Amendment to the Wellhead Protection Plan

Part I

Delineation of Wellhead Protection Area
Drinking Water Supply Management Area Delineation
Well and Drinking Water Supply Management Area Vulnerability Assessments

Prepared for

City of Adrian

June, 2013

MINNESOTA MDH DEPARTMENT OF HEALTH

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Glossary of Terms

Data Element. A specific type of information required by the Minnesota Department of Health to prepare a wellhead protection plan.

Drinking Water Supply Management Area (DWSMA). The area delineated using identifiable land marks that reflects the scientifically calculated wellhead protection area boundaries as closely as possible (Minnesota Rules, part 4720.5100, subpart 13).

Drinking Water Supply Management Area Vulnerability. An assessment of the likelihood that the aquifer within the DWSMA is subject to impact from land and water uses within the wellhead protection area. It is based upon criteria that are specified under Minnesota Rules, part 4720.5210, subpart 3.

Emergency Response Area (ERA). The part of the wellhead protection area that is defined by a one-year time of travel within the aquifer that is used by the public water supply well (Minnesota Rules, part 4720.5250, subpart 3). It is used to set priorities for managing potential contamination sources within the DWSMA.

Inner Wellhead Management Zone (IWMZ). The land that is within 200 feet of a public water supply well (Minnesota Rules, part 4720.5100, subpart 19). The public water supplier must manage the IWMZ to help protect it from sources of pathogen or chemical contamination that may cause an acute health effect.

Wellhead Protection (WHP). A method of preventing well contamination by effectively managing potential contamination sources in all or a portion of the well's recharge area.

Wellhead Protection Area (WHPA). The surface and subsurface area surrounding a well or well field that supplies a public water system, through which contaminants are likely to move toward and reach the well or well field (Minnesota Statutes, part 103I.005, subdivision 24).

Well Vulnerability. An assessment of the likelihood that a well is at risk to human-caused contamination, either due to its construction or indicated by criteria that are specified under Minnesota Rules, part 4720.5550, subpart 2.

Acronyms

CWI - County Well Index

DNR - Minnesota Department of Natural Resources

EPA - United States Environmental Protection Agency

FSA - Farm Security Administration

MDA - Minnesota Department of Agriculture

MDH - Minnesota Department of Health

MGS - Minnesota Geological Survey

MnDOT - Minnesota Department of Transportation

MnGEO - Minnesota Geospatial Information Office

MPCA - Minnesota Pollution Control Agency

NRCS - Natural Resource Conservation Service

SWCD - Soil and Water Conservation District

UMN - University of Minnesota

USDA - United States Department of Agriculture

USGS - United States Geological Survey

1. Introduction

The Minnesota Department of Health (MDH) developed Part I of the wellhead protection (WHP) plan at the request of the city of Adrian (public water supply identification number 1530001). The work was performed in accordance with the Minnesota Wellhead Protection Rule, parts 4720.5100 to 4720.5590.

This report presents delineations of the wellhead protection area (WHPA) and drinking water supply management area (DWSMA), and the vulnerability assessments for the public water supply wells and DWSMA. Figure 1 shows the boundaries for the WHPA and DWSMA. The WHPA is defined by a 10-year time of travel. Figure 1 also shows the emergency response area (ERA), which is defined by a one-year time of travel. An inner wellhead management zone (IWMZ), which is the area within a 200-foot radius around the well, serves as the wellhead protection area for emergency wells and is not displayed in this report. Definitions of rule-specific terms that are used are provided in the "Glossary of Terms."

This report also documents the technical information that was required to prepare this portion of the WHP plan in accordance with the Minnesota Wellhead Protection Rule. Additional technical information is available from MDH.

The wells included in the WHP plan are listed in Table 1.

Table 1 - Water Supply Well Information
Adrian

Local Well Name	Unique Number	Use/ Status[1]	Casing Diameter (inches)	Casing Depth (feet)	Well Depth (feet)	Date Constructed	Well Vulnerability	Aquifer
Well 1	241354	E	14	56	56	1948	Vulnerable	Glacial Drift
Well 5	149184	P	12	19	26	1984	Vulnerable	Glacial Drift
Well 6	149187	P	12	31	42	1985	Vulnerable	Glacial Drift
Well 7	721689	P	18	23	42	2006	Vulnerable	Glacial Drift

Note: 1. Primary (P) or Emergency Backup (E) Well.

2. Assessment of the Data Elements

MDH staff met with representatives of the public water supplier on June 6, 2012, for a scoping meeting that identified the data elements required to prepare Part I of the WHP plan. Table 2 presents the assessment of these data elements relative to the present and future implications of planning items, specified in Minnesota Rules, part 4720.5210.

Table 2 - Assessment of Data Elements

Data Element	Present and Future Implications				Data Source
	Use of the Well (s)	Delineation Criteria	Quality and Quantity of Well Water	Land and Groundwater Use in DWSMA	
Precipitation	H	H	H	L	MN Climatology Office
Geology					
Maps and geologic descriptions	M	H	H	H	MGS
Subsurface data	M	H	H	H	MGS, MDH, CWI
Borehole geophysics	M	H	H	H	MGS
Surface geophysics	L	L	L	L	Not Available
Maps and soil descriptions	L	H	H	M	NRCS
Eroding lands					
Water Resources					
Watershed units	L	H	M	L	DNR, USGS
List of public waters	L	H	M	L	DNR
Shoreland classifications					
Wetlands map	L	L	L	L	U.S. Fish and Wildlife Service
Floodplain map					
Land Use					
Parcel boundaries map	L	H	L	L	Not Available
Political boundaries map	L	L	L	L	City, MnGEO
PLS map	L	H	L	M	MnGEO, MDH
Land use map and inventory					
Comprehensive land use map					
Zoning map					
Public Utility Services					
Transportation routes and corridors	L	M	L	L	MnGEO, MnDOT
Storm/sanitary sewers and PWS system map	L	M	L	L	City
Oil and gas pipelines map					
Public drainage systems map/list					City, SWCD
Records of well construction, maintenance, and use	H	H	H	H	City, CWI, MDH Files
Surface Water Quantity					
Stream flow data	L	M	L	L	DNR, USGS
Ordinary high water mark data	L	M	L	L	DNR, USGS
Permitted withdrawals	L	L	L	L	DNR
Protected levels/flows	L	L	L	L	DNR
Water use conflicts	L	L	L	L	DNR
Groundwater Quantity					
Permitted withdrawals	H	H	H	H	DNR, City
Groundwater use conflicts	L	L	L	L	DNR
Water levels	H	H	H	H	CWI, MDH, City

Data Element	Present and Future Implications				Data Source
	Use of the Well (s)	Delineation Criteria	Quality and Quantity of Well Water	Land and Groundwater Use in DWSMA	
Surface Water Quality					
Stream and lake water quality management classification					
Monitoring data summary	M	M	M	M	MDH, MPCA
Groundwater Quality					
Monitoring data	H	H	H	H	MDH
Isotopic data	H	H	H	H	MDH
Tracer studies	H	H	H	H	Not Available
Contamination site data	M	M	M	M	Not Available
Property audit data from contamination sites					
MPCA and MDA spills/release reports	M	M	M	L	MPCA, MDA

Definitions Used for Assessing Data Elements:

High (H) - the data element has a direct impact

Moderate (M) - the data element has an indirect or marginal impact

Low (L) - the data element has little if any impact

Shaded - the data element was not required by MDH for preparing the WHP plan

Acronyms used in this report are listed on page ii, after the "Glossary of Terms."

3. General Descriptions

3.1 Description of the Water Supply System

Adrian obtains its drinking water supply from three primary wells. Table 1 summarizes information regarding them.

