Appendix D

Groundwater Flow Model Report
Golden Sands Dairy, LLC
Wisconsin

Groundwater Flow Model for Golden Sands Dairy Saratoga Township Wisconsin

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REPORT

Section 1
Introduction

This report describes an evaluation of the effects of groundwater production associated with development and operation of 39 new high capacity wells and one existing high capacity well in the Town of Saratoga, Wood County, Wisconsin for the Golden Sands Dairy (GSD)[1]. This report describes calculated impacts of the proposed groundwater pumping for irrigation and dairy operations on groundwater levels and stream flows in the vicinity of these proposed wells.

Golden Sands Dairy, LLC plans to irrigate about 4,660 acres in the Town of Saratoga in Wood County (Figure 1). Most of the land is currently red pine plantations. After conversion to irrigated agriculture the planned crops are potato, alfalfa, snap beans, peas, and corn for silage and grain which will be grown on a rotational cycle. Thirty-seven new high capacity irrigation well and one existing high capacity well are proposed to supply water for the irrigated fields. These wells will be nominally about 120 feet deep and have a capacity designed to provide 8 gpm per acre; a well used to irrigate 140 acres will have a capacity of 1,120 gpm (1.6 million gallons per day). The locations of the proposed high capacity wells are shown on Figure 2, and a list of the high capacity wells is contained on Table 1. The high capacity wells have been grouped into six high capacity well systems and a high capacity well application has been submitted for each. This report describes the effects of all proposed wells on groundwater levels and stream flows as well as the effects of each of the six high capacity well systems individually.

The GSD Production Area will contain building structures and equipment to house 3,400 milk cows, 600 dry cows, 300 heifers and 1,000 calves, totaling 6,130 animal units. The GSD Production Area will have two high capacity wells; a primary well with a capacity of 350 gpm (0.5 million gallons per day) and a backup well with a capacity of 250 gpm (360 million gallons per day). The dairy is estimated to produce about 55 million gallons per year of wastewater and liquid manure and about 25,000 tons of manure solids. The liquid and solids will be applied to the irrigated fields to build up the organic matter content of the soils and to provide nutrients.

The GSD project is located on a relatively flat plain that slopes gently toward the Wisconsin River on the west and represents sand deposits from glacial Lake Wisconsin. Surface elevations range from about 990 feet to 1,040 feet above mean sea level in the fields to be converted and irrigated. Tenmile Creek, which is incised about 20 feet below the elevation of the fields in the eastern part of the project and about 40 feet below the elevation of the fields in the west, flows through the southern portion of the project. The Wisconsin River, which at its closest is only about one mile west of the project fields, is incised about 60 feet below the elevation of the fields. Sevenmile Creek, which flows east to west just north of the project fields, is significantly incised below the elevation of the fields only in the far western portion of the project.

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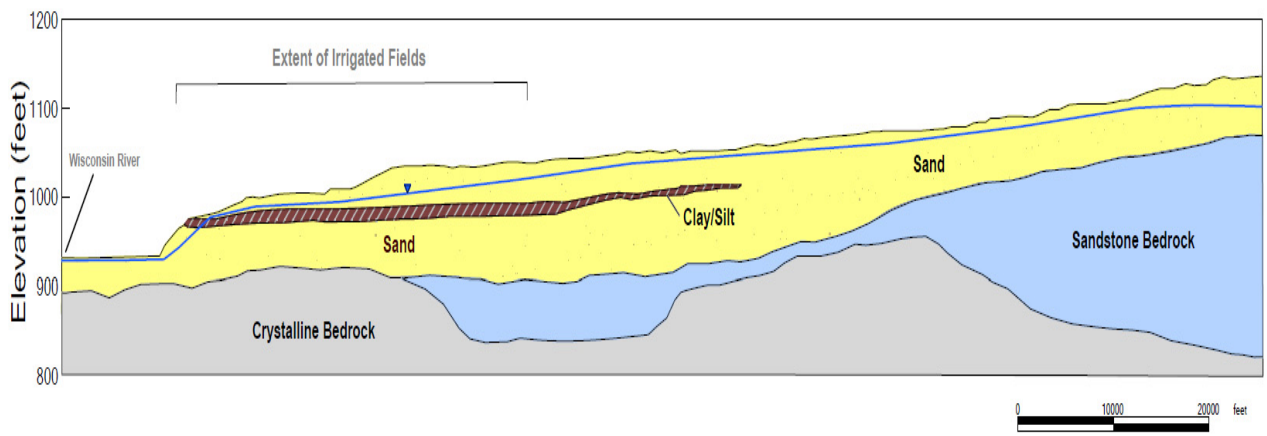
[1] This project also includes cropping on 1800 acres of existing irrigated fields in Portage County. The existing irrigated wells are not subject to any regulatory action concerning the GSD project and have not been evaluated as part of this groundwater modeling analysis.

This project is located in a region with a very productive groundwater aquifer. A schematic east-west trending hydrologic cross section of the aquifer system is shown in the figure below; the section runs approximately from the Wisconsin River on the west to I-39 on the east. The main aquifer is a water table aquifer consisting of glacial sands and gravels that are up to 130 feet thick at the property. The water table is nominally about 20 feet below land surface. Underlying the sands and gravels is an aquifer consisting of Cambrian-aged sandstones of the Mt. Simon Formation that overlies pre-Cambrian aged crystalline bedrock that is not a productive aquifer. The sandstone is reported to be comprised of mainly well-rounded medium grained sand. The sandstone unit generally thickens toward the southeast and is absent to the west of the project area. This region is often referred to as the Central Sands region and/or the Central Sand Plain of Wisconsin.

A silt/clay unit, referred to as the New Rome member, occurs throughout much of the sand plains. This unit consists primarily of silt and clay, which may or may not be rhythmically banded, and is regionally extensive near the project area. The unit, as mapped by Brownell (1986) is about 10 feet thick in the project area and the top of the unit occurs at an elevation of about 950' to the south and west to greater than 1000' above MSL towards the north and east



(Brownell, 1986). The unit has been truncated by younger deposits along the Wisconsin River, and the western extent of the unit is defined by previous stands of glacial Lake Wisconsin. The New Rome member has been mapped in Adams County (Clayton, 1987) and Wood County (Clayton, 1991) and is shown in geologic cross sections of the area (see Attachment A).

The aquifers at the property are regionally extensive and extend beyond the regional drainage systems, which are the Wisconsin River to the west and the Wolf River to the east. In the project area groundwater flow is primarily from east to west as shown on the water table map on Figure 3[2]. The map on Figure 3 depicts water levels from the groundwater divide between the Wisconsin and Wolf River drainages, located along the north-south trending moraine about 13 miles east of the project area, to the Wisconsin River - the regional groundwater discharge area. Residences in the vicinity of the project area obtain water supply from wells completed in the

[2] Figure 3 depicts water levels measured in the period 1970 through 1979; a period in which a large number of water levels measurements were made.

sand and gravel aquifer. The nearest municipal well is located in Nekoosa about 4 miles northwest of the project area on the west side of the Wisconsin River. Municipal wells are shown on Figure 1.

The locations and pumping rates for existing high capacity wells in the vicinity of the project are shown in Figure 4. Most of these high capacity wells are used for irrigated agriculture. Most of the high capacity irrigation wells in the area are located to the east of this project. Details of the existing high capacity wells and average pumping rates are contained in Attachment E.

Groundwater resources in the vicinity of the project area have been investigated by a number of researchers over the years. A study of groundwater conditions in the Buena Vista basin, which is located immediately to the north of the project area, was conducted by staff at the Wisconsin Geological and Natural History Survey (Bradbury and others, 1992). Recently researchers at the Center for Watershed Science and Education at the University of Wisconsin – Stevens Point have completed a number of studies of groundwater conditions in the Central Sand Plain with an emphasis on understanding the effects of irrigation pumping on water resources (Kraft and Mechenich, 2010; Mechenich and others, 2009; Kraft and others, 2012). Other studies of hydrogeologic conditions in the area include a study by the U.S. Geological Survey titled "Effects of Irrigation on Streamflow in the Central Sand Plain of Wisconsin" (Weeks and Stangland, 1971), another study by the U.S. Geological Survey titled "Hydrology of the Little Plover River Basin Portage County, Wisconsin and the Effects of Water Resource Development" (Weeks and others, 1965), and the U.S. Geological Survey study "Low-Flow Characteristics of Streams in the Central Wisconsin River Basin, Wisconsin" (Gebart, 1982). Kniffin and others (2014) provide a summary of the water resource issues in the Central Sands.

The surface water features in the project area, as defined in the National Hydrography dataset[3], are shown on Figure 5. The major stream in the project area is the groundwater fed Tenmile Creek, a tributary of the Wisconsin River. Tenmile Creek has a drainage area of about 84 square miles. Much of the flow in the stream occurs as the result of groundwater discharge to a large network of ditches in the headwaters of this stream to the east of the project area. The U.S. Geological Survey maintains a stream gaging station on Tenmile Creek at Highway 13 about one and one-half miles downstream of the project[4]. Daily flow data are available for the periods 1965 to 1979, 1987 to 1994 and 1998 to the present at this location. The average annual flow at this gage, based on the period 2001 through 2011, is 55 cubic feet per second (cfs). Almost all of the flow is derived from groundwater discharge as surface water runoff in this area is minimal because of the flat topography and very permeable soils. Flow varies seasonally with the highest flows occurring in the late winter and spring when much of the groundwater recharge occurs and generally declines from these peak flows until the following late winter. Tenmile Creek from the Wisconsin River to one mile east of Highway 13 is a designated Class II trout stream (5-mile long reach) and the reach from one mile east of Highway 13 to the Wood County line is a designated Class III trout stream (3-mile long reach).

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[3] http://nhd.usgs.gov/.

[4] Drainage area upstream of gage is about 73 square miles.

The southeastern portion of the project lies within the drainage basin of Spring Branch, a tributary of Fourteenmile Creek. Much of the Spring Branch watershed was altered by the construction of Kingsway Dam, which created Upper Lake Camelot, and Sherwood Dam, which created Lake Sherwood Lake in the late 1960's and early 1970's (Evans 2007a, 2007b). Spring Branch is ephemeral upstream of Upper Lake Camelot. During field visits to Spring Branch where it crosses Akron Road on June 14, July 17 and August 16, 2012 and on July 4, 2013 no flow was observed in the channel. Spring Branch at Akron Road is located about 3,000 feet upstream of the upper bay of Upper Lake Camelot (this upper impounded area is known as Walden Pond). Groundwater discharge to Upper Lake Camelot and Lake Sherwood are qualitatively described in Shaw and others (2001).

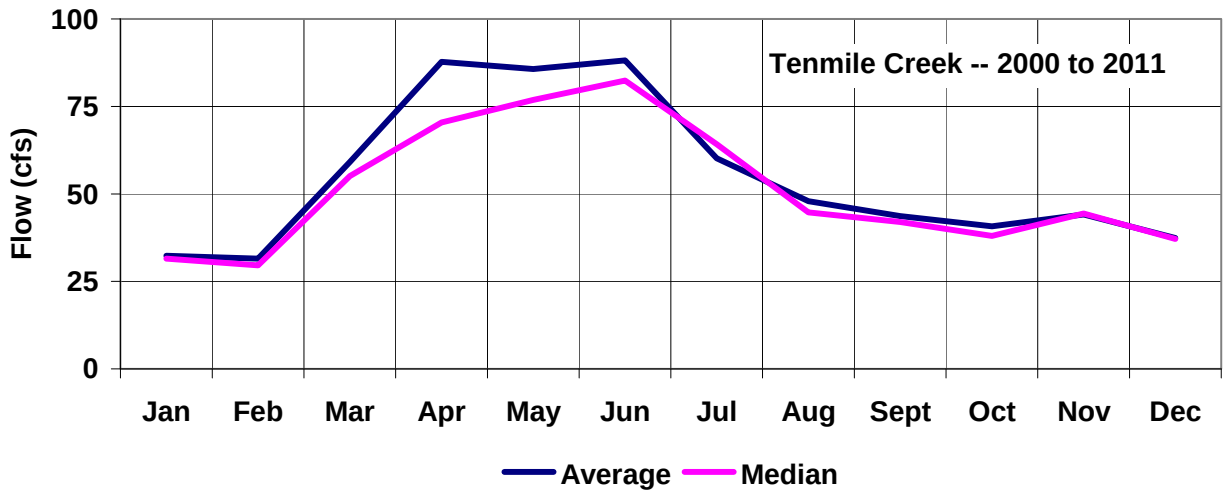
Located about two and one-half miles to the north of Tenmile Creek is Sevenmile Creek. This creek is significantly smaller than Tenmile Creek and it is likely that historical drainage activities diverted a portion of the headwater flow of Sevenmile Creek into Tenmile Creek. Sevenmile Creek has a drainage basin of only about 17 square miles. Flow data for Sevenmile Creek are limited; one measurement is available from July 1999 and data were collected on eight occasions between May 2012 and September 2013 at selected locations along Sevenmile Creek. The most comprehensive flow data were collected on October 3, 2012 when measurements were taken at 11 locations in the reach of Sevenmile Creek downstream of Rangeline Road to its mouth at the Wisconsin River. On this date, flow gradually increased from Rangeline Road to the diversion dam for the cranberry operation located downstream of Hollywood Road where the total flow of about 1.6 cfs was diverted from the stream. Below the diversion dam, the flow gradually increased to about 2 cfs at its mouth. During the summers of 2012 and 2013, Sevenmile Creek was perennial only in the reach from Rangeline Road to the Wisconsin River. All available flow data from Sevenmile Creek are described in Attachment D.

Sevenmile Creek from Rangeline Road to the Wisconsin River is a designated Class I trout stream and is a designated Exceptional Resource Waters (3-mile long reach). Though it is a designated trout stream, water temperatures in the summer are elevated as the result of a large unshaded ponded area in the stream just upstream of the Rangeline Road bridge. On May 24, 2012 the stream water temperature just downstream of the bridge was 69° F at 11:15 am. The picture to the right shows the stream upstream of Rangeline Road on May 24, 2012 where significant ponding occurs.

Section 2
Climatic Conditions and Recharge Rates

For purposes of analyzing the effects of the GSD project, climatic and stream flow data from the twelve year period 2000 through 2011 were used. Average annual precipitation during this period, based on data from the Hancock and Wisconsin Rapids stations, was 32.95 inches. This value approximates the long-term average precipitation in the area and thus it is appropriate to use the period 2000 through 2011 as a reference period for normal climatic conditions. Average stream flow in Tenmile Creek during this period was 54.9 cubic feet per second.

Average values of precipitation and stream flow are significantly influenced by outliers, therefore, for purposes of this analysis median monthly precipitation and median monthly stream flows were used. Median values, which represent conditions that are likely to occur fifty percent of the time, represent expected conditions better than average values. Annual precipitation during the period 2000 through 2011, based on median monthly precipitation, was 30.5 inches. Median streamflow in Tenmile Creek during this period was 51.4 cfs. The graph below compares average monthly and median monthly stream flow in Tenmile Creek from 2000 through 2011.



Tenmile Creek is groundwater fed stream, with minimal surface water runoff except during unusual climatic events. On a long term basis, the difference between the average annual flow of 55 cfs, and the median flow of 51 cfs approximately reflects the amount of surface water runoff in the basin. As a result, the median flows in Tenmile Creek approximates the amount of recharge that occurs within the watershed. Based on median conditions, the annual recharge rate is 9.6 inches in the Tenmile Creek watershed (This is calculated by dividing the flow rate of 51 cfs by 72 square miles, the drainage area upstream of the gage, and making the appropriate unit conversions). Much of the annual recharge occurs in March, April and May, the period in which stream flows increase markedly above winter flow levels.

The difference between the annual precipitation of 30.5 inches per year (based on median conditions) and the recharge rate of 9.6 inches per year is 20.9 inches per year. This difference reflects the amount of evapotranspiration that occurs currently within the Tenmile Creek watershed. Groundwater pumping occurs within the watershed for irrigation but since the groundwater is used within the watershed, the effect of the pumping on the water budget is to increase the annual evapotranspiration rate. If there was no groundwater pumping for irrigation, the estimated annual average evapotranspiration rate would be lower, the estimated recharge rate would be larger, and the annual flow in Tenmile Creek would be larger.

A crucial variable in estimating the effects of irrigated agriculture on groundwater levels and stream flows is the difference in recharge under pre-irrigation conditions and net recharge under irrigated conditions. This difference is termed the "irrigation effect". Researchers at the University of Wisconsin-Stevens Point have published a number of papers in recent years that have attempted to quantify the irrigation effect in the Central Sands Region (Kraft and others, 2012; Kraft and others, 2010; Mechenich and others, 2009). This research has concluded that the irrigation effect is about 2 inches per year (Kraft and others, 2010). It has been noted that there is uncertainty associated with the estimated irrigation effect but it has been suggested that the potential range of the irrigation effect is between 1.6 inches and 4 inches per year depending on the pre-irrigation vegetation type (Kraft and others, 2010).

On irrigated fields in the project area, typically about 14 inches of water will be applied to the fields each year[5]. Some of the applied water will be transpired by the crops, some will be evaporated and the remainder will infiltrate into the subsurface and return back to the water table. In addition, some of the precipitation that falls on the fields will infiltrate into the subsurface and recharge the water table. The total recharge that will occur beneath the irrigated fields will consists of the component of the irrigation water that infiltrates into the subsurface and the component of precipitation that infiltrates into the subsurface. For fields irrigated with groundwater, the concept of "net recharge" is used where "net recharge" is the total recharge minus the amount of groundwater applied to the fields. Thus if 14 inches of water is applied to the fields per year and 10 inches of the applied water recharges the water table per year and 12 inches of precipitation recharges the water table per year, the net recharge is 8 inches per year (10" + 12" - 14" = 8").

[5] Based on data maintained by Wysocki Produce Farms for its irrigated lands in the Central Sands region.

Section 3
Groundwater Model for Evaluating Pumping Effects

The best method available for estimating the potential effect of pumping groundwater on water levels and stream flows is numerical groundwater models. Numerical groundwater models can represent the spatial geometries of the groundwater system, such as thickness of geologic units and spatial locations of pumping wells and headwater streams, and the hydraulic properties of the aquifers. The appropriate representation of spatial geometries and hydraulic properties is essential for estimating the water level changes that have the potential to occur as the result of pumping and the potential rate of propagation of the water level changes to groundwater discharge areas. There are a number of computer programs that are used to develop numerical models of groundwater systems; the most commonly used program is MODFLOW developed by the U.S. Geological Survey.

A regional model of groundwater flow in the Central Sands region has been developed by Mechenich and others (2009) using the MODFLOW program (the model is referred to in this report as the "regional model" and "regional groundwater model"). As this model was based on a comprehensive compilation of available groundwater data, and was consistent with available data, a model similar in structure to the regional groundwater model was used to estimate the effects of groundwater pumping for this project.

The groundwater model that was developed for these analyses encompasses an area of approximately 600 square miles (Figure 6). This model is referred to in this report as the "site-specific model". The site-specific model domain is much smaller than the model domain used in the regional model, but is sufficiently large to include all of the important factors and processes that are relevant to understanding the effects of pumping for irrigation of project lands and the proposed dairy. The eastern boundary of the model domain is the groundwater divide between the Wisconsin River and Wolf River drainages, the western boundary is the Wisconsin River and Petenwell Lake, the northern boundary is the Little Plover River and the southern boundary is the downstream portion of Big Roche-A-Cri Creek. Major streams in the site-specific model domain, all of which are tributaries to the Wisconsin River, include headwaters of Big Roche-A-Cri Creek, Fourteen Mile Creek, Tenmile Creek, Sevenmile Creek, Fivemile Creek, and Buena Vista Creek, Twomile Creek and Onemile Creek.

A modified version of the finite-difference computer program MODFLOW-2000 developed by the U.S. Geological Survey was used for the site-specific model. This version of MODFLOW (Bedekar et al. 2011) was developed by SSP&A for the U.S. Department of Energy (CHPRC-00258 Rev 2) to handle dry cells in a manner similar to MODFLOW-SURFACT and MODFLOW-NWT. The graphic-user-interface Groundwater Vistas was used to prepare groundwater model input files and to evaluate model results. The model finite-difference grid and model input parameters are described below.

The modeled effect of the long-term pumping of groundwater within the model domain is to lower groundwater levels in the immediate vicinity of the pumped wells and to decrease groundwater discharge to streams. The modeled reduction that occurs in groundwater discharge is a function of the length of time that the well is pumped. When a well is initially pumped, all of the water that is pumped comes from groundwater in storage in the aquifer as a result of a lowering of the water table in the vicinity of the well, and initially there is no reduction in groundwater discharge to streams. As a well is pumped for a longer period of time, water-table declines eventually propagate to the groundwater discharge areas at the headwater streams, and a reduction in groundwater discharge occurs. Theoretically, if a well is pumped at a constant rate for a very long period of time, water-table declines stabilize and the reduction in groundwater discharge equals the pumping rate.

Groundwater pumping for irrigated agriculture currently occurs within the model domain. The locations of high capacity wells in the model domain, with average annual pumping rates during the period 2007 to 2011, are shown on Figure 4 (only wells with median pump rates of greater than 4 million gallons per year are shown). Most of the high capacity wells are located in the eastern part of the model domain to the east of the project area. Almost all of the high capacity wells are used for irrigation. This pumping primarily occurs during the summer growing season of June through August. This pumping has resulted in a lowering of the water table, has resulted in a decrease in groundwater discharge, and has resulted in a decrease in stream flows relative to conditions that would have existed had no pumping ever occurred. The magnitudes of the lowering of the water-table and stream flow reductions that have occurred in the area as a result have not, however, been measured. Existing conditions, with the current pumping, were the baseline conditions from which impacts of the proposed pumping were determined.

Finite-Difference Grid and Boundary Conditions

The site-specific model grid consists of 117 rows and 142 columns. A model grid spacing of 650 feet by 650 feet is used in the vicinity of the proposed project where most effects on groundwater levels and stream flows will occur; large grid spacings are used elsewhere. Four layers are represented in the model: model layer 1 represents approximately the upper saturated portion of the sand and gravel aquifer; model layer 2 represents fine-grained layer that occurs within the sand and gravel aquifer in the project area[6], model layer 3 represents the lower part of the sand and gravel aquifer and model layer 4 represents the sandstone aquifer where present. The sand and gravel aquifer was modeled as three layers so that the hydrologic effects of the areally extensive fine-grained layer could be represented.

The base of the sand and gravel layer (model layer 3) was developed from an analysis of available data on the elevation of the top of the bedrock in the model domain. These data are described in Attachment C. The base of model layer 4 was derived from the contour map representing the bottom of sandstone in Mechenich and others (2009), which is generally consistent with the thickness of the sandstone unit as depicted in Olcott (1992) and sandstone

[6] Where the fine-grained layer is not present within the model domain, layer 2 is assigned a nominal thickness of 1 foot and a high vertical conductivity .

thickness data as reported in lithologic logs. The base of the sand and gravel aquifer as represented in the site-specific model is shown on Figure 7 and the base of the sandstone aquifer as represented in the site-specific model is shown on Figure 8.

A no-flow boundary is used to represent the regional groundwater divide, while the rivers and streams that bound the domain to the north, west and south are simulated with constant head boundaries. The heads specified along these constant-head boundaries were derived from 1:24,000 scale U.S. Geological Survey topographic maps.

The streams within the model domain were all modeled with the MODFLOW drain package except for Nepco Lake, which was simulated with the MODFLOW river package. Elevations at each model cell were determined based on visual analysis of 1:24,000 USGS topographic maps. Drain conductances were specified consistent with the assumption of a well connected stream.

Recharge

Variable recharge rates were specified for the model domain using the MODFLOW recharge package. Annual and monthly recharge values were estimated in the model calibration process as described below. For purposes of model calibration, two recharge zones were defined. A zone in the western part of the model domain where there are extensive conifer plantings, and a zone in the eastern part of the model domain. The recharge zones in the model domain are shown on Figure 9.

Pumping

There are a total of about 816 high-capacity wells within the model domain that had an average pumping rate of greater than 4 million gallons per year during the period 2007 to 2011. The total annual pumping rate from these wells during the period 2007 through 2011 was about 24 billion gallons per year (equivalent to about 45,700 gallons per minute). These wells and average pumping rates are listed in Attachment E[7]. The average pumping rates are the average annual 2007 to 2011 pumping rates as reported by the WDNR; however, for wells that only had 2012 pumping rates reported, the 2007 to 2011 average rates were estimated based on the ratio between the 2012 pumping rates and the average rates in 2007 to 2011 reported for wells in the area.

These wells were simulated with the MODFLOW well package using the average pumping rates for the period 2007 to 2011 from each of the active high capacity wells in the

[7] Irrigation pumping data obtained from the Wisconsin Department of Natural Resources database; http://prodoasext.dnr.wi.gov/inter1/hicap$.startup and from Kathleen Mooney, IT System Developer, DNR, Madison.

model domain and additional recharge to reflect increases in recharge as a result of irrigation pumping[8].

Model Parameters

The important parameters in the groundwater model are the horizontal hydraulic conductivity in the different model layers, and the vertical hydraulic conductivity of the fine-grained layer (model layer 2). The horizontal hydraulic conductivity in the sand and gravel aquifer was estimated in the model calibration process described below. Based on well testing data, the horizontal hydraulic conductivity in the sand and gravel aquifer within the model domain was estimated to be between 46 and 734 feet per day, the distribution of which is described in Attachment D. The horizontal hydraulic conductivity of the sandstone aquifer is represented by a single zone and estimated to be 10 feet per day. The vertical hydraulic conductivity of the fine-grained layer was calibrated as 0.3 feet per day as described below.

Model Calibration Process

The automated model calibration computer program "PEST - Model Independent Parameter Estimation" (*PEST*) was used to assist with model calibration (Doherty, 2009). A groundwater model is deemed calibrated when the difference between model outputs and field observations, referred to as calibration targets, has been reduced to a minimum in the weighted least squares sense [i.e., the sum of squared differences between model outputs and measurements, termed the objective function or PHI (Φ)]. Model calibration is an iterative process that seeks to reduce Φ by determining the sensitivity of the model parameters to the calibration data. When the calibration process can no longer reduce Φ (i.e., $\Phi = \Phi_{min}$), the parameters are considered optimal with respect to the measured data set and may be used to make predictions under conditions comparable to the calibration conditions. The computer program PEST automates the procedure of determining the minimum value of Φ.

The first step in the model calibration process is the identification of measured hydrologic data that can be used as calibration targets. Two sets of calibration targets were identified: water levels in monitoring wells, and measured stream flows. Water levels at 572 wells in the sand and gravel aquifer (as described in Attachment C), and base stream flows at nine locations (as described in Attachment D) were used in the model calibration process.

All calibration targets that were identified are intended to represent average, baseline hydrologic conditions. As a result, the calibration process consisted of the development of a groundwater model to simulate average, baseline conditions. In the calibration of this model, since monthly flows were available for Tenmile Creek, the model was run in monthly time steps. The monthly average flows in Tenmile Creek and calculated average annual water levels and flows at other targets were used to judge the goodness of the model calibration. In this

[8] In simulating the irrigation pumping it was specified that during the irrigation season that 75 percent of the pumped water was consumed and on an annual basis that 20 percent of the pumped water was consumed. A discussion of consumptive use is contained in Attachment G.

groundwater model, the variable parameters are the distribution of hydraulic conductivity, the magnitude of hydraulic conductivities, the storage properties of the aquifer units and the monthly recharge rates. For purposes of model calibration the storage properties were specified as a specific yield of 0.25 and a specific storage of 10^{-6} per foot. In some circumstances, a model of this type has other variable parameters (such as thickness of geologic units and recharge rate), but in this study, the thickness of the permeable glacial aquifer and the recharge rates were assumed to be known.

The second step in the model calibration process is the identification of conditioning information on model parameters. Two types of conditioning information were identified: geologic information and estimates of aquifer hydraulic conductivity from specific capacity tests on 60 high capacity wells within the model domain (refer to Attachment B). The known geologic information was the presence of the fine-grained unit. The hydraulic conductivity of the sand and gravel aquifer based on the specific capacity tests ranged between 46 feet per day and 734 feet per day and the hydraulic conductivity of the sandstone aquifer ranged between 1 and 159 feet per day[9].

