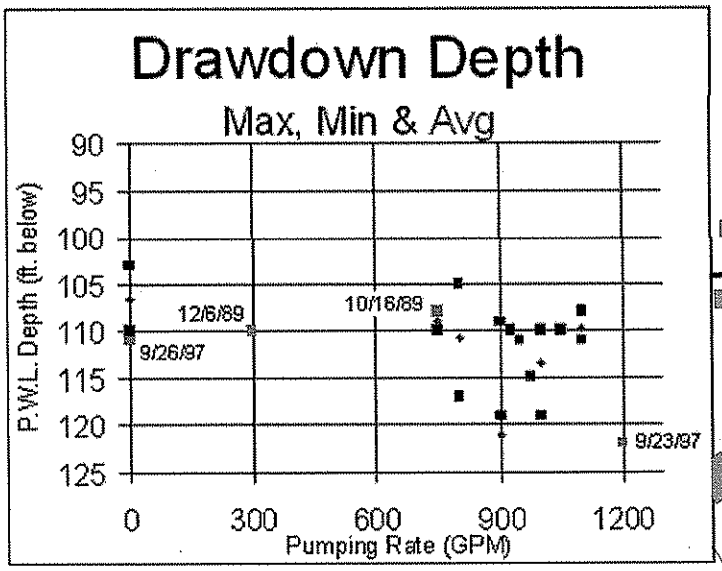


WELL 15

Address: 590 20th Avenue NW
DNR #: 582628
Excel meters: 0003600609
Year installed: 1997

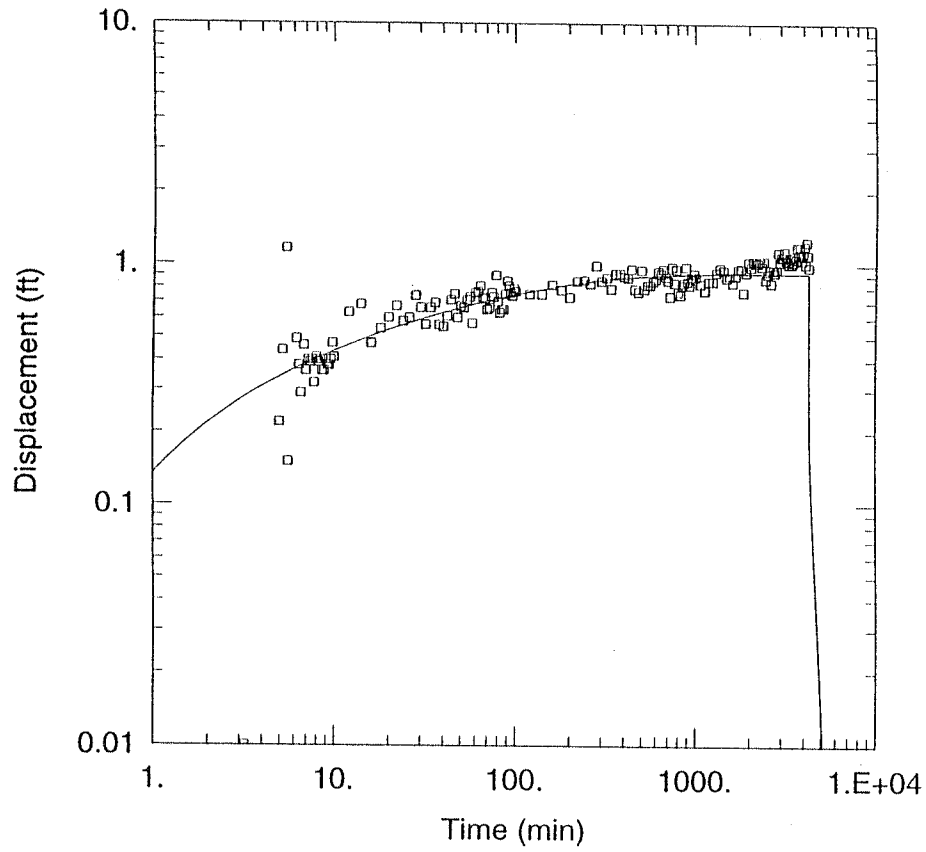
Casing size: 24"x18"
Capacity: 1000 GPM
Remedial Target: 687.5 GPM
Priority: 1





Appendix B

Aquifer Test Results



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\NB14P.AQT
Date: 02/16/99 Time: 13:48:39

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 49.34 ft^2/min
S = 105.3
r/B = 0.05

AQUIFER DATA

Saturated Thickness: 119. ft

Anisotropy Ratio (Kz/Kr): 1.

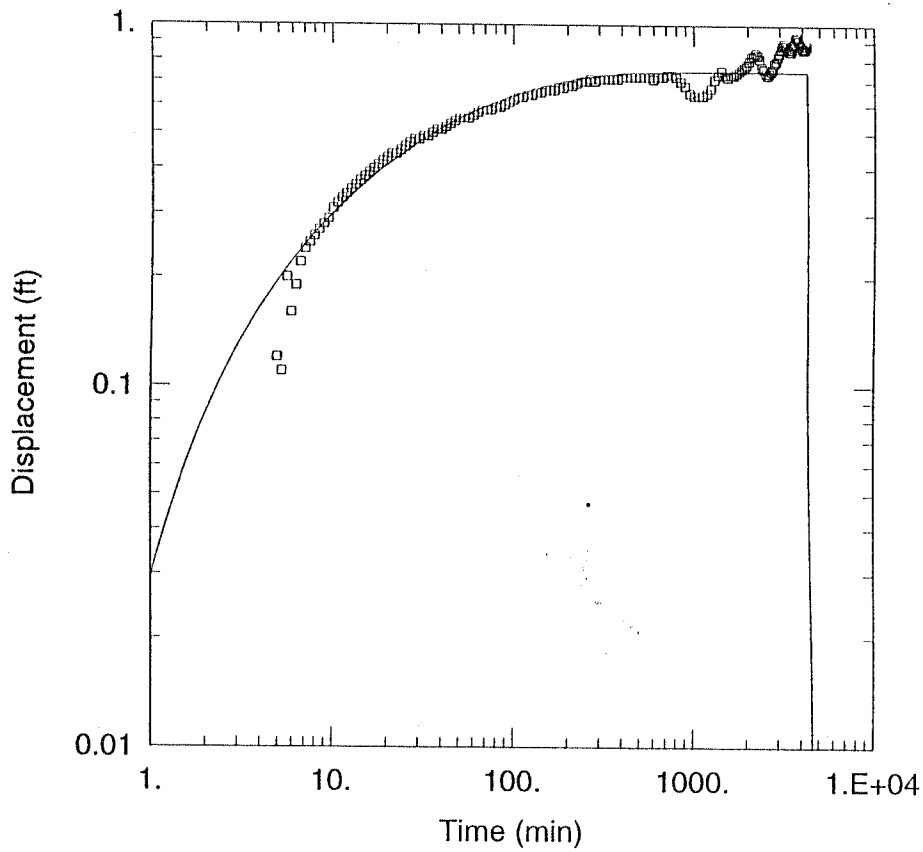
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ NB-14	0.75	0



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\MW5P.AQ

Date: 02/12/99 Time: 10:10:55

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 39.78 ft^2/min
S = 0.001538
r/B = 0.15

AQUIFER DATA

Saturated Thickness: 121. ft

Anisotropy Ratio (Kz/Kr): 1.

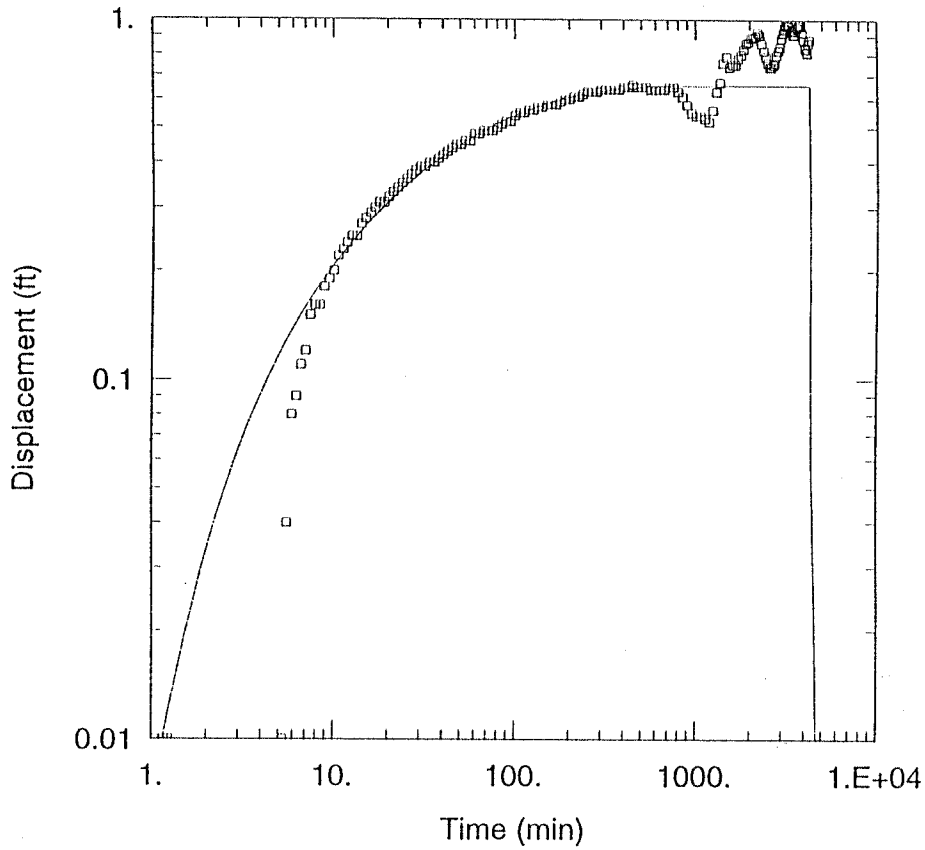
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-5	351	0



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: C:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\04U877P.A
Date: 08/19/98 Time: 09:05:44

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 39.03 ft^2/min
S = 0.0001797
r/B = 0.2

AQUIFER DATA

Saturated Thickness: 125. ft

Anisotropy Ratio (Kz/Kr): 1.

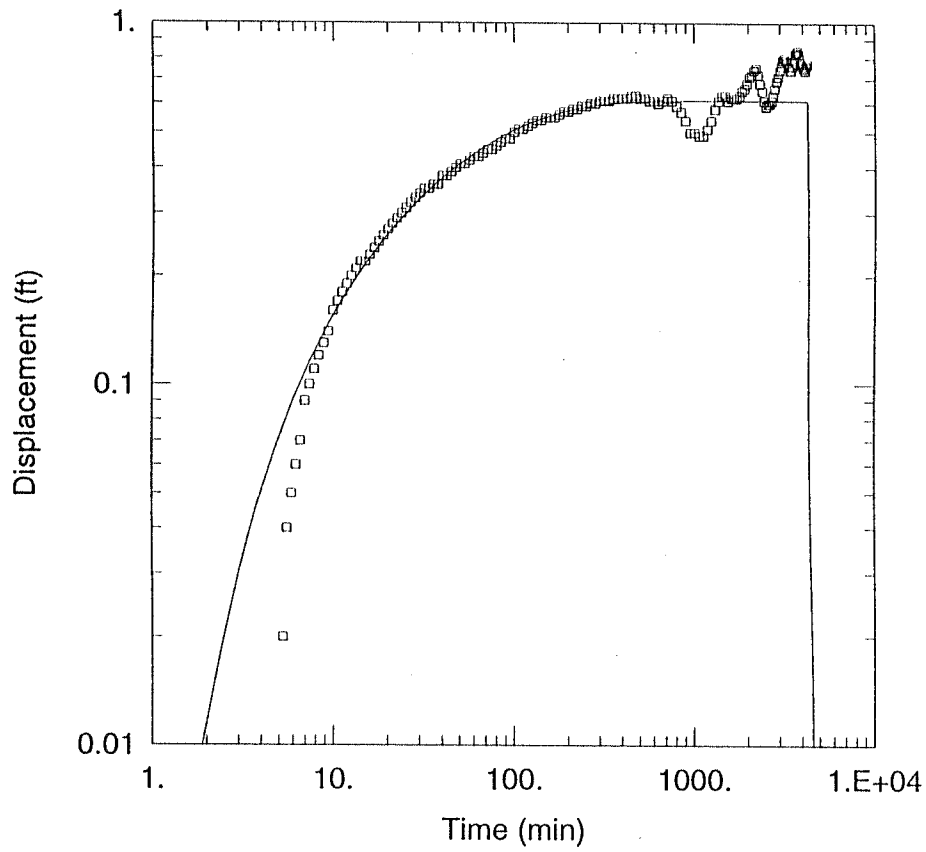
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ 04U877	1391	0



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\MW3P.AQT
Date: 02/12/99 Time: 10:11:05

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 32.83 ft^2/min
S = 0.0001769
r/B = 0.3

AQUIFER DATA

Saturated Thickness: 111. ft

Anisotropy Ratio (Kz/Kr): 1.

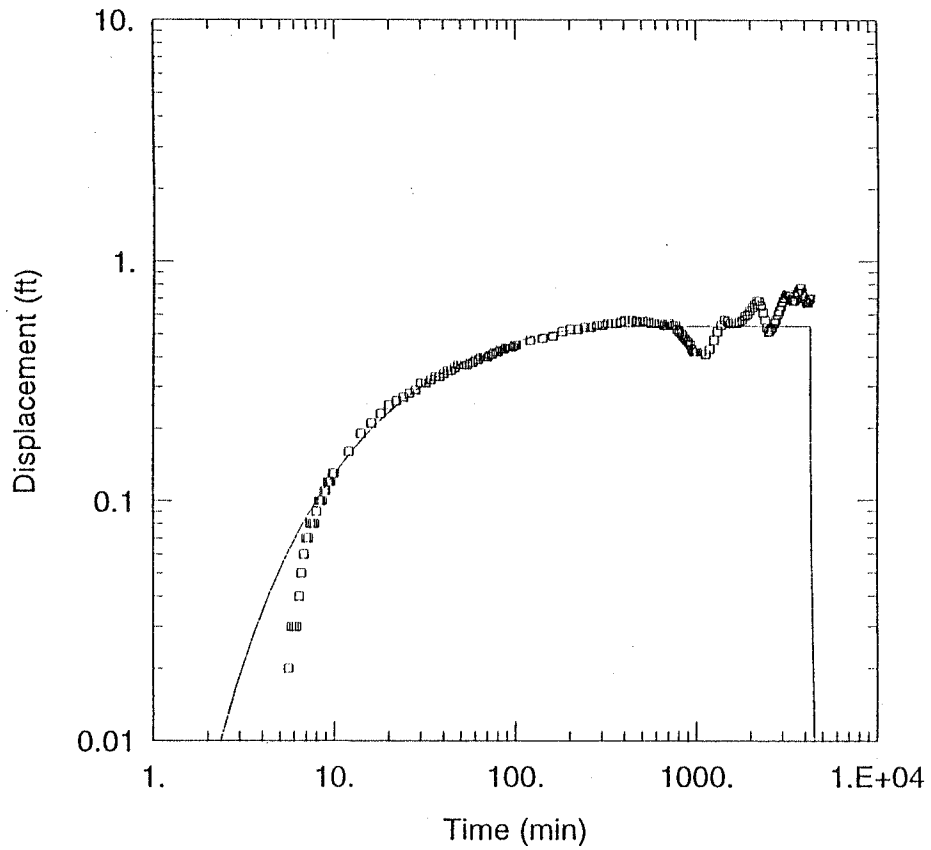
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-3	1699	0



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: C:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\NB15P.AQT
Date: 08/17/98 Time: 15:36:15

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 30.41 ft^2/min
S = 0.0001598
r/B = 0.4

AQUIFER DATA

Saturated Thickness: 119. ft

Anisotropy Ratio (Kz/Kr): 1.

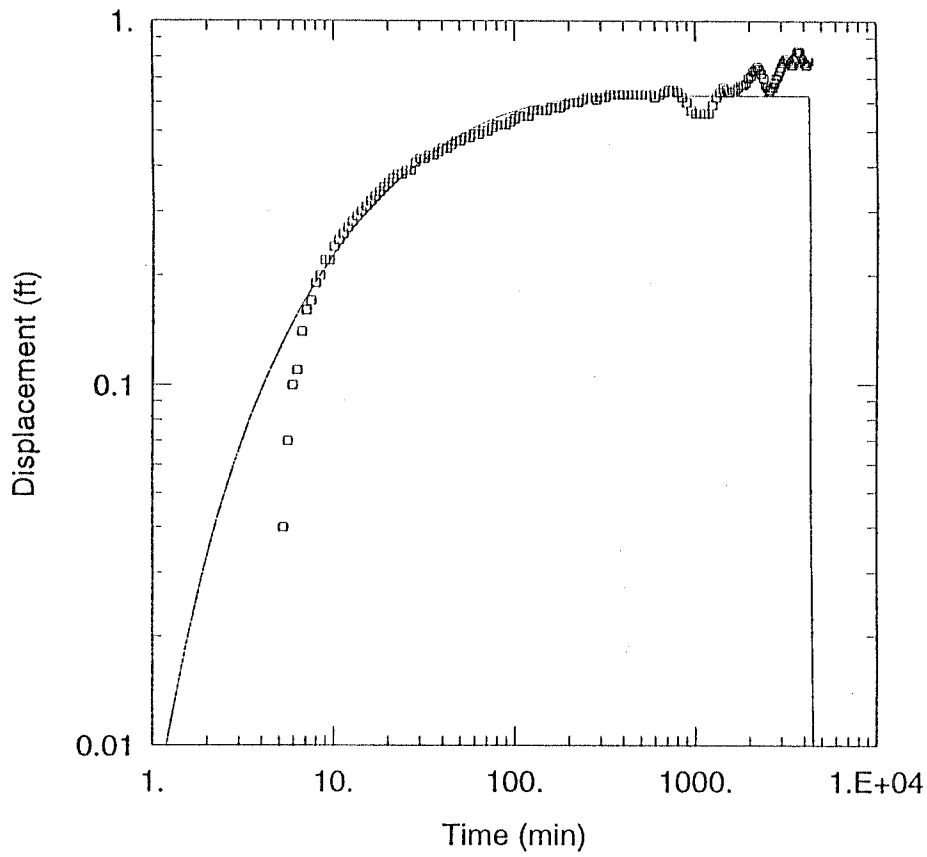
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ NB-15	1944	0



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: C:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\04U846P.A
Date: 08/17/98 Time: 17:43:10

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 32.09 ft^2/min
S = 7.188E-05
r/B = 0.3

AQUIFER DATA

Saturated Thickness: 115. ft

Anisotropy Ratio (Kz/Kr): 1.

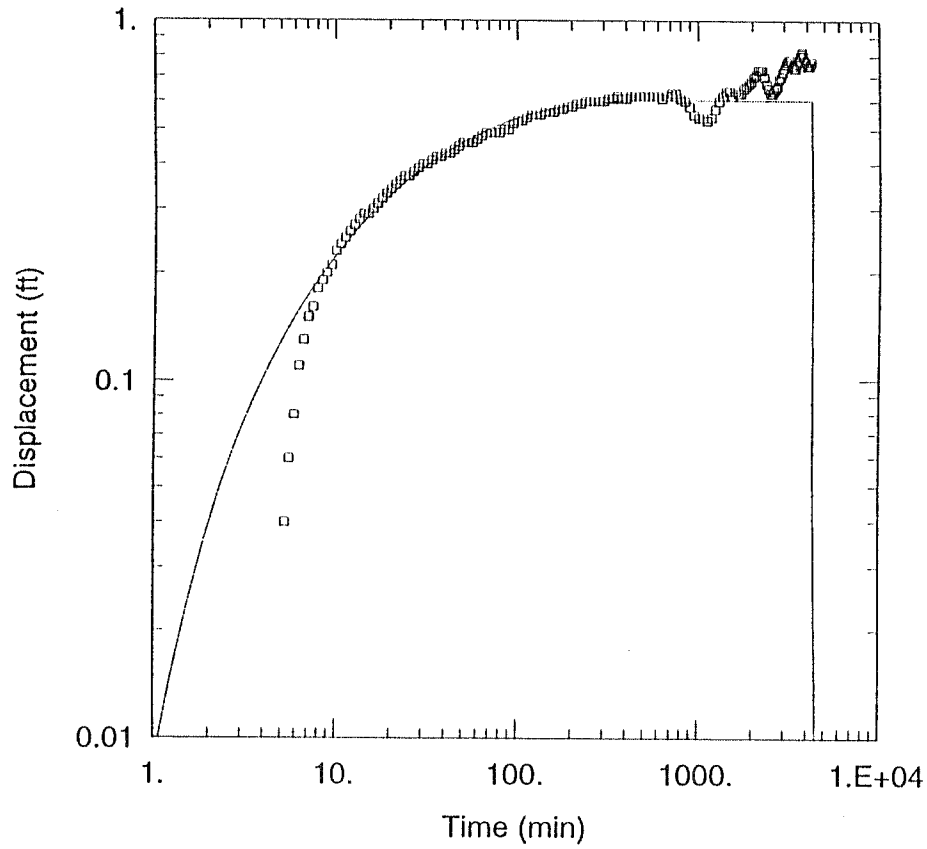
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ 04U846	2100	0



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: C:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\04U850P.A
Date: 08/19/98 Time: 09:05:34

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 37.27 ft^2/min
S = 5.772E-05
r/B = 0.25

AQUIFER DATA

Saturated Thickness: 120. ft

Anisotropy Ratio (Kz/Kr): 1.

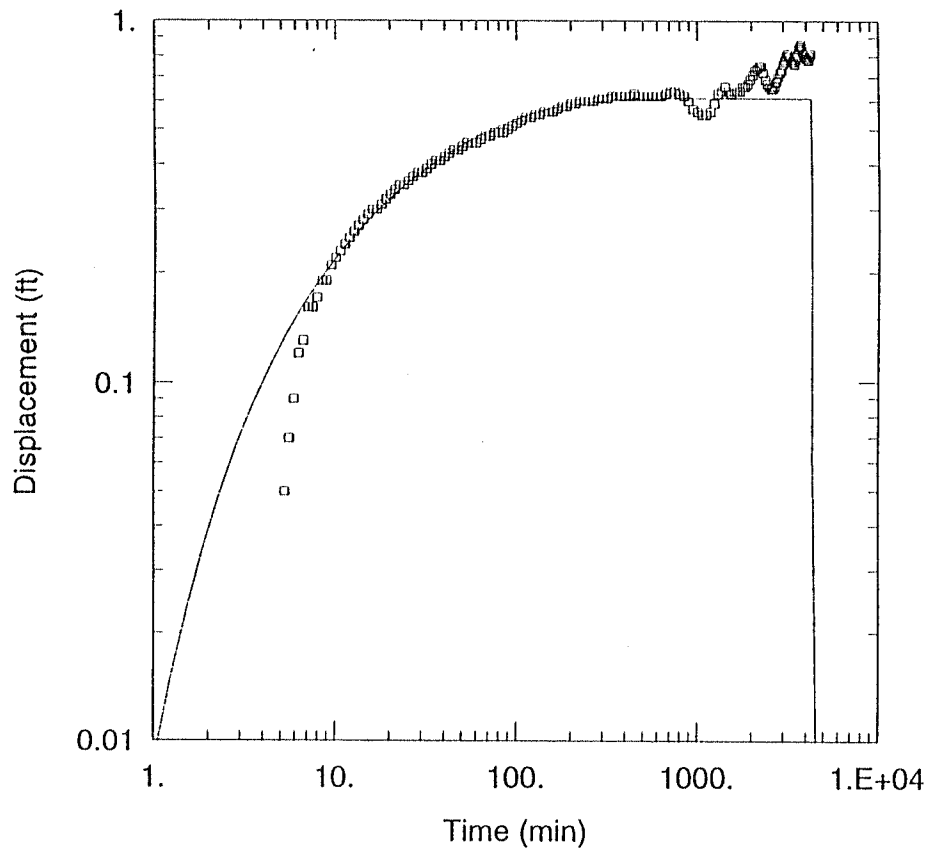
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ 04U850	2326	0



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: C:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\04U866P.A
Date: 08/19/98 Time: 09:06:03

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 38.73 ft^2/min
S = 5.846E-05
r/B = 0.23

AQUIFER DATA

Saturated Thickness: 108. ft

Anisotropy Ratio (Kz/Kr): 1.

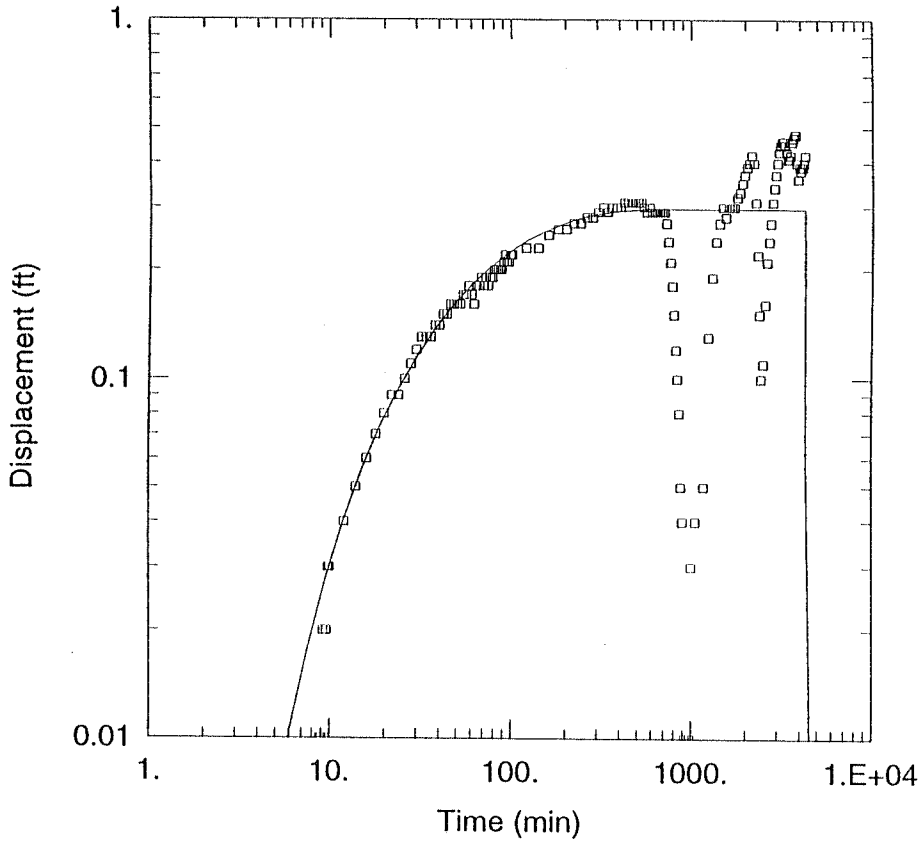
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ 04U866	2332	0



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\MW1P.AQT
Date: 02/12/99 Time: 10:11:12

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 45.56 ft^2/min
S = 0.0001597
r/B = 0.5

AQUIFER DATA

Saturated Thickness: 130. ft

Anisotropy Ratio (Kz/Kr): 1.

