WELLHEAD PROTECTION PLAN FOR THE CITY OF REDWOOD FALLS

PART 1

PREPARED FOR:

CITY OF REDWOOD FALLS, MINNESOTA

NOVEMBER, 2007

PREPARED BY:

Liesch Companies

Minneapolis, MN • Madison, WI • Scottsdale, AZ

Wellhead Protection Plan Part I
Redwood Falls, Minnesota

PREPARED FOR:

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1.0 INTRODUCTION

The City of Redwood Falls has a population of over 5,200 and is the seat of Redwood County. Redwood Falls is located approximately 110 miles west of the Twin Cities metropolitan area and serves as a sub-regional economic hub for the surrounding 17,000 residents in Redwood and Renville Counties. The City has a growing and diverse economic base comprised of tourism and entertainment, light and heavy industry and high-tech computer component manufacturing in addition to its retail and agricultural roots.

An important component in maintaining this growth will be the availability of a high quality municipal water supply. As part of this work, the City of Redwood Falls is preparing a Wellhead Protection Plan to assist in preventing potential contaminants from entering the City's water supply at the source. Wellhead protection planning makes sense from a public health standpoint because it is intended to minimize exposure to potentially harmful contaminants and also from an economic standpoint as water supply contamination can be very costly to investigate, monitor and correct.

Under the provisions of the 1986 and 1996 amendments to the Safe Drinking Water Act (SDWA), administered by the United States Environmental Protection Agency (EPA), states are required to develop wellhead protection programs for public water supplies. The 1986 Minnesota Groundwater Protection Act authorizes the Department of Health (MDH) to develop Minnesota's well head protection program which it administers through Minnesota Rules, Chapter 4720.5100 to 4720.5580.

Minnesota's wellhead protection program requires public water suppliers to identify the area that contributes water to a public supply well, or well field, within a certain period of time. This is known as the wellhead protection area (WHPA) delineation which is in turn used to establish the drinking water supply management area (DWSMA). The City wells and this area are then assessed to determine the vulnerability of the water supply to contamination. These items constitute Part I of Minnesota's wellhead protection program which is the subject of this report.

Part II of the program involves developing a management plan that may include an inventory of potential sources of contamination within the DWSMA and ways to manage existing and future activities that could impact the City's water supply. Activities to be included in Part II will be dependent on the results of Part I, particularly on whether the wells or DWSMAs are found to be vulnerable. If the City supply wells and associated DWSMA are found to be "not vulnerable", this indicates that the wells are properly constructed and that the geologic formations provide

natural protection to the aquifer. This protection is usually in the form of a thick, low permeability confining layer that prevents or restricts potential contaminants from reaching the aquifer. In these cases, Part II may focus on preventing activities that could breach the confining layer such as improperly constructed or sealed wells. If one or more of the wells, or the DWSMA, is found to be vulnerable, then a more proactive approach to wellhead protection may be required including items such as a contaminant source inventory, enforcement of existing regulations regarding potential contaminant sources, monitoring of potential contaminant sources and public education in addition to development of a contingency plan to be implemented in the event of source water contamination.

This report documents Part I of Redwood Falls' wellhead protection program, prepared in accordance with the rules (Minnesota Rules 4720.5100 to 4720.5580) for preparing and implementing wellhead protection measures for public water supply wells. The next step in this process is to submit this report to the MDH for review and approval. The results described in this report are a group effort involving staff from the City of Redwood Falls, MDH and Liesch Associates, Inc.

2.0 DESCRIPTION OF WATER SUPPLY

Redwood Falls' water supply is currently obtained from five wells that utilize three glacial aquifers. These aquifers consist of sand and gravel outwash deposits sandwiched between glacial till layers and the underlying granitic bedrock.

The uppermost aquifer (A Aquifer) averages about 20 foot in thickness just south of Redwood Falls where it is tapped by the South Ramsey Well. The B Aquifer is deeper and is the aquifer that supplies City Wells 1 and 2. The C Aquifer occurs on top of the granitic bedrock where a northwest- southeast trending channel has been eroded into the bedrock surface. This aquifer is the water source for City Wells 3 and 5.

Locations for the City production wells are shown on **Figures 1** and **2** located in **Appendix B** and the wells are identified by name on **Figure 3** in **Appendix B**. Well and Boring Records for the City's wells are provided in **Appendix C**.

3.0 PHYSICAL SETTING

The topography and landforms of the Redwood Falls area are primarily the result of Wisconsinan glaciation and more recent alluvial processes. Redwood Falls is located at the junction of the Redwood and Minnesota Rivers. Except for these river valleys, the topography can be characterized as a gently rolling plain interrupted by bands of low knobs and ridges. The knobs

and ridges represent glacial moraines and the smooth rolling topography is representative of a glacial till plain.

The City is located at on the southern bank of the Minnesota River approximately midway between the eastern and western boundaries of Redwood County Minnesota. The current City Limits include an area of approximately 2.5 square miles located in part of section 36 of township 113 north, range 36 west; most of section 1 township 112 north, range 36 west; portions of sections 31 and 32 of township 113 north, range 35 west; and fractions of section 6 in township 112 north, range 35west.

The annual average temperature for Redwood Falls is approximately 45^{o} F with average annual precipitation of 26 inches. Drainage of the Redwood Falls area is through the Minnesota River and its tributaries.

3.1 GEOLOGY

An intensive discussion of the geology of the area is included in the report published by the U. S. Geological Survey in 1964: "Geology and Ground-Water Conditions of the Redwood Falls Area, Redwood County, Minnesota." The geology may be summarized as follows: The area is underlain by glacial drift deposits, thin, sporadic remnants of Cretaceous sediments and crystalline bedrock.

Groundwater supplies adequate for municipal use are available only from the glacial drift deposits. Stratified glacial drift is deposited by glacial melt water. Accordingly, the accumulation of clay, silt, sand and gravel in discrete layers or strata occurs in response to the load carrying capacity or energy of the flowing melt water. In contrast, non-stratified glacial drift, which is largely glacial till, is deposited directly by moving ice which forms a tough, compact, heterogeneous mixture of all earth particles ranging in size from boulders to clay or rock flour.

The stratified glacial drift deposits of sand and gravel form the major aquifers in much of Minnesota. The aquifers are characteristically lenticular, sinuous and elongate and as a result are difficult to locate and map by drilling methods alone. Three major glacial drift aquifers have been identified, described and partially tested in the Redwood Falls area.

3.2 HYDROGEOLOGY

The uppermost aquifer has been named the A aquifer. This aquifer occurs at an elevation of approximately 970 feet above sea level to the south and southwest of the City. The A Aquifer

averages about 20 feet in thickness in the area where it is tapped by the South Ramsey Well. The A aquifer thins to the east and southeast and thickens to over 40 feet southwest of the South Ramsey well area.

The B Aquifer occurs at an elevation of approximately 930 feet above sea level. This aquifer maintains a thickness of approximately 50 feet where utilized by City Wells 1 and 2.

The C Aquifer occurs on top of the granitic bedrock where a northwest- southeast trending channel has been eroded into the bedrock surface. This aquifer occurs at an elevation of approximately 850 feet above sea level and is the water source for City Wells 3 and 5. The C Aquifer has an average thickness of 40 feet where present near Redwood Falls. Previous test drilling and aquifer testing confirm that there is a direct hydrologic connection between the B Aquifer and the C Aquifer in the vicinity of City Wells 2, 3 and 5. Geologic cross sections are provided on **Figures 4** and **5** in **Appendix B**, and the lines of section are illustrated on **Figure 3** in **Appendix B**.

4.0 DELINEATION OF THE WELLHEAD PROTECTION AREA

The following discussion presents the values selected to meet the criteria for the delineation of the Redwood Falls Wellhead Protection Area (WHPA). These criteria are specified in Minnesota Rule 4720.

Time of Travel – A 10-year time of travel was selected.

Hydrologic Flow Boundaries – The principal hydrologic flow boundaries of concern in the Redwood Falls area relate to the aquifer geometry, recharge and discharge areas and presence of other high capacity pumping wells. In general, the conceptual models prepared for the Redwood Falls WHPA delineation, treat the three unconsolidated glacial outwash aquifers as separate hydrostratigraphic units. The same characteristics are assigned to the global aquifer in both models. Areas where the glacial aquifers are present are represented by inhomogeneities nested in the global aquifer. The aquifers receive recharge from above with the majority of the discharge occurring along the Minnesota River and a lesser amount discharging to the Redwood River. The recharge is primarily from the infiltration of local rainfall through the overlying strata. Other than the Redwood Falls City Wells, there are two high capacity wells located in the vicinity of the A, B and C Aquifers. One well (MDH 229604) is screened in the A Aquifer and is located approximately 1,000 feet from the South Ramsey Well. The other well (MDH 502652) is screened in the B Aquifer and is located about one half mile south of Well 1.

The thickness and areal extent of each aquifer was inferred from the drilling information available from area wells. In the B and C Aquifer model, there is an area where both the B and C

Aquifers appear to join and form a single hydrologically connected unit. (This hydrologic connection between the B and C aquifers was identified from the B. A. Liesch pumping test conducted at replacement Well 3 during the spring of 1985.) In the area where this connection occurs, the model has one aquifer with an average thickness and thickness weighted hydraulic conductivity of both the B and C Aquifers.

In the A Aquifer model, the B and C Aquifers are not represented since they have no hydraulic effect on the A Aquifer. The need for a second separate model to simulate the hydrologic conditions in the A aquifer was determined by the characteristics of the computer modeling software. The computer model was initiated as a single layer model. Because of this, the polygons used to divide the B and C aquifers into areas with different characteristics interfered with the 10-year and 20-year particle tracking in the A Aquifer. The second model was required to allow the reverse particle tracking to reach the full requested extent.

Daily Volume – Table 1 in **Appendix A** presents the currently active high volume wells (DNR SWUDS database) in the Redwood Falls area of concern. These well locations were pumped at a yearly average rate based upon the highest total yearly volume reported for each active well. **Table 2** in **Appendix A** shows the reported water use for the City of Redwood Falls' wells over a five-year period. The City anticipates that this table also represents the near term future needs for the City. The table also lists the projected outputs in cubic meters per day which are the input units required by the groundwater model. In the A Aquifer model, the South Ramsey Well and well 229604 are the only wells pumping. In the B and C Aquifer model Wells 1, 2 3, 5 and 502652 are the pumping wells.

Groundwater Flow – The regional groundwater flow in the vicinity of Redwood Falls is towards the Minnesota River. Near the Redwood River, local flow is towards the Redwood River. This interpretation is based upon County Well Index static water level information and the generalized contours of the piezometric surface in August of 1953 as illustrated on Plate 4 of the USGS Water Supply Paper 1669-R.

Aquifer Transmissivity – Since the selected groundwater models require a value for hydraulic conductivity rather than a transmissivity value, an aquifer hydraulic conductivity of 3 m/day was utilized for the global aquifer. Hydraulic conductivities of 140 m/day for the A Aquifer, 100 m/day for the B Aquifer, 120 m/day for the C Aquifer and a value of 110 m/day where the B and C Aquifers were present and assumed to be hydrologically connected, were utilized in the inhomogeneities inserted into the global Aquifer to represent the three Glacial outwash aquifers.

These values were chosen based upon pumping tests conducted on the City municipal wells and test wells. The testing was conducted by both the U. S, Geological Survey and Liesch

Associates, Inc. Hydrologic testing conducted on the A Aquifer suggests hydraulic conductivities on the order of 143 to 155 m/day, in the B Aquifer hydraulic conductivities appear to range from 85 to 109 m/day and the C Aquifer exhibits values of 90 to 136 m/day. A compilation of the aquifer parameters that were determined through aquifer testing of the Redwood Falls area glacial aquifers is presented on **Table 3** in **Appendix A**.

4.1 METHODOLOGY

For the purpose of delineation of the wellhead protection area, the glacial aquifers have been represented by two distinct single layer models. The B ands C Aquifers have been modeled together, due to their areal extent and hydrologic connection. A separate model was used to represent the A Aquifer because this aquifer is not hydrologically connected to the B or C Aquifers and thus, does not interact with these deeper aquifers. The separate model was necessary due to the length of the ten and twenty year particle traces. One single layer model could not account for the presence of both the B and C Aquifers together in the same area as the overlying, hydrologically unconnected A Aquifer. The general layout of the B and C model is presented on **Figure 1** in **Appendix B** and the model geometry for the A Aquifer model is provided on Figure **2** in **Appendix B**. Printed copies of both MLAEM model input sets are included in **Appendix F**.

Calibration of the models were accomplished by comparison with the general head values presented in USGS Water Supply Paper 1669-R. Due to the lack of other simultaneously measured water level data sets for the modeled area, the USGS representation was selected as the best available data to use for initial calibration.

The models were run without any wells pumping and the head values from the models were visually compared with the USGS report water level contours. At the completion of calibration, each model illustrated water elevations in general agreement with those provided in the USGS Report. The average stream flow increase between Marshall and Redwood Falls on the Redwood River was examined in an attempt to quantify and compare groundwater discharge into the Redwood River. The method did not aid in calibration due to the large variations in geology along the Redwood River and the inability of the model to create significant variations in the Redwood River discharge values through supportable alterations to the recharge rates and hydraulic conductivities in the aquifers. The method of calibration used for these models is rather crude. In order to account for this, a plus and minus 10 degree change was subsequently applied to the model flow direction.