In using PEST, a technique known as pilot-points was used to estimate the spatial distribution of parameter values. The parameter estimation program, PEST, estimates values for each pilot-point and these discrete estimates are then transformed (via kriging-interpolation) into a continuous hydraulic conductivity field that is used by the model. The calibration introduced variability or heterogeneity that was supported by the calibration data; the degree of heterogeneity introduced was controlled by using preferred-value regularization (Doherty, 2009). The preferred-value scheme is used here because of the available specific capacity tests. By using a preferred-value scheme a calibrated pilot-point value differed from its initial value only if there was a marked improvement in the fit of the model to the calibration data (a reduction in Φ). While the specific capacity tests in the sandstone aquifer suggested some variability in the hydraulic conductivity, there is insufficient head data in this unit to warrant a pilot-point calibration, so a uniform zone is used.

The third step in the calibration process is automated calibration using the computer program PEST. The result of this step is the calibrated groundwater model. The calibrated hydraulic conductivity of the sand and gravel aquifer varied from about 100 feet per day in the western portion of the model domain to 250 feet per day in the eastern portion of the model domain (Figure 10). The calibrated vertical hydraulic conductivity of the fine-grained unit (model layer 2) is 0.3 feet per day, but sensitivity analyses indicated that model results are not very sensitive to this parameter if it is varied by plus or minus an order of magnitude. The calibrated hydraulic conductivity of the sandstone aquifer was 10 feet per day. The calibrated annual recharge rate in the eastern zone is 10.2 inches per year and the calibrated annual

[9] In an area to the north of the model domain in the Central Sand Region, Bradbury and others (1992) estimated based on 10 pumping tests that the hydraulic conductivity of the sand and gravel aquifer ranged from 70 feet per day to 200 feet per day in the region investigated. The hydraulic conductivity of the Mt. Simon Sandstone was estimated by Bradbury and others (1999) to the south of the model domain in Dane County to range between 6 and 31 feet per day based on 14 pumping tests.

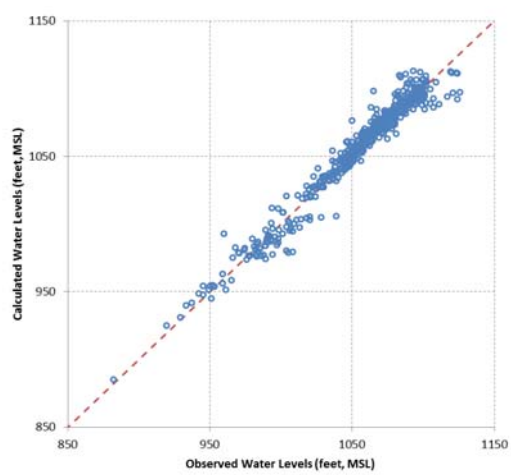
recharge rate in the western zone is 8.7 inches per year. The calibrated monthly recharge rates are listed below. The difference in recharge rates between the two zones is the result of differences in vegetation types between the zones.

	Average Monthly Recharge Rate (inches)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eastern Zone	0.0	0.3	2.3	3.1	2.1	1.7	0.0	0.0	0.0	0.2	0.5	0.0
Western Zone	0.0	0.3	2.1	2.8	2.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0

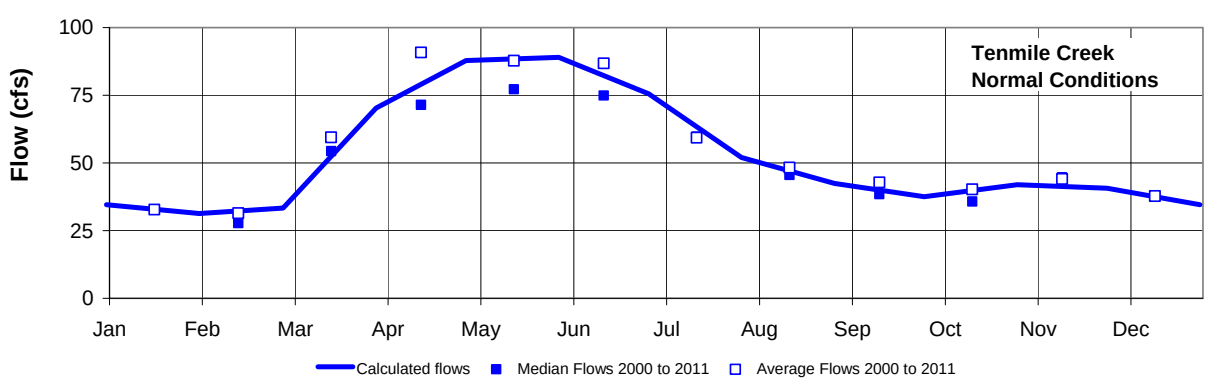
A monthly water balance for the model domain was developed from these recharge rates. The components of the water balance are precipitation, evapotranspiration, change in soil water content and the recharge rate. The monthly water balances are described in Attachment F.

Model Calibration Results

The calculated average water table in the calibrated model is shown on Figure 11. Also shown on Figure 11 are the differences between model calculated water levels and observed water levels at locations included in the calibration process. Overall the model calculated water levels and the observed water levels are similar. The conventional way to qualitatively judge the goodness of a model calibration is to examine a plot of observed versus calculated water levels; if the match between observed and calculated water levels is excellent all of the data points plot on a straight line. Such a plot is shown to the right and it shows excellent correspondence between observed and calculated water levels.



The model calculated base stream flows are listed and compared to measured stream flows on Table 1. Except at a few headwater streams, the comparison between observed and model calculated stream flow is good. A comparison of model calculated and measured average monthly flows in Tenmile Creek at the gaging location at Highway 13 is shown below. The comparison is excellent.



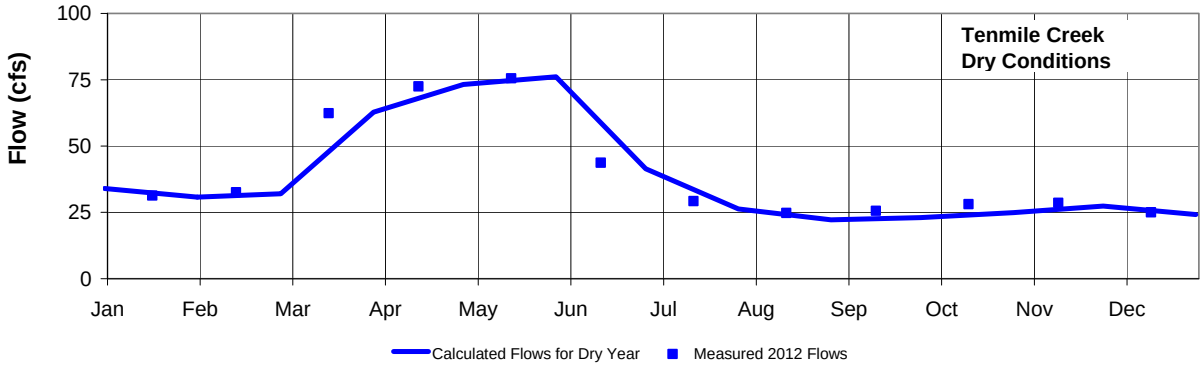
As a result of the favorable comparison of observed and calculated groundwater levels and stream flows, we concluded that the site-specific model appropriately represented the groundwater system in the project area. Thus, we concluded that the site-specific model was an appropriate method to use to evaluate the effects of pumping for the project.

Section 4
Evaluation of Effects of GSD Pumping

Dry Year Conditions

In calculating impacts of groundwater pumping, effects in a normal year as well as effects in years that are drier than normal are of interest. For purposes of simulating dry year conditions, climatic data from 2012, which was a year with a hot and dry summer, were used to estimate monthly recharge rates for a dry year evaluation. The estimated annual recharge rate for the dry year in the eastern recharge zone is 6.5 inches and in the western recharge zone is 5.0 inches. The estimated monthly recharge rates in a dry year, based in part on 2012 conditions, and a monthly water balance for the dry year evaluation are described in Attachment F.

For purposes of calculating the impacts of groundwater pumping in a dry year, the site-specific model was run for 48 years with recharge rates and pumping from existing irrigation wells at rates representing conditions in normal years and then the model was run for an additional year with the dry year recharge rates and rates for existing irrigation wells specified at 153 percent of average rates between 2007 and 2011[10]. The model calculated flows in Tenmile Creek at Highway 13 for this dry year are compared to measured monthly flows in 2012 on the graph below.



Effects of Groundwater Pumping

The site-specific model was used to evaluate the effects of Golden Sands Dairy's proposed wells on stream flows and groundwater levels under "normal conditions" and "dry conditions". The effects from as all of the proposed wells as well as the effects from each of the six high capacity well systems were evaluated. For purposes of simulating the proposed wells

[10] The factor of 153 percent is based on the pumping data reported to the DNR for the high capacity wells within the model domain. The total pumping in the model domain in 2012 was approximately 153 percent greater than the average annual pumping in 2007 through 2011.

the project was specified as consisting of 37 new high capacity irrigation wells and one existing irrigation well that are used to irrigate 4,660 acres. In addition, pumping for the dairy was simulated at 250 gpm during the three summer months and 103 gpm during the remainder of the year (annual pumping of 72.5 million gallons)[11]. All of the proposed high capacity wells were specified as being completed in the sand and gravel aquifer (model layer 3). Irrigation water was specified as being applied at the land surface equally across the 4,660 acres proposed for irrigation. The model was run in transient mode with monthly time steps for fifty years to simulate the groundwater pumping and water application to the fields.

Normal conditions are based on median monthly hydrologic conditions during the twelve year period 2000 through 2011 and dry conditions are based on hydrologic conditions in 2012. In the normal year, two irrigation scenarios were simulated: one in which 14-inches of irrigation water is applied to the fields during the irrigation season (this is the expected irrigation rate in a normal year based on data from water use)[12] and a second in which 11.5 inches of irrigation water is applied to the fields during the irrigation season.[13] In the dry year, in the modeling analyses it was specified that 21.2 inches of water is applied during the irrigation season. The dry year irrigation rate is estimated based on actual irrigation rates in 2012 on fields farmed by the Wysocki's east of the Golden Sands Dairy Project and fields at the Central Sands Dairy and it corresponds to the consumption by the crops of 70 percent of the applied water. Monthly irrigation rates for both normal year simulations and the dry year simulation are listed in Attachment F.

On the basis of initial evaluations of the effects of the project on stream flows, irrigation and dairy well locations were adjusted to minimize declines in the flow of Sevenmile Creek. The well locations were moved to the south such that effects on Tenmile Creek were larger and effects on Sevenmile Creek were smaller relative to those calculated with initial locations. The results described below are based on the final well locations.

The calculated stream flows in Sevenmile Creek and Tenmile Creek in the normal year and in the dry year both without and with pumping for the Golden Sands Dairy Project are shown on Figure 12 and listed on Table 2. Calculated stream flows are shown for Tenmile Creek

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[11] The water for the Production Area was all specified as pumped from well D1 which will be located about ½ mile south of the Production Area. Well D2, which will be located on the southern boundary of the Production Area, is specified as being used only for emergency water supply. When evaluating the project, it was specified that recharge at the Production Area would increase by the equivalent of 9.5 million gallons per year due to a decrease in evapotranspiration at the Production Area after conversion from pine plantation to a dairy. When evaluating High Capacity Well System No. 1, which includes the dairy wells, this increase in recharge at the Production Area was not included in the evaluation.

[12] An irrigation rate of 14 inches per year in an average year is based on data from fields at the Central Sand Dairy and fields currently farmed by the Wyscoki's that are located immediately to the east of the Golden Sands Dairy Agricultural Fields.

[13] The second scenario was simulated in response to comments from DNR suggesting that 14 inches of irrigation water in a normal year was inconsistent with common practices in the Central Sands region. The irrigation rate of 11.5 inches per year is based on 80 percent of the water applied to fields during irrigation season (irrigation water plus precipitation) being consumptively used. The first scenario with 14 inches of irrigation water applied corresponds to approximately 70 percent of applied water being consumptively used.

at Highway 13 (location of U.S. Geological Survey gage) and at County Highway Z (just upstream of the mouth of the creek) and stream flows are shown for Sevenmile Creek at Rangeline Road (near the beginning of the perennial reach of this stream) and at County Highway Z (just upstream of the mouth of the creek). The effects of pumping from the proposed wells are small. On most of the hydrographs shown on Figure 12 it is difficult to distinguish calculated flows without the project from calculated flows with the project as the graphs overlap.

A commonly used measure to assess the potential biological significance of a steam flow reduction is the change in the median August flow of a stream (also called the index flow) (Hamilton and Seelbach, 2010; Armstrong and Parker, 2003, and U.S. Fish and Wildlife Service, 1981). The calculated median August stream flow in Tenmile Creek at Highway 13 is 39.9 cfs.[14] The estimated change in August flow at Highway 13 due to the proposed wells is about 1.0 cfs, which represents approximately a 2.5 percent reduction in the median August stream flow. The calculated median August flow at the mouth of Tenmile Creek is 46.4 cfs and the calculated effect of the project is to reduce this flow by 4.7 percent. The stream flow changes in Tenmile Creek are below thresholds commonly used for determination of an adverse impact in a cool, warm transition, stream such as Tenmile Creek (Hamilton and Seelbach, 2010). The median calculated August flow in Sevenmile Creek near the mouth is 3.9 cfs and the calculated median August flow at Rangline Road is 1.7 cfs; the calculated effect of the project is to decrease the median flow by less than 1 percent. These are small stream flow changes and below thresholds for determination of an adverse resource impact.

The calculated changes in average annual flows based on the normal year (which simulates median monthly flows) and the dry year are tabulated on Tables 4 through 6. Results are shown both for normal year simulation with 14 inches of irrigation water (Table 4), normal year simulation with 11.5 inches of irrigation water (Table 5), and dry year simulation (Table 6). Also listed on the tables are calculated changes in median August and September flows in streams in the vicinity of the GSD project. The total calculated change in stream flows as the result of the proposed wells in a normal year is 1.6 cfs. Most of the flow change occurs in Tenmile and Sevenmile Creeks; total change in these two creeks is 1.3 cfs. In additional, there is an approximately 0.1 cfs reduction in the flow of the Fourteenmile Creek drainage, and the other flow changes of 0.2 cfs represent reductions in direct groundwater discharge to the Wisconsin River and small flow changes in other streams in the model domain.

The calculated changes in water levels in the sand and gravel aquifer are very small. These calculated average water level changes in July in the dry year, the month with the highest rates of irrigation pumping, are shown on Figure 13. The maximum water level change on lands outside of the irrigated fields is less than five feet, with the exception of a small corner of the properties located southwest of proposed irrigation wells W-20 and W-25. Attachment H contains maps showing the calculated drawdowns for the individual high capacity well systems in July of the dry year.

[14] The median August flow based on stream flow records from 2000 through 2011 is 45.54 cfs which is slightly larger than the calculated median August flow.

Cumulative Effects

An estimate of the changes in the base flows of streams in the model domain that may occur in the future as the result of increases in irrigation pumping was calculated using the site-specific groundwater model. Two factors were included in this analysis: 1) lands within the Sevenmile Creek and Tenmile Creek watersheds that have the potential for conversion to irrigated agriculture and 2) high capacity wells permitted in 2012 and 2013.

A determination of the potential for conversion of lands with the Sevenmile Creek and Tenmile Creek watersheds to irrigated agriculture was made by reviewing land use on each parcel shown on plat maps within the Sevenmile Creek and Tenmile Creek and then assessing likelihood of conversion to irrigated agriculture. A parcel within the watershed that is not currently irrigated was deemed to have the potential for irrigated agriculture unless: 1) the parcel was too small for conversion or is a home site; 2) the parcel is government owned, owned by a conservation group, or has a deed restriction prohibiting irrigated agriculture, 3) parcel is identified as a wetland, 4) parcel is located within a city, is commercial, is a farmstead, or is a gravel pit; or 5) conversion of parcel is prohibited by zoning (Townships of Saratoga and Rome have local zoning restrictions on irrigated agriculture). A total of approximately 4,500 acres within the watersheds were identified as having the potential for conversion to irrigated agriculture; currently about 12,000 acres with the watersheds are used for irrigated agriculture.

All irrigation wells permitted in 2012 and 2013 by the Department in the model domain were identified. The locations of these wells are shown on Figure 4. Groundwater pumping from these wells and groundwater pumping for the lands identified as having potential for conversion to irrigated agriculture within the Sevenmile and Tenmile watersheds were then included in the analysis of existing irrigation wells[15].

The additional irrigation pumping that may occur in the future is calculated to reduce, in the long term, the annual flow of Tenmile Creek by approximately one cfs (2%) and to have a negligible effect on flow of Sevenmile Creek. The calculated average annual base flows in Sevenmile Creek and Tenmile Creek with the potential future irrigation pumping are listed on the table below. These calculated cumulative flow reductions that could result from additional irrigation pumping for lands not in irrigated agriculture as of 2011 were developed to provide an understanding of the magnitude of flow changes in Sevenmile Creek and Tenmile Creek in the future. The calculated cumulative flow reductions are small.

[15] The irrigation wells permitted in 2012 and 2013 were specified as pumping sufficient water to supply 12 inches of water per year to irrigated fields. Wells with permitted maximum capacities of 900 gpm or greater were specified as supplying water to 130 acres, smaller wells were specified as supplying water to 65 acres. The lands identified in the watershed for conversion to irrigated agriculture were specified as being supplied with 14 inches per year of irrigation water annually, except for lands in areas with a shallow water table for which 12 inches per year of irrigation water were specified. For these lands it was specified that 130 acres would be irrigated in each 160 acre parcel.

Location	Model Calculated Base Flow Normal Year (cfs)				Change in Flow as a Result of Future Irrigation Pumping
	Flow with Irrigation Pumping Existing as of 2011	Flow with Existing and Future Irrigation Pumping	Flow with Existing and GSD Irrigation Pumping	Flow with Existing, Future, and GSD Irrigation Pumping	
Tenmile Creek near Nekoosa	52.13	50.93	51.74	50.54	2.3%
Tenmile Creek at mouth	58.81	57.60	57.55	56.34	2.1%
Sevenmile Creek at Rangeline	1.70	1.67	1.69	1.66	1.3%
Sevenmile Creek at mouth	3.95	3.93	3.93	3.90	0.6%

Section 5
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FIGURES

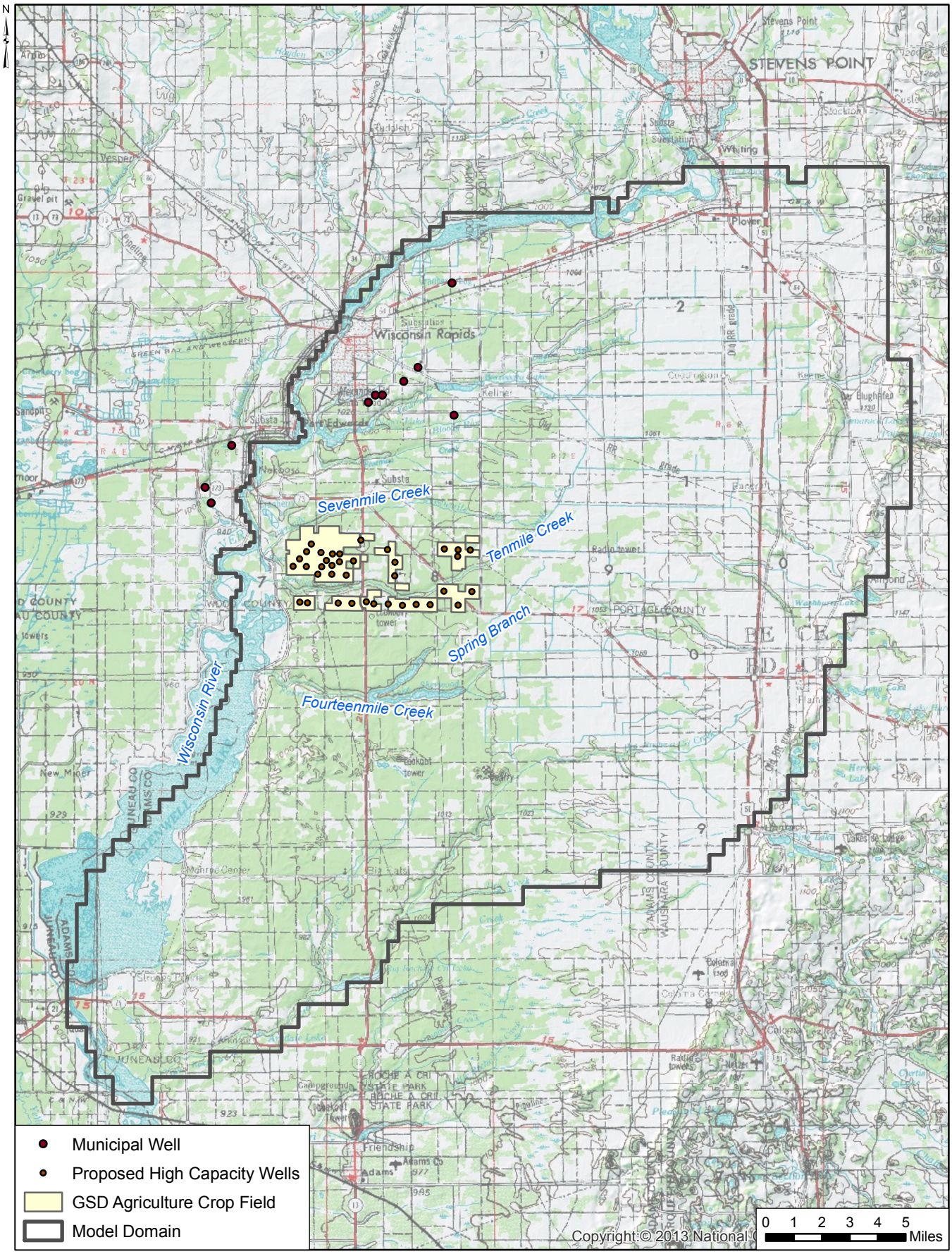


Figure 1 Location Map

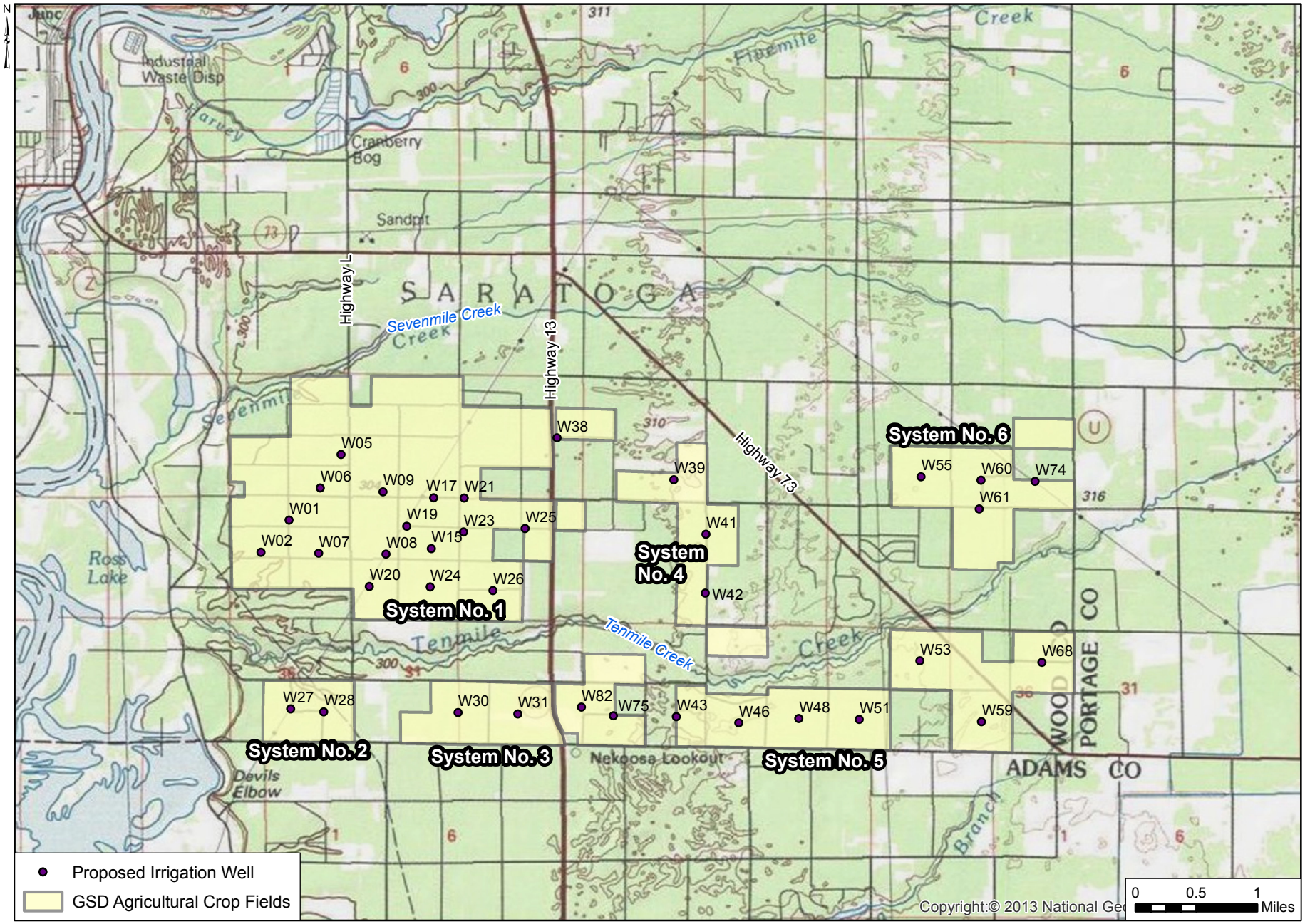


Figure 2 Proposed Irrigation Wells and Irrigated Fields

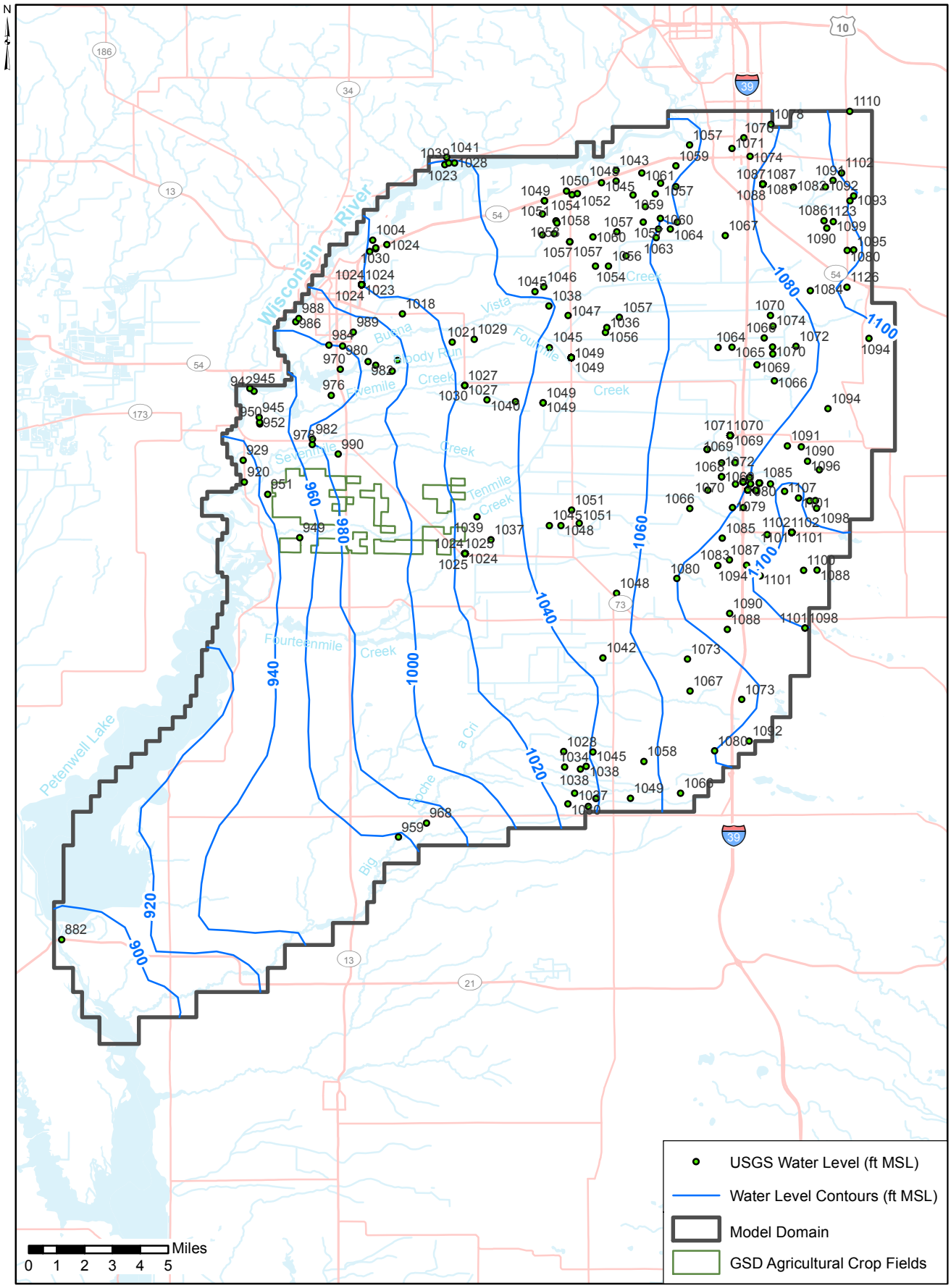


Figure 3 Groundwater Levels in the Sand and Gravel Aquifer (1970 to 1979)