3.2 Description of the Hydrogeologic Setting

The hydrogeologic setting for the Quaternary water table aquifer used by the city of Adrian is described in the original Part 1 report (Olsen, 2002). The aquifer used by the Adrian city wells consists of sand and gravel deposits that occur within the valley of Kanaranzi Creek. The general composition of the geological materials present beneath the soil horizon is shown in Figure 2. These are the materials that either form the aquifer used by the city wells or affect the direction that groundwater takes as it moves toward Kanaranzi Creek.

Groundwater moves from the upland areas toward Kanaranzi Creek, which controls the distribution of hydraulic head (water table elevations) in the outwash channel aquifer (Olsen, 2002). The configuration of the water table within the valley and surrounding uplands is shown in Figure 2. This map was prepared using a computer model to simulate groundwater conditions and was checked using water levels measured in observation wells, domestic wells, city wells, and irrigation wells.

The description of the hydrogeologic setting for the aquifer used to supply drinking water is presented in Table 3.

Figures 3, 4a, and 4b show The distribution of the aquifer and its stratigraphic relationships with adjacent geologic materials are shown in Figures 3, 4a, and 4b. They were prepared using well record data that is contained in the County Well Index (CWI) database. The geological maps and studies that were used to further define local hydrogeologic conditions are provided in the "Selected References" section of this report.

Table 3 - Description of the Hydrogeologic Setting at Adrian Wells

Aquifer	Attribute	Descriptor	Data Source
Quaternary Water Table Aquifer (QWTA)	Aquifer Material	Sand and Gravel	Well logs.
	Primary Porosity	0.25	Estimated porosity value.
	Aquifer Saturated Thickness	23 to 30 feet	Adrian well logs.
	Static Water Table Elevation	1515 to 1522 feet MSL	Adrian well logs.
	Stratigraphic Bottom Elevation	1488 to 1492 feet MSL	Adrian well logs.
	Hydraulic Confinement	Unconfined	Adrian well logs.
	Transmissivity (T)	Range: 2,550 – 6,000 ft^2/day	The original aquifer test plan was approved on August 30, 2000, and the reference value for the transmissivity of the QWTA was determined from an aquifer test conducted by MDH staff from August 31 to September 11, 2000. The range of transmissivities was obtained from the 2000 pump test at Well 3. The high end value was confirmed by that obtained by re-analyzing the data from the 2006 pump test at Well 7 (Liesch, 2006). The aquifer test plan was re-approved by MDH on March 26, 2013.
	Hydraulic Conductivity (K)	Range: 85 – 260 feet/day	The hydraulic conductivity of the QWTA was calculated from the transmissivity and the saturated thickness at the wells.
	Groundwater Flow Field	Flow to the West-Northwest See Figure 2	Modeled groundwater flow field.

4. Delineation of the Wellhead Protection Area

4.1 Delineation Criteria

The boundaries of the WHPA for Adrian are shown in Figure 1. Table 4 describes how the delineation criteria that are specified under Minnesota Rules, part 4720.5510, were addressed.

Table 4 - Description of WHPA Delineation Criteria

Criterion	Descriptor	How the Criterion was Addressed
Flow Boundary	Kanaranzi Creek, middle branch of the Kanaranzi Creek, and small unnamed creek that flows south of city wells 5 and 6.	The creeks and stream provided boundary conditions to the model that extended to these natural boundaries. They were included in the model and set the regional groundwater flow.
Flow Boundary	Other High-Capacity Wells (Table 6)	Only one other capacity well is located within two miles of the Adrian wells. This well is screened in the same aquifer as the Adrian wells, and was included in the delineation. The discharge at the well was based on the maximum annual volume pumped from 2006 to 2010 (Table 6).
Daily Volume of Water Pumped	See Table 5	Pumping information was obtained from Department of Natural Resources (DNR) Groundwater Appropriations Permit No. 1975-4223.
Groundwater Flow Field	See Figure 2	The model calibration process addressed the relationship between the calculated versus observed groundwater flow field.
Aquifer Transmissivity	Reference Value (QWTA): 2,550 ft^2/day	The aquifer test plan was approved on March 26, 2013, and the reference value for the transmissivity of the QWTA was determined from an aquifer test conducted by MDH staff from August 31 to September 11, 2000.
Time of Travel	10 years	The public water supplier selected a 10-year time of travel.

Information provided by Adrian was used to identify the maximum volume of water pumped annually by each well over the previous five-year period, as shown in Table 5. No increase in pumping is expected in the next five years. Previous pumping values have been reported to the DNR, as required by Groundwater Appropriation Permit No. 1975-4223. The maximum daily volume of discharge used as an input parameter in the model was calculated by dividing the greatest annual pumping volume by 365 days.

Table 5 - Annual Volume of Water Pumped from Adrian Wells (Gallons)

Well Name	Unique Number	Total Annual Withdrawal (gal/year) Permit Number: 1975-4223					Maximum Withdrawal 2007 - 2011 (gallons/year)	Daily Volume (cubic meters per day)
		2007	2008	2009	2010	2011		
Well 1	241354	0	0	0	0	0	0	0
Well 5	149184	**15,922,000**	11,001,000	6,616,000	13,938,000	8,591,000	15,922,000	165.0
Well 6	149187	**20,511,000**	11,439,000	12,291,000	4,765,000	8,348,000	20,511,000	212.6
Well 7	721689	14,605,000	26,371,000	**26,809,000**	24,544,000	22,669,000	26,809,000	277.8
Totals		51,038,000	48,811,000	45,716,000	43,247,000	39,608,000	63,242,000	655.4

Sources: Adrian staff and the DNR State Water Use Database System (SWUDS), DNR Groundwater Application Permit No. 1975-4223.

Bolded values indicate the annual volume used for the wellhead protection area delineation.

Table 6 - Other Permitted High-Capacity Wells Within Two Miles

Unique Number	Well Name	DNR Permit Number	Aquifer	Use	Maximum 5-yr Annual Volume of Water Pumped (gallons/year)
223427	Adrian Area Country Club	2001-4080	QWTA	Non-Crop Irrigation	5,941,000

4.2 Method Used to Delineate the Wellhead Protection Area

The original WHPA for Adrian was delineated using a Single Layer Analytic Element Model (SLAEM). SLAEM is based on the Analytic Element Method developed by Dr. O.D.L. Strack (Prentice-Hall, 1989).

The clay-rich tills, into which the outwash channel was eroded, were used to set the parameters for the global aquifer. That is, the channel aquifer is but a small part of the model domain with most of the area represented as low permeable material. A hydraulic conductivity of four (4) meters per day was used to represent the clay-rich till and the porosity set at 0.1 to reflect the thin beds of sand and gravel that occur within it. The value for the hydraulic conductivity obtained from the Minnesota Pollution Control Agency, from studies conducted at the Rock County landfill, was set at 4 meters per day (Olsen, 2002). The base of the aquifer was set at 425 meters and the model was set to reflect unconfined hydraulic conditions. Global recharge was set to 0.000075 meters per year (1 inch) using a single given strength areal element that covers the entire modeling domain. The channel aquifer used by the well field was represented in the model by inhomogeneity element with a base set between 437 m to 448 m, and a hydraulic conductivity of 42 m/day. In the Adrian well area, the hydraulic conductivity was set at 15.2 m/day to reflect the transmissivity estimated from the Adrian pump test.

The main branch of Kanaranzi Creek and a middle branch, located about 3 miles north of the city of Adrian, were incorporated into the model as a series of head specified line sinks. In addition, a small, perennial creek that flows south and west from the city wells was included. Head values were assigned using elevations taken from the 7.5 minute Adrian topographic maps prepared by the U.S. Geological Survey. Further description of the original model can be found in Olsen (2002).