MLAEM developmental Version 5.1.08 developed by Strack Consulting was used to create and the run the Redwood Falls models. After calibration, the maximum yearly values reported for

each of the two active appropriations permitted wells in the Redwood Falls area (SWUDS data base) were divided by 365 days and this rate applied as the continuous daily pumping rate to each active well. The Redwood Falls City Wells were pumped at the pumping rates selected for the capture zone determination. In the B and C model, Redwood Falls wells 1, 2, 3 and 5 along with SWUDS well 502652 were pumped at their applicable rates. In the A Aquifer model only the South Ramsey well and SWUDS well 229604 were pumping. Each model was run to delineate the one year, ten year and twenty year capture zones for the Redwood Falls wells.

The capture zones were identified for each of the Redwood Falls wells by utilizing reverse particle tracking techniques. The one year, ten year and twenty year capture zones were plotted. These capture zones are illustrated on **Figures 6** and **7** in **Appendix B**. The ten year capture zones were then adjusted for uncertainty (as discussed in the uncertainty analysis) and subsequently utilized to generate the Wellhead Protection Areas as shown on **Figure 8** in **Appendix B**. Adjusted one-year capture zones were created and used to determine the Emergency Management Zones (EMZ) for each Redwood Falls well and the adjusted Wellhead Protection Areas were enclosed within the Drinking Water Supply Management Area shown on **Figure 9**.

4.2 UNCERTAINTY ANALYSIS

An uncertainty analysis was conducted to determine each model's sensitivity to changes in aquifer parameters. Preliminary runs of the models indicate that the models are most sensitive to flow field created to match the initial water level conditions. Because of insufficient data available from the County Well Index or any other available sources, the interpretation of water levels presented in the 1964 U.S. Geological Survey water supply paper 1669-R were utilized. This data is old and most likely does not accurately portray the situation as it exists today. In addition, the U. S. Geological Survey paper assumes that all three aquifers exhibit the same potentiometric surface.

The capture zones are directly influenced by the hydraulic conductivity, thickness and areal extent assigned to each aquifer polygon. After reviewing the pumping test information and reports, the most likely values were selected for the aquifer hydraulic conductivities based upon the significant data base of pumping test information. Aquifer thicknesses were plotted at each County Well Indexed well whose location could be identified to the quarter section or smaller areal unit. The sand and gravel aquifers were correlated throughout the Redwood Falls area and average thicknesses were selected for each aquifer polygon based upon the aquifer thickness exhibited in each polygon area.

In order to compensate for the uncertainty evident in the Redwood Falls aquifer models, the 10-

year capture zones have been adjusted by including a 10 degree variance to both the east and west in the 10 year reverse particle tracking from each well. The additional area resulting from this adjustment has been added to the model defined capture zone. The adjustment made to the capture zones to compensate for the aforementioned uncertainty is shown on **Figure 8** in **Appendix B**.

In addition, the lack of specific stratigraphic information in some areas south of Redwood Falls limits the accuracy to which the extent of the glacial aquifers can be defined. The City should make efforts to collect information from any new wells or test holes drilled in the vicinity of the DWSMA. This information can then be utilized to make adjustments to the vulnerability area boundaries as necessary.

5.0 DRINKING WATER SUPPLY MANAGEMENT AREA DELINEATION

The Drinking Water Supply Management Areas (DWSMA) for the adjusted 10-year time of travel WHPA is shown on **Figure 9**. This DWSMA incorporates all of the ten year capture areas and the adjustments for uncertainty addressed in the previous section. The area was delineated using transportation corridors, surface water bodies, United States public land survey units and other criteria as defined by the wellhead protection rule.

6.0 VULNERABILITY ASSESSMENT

This section documents the vulnerability assessments for the Redwood Falls' municipal production wells and the DWSMA delineated to encompass the 10-year time of travel WHPAs. This assessment has been performed in accordance with Minnesota Rule 4720.5210 for preparing and implementing wellhead protection measures for public water supply wells.

The vulnerability of the Redwood Falls production wells was determined by evaluating available information on the geology, well construction and groundwater chemical and isotope concentrations. This information was then compared to the vulnerability criteria specified in Minnesota Rule 4720.5550.

The vulnerability of the DWSMA has been determined by evaluating the geologic conditions within the Redwood Falls area with particular emphasis upon the continuity of the three individual glacial outwash aquifers identified in U. S. Geological Survey Water Supply Paper 1169-R. Reviews of previously published reports, County Well Index stratigraphic information and Liesch Associates, Inc. pumping test reports along with the radiological composition of the

aquifer waters and Chapters 1 and 3 of the DWSMA Vulnerability Assessment Guidance Document, have been instrumental in the determination of the DWSMA vulnerability.

6.1 WELL VULNERABILITY ASSESSMENT

Redwood Falls South Ramsey and Well 5 are considered "Vulnerable". These wells exhibited elevated tritium values when sampled by the Minnesota Department of Health (MDH). The laboratory results reported tritium concentrations of 1.2 and 1.3 tritium units at South Ramsey and Well 5, respectively. Redwood Falls' Wells 1, 2 and 3 have not been sampled for tritium. At present MDH has preliminarily scored these wells as "Not Vulnerable".

The available Well and Boring Records for each of the Redwood Falls production wells were reviewed to determine well construction and the composition of the strata encountered during the drilling of each well. The South Ramsey well geology was inferred from surrounding well information. The materials encountered during drilling indicate the presence of significant thicknesses of lower permeability confining layers at the locations of all of the wells. All of the Redwood Falls production wells appear to meet current MDH well code. Copies of the Redwood Falls Well and Boring Records are included in **Appendix C**.

Nitrate has been identified at low concentrations in Wells 1 and 5. Well 1 had a reported nitrate concentration of 1.5 mg/L and Well 5 exhibited a concentration of 0.5 mg/L. Both of these concentrations are significantly below the Federal Drinking Water Standard of 10 mg/L. As previously mentioned, the MDH has analyzed water samples from the Ramsey well and Well 5 for tritium content. Both of these wells had a tritium present indicating recharge from waters with a surface exposure more recent than 1953. Wells 1, 2 and 3 have not yet been tested for the presence of a detectable tritium. In the future, tritium testing could be conducted at these wells to substantiate their vulnerability.

Copies of the MDH 2002 well vulnerability ratings with available tritium analysis results are included in **Appendix D**. At present, the City has no additional information that warrants changing the MDH assessments.

6.2 DRINKING WATER SUPPLY MANAGEMENT AREA VULNERABILITY ASSESSMENT

The Redwood Falls Wellhead Protection Plan identifies one distinct DWSMA. The DWSMA has been assessed on the basis of area well logs, cross sections of geologic logs from wells located within the WHPA, previous test drilling conducted by the City and the radiological analyses performed by MDH. Methods outlined in the MDH Guidance Document: "Assessing Well and Aquifer Vulnerability for Wellhead Protection" were applied to assess DWSMA vulnerability.

The Redwood Falls DWSMA has been assigned a "Moderate Vulnerability". The DWSMA area exhibits confining clay layers in excess of 50 feet in thickness, however, because of the presence of the tritium isotope in water from Well 5 and the South Ramsey well, the DWSMA has been assigned a moderate rather than low vulnerability.

6.3 RECOMMENDATIONS

At present, Wells 1, 2 and 3 have not been tested for tritium content. It is recommended that the MDH conduct tritium sampling at these three wells so that the degree of vulnerability can be verified.

Based on the results of the current WHPA and DWSMA delineation and vulnerability assessment, Part II of Redwood Falls' Wellhead Protection Plan should address "Moderately Vulnerable" areas by the identification of existing underground storage tanks, wells, large sewer systems, cesspools and automotive disposal systems. Wellhead protection in this area should include monitoring the status of any reported underground storage tank releases in this area and the identifying and properly sealing of abandoned wells that could provide a conduit for potential contaminants to reach the aquifer.

The WHPA delineation conducted for this report was prepared using two calibrated steady-state, single-layer analytic element models (MLAEM). Pumping rates and locations for high volume pumping wells were computed from the State Water Use Data System (SWUDs) database. While this database may currently be the best source of information, the information is sometimes in error and not always current. When the Redwood Falls models are updated, the available data bases should be assessed to determine if more accurate high volume well locations and pumping rates are available at that time.

As Redwood Falls continues to operate, maintain and expand its water supply system, information from any newly identified wells located near and within the DWSMA should be collected. Data concerning the geology, static and pumping water levels and any hydraulic testing should be collected and compiled for use in future model adjustments and calibrations. Any pumping test procedures conducted at existing or future wells should also include detailed water level measurements at available wells to facilitate calculation of aquifer parameters.

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APPENDIX A

TABLE 1: ACITVE APPROPRIATIONS PERMITS NEAR REDOWWD FALLS

Use	Township	Range	Section	QQQQ	Well Unique	Source Aquifer	---- Permitted ---- Acres	GPM	MGY	2001	2002	2003	2004	2005	Status	Highest in 5 Yrs	Daily Rate (gpm)	Daily Rate (m^3/day)
285	112	36	12	BAC	229604	QBAA	10	250	3.3						1	3,300,000	6.3	34
290	112	36	25	BDA	502652	QBAA	60	300	19.6						1	19,600,000	37.3	203

TABLE 2: SUMMARY OF REPORTED PUMPING

Well	Unique No	2001	2002	2003	2004	2005	2006	Highest in 5 Yrs	Daily Rate (gpm)	Daily Rate (m^3/day)
RF-1	209660		71,300,000	67,400,000	64,600,000	63,900,000	35,199,800	71,300,000	135.7	739
RF-2	209659		35,800,000	28,100,000	36,800,000	33,600,000	33,382,000	36,800,000	70.0	382
RF-3	403955		59,300,000	66,000,000	62,500,000	54,300,000	58,590,000	66,000,000	125.6	684
RF-5	403995		41,800,000	41,100,000	37,100,000	37,000,000	65,365,320	65,365,320	124.4	678
RF-Ramsey	241414		13,400,000	13,900,000	12,700,000	11,400,000	12,933,000	13,900,000	26.4	144
	Total		221,600,000	216,500,000	213,700,000	200,200,000	205,470,120	253,365,320		

TABLE 3: AQUIFER PARAMETERS FROM LITERATURE AND CITY PUMPING TESTS

SOURCE	AQUIFER	PARAMETER	MOST LIKELY	PUMPING RATE
Publication				
	A	Transmissivity Storativity	70,000 g/d/ft 7.0×10^{-4}	823 gpm
USGS Water Supply Paper 1669-R	B	Transmissivity Storativity	126,000 g/d/ft 2.5×10^{-4}	360 gpm
	C	Transmissivity Storativity	126,000 g/d/ft 2.0×10^{-4}	520 gpm
Pumping Test at				
City Well T2	A	Transmissivity Storativity	76,000 g/d/ft 1.8×10^{-4}	198 gpm
City Well T5	C	Transmissivity Storativity	120,000 g/d/ft 6.3×10^{-4}	198 gpm
City Well 1	B	Transmissivity Storativity	134,000 g/d/ft	360 gpm
City Well 2	B	Transmissivity Storativity	132,000 g/d/ft	500 gpm
City Well 3	B & C	Transmissivity Storativity	100,000 g/d/ft	1100 gpm
City New Well 2	B	Transmissivity Storativity	127,000 g/d/ft 5.0×10^{-4}	750 gpm
City New Well 3	B & C	Transmissivity Storativity	>75,000 g/d/ft	690 gpm
City Well 5	C	Transmissivity Storativity	150,000 g/d/ft 1.3×10^{-3}	1090 gpm

APPENDIX B

Legend

- City Wells
- Elevation Control
- Area Wells
- Far Field Controls
- B & C Aquifer Polygons