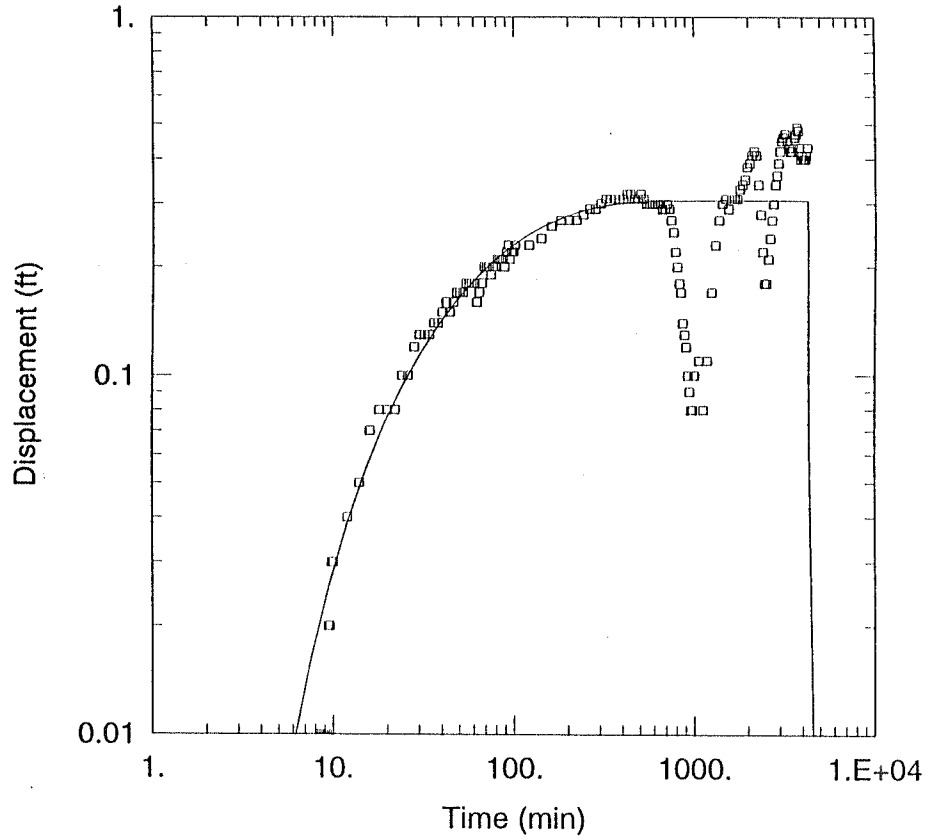
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
MW-1	3491	0



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\NB3P.AQT
Date: 02/12/99 Time: 10:11:20

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 42.63 ft^2/min
S = 0.000154
r/B = 0.52

AQUIFER DATA

Saturated Thickness: 125. ft

Anisotropy Ratio (Kz/Kr): 1.

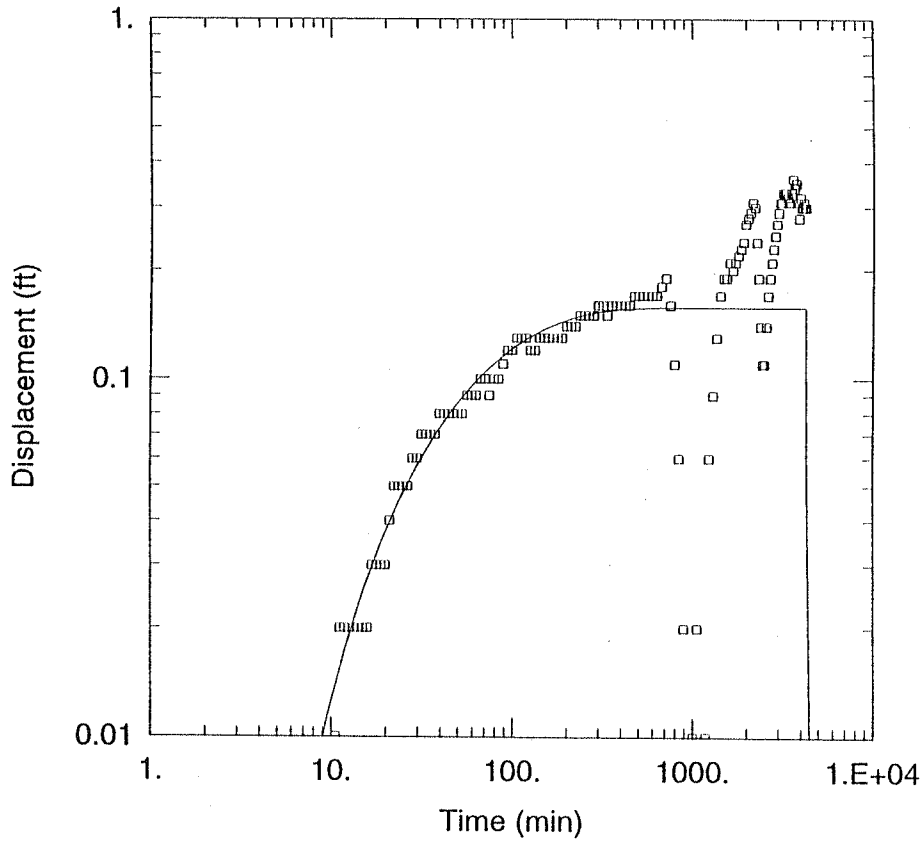
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
NB-3	3565	0



NB-14 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\MW7P.AQT
Date: 02/12/99 Time: 10:11:27

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 72.02 ft^2/min
S = 9.009E-05
r/B = 0.6

AQUIFER DATA

Saturated Thickness: 62. ft

Anisotropy Ratio (Kz/Kr): 1.

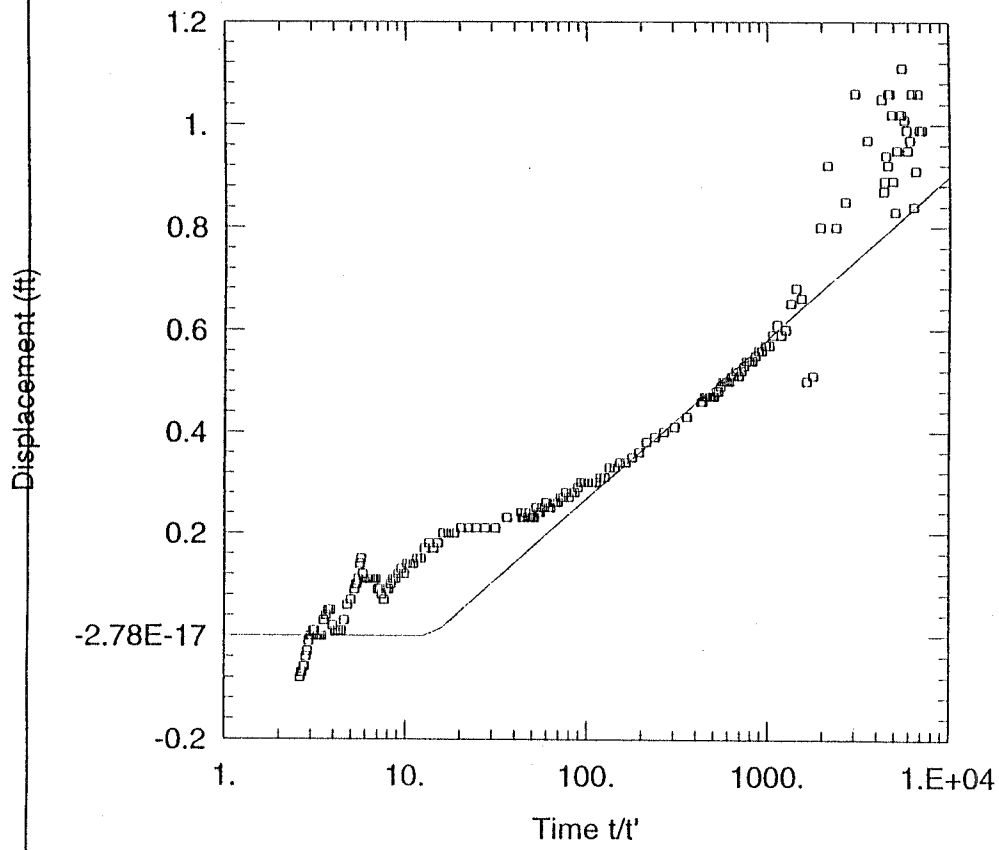
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
MW-7	6514	0



NB-14 AQUIFER TEST: RECOVERY DATA

Data Set: C:\PROJECTS\TCAAP\NB14RE~1\AQTFIL~1\NB14R.AQT
Date: 09/10/98 Time: 16:53:29

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Confined
Solution Method: Theis Recovery
T = 53.3 ft^2/min
S' = 14.2

AQUIFER DATA

Saturated Thickness: 112. ft

Anisotropy Ratio (Kz/Kr): 1.

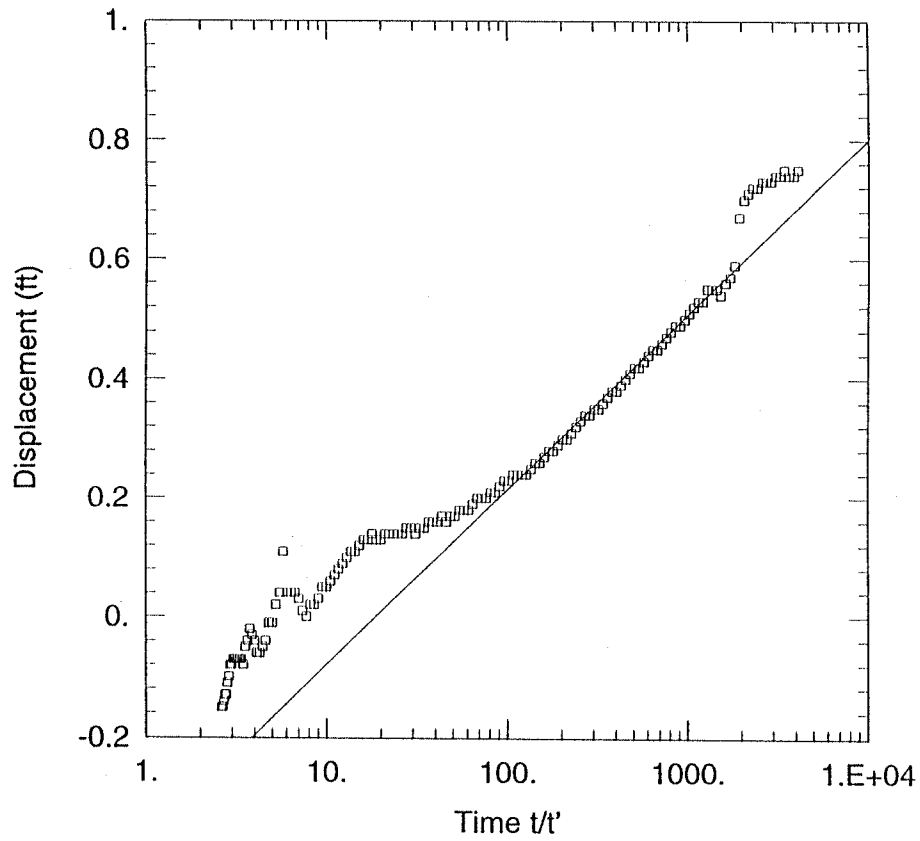
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ NB-14	0.75	0



NB-14 AQUIFER TEST: RECOVERY DATA

Data Set: D:\PROJECTS\TCAAP\NB14RE~1\AQTFIL~1\MW5R.AQT
Date: 02/12/99 Time: 10:28:12

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)
T = 57.29 ft^2/min
S' = 18.65

AQUIFER DATA

Saturated Thickness: 121. ft

Anisotropy Ratio (Kz/Kr): 1.

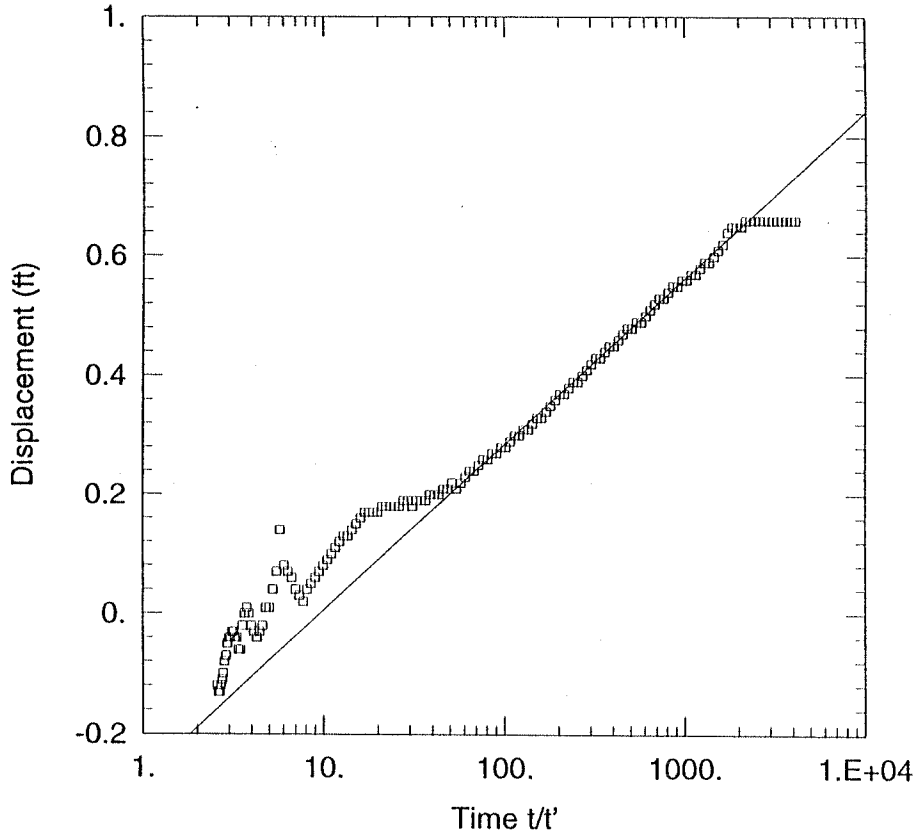
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-5	351	0



NB-14 AQUIFER TEST: RECOVERY DATA

Data Set: D:\PROJECTS\TCAAP\NB14RE~1\AQTFIL~1\MW3R.AQT
Date: 02/12/99 Time: 10:28:20

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)
T = 60.33 ft^2/min
S' = 9.533

AQUIFER DATA

Saturated Thickness: 111. ft

Anisotropy Ratio (Kz/Kr): 1.

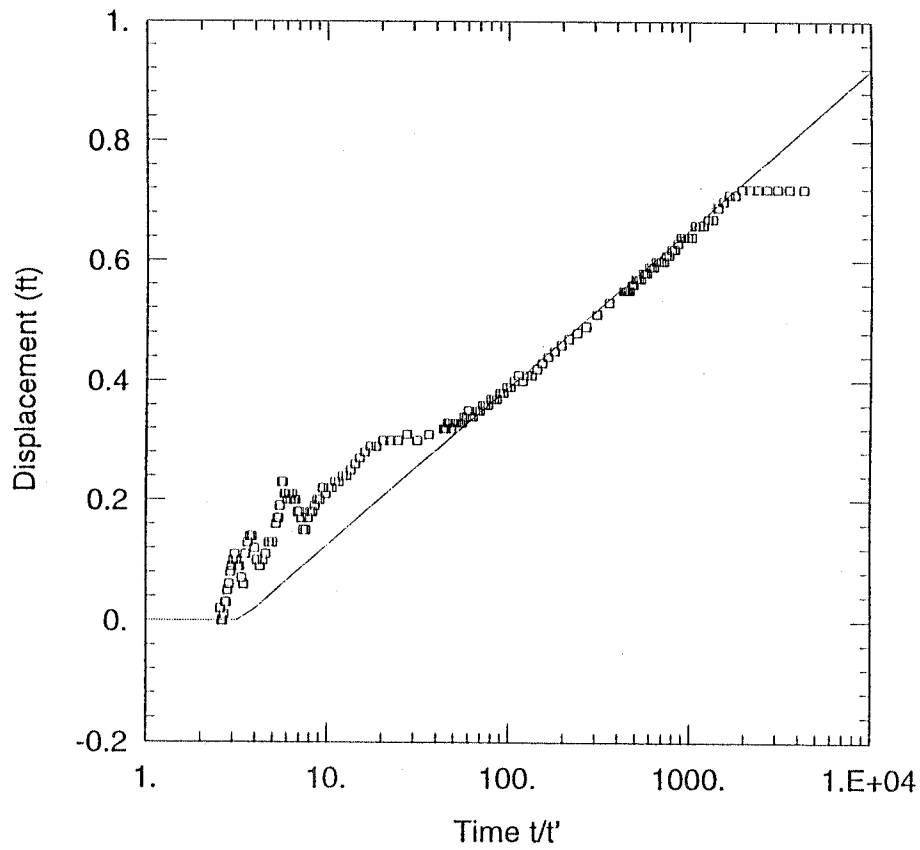
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-3	1699	0



NB-14 AQUIFER TEST: RECOVERY DATA

Data Set: C:\PROJECTS\TCAAP\NB14RE~1\AQTFIL~1\NB15R.AQT
Date: 09/10/98 Time: 16:53:51

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Confined
Solution Method: Theis Recovery
T = 63.62 ft^2/min
S' = 3.371

AQUIFER DATA

Saturated Thickness: 119. ft

Anisotropy Ratio (Kz/Kr): 1.

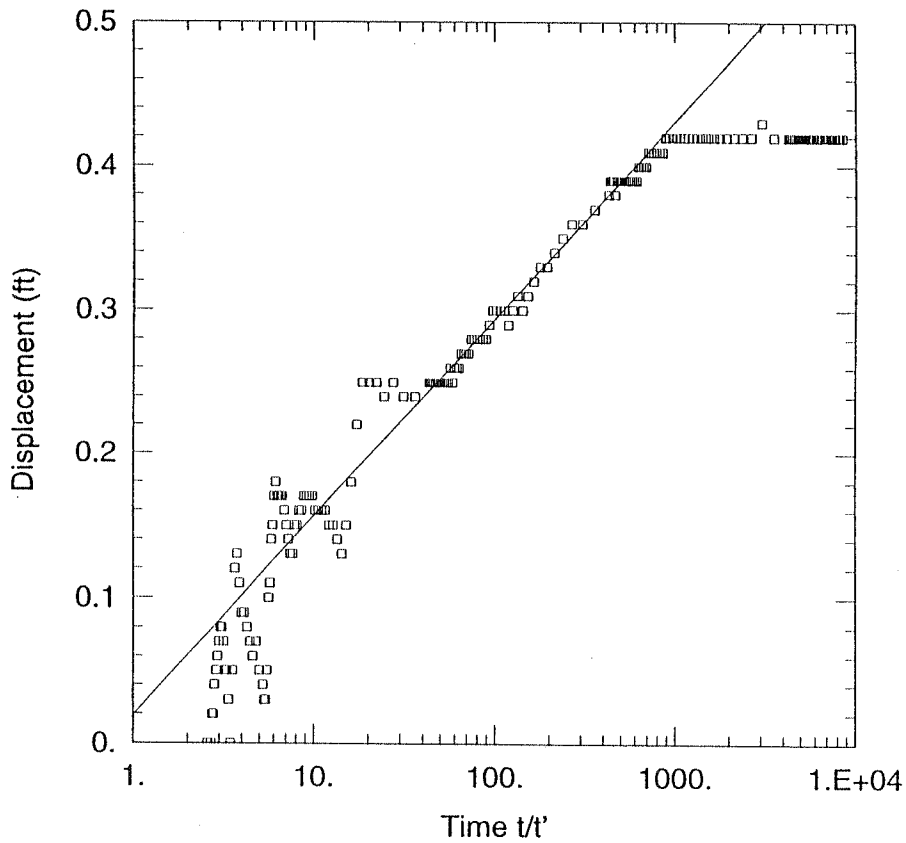
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
NB-15	1944	0



NB-14 AQUIFER TEST: RECOVERY DATA

Data Set: D:\PROJECTS\TCAAP\NB14RE~1\AQTFIL~1\MW1R.AQT
Date: 02/12/99 Time: 10:38:22

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)
T = 122.5 ft^2/min
S' = 0.7259

AQUIFER DATA

Saturated Thickness: 130. ft

Anisotropy Ratio (Kz/Kr): 1.

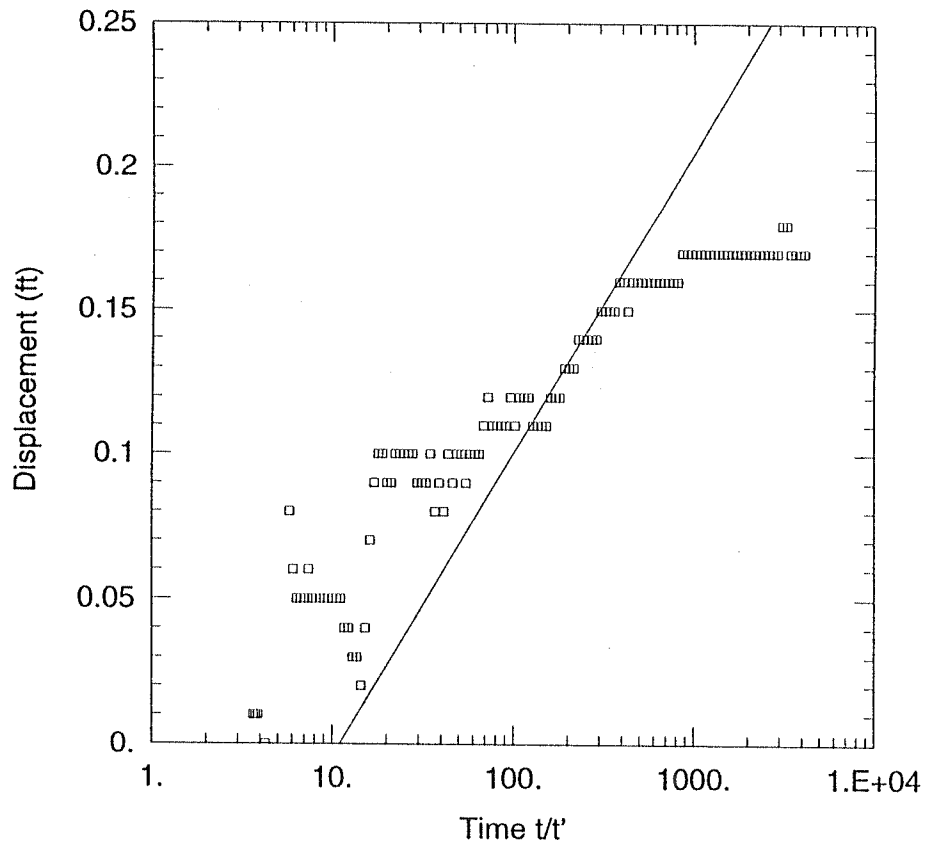
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
MW-1	3491	0



NB-14 AQUIFER TEST: RECOVERY DATA

Data Set: D:\PROJECTS\TCAAP\NB14RE~1\AQTFIL~1\MW7R.AQT
Date: 02/12/99 Time: 10:24:34

PROJECT INFORMATION

Company: Montgomery Watson
Client: TCAAP
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-14
Test Date: 7/11/98

SOLUTION

Aquifer Model: Confined
Solution Method: Theis (Recovery)
T = 160.3 ft^2/min
S' = 11.03

AQUIFER DATA

Saturated Thickness: 62. ft

Anisotropy Ratio (Kz/Kr): 1.

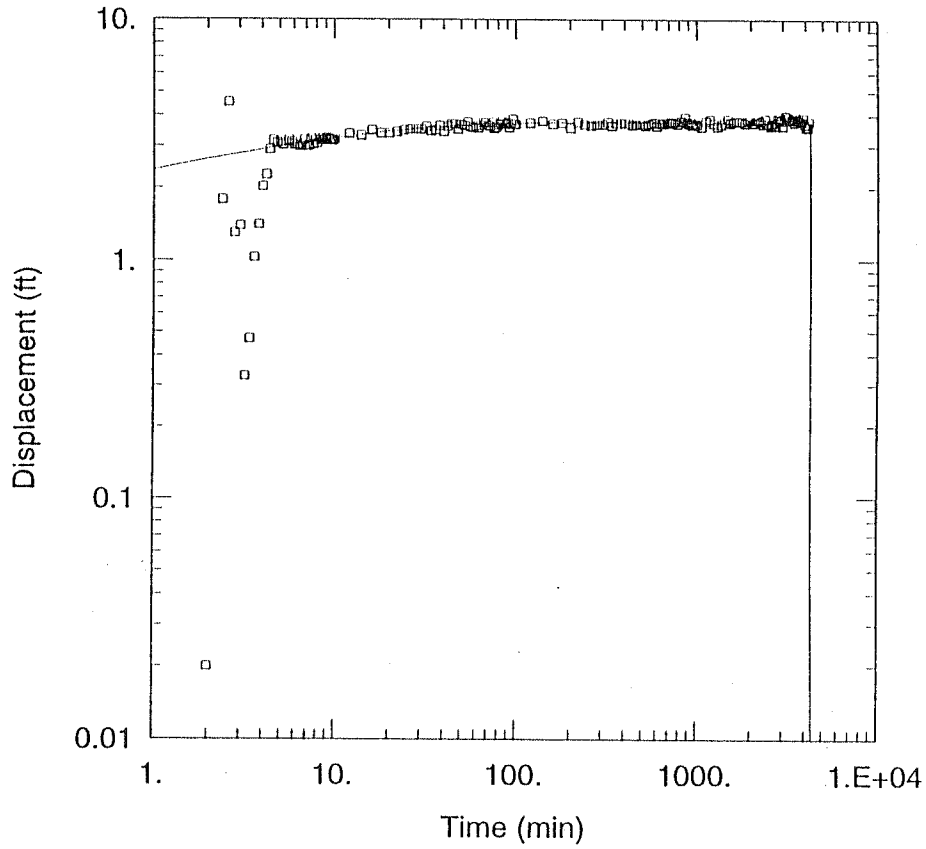
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-14	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-7	6514	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: C:\PROJECTS\TCAAP\NB14PU~1\AQTFIL~1\NB15P.AQ
Date: 08/17/98 Time: 16:58:14

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 18.47 ft^2/min
S = 0.1032
r/B = 0.01

AQUIFER DATA

Saturated Thickness: 119. ft

Anisotropy Ratio (Kz/Kr): 1.

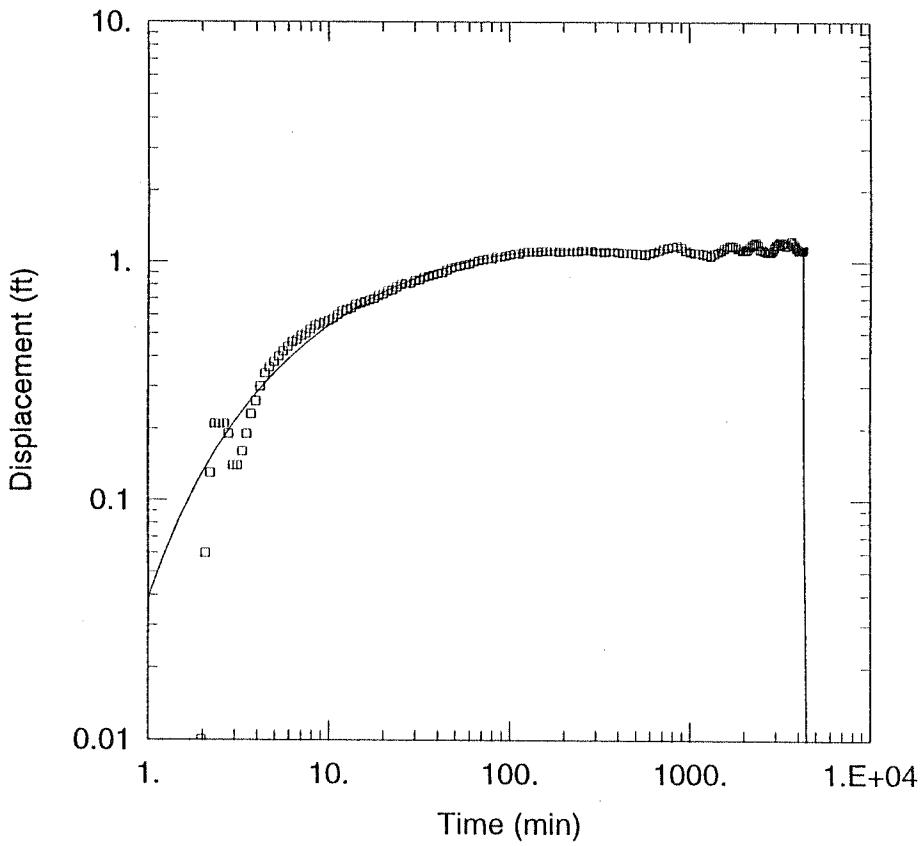
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ NB-15	1	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB15PU~1\AQTFIL~1\MW3P.AQT
Date: 02/12/99 Time: 10:48:11

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 18.9 ft^2/min
S = 0.001879
r/B = 0.2707

AQUIFER DATA

Saturated Thickness: 111. ft

Anisotropy Ratio (Kz/Kr): 1.