The SLAEM model was converted into a single layer MODFLOW Model. MODFLOW is a 3D, cell-centered, finite difference, saturated flow model developed by the U.S. Geological Survey (McDonald and Harbaugh, 1988; Harbaugh et al., 2000).

The original head-specified line sinks were represented in the MODFLOW model by river conductance cells. The river elevations were extracted from a Nobles County LiDAR data acquired in 2010 for the Minnesota Department of Natural Resources. The conductance of the Kanaranzi Creek and the middle branch was set using a vertical hydraulic conductivity of 0.02 cm/s. The conductance of the creek that flows south and west from the city was set using a vertical hydraulic conductivity of

0.01 cm/s. With this smaller value, the Adrian wells extract no more than 20 percent of their water from the creek, comparable to the original model (Olsen, 2002).

The model grid was refined around Adrian wells. Variable grid spacing was used, ranging from two meters near Adrian wells to 250 meters at the edge of the grid. This refinement was required for an accurate computation of the particle flow paths for determining the WHPA delineation. Prior to their use in the delineations, the pumping rates to be used in the WHPA (Table 5) were assigned to Adrian wells.

The delineation, using the particle tracking MODPATH Code, was performed by backtracking particles from the well to a 10-year time of travel. A series of 50 particles were launched at each well. A porosity of 25 percent was used for the Quaternary Water Table Aquifer.

4.3 Calibration and Sensitivity

Model quality is commonly evaluated by three different measures: calibration, sensitivity, and uncertainty analyses. Model calibration is a procedure that compares the results of a model based on estimated input values to measured or "known" values. This procedure is used to define model validity over a range of input values. The result of calibration is an assessment of the general quality of the model and the confidence that may be placed in the model results. As a matter of practice, groundwater flow models usually are calibrated using groundwater elevation and flow (if available). Sensitivity analysis quantifies the differences in model results produced by the natural variability of a particular parameter. Uncertainty analysis addresses the effects of poor data quality (lack of local detailed information or deficiencies in the data) on the model results. Together, sensitivity and uncertainty analyses are commonly used to evaluate the effects that natural variability and uncertainties in the hydrogeologic data have on the size and shape of the capture zones. In regards to the WHPA delineation, these analyses are used to document that the delineation is optimal, conservative, and protective of public health based on existing information.

4.3.1. Calibration

The Adrian Model was calibrated to the CWI database water level targets. The water level data is very sparse and either concentrated near the city well field along the outwash valley or within the upland till. The calibration was verified by comparing modeled piezometric heads against measured values at observation well locations. A quantitative measure by which to evaluate the success obtained during calibration is to compare the mean root, mean square of the residuals (RMSE), and the maximum observed head difference across the model. A usually accepted calibration target is a RMSE that represents less than 15 percent of the total head change across the modeled area. For the present calibration, the RMSE is 15.04 percent of the maximum observed head difference across the model. The calibrated hydraulic head contours in the vicinity of the city of Adrian, along with the CWI database water level targets, are depicted in Figure 2.

4.3.2. Sensitivity Analysis

Sensitivity is the amount of change in model results caused by the variation of a particular input parameter. Because of the relative simplicity of the groundwater model, the direction and extent of the modeled capture zone may be very sensitive to any of the input parameters.

The **pumping rate** directly affects the volume of the aquifer that contributes water to the well. An increase in pumping rate leads to an equivalent increase in the volume of aquifer and an expanded capture zone, proportional to the porosity of the aquifer materials.

Results - The pumping rate defined by WHP rule requirements is the highest rate that can be expected under normal water demand. Therefore, with respect to the delineation of the WHPA, the sensitivity of the capture zone to variations in the pumping rate is minimized.

The **direction of groundwater flow** determines the orientation of the capture zone. Variations in the direction of groundwater flow will not affect the size of the capture zone but are important for defining the areas that are contributing water to the well.

Results - The ambient groundwater flow field was difficult to determine due to the scarcity and distribution of water level data. The modeled groundwater flow field defined in Figure 2 provides the basis for determining the extent to which each model run reflects the conceptual understanding of the orientation of the capture area for a well. The sensitivity of the capture zone to the direction of groundwater flow was somewhat captured by the different scenarios analyzed. The actual impact is difficult to ascertain given the limited knowledge on hydraulic head distribution in the aquifer.

The **hydraulic gradient** (along with aquifer transmissivity) determines the rate at which water moves through the aquifer materials.

Results - The groundwater flow field defined in Figure 2 provides the basis for determining the extent to which each model run reflects the conceptual understanding of the orientation of the capture area for a well. The regional model has been calibrated to hydraulic heads. The sensitivity of the WHPA to the hydraulic gradient should not be significant, the hydraulic gradient being relatively flat in the highly conductive outwash valley.

The **horizontal hydraulic conductivity** influences the size and shape of the capture zone. In the base-case scenario, the horizontal hydraulic conductivity was computed from the transmissivities estimated from the pumping test at Adrian Well 3 (223427). The transmissivity value obtained from this test was used in the groundwater model to delineate the 10-year time of travel capture zones for the Base Case scenario. The range of transmissivity estimated from the pumping test was relatively large with values up to 6,000 ft^2/day. A second run was performed for the upper range value of the estimated transmissivity given in Table 3.

Results - A high horizontal hydraulic conductivity value elongates the capture zone while reducing its width. It also shifted the direction of the capture zones as more water is being provided by the unnamed creek (Figure 5).

The **riverbed conductance of the unnamed creek** influences the size and shape of the capture zone. In the base-case scenario, the vertical hydraulic conductivity of the riverbed sediment was assumed to be 0.01 cm/sec. Two additional runs were performed by increasing/reducing the riverbed conductance by one order of magnitude to investigate the impact on the capture zone delineation of a better (worse) connection between the creek and the aquifer.

Results – The delineation of the capture zone was not very sensitive to the change by one order of magnitude in the riverbed conductance (Figure 5).

The aquifer **porosity** influences the size and shape of the capture zone.

Results - Decreasing the porosity causes a linear, proportional increase in the areal extent of the capture zone.

The Capture Zone for Adrian wells in Figure 1 consists of a composite of the porous media aquifer delineations for the different input parameters used in the sensitivity analysis. The input files for all models are available upon request at MDH.

4.4 Addressing Model Uncertainty

Using computer models to simulate groundwater flow involves representing a complicated natural system in a simplified manner. Local geologic conditions may vary within the capture areas of Adrian wells, but existing information is not sufficiently detailed to define this degree of variability. In addition, the available groundwater flow modeling techniques may not represent the natural flow system exactly, but the results are valid within a range defined by the reasonable variation of input parameters.

Traditional numerical groundwater models were used to delineate the capture zone for the porous media aquifer that contributes water to the public water supply well. The steps employed for this delineation to address model uncertainty were:

- Pumping Rate - For each well, a maximum historical (five-year) pumping rate or an engineering estimate of future pumping, whichever is greater (Minnesota Rules, part 4720.5510, subpart 4).
- Transmissivity - Uncertainty with respect to transmissivity was addressed by considering different input parameters in the capture zone delineation.
- Streambed conductance was addressed by considering different input parameters in the capture zone delineation

Capture zones were delineated for the base case (representative) values of transmissivity and riverbed conductance, and the range of parameters discussed in the sensitivity analysis. As the model code uses constant input values for each run, several runs were required to include all variations in input parameters. The capture zone for Adrian wells consists of a composite of the porous media aquifer delineations for the different input parameters used in the sensitivity analysis. This provides a conservative approach to addressing model uncertainty and produces a capture zone that will likely be most protective of public health.