A

B

C

B & C

N
W E
S

0 2 4 6 8 10

Miles

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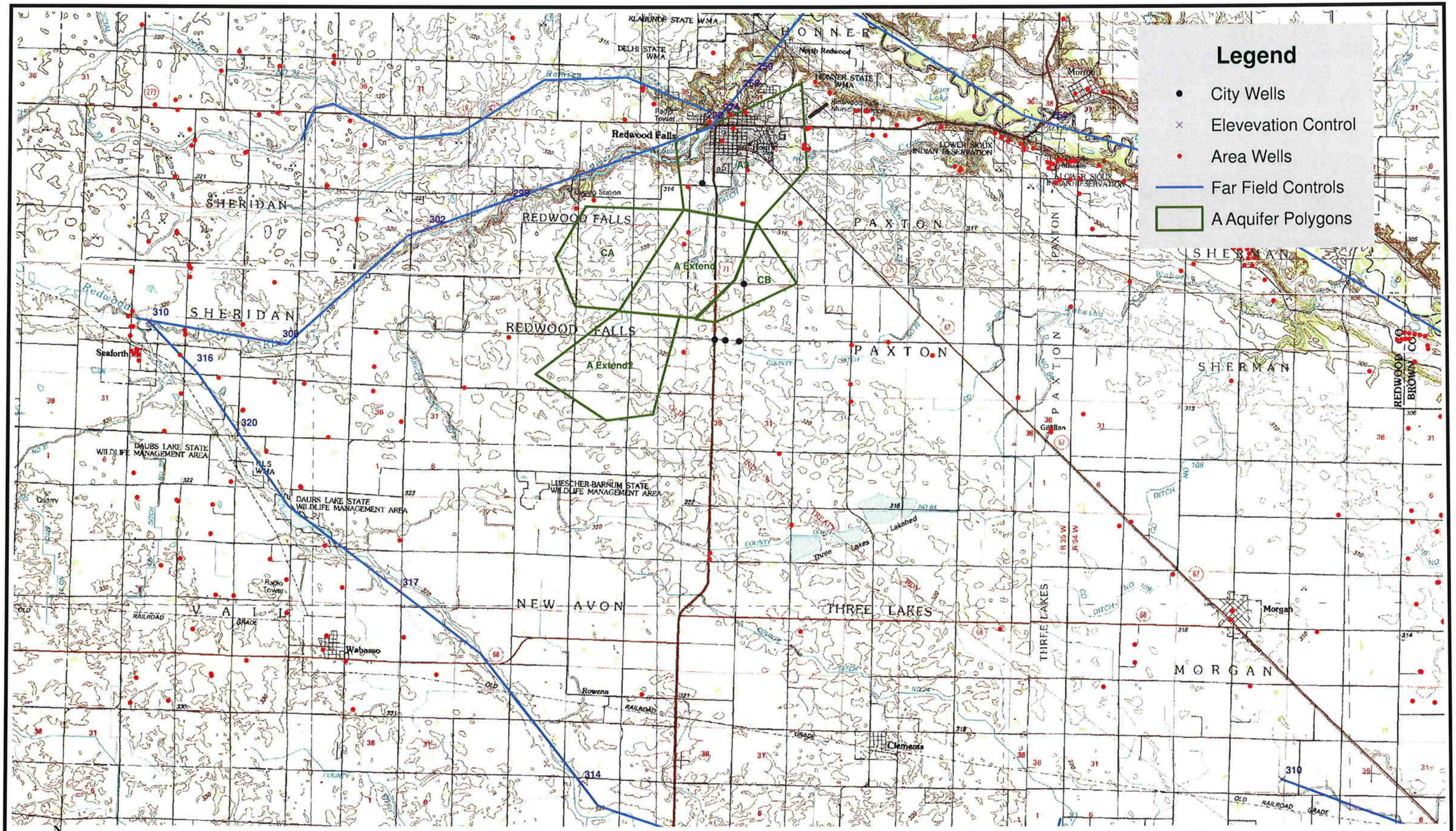
CONCEPTUAL HYDROGEOLOGIC MODEL
B & C AQUIFERS

FIG. 1



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CONCEPTUAL HYDROGEOLOGIC MODEL A AQUIFER

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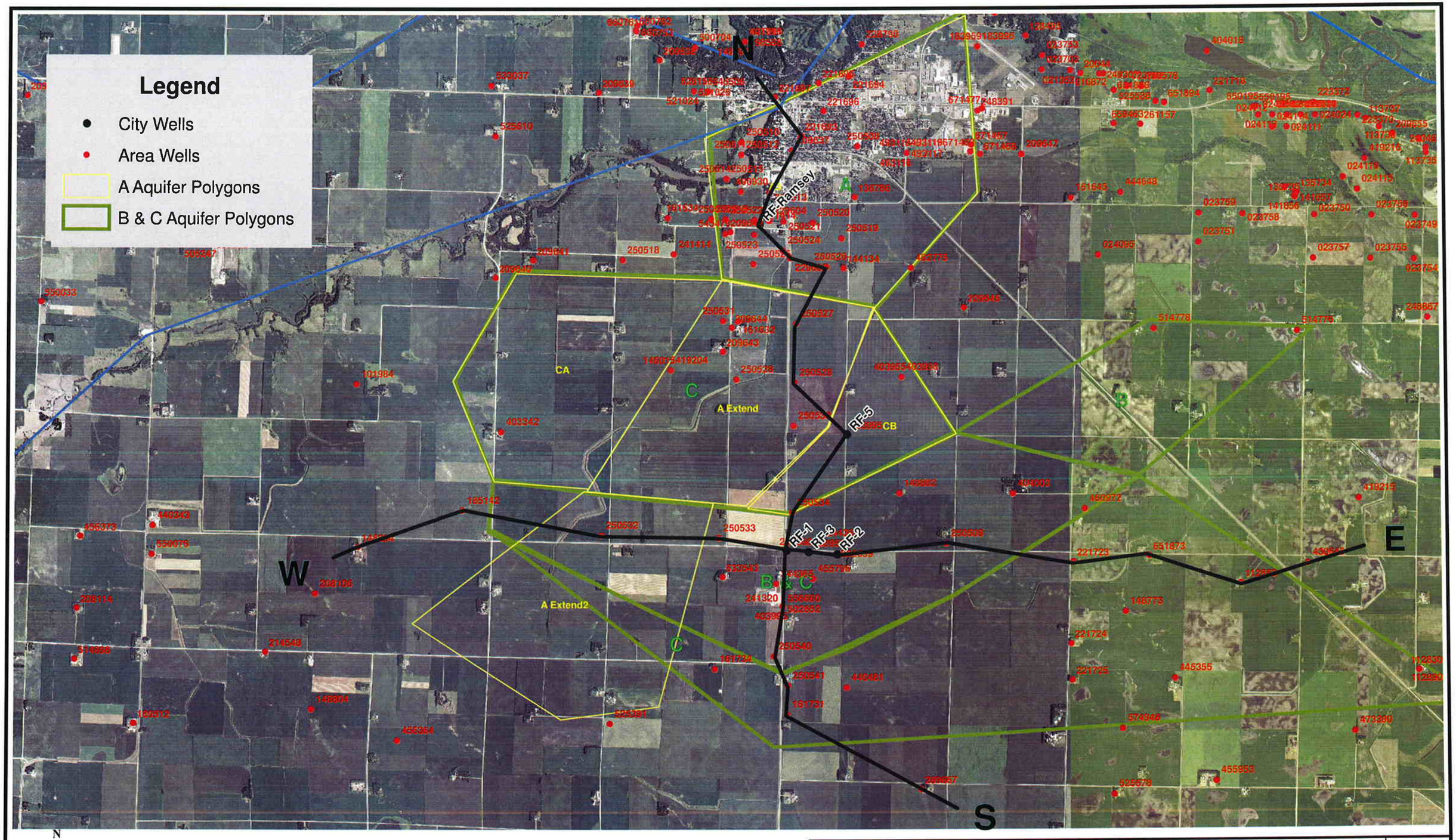
FIG. 2



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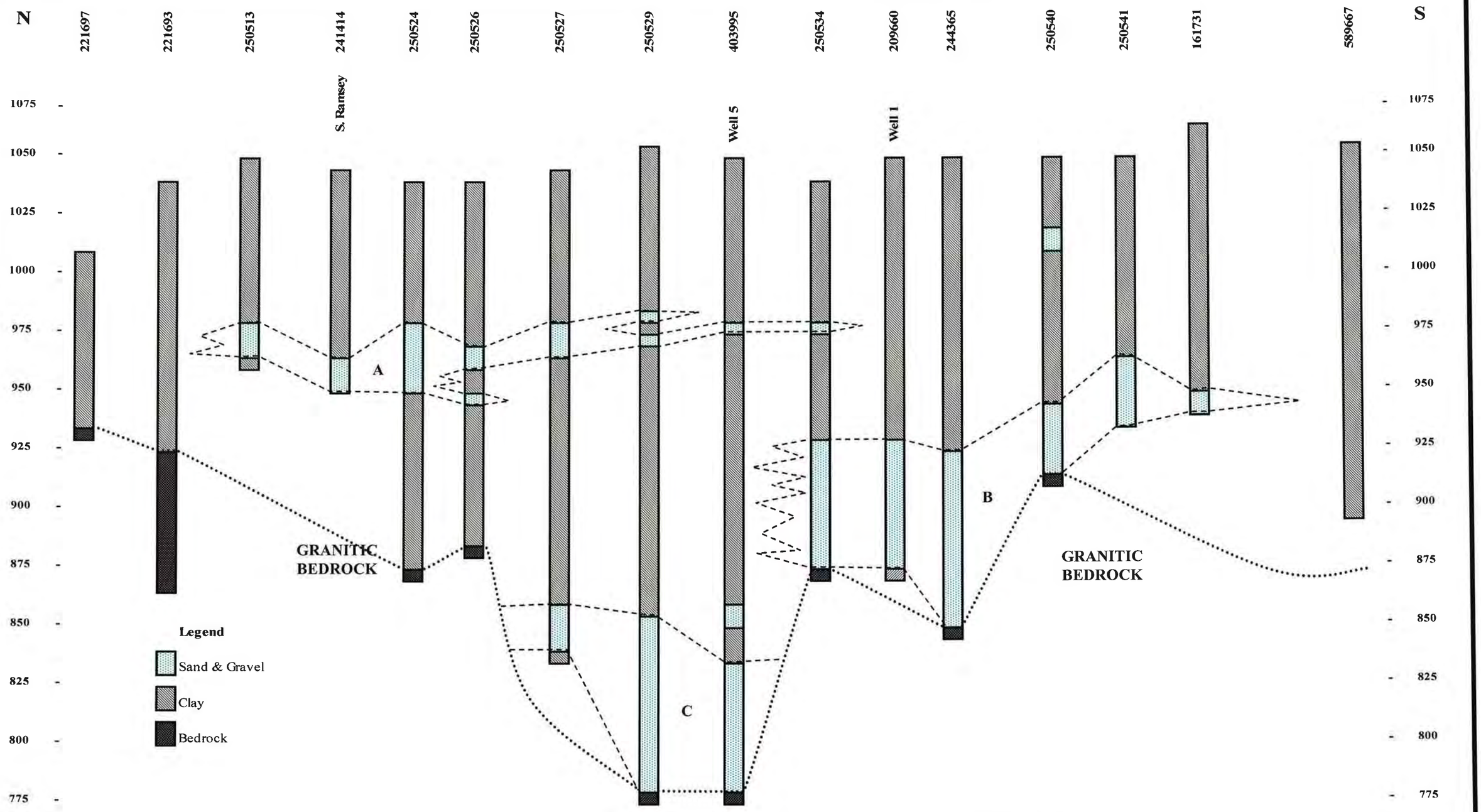
CROSS SECTION LOCATION MAP

FIG. 3



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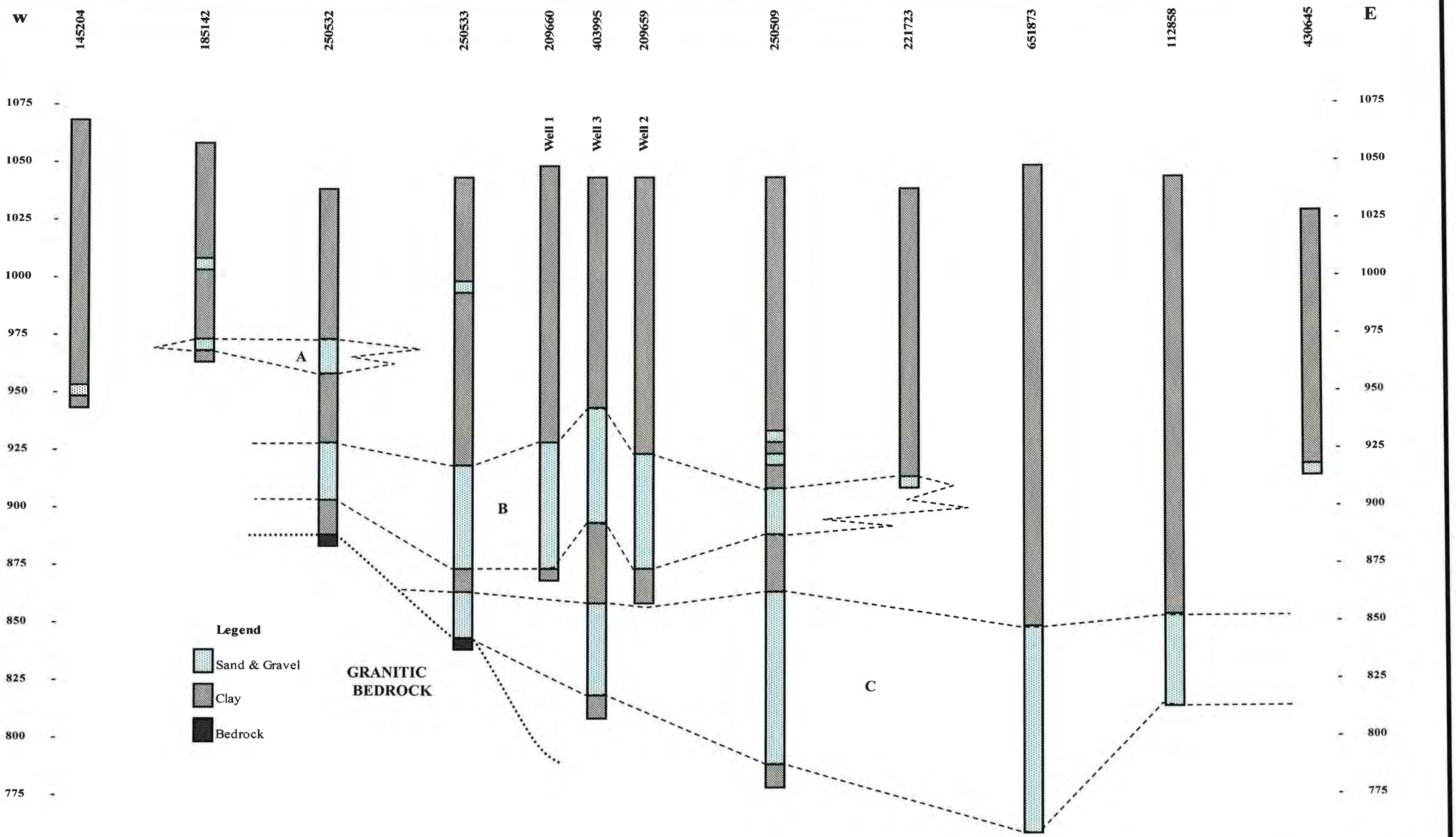
13400 15th Avenue N Minneapolis, MN 55441 (763) 489-3100
4300 N Miller Rd, Suite 211 Scottsdale, AZ 85251 (480) 421-0853