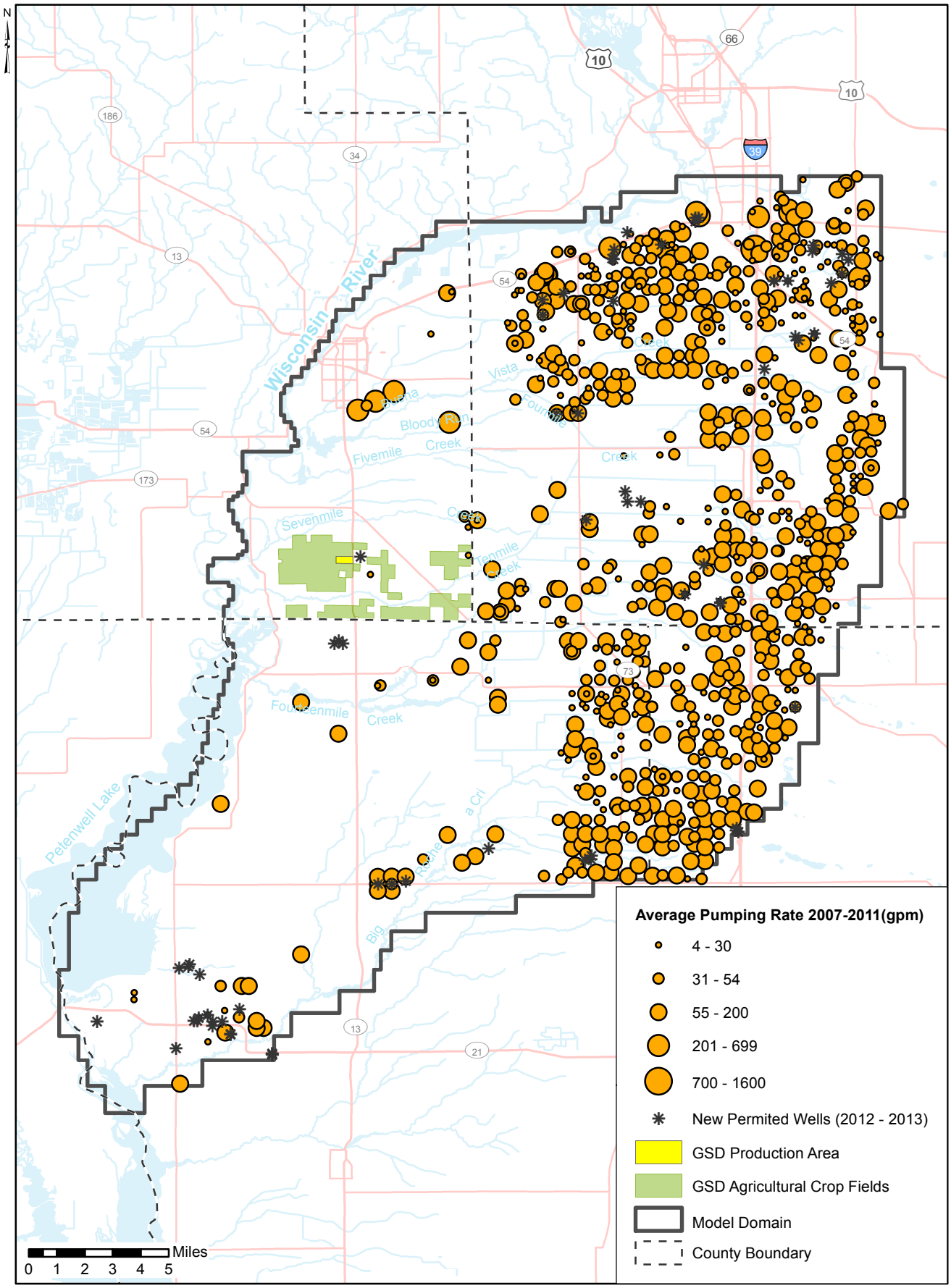


Figure 4 Location of High Capacity Wells in Model Area

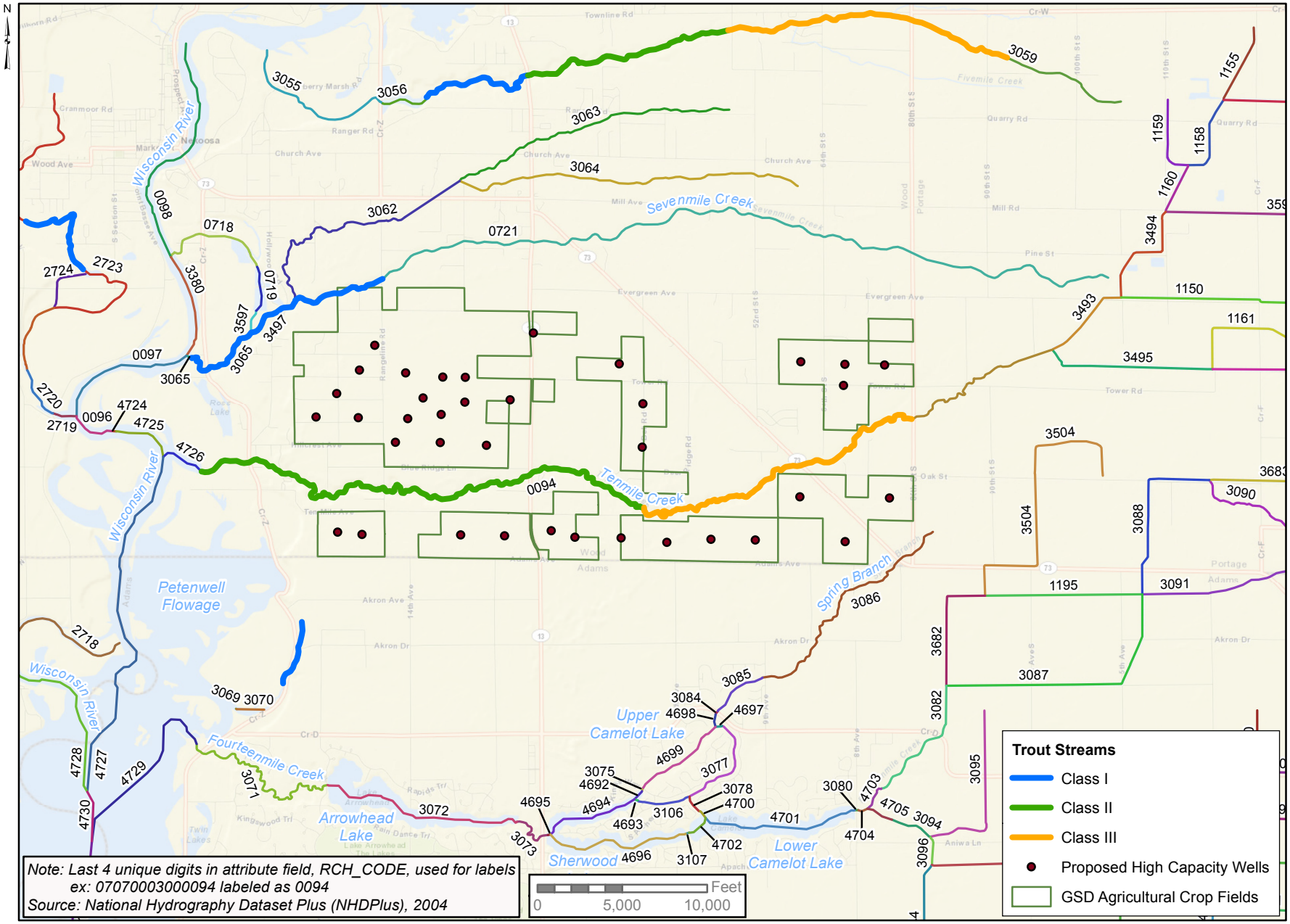


Figure 5 Stream Segments in the Project Vicinity

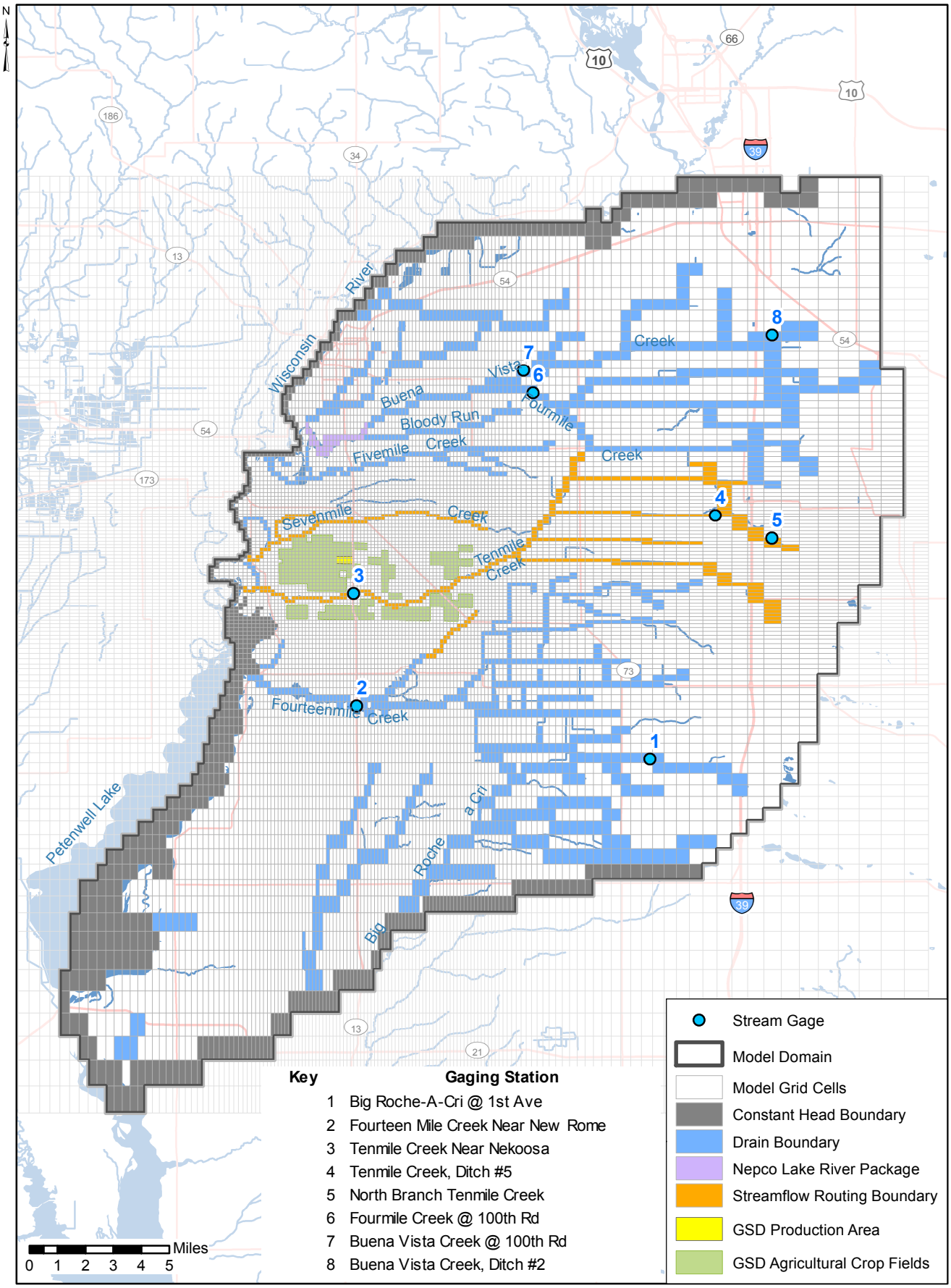


Figure 6 Model Domain and Boundary Conditions and Stream Gaging Locations

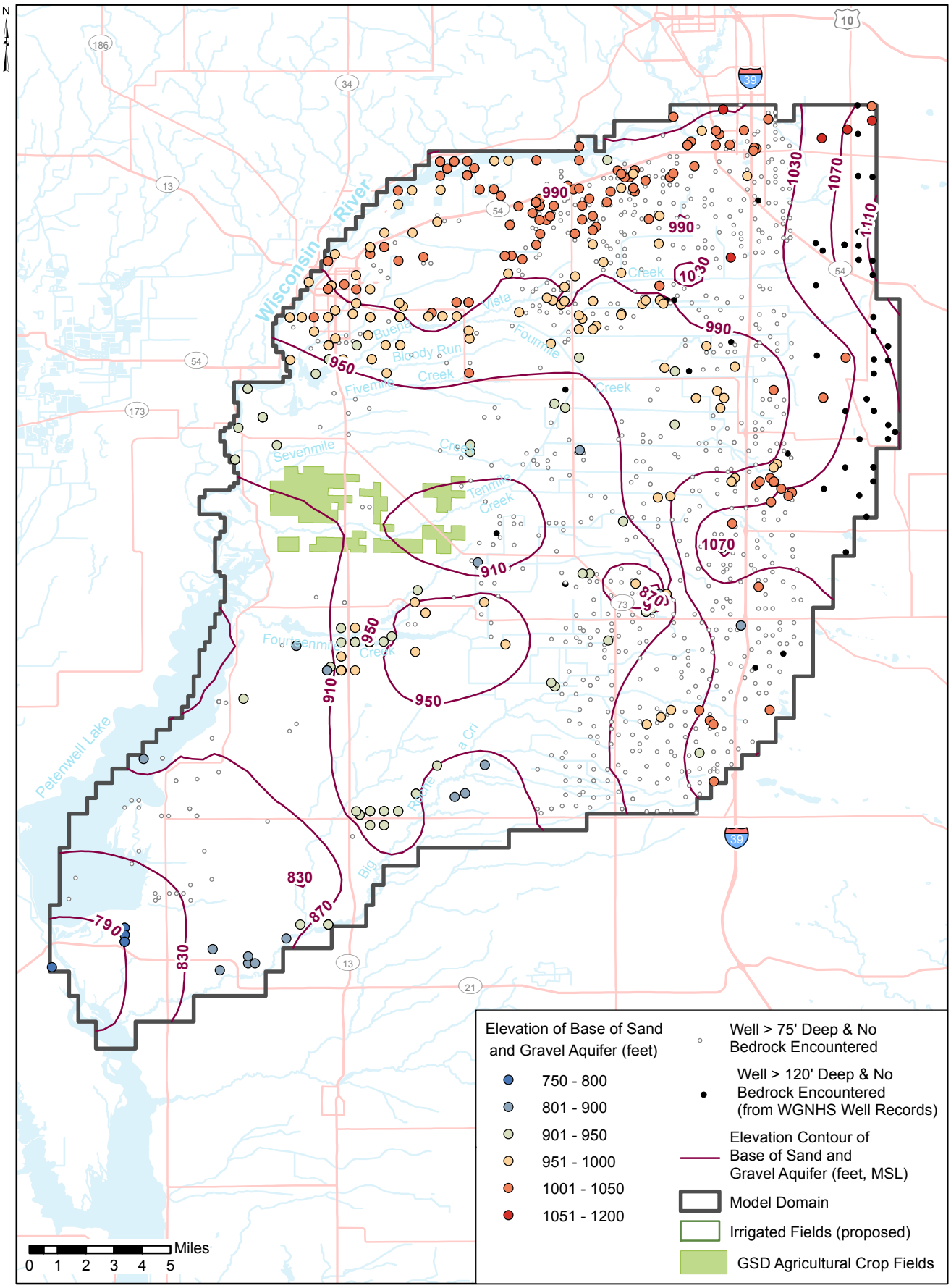


Figure 7 Base of the Sand and Gravel Aquifer

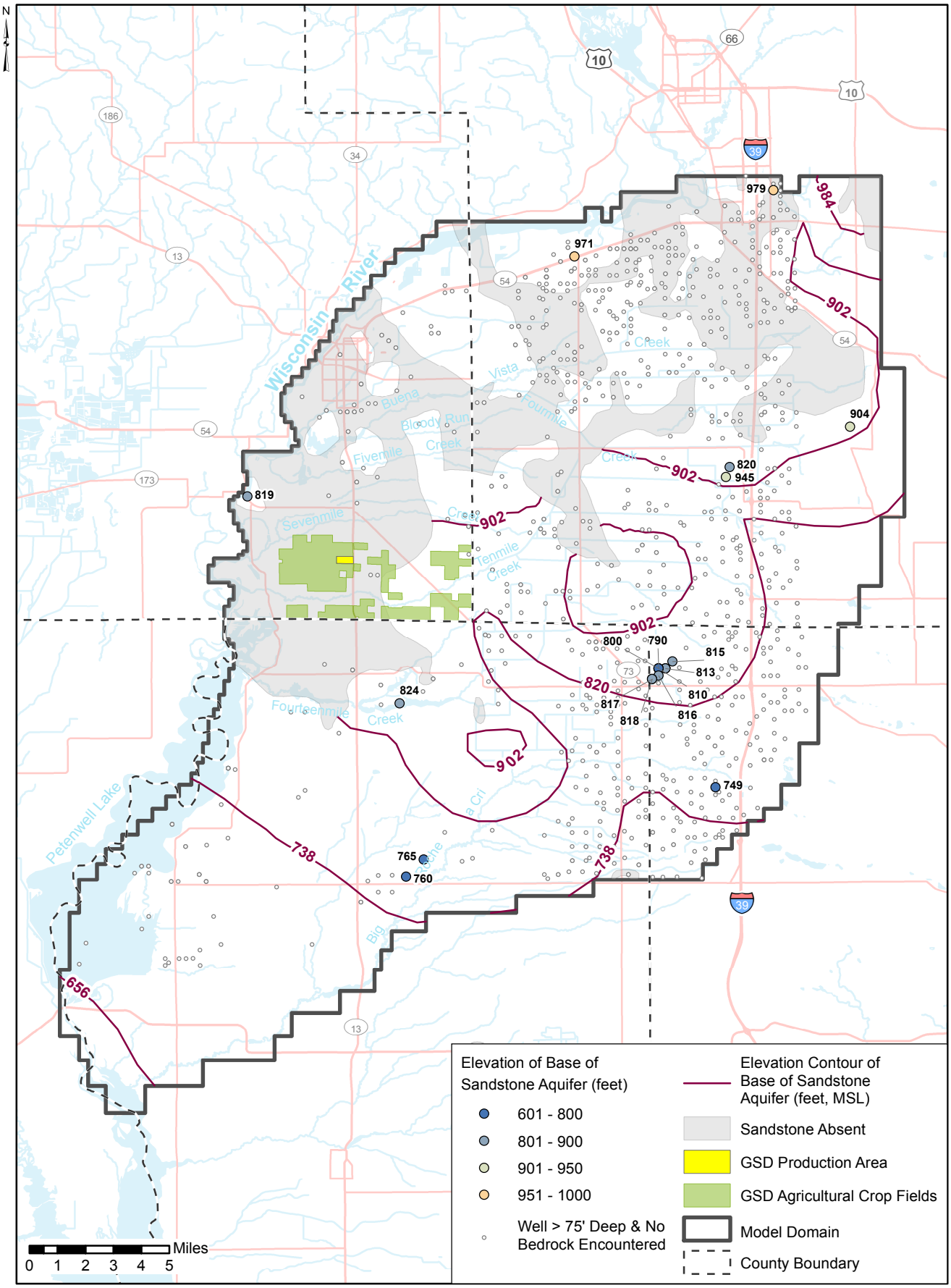


Figure 8 Base of the Sandstone Aquifer

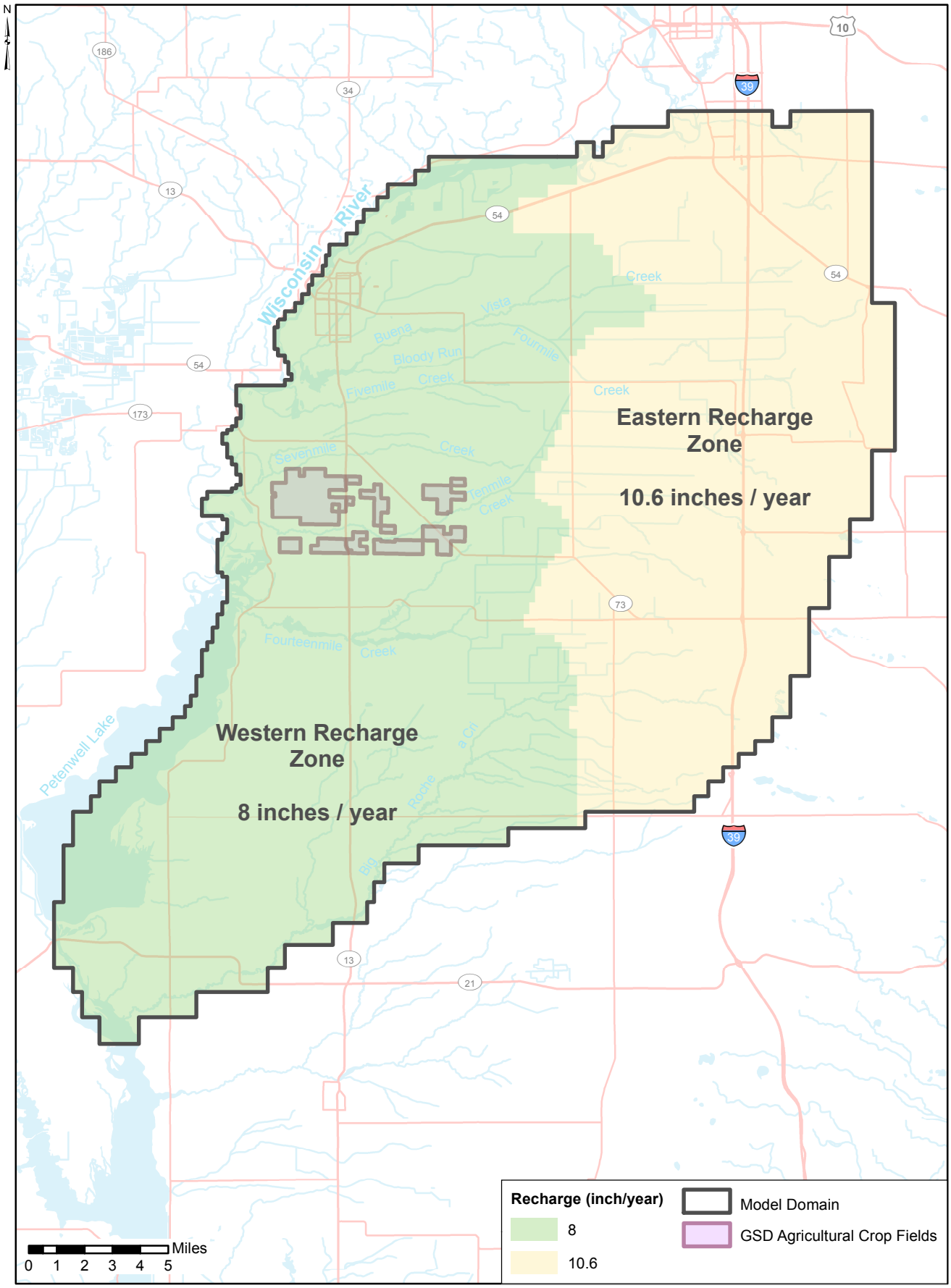


Figure 9 Recharge Rates

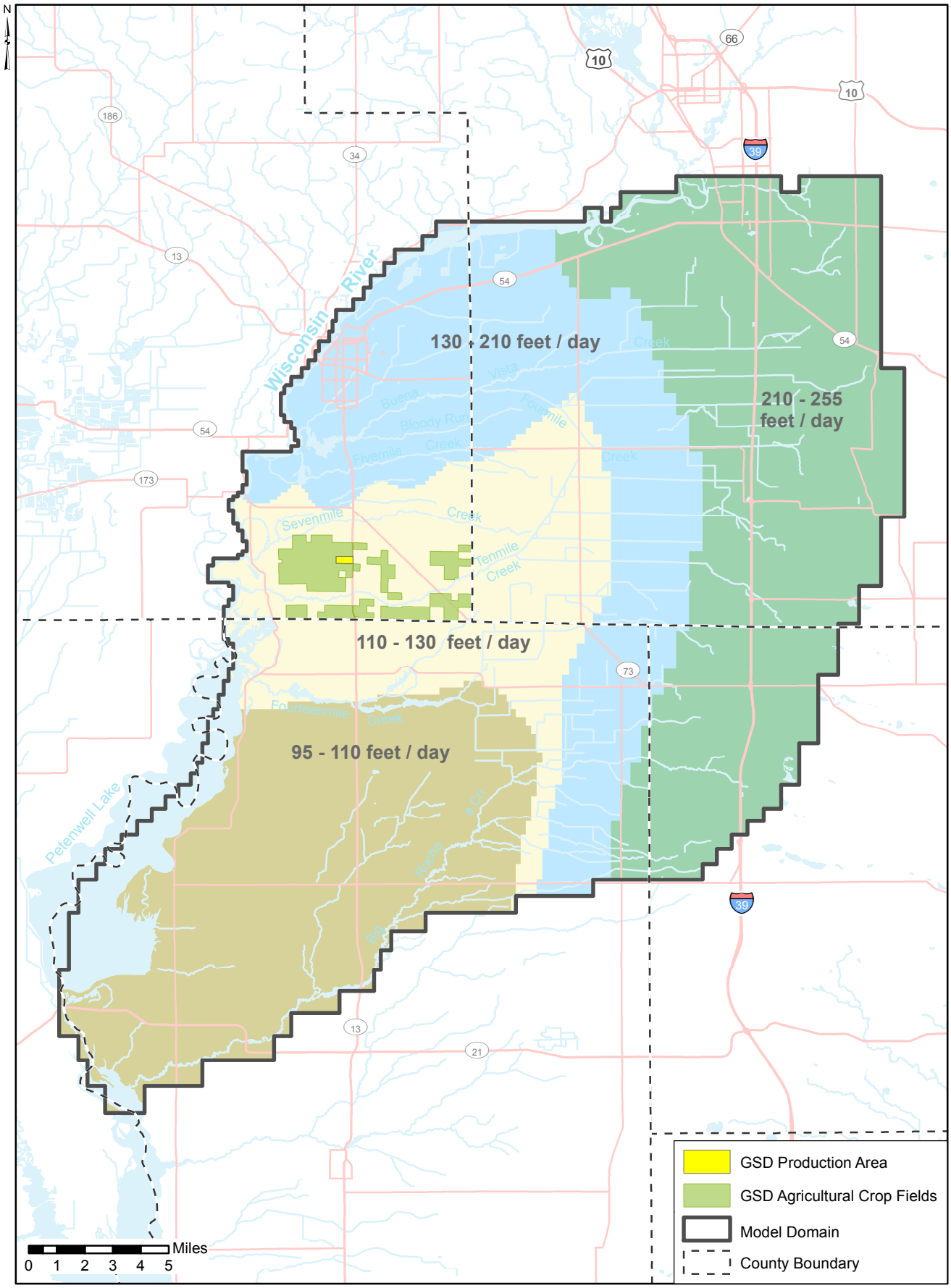


Figure 10 Calibrated Hydraulic Conductivity of Sand and Gravel Aquifer

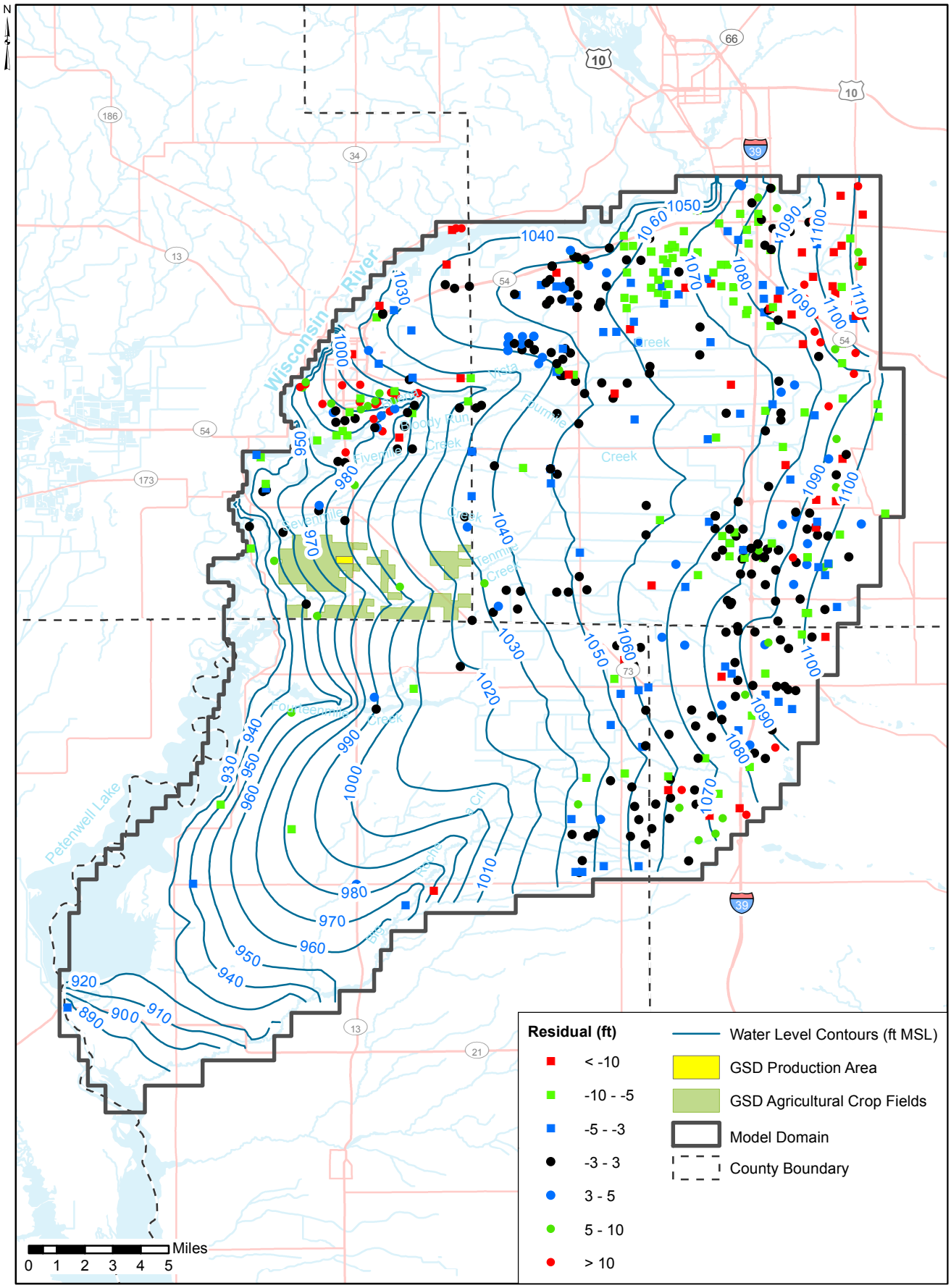


Figure 11 Calculated Water Levels in Model Area

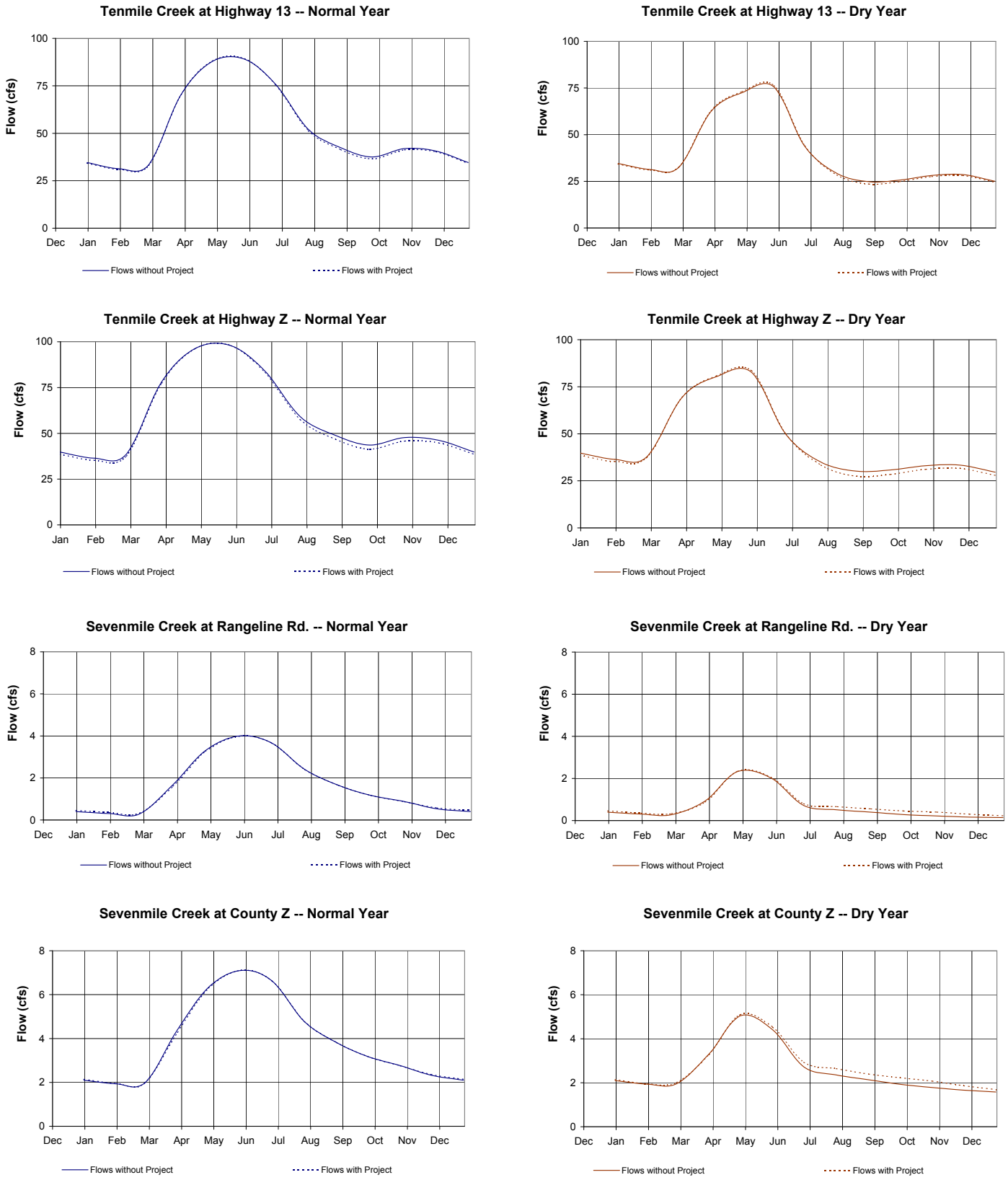
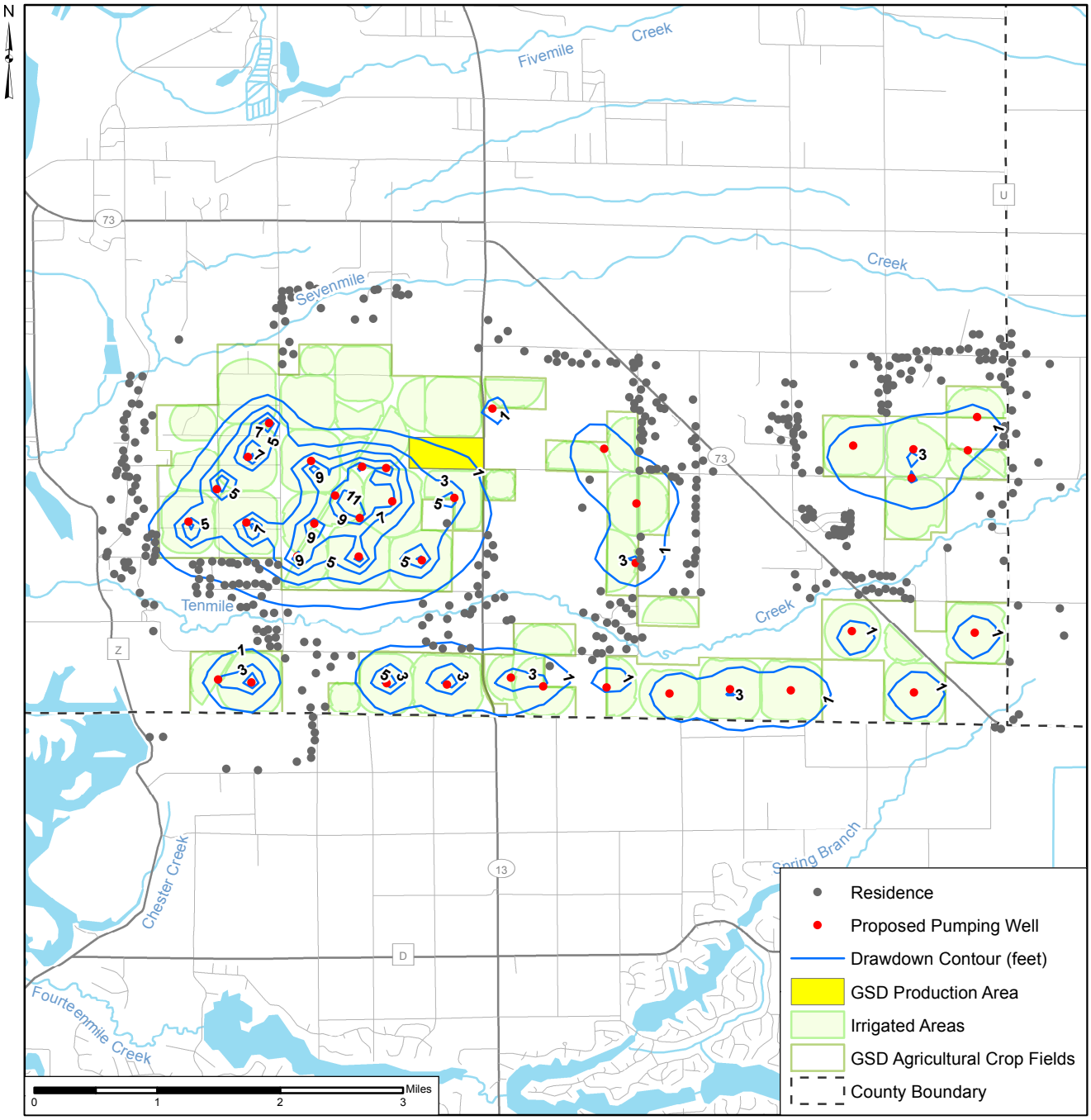


Figure 12 Calculated Flows in Tenmile Creek and Sevenmile Creek with and without Project



Note: Residential locations are based on 2012 air photo

Figure 13 Calculated Drawdowns In July - Dry Year

TABLES

Table 1

Proposed and Existing High Capacity Wells

High Capacity Well	High Capacity Well System No.	Irrigated Fields	Total Acres	Well Capacity (MGD)
W01	1	P01A and P01B	132	1.52
W02	1	P02	125	1.44
W05	1	P05	142	1.64
W06	1	P06	148	1.70
W07	1	P07	156	1.79
W08	1	P08 and P012	151	1.74
W09	1	P09	143	1.65
W15	1	P15	123	1.42
W17	1	P16 and P17	128	1.47
W19	1	P13 and P19	132	1.52
W20	1	P11 and P20	137	1.58
W21	1	P21	130	1.50
W23	1	P23	146	1.68
W24	1	P24	153	1.76
W25	1	P25 and P81	126	1.45
W26	1	P26	142	1.63
W27	2	P27	52	0.60
W28	2	P28	133	1.53
W30	3	P29 and P30	155	1.78
W31	3	P31	161	1.85
W38	1	P38	57	0.65
W39	4	P38 and P40	114	1.31
W41	4	P41 and P44	120	1.38
W42	4	P42 and P45	112	1.29
W43	5	P43	61	0.71
W46	5	P46	105	1.21
W48	5	P48	141	1.63
W51	5	P51	140	1.61
W53	5	P53 and P58	135	1.56
W55	6	P55	138	1.59
W59	5	P59	139	1.60
W60	6	P60	125	1.44
W61	6	P61	125	1.45
W68	5	P68	136	1.56
W74	6	P74 and P79	53	0.61
W75	3	P75	92	1.06
W82	3	P73 and P82	98	1.13
38632	6	P76	58	0.67
D1	1	-	-	0.5
D2	1	-	-	0.36

Table 2

Estimated and Calculated Stream Base Flows in Normal and Dry Years

Location	Estimated Base Flow from Measured Data (cfs)	Model Calculated Base Flow (cfs)	
		Existing Conditions Normal Year (cfs)	Existing Conditions Dry Year (cfs)
Big Roche-A-Cri at 1st Ave	9.0	10.9	8.5
Fourteenmile Creek near New Rome	19 to 43	36.2	25.4
Fourteenmile at mouth		47.3	35.2
Buena Vista Creek at 100th Rd	31.0	24.1	17.6
Buena Vista Cr. Ditch #2 N.Fork @ Isherwood	6.0	3.4	2.6
Fourmile Creek at 100th Rd	40 to 45	36.0	27.3
Tenmile Cr. Ditch #5 at Taft	6.4	5.7	4.3
Fourmile Creek at JJ&BB	1.0	4.1	3.2
NB Tenmile Cr. at Isherwood/Harding	0.7	1.6	1.1
Tenmile Creek near Nekoosa	51.4	52.1	38.7
Tenmile Creek at mouth		58.8	44.4
Sevenmile Creek at Rangeline		1.7	0.7
Sevenmile Creek at mouth		4.0	2.6
Fivemile Creek at mouth		12.5	9.7

Table 3

Summary of Streamflow Effects -- Normal Year with 14" of Irrigation Water

Average Annual Stream Baseflows and Calculated Changes in Average Base Flow due to Pumping

Location	Base Flow Existing Conditions (cfs)	Percent Change in Base Flow						
		Entire Project	High Capacity Well System No.					
			1	2	3	4	5	6
Big Roche-A-Cri at 1st Ave	10.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chester Creek	4.1	0.33	0.08	0.13	0.10	0.00	0.02	0.00
Fourteenmile Creek near New Rome	36.2	0.26	0.01	0.00	0.02	0.00	0.22	0.01
Fourteenmile at mouth	47.3	0.24	0.01	0.01	0.03	0.00	0.18	0.01
Buena Vista Creek at 100th Rd	24.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Buena Vista Cr. Ditch #2 N.Fork @ Isherwood	3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fourmile Creek at 100th Rd	36.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tenmile Cr. Ditch #5 at Taft	5.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fourmile Creek at JJ&BB	4.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NB Tenmile Cr. at Isherwood/Harding	1.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tenmile Creek near Nekoosa	52.1	0.75	0.23	0.00	0.05	0.09	0.24	0.16
Tenmile Creek at mouth	58.8	2.14	1.49	0.05	0.18	0.09	0.22	0.14
Sevenmile Creek at Rangeline	1.70	0.47	-2.38	0.01	0.05	1.67	0.19	1.83
Sevenmile Creek at mouth	3.95	0.62	-0.58	0.01	0.03	0.75	0.08	0.79
Fivemile Creek at mouth	12.5	0.05	-0.02	0.00	0.00	0.03	0.00	0.04

Change in August Base Flow due to Pumping

Location	August Flow Existing Conditions (cfs)	Percent Change in August Flow						
		Entire Project	High Capacity Well System No.					
			1	2	3	4	5	6
Sevenmile Creek at Rangeline	1.7	0.72	-2.48	0.01	0.05	1.85	0.23	1.94
Sevenmile Creek at Cty Z (mouth)	3.9	0.47	-0.91	0.01	0.03	0.85	0.10	0.86
Tenmile Creek at Hwy 13 (gage)	39.9	2.47	0.32	0.00	0.17	0.21	1.29	0.52
Tenmile Creek at Cty Z (mouth)	46.4	4.71	2.12	0.22	0.66	0.19	1.12	0.45

Change in September Base Flow due to Pumping

Location	September Flow Existing Conditions (cfs)	Percent Change in September Flow						
		Entire Project	High Capacity Well System No.					
			1	2	3	4	5	6
Sevenmile Creek at Rangeline	1.2	1.26	-3.93	0.01	0.08	2.59	0.31	3.44
Sevenmile Creek at Cty Z (mouth)	3.2	0.57	-1.33	0.01	0.04	1.01	0.12	1.29
Tenmile Creek at Hwy 13 (gage)	35.3	2.72	0.39	0.00	0.21	0.25	1.27	0.62
Tenmile Creek at Cty Z (mouth)	41.3	5.59	2.72	0.27	0.79	0.23	1.09	0.53

Table 4

Summary of Streamflow Effects -- Dry Year

Average Annual Stream Baseflows and Calculated Changes in Average Base Flow due to Pumping

Location	Base Flow Existing Conditions (cfs)	Percent Change in Base Flow						
		Entire Project	High Capacity Well System No.					
			1	2	3	4	5	6
Big Roche-A-Cri at 1st Ave	8.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chester Creek	3.77	0.31	0.09	0.10	0.09	0.00	0.03	0.00
Fourteenmile Creek near New Rome	25.39	0.24	0.01	0.00	0.02	0.00	0.19	0.02
Fourteenmile at mouth	35.22	0.22	0.01	0.01	0.04	0.00	0.15	0.01
Buena Vista Creek at 100th Rd	17.63	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Buena Vista Cr. Ditch #2 N.Fork @ Isherwood	2.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fourmile Creek at 100th Rd	27.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tenmile Cr. Ditch #5 at Taft	4.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fourmile Creek at JJ&BB	3.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NB Tenmile Cr. at Isherwood/Harding	1.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tenmile Creek near Nekoosa	38.70	0.64	0.28	0.00	0.01	0.05	0.18	0.14