4.5 Assessing Conjunctive Delineation

The need for a conjunctive delineation was also assessed as part of this delineation. Delineation of the wellhead protection area for the city of Adrian well field has to include the upland areas adjacent to the channel aquifer that will most likely contribute runoff that could provide recharge. These surface water runoff component boundaries were determined using topographic maps, the map showing hydraulic head distribution in the aquifer generated by the groundwater flow model, and personal observations. City staff verified the position of the boundaries after MDH staff incorporated these boundaries into the Drinking Water Supply Management Area Vulnerability map in 2002 (Olsen, 2002).

Water samples were collected in June 2006, October 2007, and February 2008 for Adrian Wells 5, 7, and 6, respectively. The samples were analyzed for the stable isotopes of oxygen and hydrogen. The results are provided in Appendix A.

The stable isotope results for the public wells fall on the meteoric water line, indicating there was little or no surface water contribution at the time of monitoring. It is possible the single set of water samples that have been taken to date, are misleading because of their failure to take into account seasonal variability. It is recommended that Adrian undergo a year-long program of quarterly monitoring of the public wells and the unnamed creek south of the city wells to confirm the model findings and allow for a more accurate assessment of the relationship between the aquifer used by the wells and the surface water features.

5. Delineation of the Drinking Water Supply Management Area

The boundaries of the DWSMA were defined by the public water supplier using the following features (Figure 1):

- Center-lines of highways, streets, roads; and
- Public Land Survey coordinates.

6. Vulnerability Assessments

The Part I wellhead protection plan includes the vulnerability assessments for the public water supply wells and DWSMA. These vulnerability assessments are used to help define potential contamination sources within the DWSMA and to select appropriate measures for reducing the risk they present to the public water supply.

6.1 Assessment of Well Vulnerability

The vulnerability assessment for each well used by the public water supplier is listed in Table 1 and is based upon the following conditions:

1) The Adrian wells meet current State Well Code construction specifications (Minnesota Rules, part 4725) and the wells themselves do not provide a pathway for contaminants to enter the aquifer used by the public water supplier.

2) The Adrian wells are screened in a sand and gravel water table aquifer that has no geologic cover over it to retard the vertical movement of contamination.

3) Water quality monitoring shows the presence of nitrate nitrogen in the wells throughout the year. Nitrate levels consistently exceed 5 parts per million and both wells have, at time, exceeded the 10 part per million federal drinking water standard for nitrate nitrogen. These levels indicate that the wells pump groundwater that is under the influence of nitrogen sources related to human activities.

The Adrian wells are considered vulnerable to contamination. A summary of the isotope and water quality results for samples collected as part of this project is provided in Appendix A.

6.2 Assessment of the Drinking Water Supply Management Area Vulnerability

The vulnerability of the DWSMA ranges from low to very high and is based upon the following information (Figure 6):

1) Static water levels, measured in the city wells and nearby observation wells, indicate that the water table in the aquifer is generally within 20 feet of the land surface. Subsurface information indicates that there are no laterally persistent layers of clay-rich material over the outwash channel aquifer to prevent or to retard the vertical movement of contaminants. Therefore, the Kanaranzi channel aquifer is highly vulnerable to potential sources of contamination that 1) are located directly over the aquifer or 2) may introduce contaminants to surface water runoff that may recharge the aquifer from higher topographic elevations.

2) Groundwater occurring in the areas, characterized by clay-rich till, are not vulnerable to contamination. The vulnerability of these areas is considered to be low. However, surface water runoff may enter the aquifer as focused recharge.

7. Selected References

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Figures

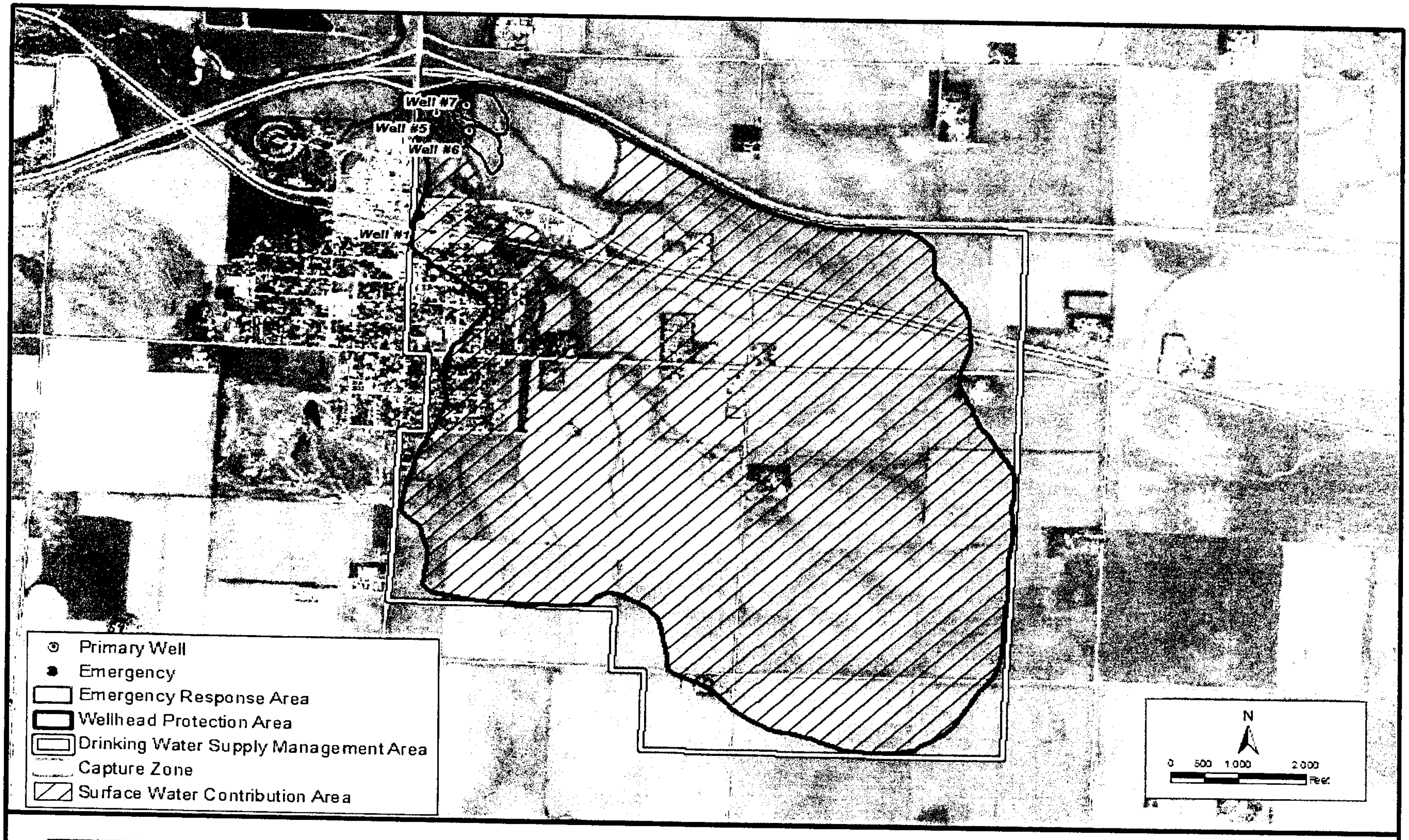

Figure 1
Wellhead Protection and
Drinking Water Supply Management Area
City of Adrian