CITY OF REDWOOD FALLS, MN

NOV 07

GEOLOGIC X-SECTION N - S

FIG. 4



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4300 N Miller Rd, Suite 211, Scottsdale, AZ 85251, (480) 421-0853

CITY OF REDWOOD FALLS, MN

NOV 07

GEOLOGIC X-SECTION W - E

FIG. 5

Legend

- Potentiometric Surface Contour
- 1-Year Capture Zone
- 10-Year Capture Zone
- 20-Year Capture Zone
- B & C Aquifer Polygons

N
W E
S

0 1 2 3 4 5
Miles

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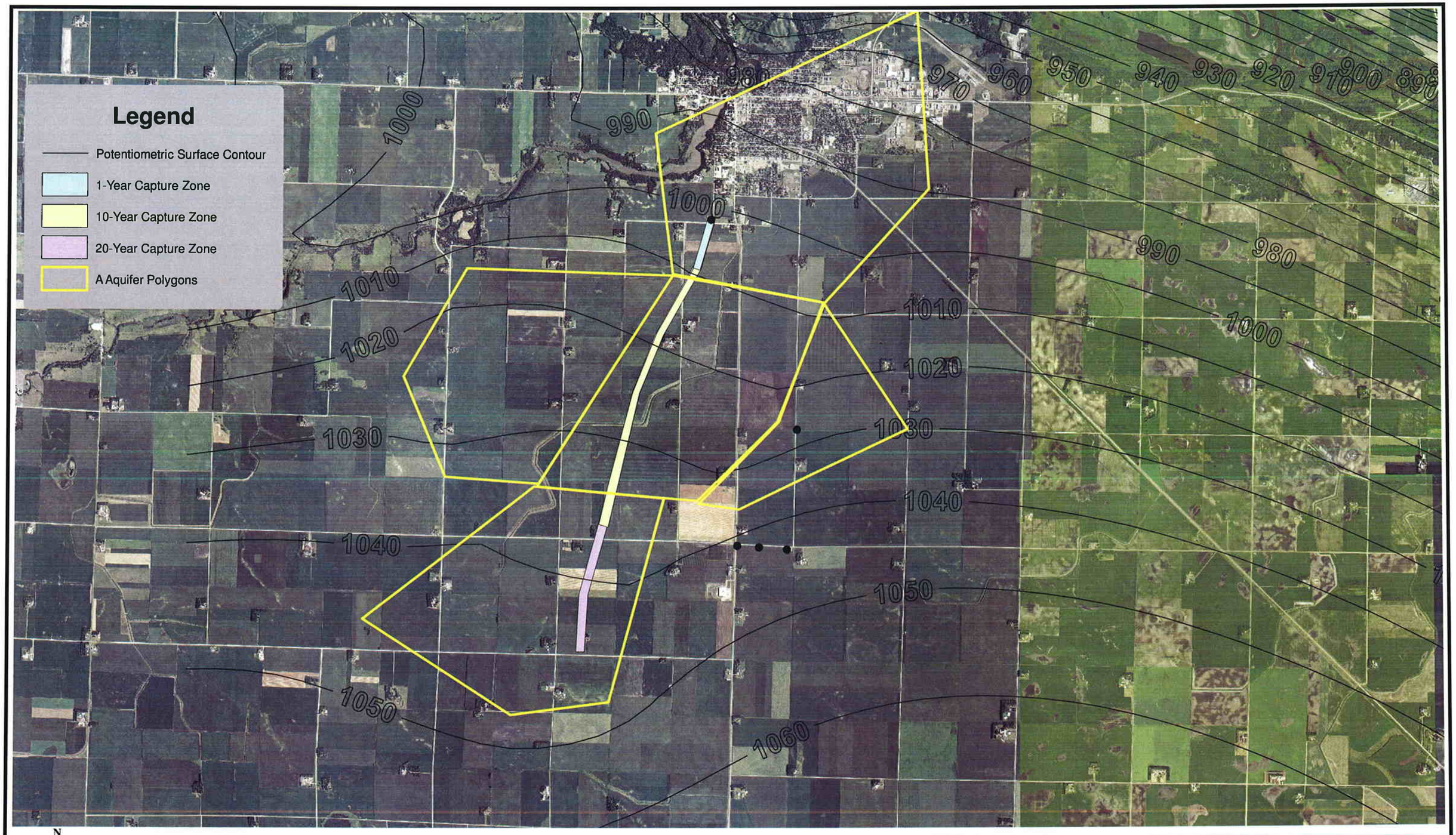
B & C AQUIFERS
1, 10 and 20 YEAR CAPTURE ZONES

FIG. 6



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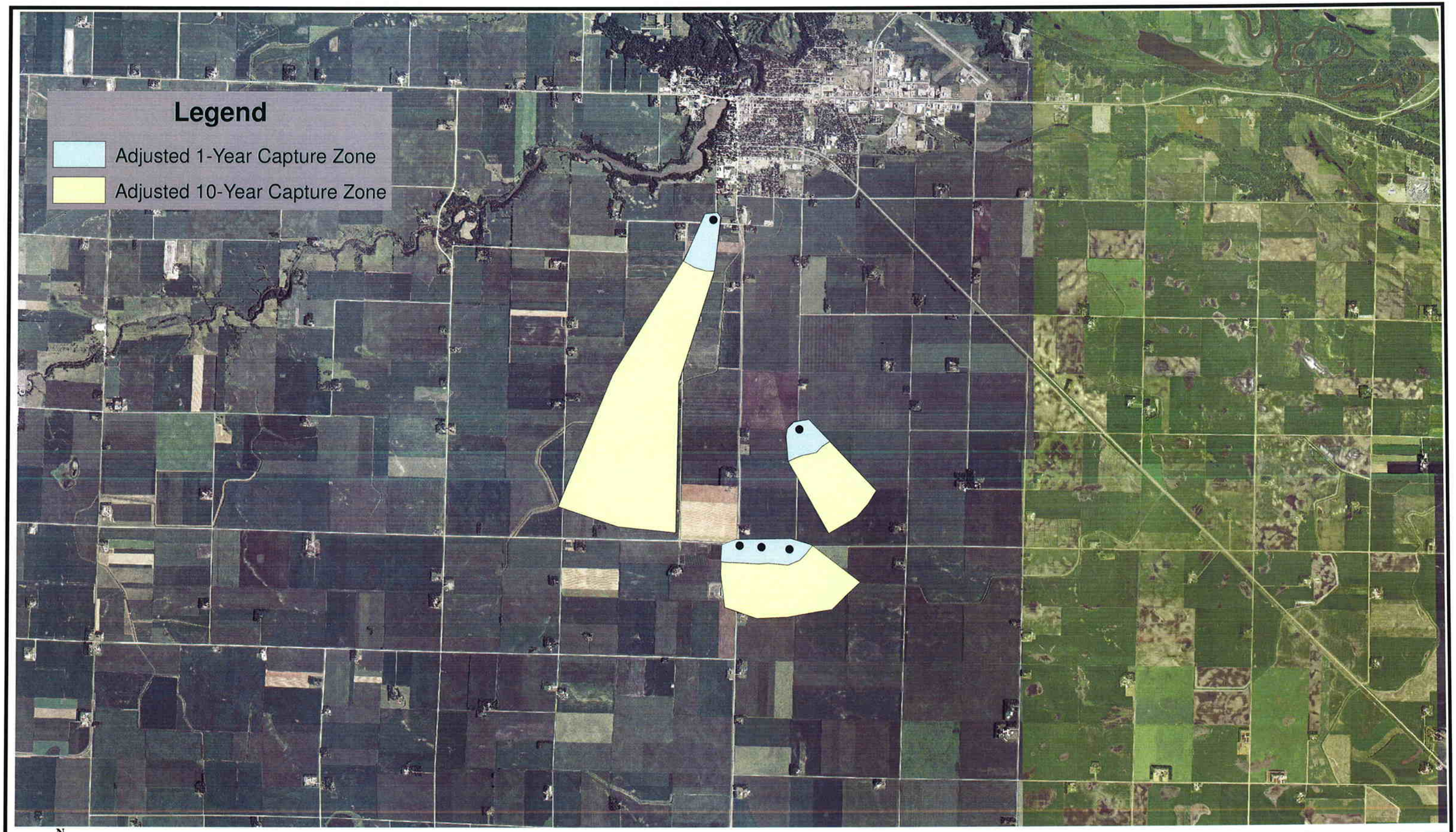
A AQUIFER
1, 10 and 20 YEAR CAPTURE ZONES

FIG. 7



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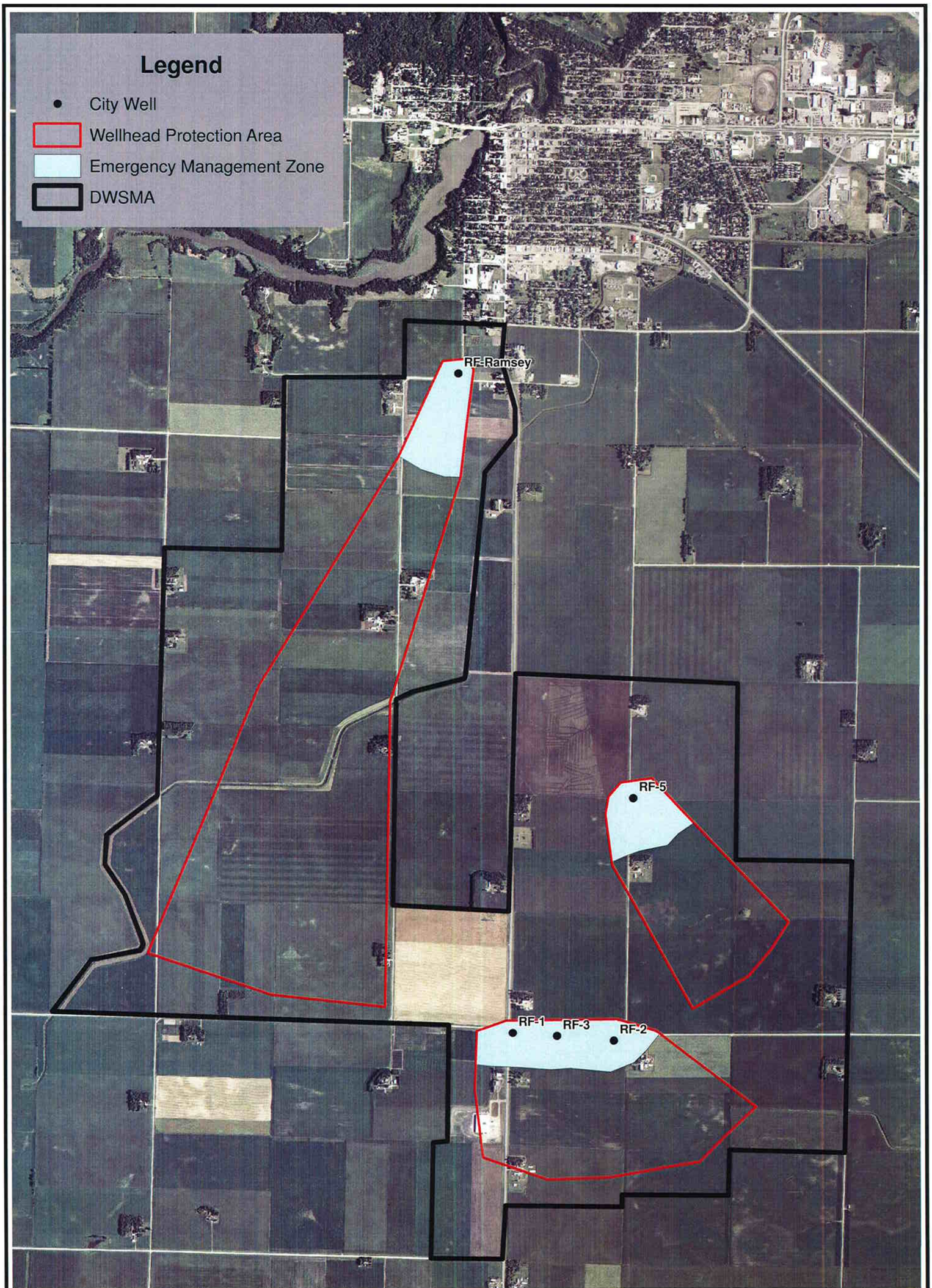
CAPTURE ZONES ADJUSTED FOR UNCERTAINTY