Tenmile Creek at mouth	44.41	2.44	1.91	0.05	0.17	0.06	0.16	0.12
Sevenmile Creek at Rangeline	0.68	-11.69	-15.28	0.01	0.09	2.67	0.26	2.25
Sevenmile Creek at mouth	2.56	-5.44	-6.37	0.01	0.03	0.77	0.07	0.61
Fivemile Creek at mouth	9.67	0.05	-0.03	0.00	0.00	0.04	0.00	0.05

Change in August Base Flow due to Pumping

Location	August Flow Existing Conditions (cfs)	Percent Change in August Flow						
		Entire Project	High Capacity Well System No.					
			1	2	3	4	5	6
Sevenmile Creek at Rangeline	0.40	-37.74	-38.11	0.02	0.11	1.71	0.10	0.49
Sevenmile Creek at Cty Z (mouth)	2.1	-11.55	-11.58	0.01	0.03	0.38	0.02	0.10
Tenmile Creek at Hwy 13 (gage)	22.2	5.91	0.52	0.01	0.41	0.39	3.40	1.25
Tenmile Creek at Cty Z (mouth)	27.6	10.25	4.03	0.57	1.67	0.34	2.75	1.01

Change in September Base Flow due to Pumping

Location	September Flow Existing Conditions (cfs)	Percent Change in September Flow						
		Entire Project	High Capacity Well System No.					
			1	2	3	4	5	6
Sevenmile Creek at Rangeline	0.29	-57.43	-57.70	0.03	0.16	2.28	0.14	0.68
Sevenmile Creek at Cty Z (mouth)	1.9	-14.73	-14.73	0.01	0.04	0.41	0.02	0.11
Tenmile Creek at Hwy 13 (gage)	23.0	3.73	0.56	0.00	0.26	0.28	1.64	1.01
Tenmile Creek at Cty Z (mouth)	28.1	8.71	4.49	0.49	1.34	0.25	1.35	0.83

Table 5

Summary of Streamflow Effects -- Normal Year with 11.5" of Irrigation Water

Average Annual Stream Baseflows and Calculated Changes in Average Base Flow due to Pumping

Location	Base Flow Existing Conditions (cfs)	Percent Change in Base Flow						
		Entire Project	High Capacity Well System No.					
			1	2	3	4	5	6
Big Roche-A-Cri at 1st Ave	10.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Chester Creek	4.1	0.33	0.08	0.12	0.10	0.00	0.02	0.00
Fourteenmile Creek near New Rome	36.2	0.25	0.01	0.00	0.02	0.00	0.21	0.01
Fourteenmile at mouth	47.3	0.23	0.01	0.01	0.03	0.00	0.17	0.01
Buena Vista Creek at 100th Rd	24.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Buena Vista Cr. Ditch #2 N.Fork @ Isherwood	3.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fourmile Creek at 100th Rd	36.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tenmile Cr. Ditch #5 at Taft	5.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fourmile Creek at JJ&BB	4.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NB Tenmile Cr. at Isherwood/Harding	1.6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tenmile Creek near Nekoosa	52.1	0.77	0.24	0.00	0.05	0.09	0.24	0.16
Tenmile Creek at mouth	58.8	2.04	1.38	0.05	0.18	0.09	0.23	0.14
Sevenmile Creek at Rangeline	1.70	2.61	-0.10	0.01	0.05	1.58	0.19	1.80
Sevenmile Creek at mouth	3.95	2.00	0.86	0.01	0.03	0.71	0.09	0.78
Fivemile Creek at mouth	12.5	0.07	0.01	0.00	0.00	0.03	0.00	0.04

Change in August Base Flow due to Pumping

Location	August Flow Existing Conditions (cfs)	Percent Change in August Flow						
		Entire Project	High Capacity Well System No.					
			1	2	3	4	5	6
Sevenmile Creek at Rangeline	1.7	2.63	-0.42	0.01	0.05	1.74	0.23	1.90
Sevenmile Creek at Cty Z (mouth)	3.9	1.57	0.26	0.01	0.03	0.80	0.11	0.84
Tenmile Creek at Hwy 13 (gage)	39.9	2.47	0.33	0.00	0.17	0.20	1.29	0.51
Tenmile Creek at Cty Z (mouth)	46.4	4.56	1.99	0.21	0.66	0.19	1.12	0.44

Change in September Base Flow due to Pumping

Location	September Flow Existing Conditions (cfs)	Percent Change in September Flow						
		Entire Project	High Capacity Well System No.					
			1	2	3	4	5	6
Sevenmile Creek at Rangeline	1.2	4.40	-0.59	0.01	0.08	2.44	0.32	3.39
Sevenmile Creek at Cty Z (mouth)	3.2	2.77	0.93	0.01	0.04	0.95	0.12	1.28
Tenmile Creek at Hwy 13 (gage)	35.3	2.84	0.40	0.00	0.26	0.28	1.28	0.64
Tenmile Creek at Cty Z (mouth)	41.3	5.60	2.62	0.29	0.82	0.25	1.10	0.55

ATTACHMENTS

Attachment A

Elevation of Base of Sand and Gravel and Sandstone Units and Regional Geologic Sections

Attachment A

Elevation of Base of Sand and Gravel Unit and Sandstone Unit

The base of the sand and gravel unit (equivalent to the top of the bedrock surface) was estimated based on the top of rock as reported for individual wells in the DNR 2012 Well Information database[1] and the WiscLith[2] database. These data were krigged to develop a structure contour map of the top of the bedrock surface. The contoured surface was adjusted in some areas of the model domain based on the depth of wells (greater than 75 feet deep) that were completed in the sand and gravel aquifer where the bottom elevation of the well could provide a maximum elevation of the bedrock surface.

Additional data on the base of the sand and gravel was derived by reviewing paper logs available from the Wisconsin Geological and Natural History Survey for wells greater than about 120 feet deep (for wells constructed prior to about 1988). The contoured surface was adjusted in some areas of the model domain based on the depth of wells completed in the sand and gravel aquifer where the bottom elevation of the well could provide a maximum elevation of the bedrock surface. The well data used in developing the top of rock surface are summarized in Table A-1 and shown in Figure A-1 of this Attachment.

The base of the sandstone unit was developed based on the bottom of the sandstone unit as defined in Mechenich and others (2009), in addition to lithologic data in the WiscLith database, where the top of the sandstone was defined by 20 borings located in or near the model area that penetrated through the sandstone into an underlying stratigraphic unit. These data are summarized in Table A-2. WiscLith point data, where the sandstone unit was encountered but not fully penetrated, also were used to determine the maximum elevation of the base of the sandstone unit. These data were combined into a GIS file where the sandstone thickness contours of Mechenich and others (2009) were found to be generally consistent with the WiscLith point data. The area where the sandstone unit is not present was based on Mechenich and other (2009) and was used to define the extent of the sandstone unit. The base of the sandstone unit is shown in Figure A-2 of this Attachment.

Regional geologic cross sections developed by Clayton (1987) are shown on Figure A-3 of this Attachment.

[1] Wisconsin Department of Natural Resources, 2012. Well Data, CD 2102 Well Data.exe

[2] Wisconsin Geological and Natural History Survey, 2009. Wisclith, Open File Report 2009-03.