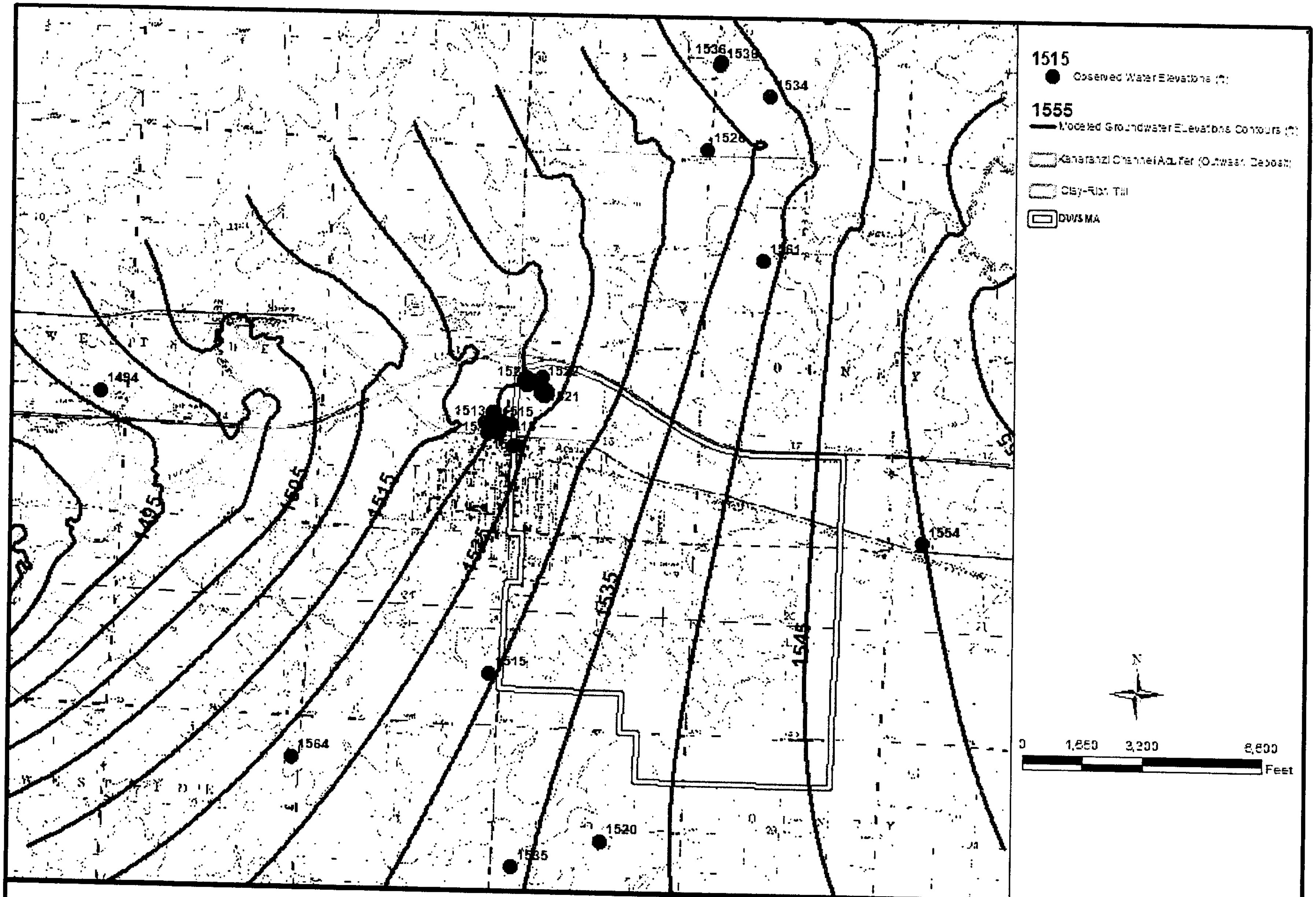

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Figure 2
Modeled Groundwater Flow Field
City of Adrian