FIG. 8



N
W E
S

0 2,000 4,000 6,000 8,000 10,000

Feet

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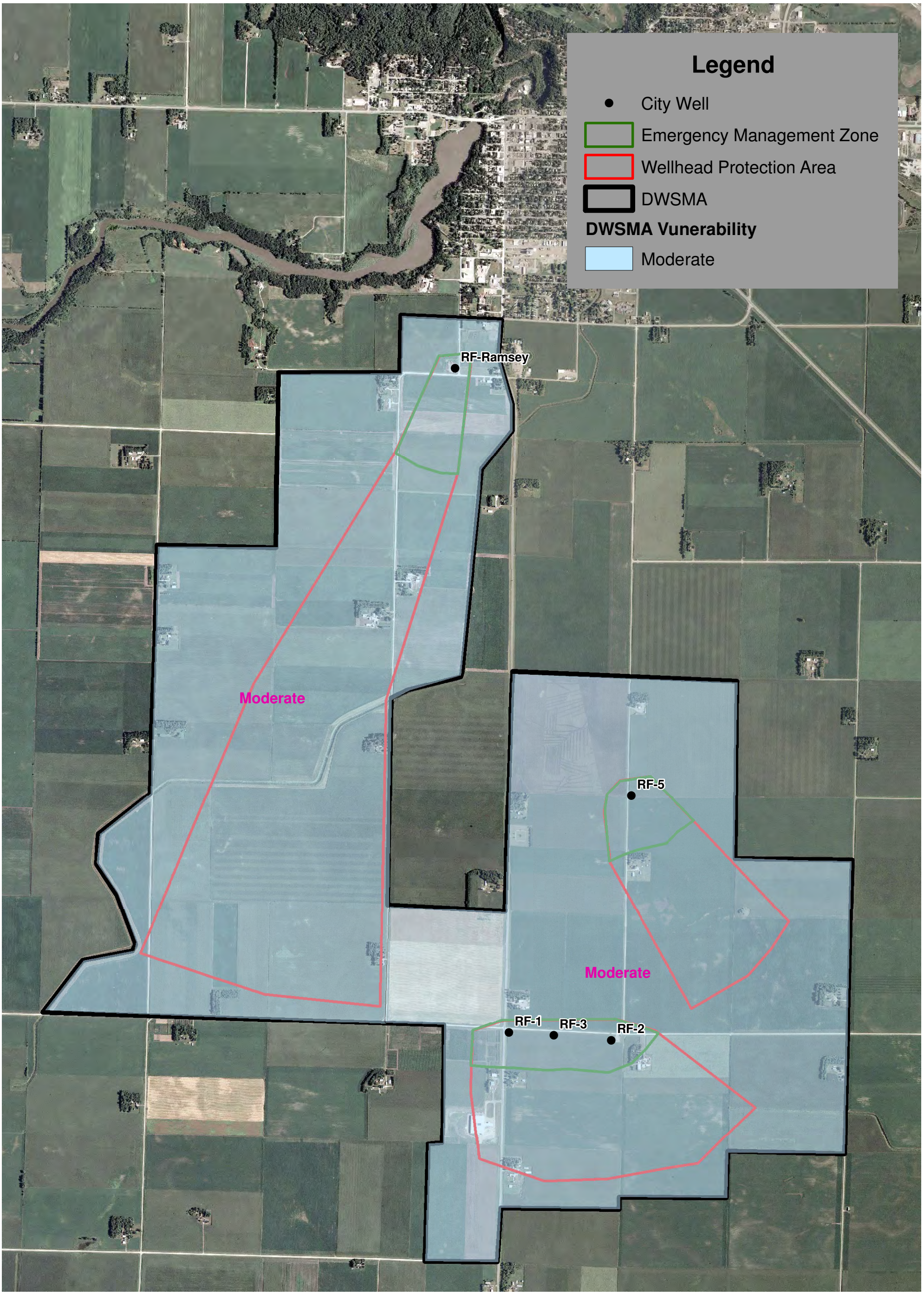
CITY OF REDWOOD FALLS

NOV 07

WELLHEAD PROTECTION AREAS
WITH DWSMA AND EMZS

FIG. 9



N
W E
S

0 2,000 4,000 6,000 8,000 10,000
Feet

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CITY OF REDWOOD FALLS

NOV 07

DWSMA WITH VUNERABILITY AREAS

FIG. 10

APPENDIX C

TABLE 3-1

WELL CONSTRUCTION AND OPERATING DATA

	Well 0	Well 1	Well 2	Well 3
Location	South edge of City, 1/4 mi. west of Hwy. 71	3 mi. south of City on Hwy. 71	3 mi. south, 1/2 mi. east of Hwy. 71	3 mi. south, 1/4 mi. east of Hwy. 71
Completed	6/50	8/54	12/56	5/71
Depth	90'	180'	185'	231'
Casing				
Diameter	12"	12"	12"	16"
Length	78'	140'	145'	140'
Screen				
Diameter	12" Tel.	12" Tel.	12" Tel.	8"
Length	12'	40'	40'	91'
Slot size (0.001 in.)	2'-40, 3'-100, 6'-125	10'-60, 30-40	5'-50, 15'-30, 20'-25	30
Material	SS	Everdur	Everdur	SS
Inlet Capacity (gpm)[1]	700	1,660	1,500	1,960
Upflow capacity (gpm)[2]	1,320	1,320	1,320	540
Static Water Level	61'	65'	55'	52'
Existing Pumping				
Level (10 min.)	78'	78'	102'	109'
Rate (gpm)	200	510	500	760
Specific Capacity (10 min.)(gpm/ft.)	11.8	39.2	10.6	13.3
Original Sp. Cap. (1 day)(gpm/ft.)	24.3	34.3		17.2
Pump				
Type	LST[3]	LST[3]	ST[4]	LST[3]
Make & Model		Berkeley 1003LM	Berkeley 753M3	Berkeley 1003M
Column or Drop Pipe				
Diameter		6"	5"	8"
Length		100'	115'	100'
Motor				
Horsepower	10	25	25	100
Miscellaneous Comments	Naturally developed Acidized in 1970	Acidized 6/70, pump installed 6/70, originally test pumped at 1,200 gpm	Acidized 5/70, pump installed 6/71, new bowls 2/73, new motor in 1978, new motor 4/81	Gravel packed, pump pulled 10/73

[1]Based on 0.1 fps inlet velocity [2]Based on 5 fps upflow velocity [3]Line shaft turbine [4]Submersible turbine

Unique No. 00241414

County Name Redwood

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 2002/01/08

Entry Date 1992/08/25

Township Name	Township	Range	Dir	Section	Subsection
	112	36	W	11	

Well Depth 94 ft. | Depth Completed 94 ft. | Date Well Completed 1950/00/00

Well Name REDWOOD FALLS SO. RAMSEY

Drilling Method

Contact's Name REDWOOD FALLS SO. RAMSEY

REDWOOD FALLS MN 56283

Drilling Fluid

Well Hydrofractured? ☐ Yes ☐ No

From ft. to ft.

Use Community Supply (municipal)

Casing Drive Shoe? ☐ Yes ☐ N

Hole Diameter

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
NO RECORDS			0	94

Screen

Open Hole From ft. to ft.

Make Type

Static Water Level ft. from Date

PUMPING LEVEL (below land surface)

ft. after hrs. pumping g.p.m.

Well Head Completion

Pitless adapter mfr Model

Casing Protection ☐ 12 in. above grade

☐ At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination

ft. direction type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed

Mfr name

Model HP Volts

Drop Pipe Length ft. Capacity g.p.m

Type

Any not in use and not sealed well(s) on property? ☐ Yes ☐ No

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

USGS Quad: Elevation 1045

Aquifer: Alt Id: 54-0268

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. MDH

License Business Name

Name of Driller

Report Copy

HE-01205-06 (Rev. 9/96)

Unique No. 00209660

County Name Redwood

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 2002/01/08

Entry Date 1988/04/17

Township Name	Township	Range	Dir	Section	Subsection
	112	36	W	25	ABBBBD

Well Depth 182 ft. **Depth Completed** 180 ft. **Date Well Completed** 1954/00/00

Well Name REDWOOD FALLS 1

Drilling Method

Contact's Name REDWOOD FALLS 1

REDWOOD FALLS MN

Drilling Fluid

Well Hydrofractured? ☐ Yes ☐ No

From ft. to ft.

Use Community Supply (municipal)

Casing **Drive Shoe?** ☐ Yes ☐ N

Hole Diameter

Casing Diameter **Weight(lbs/ft)**

12 in. to 140 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
TOPSOIL	BLACK		0	2
CLAY	YELLO		2	22
CLAY	BLUE		22	52
COARSE SAND & GRAVEL			52	54
CLAY	BLUE		54	122
COARSE SAND & GRAVEL			122	182
CLAY	BLUE		182	182

Screen Y **Open Hole** From ft. to ft.

Make JOHNSON Type

Diameter	Slot	Length	Set		Fitting
0	40	40	140 ft. to 180 ft		

Static Water Level 66 ft. from Land surface Date /19/84

PUMPING LEVEL (below land surface)

74 ft. after hrs. pumping g.p.m.

Well Head Completion

Pitless adapter mfr Model

Casing Protection ☐ 12 in. above grade

☐ At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination

ft. direction type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed Y

Mfr name

Model HP Volts

Drop Pipe Length ft. Capacity 400 g.p.m

Type T

Any not in use and not sealed well(s) on property? ☐ Yes ☐ No

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

REMARKS, ELEVATION, SOURCE OF DATA, etc.

NURE NO. 601013.

USGS Quad: Clements Elevation 1052

Aquifer: QBAA Alt Id: 54-0268

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 08317

License Business Name

Name of Driller FREDERICKSON

Report Copy

HE-01205-06 (Rev. 9/96)

Unique No. 00209659

County Name Redwood

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 2002/01/08

Entry Date 1988/04/17

Township Name	Township	Range	Dir	Section	Subsection
	112	36	W	25	AAAAAC

Well Depth		Depth Completed		Date Well Completed
184	ft.	170	ft.	1957/00/00

Well Name REDWOOD FALLS 2

Drilling Method

Contact's Name REDWOOD FALLS 2

REDWOOD FALLS MN

Drilling Fluid

Well Hydrofractured? ☐ Yes ☐ No

From ft. to ft.

Use Municipal

Casing **Drive Shoe?** ☐ Yes ☐ N

Hole Diameter

Casing Diameter **Weight(lbs/ft)**

12 in. to 130 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
TOPSOIL	BLACK		0	2
CLAY	YELLO		2	18
CLAY	BLUE		18	100
SANDY CLAY	BLUE		100	118
SAND			118	172
CLAY	BLUE		172	184

Screen Y

Open Hole From ft. to ft.

Make JOHNSON Type R

Diameter	Slot	Length	Set		Fitting
0	40	40	130	ft. to 170 ft	

Static Water Level 50 ft. from Land surface Date /19/57

PUMPING LEVEL (below land surface)

ft. after hrs. pumping g.p.m.

Well Head Completion

Pitless adapter mfr Model

Casing Protection ☐ 12 in. above grade

☐ At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? ☐ Yes ☐ No

Nearest Known Source of Contamination

ft. direction type

Well disinfected upon completion? ☐ Yes ☐ No

Pump ☐ Not Installed Date Installed Y

Mfr name

Model HP Volts

Drop Pipe Length ft. Capacity 300 g.p.m

Type S

Any not in use and not sealed well(s) on property? ☐ Yes ☐ No

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

USGS Quad: Clements Elevation 1043

Aquifer: QBAA Alt Id: 54-0268

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 08317

License Business Name

Name of Driller FREDERICKSON,

Report Copy

HE-01205-06 (Rev. 9/96)

Unique No. 00403995

County Name Redwood

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 2001/11/01

Entry Date 1992/08/25

Township Name	Township	Range	Dir	Section	Subsection
	112	36	W	25	

Well Name REDWOOD FALLS 5

Contact's Name REDWOOD FALLS # 3

REDWOOD FALLS MN 56283

Well Depth	Depth Completed	Date Well Completed
240 ft.	230 ft.	1985/05/21

Drilling Method Non-specified Rotary

Drilling Fluid

Well Hydrofractured? ☐ Yes ☐ No

From ft. to ft.