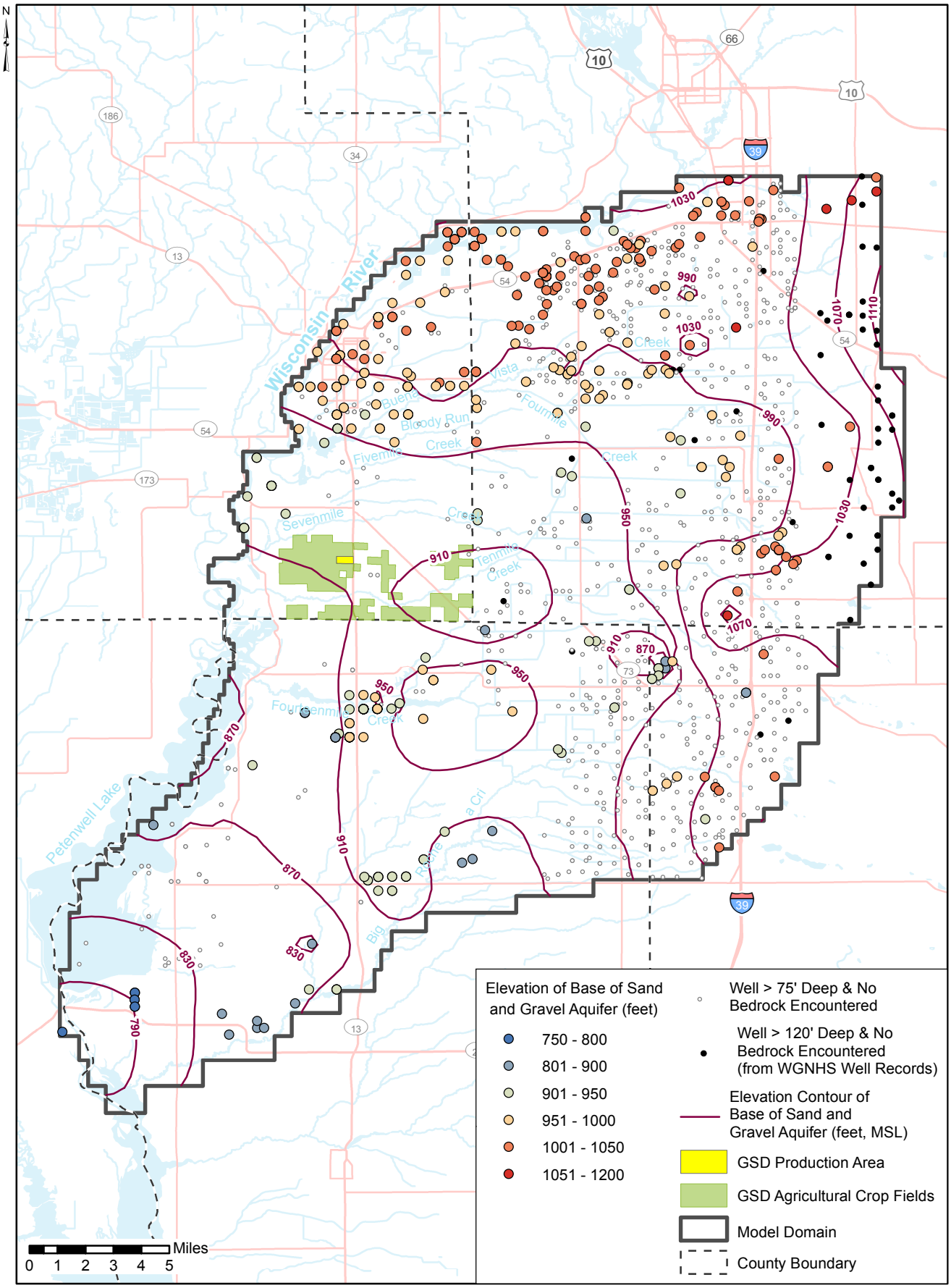


Figure A-1 Base of the Sand and Gravel Aquifer

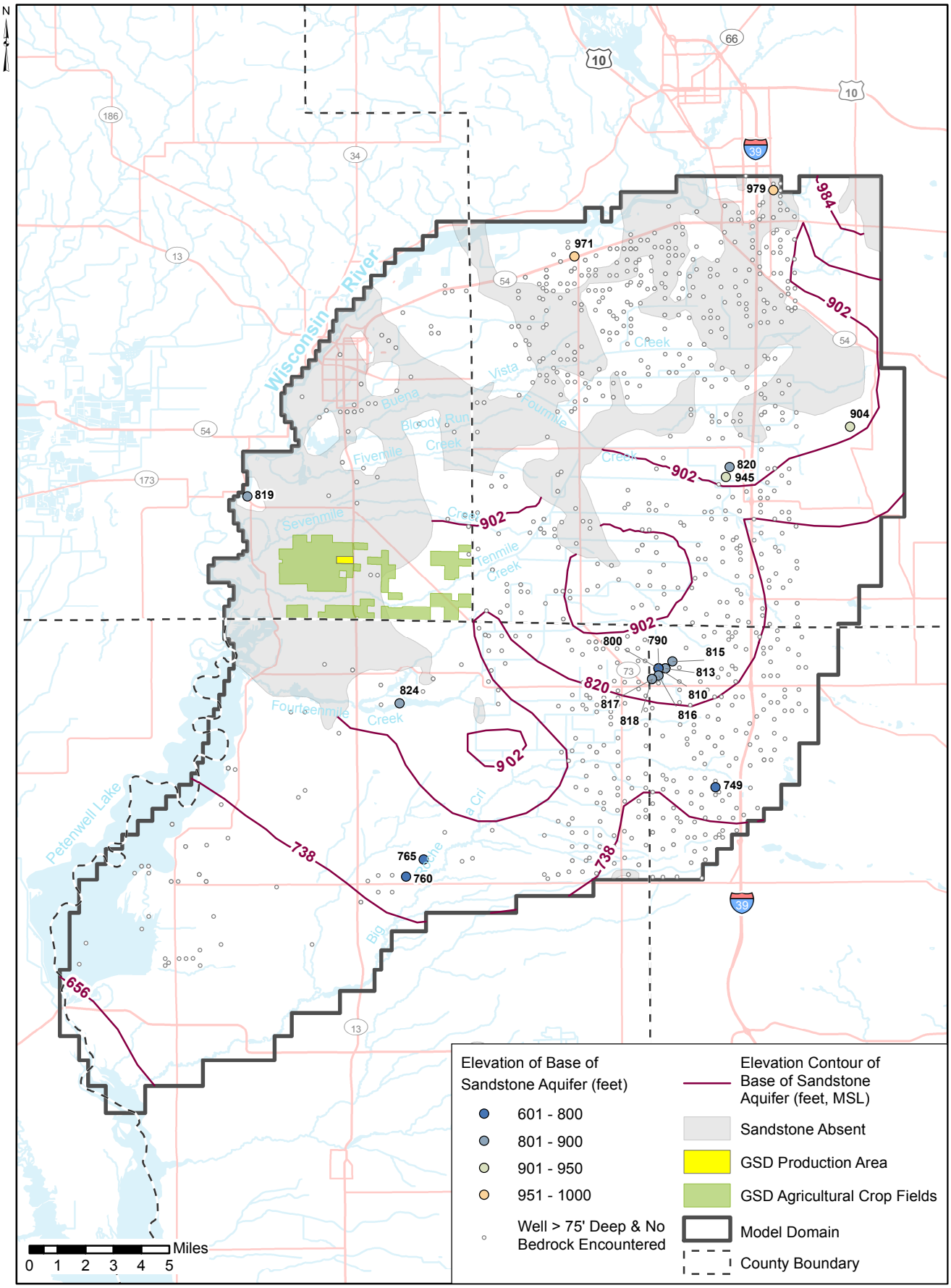
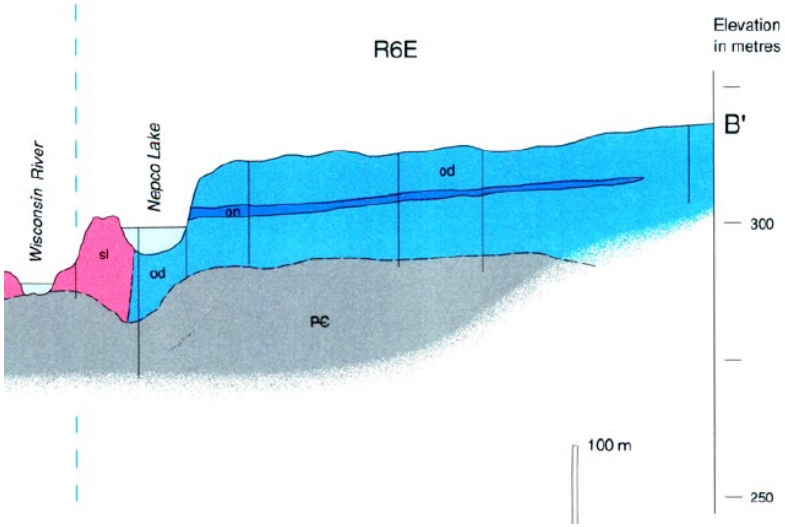


Figure A-2 Base of the Sandstone Aquifer

East-West cross section through T21N, Wood County.
The clay/silt layer is the dark blue layer, glacial sands are blue and the crystalline bedrock is grey; glaciofluvial deposits along the Wisconsin River are shown in pink. (from Clayton, 1991)



East-West cross section through T20N, Adams County.
The clay/silt layer is the blue layer, glacial sands are Pink and the crystalline bedrock is grey. (from Clayton, 1987).

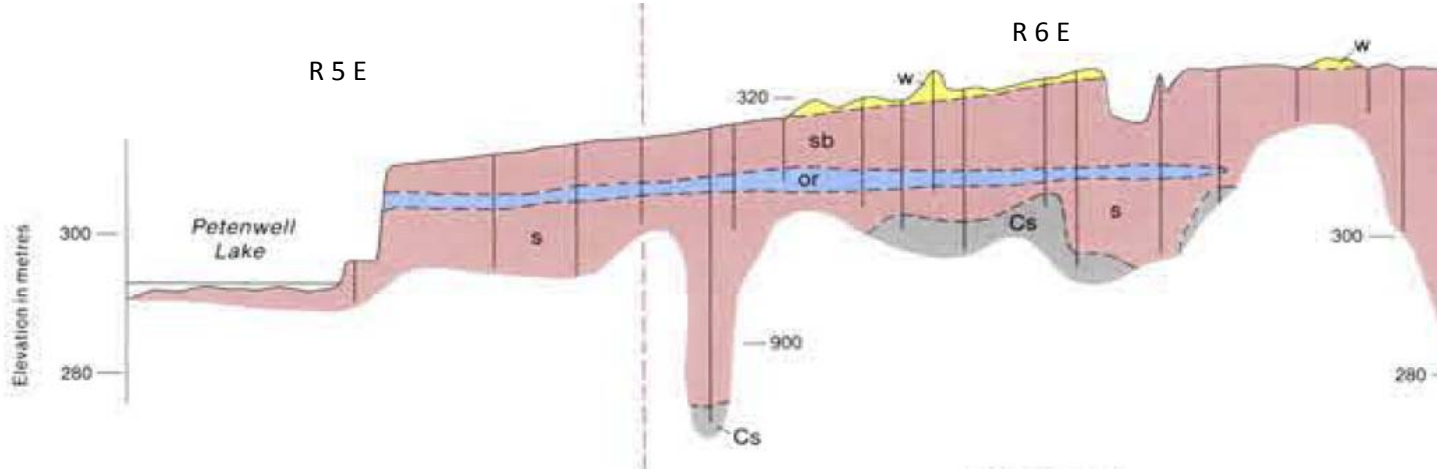


Figure A-3 Regional Geologic Sections

Table A-1

Summary of Base of Sand and Gravel Unit - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Rock (feet)	Elevation of Top of Rock (feet, MSL)	Ground Surface Elevation (Feet, MSL, estimated from DEM)	Data Source
1000131	2022257	805074	55	955	1010	Wisclith
1000253	2028134	771192	70	940	1010	Wisclith
1000310	2022893	771178	75	925	1000	Wisclith
1000313	2031354	801012	45	982	1027	Wisclith
1000314	2048213	802414	65	966	1031	Wisclith
1000393	2033271	808313	55	975	1030	Wisclith
1000425	1976879	746674	119	791	910	Wisclith
1000428	2009031	802121	105	886	991	Wisclith
1000429	1976879	749302	115	796	911	Wisclith
1000441	1976874	747986	120	790	910	Wisclith
1000442	2026911	803915	69	942	1011	Wisclith
1000443	2020927	770504	85	913	998	Wisclith
1000445	2000002	742650	110	833	943	Wisclith
1000446	2001318	742652	85	860	945	Wisclith
1000453	2031274	810280	75	953	1028	Wisclith
1000454	2031801	812556	94	926	1020	Wisclith
1000455	1999994	743970	90	862	952	Wisclith
1000473	2031456	774451	105	905	1010	Wisclith
27000327	1980416	780955	15	877	892	Wisclith
29000018	1963211	741897	145	761	906	Wisclith
50000359	2097526	900824	75	1006	1081	Wisclith
50000372	2112298	898904	80	1075	1155	Wisclith
50000405	2054742	879311	40	1019	1059	Wisclith
50000506	2049073	881011	50	1010	1060	Wisclith
50000513	2079165	830201	80	990	1070	Wisclith
50000514	2098016	829089	70	1031	1101	Wisclith
50000523	2095303	895309	88	1002	1090	Wisclith
50000533	2094881	895476	88	1002	1090	Wisclith
50000596	2074512	889323	55	1015	1070	Wisclith
50000599	2041523	859716	70	970	1040	Wisclith
50000663	2057116	866863	65	985	1050	Wisclith
50000708	2098504	832839	90	1006	1096	Wisclith
50000718	2059931	888346	65	1004	1069	Wisclith
50000797	2094724	894900	64	1026	1090	Wisclith
50000804	2061023	887641	50	1017	1067	Wisclith
50000921	2098576	832840	90	1005	1095	Wisclith
50000940	2062038	887848	54	1011	1065	Wisclith
50000960	2099923	831564	70	1033	1103	Wisclith
50000983	2069984	864387	80	980	1060	Wisclith
50001065	2089233	848573	115	955	1070	Wisclith
50001066	2088533	846693	95	970	1065	Wisclith
50001104	2058656	866066	57	995	1052	Wisclith
50001153	2072478	887272	65	1005	1070	Wisclith
50001156	2107808	848615	117	1012	1129	Wisclith
50001162	2054632	884558	55	1008	1063	Wisclith
50001187	2050783	864637	58	987	1045	Wisclith
50001229	2066602	874037	68	992	1060	Wisclith

Table A-1

Summary of Base of Sand and Gravel Unit - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Rock (feet)	Elevation of Top of Rock (feet, MSL)	Ground Surface Elevation (Feet, MSL, estimated from DEM)	Data Source
50001243	2070310	825433	117	947	1064	Wisclith
50001246	2112006	856159	134	1019	1153	Wisclith
50001250	2064586	882655	55	1010	1065	Wisclith
50001252	2058656	866066	58	994	1052	Wisclith
50001264	2062598	882006	49	1016	1065	Wisclith
50001276	2069925	887921	70	1000	1070	Wisclith
50001283	2041651	838486	115	925	1040	Wisclith
50001284	2069276	891230	47	1022	1069	Wisclith
50001289	2061264	879366	55	1007	1062	Wisclith
50001291	2062015	861443	93	962	1055	Wisclith
50001294	2051384	874593	47	1008	1055	Wisclith
50001333	2077106	869588	55	1010	1065	Wisclith
50001339	2057293	884589	48	1017	1065	Wisclith
50001352	2049408	875235	42	1012	1054	Wisclith
50001354	2050661	884508	50	1010	1060	Wisclith
50001358	2078042	854226	80	985	1065	Wisclith
50001374	2071520	889919	65	1005	1070	Wisclith
50001395	2075089	882087	65	1003	1068	Wisclith
50001396	2056620	882611	50	1015	1065	Wisclith
50001398	2077171	866919	93	972	1065	Wisclith
50001400	2062659	863433	72	983	1055	Wisclith
70000816	2077144	810532	245	828	1073	Wisclith
70000900	2077144	810532	242	831	1073	Wisclith
70000901	2075824	810515	200	870	1070	Wisclith
70000902	2075824	810515	170	900	1070	Wisclith
70000903	2075824	810515	140	930	1070	Wisclith
70000904	2077150	811855	260	813	1073	Wisclith
70000905	2078452	811866	115	963	1078	Wisclith
70000907	2075818	809192	140	930	1070	Wisclith
70000908	2074579	808525	140	927	1067	Wisclith
70000909	2074579	808525	145	922	1067	Wisclith
70000956	2074711	787439	93	969	1062	Wisclith
70001025	2086570	788094	85	994	1079	Wisclith
72000005	2018031	869879	20	1010	1030	Wisclith
72000041	2022485	860370	57	967	1024	Wisclith
72000521	1998173	843001	20	939	959	Wisclith
72000529	2034425	864501	26	1010	1036	Wisclith
72001263	2032864	874986	35	1010	1045	Wisclith
72001269	2015642	869629	40	989	1029	Wisclith
72001270	2015642	869629	40	989	1029	Wisclith
256	2025490	768546	63	938	1001	DNR 2012 Database
257	2028134	771192	70	940	1010	DNR 2012 Database
258	2025505	771188	77	932	1009	DNR 2012 Database
259	2022893	771178	76	924	1000	DNR 2012 Database
277	2057507	794552	100	931	1031	DNR 2012 Database
282	2015461	798178	100	906	1006	DNR 2012 Database
557	2019640	864347	45	980	1025	DNR 2012 Database

Table A-1

Summary of Base of Sand and Gravel Unit - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Rock (feet)	Elevation of Top of Rock (feet, MSL)	Ground Surface Elevation (Feet, MSL, estimated from DEM)	Data Source
558	2019640	864347	39	986	1025	DNR 2012 Database
373	2081720	871581	20	1050	1070	DNR 2012 Database
380	2088833	820510	5	1086	1091	DNR 2012 Database
402	2063956	885940	47	1020	1067	DNR 2012 Database
422	2081655	880811	83	986	1069	DNR 2012 Database
495	2041640	839808	115	925	1040	DNR 2012 Database
627	2061297	871394	60	996	1056	DNR 2012 Database
706	2055988	867361	69	971	1040	DNR 2012 Database
707	2061264	879366	55	1007	1062	DNR 2012 Database
767	2033271	808313	56	974	1030	DNR 2012 Database
813	2077106	869588	60	1005	1065	DNR 2012 Database
838	2057328	887227	84	981	1065	DNR 2012 Database
1245	2086570	788094	78	1001	1079	DNR 2012 Database
1308	2076783	829910	94	975	1069	DNR 2012 Database
1467	2062609	884625	48	1017	1065	DNR 2012 Database
1581	2031455	774451	81	929	1010	DNR 2012 Database
1618	1994723	741348	93	852	945	DNR 2012 Database
1771	2035483	881601	62	989	1051	DNR 2012 Database
1830	1976879	749302	124	787	911	DNR 2012 Database
1831	1976874	747986	122	788	910	DNR 2012 Database
1905	1976879	746674	119	791	910	DNR 2012 Database
1918	2009031	802121	123	868	991	DNR 2012 Database
2244	2091266	854463	104	966	1070	DNR 2012 Database
23652	2099160	836197	106	991	1097	DNR 2012 Database
23668	2090599	832917	92	994	1086	DNR 2012 Database
23704	2091261	833564	92	993	1085	DNR 2012 Database
23725	2095257	832251	84	1009	1093	DNR 2012 Database
23742	2097869	833566	90	1001	1091	DNR 2012 Database
24098	2056727	858753	70	979	1049	DNR 2012 Database
24133	2048776	871892	62	988	1050	DNR 2012 Database
24134	2065255	880684	62	1002	1064	DNR 2012 Database
24136	2065304	862110	80	977	1057	DNR 2012 Database
24139	2069925	864127	80	980	1060	DNR 2012 Database
24167	2064630	866758	76	979	1055	DNR 2012 Database
24179	2101941	830883	73	1035	1108	DNR 2012 Database
24213	2058656	866066	57	995	1052	DNR 2012 Database
24224	2072459	891257	55	1015	1070	DNR 2012 Database
24235	2073881	866188	78	987	1064	DNR 2012 Database
24237	2061996	864097	72	983	1055	DNR 2012 Database
24244	2070582	889914	68	1002	1070	DNR 2012 Database
24259	2079062	889978	69	1005	1074	DNR 2012 Database
24261	2069943	872042	67	993	1060	DNR 2012 Database
24263	2072186	887932	65	1005	1070	DNR 2012 Database
24321	2076991	877502	76	989	1065	DNR 2012 Database
36675	2095666	813218	97	1008	1105	DNR 2012 Database
36759	2074710	787439	93	969	1062	DNR 2012 Database
38637	2015642	869629	50	979	1029	DNR 2012 Database

Table A-1

Summary of Base of Sand and Gravel Unit - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Rock (feet)	Elevation of Top of Rock (feet, MSL)	Ground Surface Elevation (Feet, MSL, estimated from DEM)	Data Source
58406	2083031	896632	51	1024	1075	DNR 2012 Database
58420	2054632	884558	57	1006	1063	DNR 2012 Database
58421	2054632	884558	91	972	1063	DNR 2012 Database
58422	2054632	884558	55	1008	1063	DNR 2012 Database
58425	2054632	884558	59	1004	1063	DNR 2012 Database
58426	2054632	884558	57	1006	1063	DNR 2012 Database
58427	2054632	884558	60	1003	1063	DNR 2012 Database
58431	2054632	884558	60	1003	1063	DNR 2012 Database
58432	2054648	885881	60	1004	1064	DNR 2012 Database
90335	2029056	865726	42	993	1035	DNR 2012 Database
90368	2088343	898006	70	1010	1080	DNR 2012 Database
2661	2020927	770504	73	925	998	DNR 2012 Database
2687	1993353	745299	91	847	938	DNR 2012 Database
2840	2085922	858297	85	980	1065	DNR 2012 Database
3203	2077848	866250	93	973	1066	DNR 2012 Database
2886	2093568	890161	100	989	1089	DNR 2012 Database
3220	2010369	758515	151	821	972	DNR 2012 Database
3363	2055956	881951	50	1011	1061	DNR 2012 Database
67258	2067947	887259	60	1009	1069	DNR 2012 Database
4185	2044234	810287	57	973	1030	DNR 2012 Database
3476	2048092	875217	44	1011	1055	DNR 2012 Database
70500	2053303	883234	58	1004	1062	DNR 2012 Database
70502	2054631	881937	59	1003	1062	DNR 2012 Database
71371	2035419	779708	110	909	1019	DNR 2012 Database
71372	2044385	779839	120	900	1020	DNR 2012 Database
71373	2038712	773825	130	885	1015	DNR 2012 Database
71374	2040695	774511	128	889	1017	DNR 2012 Database
71467	2064022	815664	144	915	1059	DNR 2012 Database
71468	2062708	815663	142	916	1058	DNR 2012 Database
71702	2057457	847494	134	921	1055	DNR 2012 Database
71805	2043069	817764	154	879	1033	DNR 2012 Database
AD942.TIF	2009790	749905	58	902	960	WGNHS Well Records
AD952.TIF	2007167	747286	115	840	955	WGNHS Well Records
AD1119.TIF	2015007	749903	4	946	950	WGNHS Well Records
AD1120.TIF	2015007	749903	4	946	950	WGNHS Well Records
AD1121.TIF	2015007	749903	25	925	950	WGNHS Well Records
AD1263.TIF	2022893	771178	76	924	1000	WGNHS Well Records
AD1264.TIF	2025505	771188	77	931	1008	WGNHS Well Records
AD1274.TIF	2022877	768535	68	932	1000	WGNHS Well Records
AD1528.TIF	2022717	802878	39	954	993	WGNHS Well Records
AD1529.TIF	2022717	802878	7	986	993	WGNHS Well Records
AD1531.TIF	2022717	802878	30	963	993	WGNHS Well Records
AD1564.TIF	2017441	802807	60	937	997	WGNHS Well Records
AD1566.TIF	2020071	802844	65	928	993	WGNHS Well Records
AD1567.TIF	2020071	802844	11	982	993	WGNHS Well Records
AD1568.TIF	2020071	802844	18	975	993	WGNHS Well Records
AD1629.TIF	2014798	797519	68	932	1000	WGNHS Well Records

Table A-1

Summary of Base of Sand and Gravel Unit - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Rock (feet)	Elevation of Top of Rock (feet, MSL)	Ground Surface Elevation (Feet, MSL, estimated from DEM)	Data Source
AD1634.TIF	2014798	797519	26	974	1000	WGNHS Well Records
AD1637.TIF	2014798	797519	35	965	1000	WGNHS Well Records
AD1642.TIF	2014798	797519	100	900	1000	WGNHS Well Records
AD1648.TIF	2017439	797535	27	986	1013	WGNHS Well Records
AD1649.TIF	2017439	797535	20	993	1013	WGNHS Well Records
AD1651.TIF	2017439	797535	40	973	1013	WGNHS Well Records
AD1652.TIF	2017439	797535	32	981	1013	WGNHS Well Records
AD1653.TIF	2017439	797535	21	992	1013	WGNHS Well Records
AD1654.TIF	2017439	797535	38	975	1013	WGNHS Well Records
AD1656.TIF	2017439	797535	25	988	1013	WGNHS Well Records
AD1657.TIF	2017439	797535	36	977	1013	WGNHS Well Records
AD1659.TIF	2017439	797535	42	971	1013	WGNHS Well Records
AD1661.TIF	2017439	797535	35	978	1013	WGNHS Well Records
AD1662.TIF	2017439	797535	35	978	1013	WGNHS Well Records
AD1663.TIF	2017439	797535	41	972	1013	WGNHS Well Records
AD1664.TIF	2017439	797535	32	981	1013	WGNHS Well Records
AD1665.TIF	2017439	797535	38	975	1013	WGNHS Well Records
AD1666.TIF	2017439	797535	35	978	1013	WGNHS Well Records
AD1667.TIF	2017439	797535	32	981	1013	WGNHS Well Records
AD1669.TIF	2017439	797535	28	985	1013	WGNHS Well Records
AD1674.TIF	2017439	797535	37	976	1013	WGNHS Well Records
AD1675.TIF	2017439	797535	42	971	1013	WGNHS Well Records
AD1676.TIF	2017439	797535	40	973	1013	WGNHS Well Records
AD1677.TIF	2020075	797554	28	992	1020	WGNHS Well Records
AD1687.TIF	2017446	800159	10	999	1009	WGNHS Well Records
AD1688.TIF	2017446	800159	36	973	1009	WGNHS Well Records
AD2883.TIF	2028134	771192	70	940	1010	WGNHS Well Records
AD2884.TIF	2020274	771156	68	932	1000	WGNHS Well Records
AD2885.TIF	2025490	768546	63	938	1001	WGNHS Well Records
AD2952.TIF	1999137	792248	35	940	975	WGNHS Well Records
AD2964.TIF	2022717	802878	28	965	993	WGNHS Well Records
AD2965.TIF	2022717	802878	32	961	993	WGNHS Well Records
AD2967.TIF	2022717	802878	16	977	993	WGNHS Well Records
AD2968.TIF	2022717	802878	12	981	993	WGNHS Well Records
AD2969.TIF	2022717	802878	43	950	993	WGNHS Well Records
AD2970.TIF	2022717	802878	32	961	993	WGNHS Well Records
AD2971.TIF	2022717	802878	29	964	993	WGNHS Well Records
AD2973.TIF	2025381	802911	44	949	993	WGNHS Well Records
AD2981.TIF	2020071	802844	64	929	993	WGNHS Well Records
AD2982.TIF	2020071	802844	41	952	993	WGNHS Well Records
AD2983.TIF	2020071	802844	52	941	993	WGNHS Well Records
AD2984.TIF	2020071	802844	84	909	993	WGNHS Well Records
AD2985.TIF	2020071	802844	51	942	993	WGNHS Well Records
AD2986.TIF	2020071	802844	67	926	993	WGNHS Well Records
AD2988.TIF	2020071	802844	52	941	993	WGNHS Well Records
AD2990.TIF	2020071	802844	79	914	993	WGNHS Well Records
AD2991.TIF	2020071	802844	70	923	993	WGNHS Well Records