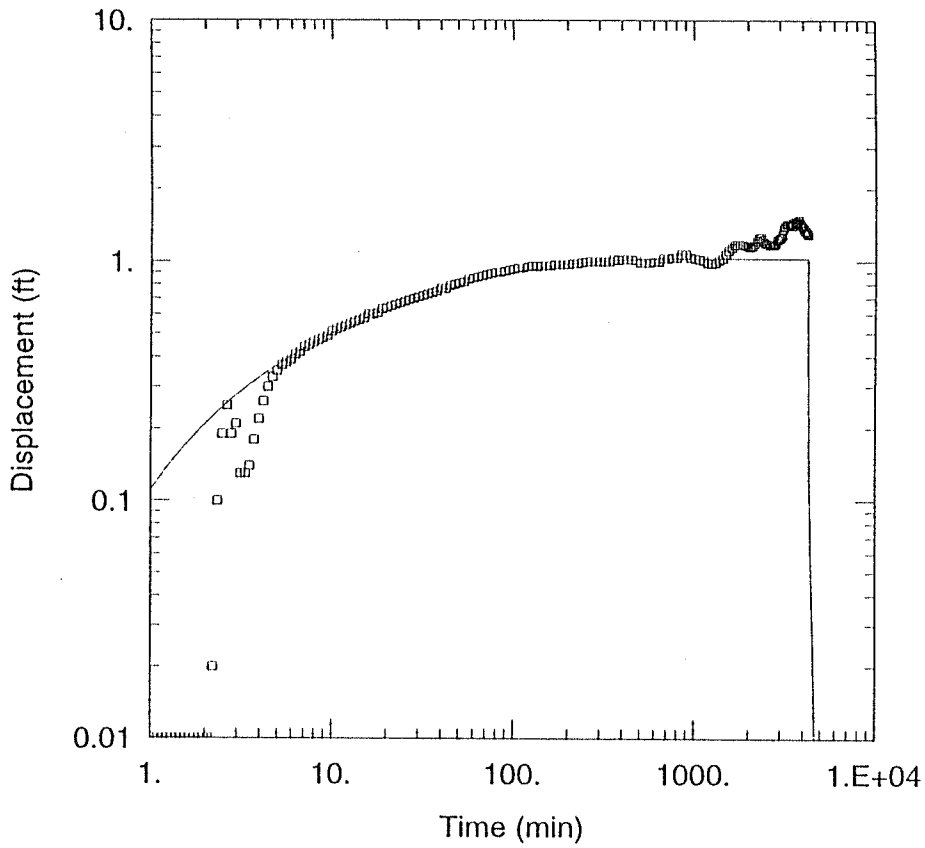
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ MW-3	245	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: C:\PROJECTS\TCAAP\NB15PU~1\AQTFIL~1\04U877P./
Date: 08/19/98 Time: 10:07:10

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 34.6 ft^2/min
S = 0.0001328
r/B = 0.1

AQUIFER DATA

Saturated Thickness: 125. ft

Anisotropy Ratio (Kz/Kr): 1.

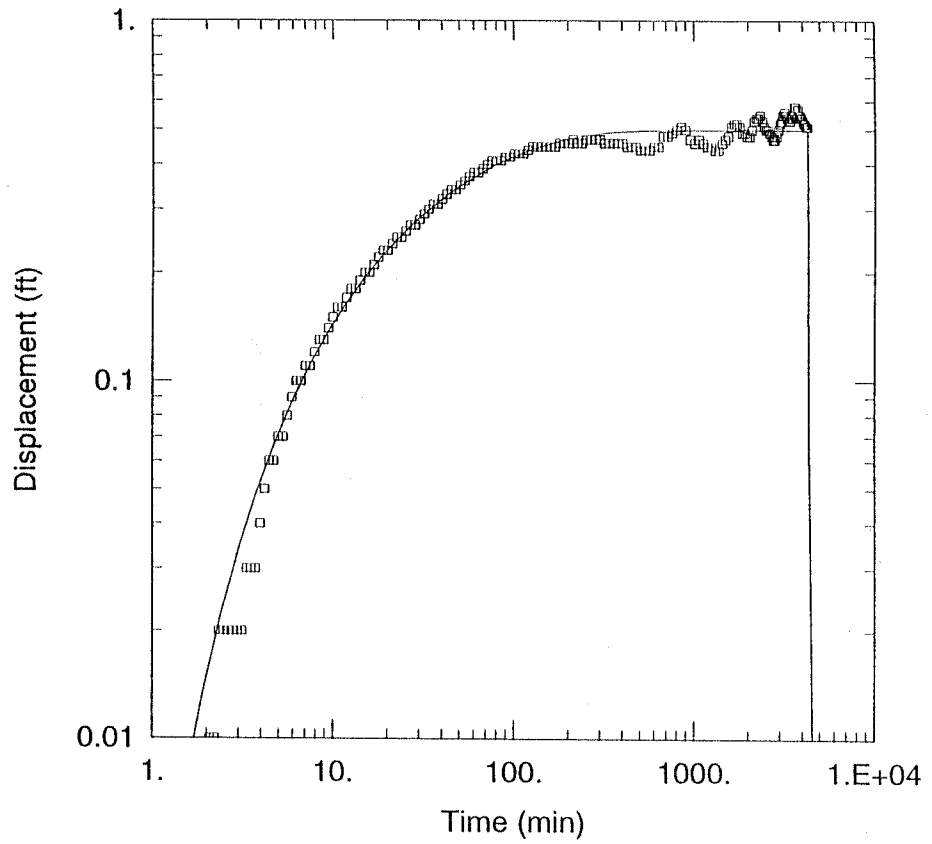
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ 04U877	742	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB15PU~1\AQTFIL~1\MW5P.AQT
Date: 02/12/99 Time: 10:48:17

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 42.52 ft^2/min
S = 0.0002008
r/B = 0.2754

AQUIFER DATA

Saturated Thickness: 121. ft

Anisotropy Ratio (Kz/Kr): 1.

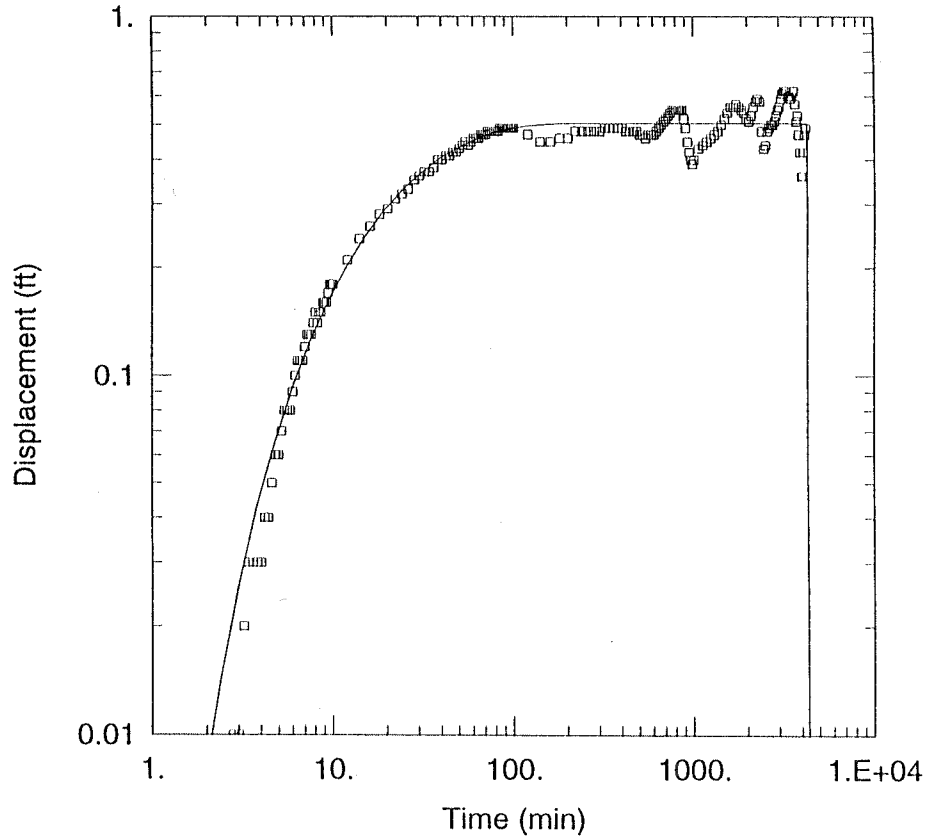
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
MW-5	1638	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB15PU~1\AQTFIL~1\MW1P.AQT
Date: 02/12/99 Time: 10:48:37

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 21.39 ft^2/min
S = 0.000119
r/B = 0.6299

AQUIFER DATA

Saturated Thickness: 130. ft

Anisotropy Ratio (Kz/Kr): 1.

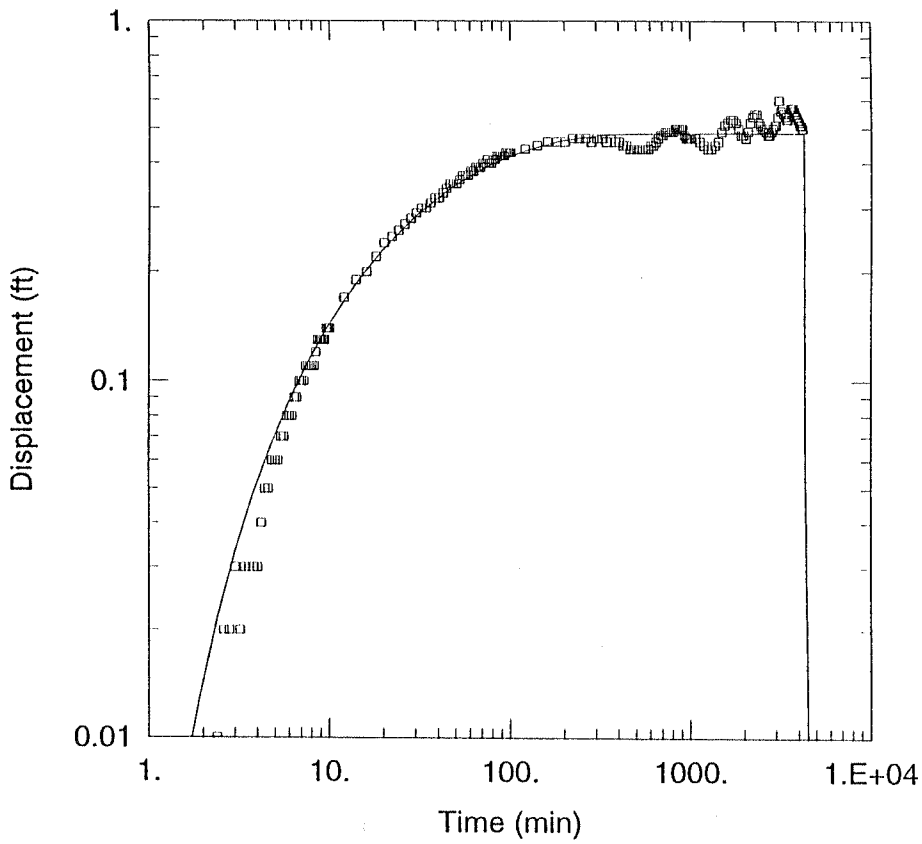
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
MW-1	1893	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB15PU~1\AQTFIL~1\NB14P.AQ
Date: 02/12/99 Time: 10:48:45

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 41.35 ft^2/min
S = 0.0001427
r/B = 0.3

AQUIFER DATA

Saturated Thickness: 119. ft

Anisotropy Ratio (Kz/Kr): 1.

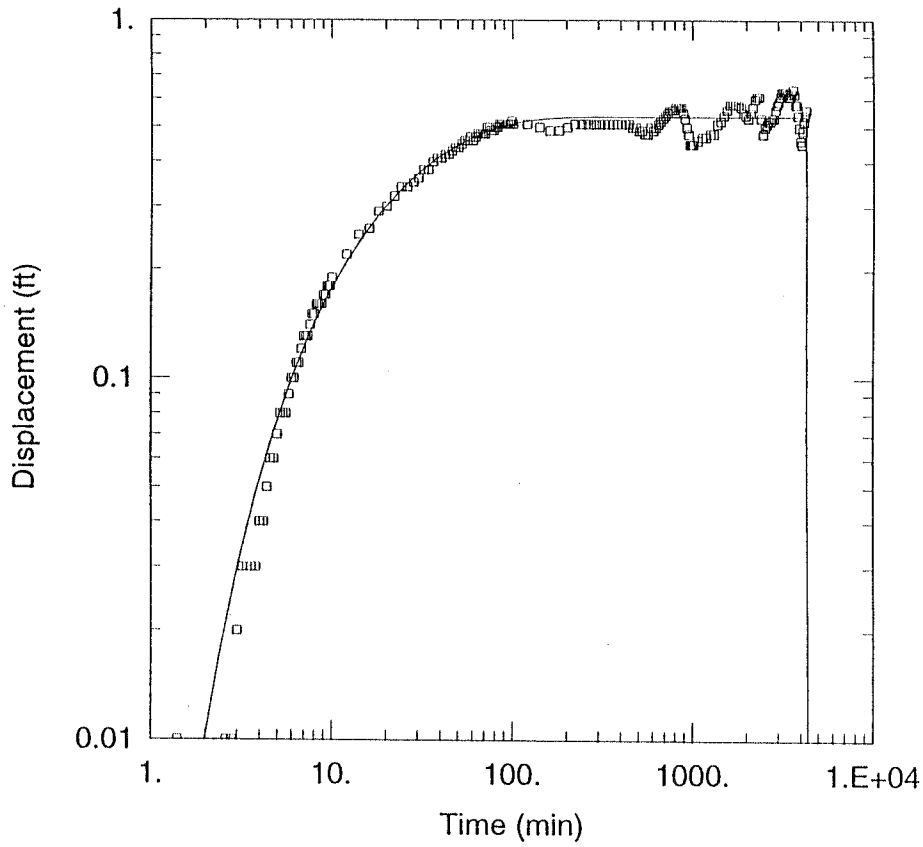
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ NB-14	1944	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB15PU~1\AQTFIL~1\NB3P.AQT
Date: 02/12/99 Time: 10:48:57

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 23.21 ft^2/min
S = 0.00011
r/B = 0.5472

AQUIFER DATA

Saturated Thickness: 125. ft

Anisotropy Ratio (Kz/Kr): 1.

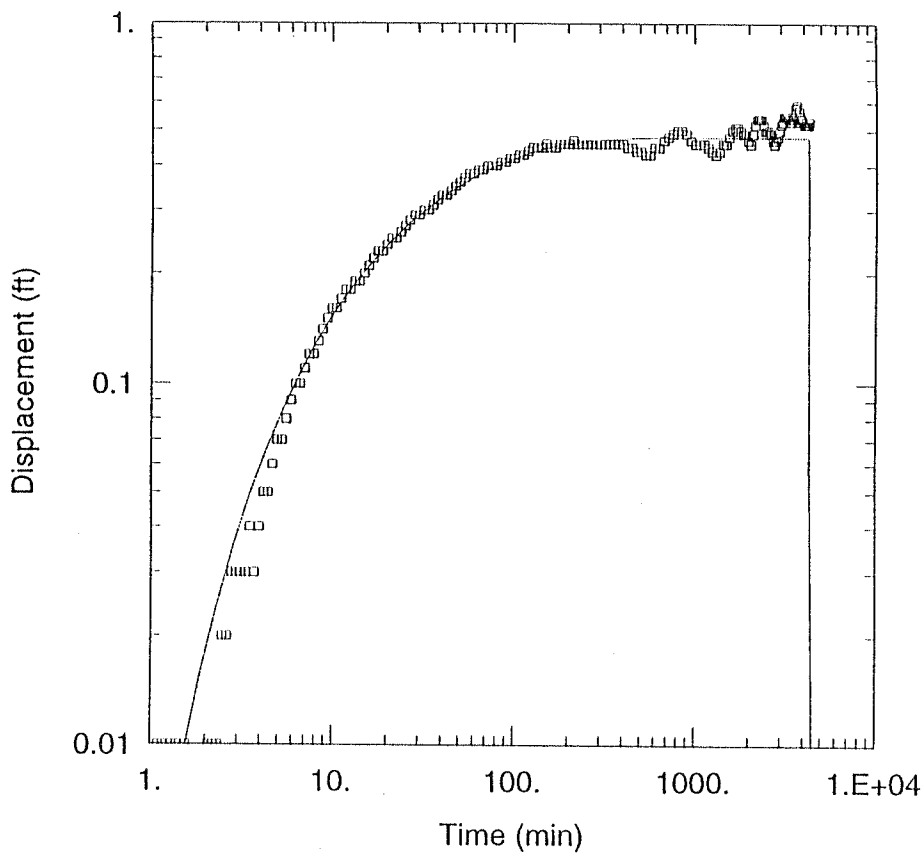
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
NB-3	1958	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: C:\PROJECTS\TCAAP\NB15PU~1\AQTFIL~1\04U850P./
Date: 08/19/98 Time: 10:06:58

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 42.79 ft^2/min
S = 0.0001013
r/B = 0.29

AQUIFER DATA

Saturated Thickness: 120. ft

Anisotropy Ratio (Kz/Kr): 1.

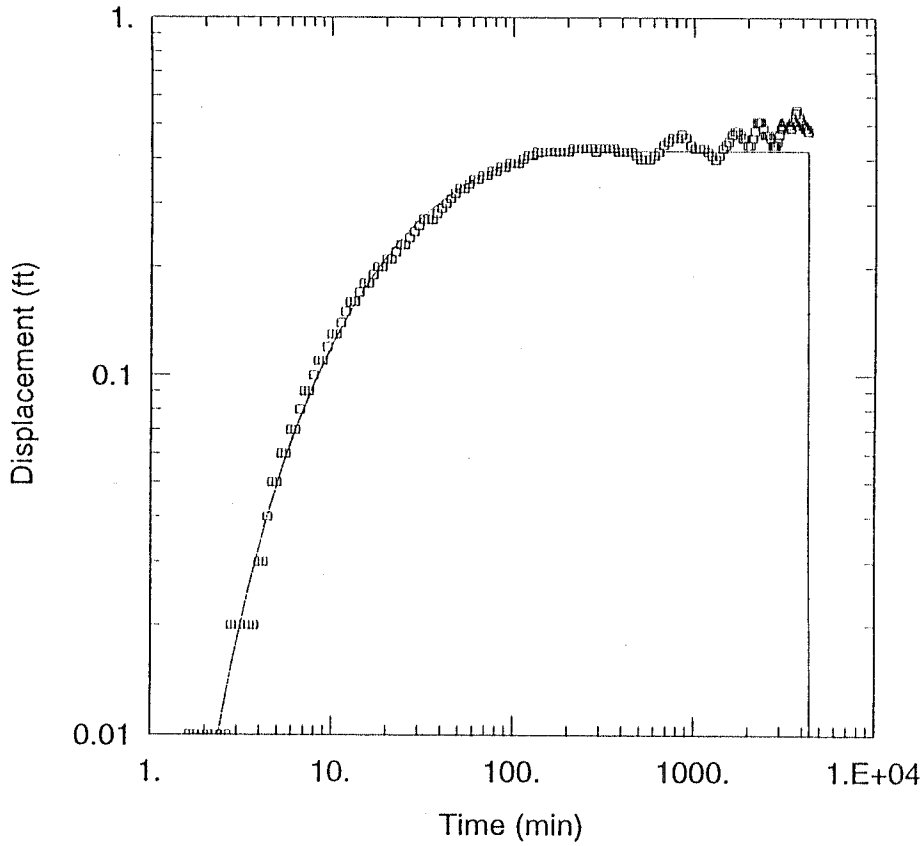
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ 04U850	2217	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: C:\PROJECTS\TCAAP\NB15PU~1\AQTFIL~1\04U846P.A

Date: 08/17/98 Time: 16:58:26

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob

T = 32.03 ft^2/min
S = 5.242E-05
r/B = 0.5

AQUIFER DATA

Saturated Thickness: 115. ft

Anisotropy Ratio (Kz/Kr): 1.

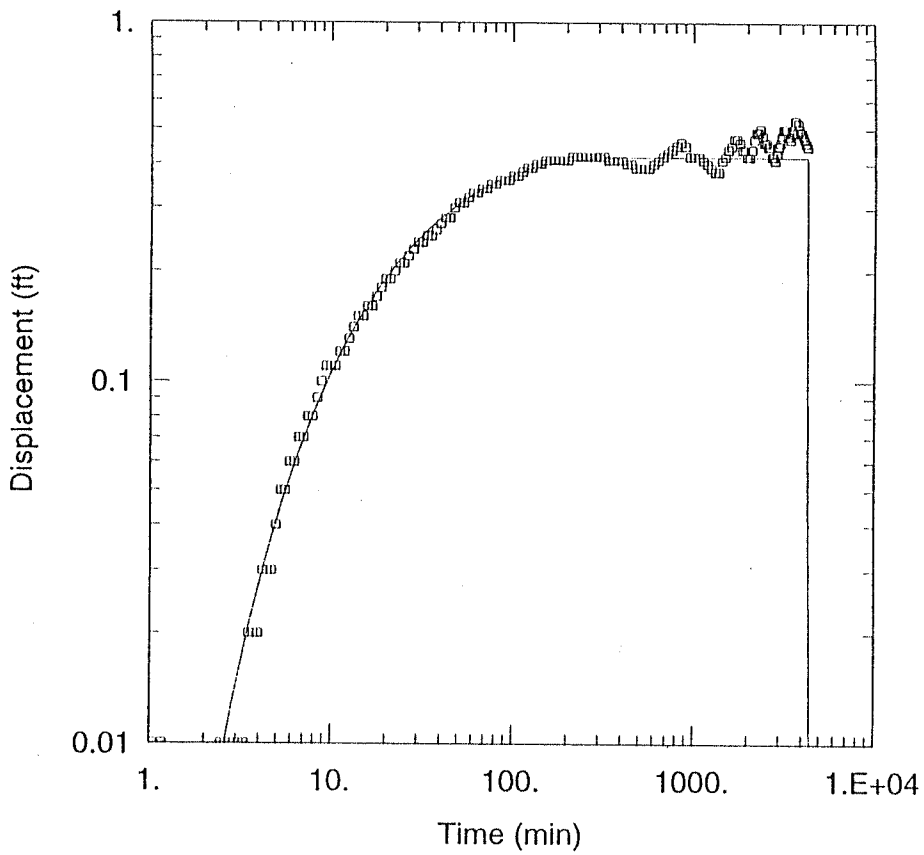
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ 04U846	3455	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: C:\PROJECTS\TCAAP\NB15PU~1\AQTFIL~1\04U866P.A
Date: 08/19/98 Time: 10:07:04

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 35.34 ft^2/min
S = 4.718E-05
r/B = 0.45

AQUIFER DATA

Saturated Thickness: 108. ft

Anisotropy Ratio (Kz/Kr): 1.

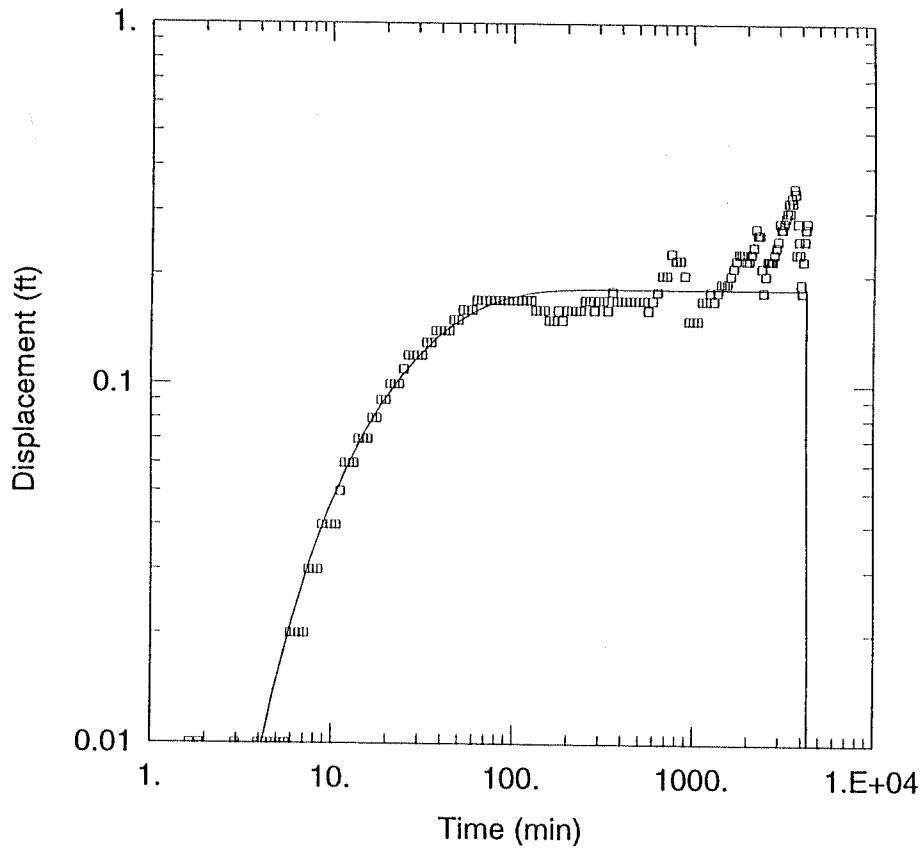
WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
▫ 04U866	3930	0



NB-15 AQUIFER TEST: PUMPING DATA

Data Set: D:\PROJECTS\TCAAP\NB15PU~1\AQTFIL~1\MW7P.AQT
Date: 02/12/99 Time: 10:49:20

PROJECT INFORMATION

Company: Montgomery Watson
Client: USACE
Project: 1212026.01092003
Test Location: New Brighton
Test Well: NB-15
Test Date: 7/16/98

SOLUTION

Aquifer Model: Leaky
Solution Method: Hantush-Jacob
T = 52.76 ft^2/min
S = 5.918E-05
r/B = 0.7

AQUIFER DATA

Saturated Thickness: 62. ft

Anisotropy Ratio (Kz/Kr): 1.

WELL DATA

Pumping Wells

Well Name	X (ft)	Y (ft)
NB-15	0	0

Observation Wells

Well Name	X (ft)	Y (ft)
MW-7	4993	0

Brooklyn Center #9 Pumping Test
March 17, 1997

Transmissibity T (ft2/day)	Storage Coefficient S	Time Period Emphasized	Analysis Method	remark
Pumping Well: Brooklyn Center #9 (0000110493)				
32500	NA		Jacob recovery	
9940	NA		Jacob recovery	
8330	NA	Early time pumping	Theis	
9370	NA	Early time recovery	Theis	
7750	NA	Late time pumping	Jacob	
Observation Well: 0000127269				
11200	0.000023	Early time pumping	Theis	
11800	0.000021	Early time recovery	Theis	
8900	0.000035	Late time pumping	Jacob	
8900	0.000035	Late time recovery	Jacob recover	
Observation Well: 0000203257				
8650	0.000072	Early time pumping	Theis	
8100	0.00016	Early time recovery	Jacob recover	
8000	0.000066	Early time recovery	Theis	
7400	0.000086	Late time pumping	Jacob	
22600		Late time recovery	Jacob recover	

Worksheet for Estimating Transmissivity and Hydraulic Conductivity from Specific Capacity Test Data

Explanation and notes attached.