Use Municipal

Casing Drive Shoe? ☐ Yes ☑ N

Hole Diameter

Casing Diameter				Weight(lbs/ft)
12	in. to	189	ft	49.56

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
TOPSOIL	BLACK	SOFT	0	1
CLAY	GRY-Y	SOFT	1	12
CLAY	YEL-G	SOFT	12	15
CLAY STICKY	GRN-B	SOFT	15	18
CLAY	BLUE	SOFT	18	27
CLAY & GRAVEL	BLUE	SOFT	27	30
SANDY CLAY	D.BLU	M.SOFT	30	60
SANDY CLAY	D.BLU-	M.HARD	60	64
GRAVEL		M.SOFT	64	66
CLAY	D.BLU-	M.HARD	66	92
ROCKY CLAY		HARD	92	93
SILT	GRAY	M.HARD	93	105
GRAVEL & SAND		SOFT	105	115
SAND & GRAVEL		SOFT	115	132
FINE SILTY SAND STICKY		SOFT	132	146
SILT SILT CLAY STICKY		SOFT	146	157
SANDY CLAY	GRAY	M.HARD	157	181
SAND & CLAY FINE			181	218
SAND & GRAVEL COARSE		MEDIUM	218	231
CLAY	YELLO	M.HARD	231	240

Screen Y

Open Hole From ft. to ft.

Make JOHNSON Type L

Diameter	Slot	Length	Set		Fitting
10	20	47	187 ft. to 230 ft		

Static Water Level 49 ft. from Land surface Date 1985/05/28

PUMPING LEVEL (below land surface)

103.07 ft. after 75.5 hrs. pumping 1050 g.p.m.

Well Head Completion

Pitless adapter mfr Model

Casing Protection ☑ 12 in. above grade

☐ At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? ☑ Yes ☐ No

Material	From	To (ft.)	Amount(yds/bags)	
G	0	187	7	Y

Nearest Known Source of Contamination

ft. direction type

Well disinfected upon completion? ☑ Yes ☐ No

Pump ☑ Not Installed Date Installed N

Mfr name

Model HP Volts

Drop Pipe Length ft. Capacity g.p.m

Type

Any not in use and not sealed well(s) on property? ☐ Yes ☐ No

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

USGS Quad: Elevation

Aquifer: Alt Id: 54-0268

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 65252

License Business Name

Name of Driller ERVIN, D.

Report Copy

HE-01205-06 (Rev. 9/96)

Unique No. 00403955

County Name Redwood

MINNESOTA DEPARTMENT OF HEALTH

WELL AND BORING RECORD

Minnesota Statutes Chapter 1031

Update Date 2001/11/01

Entry Date 1992/08/25

Township Name	Township	Range	Dir	Section	Subsection
	112	35	W	18	

Well Depth 274 ft. | Depth Completed 268 ft. | Date Well Completed 1984/05/16

Well Name REDWOOD FALLS 3-B

Drilling Method Non-specified Rotary

Contact's Name REDWOOD FALLS ~~3-B~~ 5

REDWOOD FALLS MN 56283

Drilling Fluid

Well Hydrofractured? ☐ Yes ☐ No

From ft. to ft.

Use Community Supply (municipal)

Casing Drive Shoe? ☐ Yes ☑ N

Hole Diameter in. to 215 ft

Casing Diameter Weight(lbs/ft)

16 in. to 220 ft

GEOLOGICAL MATERIAL	COLOR	HARDNESS	FROM	TO
TOPSOIL	BLACK	SOFT	0	2
CLAY	YELLO	SOFT	2	14
SANDY CLAY	BLUE	SOFT	14	69
FINE SAND		M.SOFT	69	76
ROCK		HARD	76	77
SANDY CLAY	GRAY	M.SOFT	77	81
CLAY	BLUE	SOFT	81	91
SAND & GRAVEL		SOFT	91	95
CLAY	GRAY	M.HARD	95	183
GRAVEL & CLAY	GRAY	M.SOFT	183	190
FINE SAND		M.SOFT	190	202
CLAY & GRAVEL	GRAY	M.SOFT	202	215
SAND & GRAVEL		M.SOFT	215	270
DECOMPOSED GRANITE			270	274

Screen Y | Open Hole From ft. to ft.

Make JOHNSON Type L

Diameter	Slot	Length	Set	Fitting
12	60	54	220 ft. to 270 ft	

Static Water Level 47 ft. from Land surface Date 1984/05/16

PUMPING LEVEL (below land surface)

59.95 ft. after 18.5 hrs. pumping 1090 g.p.m.

Well Head Completion

Pitless adapter mfr Model

Casing Protection ☑ 12 in. above grade

☐ At-grade(Environmental Wells and Borings ONLY)

Grouting Information Well grouted? ☑ Yes ☐ No

Material	From	To (ft.)	Amount(yds/bags)	
G	0	215	11	Y

Nearest Known Source of Contamination

ft. direction type

Well disinfected upon completion? ☑ Yes ☐ No

Pump ☑ Not Installed Date Installed N

Mfr name

Model HP Volts

Drop Pipe Length ft. Capacity g.p.m

Type

Any not in use and not sealed well(s) on property? ☐ Yes ☐ No

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

USGS Quad: Elevation

Aquifer: Alt Id: 54-0268

Well CONTRACTOR CERTIFICATION Lic. Or Reg. No. 65252

License Business Name

Name of Driller ERVIN, D.

Report Copy

HE-01205-06 (Rev. 9/96)

APPENDIX D

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: 1640008 TIER: 4
SYSTEM NAME: Redwood Falls WHP RANK:
WELL NAME: Well #1 UNIQUE WELL #: 00209660

COUNTY: Redwood TOWNSHIP NUMBER: 112 RANGE: 36 W SECTION: 25 QUARTERS: ABBB

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Quaternary Buried Artesian	
DNR Geologic Sensitivity Rating	:	Very low	10
L Score	:	10	
Geologic Data From	:	Well Record	
Year Constructed	:	1954	
Construction Method	:	Rotary/Drilled	0
Casing Depth	:	140	10
Well Depth	:	180	
Casing grouted into borehole?		Unknown	5
Cement grout between casings?		Not applicable	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	:	400	5
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	1.5 02/01/1974	10
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	:		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: 1640008
SYSTEM NAME: Redwood Falls
WELL NAME: Well #2

TIER: 4
WHP RANK:
UNIQUE WELL #: 00455796

COUNTY: Redwood TOWNSHIP NUMBER: 112 RANGE: 36 W SECTION: 25 QUARTERS:

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Quaternary Buried Artesian	
DNR Geologic Sensitivity Rating	:	Very low	10
L Score	:	8	
Geologic Data From	:	Well Record	
Year Constructed	:	1988	
Construction Method	:	Rotary/Drilled	0
Casing Depth	:	116	10
Well Depth	:	168	
Casing grouted into borehole?		Yes	0
Cement grout between casings?		Not applicable	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	:	500	5
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	:		25
Wellhead Protection Vulnerability Rating	:		NOT VULNERABLE
Vulnerability Overridden	:		

COMMENTS
GEOLOGY INFERRED FROM WELL #1

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: 1640008
SYSTEM NAME: Redwood Falls
WELL NAME: Well ~~#5~~ 3

TIER: 4
WHP RANK:
UNIQUE WELL #: 00403995

COUNTY: Redwood | TOWNSHIP NUMBER: 112 RANGE: 36 W | SECTION: 25 | QUARTERS:

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Quaternary Buried Artesian	
DNR Geologic Sensitivity Rating	:	Very low	10
L Score	:	9	
Geologic Data From	:	Well Record	
Year Constructed	:	1985	
Construction Method	:	Rotary/Drilled	0
Casing Depth	:	189	10
Well Depth	:	230	
Casing grouted into borehole?		Yes	0
Cement grout between casings?		Not applicable	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 10/01/1986	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	:		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: 1640008
SYSTEM NAME: Redwood Falls
WELL NAME: Well #~~3~~ 5

TIER: 4
WHP RANK:
UNIQUE WELL #: 00403955

COUNTY: Redwood | TOWNSHIP NUMBER: 112 | RANGE: 35 W | SECTION: 18 | QUARTERS:

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Quaternary Buried Artesian	
DNR Geologic Sensitivity Rating	:	Very low	0
L Score	:	15	
Geologic Data From	:	Well Record	
Year Constructed	:	1984	
Construction Method	:	Rotary/Drilled	0
Casing Depth	:	220	5
Well Depth	:	268	
Casing grouted into borehole?		Yes	0
Cement grout between casings?		Not applicable	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	:	1090	20
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	.5 10/01/1986	0
Maximum tritium detected	:	1.3 10/10/2002	VULNERABLE
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	Unknown	0
Wellhead Protection Score	:		25
Wellhead Protection Vulnerability Rating	:		VULNERABLE
Vulnerability Overridden	:		

COMMENTS
WELLS #3 AND 5 APPEAR SWITCHED IN THE WATER SUPPLY REPORT
NOTE: WATER SUPPLY REPORT IS CORRECT

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: 1640008 TIER: 4
SYSTEM NAME: Redwood Falls WHP RANK:
WELL NAME: Well So. Ramsey UNIQUE WELL #: 00241414

COUNTY: Redwood TOWNSHIP NUMBER: RANGE: SECTION: QUARTERS:

CRITERIA		DESCRIPTION	POINTS
Aquifer Name(s)	:	Indeterminate	
DNR Geologic Sensitivity Rating	:	Low	20
L Score	:	3	
Geologic Data From	:	Data Inferred From Nearby Wells	
Year Constructed	:	1950	
Construction Method	:	Cable Tool/Bored	0
Casing Depth	:	82	10
Well Depth	:	94	
Casing grouted into borehole?		Unknown	0
Cement grout between casings?		Not applicable	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	:	200	5
Pathogen Detected?			0
Surface Water Characteristics?			0
Maximum nitrate detected	:	Unknown	0
Maximum tritium detected	:	1.2 10/10/2002	VULNERABLE
Non-THMS VOCs detected?			0
Pesticides detected?			0
Carbon 14 age	:	Unknown	0
Wellhead Protection Score	:		35
Wellhead Protection Vulnerability Rating	:		VULNERABLE
Vulnerability Overridden	:		