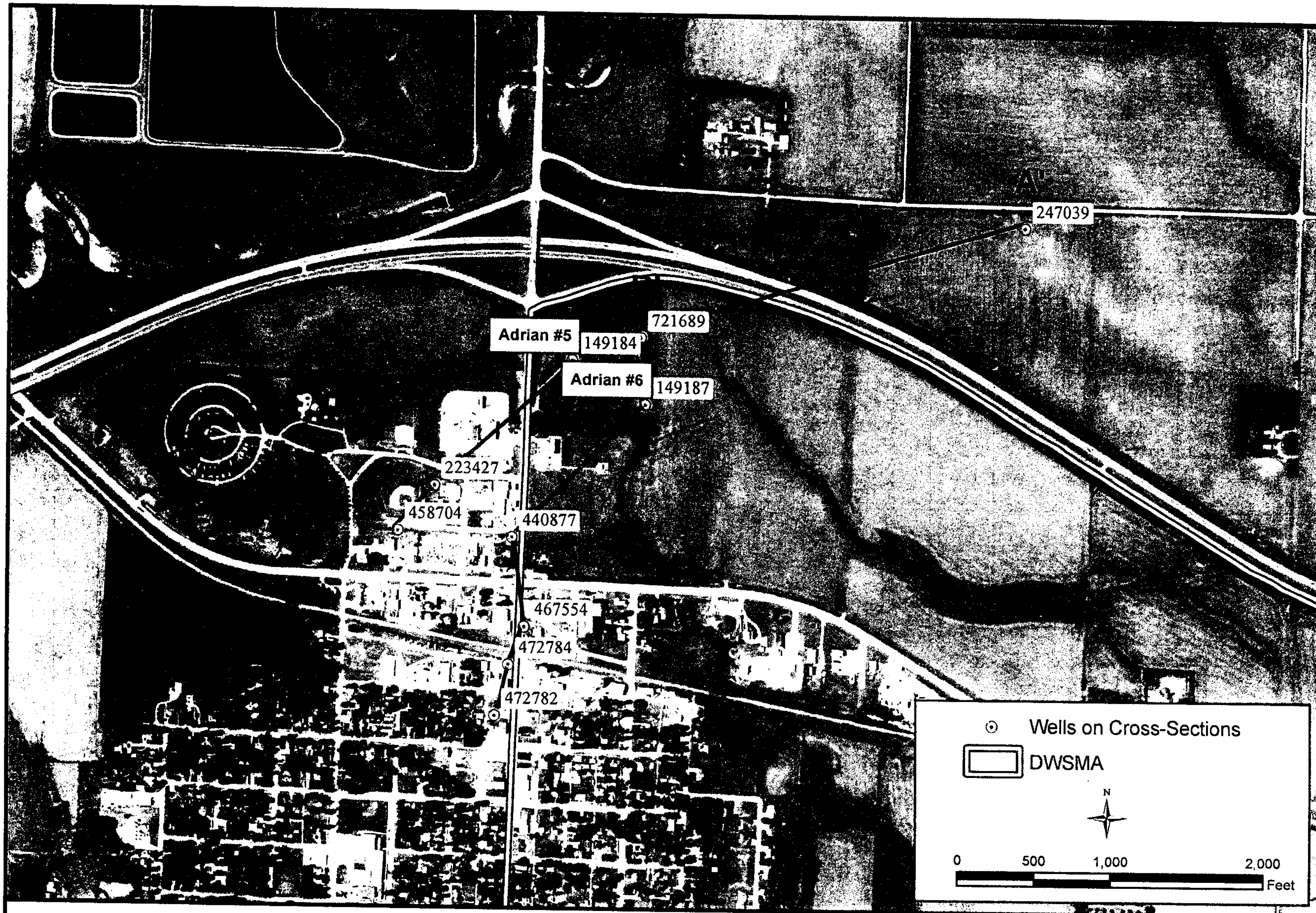

Figure 3 - Geologic Cross-Section Locations
City of Adrian

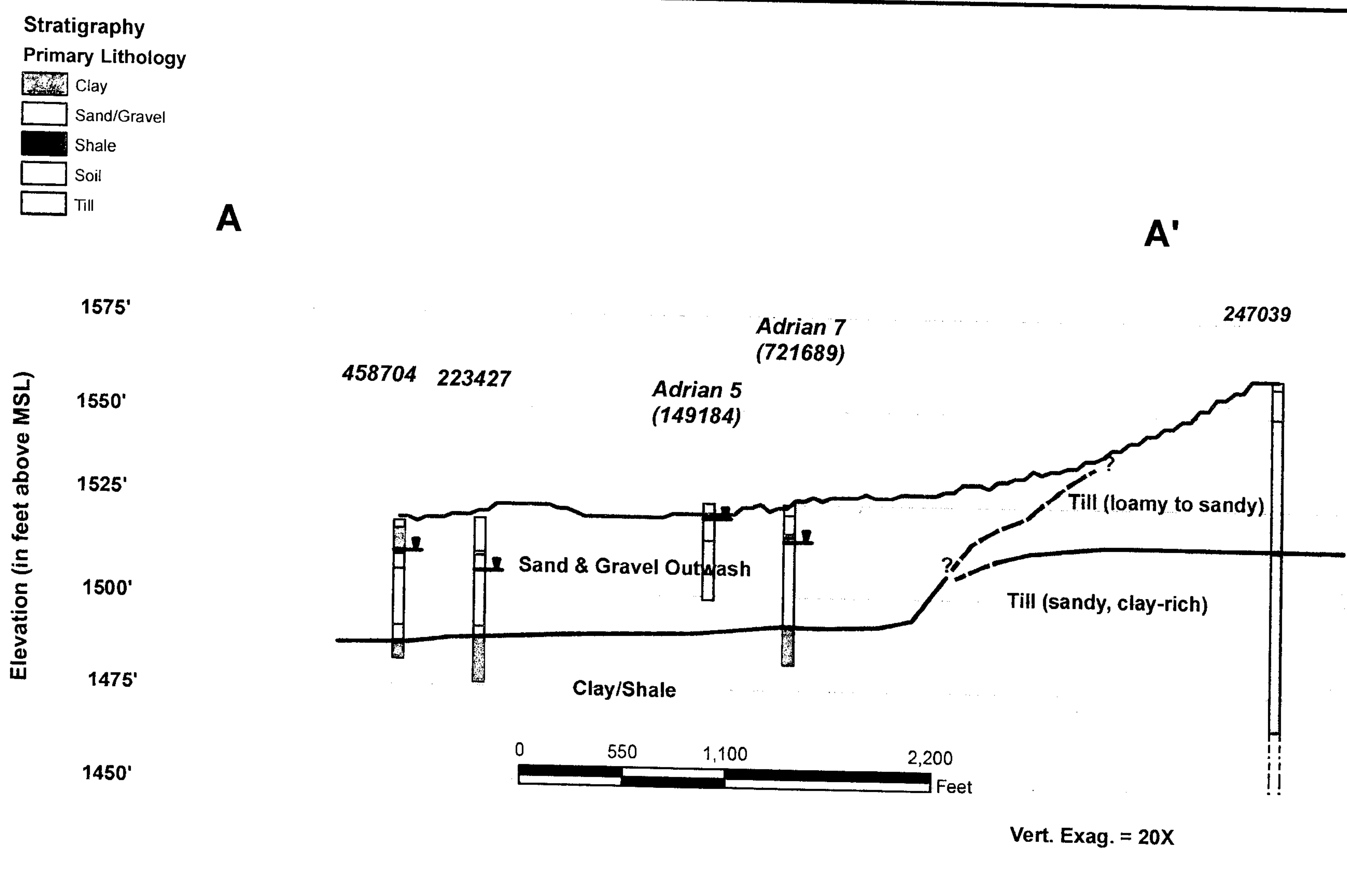

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Figure 4 - Geologic Cross-Section A-A'
City of Adrian

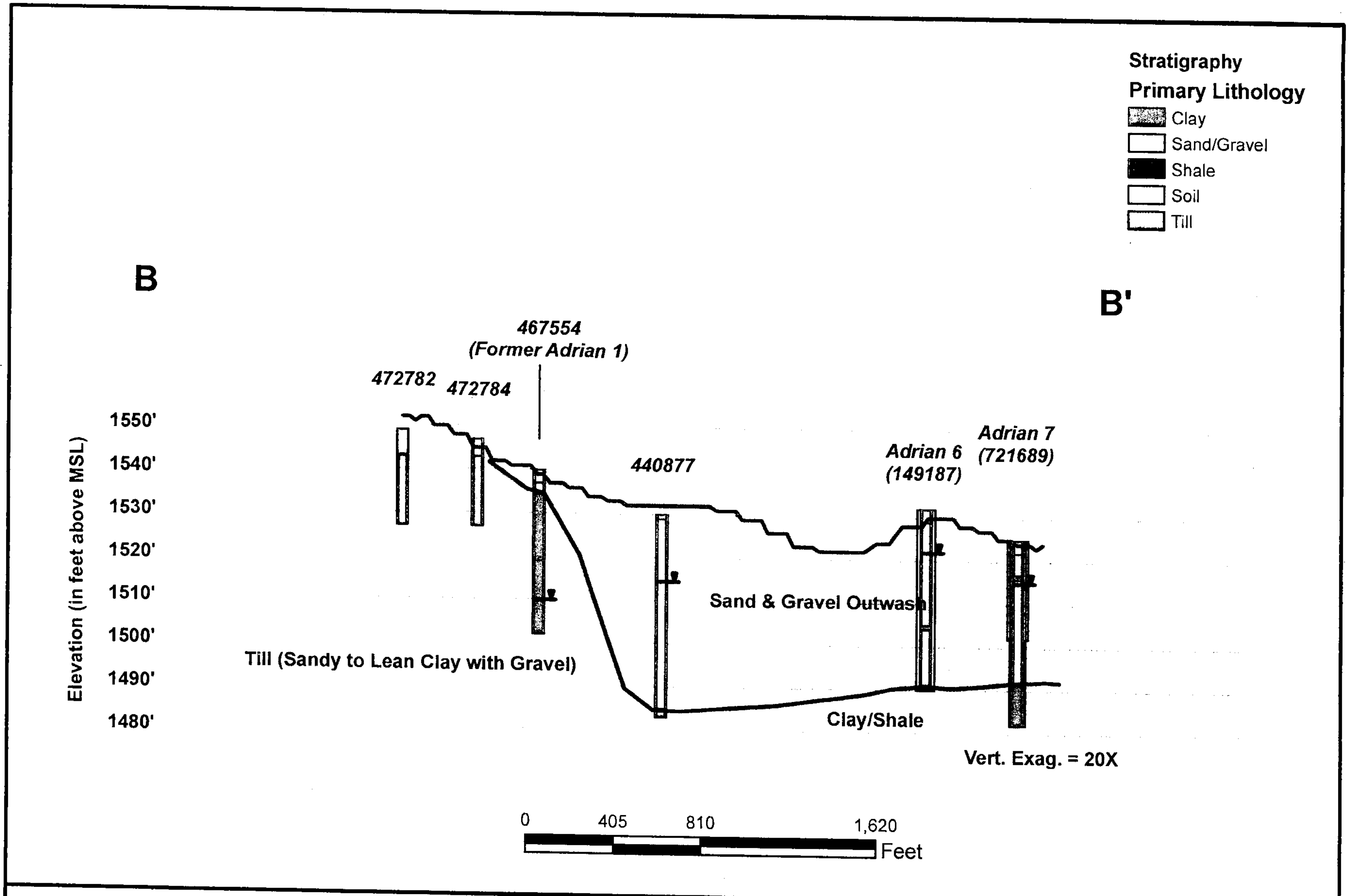
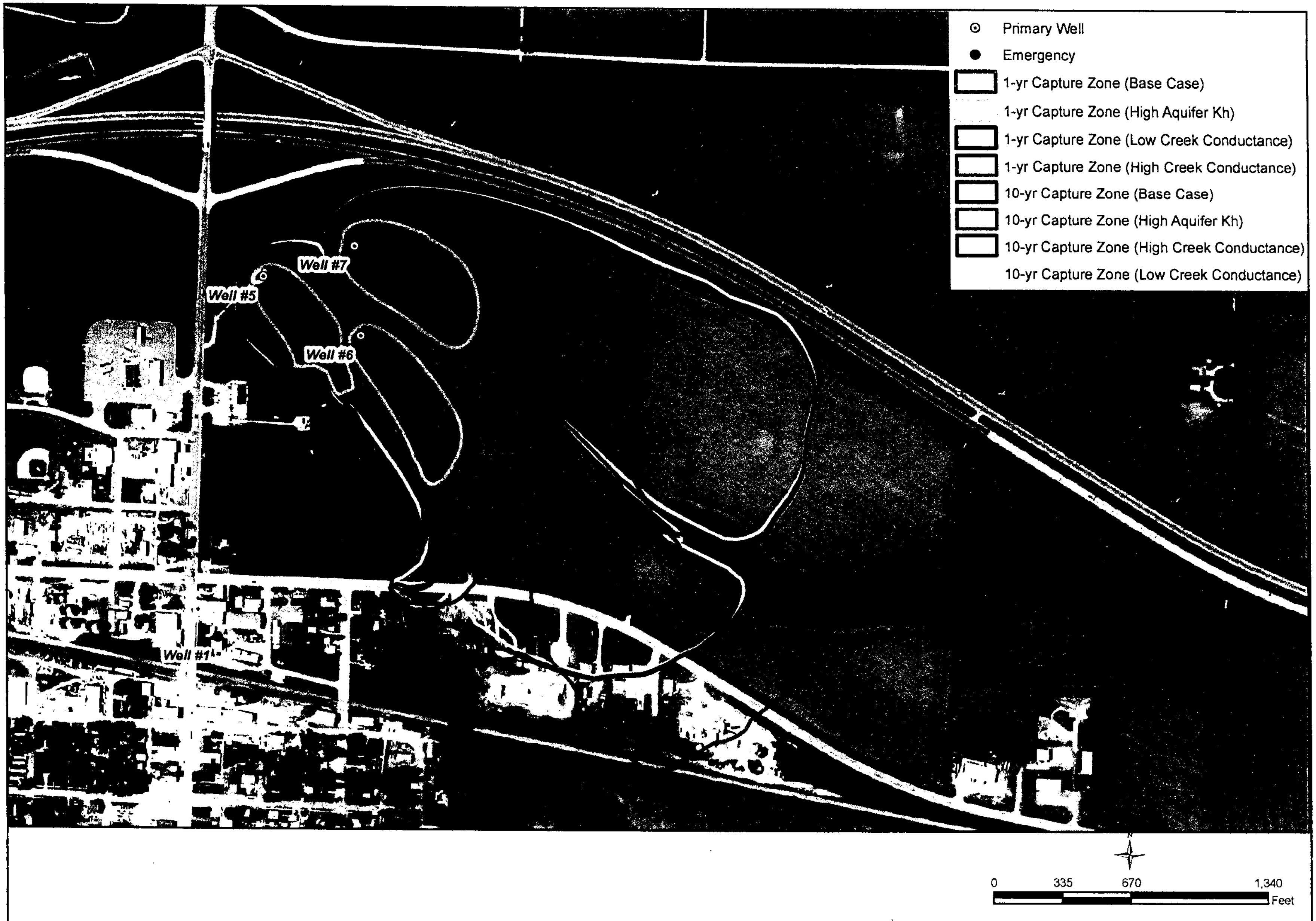