Maximum iterations	100
Error tolerance (as drawdown)	0.001 feet

Field Data								*Estimated Parameters*			*Calculated Results*							*Diagnostics*					
		Depth to Water				Screened Interval												*Solution Integrity*			*Sensitivity of T:*		
Location	Well Diam.	Initial	Final	Test Duration	Mean Pumping Rate	Depth to Top	Depth to Bottom	Storage Coeff. (S)	Well loss Coeff. (C)	Aquifer Thickness (b)	Measured Drawdown (s_m)	Saturated Screen Length (L)	Well loss (s_w)	Partial Penetration Parameter (s_p)	Specific Capacity	**Transmissivity (T)**	**Conductivity (K)**	Calculated Drawdown	Error as Drawdown	Well Bore Storage Test	to S at ± 1 factor of 10	to s_w at 10% of s_m	to b at ± 25%
	inches	feet	feet	hours	gpm	feet	feet	-	sec^2/ft^5	feet	feet	feet	feet	-	gpm/ft	**sq ft/sec**	**ft/day**	feet			sq ft/sec	sq ft/sec	sq ft/sec
Well 8	14	353.0	449.0	6.3	757.0	815.0	868.0	0.001	0	172	96.00	53.0	0.0E+00	9.11	7.89	**4.8E-02**	**2.4E+01**	96.00	0.00%	pass	3.3E-03	5.5E-03	2.1E-02
Well 9	14	375.3	436.0	7	750.0	782.0	937.0	0.001	0	172	60.70	155.0	0.0E+00	0.38	12.36	**3.6E-02**	**1.8E+01**	60.70	0.00%	pass	5.4E-03	4.3E-03	9.7E-03
Well 10	18	279.7	342.2	7.5	750.0	779.0	931.0	0.001	0	166	62.51	152.0	0.0E+00	0.29	12.00	**3.3E-02**	**1.7E+01**	62.51	0.00%	pass	5.2E-03	4.0E-03	8.5E-03
Well 11	18	237.0	300.0	12	732.0	775.0	950.0	0.001	0	240	63.00	175.0	0.0E+00	1.45	11.62	**3.8E-02**	**1.4E+01**	63.00	0.00%	pass	5.0E-03	4.5E-03	1.3E-02
Well 12	16	225.0	298.0	7.5	1200.0	730.0	790.0	0.001	0	200	73.00	60.0	0.0E+00	9.47	16.44	**1.0E-01**	**4.5E+01**	73.00	0.00%	pass	6.9E-03	1.2E-02	4.4E-02

References:

Bradbury, K.B., and E.R. Rothschild, 1985. A computerized technique for estimating the hydraulic conductivity of aquifer from specific capacity data: Ground Water vol. 23, No. 2, pp. 240-246.

ASTM International, 2004. Standard Test Method for Determining Specific Capacity and Estimating Transmissivity at the Control Well, Standard D 5472-93, in Annual Book of ASTM Standards, Vol. 04.08 pp. 1279-1282.

Appendix C

Development of Groundwater Model

Appendix C
Development of Groundwater Model
City of New Brighton Wellhead
Protection Area Delineation

Table of Contents

C-1.0 Introduction 1

C-2.0 Model Construction 2

C-3.0 Model Calibration 4
- C-3.1 Model Parameters for Calibration 4
- C-3.2 Target Values for Calibration 5
- C-3.3 Results of Model Calibration 5
- C-3.4 Model Sensitivity 5

C-4.0 References 7

Tables
Figures

C-1.0 Introduction

The City of New Brighton has 11 municipal water supply wells. Two of these wells (Wells 3 & 4) are completed in both the Prairie du Chien Group and Jordan Sandstone aquifers. Two wells (14 & 15) are completed in the Prairie du Chien Group aquifer. Two wells (5 & 6) are completed in the Jordan Sandstone aquifer. Five wells (8, 9, 10, 11, & 12) are completed in the Mt. Simon Sandstone aquifer. In order to accurately delineate the wellhead protection area (WHPA) for each of the wells, a groundwater flow model capable of capturing both regional-scale features and local conditions is needed.

This Appendix discusses the groundwater flow model that was constructed and used to delineate the WHPAs for the New Brighton municipal wells.

C-2.0 Model Construction

The finite difference groundwater modeling code MODFLOW-96 (McDonald and Harbaugh, 1988; Harbaugh and McDonald, 1996) as implemented in the modeling package Ground Water Vistas (ver. 5.37 Build 6) (Environmental Simulations, Inc., 2007) was used to model the groundwater flow. The version of MODFLOW-96 implemented in Ground Water Vistas handles the computation of the VCONT parameter in a different manner than the original USGS code. The VCONT parameter for the computation of leakance between model layers is computed automatically from values of vertical hydraulic conductivity, which are stored in a separate array (Environmental Simulations, Inc., 2007).

The base finite difference model used in this study is the Twin Cities Metropolitan Area Groundwater Flow Model, Version 2.0 (Metro Model 2) developed for Metropolitan Council Environmental Services by Barr Engineering Company (Metropolitan Council, 2009). The model is divided into nine layers that are generally assigned to the major hydrostratigraphic units. In general the layer assignments are as follows:

Layer 1 – Quaternary

Layer 2 – St. Peter Sandstone

Layer 3 – Prairie du Chien Group

Layer 4 – Jordan Sandstone

Layer 5 – St. Lawrence Formation

Layer 6 – Franconia Formation

Layer 7 – Ironton and Galesville Sandstones

Layer 8 – Eau Claire Formation

Layer 9 – Mt. Simon and Hinckley Sandstones

The Quaternary can occupy more than one layer because the upper bedrock units do not extend over the entire model domain. Where the upper bedrock units are not present the model layer is occupied by the Quaternary. For example, in areas where the Jordan Sandstone is the first bedrock unit present (i.e. the St. Peter Sandstone and Prairie Du Chien Group are not present) the Quaternary occupies model layers 1-3.

This model takes into account regional flow boundaries. The major flow boundaries near New Brighton are the Mississippi and Saint Croix Rivers. Smaller streams and area lakes are also included in the model. These boundaries are represented in the model using the River Package (Harbaugh and McDonald, 1996). In addition, high capacity pumping wells from the State Water Use Database System (SWUDS) area included in the model.

Recharge for the model was calculated using the SWB recharge model (Dripps and Bradbury, 2007). The SWB model calculates recharge based on methods similar to Thornthwaite (1948) and Thornthwaite and Mather (1957) but is geared more towards using GIS-type data. Recharge is estimated using soil type, land use, climate, and topography. The average recharge values as calculated for 1975-2003 were used in the groundwater flow model.

The Metro Model 2 (Metropolitan Council, 2009) was modified in the vicinity of New Brighton to better represent the local conditions. Changes made to the Metro Model 2 for use in delineating the New Brighton WHPAs included:

- Refine the model grid with a minimum spacing of 10 m by 10 m in the vicinity of the New Brighton wells and a maximum grid spacing of 500 m by 500 m;
- Adjust the extent of the St. Peter Sandstone, Prairie du Chien Group, and Jordan Sandstone to better match the refined grid and updated bedrock geology from well logs in the area;
- Add in additional hydraulic head calibration targets in the New Brighton area based on data associated with TCAAP studies;
- Adjusted the hydraulic conductivity of the Prairie du Chien Group in the vicinity of New Brighton (hydraulic conductivity zone 223) to 156 m/d to match the average hydraulic conductivity determined from pumping tests at Well 13, 14 and 15;
- Hydraulic conductivity zones 206 and 223, representing the Prairie du Chien group in the vicinity of New Brighton, were merged together and the hydraulic conductivity was fixed at 156 m/d as described above;
- Adjusted the hydraulic conductivity of the Jordan Sandstone in the New Brighton area (hydraulic conductivity zone 323) to 36 m/d to match the hydraulic conductivity determined from the pumping tests at Brooklyn Center Well 9;
- Adjusted the hydraulic conductivity of the Mt Simon – Hinckley Sandstone to 7.3 m/d to match the hydraulic conductivity determined from specific capacity tests from wells 8, 9, 10, 11 and 12;

- Porosity values were updated to better reflect aquifer properties (Mt Simon – Hinckley Sandstone = 0.2, Jordan Sandstone = 0.2, Prairie du Chien Group = 0.056, St. Peter Sandstone = 0.283, Quaternary Sediments = 0.25);
- Adjust the configuration of Rice Creek and nearby lakes to match the level of detail of the refined model grid;
- Change the model cells representing the Mississippi River west of New Brighton from river cells to constant head cells.

C-3.0 Model Calibration

After making the adjustments to the model described above the model simulated head values were compared to measured head values. It was determined that the model results did not accurately represent the measured values to the level of detail necessary for delineation of the WHPAs. Additional model calibration was conducted using the model-independent parameter estimating software PEST (Version 11.8) (Watermark Numerical Computing, 2005 & 2008).

C-3.1 Model Parameters for Calibration

A total of eight adjustable parameters were used during model calibration, focusing on the hydraulic conductivity of the St. Peter Sandstone, Prairie du Chien Group, and Jordan Sandstone in the vicinity of New Brighton. Areas described above where the hydraulic conductivity was fixed to match aquifer test data remained fixed at those values during the model calibration. The following hydraulic conductivity zones were used during calibration and are shown on Figures C3 to C5.

- Zone 101(St. Peter Sandstone) Horizontal Hydraulic Conductivity
- Zone 201 (Prairie du Chien) Horizontal Hydraulic Conductivity
- Zone 219 (Prairie du Chien) Horizontal Hydraulic Conductivity
- Zone 223 (Prairie du Chien) Vertical Hydraulic Conductivity
- Zone 307 (Jordan Sandstone) Horizontal Hydraulic Conductivity
- Zone 320(Jordan Sandstone) Horizontal Hydraulic Conductivity
- Zone 322(Jordan Sandstone) Horizontal Hydraulic Conductivity
- Zone 351(Jordan Sandstone) Horizontal Hydraulic Conductivity

C-3.2 Target Values for Calibration

Hydraulic head values in the vicinity of New Brighton were used as calibration targets. Many of these values are cross-validated values from the County Well Index and were used in the original calibration of the Metro Model 2. A number of additional head calibration targets were added using historical data associated with groundwater studies related to the Twin Cities Army Ammunition Plant (Wenck, 2006).

C-3.3 Results of Model Calibration

Simulated hydraulic head values correlate well with measured values in the New Brighton Area. The model had the following characteristics with respect to hydraulic head calibration targets in the New Brighton Area.

- Number of target values = 1335
- Minimum Residual = -29.8 m
- Maximum Residual = 41.6 m
- Mean residual = -0.20 m
- Residual standard deviation = 4.96 m
- Residual Standard Deviation / Range in target values = 0.048
- 96.8 % of head residuals within 10% of the range in head target values

A chart showing observed target values verses model computed values is shown in Figure C-1.

Final hydraulic conductivity values for the Jordan Sandstone (Layer 4) and above are shown on Figures C2 to C5. Model generated contours of hydraulic head are shown on Figures C6 and C7.

C-3.4 Model Sensitivity

A sensitivity analysis was performed using the auto sensitivity option in Ground Water Vistas, the results of which are shown in Table C-1 and Figures C-8 to C-10. The model was most sensitive to the horizontal hydraulic conductivity (Kx) of the Prairie du Chien Group near New Brighton (Zones 201 and 223) and the horizontal hydraulic conductivity (Kx) of the Jordan Sandstone northeast of New Brighton (Zone 351) (Figure C-10).

C-4.0 References

Dripps W.R. and K.R. Bradbury. 2007. A simple daily soil-water balance model for estimating the spatial and temporal distribution of groundwater recharge in temperate humid areas. Hydrogeology Journal 15, 433-444

Environmental Simulations, Inc., 2007. Guide to using Groundwater Vistas, Version 5, Environmental Simulations Inc.

Harbaugh, A.W., and McDonald, M.G. 1996. User's documentation for MODFLOW-96, an update to the U.S. Geological Survey modular finite-difference ground-water flow model: U.S. Geological Survey Open-File Report 96-485. 56 p.

McDonald, M.G., and A.W. Harbaugh. 1988. A Modular Three-Dimensional Finite-Difference Groundwater Flow Model, U.S. Geological Survey Techniques of Water Resource Investigations, TWRI 6-A1. 575 p.

Metropolitan Council, 2009. Twin Cities Metropolitan Area Regional Groundwater Flow Model Version 2.00: Technical Report in Support of the Metropolitan Area Master Water Supply Plan

Montgomery Watson. 2000.Twin Cities Army Ammunition Plant – OU-1 Pumping Test Report. Prepared for U.S. Army Corps of Engineers Omaha District, May 2000.

Thornthwaite C.W. 1948. An approach toward a rational classification of climate. Geog. Rev. 38: no.1, 55-94

Thornthwaite C.W. and J.R. Mather. 1957. Instructions and tables for computing potential evapotranspiration and the water balance. Publications in Climatology. 10: no. 3.

Watermark Numerical Computing, 2005. PEST: Model-Independent Parameter Estimation. User Manual. 5th edition.

Watermark Numerical Computing. 2008. Addendum to the PEST Manual.

Wenck Associates, Inc. 2006. Installation Restoration Program, Twin Cities Army Ammunition Plant, Fiscal year 2005 Annual Performance Report.

Table C1
Sensitivity Analysis Results

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 101 Kx101

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.577783	4.953321	0.007871	0	0	46898.43417	-32828.90392	56263.34046
2	0.5	3.28E+04	3.575651	4.95283	0.021053	0	0	65629.12402	-32814.56201	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.57094	4.954219	0.059824	0	0	109368.6708	-32810.60123	
5	1.5	3.28E+04	3.570238	4.95481	0.067895	0	0	65628.24675	-32814.12338	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 101 Kz101

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.576165	4.947019	-0.025754	0	0	46802.27153	-32761.59007	56248.4615
2	0.5	3.28E+04	3.574053	4.948783	0.001901	0	0	65538.62831	-32769.31416	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.572279	4.955934	0.064985	0	0	109439.5133	-32831.85399	
5	1.5	3.28E+04	3.57238	4.957441	0.074944	0	0	65694.65148	-32847.32574	

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 104 Kx104

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.574391	4.952317	0.030153	0	0	46865.86786	-32806.1075	56240.15168
2	0.5	3.28E+04	3.573593	4.952772	0.036922	0	0	65613.87659	-32806.93829	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.571628	4.953696	0.051055	0	0	109357.5405	-32807.26216	
5	1.5	3.28E+04	3.571289	4.95385	0.053475	0	0	65614.4355	-32807.21775	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 104 Kz104

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.571218	4.951502	0.035551	0	0	46837.18686	-32786.0308	56238.75606
2	0.5	3.28E+04	3.571607	4.952115	0.039316	0	0	65585.68393	-32792.84196	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.572516	4.954144	0.050561	0	0	109384.152	-32815.24561	
5	1.5	3.28E+04	3.57267	4.954589	0.052839	0	0	65640.32527	-32820.16263	

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 121 Kx121

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.571861	4.952954	0.044304	0	0	46860.71284	-32802.49899	56240.64093
2	0.5	3.28E+04	3.57198	4.953102	0.045106	0	0	65608.0489	-32804.02445	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.572377	4.95361	0.047788	0	0	109363.9424	-32809.18273	
5	1.5	3.28E+04	3.572461	4.953719	0.048396	0	0	65620.56902	-32810.28451	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 121 Kz121

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.27E+04	3.557415	4.938238	-0.019149	0	0	46651.33979	-32655.93785	56182.22814
2	0.5	3.27E+04	3.563327	4.944846	0.011589	0	0	65436.8286	-32718.4143	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.575335	4.95639	0.058114	0	0	109465.2671	-32839.58013	
5	1.5	3.29E+04	3.576925	4.957919	0.063726	0	0	65713.11648	-32856.55824	

Table C1
Sensitivity Analysis Results

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 201 Kx201

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.34E+04	3.634211	4.96883	-0.090393	0	0	47776.79017	-33443.75312	56715.71823
2	0.5	3.32E+04	3.60555	4.96054	-0.049144	0	0	66300.16135	-33150.08068	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.568808	4.955485	0.100068	0	0	109286.733	-32786.0199	
5	1.5	3.28E+04	3.569786	4.958739	0.1336	0	0	65654.64629	-32827.32315	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 201 Kz201

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.574131	4.952295	0.022954	0	0	46869.99951	-32808.99966	56243.69486
2	0.5	3.28E+04	3.57314	4.952765	0.035084	0	0	65613.59647	-32806.79824	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.572037	4.953669	0.05017	0	0	109360.3221	-32808.09663	
5	1.5	3.28E+04	3.571942	4.953802	0.051736	0	0	65617.39022	-32808.69511	

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 219 Kx219

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.27E+04	3.566685	4.940492	-0.052711	0	0	46729.36082	-32710.55258	56268.10457
2	0.5	3.27E+04	3.567161	4.944174	-0.017602	0	0	65458.89978	-32729.44989	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.29E+04	3.575757	4.958874	0.075709	0	0	109545.9	-32863.77	
5	1.5	3.29E+04	3.578297	4.962445	0.091912	0	0	65806.84832	-32903.42416	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 219 Kz219

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.27E+04	3.566229	4.946174	0.008514	0	0	46764.0182	-32734.81274	56205.60855
2	0.5	3.28E+04	3.569068	4.949803	0.028345	0	0	65540.1993	-32770.09965	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.573171	4.954468	0.051606	0	0	109394.9595	-32818.48786	
5	1.5	3.28E+04	3.573599	4.954945	0.053867	0	0	65647.19891	-32823.59945	

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 223 Kx223

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.37E+04	3.651436	5.001354	-0.009088	0	0	48116.63048	-33681.64133	56600.67318
2	0.5	3.33E+04	3.616473	4.982062	0.002765	0	0	66643.8701	-33321.93505	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.26E+04	3.557693	4.942594	0.074204	0	0	108763.1886	-32628.95659	
5	1.5	3.25E+04	3.550387	4.936924	0.091788	0	0	65084.71589	-32542.35795	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 223 Kz223

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.27E+04	3.566065	4.949282	0.063262	0	0	46780.79266	-32746.55486	56231.80295
2	0.5	3.28E+04	3.568059	4.950596	0.058115	0	0	65532.01033	-32766.00516	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.574553	4.954915	0.041319	0	0	109428.9543	-32828.68629	
5	1.5	3.28E+04	3.575931	4.955811	0.0382	0	0	65682.81325	-32841.40662	

Table C1
Sensitivity Analysis Results

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 307 Kx307

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.33E+04	3.610798	4.985863	-0.010108	0	0	47568.48752	-33297.94127	56375.48818
2	0.5	3.31E+04	3.596452	4.97414	0.009464	0	0	66236.65458	-33118.32729	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.27E+04	3.561555	4.944077	0.0654	0	0	108898.1963	-32669.45889	
5	1.5	3.26E+04	3.55557	4.938716	0.076537	0	0	65182.48883	-32591.24442	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 307 Kz307

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.572287	4.953541	0.047287	0	0	46869.69495	-32808.78647	56242.21046
2	0.5	3.28E+04	3.572268	4.953495	0.047103	0	0	65616.32821	-32808.1641	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.572231	4.953413	0.046742	0	0	109357.1694	-32807.15081	
5	1.5	3.28E+04	3.572255	4.953423	0.046581	0	0	65614.72597	-32807.36299	

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 320 Kx320

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.569495	4.953543	0.021884	0	0	46884.62242	-32819.2357	56264.20825
2	0.5	3.28E+04	3.569906	4.953261	0.032397	0	0	65622.17028	-32811.08514	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.573919	4.954083	0.050534	0	0	109381.0439	-32814.31318	
5	1.5	3.28E+04	3.575292	4.954702	0.05155	0	0	65643.79409	-32821.89704	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 320 Kz320

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.572219	4.953408	0.046826	0	0	46867.19622	-32807.03736	56240.79711
2	0.5	3.28E+04	3.572239	4.953428	0.046804	0	0	65614.67333	-32807.33667	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.572238	4.953433	0.046865	0	0	109357.9234	-32807.37703	
5	1.5	3.28E+04	3.572222	4.953423	0.046931	0	0	65614.39799	-32807.199	

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 322 Kx322

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.29E+04	3.5881	4.951041	-0.039627	0	0	47005.2141	-32903.64987	56339.14852
2	0.5	3.29E+04	3.581463	4.951082	-0.012834	0	0	65715.84601	-32857.92301	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.57007	4.956337	0.078569	0	0	109388.7723	-32816.63169	
5	1.5	3.28E+04	3.569926	4.958786	0.098431	0	0	65673.08294	-32836.54147	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 322 Kz322

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.57304	4.951659	0.028474	0	0	46847.98085	-32793.5866	56236.45385
2	0.5	3.28E+04	3.572668	4.952408	0.036779	0	0	65598.1294	-32799.0647	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.572114	4.953815	0.050151	0	0	109369.0497	-32810.71491	
5	1.5	3.28E+04	3.572049	4.954009	0.051839	0	0	65624.92686	-32812.46343	

Table C1
Sensitivity Analysis Results

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 323 Kx323

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.31E+04	3.597061	4.965514	-0.020471	0	0	47278.07063	-33094.64944	56360.2833
2	0.5	3.30E+04	3.586823	4.960649	0.000901	0	0	65963.59306	-32981.79653	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.27E+04	3.567196	4.951	0.07193	0	0	109159.5397	-32747.8619	
5	1.5	3.27E+04	3.564785	4.949897	0.088055	0	0	65442.49597	-32721.24799	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 323 Kz323

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.572262	4.953429	0.046686	0	0	46867.79364	-32807.45555	56241.44012
2	0.5	3.28E+04	3.572245	4.953427	0.046798	0	0	65614.72417	-32807.36208	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.572218	4.953419	0.046935	0	0	109357.1758	-32807.15275	
5	1.5	3.28E+04	3.572249	4.953447	0.046814	0	0	65615.0866	-32807.5433	

Groundwater Vistas Sensitivity Analysis
Parameter: Kx Zone: 351 Kx351

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.36E+04	3.643882	5.016639	0.135817	0	0	48044.83225	-33631.38258	56481.6234
2	0.5	3.33E+04	3.618917	4.994125	0.107405	0	0	66670.89277	-33335.44638	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.26E+04	3.552549	4.935893	0.015664	0	0	108608.9753	-32582.6926	
5	1.5	3.25E+04	3.542034	4.926189	-0.003509	0	0	64918.41455	-32459.20728	

Groundwater Vistas Sensitivity Analysis
Parameter: Kz Zone: 351 Kz351

Run	Multiplier	Sum of Squares	Residual Mean	Residual Std.	Average Drawdown	CH	River	Sensitivity	DeltaRss	
1	0.3	3.28E+04	3.572616	4.953808	0.047108	0	0	46875.0973	-32812.56811	56244.10977
2	0.5	3.28E+04	3.572408	4.953602	0.046955	0	0	65619.45385	-32809.72693	
3	1	3.28E+04	3.572236	4.95343	0.046863	0	0	0	-32807.34358	
4	1.3	3.28E+04	3.572214	4.953405	0.046763	0	0	109356.661	-32806.99831	
5	1.5	3.28E+04	3.572181	4.953373	0.046807	0	0	65613.12224	-32806.56112	

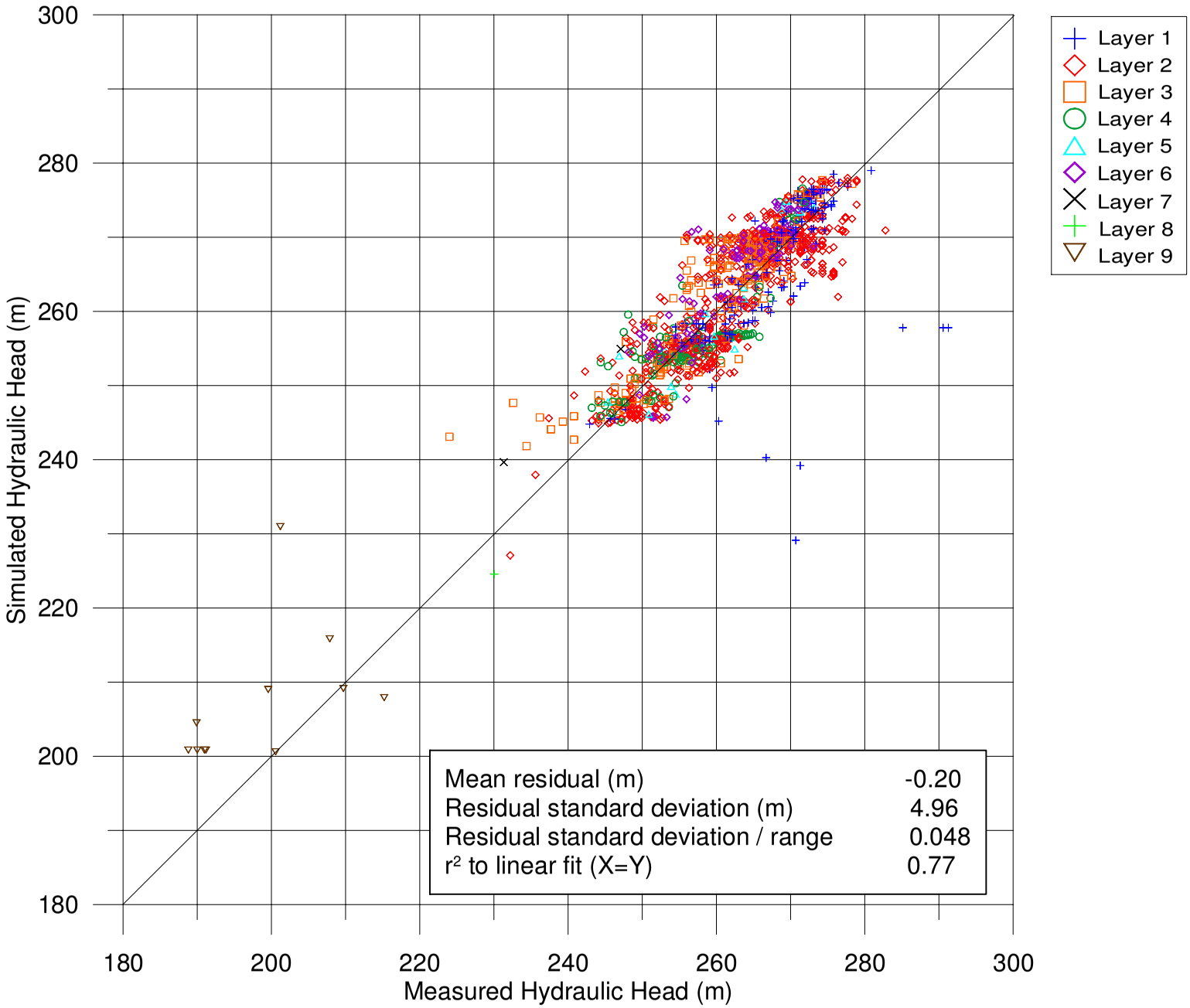


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Figure C1

OBSERVED VS COMPUTED HYDRAULIC HEAD VALUES FOR NEW BRIGHTON AREA
WHPP Amendment
City of New Brighton
Ramsey County, MN