COMMENTS

APPENDIX E

```
  return
window 3.21296e+005 4.92312e+006 3.42632e+005 4.93676e+006
aquifer
  layer 1
  global
    base 238.000000
    perm 1.50000e+000
    thick 150.000000
    por 0.300000
  ret
reference
  layer 1
  338647.000000 4911140.000000 310.000000
  return
polygon
  input C3
  3.275884062500000e+005 4.928916500000000e+006
  3.316824375000000e+005 4.928459000000000e+006
  3.339893437500000e+005 4.929560500000000e+006
  3.328674062500000e+005 4.931306000000000e+006
  3.307473125000000e+005 4.931721500000000e+006
  3.278789062500000e+005 4.931784000000000e+006
  3.270268437500000e+005 4.930308500000000e+006
  input C4
  3.275465625000000e+005 4.928209000000000e+006
  3.314734062500000e+005 4.925184500000000e+006
  3.411906875000000e+005 4.925785000000000e+006
  3.365666562500000e+005 4.928937000000000e+006
  3.339480937500000e+005 4.927274000000000e+006
  3.315993750000000e+005 4.926214000000000e+006
  input B3
  3.339893437500000e+005 4.929560500000000e+006
  3.365666562500000e+005 4.928937000000000e+006
  3.389772500000000e+005 4.931015000000000e+006
  3.366703750000000e+005 4.931098000000000e+006
  input A3
  3.307473125000000e+005 4.931721500000000e+006
  3.328674062500000e+005 4.931306000000000e+006
  3.343010312500000e+005 4.932885500000000e+006
  3.341348750000000e+005 4.935379500000000e+006
  3.305393125000000e+005 4.933675500000000e+006
  input RAIN
  3.102522187500000e+005 4.948685000000000e+006
  3.095736250000000e+005 4.909711000000000e+006
  3.709314375000000e+005 4.911322500000000e+006
  3.694802500000000e+005 4.947172500000000e+006
  input B&C
  3.275884062500000e+005 4.928916500000000e+006
  3.275465625000000e+005 4.928209000000000e+006
  3.315993750000000e+005 4.926214000000000e+006
  3.339480937500000e+005 4.927274000000000e+006
  3.365666562500000e+005 4.928937000000000e+006
  3.339893437500000e+005 4.929560500000000e+006
  3.316824375000000e+005 4.928459000000000e+006
  return
aquifer
  layer 1
  polygon C3
    base 330250.093750 4930184.500000 238.000000
    perm 330250.093750 4930184.500000 1.20000e+002
    thick 330250.093750 4930184.500000 12.000000
    por 330250.093750 4930184.500000 0.250000
  polygon C4
```

```
    base 335113.906250 4926322.000000 238.000000
    perm 335113.906250 4926322.000000 1.20000e+002
    thick 335113.906250 4926322.000000 12.000000
    por 335113.906250 4926322.000000 0.250000
  polygon B3
    base 336461.937500 4930020.000000 260.000000
    perm 336461.937500 4930020.000000 1.00000e+002
    thick 336461.937500 4930020.000000 15.000000
    por 336461.937500 4930020.000000 0.250000
  polygon A3
    base 332358.187500 4933029.500000 290.000000
    perm 332358.187500 4933029.500000 1.40000e+002
    thick 332358.187500 4933029.500000 6.000000
    por 332358.187500 4933029.500000 0.250000
  polygon B&C
    base 333325.500000 4928201.000000 238.000000
    perm 333325.500000 4928201.000000 1.10000e+002
    thick 333325.500000 4928201.000000 27.000000
    por 333325.500000 4928201.000000 0.250000
  return
well
  layer 1
  given
  3.3127200000e+005 4.9324600000e+006 0.00000e+000 0.305000 [SRAMSEY]
  3.3140837500e+005 4.9327295000e+006 0.00000e+000 0.300500 [229604]
  3.3157790625e+005 4.9274135000e+006 2.03000e+002 0.305000 [502652]
  3.3164100000e+005 4.9279190000e+006 7.39000e+002 0.305000 [REDWOOD1]
  3.3233000000e+005 4.9278840000e+006 3.82000e+002 0.305000 [REDWOOD2]
  3.3194700000e+005 4.9278980000e+006 6.84000e+002 0.254000 [REDWOOD3]
  3.3247700000e+005 4.9295380000e+006 6.78000e+002 0.305000 [REDWOOD5]
  return
varel
  layer 1
  top
  polygon RAIN
  given const
   3.3757265625e+005 4.9181590000e+006 -1.22000e-004 [RAIN]
  return
linesink
  layer  1
  head
   3.09993E+05  4.93082E+06
   3.14865E+05  4.92856E+06
   3.12400E+02 [0]
  head
   2.86601E+05  4.93082E+06
   3.09993E+05  4.93082E+06
   3.18500E+02 [0]
  head
   2.76880E+05  4.93781E+06
   2.86601E+05  4.93082E+06
   3.27700E+02 [0]
  head
   3.05892E+05  4.94540E+06
   3.17740E+05  4.94844E+06
   3.12400E+02 [0]
  head
   3.00728E+05  4.93781E+06
   3.05892E+05  4.94540E+06
   3.19400E+02 [0]
  head
   2.92016E+05  4.95224E+06
   3.07444E+05  4.95677E+06
```

```
 2.95700E+02 [0]
head
 2.88024E+05  4.95461E+06
 2.92016E+05  4.95224E+06
 3.12400E+02 [0]
head
 2.85154E+05  4.95273E+06
 2.87982E+05  4.95461E+06
 3.13900E+02 [0]
head
 2.84323E+05  4.94820E+06
 2.85154E+05  4.95273E+06
 3.17900E+02 [0]
head
 2.71098E+05  4.94359E+06
 2.84323E+05  4.94820E+06
 3.27700E+02 [0]
head
 2.65152E+05  4.94442E+06
 2.71098E+05  4.94359E+06
 3.33800E+02 [0]
head
 2.56668E+05  4.92491E+06
 2.65235E+05  4.94446E+06
 3.61200E+02 [0]
head
 3.09140E+05  4.90625E+06
 2.93730E+05  4.91444E+06
 3.30000E+02 [0]
head
 3.09232E+05  4.90622E+06
 3.32903E+05  4.89482E+06
 3.20000E+02 [0]
head
 3.32903E+05  4.89482E+06
 3.49753E+05  4.90080E+06
 3.05000E+02 [0]
head
 3.49753E+05  4.90080E+06
 3.55972E+05  4.89833E+06
 3.00000E+02 [0]
head
 3.55972E+05  4.89833E+06
 3.58536E+05  4.90229E+06
 2.95000E+02 [0]
head
 3.58536E+05  4.90229E+06
 3.62576E+05  4.89994E+06
 2.85000E+02 [0]
head
 3.62576E+05  4.89994E+06
 3.68328E+05  4.90648E+06
 2.80000E+02 [0]
head
 3.68328E+05  4.90650E+06
 3.81717E+05  4.90900E+06
 2.60000E+02 [0]
head
 3.38637E+05  4.91105E+06
 3.46914E+05  4.90653E+06
 3.00000E+02 [0]
head
 3.46914E+05  4.90653E+06
```

```
   3.58224E+05  4.90220E+06
   2.90000E+02 [0]
  return
lleak
return
string
  open
  input MINN_R
  cu
    3.2143355947e+005 4.9464754138e+006
    3.2822896867e+005 4.9421514221e+006
    3.3356821875e+005 4.9387540000e+006
  cu
    3.3414637033e+005 4.9383861160e+006
    3.3460063228e+005 4.9380970642e+006
  cu
    3.4472791295e+005 4.9348212596e+006
    3.6743905193e+005 4.9188774378e+006
  cu
    3.7596919246e+005 4.9128890530e+006
    3.8682573495e+005 4.9052674723e+006
    return
  open
  input REDWD_R
  cu
    3.3452615650e+005 4.9381444539e+006
    3.3282840840e+005 4.9343586416e+006
    3.2342101524e+005 4.9313211782e+006
  cu
    3.1966786353e+005 4.9301007598e+006
    3.1489112500e+005 4.9285475000e+006
    return
  open
  input SLPEYE_R
  cu
    3.1489112500e+005 4.9285475000e+006
    3.2031994598e+005 4.9223643770e+006
    3.2465160577e+005 4.9183187964e+006
  cu
    3.2820885688e+005 4.9149964796e+006
    3.3863712500e+005 4.9110515000e+006
    return
  open
  input SPR_CK
  cu
    3.6731218750e+005 4.9189665000e+006
    3.6599369303e+005 4.9168537151e+006
    3.5599531250e+005 4.9179940000e+006
  cu
    3.5453665625e+005 4.9143840000e+006
    3.5238509375e+005 4.9133425000e+006
  cu
    3.5058164132e+005 4.9142045376e+006
    3.4828633822e+005 4.9153016763e+006
    return
  open
  input RAMSEY
  cu
    3.3097142509e+005 4.9344412622e+006
    3.2950411272e+005 4.9363360041e+006
    3.2014068750e+005 4.9330270000e+006
    return
  return
```

```
curel
  layer 1
  string MINN_R
  head
  element 1 6 4.000000
  element 2 6 4.000000
  element 3 8 4.000000
  element 4 6 4.000000
  boundary condition
    3.2143355947e+005 4.9464754138e+006 256.000000 300.000000
    3.3371040257e+005 4.9386635269e+006 252.000000 300.000000
    3.3585810231e+005 4.9376653129e+006 250.000000 300.000000
    3.5188521964e+005 4.9293002617e+006 245.000000 300.000000
    3.6795591773e+005 4.9185145843e+006 240.000000 300.000000
    return
  layer 1
  string REDWD_R
  resistance
  element 1 8 4.000000
  element 2 8 4.000000
  boundary condition
    3.3373672585e+005 4.9368061209e+006 50.000000 259.000000 50.000000
    3.3129105174e+005 4.9346384708e+006 100.000000 298.000000 50.000000
    3.2400334025e+005 4.9315112855e+006 100.000000 302.000000 50.000000
    3.1928515950e+005 4.9299763153e+006 100.000000 306.000000 50.000000
    3.1489112500e+005 4.9285475000e+006 100.000000 310.000000 50.000000
    return
  layer 1
  string SLPEYE_R
  resistance
  element 1 6 4.000000
  element 2 6 4.000000
  boundary condition
    3.1637528238e+005 4.9268738150e+006 100.000000 316.000000 100.000000
    3.1873443905e+005 4.9242886701e+006 100.000000 320.000000 100.000000
    3.2260265725e+005 4.9202902396e+006 100.000000 317.000000 100.000000
    3.2800415247e+005 4.9158663163e+006 100.000000 314.000000 100.000000
    3.3863712500e+005 4.9110515000e+006 100.000000 310.000000 100.000000
    return
  layer 1
  string SPR_CK
  resistance
  element 1 6 4.000000
  element 2 6 4.000000
  element 3 6 4.000000
  boundary condition
    3.6713251002e+005 4.9187036608e+006 50.000000 240.000000 25.000000
    3.6481406516e+005 4.9174947260e+006 100.000000 250.000000 25.000000
    3.6204036036e+005 4.9174397255e+006 100.000000 275.000000 25.000000
    3.5994175531e+005 4.9175871943e+006 100.000000 300.000000 25.000000
    3.5463022536e+005 4.9153407789e+006 100.000000 305.000000 25.000000
    3.4828633822e+005 4.9153016763e+006 100.000000 310.000000 25.000000
    return
  layer 1
  string RAMSEY
  resistance
  element 1 6 4.000000
  boundary condition
    3.2917736368e+005 4.9355037810e+006 100.000000 305.000000 25.000000
    3.2187428861e+005 4.9336334969e+006 100.000000 310.000000 25.000000
    return
  return
doublet
```

```
layer 1
order 8
controlpoints 32
element
  3.270268437500000e+005 4.930308500000000e+006
  3.278789062500000e+005 4.931784000000000e+006
order 8
controlpoints 32
element
  3.278789062500000e+005 4.931784000000000e+006
  3.307473125000000e+005 4.931721500000000e+006
order 8
controlpoints 32
element
  3.328674062500000e+005 4.931306000000000e+006
  3.339893437500000e+005 4.929560500000000e+006
order 8
controlpoints 32
element
  3.339893437500000e+005 4.929560500000000e+006
  3.366703750000000e+005 4.931098000000000e+006
order 8
controlpoints 32
element
  3.366703750000000e+005 4.931098000000000e+006
  3.389772500000000e+005 4.931015000000000e+006
order 8
controlpoints 32
element
  3.389772500000000e+005 4.931015000000000e+006
  3.365666562500000e+005 4.928937000000000e+006
order 8
controlpoints 32
element
  3.365666562500000e+005 4.928937000000000e+006
  3.411906875000000e+005 4.925785000000000e+006
order 8
controlpoints 32
element
  3.411906875000000e+005 4.925785000000000e+006
  3.314734062500000e+005 4.925184500000000e+006
order 8
controlpoints 32
element
  3.314734062500000e+005 4.925184500000000e+006
  3.275465625000000e+005 4.928209000000000e+006
order 8
controlpoints 32
element
  3.270268437500000e+005 4.930308500000000e+006
  3.275884062500000e+005 4.928916500000000e+006
order 8
controlpoints 32
element
  3.275884062500000e+005 4.928916500000000e+006
  3.316824375000000e+005 4.928459000000000e+006
order 8
controlpoints 32
element
  3.316824375000000e+005 4.928459000000000e+006
  3.339893437500000e+005 4.929560500000000e+006
order 8
controlpoints 32
```

```
  element
    3.339893437500000e+005 4.929560500000000e+006
    3.365666562500000e+005 4.928937000000000e+006
  order 8
  controlpoints 32
  element
    3.365666562500000e+005 4.928937000000000e+006
    3.339480937500000e+005 4.927274000000000e+006
  order 8
  controlpoints 32
  element
    3.339480937500000e+005 4.927274000000000e+006
    3.315993750000000e+005 4.926214000000000e+006
  order 8
  controlpoints 32
  element
    3.315993750000000e+005 4.926214000000000e+006
    3.275465625000000e+005 4.928209000000000e+006
  order 8
  controlpoints 32
  element
    3.275465625000000e+005 4.928209000000000e+006
    3.275884062500000e+005 4.928916500000000e+006
  order 8
  controlpoints 32
  element
    3.307473125000000e+005 4.931721500000000e+006
    3.328674062500000e+005 4.931306000000000e+006
  order 8
  controlpoints 32
  element
    3.307473125000000e+005 4.931721500000000e+006
    3.305393125000000e+005 4.933675500000000e+006
  order 8
  controlpoints 32
  element
    3.305393125000000e+005 4.933675500000000e+006
    3.341348750000000e+005 4.935379500000000e+006
  order 8
  controlpoints 32
  element
    3.341348750000000e+005 4.935379500000000e+006
    3.343010312500000e+005 4.932885500000000e+006
  order 8
  controlpoints 32
  element
    3.343010312500000e+005 4.932885500000000e+006
    3.328674062500000e+005 4.931306000000000e+006