Figure 4b - Geologic Cross-Section B-B'
City of Adrian



MINNESOTA MDH DEPARTMENT OF HEALTH

Figure 5
Sensitivity of the 10-Yr. Capture Zone to Hydraulic Conductivity and Riverbed Conductance
City of Adrian

Appendix A

Water Quality Results

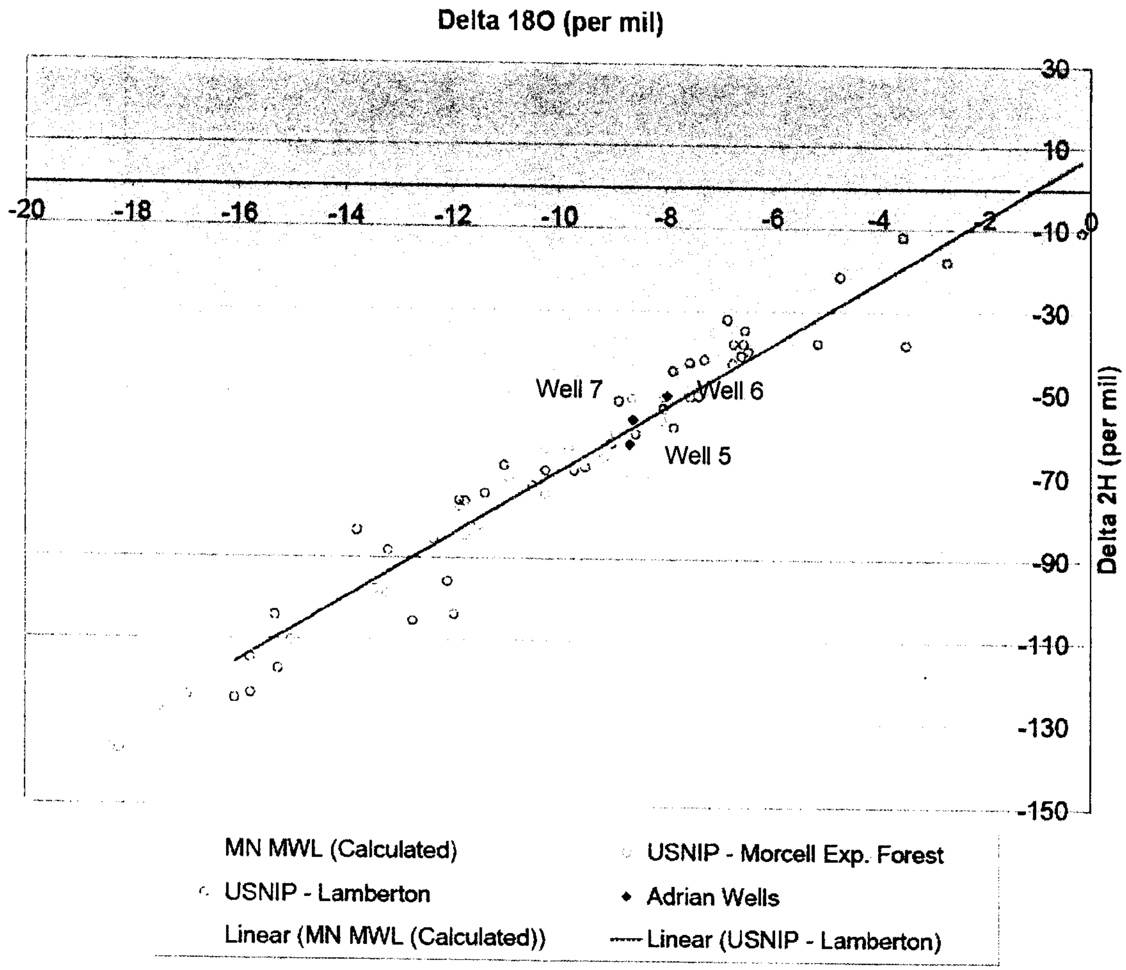
City of Adrian

Nitrate and Isotope Results

Name	Sampling Date	Nitrate (mg/l)	Stable Isotopes (per mil)	
			Delta 18O	**Delta 2H**
Well 5 (149184)	June 5, 2006	13[1]	-8.68	-62.05
Well 7 (721689)	October 11, 2007	Not Sampled	-8.62	-56.14
Well 6 (149187)	February 11, 2008	20	-7.98	-50.46

Notes: [1] Sampled on December 17, 1993.