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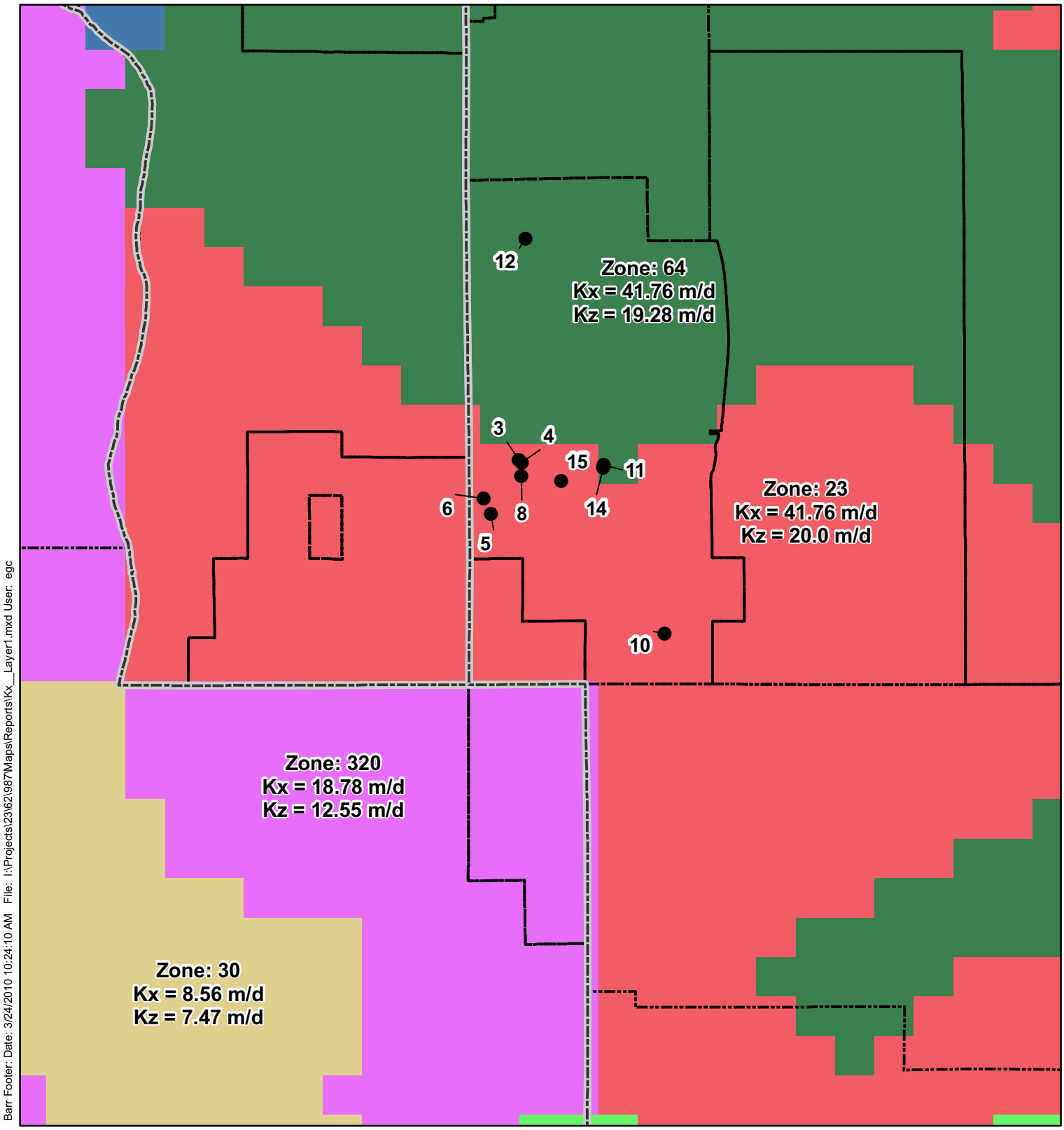

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K Zone

- 22
- 23
- 30
- 56
- 64
- 74

New Brighton Well

County Boundary

Municipal Boundaries

N

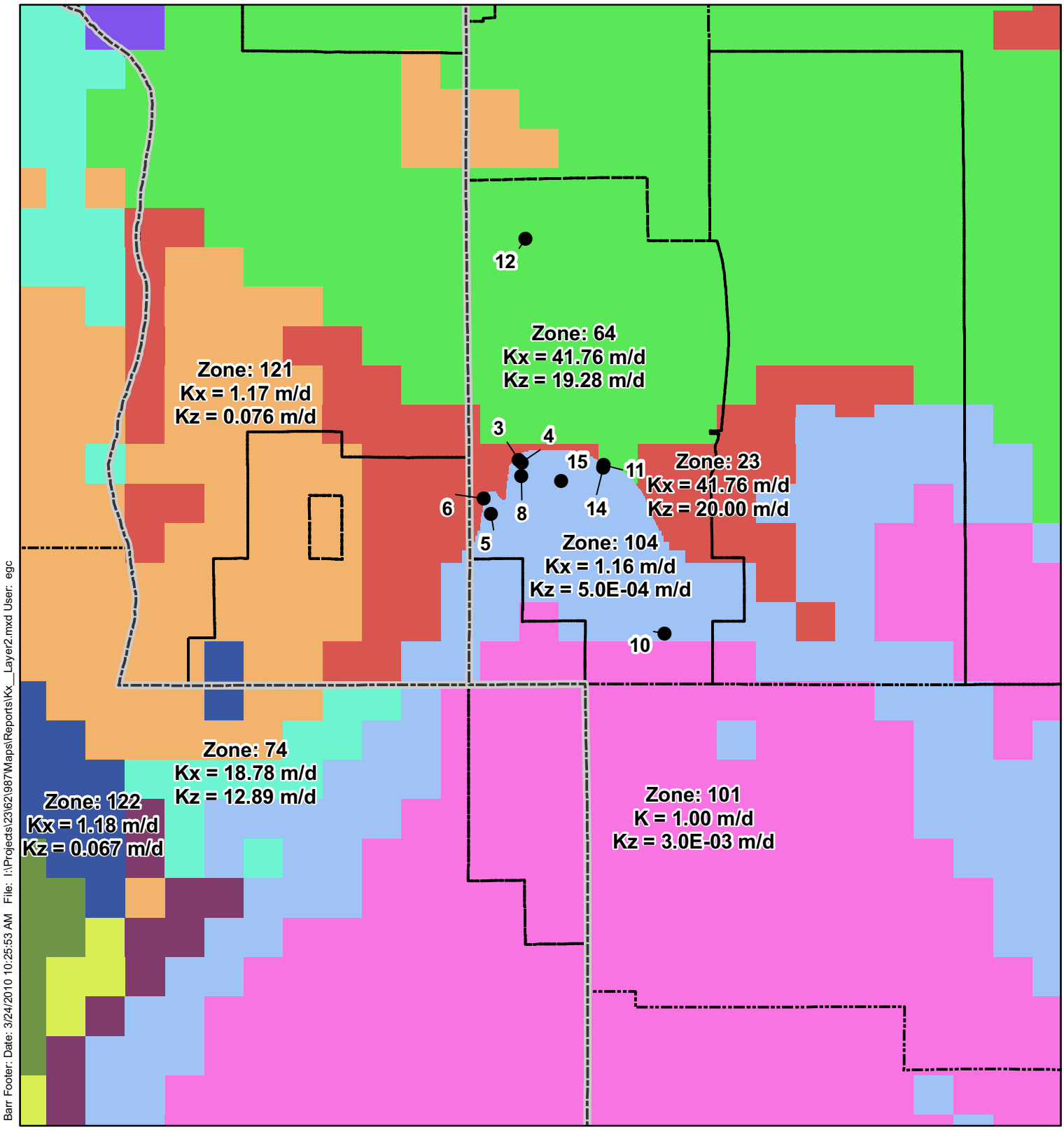
Miles

0 0.5 1

BARR

Figure C2

Hydraulic Conductivity Layer 1
WHPP Part 1
City of New Brighton
Ramsey County, MN



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K Zone

22	101		
23	104		
30	121		
64	122		
74	123		
	124		

New Brighton Well

County Boundary

Municipal Boundaries

N

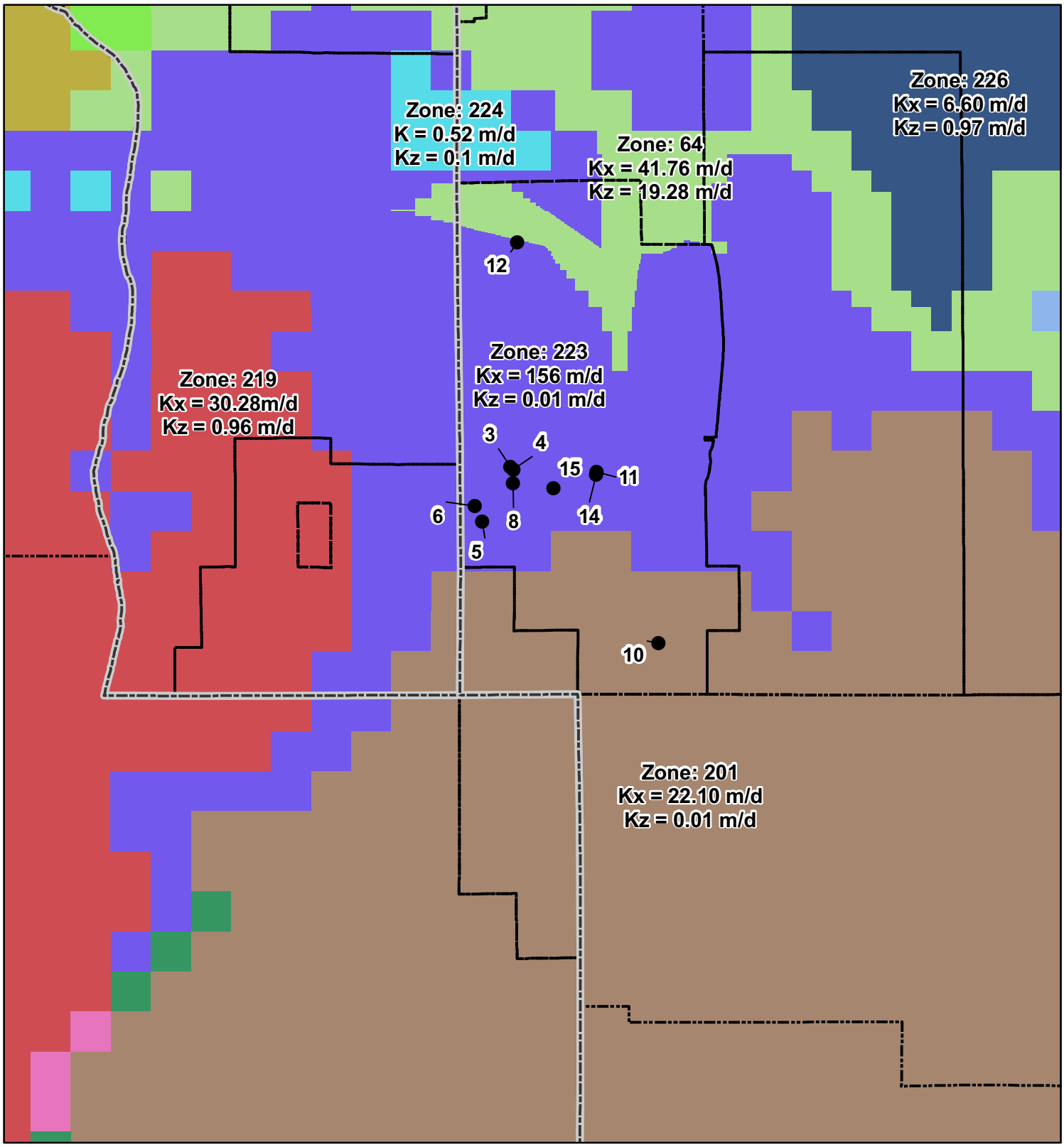
Miles

0 0.5 1

BARR

Figure C3

Hydraulic Conductivity Layer 2
WHPP Part 1
City of New Brighton
Ramsey County, MN



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K Zone

22	206	New Brighton Well
64	219	County Boundary
74	223	Municipal Boundaries
201	224	
205	226	
	232	

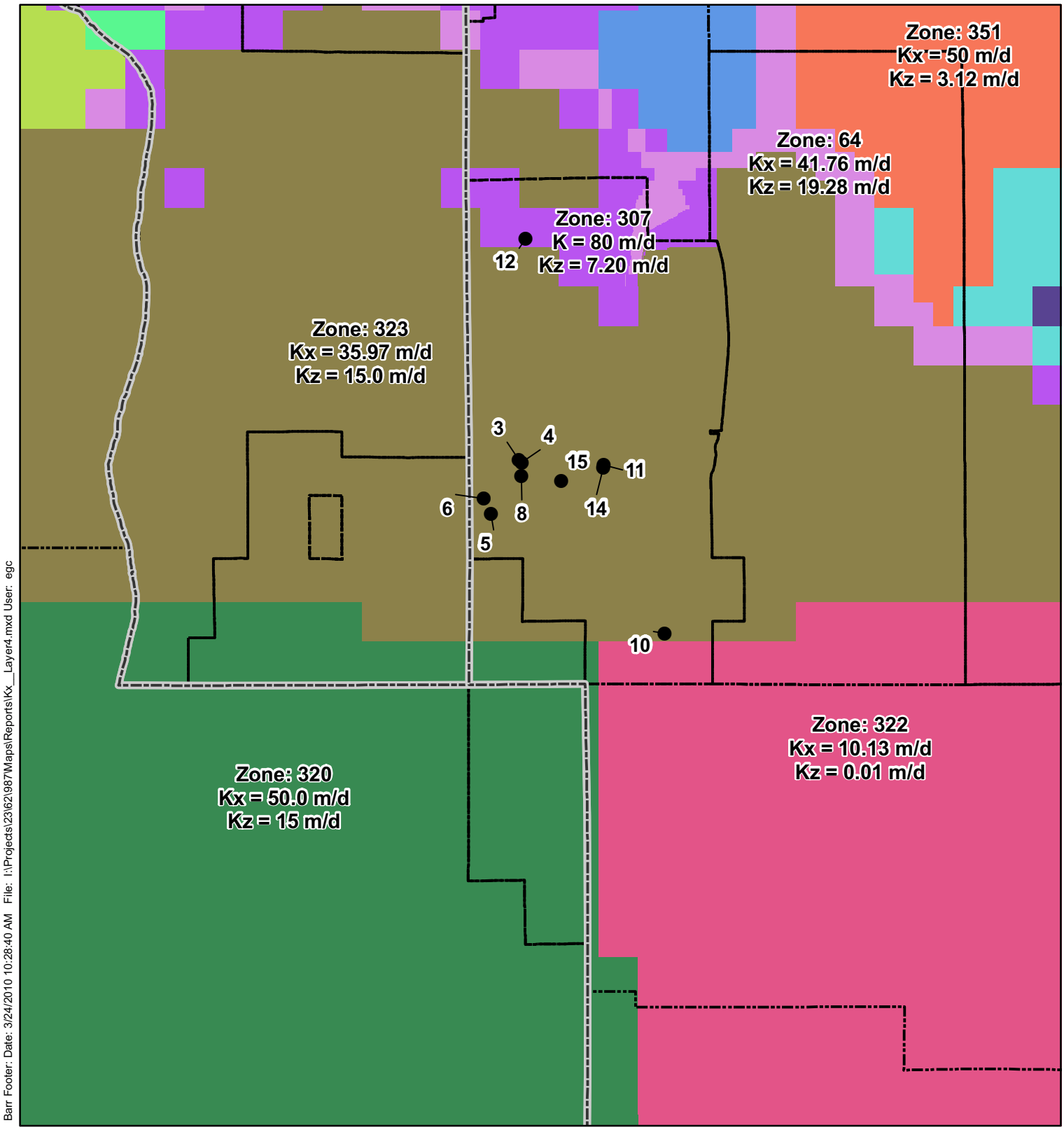
N

Miles
0 0.5 1

BARR

Figure C4

Hydraulic Conductivity Layer 3
WHPP Part 1
City of New Brighton
Ramsey County, MN



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K Zone

22	308
64	320
74	322
301	323
307	350
	351

New Brighton Well

County Boundary

Municipal Boundaries

N

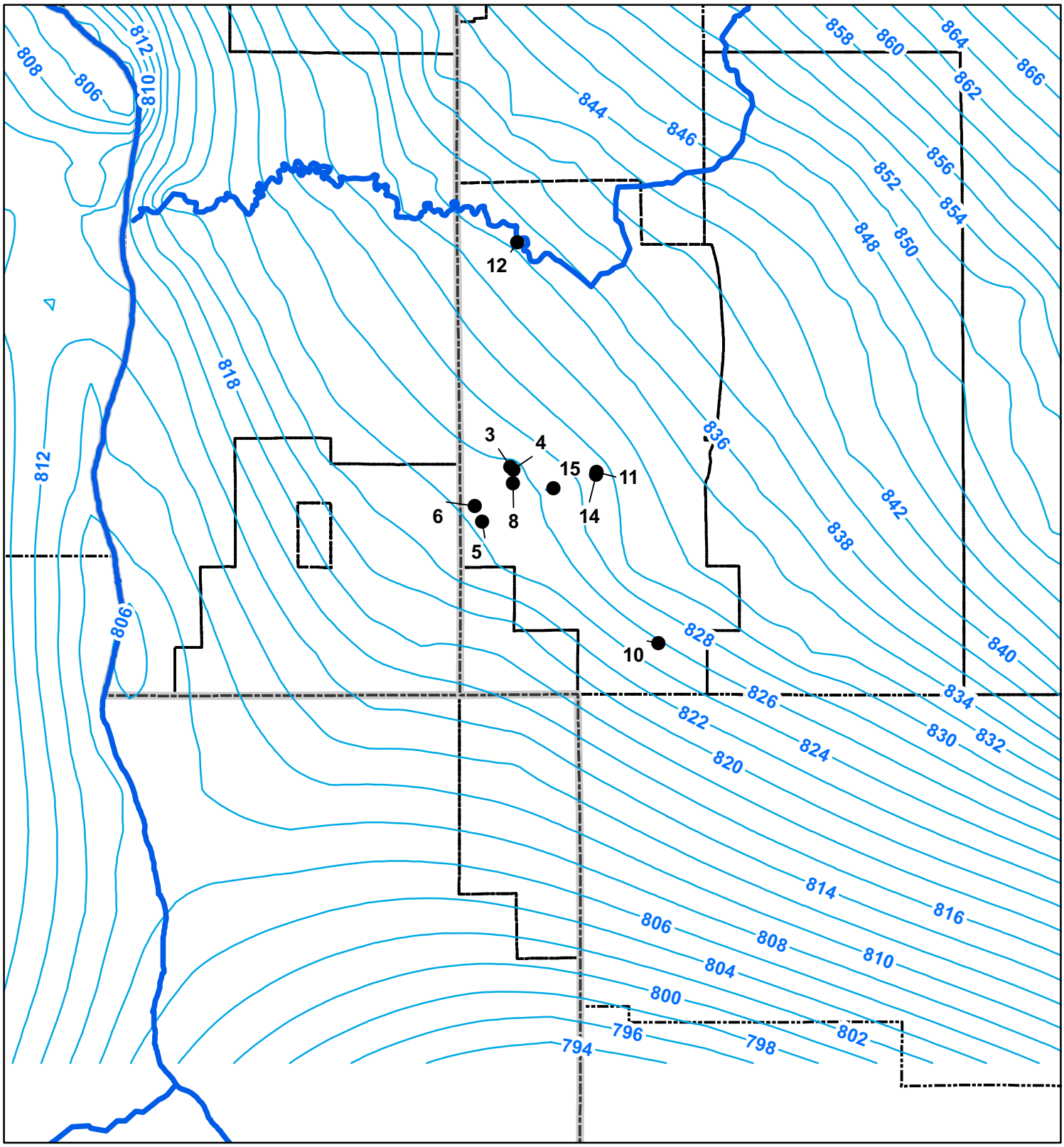
Miles

0 0.5 1

BARR

Figure C5

Hydraulic Conductivity Layer 4
WHPP Part 1
City of New Brighton
Ramsey County, MN



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Groundwater Contour (ft, MSL)

Rivers

New Brighton Well

County Boundary

Municipal Boundaries

Contour Interval = 2 ft

N

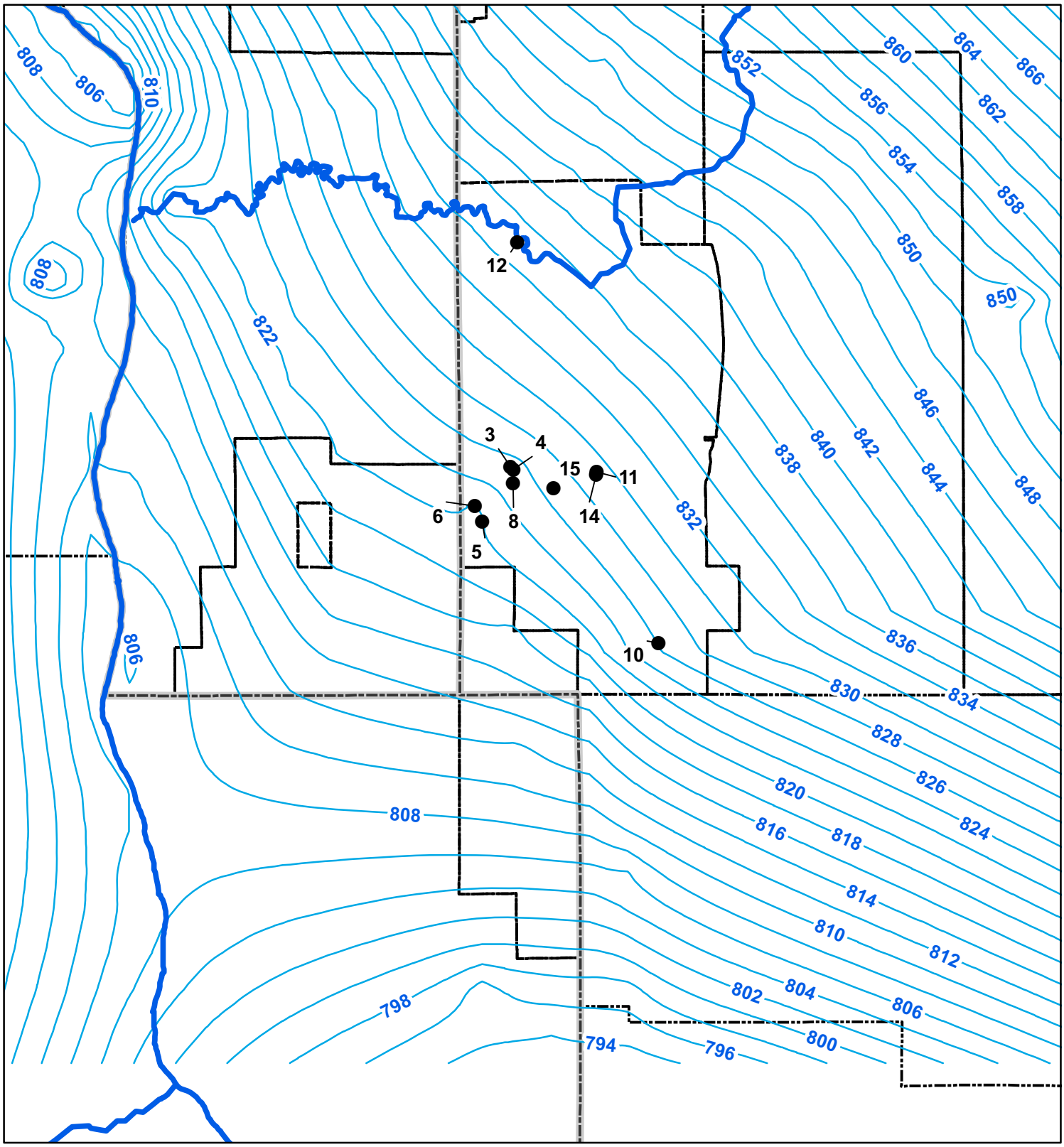
Miles

0 0.5 1

BARR

Figure C6

Groundwater Contours Layer 3
Mostly OPDC
WHPP Part 1
City of New Brighton
Ramsey County, MN



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New Brighton Well

Rivers

Groundwater Contour (ft, MSL)

County Boundary

Municipal Boundaries

Contour Interval = 2 ft

N

Miles

0 0.5 1

BARR

Figure C7

Groundwater Contours Layer 4
Mostly CJDN
WHPP Part 1
City of New Brighton
Ramsey County, MN

Figure C8
Senstivity Analysis
Sum of Squares

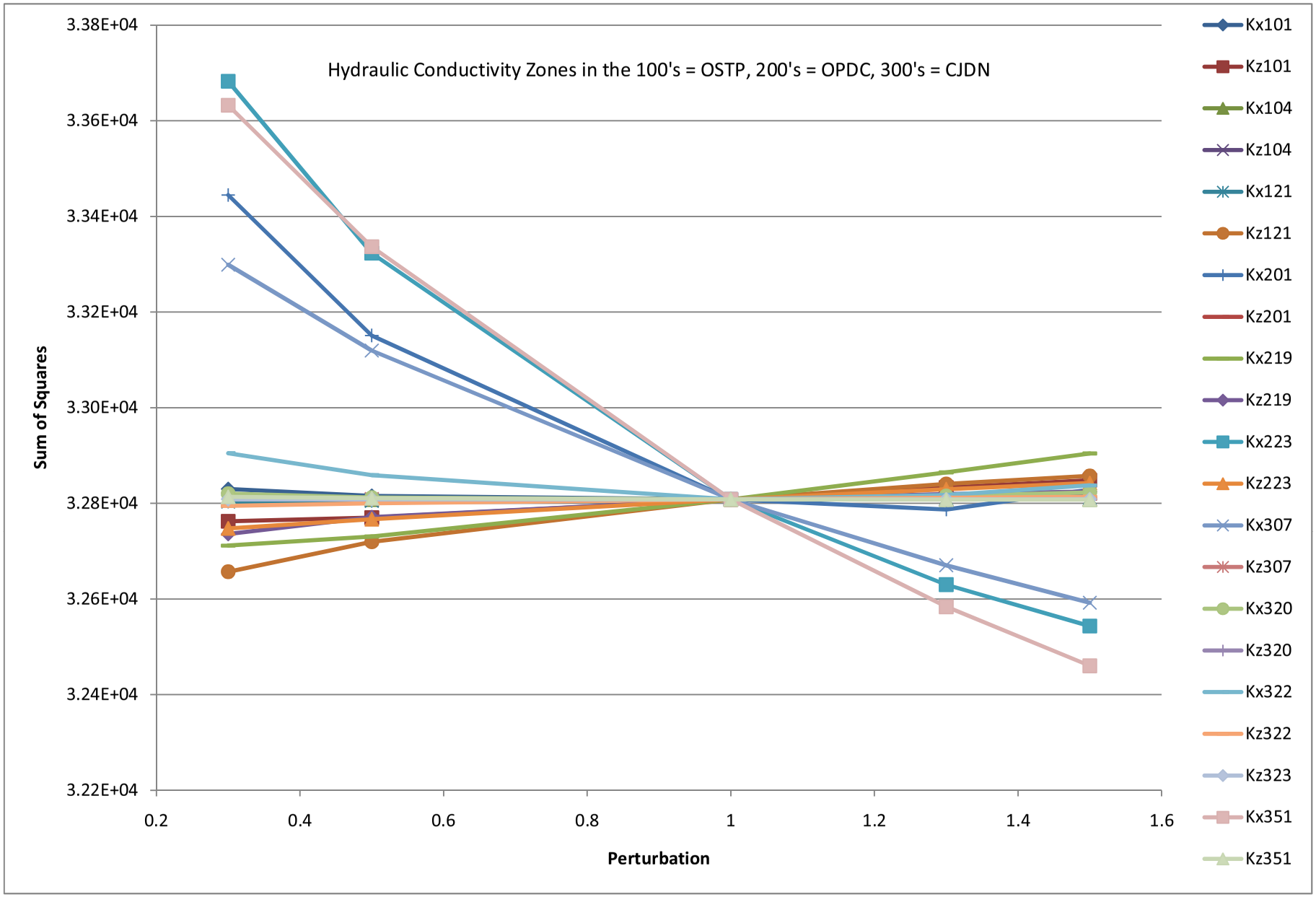

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Figure C9
Senstivity Analysis
Residual Mean