  return
switch
  end
```

```
  return
window 3.23997e+005 4.92325e+006 3.44497e+005 4.93636e+006
aquifer
  layer 1
  global
    base 238.000000
    perm 3.00000e+000
    thick 150.000000
    por 0.300000
  ret
reference
  layer 1
  338647.000000 4911140.000000 310.000000
  return
polygon
  input A3
  3.307473125000000e+005 4.931721500000000e+006
  3.328674062500000e+005 4.931306000000000e+006
  3.343010312500000e+005 4.932885500000000e+006
  3.341348750000000e+005 4.935379500000000e+006
  3.305393125000000e+005 4.933675500000000e+006
  input RAIN
  3.102522187500000e+005 4.948685000000000e+006
  3.095736250000000e+005 4.909711000000000e+006
  3.709314375000000e+005 4.911322500000000e+006
  3.694802500000000e+005 4.947172500000000e+006
  input AEXTEND
  3.328674062500000e+005 4.931306000000000e+006
  3.307473125000000e+005 4.931721500000000e+006
  3.288647414325862e+005 4.928773872034951e+006
  3.310877273673915e+005 4.928525457696352e+006
  3.322207500000000e+005 4.929644000000000e+006
  input CA
  3.307473125000000e+005 4.931721500000000e+006
  3.278789062500000e+005 4.931784000000000e+006
  3.270268437500000e+005 4.930308500000000e+006
  3.275884062500000e+005 4.928916500000000e+006
  3.288647414325862e+005 4.928773872034951e+006
  input CB
  3.310877273673915e+005 4.928525457696352e+006
  3.316824375000000e+005 4.928459000000000e+006
  3.339893437500000e+005 4.929560500000000e+006
  3.328674062500000e+005 4.931306000000000e+006
  3.322207500000000e+005 4.929644000000000e+006
  input AEXTEND2
  3.310877273673915e+005 4.928525457696352e+006
  3.288647414325862e+005 4.928773872034951e+006
  3.264468750000000e+005 4.926914000000000e+006
  3.285212812500000e+005 4.925568000000000e+006
  3.303309687500000e+005 4.925766000000000e+006
  return
aquifer
  layer 1
  polygon A3
    base 332358.187500 4933029.500000 290.000000
    perm 332358.187500 4933029.500000 1.40000e+002
    thick 332358.187500 4933029.500000 6.000000
    por 332358.187500 4933029.500000 0.250000
  polygon AEXTEND
    base 331410.218750 4930339.500000 290.000000
    perm 331410.218750 4930339.500000 1.40000e+002
    thick 331410.218750 4930339.500000 6.000000
    por 331410.218750 4930339.500000 0.250000
```

```
  polygon CA
    base 328354.437500 4930315.500000 290.000000
    perm 328354.437500 4930315.500000 1.40000e+002
    thick 328354.437500 4930315.500000 6.000000
    por 328354.437500 4930315.500000 0.250000
  polygon CB
    base 332822.593750 4929691.000000 290.000000
    perm 332822.593750 4929691.000000 1.40000e+002
    thick 332822.593750 4929691.000000 1.000000
    por 332822.593750 4929691.000000 0.250000
  polygon AEXTEND2
    base 329271.562500 4927399.500000 290.000000
    perm 329271.562500 4927399.500000 1.40000e+002
    thick 329271.562500 4927399.500000 15.000000
    por 329271.562500 4927399.500000 0.250000
  return
well
  layer 1
  given
  3.3127200000e+005 4.9324600000e+006 1.44000e+002 0.305000 [SRAMSEY]
  3.3140837500e+005 4.9327295000e+006 3.40000e+001 0.300500 [229604]
  3.3157790625e+005 4.9274135000e+006 0.00000e+000 0.305000 [502652]
  3.3164100000e+005 4.9279190000e+006 0.00000e+000 0.305000 [REDWOOD1]
  3.3233000000e+005 4.9278840000e+006 0.00000e+000 0.305000 [REDWOOD2]
  3.3194700000e+005 4.9278980000e+006 0.00000e+000 0.254000 [REDWOOD3]
  3.3247700000e+005 4.9295380000e+006 0.00000e+000 0.305000 [REDWOOD5]
  return
varel
  layer 1
  top
  polygon RAIN
  given const
   3.3757265625e+005 4.9181590000e+006 -1.39000e-004 [RAIN]
  return
linesink
  layer  1
  head
   3.09993E+05  4.93082E+06
   3.14865E+05  4.92856E+06
   3.12400E+02 [0]
  head
   2.86601E+05  4.93082E+06
   3.09993E+05  4.93082E+06
   3.18500E+02 [0]
  head
   2.76880E+05  4.93781E+06
   2.86601E+05  4.93082E+06
   3.27700E+02 [0]
  head
   3.05892E+05  4.94540E+06
   3.17740E+05  4.94844E+06
   3.12400E+02 [0]
  head
   3.00728E+05  4.93781E+06
   3.05892E+05  4.94540E+06
   3.19400E+02 [0]
  head
   2.92016E+05  4.95224E+06
   3.07444E+05  4.95677E+06
   2.95700E+02 [0]
  head
   2.88024E+05  4.95461E+06
   2.92016E+05  4.95224E+06
```

```
   3.12400E+02 [0]
  head
   2.85154E+05  4.95273E+06
   2.87982E+05  4.95461E+06
   3.13900E+02 [0]
  head
   2.84323E+05  4.94820E+06
   2.85154E+05  4.95273E+06
   3.17900E+02 [0]
  head
   2.71098E+05  4.94359E+06
   2.84323E+05  4.94820E+06
   3.27700E+02 [0]
  head
   2.65152E+05  4.94442E+06
   2.71098E+05  4.94359E+06
   3.33800E+02 [0]
  head
   2.56668E+05  4.92491E+06
   2.65235E+05  4.94446E+06
   3.61200E+02 [0]
  head
   3.09140E+05  4.90625E+06
   2.93730E+05  4.91444E+06
   3.30000E+02 [0]
  head
   3.09232E+05  4.90622E+06
   3.32903E+05  4.89482E+06
   3.20000E+02 [0]
  head
   3.32903E+05  4.89482E+06
   3.49753E+05  4.90080E+06
   3.05000E+02 [0]
  head
   3.49753E+05  4.90080E+06
   3.55972E+05  4.89833E+06
   3.00000E+02 [0]
  head
   3.55972E+05  4.89833E+06
   3.58536E+05  4.90229E+06
   2.95000E+02 [0]
  head
   3.58536E+05  4.90229E+06
   3.62576E+05  4.89994E+06
   2.85000E+02 [0]
  head
   3.62576E+05  4.89994E+06
   3.68328E+05  4.90648E+06
   2.80000E+02 [0]
  head
   3.68328E+05  4.90650E+06
   3.81717E+05  4.90900E+06
   2.60000E+02 [0]
  head
   3.38637E+05  4.91105E+06
   3.46914E+05  4.90653E+06
   3.00000E+02 [0]
  head
   3.46914E+05  4.90653E+06
   3.58224E+05  4.90220E+06
   2.90000E+02 [0]
  return
lleak
```

```
return
string
  open
  input MINN_R
  cu
    3.2143355947e+005 4.9464754138e+006
    3.2822896867e+005 4.9421514221e+006
    3.3356821875e+005 4.9387540000e+006
  cu
    3.3414637033e+005 4.9383861160e+006
    3.3460063228e+005 4.9380970642e+006
  cu
    3.4472791295e+005 4.9348212596e+006
    3.6743905193e+005 4.9188774378e+006
  cu
    3.7596919246e+005 4.9128890530e+006
    3.8682573495e+005 4.9052674723e+006
    return
  open
  input REDWD_R
  cu
    3.3452615650e+005 4.9381444539e+006
    3.3282840840e+005 4.9343586416e+006
    3.2342101524e+005 4.9313211782e+006
  cu
    3.1966786353e+005 4.9301007598e+006
    3.1489112500e+005 4.9285475000e+006
    return
  open
  input SLPEYE_R
  cu
    3.1489112500e+005 4.9285475000e+006
    3.2031994598e+005 4.9223643770e+006
    3.2465160577e+005 4.9183187964e+006
  cu
    3.2820885688e+005 4.9149964796e+006
    3.3863712500e+005 4.9110515000e+006
    return
  open
  input SPR_CK
  cu
    3.6731218750e+005 4.9189665000e+006
    3.6599369303e+005 4.9168537151e+006
    3.5599531250e+005 4.9179940000e+006
  cu
    3.5453665625e+005 4.9143840000e+006
    3.5238509375e+005 4.9133425000e+006
  cu
    3.5058164132e+005 4.9142045376e+006
    3.4828633822e+005 4.9153016763e+006
    return
  open
  input RAMSEY
  cu
    3.3097142509e+005 4.9344412622e+006
    3.2950411272e+005 4.9363360041e+006
    3.2014068750e+005 4.9330270000e+006
    return
  return
curel
  layer 1
  string MINN_R
  head
```

```
  element 1 6 4.000000
  element 2 6 4.000000
  element 3 8 4.000000
  element 4 6 4.000000
  boundary condition
    3.2143355947e+005 4.9464754138e+006 256.000000 300.000000
    3.3371040257e+005 4.9386635269e+006 252.000000 300.000000
    3.3585810231e+005 4.9376653129e+006 250.000000 300.000000
    3.5188521964e+005 4.9293002617e+006 245.000000 300.000000
    3.6795591773e+005 4.9185145843e+006 240.000000 300.000000
    return
  layer 1
  string REDWD_R
  resistance
  element 1 8 4.000000
  element 2 8 4.000000
  boundary condition
    3.3373672585e+005 4.9368061209e+006 50.000000 259.000000 50.000000
    3.3129105174e+005 4.9346384708e+006 100.000000 298.000000 50.000000
    3.2400334025e+005 4.9315112855e+006 100.000000 302.000000 50.000000
    3.1928515950e+005 4.9299763153e+006 100.000000 306.000000 50.000000
    3.1489112500e+005 4.9285475000e+006 100.000000 310.000000 50.000000
    return
  layer 1
  string SLPEYE_R
  resistance
  element 1 6 4.000000
  element 2 6 4.000000
  boundary condition
    3.1637528238e+005 4.9268738150e+006 100.000000 316.000000 100.000000
    3.1873443905e+005 4.9242886701e+006 100.000000 320.000000 100.000000
    3.2260265725e+005 4.9202902396e+006 100.000000 317.000000 100.000000
    3.2800415247e+005 4.9158663163e+006 100.000000 314.000000 100.000000
    3.3863712500e+005 4.9110515000e+006 100.000000 310.000000 100.000000
    return
  layer 1
  string SPR_CK
  resistance
  element 1 6 4.000000
  element 2 6 4.000000
  element 3 6 4.000000
  boundary condition
    3.6713251002e+005 4.9187036608e+006 50.000000 240.000000 25.000000
    3.6481406516e+005 4.9174947260e+006 100.000000 250.000000 25.000000
    3.6204036036e+005 4.9174397255e+006 100.000000 275.000000 25.000000
    3.5994175531e+005 4.9175871943e+006 100.000000 300.000000 25.000000
    3.5463022536e+005 4.9153407789e+006 100.000000 305.000000 25.000000
    3.4828633822e+005 4.9153016763e+006 100.000000 310.000000 25.000000
    return
  layer 1
  string RAMSEY
  resistance
  element 1 6 4.000000
  boundary condition
    3.2917736368e+005 4.9355037810e+006 100.000000 305.000000 25.000000
    3.2187428861e+005 4.9336334969e+006 100.000000 310.000000 25.000000
    return
  return
doublet
  layer 1
  order 8
  controlpoints 32
  element
```

```
  3.270268437500000e+005 4.930308500000000e+006
  3.278789062500000e+005 4.931784000000000e+006
order 8
controlpoints 32
element
  3.328674062500000e+005 4.931306000000000e+006
  3.339893437500000e+005 4.929560500000000e+006
order 8
controlpoints 32
element
  3.270268437500000e+005 4.930308500000000e+006
  3.275884062500000e+005 4.928916500000000e+006
order 8
controlpoints 32
element
  3.316824375000000e+005 4.928459000000000e+006
  3.339893437500000e+005 4.929560500000000e+006
order 8
controlpoints 32
element
  3.307473125000000e+005 4.931721500000000e+006
  3.328674062500000e+005 4.931306000000000e+006
order 8
controlpoints 32
element
  3.307473125000000e+005 4.931721500000000e+006
  3.305393125000000e+005 4.933675500000000e+006
order 8
controlpoints 32
element
  3.305393125000000e+005 4.933675500000000e+006
  3.341348750000000e+005 4.935379500000000e+006
order 8
controlpoints 32
element
  3.341348750000000e+005 4.935379500000000e+006
  3.343010312500000e+005 4.932885500000000e+006
order 8
controlpoints 32
element
  3.343010312500000e+005 4.932885500000000e+006
  3.328674062500000e+005 4.931306000000000e+006
order 6
controlpoints 24
element
  3.328674062500000e+005 4.931306000000000e+006
  3.307473125000000e+005 4.931721500000000e+006
order 6
controlpoints 24
element
  3.328674062500000e+005 4.931306000000000e+006
  3.307473125000000e+005 4.931721500000000e+006
order 6
controlpoints 24
element
  3.307473125000000e+005 4.931721500000000e+006
  3.288647414325862e+005 4.928773872034951e+006
order 6
controlpoints 24
element
  3.310877273673915e+005 4.928525457696352e+006
  3.322207500000000e+005 4.929644000000000e+006
order 6
```

```
  controlpoints 24
  element
    3.322207500000000e+005 4.929644000000000e+006
    3.328674062500000e+005 4.931306000000000e+006
  order 6
  controlpoints 24
  element
    3.316824375000000e+005 4.928459000000000e+006
    3.310877273673915e+005 4.928525457696352e+006
  order 6
  controlpoints 24
  element
    3.307473125000000e+005 4.931721500000000e+006
    3.278789062500000e+005 4.931784000000000e+006
  order 6
  controlpoints 24
  element
    3.288647414325862e+005 4.928773872034951e+006
    3.275884062500000e+005 4.928916500000000e+006
  order 6
  controlpoints 24
  element
    3.288647414325862e+005 4.928773872034951e+006
    3.310877273673915e+005 4.928525457696352e+006
  order 6
  controlpoints 24
  element
    3.288647414325862e+005 4.928773872034951e+006
    3.264468750000000e+005 4.926914000000000e+006
  order 6
  controlpoints 24
  element
    3.264468750000000e+005 4.926914000000000e+006
    3.285212812500000e+005 4.925568000000000e+006
  order 6
  controlpoints 24
  element
    3.285212812500000e+005 4.925568000000000e+006
    3.303309687500000e+005 4.925766000000000e+006
  order 6
  controlpoints 24
  element
    3.303309687500000e+005 4.925766000000000e+006
    3.310877273673915e+005 4.928525457696352e+006
  return
switch
  end
```