Stable Isotope Results
City of Adrian



Notes: The stable isotope results for the public wells fall on the meteoric water line, indicating there was little or no surface water contribution at the time of monitoring, except maybe for Well 5. This could be indicative of the fast recharge potential of the outwash valley deposit.

THE CITY OF ADRIAN
ADRIAN PUBLIC UTILITIES
209 Maine Ave., Suite 106 • P.O. Box 190
Adrian, Minnesota 56110
Telephone / TDD (507) 483-2849
Fax (507) 483-2005
cityofadrian@iw.net

Date: March 19, 2013

To: Robert. S. Demuth Jr.,Nobles County Chair, P.O. Box 757, Worthington, MN 56187
Gene DeBeer, Westside Township Chair, 11388 250th St., Adrian, MN 56110
Lane Erlandson, Olney Township Chair, 20377 235th St., Rushmore, MN 56168
Tim Taylor, Kanaranzi-Little Rock WD Chair, P.O Box 190, Adrian, MN 56110
Miron Carney, SWRDC Chair, 2401 Broadway Avenue, Suite 1, Slayton, MN 56172
John Blomme, MN Dpmt. of Health, 1400 W. Lyon Street, Marshall, MN 56258
Terry Bovee, Minnesota Department of Health, Mankato Place, 12 Civic Center Plaza, Suite 2105, Mankato, MN 56001-7789

From: Terrance L. Miller, Superintendent

Re: Adrian, MN Wellhead Protection Program

The City of Adrian/Public Utilities is notifying neighboring and overlying units of government of its intent to amend our state-approved wellhead protection plan. The purpose of the amendment is to include new wells that are now part of the public water supply system. The goal of a wellhead protection plan is to prevent human caused contaminants from entering our water supply wells and to protect all who use our water supply from adverse health effects associated with groundwater contamination. This notice is required by the Minnesota Wellhead Protection Rule 4720, part 4720.5300.

The entire project will take 2 years to complete. Public informational meetings will be held later this year.

In accordance with the wellhead protection rule, the following information must be included in this notice:

1. Wellhead protection manager: Terrance L. Miller, City of Adrian/Public Utilities
20 Maine Ave., Adrian, MN 56110
2. Unique well numbers: 149184 (Well 5), 149187 (Well 6), 721689 (Well 7)
3. Date wellhead protection plan must be completed: May 28, 2014
4. General project work plan – See attached work plan
5. Missing data elements needed for wellhead protection plan:

Any existing information (plans, controls, policies) related to water resources and land-use issues, concerns or opportunities that you feel are pertinent to the development of the wellhead protection plan, please contact Terrance Miller, Wellhead Protection Coordinator. Also, if you have any questions, please contact Terrance at 507-483-2680. Thank you for your assistance in our wellhead protection efforts.

cc: Wayne Smith, Nobles County Environmental Services, P.O. Box 187, Worthington, MN 56187
Dennis Healy, LPRW, 415 E. Benton Street, Lake Benton, MN 56149
Ken Wolf, Nobles Soil & Water Conservation District, 1567 McMillan Ave., Worthington, MN 56187
Bruce Heitkamp, Adrian City Hall, 209 Maine Avenue, Suite 106, Adrian, MN 56110

City of Adrian WHP Amendment Work Plan

Step	Projected Completion Date (Month,Year)
PART I	
*Letter from MDH Informing Need to Amend Plan	Nov. 29, 2011
Notice of Plan Development Sent to Local Units of Government (LUGs)	March 20, 2013
Public Meeting Held with LUGs	June 2013
WHP Manager Appointed	July 18, 2012
LUG Team Established (Optional)	July 18, 2012
Wellhead Protection Team Appointed	July 18, 2012
Scoping 1 Meeting Held	June 6, 2012
*MDH Scoping Decision (Letter)	July 5, 2012
Prepare Aquifer Test Plan and Submit to MDH	April 2013
*MDH Approval of Test Plan	May 2013
Wellhead Protection Area (WHPA) Delineation	May 2013
Drinking Water Supply Management Area (DWSMA) Delineation	May 2013
Conduct Vulnerabililty Assessment	May 2013
Vulnerability and DWSMA Submitted to MDH	June 2013
*MDH Approval of DWSMA, WHPA, and Vulnerability Assessments	June/July 2013
Vulnerability, WHPA and DWSMA Submitted to LUGs	August 2013
Public Meeting Held	August 2013
PART II	
Scoping 2 Meeting Held	Sept. 2013
*MDH Scoping Decision (Letter)	Oct. 2013
Inventory of Potential Scource Contamination	Oct. – Dec. 2013
Management Portion of Plan[1]	December 2013
Submit Plan to LUGs	Jan. – Feb. 2014
Consider Comments Received by LUGs[2]	March 2014
Public Hearing Held	March 2014
Submit Plan to MDH	March 2014
*MDH Review	March – May 2014
*MDH Approval	May 2014
Provide Notice to LUGs About Plan Approval	June 2014
Begin Plan Implementation	June 2014

1 Prepare response to impact of changes on PWS well; issues, problems and opportunities; WHP goals; objectives and plan of action; evaluation program; alternate water supply; contingency strategy.

2 Incorporate response to comments in plan.

* Highlighted text denotes steps completed by MDH

Name of Person Completing This Form	Date
Terrance L. Miller	March 19, 2013

MINNESOTA
MDH
DEPARTMENT OF HEALTH
Protecting, maintaining and improving the health of all Minnesotans

September 13, 2013

Mr. Terry Miller, Utility Superintendent
City of Adrian
P.O. Box 357
Adrian, Minnesota 56110-0357

Dear Mr. Miller:

We are pleased to notify you that the Minnesota Department of Health has approved the amended 1) delineation of the wellhead protection area, 2) delineation of the drinking water supply management area, and 3) assessments of well and aquifer vulnerability for your public water supply wells, as submitted. The approval pertains to the following public wells:

Well No. 5	Unique Well No. 149184
Well No. 6	Unique Well No. 149187
Well No. 7	Unique Well No. 721689

Procedurally, you must submit a copy of the amended delineated wellhead protection area, drinking water supply management area, and assessments of well and aquifer vulnerability to local units of government that are wholly or partially within these areas. Notification must occur within 30 days after receiving this letter. If you need assistance getting this information out, please contact Mr. Terry Bovee of the Minnesota Department of Health (507/344-2744).

Within 60 days of the receipt of this letter, you must hold a public information meeting for the general public at which the approved wellhead protection area, drinking water supply management area, and vulnerability assessments are available for review by the public. This meeting can be held solely for this purpose or it can be incorporated into another public meeting, such as a regular meeting of your city council. If you would like a representative of the Minnesota Department of Health to be present at the public information meeting, please contact Mr. Bovee.

You will be hearing from Mr. Bovee to schedule a second scoping meeting to initiate Part II of the wellhead protection amendment process. Please contact me at 651/201-4686 if you have any questions regarding this letter.

Sincerely,

Yarta Clemens-Billaigbakpu, Hydrologist
Source Water Protection Unit
Environmental Health Division
P.O. Box 64975
St. Paul, Minnesota 55164-0975

YCB:TVW
cc: Mr. Aaron Meyer, Minnesota Rural Water Association
Mr. Terry Bovee, Planner, Source Water Protection Unit, Mankato District Office
Mr. Paul Flynn, Natural Resource Conservation Service
Ms. Michelle Page, Farm Service Agency