Table A-1

Summary of Base of Sand and Gravel Unit - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Rock (feet)	Elevation of Top of Rock (feet, MSL)	Ground Surface Elevation (Feet, MSL, estimated from DEM)	Data Source
AD2992.TIF	2020071	802844	50	943	993	WGNHS Well Records
AD2993.TIF	2020071	802844	75	918	993	WGNHS Well Records
AD2994.TIF	2020071	802844	72	921	993	WGNHS Well Records
AD2995.TIF	2017427	805478	44	947	991	WGNHS Well Records
AD2996.TIF	2020065	805510	70	951	1021	WGNHS Well Records
AD3002.TIF	2072615	813790	89	979	1068	WGNHS Well Records
AD3025.TIF	2067491	803138	104	947	1051	WGNHS Well Records
AD3045.TIF	2056837	795213	100	929	1029	WGNHS Well Records
PT5.TIF	2070310	825433	117	947	1064	WGNHS Well Records
PT13.TIF	2087920	849875	115	952	1067	WGNHS Well Records
PT17.TIF	2079970	843590	127	938	1065	WGNHS Well Records
PT40.TIF	2107808	848616	117	1012	1129	WGNHS Well Records
PT147.TIF	2053993	877298	48	1009	1057	WGNHS Well Records
PT149.TIF	2064599	877373	68	997	1065	WGNHS Well Records
PT156.TIF	2041321	866526	25	1015	1040	WGNHS Well Records
PT159.TIF	2059319	866736	57	995	1052	WGNHS Well Records
PT165.TIF	2062055	856151	108	947	1055	WGNHS Well Records
PT180.TIF	2074530	866875	78	986	1064	WGNHS Well Records
PT331.TIF	2069930	890573	71	999	1070	WGNHS Well Records
PT332.TIF	2069930	890573	68	1002	1070	WGNHS Well Records
PT334.TIF	2067322	893187	111	937	1048	WGNHS Well Records
PT337.TIF	2062039	893119	22	1018	1040	WGNHS Well Records
PT338.TIF	2048786	893066	38	999	1037	WGNHS Well Records
PT339.TIF	2041089	890314	25	1020	1045	WGNHS Well Records
PT340.TIF	2041088	892951	21	1016	1037	WGNHS Well Records
PT341.TIF	2046061	887716	30	1016	1046	WGNHS Well Records
PT342.TIF	2053979	885210	60	1005	1065	WGNHS Well Records
PT343.TIF	2053979	885210	60	1005	1065	WGNHS Well Records
PT344.TIF	2053979	885210	60	1005	1065	WGNHS Well Records
PT345.TIF	2053979	885210	58	1007	1065	WGNHS Well Records
PT346.TIF	2053979	885210	59	1006	1065	WGNHS Well Records
PT393.TIF	2085049	898626	88	952	1040	WGNHS Well Records
PT394.TIF	2085049	898626	75	965	1040	WGNHS Well Records
PT404.TIF	2087697	898653	66	1014	1080	WGNHS Well Records
PT405.TIF	2087697	898653	34	1046	1080	WGNHS Well Records
PT425.TIF	2083671	892008	32	1043	1075	WGNHS Well Records
PT427.TIF	2079719	890646	69	1006	1075	WGNHS Well Records
PT429.TIF	2072178	890589	54	1016	1070	WGNHS Well Records
PT432.TIF	2072186	887932	65	1005	1070	WGNHS Well Records
PT1040.TIF	2059451	846787	104	947	1051	WGNHS Well Records
PT1043.TIF	2062189	838835	168	887	1055	WGNHS Well Records
PT1058.TIF	2098502	850078	47	1033	1080	WGNHS Well Records
PT1059.TIF	2083959	848551	108	955	1063	WGNHS Well Records
PT1060.TIF	2083959	848551	80	983	1063	WGNHS Well Records
PT1069.TIF	2098500	835544	106	987	1093	WGNHS Well Records
PT1087.TIF	2090599	832917	92	993	1085	WGNHS Well Records
PT1091.TIF	2095903	832910	84	1010	1094	WGNHS Well Records

Table A-1

Summary of Base of Sand and Gravel Unit - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Rock (feet)	Elevation of Top of Rock (feet, MSL)	Ground Surface Elevation (Feet, MSL, estimated from DEM)	Data Source
PT1093.TIF	2101295	830234	70	1035	1105	WGNHS Well Records
PT1094.TIF	2098553	832898	90	1006	1096	WGNHS Well Records
PT1101.TIF	2090718	825061	80	1009	1089	WGNHS Well Records
PT1417.TIF	2064592	880024	60	1004	1064	WGNHS Well Records
PT1422.TIF	2056620	882611	58	1007	1065	WGNHS Well Records
PT1437.TIF	2059308	869390	68	986	1054	WGNHS Well Records
PT1443.TIF	2041321	866526	45	995	1040	WGNHS Well Records
PT1449.TIF	2059319	866736	59	993	1052	WGNHS Well Records
PT1451.TIF	2064630	866758	76	979	1055	WGNHS Well Records
PT1452.TIF	2069925	864127	80	980	1060	WGNHS Well Records
PT1455.TIF	2064653	861443	80	976	1056	WGNHS Well Records
PT1456.TIF	2056727	858753	70	979	1049	WGNHS Well Records
PT1457.TIF	2041337	861231	70	970	1040	WGNHS Well Records
PT1460.TIF	2041418	853297	4	1035	1039	WGNHS Well Records
PT1476.TIF	2077083	882726	70	1000	1070	WGNHS Well Records
PT1486.TIF	2090467	874891	8	1065	1073	WGNHS Well Records
PT1507.TIF	2080021	853580	158	907	1065	WGNHS Well Records
PT1811.TIF	2062053	895738	17	1023	1040	WGNHS Well Records
PT1812.TIF	2062053	895738	14	1026	1040	WGNHS Well Records
PT1823.TIF	2054038	893114	21	1020	1041	WGNHS Well Records
PT1824.TIF	2054038	893114	35	1006	1041	WGNHS Well Records
PT1825.TIF	2046170	893017	22	1016	1038	WGNHS Well Records
PT1826.TIF	2046170	893017	40	998	1038	WGNHS Well Records
PT1827.TIF	2042414	891657	6	1034	1040	WGNHS Well Records
PT1828.TIF	2042414	891657	14	1026	1040	WGNHS Well Records
PT1829.TIF	2041089	890314	13	1032	1045	WGNHS Well Records
PT1830.TIF	2041089	890314	29	1016	1045	WGNHS Well Records
PT1831.TIF	2043407	887682	40	1002	1042	WGNHS Well Records
PT1832.TIF	2047371	886428	30	1019	1049	WGNHS Well Records
PT1835.TIF	2053979	885210	57	1008	1065	WGNHS Well Records
PT1836.TIF	2053979	885210	59	1006	1065	WGNHS Well Records
PT1837.TIF	2053979	885210	55	1010	1065	WGNHS Well Records
PT1838.TIF	2053979	885210	58	1007	1065	WGNHS Well Records
PT1848.TIF	2067260	885277	48	1021	1069	WGNHS Well Records
PT1898.TIF	2089023	902653	6	1079	1085	WGNHS Well Records
PT1899.TIF	2089023	902653	20	1065	1085	WGNHS Well Records
PT1908.TIF	2079705	901253	32	1013	1045	WGNHS Well Records
PT1915.TIF	2082361	895968	51	1024	1075	WGNHS Well Records
PT1917.TIF	2082361	895968	51	1024	1075	WGNHS Well Records
PT1919.TIF	2087664	896014	40	1038	1078	WGNHS Well Records
PT1922.TIF	2090283	896062	63	1017	1080	WGNHS Well Records
PT1929.TIF	2092933	898748	42	1039	1081	WGNHS Well Records
PT2066.TIF	2116980	900564	96	1073	1169	WGNHS Well Records
PT3162.TIF	2041321	866526	37	1003	1040	WGNHS Well Records
PT3196.TIF	2072178	890589	75	995	1070	WGNHS Well Records
PT3203.TIF	2116928	903235	108	1043	1151	WGNHS Well Records
PT3204.TIF	2107547	897275	49	1132	1181	WGNHS Well Records

Table A-1

Summary of Base of Sand and Gravel Unit - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Rock (feet)	Elevation of Top of Rock (feet, MSL)	Ground Surface Elevation (Feet, MSL, estimated from DEM)	Data Source
WS466.TIF	2084636	782060	141	941	1082	WGNHS Well Records
WS468.TIF	2087296	776740	80	1002	1082	WGNHS Well Records
WS1011.TIF	2092370	805938	210	891	1101	WGNHS Well Records
WS1012.TIF	2092370	805938	235	866	1101	WGNHS Well Records
WS3512.TIF	2077349	788765	80	987	1067	WGNHS Well Records
WS3516.TIF	2079295	790091	76	991	1067	WGNHS Well Records
WS3518.TIF	2087235	787435	60	1022	1082	WGNHS Well Records
WS3519.TIF	2084573	790072	66	1009	1075	WGNHS Well Records
WS3523.TIF	2097791	790099	78	1028	1106	WGNHS Well Records
WD234.TIF	2007884	855729	16	956	972	WGNHS Well Records
WD235.TIF	2016365	859764	47	969	1016	WGNHS Well Records
WD237.TIF	2030817	879562	59	983	1042	WGNHS Well Records
WD238.TIF	2025531	879526	75	966	1041	WGNHS Well Records
WD240.TIF	2028167	874270	37	1002	1039	WGNHS Well Records
WD241.TIF	2025534	876884	58	982	1040	WGNHS Well Records
WD242.TIF	2025534	876884	45	995	1040	WGNHS Well Records
WD245.TIF	2020253	871585	46	987	1033	WGNHS Well Records
WD246.TIF	2014980	868980	50	973	1023	WGNHS Well Records
WD247.TIF	2014980	868980	49	974	1023	WGNHS Well Records
WD249.TIF	2014998	863690	68	953	1021	WGNHS Well Records
WD252.TIF	2022945	863692	75	951	1026	WGNHS Well Records
WD253.TIF	2022945	863692	61	965	1026	WGNHS Well Records
WD254.TIF	2020274	866313	39	986	1025	WGNHS Well Records
WD255.TIF	2020274	866313	45	980	1025	WGNHS Well Records
WD258.TIF	2028420	863740	45	986	1031	WGNHS Well Records
WD259.TIF	2028420	863740	44	987	1031	WGNHS Well Records
WD262.TIF	2028420	863740	92	939	1031	WGNHS Well Records
WD264.TIF	2028350	866371	43	992	1034	WGNHS Well Records
WD274.TIF	2033773	863834	42	992	1034	WGNHS Well Records
WD276.TIF	2036438	863863	35	1002	1037	WGNHS Well Records
WD277.TIF	2036438	863863	38	999	1037	WGNHS Well Records
WD279.TIF	2039115	863871	37	999	1036	WGNHS Well Records
WD317.TIF	2025796	858483	39	972	1011	WGNHS Well Records
WD338.TIF	2028523	858501	57	972	1029	WGNHS Well Records
WD340.TIF	2028523	858501	29	1000	1029	WGNHS Well Records
WD343.TIF	2028523	858501	46	983	1029	WGNHS Well Records
WD397.TIF	2015058	858453	50	969	1019	WGNHS Well Records
WD406.TIF	2015058	858453	56	963	1019	WGNHS Well Records
WD424.TIF	2012374	861048	64	950	1014	WGNHS Well Records
WD427.TIF	2015159	855804	32	978	1010	WGNHS Well Records
WD439.TIF	2023175	855839	35	980	1015	WGNHS Well Records
WD445.TIF	2023175	855839	36	979	1015	WGNHS Well Records
WD467.TIF	2025962	853216	39	986	1025	WGNHS Well Records
WD663.TIF	2028148	884845	38	992	1030	WGNHS Well Records
WD664.TIF	2036059	887579	50	990	1040	WGNHS Well Records
WD1235.TIF	1999898	850324	31	935	966	WGNHS Well Records
WD1236.TIF	1999898	850324	29	937	966	WGNHS Well Records

Table A-1

Summary of Base of Sand and Gravel Unit - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Rock (feet)	Elevation of Top of Rock (feet, MSL)	Ground Surface Elevation (Feet, MSL, estimated from DEM)	Data Source
WD1247.TIF	2002714	845006	30	957	987	WGNHS Well Records
WD1248.TIF	2002714	845006	40	947	987	WGNHS Well Records
WD1249.TIF	2002714	845006	37	950	987	WGNHS Well Records
WD1250.TIF	2002714	845006	39	948	987	WGNHS Well Records
WD1251.TIF	2002714	845006	44	943	987	WGNHS Well Records
WD1253.TIF	2005395	839714	68	919	986	WGNHS Well Records
WD1255.TIF	1997554	837043	25	901	926	WGNHS Well Records
WD1256.TIF	1997554	837043	23	903	926	WGNHS Well Records
WD1398.TIF	2007815	863675	34	975	1009	WGNHS Well Records
WD1399.TIF	2007815	863675	14	995	1009	WGNHS Well Records
WD1429.TIF	2016278	875541	19	994	1013	WGNHS Well Records
WD1430.TIF	2014974	874217	13	998	1011	WGNHS Well Records
WD1431.TIF	2014974	874217	6	1005	1011	WGNHS Well Records
WD1432.TIF	2014974	874217	10	1001	1011	WGNHS Well Records
WD1434.TIF	2022887	875554	35	1002	1037	WGNHS Well Records
WD1435.TIF	2022894	876873	28	1009	1037	WGNHS Well Records
WD1436.TIF	2022894	876873	46	991	1037	WGNHS Well Records
WD1437.TIF	2022894	876873	44	993	1037	WGNHS Well Records
WD1438.TIF	2025534	876884	34	1006	1040	WGNHS Well Records
WD1440.TIF	2020257	868945	14	1014	1028	WGNHS Well Records
WD1441.TIF	2022880	868935	55	975	1030	WGNHS Well Records
WD1442.TIF	2014980	868980	20	1003	1023	WGNHS Well Records
WD1443.TIF	2011378	870295	16	978	994	WGNHS Well Records
WD1444.TIF	2010075	863684	42	974	1016	WGNHS Well Records
WD1445.TIF	2010075	863684	41	975	1016	WGNHS Well Records
WD1448.TIF	2012350	863688	17	1003	1020	WGNHS Well Records
WD1449.TIF	2016312	865011	38	984	1022	WGNHS Well Records
WD1450.TIF	2016312	865011	38	984	1022	WGNHS Well Records
WD1451.TIF	2014998	863690	33	988	1021	WGNHS Well Records
WD1452.TIF	2014998	863690	30	991	1021	WGNHS Well Records
WD1453.TIF	2028420	863740	73	958	1031	WGNHS Well Records
WD1458.TIF	2039095	866507	30	1020	1050	WGNHS Well Records
WD1459.TIF	2039095	866507	32	1018	1050	WGNHS Well Records
WD1464.TIF	2020369	858457	74	946	1020	WGNHS Well Records
WD1470.TIF	2015058	858453	55	964	1019	WGNHS Well Records
WD1471.TIF	2015058	858453	48	971	1019	WGNHS Well Records
WD1480.TIF	2012691	853109	76	907	983	WGNHS Well Records
WD1482.TIF	2015159	855804	38	972	1010	WGNHS Well Records
WD1483.TIF	2015159	855804	53	957	1010	WGNHS Well Records
WD1485.TIF	2015159	855804	62	948	1010	WGNHS Well Records
WD1487.TIF	2017793	855808	57	956	1013	WGNHS Well Records
WD1806.TIF	2037326	891561	11	1027	1038	WGNHS Well Records
WD1807.TIF	2037326	891561	10	1028	1038	WGNHS Well Records
WD1808.TIF	2037326	891561	18	1020	1038	WGNHS Well Records
WD1809.TIF	2036008	890222	30	1008	1038	WGNHS Well Records
WD1810.TIF	2035973	892864	30	1009	1039	WGNHS Well Records
WD1811.TIF	2035973	892864	3	1036	1039	WGNHS Well Records

Table A-1

Summary of Base of Sand and Gravel Unit - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Rock (feet)	Elevation of Top of Rock (feet, MSL)	Ground Surface Elevation (Feet, MSL, estimated from DEM)	Data Source
WD1812.TIF	2035973	892864	13	1026	1039	WGNHS Well Records
WD1813.TIF	2038645	892904	17	1022	1039	WGNHS Well Records
WD1814.TIF	2038645	892904	40	999	1039	WGNHS Well Records
WD1815.TIF	2038645	892904	22	1017	1039	WGNHS Well Records
WD1852.TIF	2028105	887465	18	1017	1035	WGNHS Well Records
WD1853.TIF	2030755	887507	44	986	1030	WGNHS Well Records

Note: Wisconsin Geological and Natural History Survey (WGNHS) well construction reports are by county; Well ID indicates the name of the well log image file. Coordinates for these wells are based on legal description and are approximate (quarter-quarter sections).

Table A-2

Summary of Base of Sandstone - Elevation Data

Well ID	X-Coordinate	Y-Coordinate	Depth to Top of Sandstone (feet)	Depth to Base of Sandstone (feet)	Elevation of Base of Sandstone (feet, MSL)	Ground Surface Elevation (feet, MSL, estimated from DEM)	Thickness of Sanstone (feet)	Data Source
W-1000253	2028134	771192	70	245	765	1010	175	WiscLith
W-1000442	2026911	803915	69	185	826	1011	116	WiscLith
W-1000473	2031456	774451	105	240	770	1010	135	WiscLith
W-29000013	1948844	735550	120	310	616	926	190	WiscLith
W-50000359	2097526	900824	75	102	979	1081	27	WiscLith
W-50000718	2059931	888346	65	85	984	1069	20	WiscLith
W-50001065	2089233	848573	115	135	935	1070	20	WiscLith
W-50001066	2088533	846693	95	100	965	1065	5	WiscLith
W-50001246	2112006	856159	134	247	906	1153	113	WiscLith
W-70000816	2077144	810532	245	250	823	1073	5	WiscLith
W-70000900	2077144	810532	242	250	823	1073	8	WiscLith
W-70000901	2075824	810515	200	255	815	1070	55	WiscLith
W-70000902	2075824	810515	170	255	815	1070	85	WiscLith
W-70000903	2075824	810515	140	260	810	1070	120	WiscLith
W-70000905	2078452	811866	115	260	818	1078	145	WiscLith
W-70000907	2075818	809192	140	250	820	1070	110	WiscLith
W-70000908	2074579	808525	140	245	822	1067	105	WiscLith
W-70000909	2074579	808525	145	245	822	1067	100	WiscLith
W-70001025	2086570	788094	85	315	764	1079	230	WiscLith
W-72000521	1998173	843001	20	45	914	959	25	WiscLith

Attachment B

Estimates of Hydraulic Conductivity

Attachment B

Estimates of Hydraulic Conductivity

Hydraulic conductivity (K) was estimated at high capacity well locations using measured specific capacity (as reported in the Wisconsin DNR database) values using the TGUESS model (Bradbury and Rothschild, 1985)[1]. Table B-1 lists the conductivity estimates and Figure B-1 shows the locations and estimated hydraulic conductivity value. In the sand and gravel unit, hydraulic conductivities were estimated between 46 and 734 feet/day, with an average of 252 feet/day. In the sandstone unit, the hydraulic conductivity estimates ranged between 1 and 159 feet/day, with an average of 25 feet/day.

[1] Bradbury, K. B., and E. R. Rothschild, 1985. A computerized technique for estimating the hydraulic conductivity of an aquifer from specific capacity data. Ground Water, volume 23, number 2, page 240-246.

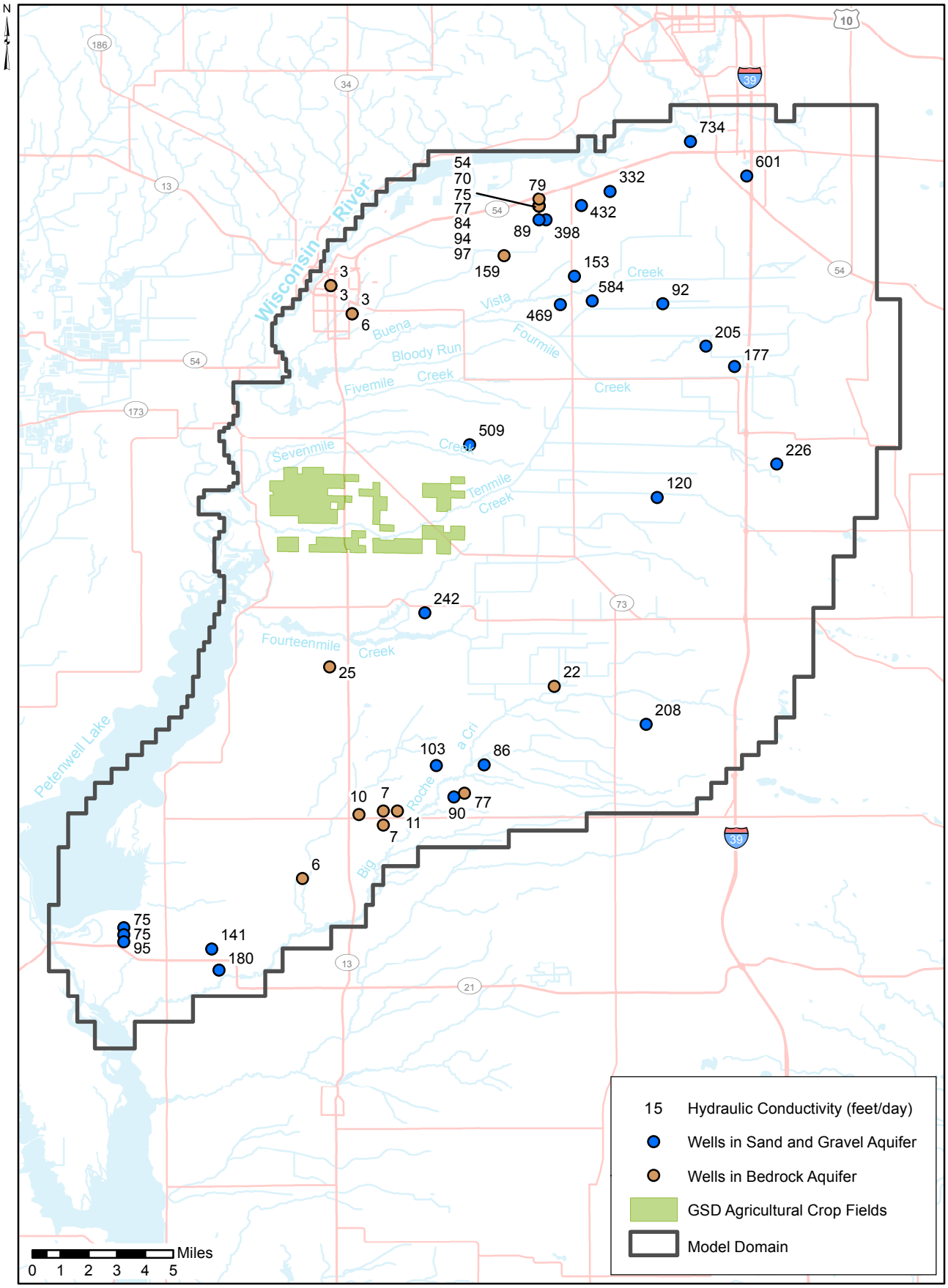


Figure B-1 Hydraulic Conductivity Estimate from Specific Capacity Data (Tguess) from Wisconsin DNR Wells Database

Table B-1

Estimates of Hydraulic Conductivity

Well ID	X-Coordinate	Y-Coordinate	Hydraulic Conductivity (feet/day)	Well Depth (feet, bgs)	AQUIFER
256	2025489.535	768546.3752	7	310	Sandstone
257	2028133.75	771192.4702	11	260	Sandstone
258	2025505.433	771187.8647	7	281	Sandstone
259	2022892.741	771178.2199	8	280	Bedrock
277	2057506.7	794551.9735	22	210	Sandstone
282	2015461.434	798177.817	25	240	Sandstone
495	2041640.043	839808.1611	509	115	Sand/Gravel
557	2019640.366	864347.4091	6	148	Granite
558	2019640.366	864347.4091	3	148	Granite
627	2061297.486	871394.0478	153	60	Sand/Gravel
767	2033270.8	808312.5273	242	56	Sand/Gravel
798	2125600.809	874387.2984	587	146	Sand/Gravel
862	2109681.319	920323.4941	46	91.5	Sand/Gravel
985	2023666.056	736201.4187	11	285	Sandstone
1308	2076782.837	829910.3294	120	95	Sand/Gravel
1344	2112035.261	776195.1663	189	165	Sand/Gravel
1467	2062609.291	884625.4954	432	48	Sand/Gravel
1498	2017005.386	747947.0466	18	263	Sandstone
1616	2005268.566	725520.3899	15	240	Sandstone
1618	1994722.735	741348.0623	180	93	Sand/Gravel
1830	1976878.903	749301.6969	75	124	Sand/Gravel
1831	1976874.328	747986.0378	75	122	Sand/Gravel
1905	1976878.802	746673.9939	95	131	Sand/Gravel
2154	1948800.926	729311.5106	137	207	Sandstone
2200	1973701.987	825681.6596	179	75	Sand/Gravel
2244	2091265.578	854463.1086	177	104	Sand/Gravel
2661	2020926.792	770503.855	10	222	Sandstone
2687	1993352.722	745298.8234	141	91	Sand/Gravel
2840	2085922.381	858296.7177	205	85	Sand/Gravel
2886	2093567.962	890161.2912	601	100	Sand/Gravel
3203	2077848.467	866250.3872	92	94	Sand/Gravel
3220	2010368.934	758514.9314	6	230	Sandstone
3363	2055956.445	881951.2634	398	61	Sand/Gravel
3476	2048092.163	875217.0228	159	45	Sandstone
4489	1980504	724248.1604	21	205	Sandstone
4490	1980511.248	725568.9593	7	138	Sandstone
4501	1979509.074	725565.5672	4	141	Sandstone
4502	1979509.074	725565.5672	4	139	Sandstone
4503	1979509.074	725565.5672	5	159	Sandstone
4504	1979509.074	725565.5672	4	140	Sandstone
4505	1979509.464	726887.9956	4	140	Sandstone
4506	1979509.464	726887.9956	4	140	Sandstone
4507	1979509.464	726887.9956	3	140	Sandstone
4508	1979509.464	726887.9956	3	140	Sandstone
4509	1979509.074	725565.5672	3	140	Sandstone
4510	1979509.074	725565.5672	3	140	Sandstone
4511	1979509.074	725565.5672	4	140	Sandstone
4512	1979509.074	725565.5672	4	139	Sandstone
4513	1979509.464	726887.9956	1	120	Sandstone

Table B-1

Estimates of Hydraulic Conductivity

Well ID	X-Coordinate	Y-Coordinate	Hydraulic Conductivity (feet/day)	Well Depth (feet, bgs)	AQUIFER
4514	1979509.464	726887.9956	3	140	Sandstone
4516	1979509.464	726887.9956	3	140	Sandstone
4517	1979509.464	726887.9956	10	173	Sandstone
4521	1978203.788	725553.3355	4	140	Sandstone
4522	1978203.788	725553.3355	4	140	Sandstone
4524	1979509.074	725565.5672	4	139	Sandstone
4525	1979509.074	725565.5672	4	138	Sandstone
4527	1979509.074	725565.5672	5	137	Sandstone
4528	1979509.074	725565.5672	4	138	Sandstone
4529	1979509.074	725565.5672	3	140	Sandstone
4530	1978203.788	725553.3355	4	145	Sandstone
4531	1979509.074	725565.5672	4	145	Sandstone
4533	1979509.074	725565.5672	4	139	Sandstone
4534	1979509.074	725565.5672	3	141	Sandstone
12986	1939605.27	747852.8079	14	110	Sandstone
23652	2099160.326	836196.8699	226	107	Sand/Gravel
24167	2064630.207	866757.6497	584	76	Sand/Gravel
24213	2058656.237	866066.0622	469	58	Sand/Gravel
36759	2074710.487	787438.6643	208	93	Sand/Gravel
38637	2015641.503	869629.4687	3	200	Granite
58406	2083030.804	896631.9587	734	52	Sand/Gravel
58420	2054632.226	884558.1588	70	87	Sandstone
58421	2054632.226	884558.1588	97	91	Sandstone
58422	2054632.226	884558.1588	75	89	Sandstone
58425	2054632.226	884558.1588	54	100	Sandstone
58426	2054632.226	884558.1588	94	93	Sandstone
58427	2054632.226	884558.1588	77	96	Sandstone
58431	2054632.226	884558.1588	84	80	Sandstone
58432	2054647.519	885880.7743	79	85	Sandstone
67258	2067947.069	887259.0221	332	60	Sand/Gravel
67997	1980504	724248.1604	3	140	Sandstone
70502	2054631.231	881937.339	89	61	Sand/Gravel
70952	1973483.06	810584.4474	157	102	Sand/Gravel
71371	2035419.422	779707.5862	103	110	Sand/Gravel
71372	2044385.057	779839.183	86	120	Sand/Gravel
71373	2038711.734	773824.503	90	130	Sand/Gravel
71374	2040695.25	774510.8561	77	128	Sandstone
71378	2034075.539	762632.7865	34	280	Sandstone
80280	1947479.758	738560.8553	53	150	Sandstone

Note - Datum for X and Y coordinates are NAD83, State Plane, Wisconsin South, FIPS 4803, feet.