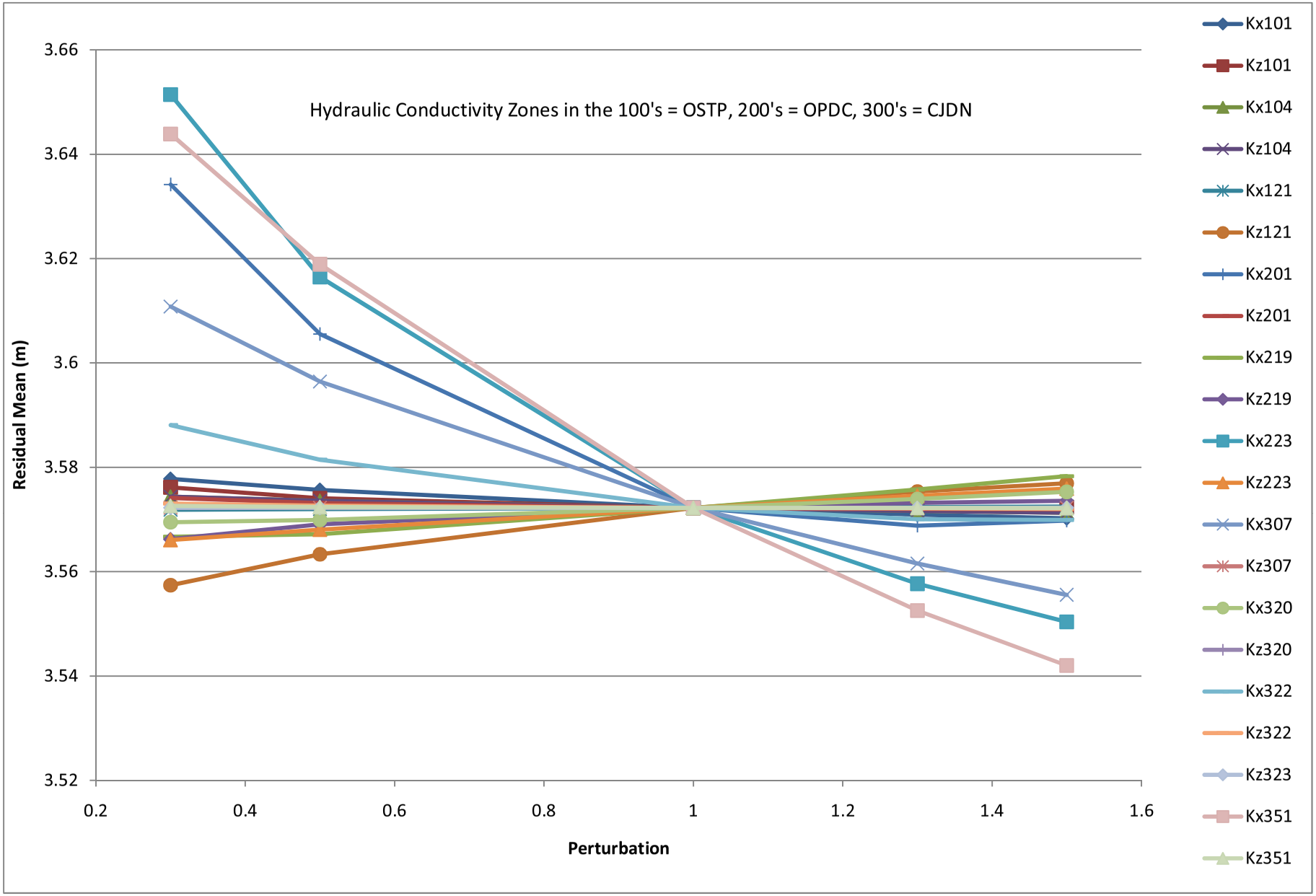

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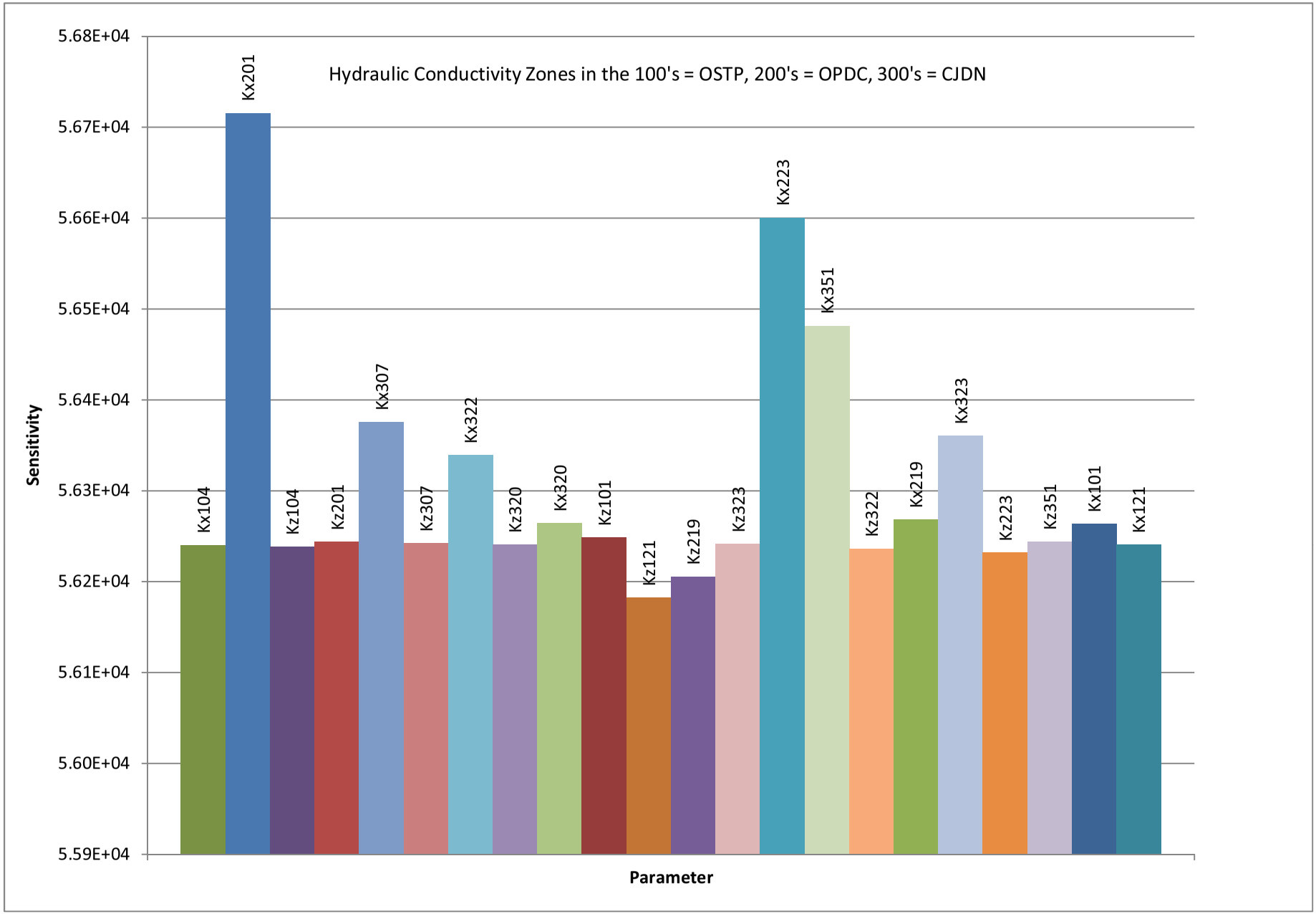
Figure C10
Parameter Sensitivities



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Appendix D

Water Use

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Public Water Supply Inventory

Public water suppliers that serve more than 1,000 people must complete this form. Smaller communities are encouraged to complete this form and maintain water use data by customer categories. Please provide your own definitions if you maintain records of customer categories that are different than the given definitions.

Permittee: **NEW BRIGHTON, CITY OF** Permit: **1970-0157**

1. a) Population served by your system: 22,300

   b) Source of population data:
   1. US Census 2. Local Census 3. Other (specify) Met Council

2. **Residential:** Enter the information on water used for normal residential purposes such as: drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, watering lawns and gardens here:

Gallons Sold	# Connections	# Metered Connections
638,832,000	5507	5507

3. **Commercial:** Enter the information on water used for motels, hotels, restaurants, office buildings, commercial facilities, and institutions both civilian and military here:

Gallons Sold	# Connections	# Metered Connections
170,356,000	326	326

4. **Industrial:** Enter the information on water used for thermoelectric power (electric utility generation) and other industrial uses such as: steel, chemical and allied products, paper and allied products, mining, and petroleum refining here:

Gallons Sold	# Connections	# Metered Connections
42,589,000	38	38

5. **Agricultural:** Enter the information on water used for agricultural purposes here:

Gallons sold	# Connections	# Metered Connections
0	0	0

6. **Other:** Enter the information on water used for categories not listed above here:

Gallons Sold	# Connections	# Metered Connections
*488,895,000	1	1

* Water is given to Fridley to meet pumpage requirement. We are required to have minimal daily pumpage.

Specify other uses:

7. **Totals:**

Total Gallons Sold	Total Reported Withdrawals (Gallons)
	1,429,574,000

8. **2008** Maximum day volume 6,099 gallons Month/Day July 30, 2009

9. If you maintain water level information on production or observation wells, please send water level data to the Department. A computer spreadsheet is available for recording/reporting the information. Contact the Ground Water Data System Coordinator at: gwlevelcoordinator@dnr.state.mn.us

10. Indicate the type of rate structure your city uses (attach a copy of the water rate schedule)

(1) Uniform	5. Seasonal Rate
2. Flat	6. Individualized Goal Rate
3. Declining Block	7. Excess Use Rate
4. Increasing Block	8. Time of Day Rate
	9. Other _____

Signature Kenny J Moore Date Feb 12, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **3**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **OPDCCSTL**

Well Unique Number: 206793
Twp: **30** Rng: **23** Sec: **29** Qtr: **BADD**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
____ 1. Well Sealed ____ 2. Emergency Source
____ 3. Water received from an alternate source, specify:
____ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 600

January	-0-	July	7,995,000
February	1,863,000	August	1,606,000
March	7,341,000	September	1,260,000
April	3,579,000	October	87,000
May	7,813,000	November	137,000
June	12,794,000	December	7,485,000
		Total	51,960,000

C. Measurement method (indicate one)

____ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ____ Hour meter
____ 3. Timing Device with: ____ Hour Meter *or* ____ Electric meter
____ 4. Alternate method: If not already approved, enclose request for approval
____ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kenny Thorne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **4**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **OPDCCSTL**

Well Unique Number: 206792
Twp: **30** Rng: **23** Sec: **30** Qtr: **BADD**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
___ 1. Well Sealed ___ 2. Emergency Source
___ 3. Water received from an alternate source, specify:
___ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 1100

January	24,870,000	July	42,796,000
February	13,502,000	August	44,005,000
March	41,931,000	September	35,009,000
April	37,191,000	October	33,337,000
May	42,938,000	November	35,915,000
June	42,342,000	December	35,396,000
		Total	429,232,000

C. Measurement method (indicate one)

___ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ___ Hour meter
___ 3. Timing Device with: ___ Hour Meter *or* ___ Electric meter
___ 4. Alternate method: If not already approved, enclose request for approval
___ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kerry J Horne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **5**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **CJDN**

Well Unique Number: 206796
Twp: **30** Rng: **23** Sec: **30** Qtr: **CBD**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
___ 1. Well Sealed ___ 2. Emergency Source
___ 3. Water received from an alternate source, specify:
___ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 900

January	10,069,000	July	5,140,000
February	12,088,000	August	155,000
March	24,629,000	September	131,000
April	6,922,000	October	216,000
May	14,801,000	November	146,000
June	9,727,000	December	7,427,000
		Total	91,451,000

C. Measurement method (indicate one)

___ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ___ Hour meter
___ 3. Timing Device with: ___ Hour Meter *or* ___ Electric meter
___ 4. Alternate method: If not already approved, enclose request for approval
___ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kenny J Home Date Feb 9, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **6**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **CJDN**

Well Unique Number: 206797
Twp: **30** Rng: **23** Sec: **30** Qtr: **CBAB**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
____ 1. Well Sealed ____ 2. Emergency Source
____ 3. Water received from an alternate source, specify:
____ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 700

January	11,613,000	July	31,959,000
February	14,246,000	August	35,922,000
March	24,648,000	September	25,339,000
April	10,997,000	October	6,078,000
May	29,471,000	November	18,643,000
June	30,668,000	December	16,817,000
		Total	256,401,000

C. Measurement method (indicate one)

____ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ____ Hour meter
____ 3. Timing Device with: ____ Hour Meter *or* ____ Electric meter
____ 4. Alternate method: If not already approved, enclose request for approval
____ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kenny Thorne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **8**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **OPDCCSTL**

Well Unique Number: 206795
Twp: **30** Rng: **23** Sec: **30** Qtr: **ADA**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
____ 1. Well Sealed ____ 2. Emergency Source
____ 3. Water received from an alternate source, specify:
____ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 900

January	-0-	July	282,000
February	-0-	August	301,000
March	-0-	September	53,000
April	-0-	October	962,000
May	941,000	November	-0-
June	2,383,000	December	-0-
		Total	4,922,000

C. Measurement method (indicate one)

____ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ____ Hour meter
____ 3. Timing Device with: ____ Hour Meter *or* ____ Electric meter
____ 4. Alternate method: If not already approved, enclose request for approval
____ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kerry J Thorne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **9**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **CMTS**

Well Unique Number: 206794
Twp: **30** Rng: **23** Sec: **30** Qtr: **CABA**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
___ 1. Well Sealed X 2. Emergency Source
___ 3. Water received from an alternate source, specify:
___ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 900

January		July	
February		August	
March		September	
April		October	
May		November	
June		December	
		Total	-0-

C. Measurement method (indicate one)

___ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ___ Hour meter
___ 3. Timing Device with: ___ Hour Meter *or* ___ Electric meter
___ 4. Alternate method: If not already approved, enclose request for approval
___ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kerry Thorne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **10**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **CMTS**

Well Unique Number: 161432
Twp: **30** Rng: **23** Sec: **32** Qtr: **DBC**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
____ 1. Well Sealed ____ 2. Emergency Source
____ 3. Water received from an alternate source, specify:
____ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 900

January	-0-	July	2,618,000
February	-0-	August	3,073,000
March	-0-	September	3,680,000
April	-0-	October	6,949,000
May	1,319,000	November	473,000
June	1,369,000	December	54,000
		Total	19,535,000

C. Measurement method (indicate one)

____ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ____ Hour meter
____ 3. Timing Device with: ____ Hour Meter *or* ____ Electric meter
____ 4. Alternate method: If not already approved, enclose request for approval
____ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kenny Thorne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **11**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **CMTS**

Well Unique Number: 509083
Twp: **30** Rng: **23** Sec: **29** Qtr: **DCA**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
___ 1. Well Sealed ___ 2. Emergency Source
___ 3. Water received from an alternate source, specify:
___ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 1000

January	-0-	July	256,000
February	-0-	August	274,000
March	-0-	September	88,000
April	-0-	October	820,000
May	893,000	November	-0-
June	2,154,000	December	-0-
		Total	4,485,000

C. Measurement method (indicate one)

___ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ___ Hour meter
___ 3. Timing Device with: ___ Hour Meter *or* ___ Electric meter
___ 4. Alternate method: If not already approved, enclose request for approval
___ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kenny J Thorne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **12**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **CMTS**

Well Unique Number: 110485
Twp: **30** Rng: **23** Sec: **18** Qtr: **ACCC**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
___ 1. Well Sealed ___ 2. Emergency Source
___ 3. Water received from an alternate source, specify:
___ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 900

January	-0-	July	886,000
February	-0-	August	-0-
March	-0-	September	1,372,000
April	-0-	October	5,801,000
May	-0-	November	-0-
June	130,000	December	68,000
		Total	8,257,000

C. Measurement method (indicate one)

___ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ___ Hour meter
___ 3. Timing Device with: ___ Hour Meter *or* ___ Electric meter
___ 4. Alternate method: If not already approved, enclose request for approval
___ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kerry Thorne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **13**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **OPDC**

Well Unique Number: 520931
Twp: **30** Rng: **23** Sec: **29** Qtr: **AC**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
X 1. Well Sealed ___ 2. Emergency Source
___ 3. Water received from an alternate source, specify:
___ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): _____

January		July	
February		August	
March		September	
April		October	
May		November	
June		December	
		Total	

C. Measurement method (indicate one)

___ 1. Flow Meter
___ 2. Flow Rate Meter with: ____ Totalizer *or* ____ Hour meter
___ 3. Timing Device with: ____ Hour Meter *or* ____ Electric meter
___ 4. Alternate method: If not already approved, enclose request for approval
___ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kerry Thorne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **14**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **OPCJ**

Well Unique Number: 554216
Twp: **30** Rng: **23** Sec: **29** Qtr: **BCA**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
____ 1. Well Sealed ____ 2. Emergency Source
____ 3. Water received from an alternate source, specify:
____ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 1200

January	23,206,000	July	12,680,000
February	36,529,000	August	25,500,000
March	23,955,000	September	2,882,000
April	3,606,000	October	172,000
May	1,180,000	November	228,000
June	273,000	December	192,000
		Total	130,403,000

C. Measurement method (indicate one)

____ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ____ Hour meter
____ 3. Timing Device with: ____ Hour Meter *or* ____ Electric meter
____ 4. Alternate method: If not already approved, enclose request for approval
____ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kenny Thorne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Installation Worksheet

Permit: **1970-0157** Installation: **15**

Permittee: **NEW BRIGHTON, CITY OF**

Use: **Municipal Waterworks**
Source Type: **Ground Water**
Source Name: **OPDCCJDN**

Well Unique Number: 582628
Twp: **30** Rng: **23** Sec: **29** Qtr: **ADC**
Ramsey County

A. If no water was withdrawn this year, indicate the reason.
____ 1. Well Sealed ____ 2. Emergency Source
____ 3. Water received from an alternate source, specify:
____ 4. Other, specify:

B. List the number of **gallons** withdrawn in each month of 2008. Pumping Rate (GPM): 1000

January	41,814,000	July	45,360,000
February	33,523,000	August	44,454,000
March	-0-	September	35,088,000
April	35,283,000	October	36,232,000
May	43,347,000	November	38,951,000
June	42,930,000	December	35,946,000
		Total	432,928,000

C. Measurement method (indicate one)

____ 1. Flow Meter
X 2. Flow Rate Meter with: X Totalizer *or* ____ Hour meter
____ 3. Timing Device with: ____ Hour Meter *or* ____ Electric meter
____ 4. Alternate method: If not already approved, enclose request for approval
____ 5. Estimated: An approved measuring device or method is required (describe below)

Signature Kenny Thorne Date Feb 1, 2009 Phone 651-638-2055

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Permit Data Verification Form

Enter the number from line 2 of the Fee Calculation Worksheet: 1429.6 million gallons

If this number is greater than **1925.0** million gallons and you expect to exceed this volume in the future, an amendment is required.

If no permit changes are required, you do not need to submit this page.

1. **Amendment:** To change the number of permitted installations, pumping rate or permitted volume, enclose the applicable items listed below with your report and water use fees:

   a. A written amendment request describing changes needed to the existing permit. Please verify all information printed on the report forms.

   b. A statement justifying why additional water or new wells are needed.

   c. Requests for an increase in the authorized volume of water must be in accordance with your water supply plan and include documentation to justify the volume of water requested.

   d. Requests for new wells must include a copy of the water well record, water level/test pumping data, the proposed pumping rate, and a map showing the locations of all wells.

   e. A copy of the current rate structure and a statement describing public education and water conservation programs that are currently implemented to reduce demands. Please note: Public water suppliers serving more than 1000 people must adopt a conservation rate structure before an increase in authorized volume can be approved. See: www.mndnr.gov/waters/watermgmt_section/appropriations/conservation.html

2. **Installation Removal:** If you need an installation removed with no other changes to the permit, please explain below. No fee is required for the removal of an installation. Provide a copy of the well sealing record.

3. **Transfer to new owner (for private systems)** include the name, address, and phone of the new property owner. Proof of ownership is required from the new owner.

Signature _____ Date _____ Phone _____

If an amendment or transfer is required, a $150 processing fee will be invoiced separately.

Fee Exemptions based on Minnesota Rules 6115.0120 and Minnesota Statutes 103G.271

1. A change in mailing address or authorized agent when land ownership has not changed
2. A change in pump location on surface water sources for the same operation
3. A replacement well completed at a similar depth in the same aquifer
4. A decrease in the permitted pumping rate, amount of water authorized, or irrigated acreage
5. A federal governmental agency or state agency as defined in statute 16B.01, subd. 2

PWS

1970-0157
2008

2008 MN DNR - Annual Report of Water Use
Fee Calculation Worksheet

Permit: **1970-0157** Permitted Volume (MG/Y): **1925.0** Permitted Installations: **12**
Use: **Municipal Waterworks**

NEW BRIGHTON, CITY OF
KERRY THORNE
803 5TH AVENUE NW
NEW BRIGHTON MN 55112-2731

Please correct address if needed:

Phone: **651-638-2055**

1. Enter the total volume of water from all installations of this permit. 1,429,574,000 gallons
2. Divide line 1 by one million, round to the nearest decimal place. 1,429.6 million gallons
3. If the amount on line 2 is less than 50 million gallons, skip to line 5. If 50 million gallons or greater, enter the **Fee Rate** from the table. $ 8 per million gallons

Volume Pumped (from line 2)	Fee
Less than 50 million gallons	Minimum fee $140
	Fee Rate
50 to 100 million gallons	$3.50
100 to 150 million gallons	$4.00 **per**
150 to 200 million gallons	$4.50 **million**
200 to 250 million gallons	$5.00 **gallons**
250 to 300 million gallons	$5.50
300 to 350 million gallons	$6.00
350 to 400 million gallons	$6.50
400 to 450 million gallons	$7.00
450 to 500 million gallons	$7.50
over 500 million gallons	$8.00

Maximum Fee

Classification	Fee
entity with 1 to 3 permits	$50,000
entity with 4 to 5 permits	$75,000
entity with more than 5 permits	$250,000
city of the first class	$250,000

4. Multiply line 2 by line 3 (when volume is 50 MG or greater). $ $11,436.80
5. Fee Determination $ $11,436.80 (355)
   a) If the amount on line 2 is less than 50 million gallons, enter the minimum permit fee of $140.
   b) If the amount on line 4 is greater than the maximum fee, enter the applicable maximum fee.
   c) Otherwise, enter the amount from line 4.
6. Enter the Summer Surcharge fee in whole dollars. $ 2306 (355)
7. **Add lines 5 and 6.** Return this fee with the water use reports and any additional information required. $ 13,742.80 due

paid

Make checks payable to: "MN DNR Waters"
Mail forms and fees to: Minnesota DNR - OMB
500 Lafayette Rd Box 10
St Paul MN 55155

Check Amt $ 13742.40
Check # 127002

This report and fee are due by February 15th. Please call (651)259-5678 with questions.

2008 MN DNR - Annual Report of Water Use
Summer Surcharge Worksheet

A surcharge of $20 per million gallons will be applied to the volume of water used in each of the months of June, July, and August that exceeds the volume of water used in January. The summer surcharge applies to community water supplies, golf course irrigation and landscape irrigation. This surcharge is in addition to the water use fee based on the yearly total volume.

For the months listed, total the individual installation volumes for the month in gallons. If the surcharge volume is negative, report zero for that month. Subtract the January total from each of the summer monthly values.

June Total	-	January Total	=	June Surcharge Volume
144,770,000		111,572,000		33,198,000
July Total	**-**	**January Total**	**=**	**July Surcharge Volume**
149,972,000		111,572,000		38,400,000
August Total	**-**	**January Total**	**=**	**August Surcharge Volume**
155,290,000		111,572,000		43,718,000

Total Surcharge Volume
(Sum of monthly surcharge volumes) 115,316,000

divide by 1 million to show in millions of gallons 115.3 x $20 = $ 2306.00 **Total Surcharge**

The fee applies when the summer surcharge volume is at least 0.1 million gallons on the last line. Report this fee on line 6 of the Fee Calculation Worksheet. Round down to the nearest whole dollar.

city of NEW BRIGHTON

the city that works for you

803 Old Highway 8 NW
New Brighton, MN 55112
(651) 638-2100

US BANK
3928 Silver Lake Road
St. Anthony, MN 55421

127002

DATE
01-29-09

17-2/910

PAY *****13,742 DOLLARS AND . . . 80/100

AMOUNT
$ *13,742.80**

TO THE ORDER OF
MN DEPT OF NATURAL RESOURCES
DIVISION OF WATERS
MINNESOTA DNR-OMB
500 LAFATETTE RD BOX 10
ST PAUL MN 55155

Steve Larson **Mayor**
Dean R. Toth **City Manager**
Daniel A. Maier **Finance Director**

⑈127002⑈ ⑆091000022⑆ 1262160429 55⑈

Void after 90 days from date of check

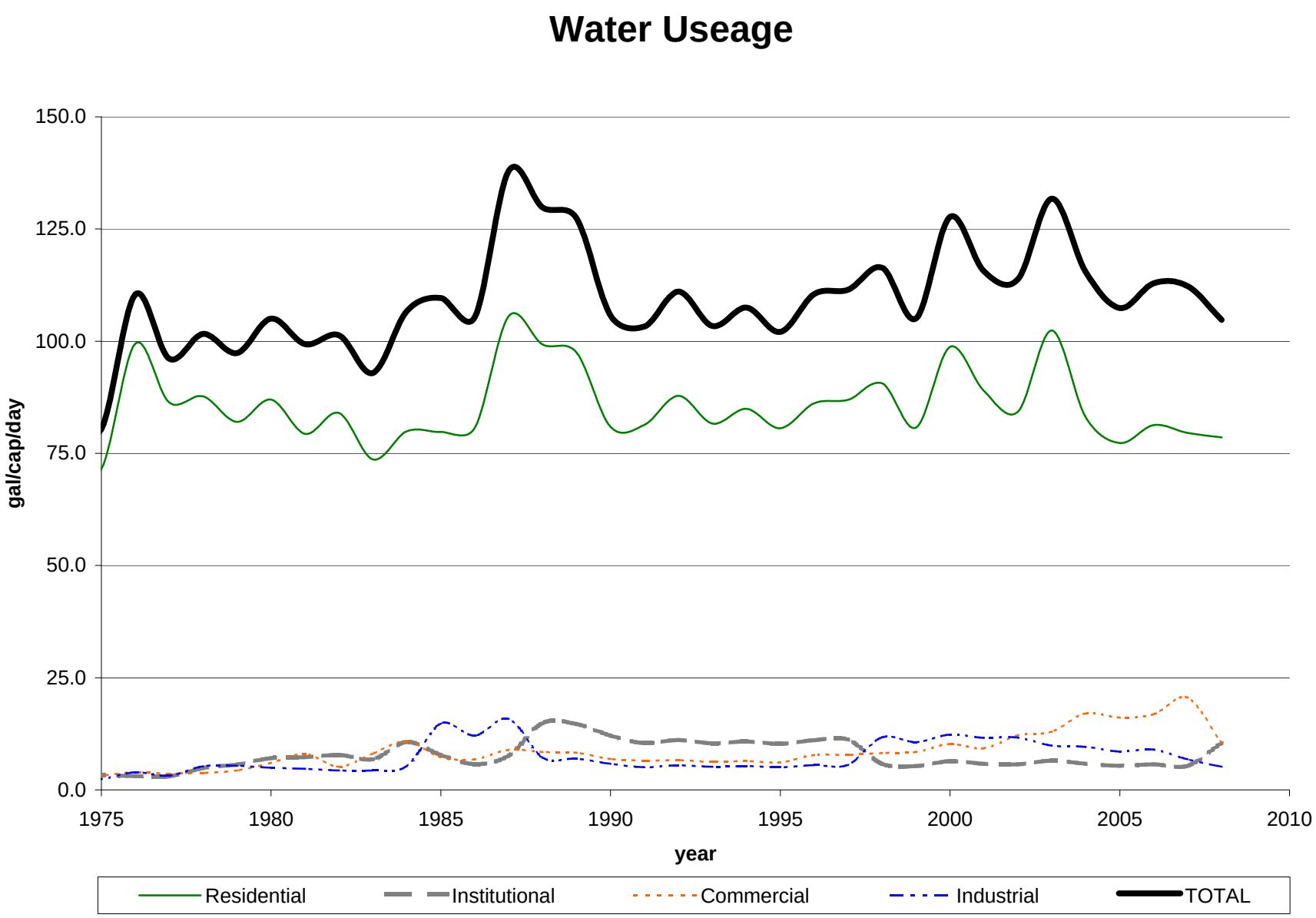
DATE	INVOICE NO.	DESCRIPTION	AMOUNT
01-22-09		08 DNR APPROPRIATIONS PERMIT FEE	13,742.80
		TOTAL	13,742.80

Cities are not required to pay the .25% additional Transit Improvement Sales Tax. Please charge only 6.5% on sales to the City of New Brighton.