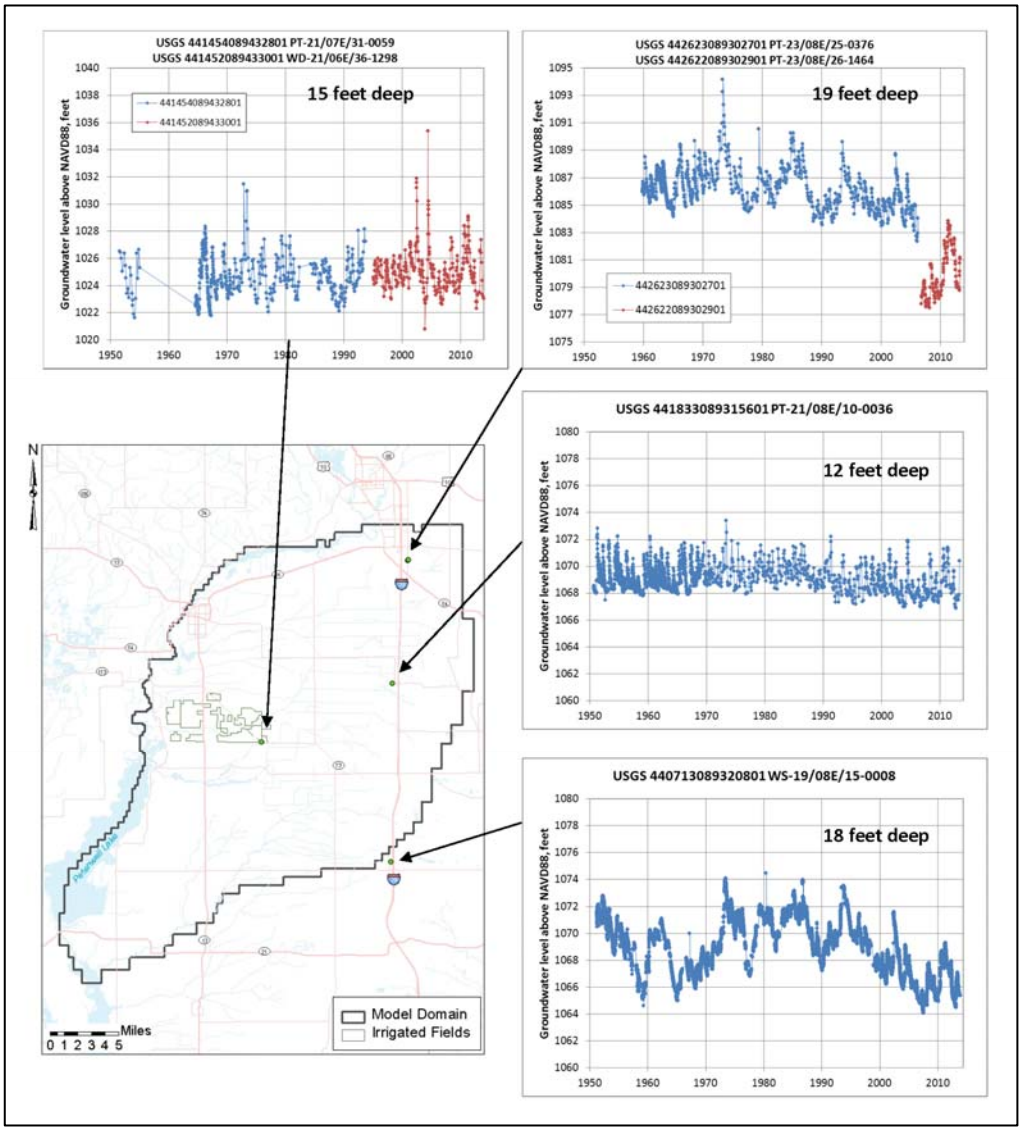
Attachment C

Water Level Data

Attachment C
Water-Level Data

A total of 574 water-level targets were identified in the model domain from the USGS database. 287 of these wells were completed in the sand and gravel unit, one in the sandstone, and 286 were not identified. Three of the targets were assigned weights of 0 after a preliminary review of the data looking for unusually high or low values. In determining target values for the USGS wells, if historical data were available, the average was used. The targets are listed in the table on the following pages and their locations shown on Figure C-1 and on Figure 3 in the groundwater flow model report.

The USGS has three long-term groundwater monitoring wells in the model domain and another long-term monitoring well less than one mile southeast of the model domain. The locations of these wells and long-term hydrographs are shown below. The wells are all relatively shallow (12 to 19 feet deep) but all are reported to be completed in the sand and gravel aquifer. The well in the northeast corner of the model domain was replaced in 2006 and the altitude was resurveyed using GPS; the apparent discrepancy in water levels between the two wells is likely due to a ~6-foot difference in ground surface elevation values.



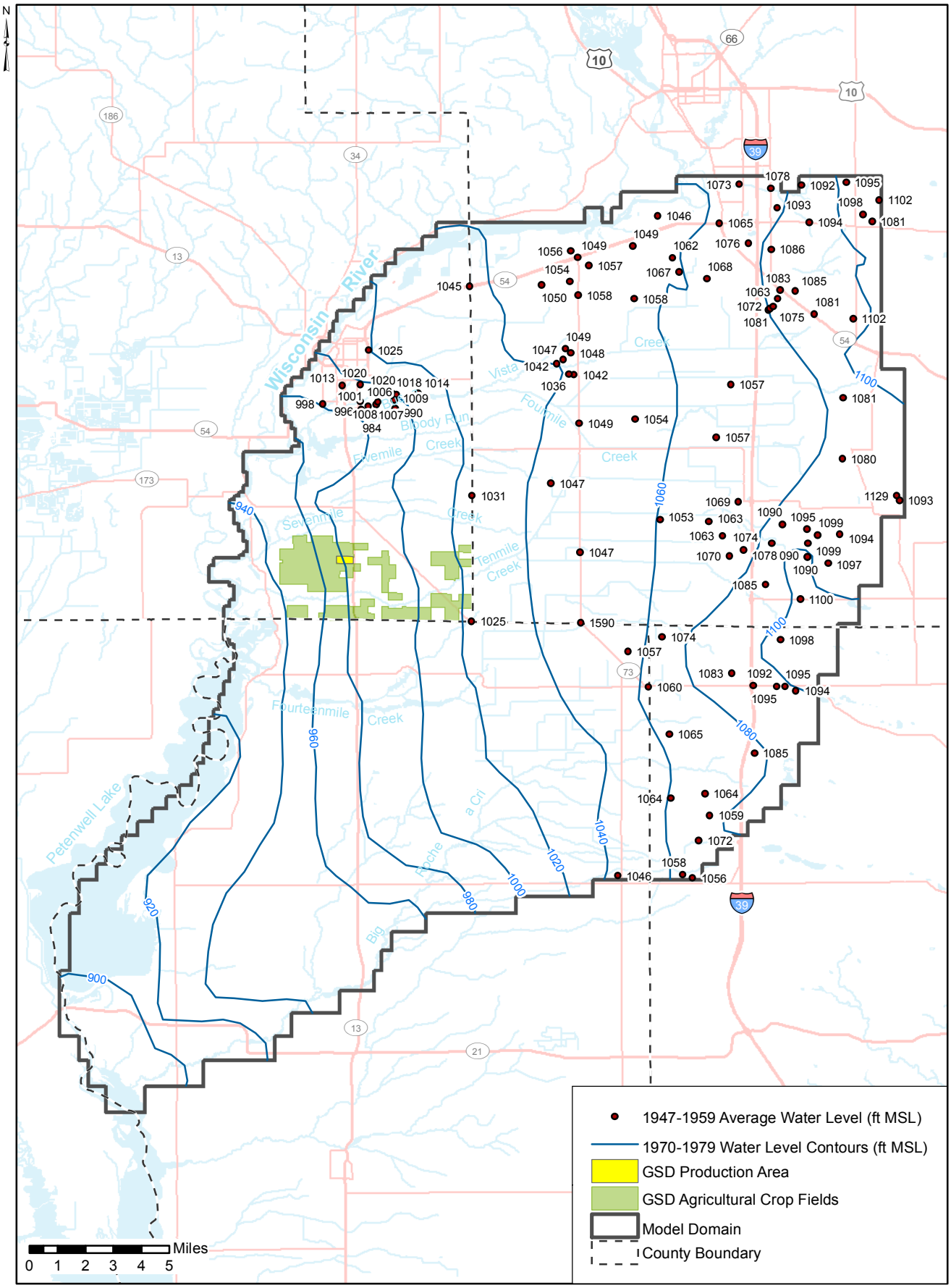


Figure C-1 Groundwater Levels in the Sand and Gravel Aquifer (1947-1959)

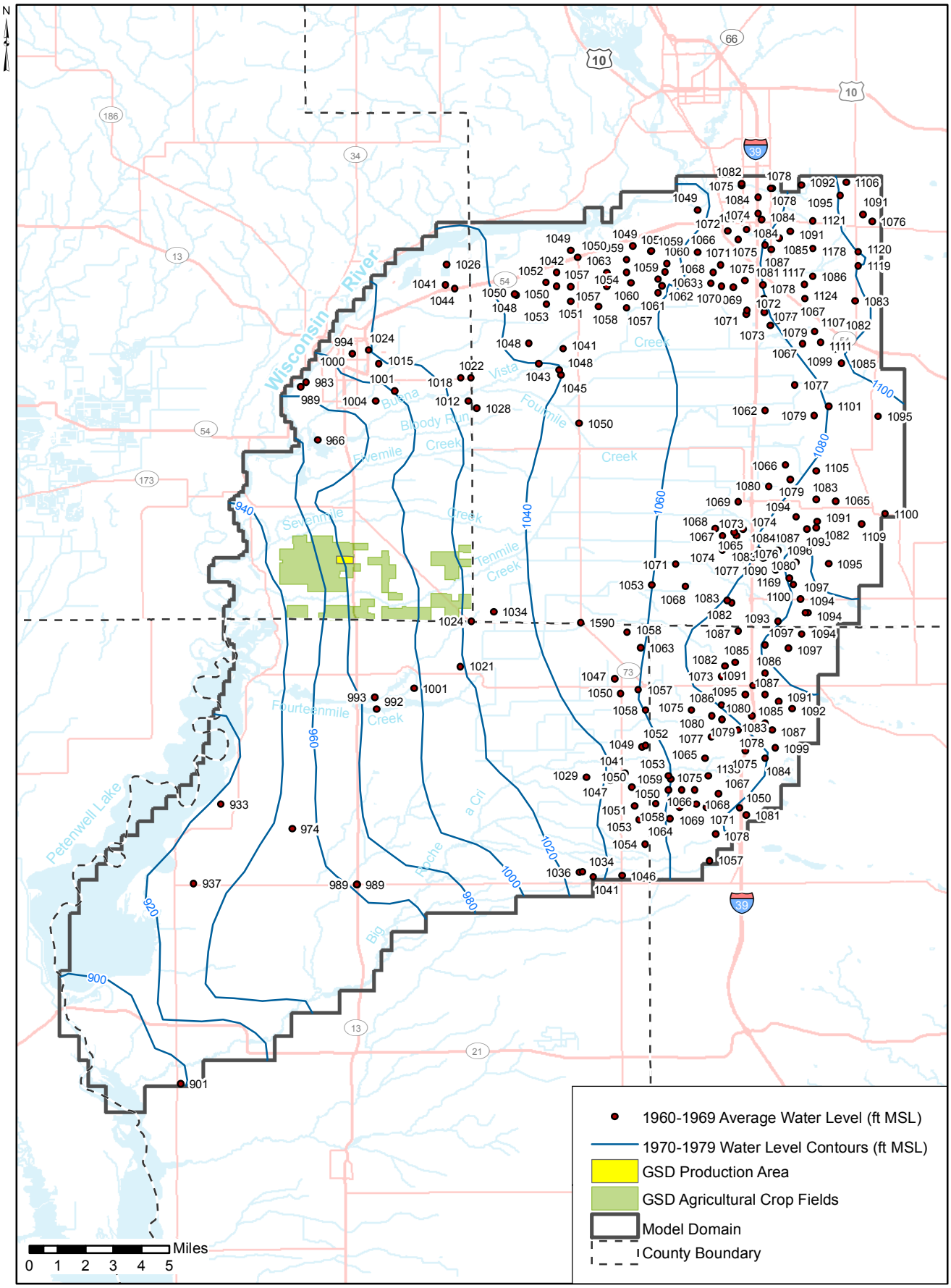


Figure C-2 Groundwater Levels in the Sand and Gravel Aquifer (1960-1969)

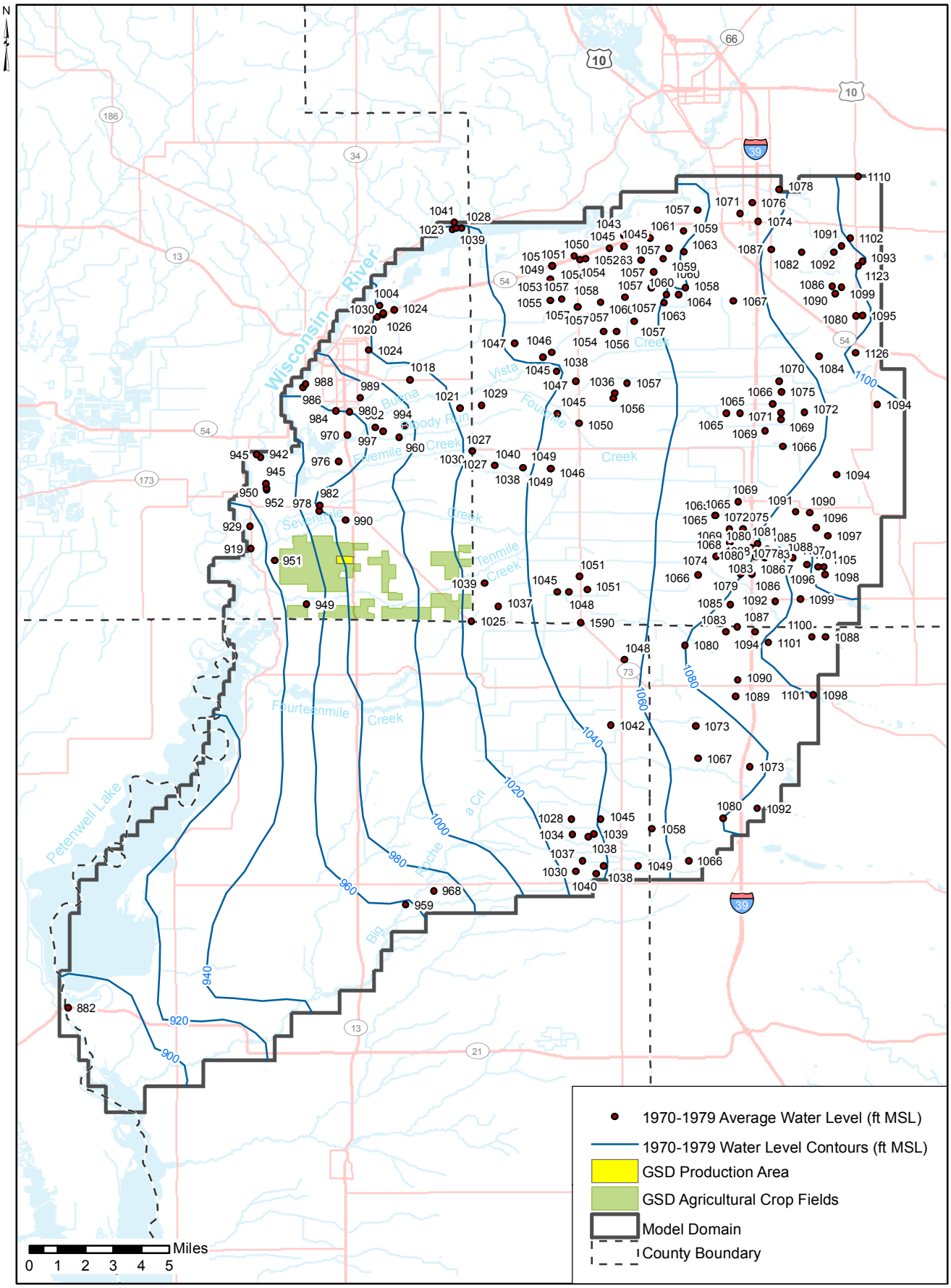


Figure C-3 Groundwater Levels in the Sand and Gravel Aquifer (1970-1979)

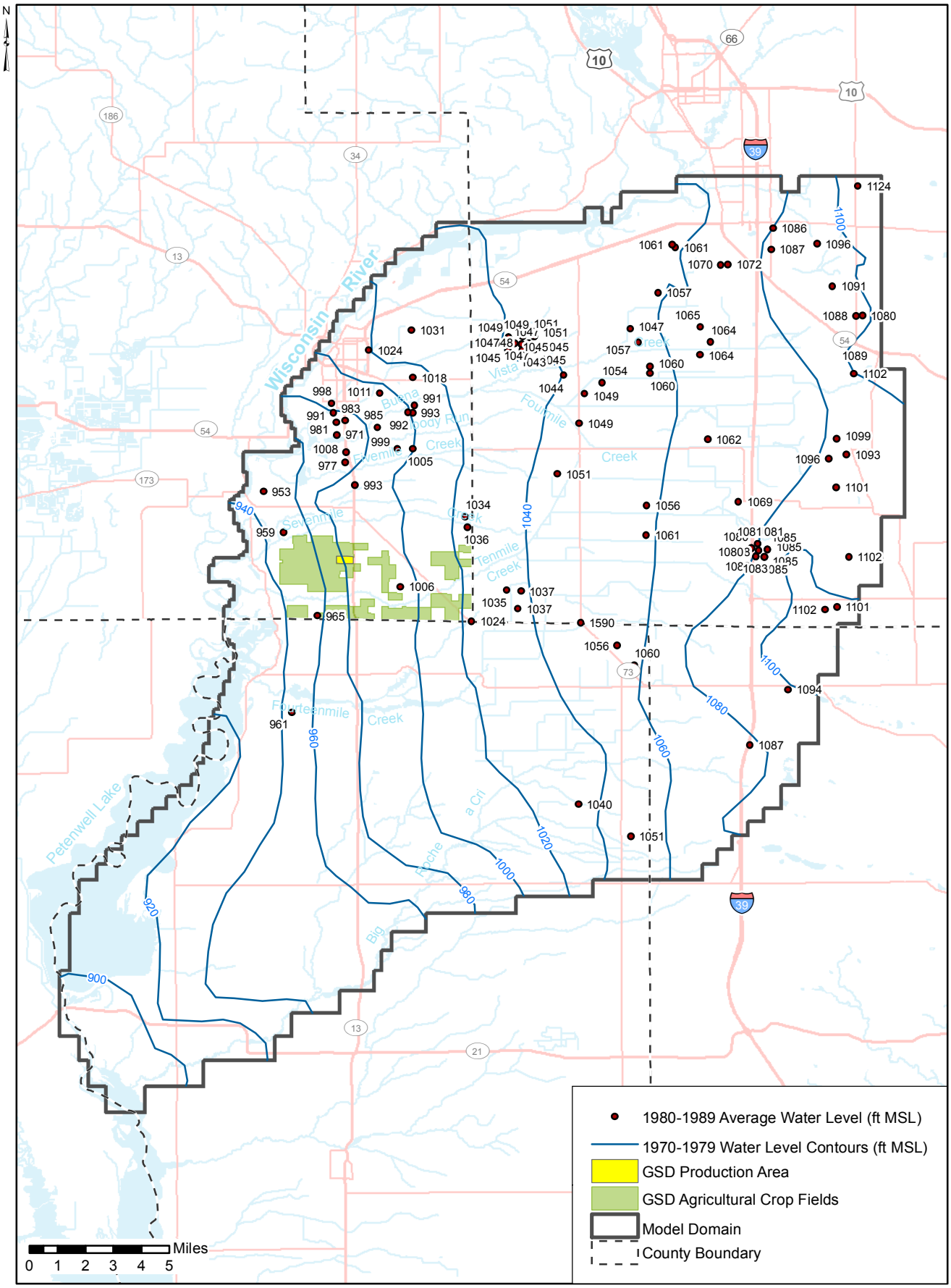


Figure C-4 Groundwater Levels in the Sand and Gravel Aquifer (1980-1989)

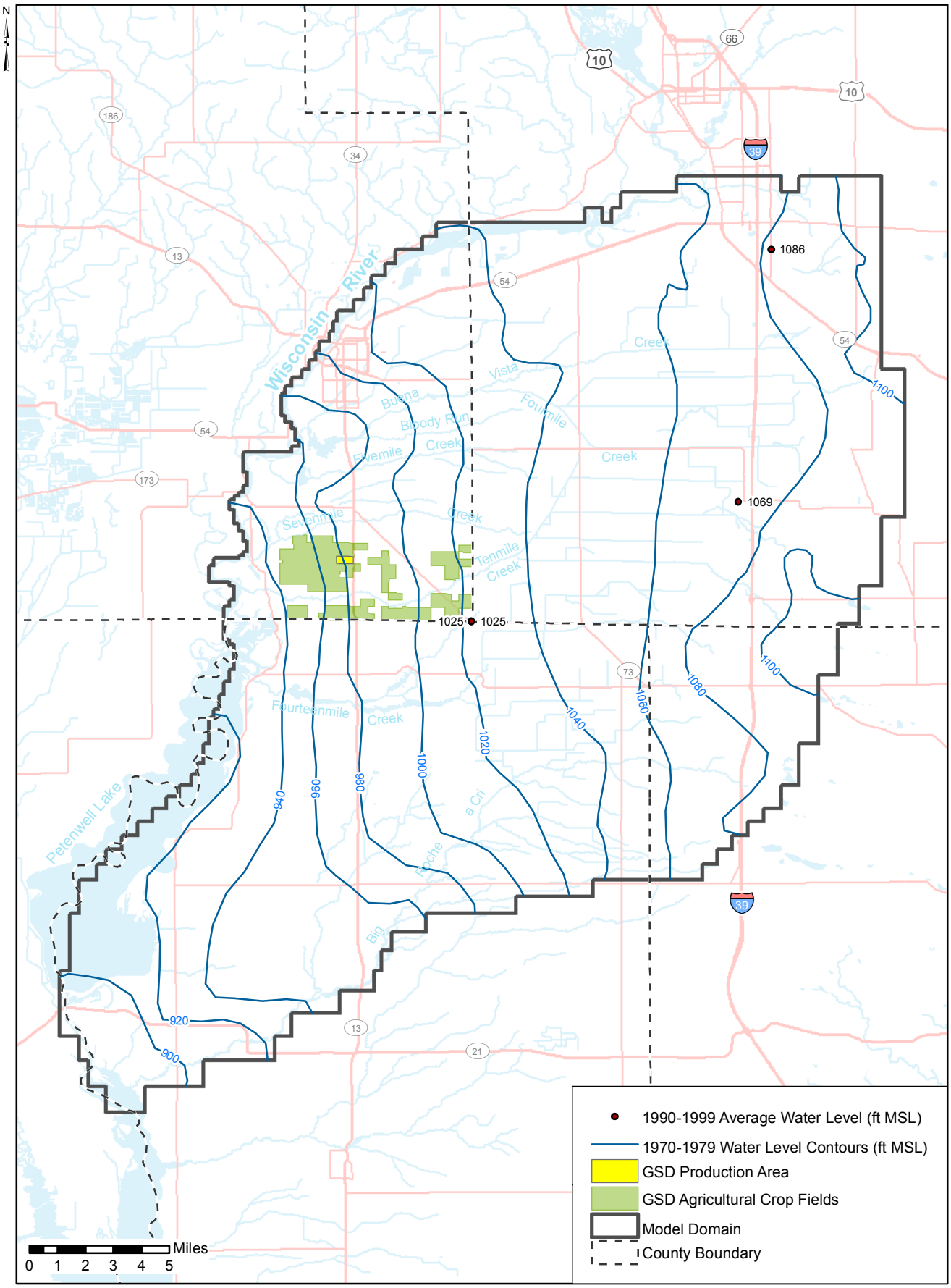


Figure C-5 Groundwater Levels in the Sand and Gravel Aquifer (1990-1999)

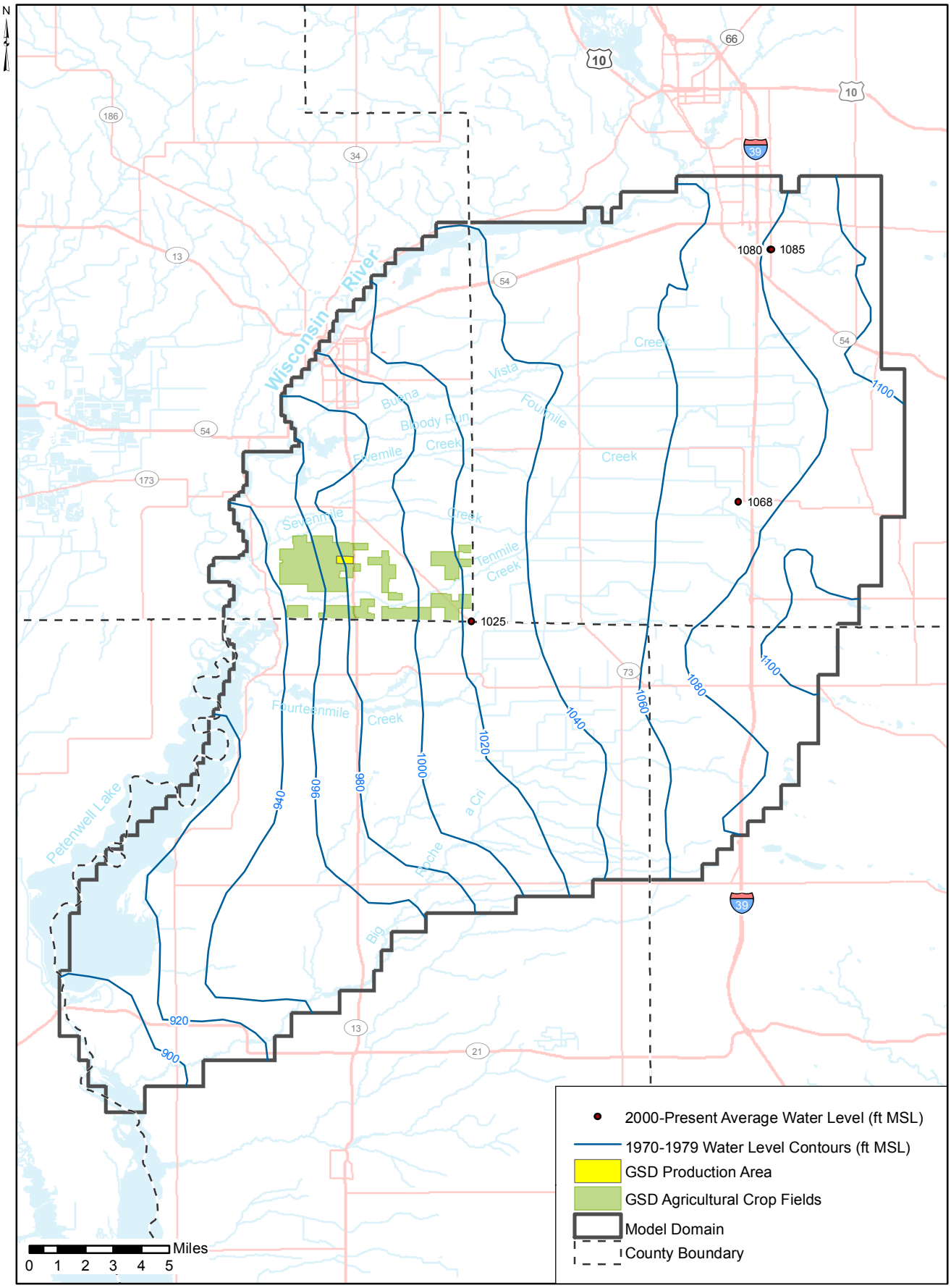


Figure C-6 Groundwater Levels in the Sand and Gravel Aquifer (2000-Present)