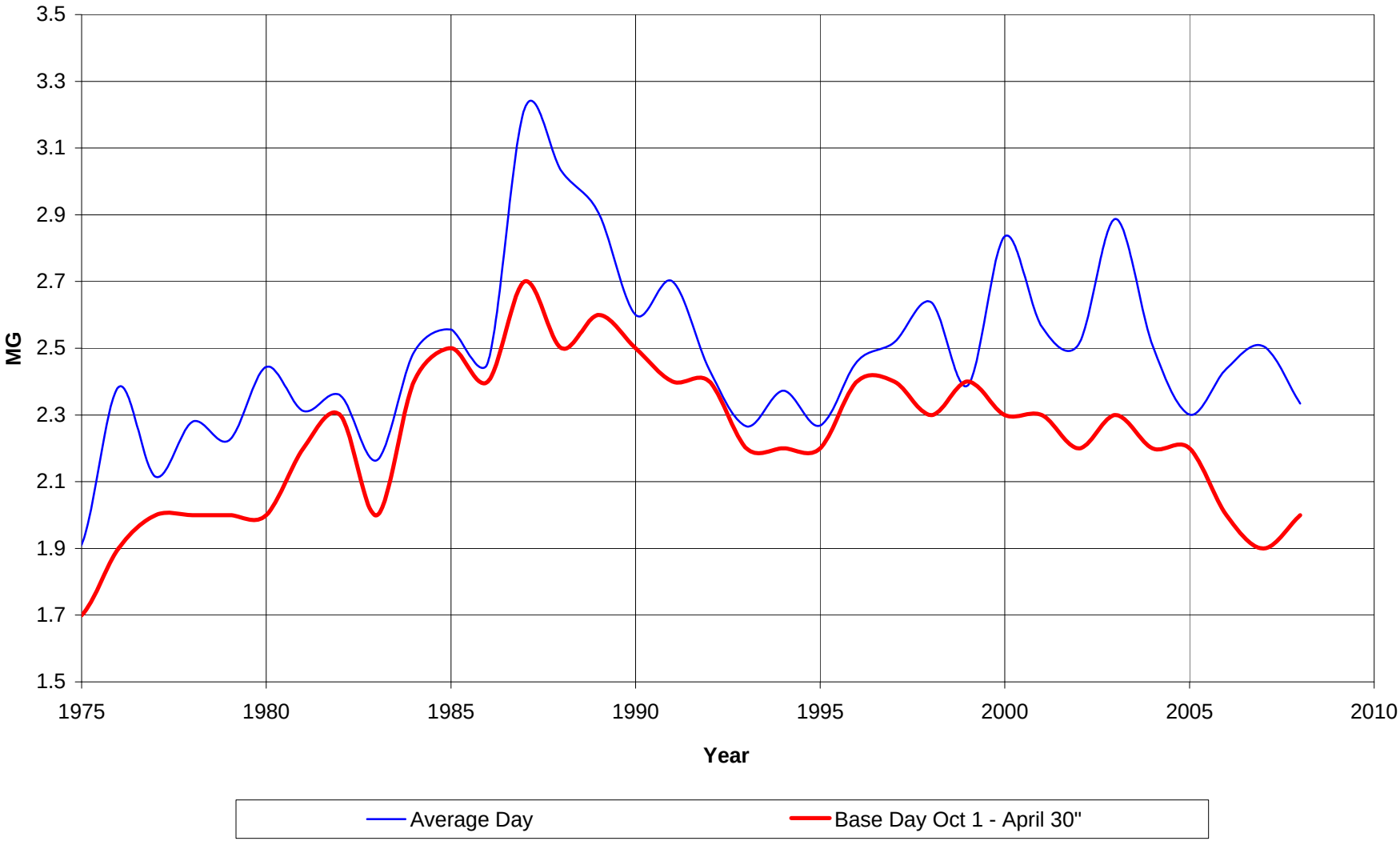
NEW BRIGHTON WATER USEAGE DATA

Year	Population			Water Production		Fridley		Water Sold in New Brighton																								
	New Brighton	Fridley	served	Purchased	Pumped	Interconnection			Total			Residential			Institutional			Commercial			Industrial			Unmetered		Avg Demand	Base Demand	Max Demand	Peak Ratio
				MG	MG	MG		Connections	MG		gal/cap/day	MG		gal/cap/day	MG		gal/cap/day	MG		gal/cap/day	MG		gal/cap/day	MG		MG	MG	MG	
2008	22,290			0	1430	489	36%	5867	852	64%	104.7	639	48%	78.5	85	6%	10.4	85	6%	10.4	42	3%	5.2	89	6.2%	2.3	2.0	6.1	2.6
2007	22,325			0	1485	489	35%	5837	915	65%	112.3	648	46%	79.5	44	3%	5.3	168	12%	20.6	56	4%	6.8	81	5.5%	2.5	1.9	7.7	3.1
2006	21,600	26,446	33,501	0	1485	569	39%	5860	890	61%	112.9	641	72%	81.3	45	5%	5.7	133	15%	16.9	71	8%	9.0	26	1.8%	2.4	2.0	6.4	2.6
2005	21,437	26,571	33,394	0	1370	410	33%	5830	840	67%	107.4	605	72%	77.3	42	5%	5.4	126	15%	16.1	67	8%	8.6	120	8.8%	2.3	2.2	6.3	2.7
2004	21,742	26,994	33,889	0	1464	516	36%	5884	916	64%	115.4	659	72%	83.0	46	5%	5.8	135	15%	17.0	76	8%	9.6	32	2.2%	2.5	2.2	6.0	2.4
2003	21,913	27,279	34,189	0	1522	468	31%	5882	1,054	69%	131.8	819	78%	102.4	52	5%	6.5	104	10%	13.0	79	7%	9.9	0	0.0%	2.9	2.3	7.5	2.6
2002	22,084	27,415	34,421	0	1462	544	37%	5848	917	63%	113.8	679	74%	84.2	46	5%	5.7	98	11%	12.2	94	10%	11.7	1	0.1%	2.5	2.2	5.7	2.3
2001	22,188	27,474	34,551	0	1567	460	33%	5791	936	67%	115.6	720	77%	88.9	47	5%	5.8	75	8%	9.3	94	10%	11.6	171	10.9%	2.6	2.3	8.4	3.3
2000	22,206	28,335	34,957	0	1511	476	32%	5793	1,035	68%	127.7	800	77%	98.7	52	5%	6.4	83	8%	10.2	100	10%	12.3	0	0.0%	2.8	2.3	5.8	2.0
1999	22,736	28,279	35,462	0	1783	744	46%	5771	872	54%	105.1	670	77%	80.7	44	5%	5.3	70	8%	8.4	88	10%	10.6	167	9.4%	2.4	2.4	6.5	2.7
1998	22,678	28,266	35,398	0	1555	423	31%	5752	963	69%	116.3	750	78%	90.6	48	5%	5.8	68	7%	8.2	97	10%	11.7	169	10.9%	2.6	2.3	7.5	2.8
1997	22,589	28,106	35,237	0	1606	583	39%	5747	919	61%	111.5	717	78%	87.0	92	10%	11.2	64	7%	7.8	46	5%	5.6	104	6.5%	2.5	2.4	7.5	3.0
1996	22,261	28,267	29,328	0	1202	148	14%	5710	898	86%	110.5	700	78%	86.2	90	10%	11.1	63	7%	7.8	45	5%	5.5	156	13.0%	2.5	2.4	6.1	2.5
1995	22,228	28,204	29,279	0	1133	193	19%	5741	828	81%	102.1	654	79%	80.6	83	10%	10.2	50	6%	6.2	41	5%	5.1	112	9.9%	2.3	2.2	5.8	2.6
1994	22,070	28,104	29,096	0	1198	256	23%	5609	866	77%	107.5	684	79%	84.9	87	10%	10.8	52	6%	6.5	43	5%	5.3	76	6.3%	2.4	2.2	6.8	2.9
1993	21,919	28,287	21,919	0	852		0%	5592	827	100%	103.4	653	79%	81.6	83	10%	10.4	50	6%	6.2	41	5%	5.1	25	2.9%	2.3	2.2	4.1	1.8
1992	21,930	NR	21,930	5	1022		0%	5509	889	100%	111.1	703	79%	87.8	89	10%	11.1	53	6%	6.6	44	5%	5.5	133	13.0%	2.4	2.4	6.5	2.7
1991	21,858	NR	21,858	4	971		0%	5449	824	100%	103.3	649	79%	81.3	83	10%	10.4	52	6%	6.5	40	5%	5.0	147	15.1%	2.7	2.4	5.3	2.0
1990	22,207	NR	22,207	4	961		0%	5421	857	100%	105.7	656	77%	80.9	98	11%	12.1	56	7%	6.9	47	5%	5.8	104	10.8%	2.6	2.5	5.1	2.0
1989	22,798	NR	22,798	0	1128		0%	5396	1,060	100%	127.4	811	77%	97.5	122	12%	14.7	69	7%	8.3	58	5%	7.0	68	6.0%	2.9	2.6	7.5	2.6
1988	23,343	NR	23,343	0	1204		0%	NR	1,106	100%	129.8	846	76%	99.3	127	11%	14.9	72	7%	8.5	61	6%	7.2	98	8.1%	3.0	2.5	7.0	2.3
1987	23,332	NR	23,332	29	1085		0%	NR	1,175	100%	138.0	899	77%	105.6	65	6%	7.6	76	6%	8.9	135	11%	15.9	-90	-8.3%	3.2	2.7	6.4	2.0
1986	23,323	NR	23,323	4	939		0%	NR	897	100%	105.4	687	77%	80.7	49	5%	5.8	58	6%	6.8	103	11%	12.1	42	4.5%	2.5	2.4	6.0	2.4
1985	23,314	NR	23,314	4	999		0%	NR	933	100%	109.6	679	73%	79.8	66	7%	7.8	62	7%	7.3	126	14%	14.8	66	6.6%	2.6	2.5	6.3	2.5
1984	23,305	NR	23,305	4	941		0%	NR	908	100%	106.7	680	75%	79.9	91	10%	10.7	92	10%	10.8	45	5%	5.3	33	3.5%	2.5	2.4	5.3	2.1
1983	23,296	NR	23,296	4	849		0%	NR	790	100%	92.9	626	79%	73.6	58	7%	6.8	69	9%	8.1	37	5%	4.4	59	6.9%	2.2	2.0	5.8	2.7
1982	23,287	NR	23,287	0	917		0%	NR	861	100%	101.3	714	83%	84.0	66	8%	7.8	44	5%	5.2	37	4%	4.4	56	6.1%	2.4	2.3	5.4	2.3
1981	23,278	NR	23,278	0	885		0%	NR	844	100%	99.3	674	80%	79.3	62	7%	7.3	68	8%	8.0	40	5%	4.7	41	4.6%	2.3	2.2	7.2	3.1
1980	23,269	NR	23,269	0	900		0%	NR	892	100%	105.0	739	83%	87.0	60	7%	7.1	51	6%	6.0	42	5%	4.9	8	0.9%	2.4	2.0	7.4	3.0
1979	22,851	NR	22,851	0	812		0%	NR	812	100%	97.4	684	84%	82.0	47	6%	5.6	36	4%	4.3	45	6%	5.4	0	0.0%	2.2	2.0	6.9	3.1
1978	22,433	NR	22,433	0	835		0%	NR	832	100%	101.6	718	86%	87.7	40	5%	4.9	31	4%	3.8	43	5%	5.3	3	0.4%	2.3	2.0	6.5	2.9
1977	22,015	NR	22,015	0	924		0%	NR	772	100%	96.1	694	90%	86.4	24	3%	3.0	29	4%	3.6	25	3%	3.1	152	16.5%	2.1	2.0	6.3	3.0
1976	21,597	NR	21,597	0	824		0%	NR	870	100%	110.4	784	90%	99.5	24	3%	3.0	31	4%	3.9	31	4%	3.9	-46	-5.6%	2.4	1.9	7.7	3.2
1975	23,786	NR	23,786	0	725		0%	NR	698	100%	80.4	621	89%	71.5	28	4%	3.2	28	4%	3.2	21	3%	2.4	27	3.7%	1.9	1.7	7.0	3.7
1974	23,599	NR	23,599	0	723		0%	NR	701	100%	81.4	629	90%	73.0	24	3%	2.8	27	4%	3.1	21	3%	2.4	22	3.0%	1.9	1.7	6.7	3.5
1973	22,404	NR	22,404	0	683		0%	NR	601	100%	73.5	529	88%	64.7	24	4%	2.9	27	4%	3.3	21	3%	2.6	82	12.0%	1.6	1.7	5.3	3.2
1972	21,692	NR	21,692	0	617		0%	NR	NR	100%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		1.7	NR	4.5	2.6
1971	21,269	NR	21,269	0	602		0%	NR	NR	100%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		1.6	NR	4.7	2.9
1970	19,507	NR	19,507	0	584		0%	NR	NR	100%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		1.6	NR	5.1	3.2
1969	19,000	NR	19,000	0	505		0%	NR	NR	100%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		1.4	NR	4.8	3.4
1968	17,300	NR	17,300	0	413		0%	NR	NR	100%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		1.1	NR	3.1	2.8
1967	14,500	NR	14,500	0	254		0%	NR	NR	100%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		0.7	NR	2.2	3.1
1966	13,100	NR	13,100	0	255		0%	NR	NR	100%	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR		0.7	NR	2.1	3.0
MAX	23,786		35,462	29	1,783	744		5,884	1,175		138.0	899		105.6	127		14.9	168		20.6	135		15.9	171		3.2	2.7	8.4	3.7
AVG				1	1,027	451		5,714	885		107.6	696		84.6	62		7.5	68		8.3	58		7.1	65		2.3	2.2	6.0	2.7
Last 10 Years 1999 - 2008																													
MAX	22,736		35,462	0	1,783	744		5,884	1,054	69%	131.8	819	78%	102.4	85	6.3%	10.4	168	15%	20.6	100	10%	12.3	171	10.9%	2.9	2.4	8.4	3.3
AVG	22,052		34,295	0	1,508	517		5,836	923	64%	114.7	688	69%	85.5	50	5.0%	6.2	108	11%	13.4	77	8%	9.5	69	4.5%	2.5	2.2	6.6	2.6

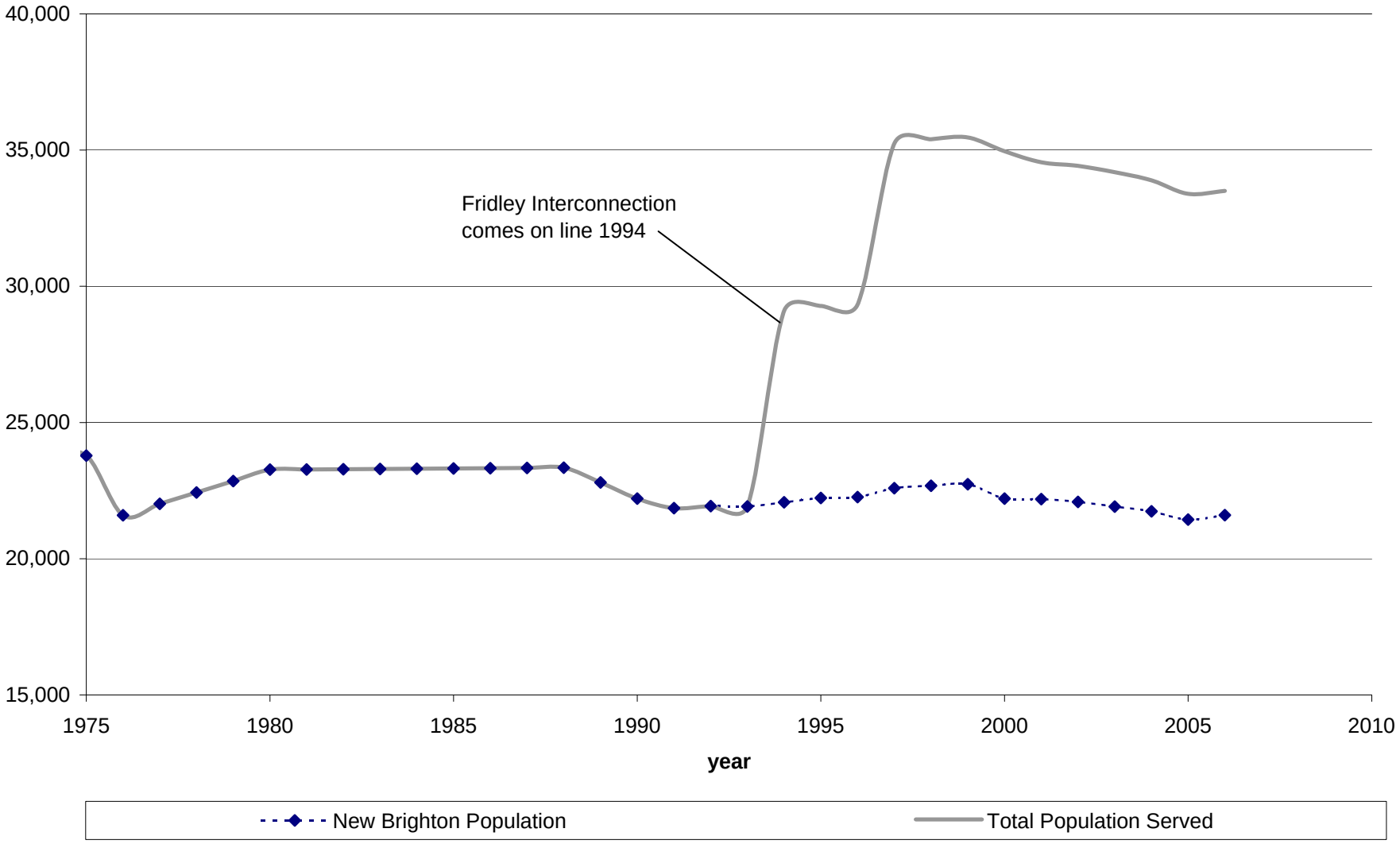
NR = Not Recorded
Avg Demand = New Brighton/365
Base Demand = Avg Daily between October 1 through April 30
Peak Ratio = Max Day/Avg Day


Water Useage
150.0
125.0
100.0
75.0
50.0
25.0
0.0
gal/cap/day
1975
1980
1985
1990
1995
2000
2005
2010
year
Residential
Institutional
Commercial
Industrial
TOTAL

Water Demand



Population Served by Water System



Appendix E

MDH Well Vulnerability Assessments

625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

PWSID: 1620009
SYSTEM NAME: New Brighton
WELL NAME: Well #10

TIER: 2
WHP RANK:
UNIQUE WELL #: 00161432

COUNTY: Ramsey TOWNSHIP NUMBER: 30 RANGE: 23 W SECTION: 32 QUARTERS: DBBD

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Mt. Simon	
DNR Geologic Sensitivity Rating	:	Very low	0
L Score	:	0	
Geologic Data From	:	Well Record	
Year Constructed	:	1983	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	779	0
Well Depth	:	931	
Casing grouted into borehole?		Unknown	0
Cement grout between casings?		Yes	0
All casings extend to land surface?		Yes	0
Gravel - packed casings?		No	0
Wood or masonry casing?		No	0
Holes or cracks in casing?		Unknown	0
Isolation distance violations?			0
Pumping Rate	:	900	10
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	.55 08/16/2004	0
Maximum tritium detected	:	Unknown	0
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	A	-20
Wellhead Protection Score	:		-10
Wellhead Protection Vulnerability Rating	:		NOT VULNERABLE
Vulnerability Overridden	:		

COMMENTS

625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

PWSID: 1620009
SYSTEM NAME: New Brighton
WELL NAME: Well #11

TIER: 2
WHP RANK:
UNIQUE WELL #: 00509083

COUNTY: Ramsey | TOWNSHIP NUMBER: 30 | RANGE: 23 W | SECTION: 29 | QUARTERS: BCAB

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Mt. Simon	
DNR Geologic Sensitivity Rating	:	Very low	0
L Score	:	0	
Geologic Data From	:	Well Record	
Year Constructed	:	1984	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	775	0
Well Depth	:	950	
Casing grouted into borehole?		Unknown	0
Cement grout between casings?		Yes	0
All casings extend to land surface?		Yes	0
Gravel - packed casings?		No	0
Wood or masonry casing?		No	0
Holes or cracks in casing?		Unknown	0
Isolation distance violations?			0
Pumping Rate	:	900	10
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	.4 08/16/2004	0
Maximum tritium detected	:	Unknown	0
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	A	-20
Wellhead Protection Score	:		-10
Wellhead Protection Vulnerability Rating	:		NOT VULNERABLE
Vulnerability Overridden	:		

COMMENTS
Very low assessment is based on the presence of the basal St. Peter, St. Lawrence, and Eau Claire confining layers.

MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1620009 | TIER: 2
SYSTEM NAME: New Brighton | WHP RANK:
WELL NAME: Well #12 | UNIQUE WELL #: 00110485

COUNTY: Ramsey | TOWNSHIP NUMBER: 30 | RANGE: 23 W | SECTION: 18 | QUARTERS: ACCC

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Mt. Simon	
DNR Geologic Sensitivity Rating	:	Very low	0
L Score	:	0	
Geologic Data From	:	Well Record	
Year Constructed	:	1984	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	730	0
Well Depth	:	790	
Casing grouted into borehole?		Unknown	0
Cement grout between casings?		Yes	0
All casings extend to land surface?		Yes	0
Gravel - packed casings?		No	0
Wood or masonry casing?		No	0
Holes or cracks in casing?		Unknown	0
Isolation distance violations?			0
Pumping Rate	:	900	10
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	.45 08/25/2005	0
Maximum tritium detected	:	Unknown	0
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	A	-20
Wellhead Protection Score	:		-10
Wellhead Protection Vulnerability Rating	:		NOT VULNERABLE
Vulnerability Overridden	:		

COMMENTS

Very low rating assigned due to the presence of the basal St. Peter St. Lawrence, and Eau Claire bedrock confining layers.

625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

PWSID: 1620009 | TIER: 2
SYSTEM NAME: New Brighton | WHP RANK:
WELL NAME: Well #14 | UNIQUE WELL #: 00554216

COUNTY: Ramsey | TOWNSHIP NUMBER: 30 | RANGE: 23 W | SECTION: 29 | QUARTERS: BDB

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Prairie Du Chien Group	
DNR Geologic Sensitivity Rating	:	Very low	10
L Score	:	8	
Geologic Data From	:	Well Record	
Year Constructed	:	1995	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	188	10
Well Depth	:	295	
Casing grouted into borehole?		Yes	0
Cement grout between casings?		Yes	0
All casings extend to land surface?		Yes	0
Gravel - packed casings?		No	0
Wood or masonry casing?		No	0
Holes or cracks in casing?		Unknown	0
Isolation distance violations?			0
Pumping Rate	:	1290	20
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	Unknown	0
Maximum tritium detected	:	Unknown	0
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	Unknown	0
Wellhead Protection Score	:		40
Wellhead Protection Vulnerability Rating	:		VULNERABLE
Vulnerability Overridden	:		Jim Walsh

COMMENTS
Assessment forced to vulnerable based on VOC detections dated 6/16/98.

625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

PWSID: 1620009
SYSTEM NAME: New Brighton
WELL NAME: Well #15

TIER: 2
WHP RANK:
UNIQUE WELL #: 00582628

COUNTY: Ramsey TOWNSHIP NUMBER: 30 RANGE: 23 W SECTION: 30 QUARTERS: ADC

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Prairie Du Chien Group	
DNR Geologic Sensitivity Rating	:	Medium	25
L Score	:	0	
Geologic Data From	:	Well Record	
Year Constructed	:	1997	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	253	5
Well Depth	:	345	
Casing grouted into borehole?		Yes	0
Cement grout between casings?		Yes	0
All casings extend to land surface?		Yes	0
Gravel - packed casings?		No	0
Wood or masonry casing?		No	0
Holes or cracks in casing?		Unknown	0
Isolation distance violations?			0
Pumping Rate	:	1200	20
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	Unknown	0
Maximum tritium detected	:	Unknown	0
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	Unknown	0
Wellhead Protection Score	:		50
Wellhead Protection Vulnerability Rating	:		VULNERABLE
Vulnerability Overridden	:		Jim Walsh

COMMENTS
Assesment forced to vulnerable based on VOC detections from 6/16/98.

MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

PWSID: 1620009 | TIER: 2
SYSTEM NAME: New Brighton | WHP RANK:
WELL NAME: Well #3 | UNIQUE WELL #: 00206793

COUNTY: Ramsey | TOWNSHIP NUMBER: 30 | RANGE: 23 W | SECTION: 30 | QUARTERS: BADD

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Prairie Du Chien-Jordan	
DNR Geologic Sensitivity Rating	:	Very low	10
L Score	:	9	
Geologic Data From	:	Well Record	
Year Constructed	:	1955	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	288	5
Well Depth	:	495	
Casing grouted into borehole?		Unknown	0
Cement grout between casings?		Yes	0
All casings extend to land surface?		Yes	0
Gravel - packed casings?		No	0
Wood or masonry casing?		No	0
Holes or cracks in casing?		Unknown	0
Isolation distance violations?			0
Pumping Rate	:	740	10
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	<.4 05/20/1991	0
Maximum tritium detected	:	Unknown	0
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	Unknown	0
Wellhead Protection Score	:		25
Wellhead Protection Vulnerability Rating	:		VULNERABLE
Vulnerability Overridden	:		Jim Walsh

COMMENTS
This well has been contaminated by organic compounds but data arev archieved in the public water supply files.

625 Robert St. N. St. Paul MN 55155
P.O. Box 64975 St. Paul MN 55164 - 0975

MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

PWSID: 1620009 | TIER: 2
SYSTEM NAME: New Brighton | WHP RANK:
WELL NAME: Well #4 | UNIQUE WELL #: 00206792

COUNTY: Ramsey | TOWNSHIP NUMBER: 30 | RANGE: 23 W | SECTION: 30 | QUARTERS: BADD

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Prairie Du Chien-Jordan	
DNR Geologic Sensitivity Rating	:	Very low	10
L Score	:	8	
Geologic Data From	:	Well Record	
Year Constructed	:	1954	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	269	5
Well Depth	:	500	
Casing grouted into borehole?		Unknown	0
Cement grout between casings?		Unknown	5
All casings extend to land surface?		Yes	0
Gravel - packed casings?		No	0
Wood or masonry casing?		No	0
Holes or cracks in casing?		Unknown	0
Isolation distance violations?			0
Pumping Rate	:	1000	10
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	.06 10/05/1994	0
Maximum tritium detected	:	Unknown	0
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	Unknown	0
Wellhead Protection Score	:		30
Wellhead Protection Vulnerability Rating	:		VULNERABLE
Vulnerability Overridden	:		Jim Walsh

COMMENTS
This well was not used in 1990 due to the presence of organic contaminants.

MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

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PWSID: 1620009 | TIER: 2
SYSTEM NAME: New Brighton | WHP RANK:
WELL NAME: Well #5 | UNIQUE WELL #: 00206796

COUNTY: Ramsey | TOWNSHIP NUMBER: 30 | RANGE: 23 W | SECTION: 30 | QUARTERS: CBAA

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Jordan	
DNR Geologic Sensitivity Rating	:	Very low	0
L Score	:	0	
Geologic Data From	:	Well Record	
Year Constructed	:	1963	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	430	0
Well Depth	:	501	
Casing grouted into borehole?		Unknown	0
Cement grout between casings?		Yes	0
All casings extend to land surface?		Yes	0
Gravel - packed casings?		No	0
Wood or masonry casing?		No	0
Holes or cracks in casing?		Unknown	0
Isolation distance violations?			0
Pumping Rate	:	850	10
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	<.4 05/20/1991	0
Maximum tritium detected	:	Unknown	0
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	Unknown	0
Wellhead Protection Score	:		10
Wellhead Protection Vulnerability Rating	:		VULNERABLE
Vulnerability Overridden	:		Jim Walsh

COMMENTS

Very low assessment is based on the presence of basal St. Peter Sandstone. Drift score is L-3.

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MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

PWSID: 1620009
SYSTEM NAME: New Brighton
WELL NAME: Well #6

TIER: 2
WHP RANK:
UNIQUE WELL #: 00206797

COUNTY: Ramsey | TOWNSHIP NUMBER: 30 | RANGE: 23 W | SECTION: 30 | QUARTERS: CBAB

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Jordan	
DNR Geologic Sensitivity Rating	:	Very low	0
L Score	:	13	
Geologic Data From	:	Well Record	
Year Constructed	:	1961	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	447	0
Well Depth	:	522	
Casing grouted into borehole?		Unknown	0
Cement grout between casings?		Yes	0
All casings extend to land surface?		Yes	0
Gravel - packed casings?		No	0
Wood or masonry casing?		No	0
Holes or cracks in casing?		Unknown	0
Isolation distance violations?			0
Pumping Rate	:	1000	10
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	<.4 05/20/1991	0
Maximum tritium detected	:	Unknown	0
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	Unknown	0
Wellhead Protection Score	:		10
Wellhead Protection Vulnerability Rating	:		VULNERABLE
Vulnerability Overridden	:		Jim Walsh

COMMENTS

625 Robert St. N. St. Paul MN 55155
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MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

PWSID: 1620009
SYSTEM NAME: New Brighton
WELL NAME: Well #8

TIER: 2
WHP RANK:
UNIQUE WELL #: 00206795

COUNTY: Ramsey TOWNSHIP NUMBER: 30 RANGE: 23 W SECTION: 30 QUARTERS: BDAD

CRITERIA		DESCRIPTION		POINTS
Aquifer Name(s)	:	Mt. Simon-Hinckley		
DNR Geologic Sensitivity Rating	:	Very low		0
L Score	:	12		
Geologic Data From	:	Well Record		
Year Constructed	:	1970		
Construction Method	:	Cable Tool/Bored		0
Casing Depth	:	815		0
Well Depth	:	868		
Casing grouted into borehole?		Unknown		0
Cement grout between casings?		Yes		0
All casings extend to land surface?		Yes		0
Gravel - packed casings?		No		0
Wood or masonry casing?		No		0
Holes or cracks in casing?		Unknown		0
Isolation distance violations?				0
Pumping Rate	:	900		10
Pathogen Detected?				0
Surface Water Characteristics?				0
Maximum nitrate detected	:	.23 08/16/2004		0
Maximum tritium detected	:	Unknown		0
Non-THMS VOCs detected?		Ethylbenzene	05/26/1991	VULNERABLE
Pesticides detected?				0
Carbon 14 age	:	Unknown		0
Wellhead Protection Score	:			10
Wellhead Protection Vulnerability Rating	:			NOT VULNERABLE
Vulnerability Overridden	:			Amal Djerrari 12/11/2009 11:50:48

COMMENTS

Well was constructed in 1970 but deepened in 1982. The Eau Claire Formation is 100-foot thick. No Ethylbenzene was detercted in the system since 1998, and in Treatment Plant 2 and Well 8 since 1995.

MINNESOTA DEPARTMENT OF HEALTH
SECTION OF DRINKING WATER PROTECTION
SWP Vulnerability Rating

625 Robert St. N. St. Paul MN 55155
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PWSID: 1620009 | TIER: 2
SYSTEM NAME: New Brighton | WHP RANK:
WELL NAME: Well #9 | UNIQUE WELL #: 00206794

COUNTY: Ramsey | TOWNSHIP NUMBER: 30 | RANGE: 23 W | SECTION: 30 | QUARTERS: CABA

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Mt. Simon	
DNR Geologic Sensitivity Rating	:	Very low	0
L Score	:	0	
Geologic Data From	:	Well Record	
Year Constructed	:	1971	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	782	0
Well Depth	:	937	
Casing grouted into borehole?		Yes	0
Cement grout between casings?		Yes	0
All casings extend to land surface?		Yes	0
Gravel - packed casings?		No	0
Wood or masonry casing?		No	0
Holes or cracks in casing?		Unknown	0
Isolation distance violations?			0
Pumping Rate	:	850	10
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	<.05 11/22/1993	0
Maximum tritium detected	:	Unknown	0
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	Unknown	0
Wellhead Protection Score	:		10
Wellhead Protection Vulnerability Rating	:		NOT VULNERABLE
Vulnerability Overridden	:		

COMMENTS

Well was origionally drilled to 476 feet in 1971 and reconstructed in 1982 to 937 feet. The very low assessment is based on the presence ofSt. Lawrence and Eau Claire bedrock confining layers.

Appendix F

Summary of Fracture Flow Capture Zone Calculations

Well 3 (206793)

Calculation for Ratio of Well Discharge to the Discharge Vector (Q/Qs)

See: Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

If Q/Qs is less than 3000 m then delineation Technique 2 should be used: Calculated Fixed Radius with An Upgradient Extension

Input variables	
Well Discharge, Q (gpm)	208.58585
Aquifer Thickness, H (ft)	125
Aquifer Hydraulic Conductivity K (m/day)	130
Hydraulic Gradient, i	0.0013

Calculated Q/Qs (m)
176.4902

Equation listed in Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

$$Q/Qs = \frac{Q\left(\frac{1ft^3}{7.48gal}\right)\left(\frac{1440\min}{1day}\right)\left(\frac{0.0283m^3}{1ft^3}\right)}{(H)\left(\frac{0.3048m}{1ft}\right)(K)(i)}$$

Calculation for Fixed Radius with No Upgradient Extention

See method 1 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

Input Variables	
Well Pumping Rate m^3/day	1137
Pumping Period (years)	10
Effective porosity, n	0.056
Thickness of saturated portion of aquifer, L (m)	32.6

Calculated Fixed Radius (m)	Volume (m^3)
850.6461	74,108,036

$$R = \sqrt{\frac{Q}{nL\pi}}$$

Where:
Q = Well Discharge (L3/T)=(Well pumping rate)(pumping time period)
n = effective porosity
L = thickness of saturated portion of aquifer (L) note: lesser of open borehole or 200 ft

Well 4 (206792)

Calculation for Ratio of Well Discharge to the Discharge Vector (Q/Qs)

See: Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

If Q/Qs is less than 3000 m then delineation Technique 2 should be used: Calculated Fixed Radius with An Upgradient Extension

Input variables	
Well Discharge, Q (gpm)	875.80373
Aquifer Thickness, H (ft)	130
Aquifer Hydraulic Conductivity K (m/day)	130
Hydraulic Gradient, i	0.0013

Calculated Q/Qs (m)
712.5398

Equation listed in Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

$$Q/Qs = \frac{Q\left(\frac{1ft^3}{7.48gal}\right)\left(\frac{1440\min}{1day}\right)\left(\frac{0.0283m^3}{1ft^3}\right)}{(H)\left(\frac{0.3048m}{1ft}\right)(K)(i)}$$

Calculation for Fixed Radius with No Upgradient Extention

See method 1 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

Input Variables	
Well Pumping Rate m^3/day	4774
Pumping Period (years)	10
Effective porosity, n	0.056
Thickness of saturated portion of aquifer, L (m)	38.7

Calculated Fixed Radius (m)	Volume (m^3)
1599.791	311,162,500

$$R = \sqrt{\frac{Q}{nL\pi}}$$

Where:
Q = Well Discharge (L3/T)=(Well pumping rate)(pumping time period)
n = effective porosity
L = thickness of saturated portion of aquifer (L) note: lesser of open borehole or 200 ft

Well 5 (206796)

Calculation for Ratio of Well Discharge to the Discharge Vector (Q/Qs)

See: Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

If Q/Qs is less than 3000 m then delineation Technique 2 should be used: Calculated Fixed Radius with An Upgradient Extension

Input variables	
Well Discharge, Q (gpm)	179.96721
Aquifer Thickness, H (ft)	113
Aquifer Hydraulic Conductivity K (m/day)	130
Hydraulic Gradient, i	0.0013

Calculated Q/Qs (m)
168.446

Equation listed in Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

$$Q/Qs = \frac{Q\left(\frac{1ft^3}{7.48gal}\right)\left(\frac{1440\min}{1day}\right)\left(\frac{0.0283m^3}{1ft^3}\right)}{(H)\left(\frac{0.3048m}{1ft}\right)(K)(i)}$$

Calculation for Fixed Radius with No Upgradient Extention

See method 1 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

Input Variables	
Well Pumping Rate m^3/day	981
Pumping Period (years)	10
Effective porosity, n	0.056
Thickness of saturated portion of aquifer, L (m)	34.4

Calculated Fixed Radius (m)	Volume (m^3)
769.1885	63,940,179

$$R = \sqrt{\frac{Q}{nL\pi}}$$

Where:
Q = Well Discharge (L3/T)=(Well pumping rate)(pumping time period)
n = effective porosity
L = thickness of saturated portion of aquifer (L) note: lesser of open borehole or 200 ft

Well 6 (206796)

Calculation for Ratio of Well Discharge to the Discharge Vector (Q/Qs)

See: Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

If Q/Qs is less than 3000 m then delineation Technique 2 should be used: Calculated Fixed Radius with An Upgradient Extension

Input variables	
Well Discharge, Q (gpm)	504.31179
Aquifer Thickness, H (ft)	127
Aquifer Hydraulic Conductivity K (m/day)	130
Hydraulic Gradient, i	0.0013

Calculated Q/Qs (m)
419.992

Equation listed in Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

$$Q/Qs = \frac{Q\left(\frac{1ft^3}{7.48gal}\right)\left(\frac{1440\min}{1day}\right)\left(\frac{0.0283m^3}{1ft^3}\right)}{(H)\left(\frac{0.3048m}{1ft}\right)(K)(i)}$$

Calculation for Fixed Radius with No Upgradient Extention

See method 1 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

Input Variables	
Well Pumping Rate m^3/day	2749
Pumping Period (years)	10
Effective porosity, n	0.056
Thickness of saturated portion of aquifer, L (m)	38.7

Calculated Fixed Radius (m)	Volume (m^3)
1213.974	179,175,893

$$R = \sqrt{\frac{Q}{nL\pi}}$$

Where:
Q = Well Discharge (L3/T)=(Well pumping rate)(pumping time period)
n = effective porosity
L = thickness of saturated portion of aquifer (L) note: lesser of open borehole or 200 ft

Well 14 (554216)

Calculation for Ratio of Well Discharge to the Discharge Vector (Q/Qs)

See: Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

If Q/Qs is less than 3000 m then delineation Technique 2 should be used: Calculated Fixed Radius with An Upgradient Extension

Input variables	
Well Discharge, Q (gpm)	822.23551
Aquifer Thickness, H (ft)	112
Aquifer Hydraulic Conductivity K (m/day)	130
Hydraulic Gradient, i	0.0013

Calculated Q/Qs (m)
776.4686

Equation listed in Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

$$Q/Qs = \frac{Q\left(\frac{1ft^3}{7.48gal}\right)\left(\frac{1440\min}{1day}\right)\left(\frac{0.0283m^3}{1ft^3}\right)}{(H)\left(\frac{0.3048m}{1ft}\right)(K)(i)}$$

Calculation for Fixed Radius with No Upgradient Extention

See method 1 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

Input Variables	
Well Pumping Rate m^3/day	4482
Pumping Period (years)	10
Effective porosity, n	0.056
Thickness of saturated portion of aquifer, L (m)	31.1

Calculated Fixed Radius (m)	Volume (m^3)
1729.152	292,130,357

$$R = \sqrt{\frac{Q}{nL\pi}}$$

Where:
Q = Well Discharge (L3/T)=(Well pumping rate)(pumping time period)
n = effective porosity
L = thickness of saturated portion of aquifer (L) note: lesser of open borehole or 200 ft

Well 15 (582628)

Calculation for Ratio of Well Discharge to the Discharge Vector (Q/Qs)

See: Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

If Q/Qs is less than 3000 m then delineation Technique 2 should be used: Calculated Fixed Radius with An Upgradient Extension

Input variables	
Well Discharge, Q (gpm)	854.52321
Aquifer Thickness, H (ft)	119
Aquifer Hydraulic Conductivity K (m/day)	130
Hydraulic Gradient, i	0.0013

Calculated Q/Qs (m)
759.4909

Equation listed in Appendix 2 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

$$Q/Qs = \frac{Q\left(\frac{1ft^3}{7.48gal}\right)\left(\frac{1440\min}{1day}\right)\left(\frac{0.0283m^3}{1ft^3}\right)}{(H)\left(\frac{0.3048m}{1ft}\right)(K)(i)}$$

Calculation for Fixed Radius with No Upgradient Extention

See method 1 of Guidance for Delineating Wellhead Protection Area in Fractured and Solution-Weatherd Bedrock in Minnesota (MDH, 2005)

Input Variables	
Well Pumping Rate m^3/day	4658
Pumping Period (years)	10
Effective porosity, n	0.056
Thickness of saturated portion of aquifer, L (m)	26.5

Calculated Fixed Radius (m)	Volume (m^3)
1909.652	303,601,786

$$R = \sqrt{\frac{Q}{nL\pi}}$$

Where:
Q = Well Discharge (L3/T)=(Well pumping rate)(pumping time period)
n = effective porosity
L = thickness of saturated portion of aquifer (L) note: lesser of open borehole or 200 ft

Revised Fixed Radius for Well 3

NB-3

Original Fixed Radius Area for Subject Well	2273252.629
Original Capture Zone Volume for Subject Well	74108035.71

Well	Search Combo	Volume of fixed radius capture zone (m^3) (No overlap)	Common interval with subject well (m)	Area of overlap with subject well (m^2)	Volume of overlap with subject well	Revised Volume Component (m^3)	Revised Volume for Subject Well (m3)	Revised Radius of Subject Well (m)
NB-3	NB-3-NB-3	74,108,036	32.6	0	0	0	146168386.9	1194.656
NB-4	NB-4-NB-3	311,162,500	32.6	2272896.73	74096433	14252689.01		
NB-5	NB-5-NB-3	63,940,179	32.6	853537.57	27825325	14937391.06		
NB-6	NB-6-NB-3	179,175,893	32.6	1881610.93	61340516	17947546.84		
NB-14	NB-14-NB-3	292,130,357	31.1	2082458.39	64764456	13105034.07		
NB-15	NB-15-NB-3	303,601,786	26.5	2272896.73	60231763	11817690.23		

Revised Fixed Radius for Well 4

NB-4

Original Fixed Radius Area for Subject Well	8040374.677
Original Capture Zone Volume for Subject Well	311162500

Well	Search Combo	Volume of fixed radius capture zone (m^3) (No overlap)	Common interval with subject well (m)	Area of overlap with subject well (m^2)	Volume of overlap with subject well	Revised Volume Component (m^3)	Revised Volume for Subject Well (m3)	Revised Radius of Subject Well (m)
NB-3	NB-3-NB-4	74,108,036	32.6	2272896.73	74096433	59843744.37	711480701.5	2419.085
NB-4	NB-4-NB-4	311,162,500	38.7	0	0	0		
NB-5	NB-5-NB-4	63,940,179	34.4	1858404.51	63929115	53031728.16		
NB-6	NB-6-NB-4	179,175,893	38.7	4148681.83	1.61E+08	101885515.6		
NB-14	NB-14-NB-4	292,130,357	31.1	5297948.44	1.65E+08	84982046.39		
NB-15	NB-15-NB-4	303,601,786	26.5	7498359.63	1.99E+08	100575167		

Revised Fixed Radius for Well 5

NB-5

Original Fixed Radius Area for Subject Well	1858726.121
Original Capture Zone Volume for Subject Well	63940178.57

Well	Search Combo	Volume of fixed radius capture zone (m^3) (No overlap)	Common interval with subject well (m)	Area of overlap with subject well (m^2)	Volume of overlap with subject well	Revised Volume Component (m^3)	Revised Volume for Subject Well (m3)	Revised Radius of Subject Well (m)
NB-3	NB-3-NB-5	74,108,036	32.6	853537.57	27825325	12887933.71	119442946.6	1051.299
NB-4	NB-4-NB-5	311,162,500	34.4	1858404.51	63929115	10897386.96		
NB-5	NB-5-NB-5	63,940,179	34.4	0	0	0		
NB-6	NB-6-NB-5	179,175,893	34.4	1858404.51	63929115	16813528.67		
NB-14	NB-14-NB-5	292,130,357	31.1	1134611.35	35286413	6336439.873		
NB-15	NB-15-NB-5	303,601,786	26.5	1858404.51	49247719	8567478.777		

Revised Fixed Radius for Well 6

NB-6

Original Fixed Radius Area for Subject Well	4629868.032
Original Capture Zone Volume for Subject Well	179175892.9

Well	Search Combo	Volume of fixed radius capture zone (m^3) (No overlap)	Common interval with subject well (m)	Area of overlap with subject well (m^2)	Volume of overlap with subject well	Revised Volume Component (m^3)	Revised Volume for Subject Well (m3)	Revised Radius of Subject Well (m)
NB-3	NB-3-NB-6	74,108,036	32.6	1881610.93	61340516	43392969.44	396866121.2	1806.723
NB-4	NB-4-NB-6	311,162,500	38.7	4148681.83	1.61E+08	58668471.37		
NB-5	NB-5-NB-6	63,940,179	34.4	1858404.51	63929115	47115586.45		
NB-6	NB-6-NB-6	179,175,893	38.7	0	0	0		
NB-14	NB-14-NB-6	292,130,357	31.1	2354131.01	73213474	27833472.65		
NB-15	NB-15-NB-6	303,601,786	26.5	4136183.29	1.1E+08	40679728.45		

Revised Fixed Radius for Well 14

NB-14

Original Fixed Radius Area for Subject Well	9393259.072
Original Capture Zone Volume for Subject Well	292130357.1

Well	Search Combo	Volume of fixed radius capture zone (m^3) (No overlap)	Common interval with subject well (m)	Area of overlap with subject well (m^2)	Volume of overlap with subject well	Revised Volume Component (m^3)	Revised Volume for Subject Well (m3)	Revised Radius of Subject Well (m)
NB-3	NB-3-NB-14	74,108,036	31.1	2082458.39	64764456	51659421.92	605719811.2	2489.893
NB-4	NB-4-NB-14	311,162,500	31.1	5297948.44	1.65E+08	79784149.96		
NB-5	NB-5-NB-14	63,940,179	31.1	1134611.35	35286413	28949973		
NB-6	NB-6-NB-14	179,175,893	31.1	2354131.01	73213474	45380001.61		
NB-14	NB-14-NB-14	292,130,357	31.1	0	0	0		
NB-15	NB-15-NB-14	303,601,786	26.5	8296813.21	2.2E+08	107815907.6		

Revised Fixed Radius for Well 15

NB-15

Original Fixed Radius Area for Subject Well	11456671.16
Original Capture Zone Volume for Subject Well	303601785.7

Well	Search Combo	Volume of fixed radius capture zone (m^3) (No overlap)	Common interval with subject well (m)	Area of overlap with subject well (m^2)	Volume of overlap with subject well	Revised Volume Component (m^3)	Revised Volume for Subject Well (m3)	Revised Radius of Subject Well (m)
NB-3	NB-3-NB-15	74,108,036	26.5	2272896.73	60231763	48414073.09	671806234	2840.692
NB-4	NB-4-NB-15	311,162,500	26.5	7498359.63	1.99E+08	98131363.18		
NB-5	NB-5-NB-15	63,940,179	26.5	1858404.51	49247719	40680240.72		
NB-6	NB-6-NB-15	179,175,893	26.5	4136183.29	1.1E+08	68929128.82		
NB-14	NB-14-NB-15	292,130,357	26.5	8296813.21	2.2E+08	112049642.4		
NB-15	NB-15-NB-15	303,601,786	26.5	0	0	0		

Upgradient Extension Well 3

NB-3

Well Location		**Center of extension**	
X	482762	X	484259.93
Y	4989793	Y	4990921.8
Length of extension (1.57 * radius of fixed radius capture zone)	1875.6104	**Center of extension +10 degrees**	
Flow Direction	53	X	484433.18
Flow Direction + 10 degrees	63	Y	4990644.5
Flow Direction - 10 degrees	43	**Center of extension - 10 degrees**	
		X	484041.16
		Y	4991164.7

Upgradient Extension Well 4

NB-4

Well Location		**Center of extension**	
X	482799	X	485871.62
Y	4989757	Y	4991989.4
Length of extension (1.57 * radius of fixed radius capture zone)	3797.9636	**Center of extension +10 degrees**	
Flow Direction	54	X	486212.59
Flow Direction + 10 degrees	64	Y	4991421.9
Flow Direction - 10 degrees	44	**Center of extension - 10 degrees**	
		X	485437.29
		Y	4992489

Upgradient Extension Well 5

NB-5

Well Location		**Center of extension**	
X	482411	X	483763.04
Y	4989103	Y	4990049.7
Length of extension (1.57 * radius of fixed radius capture zone)	1650.5388	**Center of extension +10 degrees**	
Flow Direction	55	X	483906.9
Flow Direction + 10 degrees	65	Y	4989800.5
Flow Direction - 10 degrees	45	**Center of extension - 10 degrees**	
		X	483578.11
		Y	4990270.1

Upgradient Extension Well 6

NB-6

Well Location		**Center of extension**	
X	482321	X	484672.61
Y	4989295	Y	4990881.2
Length of extension (1.57 * radius of fixed radius capture zone)	2836.5552	**Center of extension +10 degrees**	
Flow Direction	56	X	484912.32
Flow Direction + 10 degrees	66	Y	4990448.7
Flow Direction - 10 degrees	46	**Center of extension - 10 degrees**	
		X	484361.45
		Y	4991265.4

Upgradient Extension Well 14

NB-14

Well Location		**Center of extension**	
X	483832	X	486994.55
Y	4989688	Y	4991985.7
Length of extension (1.57 * radius of fixed radius capture zone)	3909.1327	**Center of extension +10 degrees**	
Flow Direction	54	X	487345.51
Flow Direction + 10 degrees	64	Y	4991401.7
Flow Direction - 10 degrees	44	**Center of extension - 10 degrees**	
		X	486547.51
		Y	4992500

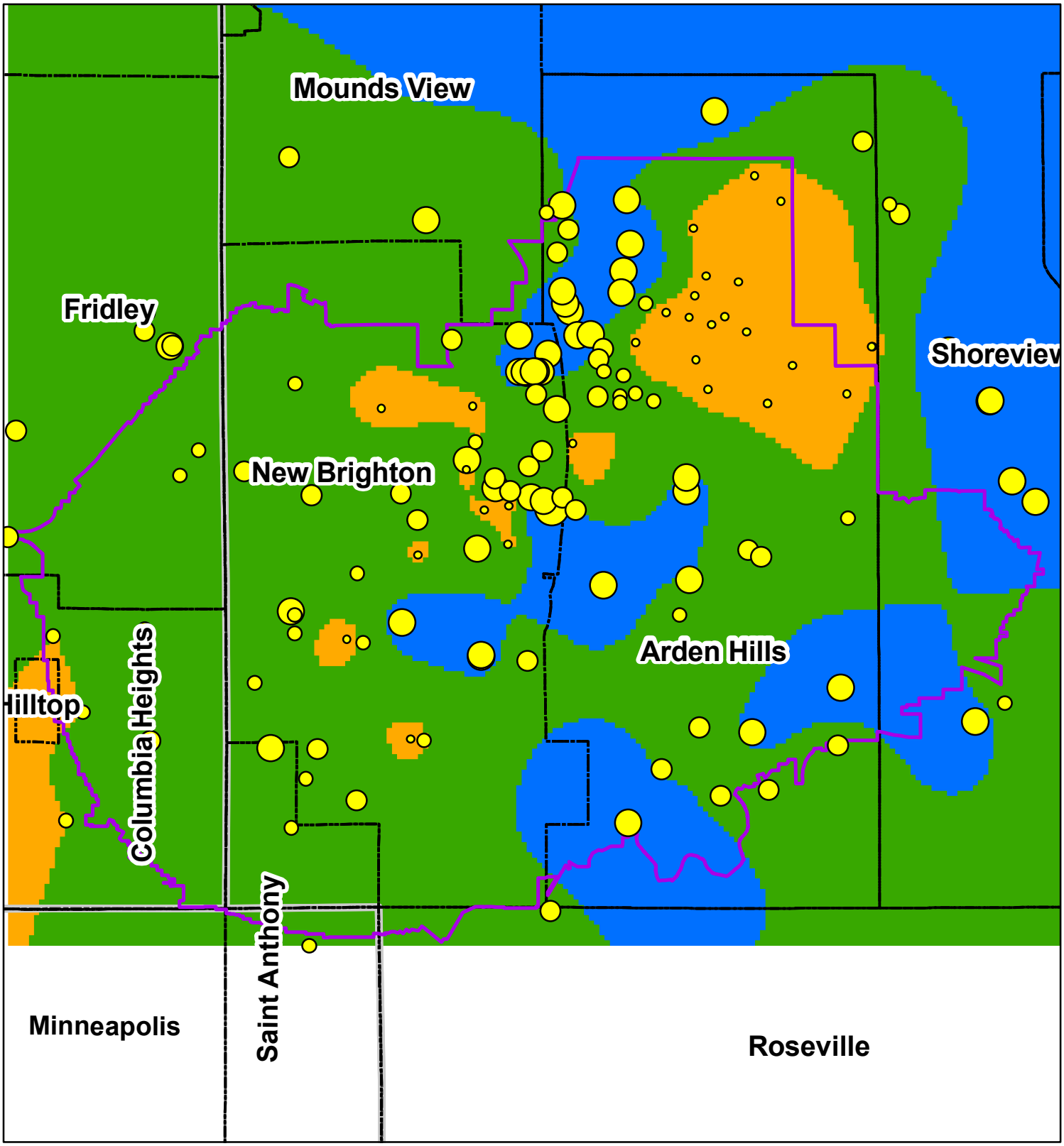
Upgradient Extension Well 15

NB-15

Well Location		**Center of extension**	
X	483300	X	486953.33
Y	4989523	Y	4992081.1
Length of extension (1.57 * radius of fixed radius capture zone)	4459.8864	**Center of extension +10 degrees**	
Flow Direction	55	X	487342.03
Flow Direction + 10 degrees	65	Y	4991407.8
Flow Direction - 10 degrees	45	**Center of extension - 10 degrees**	
		X	486453.62
		Y	4992676.6

Appendix G

L-Score Map



Barr Footer: Date: 3/24/2010 10:37:52 AM File: I:\Projects\23\62\987\Maps\Reports\L_Scores.mxd User: egc

L Score at Well

- 0
- 1 - 2
- 3 - 4
- 5 - 15
- 16 - 22

Interpolated L-Score

- 0 to 1
- 1 to 5
- > 5
- DWSMA
- Municipal Boundaries
- County Boundary

N

Miles
0 0.5 1

Kilometers
0 1 2

BARR

Figure G-1

L-Score Map
WHHP Part 1
City of New Brighton
Ramsey County, MN

Appendix H

Precipitation Data

Table H1
Summary of Precipitation
Station 218390 Arden Hills, MN

Month	Average 2005-2009 (inches)	Year	Total (inches)
Jan	0.71	2005	36.72
Feb	0.77	2006	28.56
Mar	1.46	2007	31.48
Apr	2.27	2008	22.10
May	2.83	2009	21.62
Jun	3.60		
Jul	2.26		
Aug	4.39		
Sep	4.18		
Oct	3.53		
Nov	0.73		
Dec	1.37		