Table C-1

Water Level Data

Well ID[1]	X-Coordinate (feet)[2]	Y-Coordinate (feet)[2]	Source[3]	Unit	Target Value	Date of First Measurement	Date of Last Measurement	Count	Included as Target
430715089362001	2072053.137	773242.402	USGS	Sand and Gravel	1049	4/15/1976			Yes
440253090005701	1964303.114	746465.167	USGS	Sand and Gravel	882	4/28/1972			Yes
440604089462301	2028084.954	765887.935	USGS	Sand and Gravel	959	7/6/1973			Yes
440630089451001	2033404.171	768536.015	USGS	Sand and Gravel	968	7/6/1973			Yes
440644089553701	1988019.28	769865.315	USGS	Sand and Gravel	937	9/22/1964			Yes
440654089381701	2063527.443	771077	USGS	Sand and Gravel	1041	4/30/1962			Yes
440657089370301	2068924.712	771405.011	USGS	Sand and Gravel	1046	9/17/1963			Yes
440657089371401	2068122.218	771401.313	USGS	Sand and Gravel	1046	8/1/1958			Yes
440658089342501	2080450.885	771562.424	USGS	Sand and Gravel	1057	5/8/1959			Yes
440700089381001	2064035.512	771686.815	USGS	Sand and Gravel	1040	2/10/1978			Yes
440703089385301	2060897.224	771977.061	USGS	Sand and Gravel	1036	9/16/1963			Yes
440704089384501	2061480.423	772080.821	USGS	Sand and Gravel	1034	5/12/1965			Yes
440724089341001	2081531.616	774200.888	USGS	Sand and Gravel	1066	5/8/1971			Yes
440725089384501	2061471.421	774207.328	USGS	Sand and Gravel	1037	3/10/1978			Yes
440802089334401	2083408.028	778058.784	USGS	Sand and Gravel	1072	1/1/1957			Yes
440810089364001	2070568.275	778804.987	USGS	Sand and Gravel	1051	7/12/1984			Yes
440810089383001	2062546.035	778768.873	USGS	Sand and Gravel	1037	3/16/1978			Yes
440814089330001	2086610.473	779291.088	USGS	Sand and Gravel	1078	4/11/1963			Yes
440814089391101	2059554.254	779161.217	USGS	Sand and Gravel	1034	3/23/1978			Yes
440815089381501	2063637.797	779279.936	USGS	Sand and Gravel	1038	2/28/1978			Yes
440824089354501	2074572.52	780241.833	USGS	Sand and Gravel	1058	5/14/1979			Yes
440826089511701	2006605.995	780219.04	USGS	Sand and Gravel	974	9/22/1964	10/9/1964	2	Yes
440841089361801	2072157.882	781951.726	USGS	Sand and Gravel	1053	5/4/1964			Yes
440842089375701	2064938.458	782019.821	USGS	Sand and Gravel	1045	4/18/1978			Yes
440843089345901	2077917.442	782182.417	USGS	Sand and Gravel	1064	4/6/1964			Yes
440843089391301	2059396.246	782097.234	USGS	Sand and Gravel	1028	3/28/1978			Yes
440849089314001	2092424.641	782867.682	USGS	Sand and Gravel	1081	6/30/1965			Yes
440902089315701	2091177.714	784177.092	USGS	Sand and Gravel	1050	5/16/1965			Yes
440903089343301	2079803.007	784217.281	USGS	Sand and Gravel	1069	5/10/1961			Yes
440906089362901	2071343.904	784479.505	USGS	Sand and Gravel	1051	4/30/1962			Yes
440909089335001	2082935.013	784841.117	USGS	Sand and Gravel	1068	4/5/1962	8/27/1964	2	Yes
440912089542101	1993182.503	784857.69	USGS	Sand and Gravel	933	6/21/1966			Yes
440921089345601	2078116.964	786031.538	USGS	Sand and Gravel	1064	7/14/1954			Yes
440936089335301	2082702.058	787574.088	USGS	Sand and Gravel	1065	4/12/1962			Yes
440936089342701	2080223.47	787561.239	USGS	Sand and Gravel	1075	4/2/1962			Yes
440936089350201	2077671.952	787548.3	USGS	Sand and Gravel	1050	7/14/1963			Yes
440942089363601	2070816.532	788122.612	USGS	Sand and Gravel	1050	6/25/1965			Yes
440954089373101	2066801.662	789319.299	USGS	Sand and Gravel	1047	6/21/1965			Yes
440956089345601	2078099.238	789575.775	USGS	Sand and Gravel	1059	3/18/1968			Yes
441000089383401	2062206.727	789906.643	USGS	Sand and Gravel	1029	6/8/1967			Yes
441002089331801	2085239.523	790220.469	USGS	Sand and Gravel	1133	6/15/1965			Yes
441002089350201	2077658.846	790181.156	USGS	Sand and Gravel	1053	5/12/1967			Yes
441034089305001	2096008.567	793521.385	USGS	Sand and Gravel	1084	4/1/1966			Yes
441035089332601	2084638.693	793559.085	USGS	Sand and Gravel	1065	6/1/1963			Yes
441044089311801	2093962.107	794522.194	USGS	Sand and Gravel	1085	4/22/1957			Yes
441048089314201	2092210.784	794917.236	USGS	Sand and Gravel	1075	5/1/1962			Yes
441054089302401	2097891.47	795557.854	USGS	Sand and Gravel	1099	11/19/1965			Yes
441057089360901	2072748.644	795726.795	USGS	Sand and Gravel	1049	4/12/1963			Yes
441059089360001	2073403.52	795932.46	USGS	Sand and Gravel	1052	7/15/1964			Yes
441120089345901	2077838.102	798080.912	USGS	Sand and Gravel	1065	7/21/1954			Yes
441127089303201	2097288.845	798896.131	USGS	Sand and Gravel	1087	4/17/1964			Yes
441127089315901	2090949.837	798859.575	USGS	Sand and Gravel	1078	4/15/1964			Yes
441135089335001	2082857.869	799625.721	USGS	Sand and Gravel	1073	5/18/1972			Yes
441140089305001	2095969.668	800204.864	USGS	Sand and Gravel	1085	4/18/1964			Yes
441147089324201	2087805.702	800867.489	USGS	Sand and Gravel	1080	4/19/1964			Yes
441147089324202	2087805.702	800867.489	USGS	Sand and Gravel	1079	12/1/1964			Yes
441154089312401	2093484.411	801608.219	USGS	Sand and Gravel	1083	7/1/1966			Yes
441154089330801	2085907.676	801566.049	USGS	Sand and Gravel	1080	4/20/1964			Yes
441202089361201	2072441.103	814459.972	USGS	Sand and Gravel	1063	8/11/1960			Yes

Table C-1

Water Level Data

Well ID[1]	X-Coordinate (feet)[2]	Y-Coordinate (feet)[2]	Source[3]	Unit	Target Value	Date of First Measurement	Date of Last Measurement	Count	Included as Target
441203089511701	2006567.823	802193.609	USGS	Sand and Gravel	961	11/5/1985			Yes
441205089340001	2082113.516	802659.871	USGS	Sand and Gravel	1075	8/15/1968			Yes
441205089355901	2073444.377	802616.343	USGS	Sand and Gravel	1058	5/5/1965			Yes
441206089294001	2101053.791	802868.198	USGS	Sand and Gravel	1092	7/27/1965			Yes
441209089473701	2022593.791	802835.309	USGS	Sand and Gravel	992	8/2/1968			Yes
441214089324201	2087790.813	803601.649	USGS	Sand and Gravel	1086	11/12/1965			Yes
441233089314101	2092223.606	805550.505	USGS	Sand and Gravel	1095	5/18/1962			Yes
441240089293001	2101761.323	806315.664	USGS	Sand and Gravel	1094	10/1/1958			Yes
441247089460001	2029649.507	806702.226	USGS	Sand and Gravel	1001	6/1/1969			Yes
441248089301901	2098187.493	807104.244	USGS	Sand and Gravel	1095	1/18/1957			Yes
441250089312101	2093670.546	807280.341	USGS	Sand and Gravel	1091	1/2/1951	11/3/1969	919	Yes
441304089372001	2067516.544	808563.377	USGS	Sand and Gravel	1047	5/29/1968			Yes
441313089304901	2095987.69	809622.987	USGS	Sand and Gravel	1086	11/15/1965			Yes
441313089321601	2089651.79	809586.808	USGS	Sand and Gravel	1083	6/1/1958			Yes
441326089323301	2088406.511	810896.413	USGS	Sand and Gravel	1082	5/14/1965			Yes
441329089362901	2071218.999	811112.285	USGS	Sand and Gravel	1060	5/21/1984			Yes
441333089320701	2090295.964	811615.78	USGS	Sand and Gravel	1085	4/29/1963			Yes
441355089364001	2070041.646	813739.744	USGS	Sand and Gravel	1057	4/16/1959			Yes
441359089294801	2100402.034	814307.706	USGS	Sand and Gravel	1097	4/21/1964			Yes
441406089371301	2067997.834	814844.262	USGS	Sand and Gravel	1056	5/23/1984			Yes
441410089304001	2096609.366	815399.029	USGS	Sand and Gravel	1101	4/17/1977			Yes
441415089300901	2098863.367	815918.762	USGS	Sand and Gravel	1098	7/21/1954			Yes
441420089281201	2107378.393	816477.766	USGS	Sand and Gravel	1088	3/25/1977			Yes
441421089351601	2076508.992	816403.92	USGS	Sand and Gravel	1074	7/21/1954			Yes
441425089291301	2102934.262	816956.229	USGS	Sand and Gravel	1094	11/16/1965			Yes
441454089432801	2040678.307	819597.226	USGS	Sand and Gravel	1024	8/8/1951	9/22/1993	462	Yes
441511089281301	2107272.835	821641.928	USGS	Sand and Gravel	1102	10/14/1985			Yes
441515089413001	2049260.06	821754.125	USGS	Sand and Gravel	1037	6/15/1984			Yes
441516089274201	2109525.944	822162.767	USGS	Sand and Gravel	1101	8/27/1984			Yes
441520089422001	2045618.98	822247.238	USGS	Sand and Gravel	1037	6/19/1976			Yes
441525089503801	2009370.846	822654.865	USGS	Sand and Gravel	949	10/20/1977			Yes
441529089322601	2088847.769	823355.088	USGS	Sand and Gravel	1083	8/8/1966			Yes
441531089291701	2102602.089	823638.052	USGS	Sand and Gravel	1099	9/8/1950	5/31/1974	216	Yes
441548089412201	2049829.921	825098.163	USGS	Sand and Gravel	1037	11/11/1981			Yes
441550089383001	2062346.348	825351.196	USGS	Sand and Gravel	1051	8/12/1976			Yes
441550089415901	2047136.52	825290.788	USGS	Sand and Gravel	1035	4/16/1984			Yes
441555089341501	2080901.118	825945.603	USGS	Sand and Gravel	1068	8/1/1961			Yes
441557089463501	2027048.758	825936.124	USGS	Sand and Gravel	1006	4/30/1981			Yes
441558089354201	2074568.474	826217.595	USGS	Sand and Gravel	1053	9/1/1964			Yes
441615089385001	2060880.163	827876.687	USGS	Sand and Gravel	1051	8/11/1976			Yes
441625089302001	2097984.566	829078.733	USGS	Sand and Gravel	1090	4/10/1964			Yes
441637089343901	2079133.08	830189.92	USGS	Sand and Gravel	1071	4/6/1964			Yes
441639089292701	2101832.307	830519.782	USGS	Sand and Gravel	1096	4/30/1963			Yes
441646089314701	2091642.315	831168.614	USGS	Sand and Gravel	1077	4/16/1966			Yes
441648089305301	2095569.897	831393.751	USGS	Sand and Gravel	1080	7/1/1964			Yes
441649089304901	2095860.342	831496.724	USGS	Sand and Gravel	1085	7/9/1964	5/14/1974	2	Yes
441649089304902	2095860.342	831496.724	USGS	Sand and Gravel	1086	11/27/1973			Yes
441649089304903	2095860.342	831496.724	USGS	Sand and Gravel	1085	11/27/1973			Yes
441650089305001	2095786.994	831597.552	USGS	Sand and Gravel	1085	6/11/1979	9/3/1985	24	Yes
441650089305002	2095786.994	831597.552	USGS	Sand and Gravel	1085	6/11/1979	9/3/1985	24	Yes
441651089311101	2094258.591	831689.942	USGS	Sand and Gravel	1083	6/7/1979	9/3/1985	25	Yes
441651089311102	2094258.591	831689.942	USGS	Sand and Gravel	1083	6/7/1979	9/3/1985	26	Yes
441651089325501	2086692.252	831647.502	USGS	Sand and Gravel	1073	11/28/1973			Yes
441700089384801	2061006.402	832434.426	USGS	Sand and Gravel	1047	10/2/1953			Yes
441702089310401	2094761.43	832806.85	USGS	Sand and Gravel	1087	11/28/1960	9/3/1985	18	Yes
441702089314301	2091924.197	832790.562	USGS	Sand and Gravel	1077	11/27/1973			Yes
441703089323801	2087922.416	832869.487	USGS	Sand and Gravel	1074	6/8/1964			Yes
441704089304101	2096433.487	833019.159	USGS	Sand and Gravel	1085	8/6/1979	9/3/1985	24	Yes
441704089304102	2096433.487	833019.159	USGS	Sand and Gravel	1085	8/6/1979	9/3/1985	24	Yes

Table C-1

Water Level Data

Well ID[1]	X-Coordinate (feet)[2]	Y-Coordinate (feet)[2]	Source[3]	Unit	Target Value	Date of First Measurement	Date of Last Measurement	Count	Included as Target
441706089312301	2093376.888	833203.946	USGS	Sand and Gravel	1080	6/11/1979	9/3/1985	25	Yes
441706089312302	2093376.888	833203.946	USGS	Sand and Gravel	1080	6/11/1979	9/3/1985	25	Yes
441714089310601	2094608.904	834021.215	USGS	Sand and Gravel	1081	6/11/1979	9/3/1985	25	Yes
441714089310602	2094608.904	834021.215	USGS	Sand and Gravel	1081	6/8/1979	9/3/1985	26	Yes
441716089321901	2089297.381	834193.604	USGS	Sand and Gravel	1070	11/27/1973			Yes
441716089321902	2089297.381	834193.604	USGS	Sand and Gravel	1069	11/27/1973			Yes
441716089321903	2089297.381	834193.604	USGS	Sand and Gravel	1068	11/27/1973			Yes
441728089280401	2107839.506	835519.795	USGS	Sand and Gravel	1097	9/27/1972			Yes
441729089323801	2087908.044	835502.476	USGS	Sand and Gravel	1065	5/1/1959	3/1/1964	2	Yes
441732089355601	2073503.936	835731.935	USGS	Sand and Gravel	1061	10/6/1981			Yes
441736089320701	2090159.04	836223.869	USGS	Sand and Gravel	1065	6/8/1962			Yes
441739089513801	2004981.123	836217.177	USGS	Sand and Gravel	959	7/23/1983			Yes
441742089314401	2091828.589	836840.893	USGS	Sand and Gravel	1075	7/9/1964	11/28/1973	3	Yes
441742089321901	2089282.843	836826.619	USGS	Sand and Gravel	1072	11/28/1973			Yes
441743089325701	2086518.325	836912.706	USGS	Sand and Gravel	1068	7/8/1964			Yes
441748089434001	2039747.334	837215.235	USGS	Sand and Gravel	1036	4/1/1980			Yes
441750089263701	2114153.053	837789.172	USGS	Sand and Gravel	1109	7/1/1962			Yes
441756089331301	2085347.508	838222.922	USGS	Sand and Gravel	1063	4/1/1958			Yes
441800089352001	2076108.605	838580.3	USGS	Sand and Gravel	1053	9/30/1953			Yes
441801089485701	2016687.205	838468.128	USGS	Sand and Gravel	990	10/10/1974			Yes
441804089292602	2101852.545	839128.079	USGS	Sand and Gravel	1094	5/1/1964			Yes
441807089325601	2086577.92	839343.57	USGS	Sand and Gravel	1065	11/28/1973			Yes
441807089325602	2086577.92	839343.57	USGS	Sand and Gravel	1065	11/1/1973			Yes
441807089325603	2086577.92	839343.57	USGS	Sand and Gravel	1065	11/28/1973			Yes
441813089292701	2101774.274	840039.048	USGS	Sand and Gravel	1091	8/31/1978			Yes
441819089500501	2011737.848	840280.523	USGS	Sand and Gravel	978	12/7/1971			Yes
441827089355501	2073549.904	841302.136	USGS	Sand and Gravel	1056	9/29/1981			Yes
441829089500401	2011808.568	841293.37	USGS	Sand and Gravel	982	6/18/1979			Yes
441833089315601	2090926.838	842000.724	USGS	Sand and Gravel	1069	9/7/1950	5/1/2013	1664	Yes
441834089245801	2121322.433	842294.429	USGS	Sand and Gravel	1093	6/1/1957			Yes
441842089250501	2120807.774	843101.008	USGS	Sand and Gravel	1129	1/1/1951			Yes
441846089432801	2040600.755	843091.838	USGS	Sand and Gravel	1031	9/30/1953			Yes
441859089274201	2109380.393	844745.604	USGS	Sand and Gravel	1101	4/10/1984			Yes
441907089483201	2018490.203	845156.155	USGS	Sand and Gravel	993	7/23/1980			Yes
441909089400301	2055498.083	845475.755	USGS	Sand and Gravel	1046	10/2/1953			Yes
441926089394601	2056727.15	847202.352	USGS	Sand and Gravel	1051	5/12/1982			Yes
441936089400301	2055487.21	848210.085	USGS	Sand and Gravel	1046	11/28/1973			Yes
441936089400302	2055487.21	848210.085	USGS	Sand and Gravel	1049	11/26/1973			Yes
441936089400303	2055487.21	848210.085	USGS	Sand and Gravel	1049	11/26/1973			Yes
441938089411501	2050252.178	848392.269	USGS	Sand and Gravel	1038	11/26/1973			Yes
441942089422901	2044871.125	848777.743	USGS	Sand and Gravel	1040	11/26/1973			Yes
441949089485701	2016663.092	849405.443	USGS	Sand and Gravel	977	4/25/1980			Yes
441951089491501	2015354.128	849605.114	USGS	Sand and Gravel	976	1/20/1971			Yes
441952089280101	2107964.645	850104.016	USGS	Sand and Gravel	1096	11/18/1982			Yes
442000089271501	2111303.177	850935.896	USGS	Sand and Gravel	1093	4/16/1985			Yes
442008089485501	2016804.204	851329.953	USGS	Sand and Gravel	1008	6/7/1982			Yes
442009089432701	2040645.709	851497.641	USGS	Sand and Gravel	1030	11/26/1973			Yes
442009089432702	2040645.709	851497.641	USGS	Sand and Gravel	1027	11/26/1973			Yes
442009089432703	2040645.709	851497.641	USGS	Sand and Gravel	1027	11/26/1973			Yes
442014089460201	2029377.683	851969.378	USGS	Sand and Gravel	1005	3/9/1982			Yes
442014089464101	2026542.913	851961.58	USGS	Sand and Gravel	998	7/25/1983			Yes
442029089274001	2109467.012	853860.871	USGS	Sand and Gravel	1099	4/27/1983			Yes
442030089331501	2085118.806	853817.805	USGS	Sand and Gravel	1062	5/10/1981			Yes
442033089325301	2086716.082	854130.252	USGS	Sand and Gravel	1057	10/1/1953			Yes
442047089471901	2023772.339	855296.342	USGS	Sand and Gravel	997	9/24/1974			Yes
442054089473901	2022317.082	856001.578	USGS	Sand and Gravel	982	6/11/1979			Yes
442100089384901	2060830.906	856739.166	USGS	Sand and Gravel	1050	9/7/1950	8/30/1982	1160	Yes
442107089485701	2016645.657	857304.715	USGS	Sand and Gravel	983	9/9/1982			Yes
442108089362401	2071364.201	857596.738	USGS	Sand and Gravel	1054	9/17/1953			Yes

Table C-1

Water Level Data

Well ID[1]	X-Coordinate (feet)[2]	Y-Coordinate (feet)[2]	Source[3]	Unit	Target Value	Date of First Measurement	Date of Last Measurement	Count	Included as Target
442110089474201	2022095.07	857621.407	USGS	Sand and Gravel	994	10/1/1945			Yes
442111089483001	2018606.783	857714.293	USGS	Sand and Gravel	989	8/1/1945			Yes
442113089283701	2105296.385	858290.328	USGS	Sand and Gravel	1079	5/11/1960			Yes
442122089461401	2028486.511	858853.513	USGS	Sand and Gravel	992	11/17/1982			Yes
442123089484501	2017514.036	858927.067	USGS	Sand and Gravel	980	11/29/1977			Yes
442130089435901	2038293.474	859693.138	USGS	Sand and Gravel	1021	12/27/1979			Yes
442135089430201	2042433.382	860213.244	USGS	Sand and Gravel	1029	8/16/1976			Yes
442135089455601	2029790.774	860173.733	USGS	Sand and Gravel	991	8/8/1980			Yes
442137089473701	2022451.664	860356.693	USGS	Sand and Gravel	1006	8/1/1947			Yes
442138089495501	2012424.53	860435.186	USGS	Sand and Gravel	998	8/1/1959			Yes
442143089433701	2039887.683	861014.895	USGS	Sand and Gravel	1012	9/15/1967			Yes
442143089473801	2022377.501	860964.156	USGS	Sand and Gravel	1004	6/1/1965			Yes
442149089481701	2019542.477	861564.904	USGS	Sand and Gravel	989	3/21/1977			Yes
442156089383401	2061896.685	862415.123	USGS	Sand and Gravel	1049	10/7/1983			Yes
442202089464801	2026005.266	862897.741	USGS	Sand and Gravel	1002	6/1/1965			Yes
442212089321401	2089495.02	864171.818	USGS	Sand and Gravel	1057	10/1/1953			Yes
442216089374901	2065156.999	864454.912	USGS	Sand and Gravel	1054	7/8/1982			Yes
442219089385701	2060215.913	864737.286	USGS	Sand and Gravel	1047	5/14/1976			Yes
442227089460101	2029412.774	865438.964	USGS	Sand and Gravel	1017	8/24/1981			Yes
442230089265401	2112729.297	866136.698	USGS	Sand and Gravel	1102	5/8/1985			Yes
442230089392901	2057886.771	865841.593	USGS	Sand and Gravel	1044	4/24/1982			Yes
442230089393601	2057378.287	865839.489	USGS	Sand and Gravel	1045	7/1/1962			Yes
442232089391501	2058902.897	866048.355	USGS	Sand and Gravel	1036	5/1/1959			Yes
442233089354501	2074156.554	866218.551	USGS	Sand and Gravel	1060	11/11/1983			Yes
442246089354401	2074222.813	867535.46	USGS	Sand and Gravel	1059	9/30/1983			Yes
442300089393001	2057801.708	868879.513	USGS	Sand and Gravel	1047	10/1/1958			Yes
442307089333401	2083654.007	869710.24	USGS	Sand and Gravel	1064	5/1/1981			Yes
442317089415301	2047409.446	870560.869	USGS	Sand and Gravel	1045	6/12/1980	9/4/1985	16	Yes
442317089415302	2047409.446	870560.869	USGS	Sand and Gravel	1044	6/12/1980	9/4/1985	17	Yes
442318089404401	2052420.106	870680.976	USGS	Sand and Gravel	1045	6/11/1980	9/4/1985	16	Yes
442318089404402	2052420.106	870680.976	USGS	Sand and Gravel	1045	6/11/1980	9/4/1985	17	Yes
442318089411601	2050096.164	870672.111	USGS	Sand and Gravel	1043	6/11/1980	9/4/1985	16	Yes
442320089392401	2058229.15	870906.792	USGS	Sand and Gravel	1049	10/13/1953			Yes
442320089393001	2057793.412	870905.003	USGS	Sand and Gravel	1041	3/1/1964			Yes
442329089282001	2106444.638	872071.199	USGS	Sand and Gravel	1111	5/30/1968			Yes
442329089411801	2049946.745	871785.588	USGS	Sand and Gravel	1047	6/12/1980	9/4/1985	17	Yes
442329089411802	2049946.745	871785.588	USGS	Sand and Gravel	1047	6/12/1980	9/4/1985	17	Yes
442329089415301	2047405.048	871776.168	USGS	Sand and Gravel	1047	6/12/1980	9/4/1985	17	Yes
442330089405801	2051398.743	871892.369	USGS	Sand and Gravel	1047	10/24/1969	9/4/1985	17	Yes
442330089413601	2048639.212	871881.988	USGS	Sand and Gravel	1045	9/20/1979	9/4/1985	18	Yes
442331089330601	2085674.488	872151.688	USGS	Sand and Gravel	1064	5/14/1981			Yes
442331089361401	2072022.173	872082.288	USGS	Sand and Gravel	1057	10/30/1984			Yes
442342089415101	2047545.522	873093.278	USGS	Sand and Gravel	1049	6/12/1980	9/4/1985	17	Yes
442342089415102	2047545.522	873093.278	USGS	Sand and Gravel	1049	6/12/1980	9/4/1985	16	Yes
442343089404501	2052337.74	873212.574	USGS	Sand and Gravel	1051	6/12/1980	9/4/1985	16	Yes
442343089404502	2052337.74	873212.574	USGS	Sand and Gravel	1051	6/12/1980	9/4/1985	17	Yes
442343089411501	2050159.307	873204.257	USGS	Sand and Gravel	1049	6/12/1980	9/4/1985	17	Yes
442356089363501	2070485.363	874606.929	USGS	Sand and Gravel	1047	4/22/1985			Yes
442359089333301	2083698.831	874976.884	USGS	Sand and Gravel	1065	10/12/1981			Yes
442401089303001	2096985.098	875254.001	USGS	Sand and Gravel	1073	7/22/1962			Yes
442418089264801	2113092.671	877077.102	USGS	Sand and Gravel	1084	7/12/1975	7/24/1980	2	Yes
442422089293501	2100965.641	877404.768	USGS	Sand and Gravel	1067	4/8/1964			Yes
442423089313301	2092398.134	877455.447	USGS	Sand and Gravel	1071	6/15/1962			Yes
442426089304601	2095808.607	877779	USGS	Sand and Gravel	1077	8/1/1961			Yes
442430089313001	2092611.887	878165.615	USGS	Sand and Gravel	1072	8/10/1963			Yes
442433089303101	2096893.445	878494.339	USGS	Sand and Gravel	1072	7/9/1953			Yes
442435089364401	2069813.518	878553.576	USGS	Sand and Gravel	1057	7/26/1968			Yes
442437089385201	2060520.191	878714.708	USGS	Sand and Gravel	1057	11/26/1973			Yes
442437089385202	2060520.191	878714.708	USGS	Sand and Gravel	1057	11/26/1973			Yes

Table C-1

Water Level Data

Well ID[1]	X-Coordinate (feet)[2]	Y-Coordinate (feet)[2]	Source[3]	Unit	Target Value	Date of First Measurement	Date of Last Measurement	Count	Included as Target
442437089385203	2060520.191	878714.708	USGS	Sand and Gravel	1057	11/20/1973			Yes
442450089400301	2055360.561	880010.035	USGS	Sand and Gravel	1055	11/27/1973			Yes
442451089290001	2103488.514	880357.391	USGS	Sand and Gravel	1124	4/24/1963			Yes
442452089362501	2071184.762	880281.758	USGS	Sand and Gravel	1057	10/2/1953			Yes
442500089385001	2060655.543	881044.677	USGS	Sand and Gravel	1058	10/11/1950	1/12/1955	25	Yes
442513089320601	2089974.103	882505.655	USGS	Sand and Gravel	1069	5/2/1963			Yes
442513089441101	2037350.24	882274.661	USGS	Sand and Gravel	1044	5/22/1965			Yes
442514089274801	2108700.109	882719.866	USGS	Sand and Gravel	1089	8/2/1976	7/24/1980	2	Yes
442516089351201	2076471.916	882738.101	USGS	Sand and Gravel	1062	3/15/1966			Yes
442516089392701	2057963.084	882653.843	USGS	Sand and Gravel	1058	11/27/1973			Yes
442516089392702	2057963.084	882653.843	USGS	Sand and Gravel	1058	11/27/1973			Yes
442516089392703	2058109.927	882249.335	USGS	Sand and Gravel	1058	10/24/1973			Yes
442517089433201	2040179.712	882688.969	USGS	Sand and Gravel	1045	8/8/1951	1/11/1955	22	Yes
442520089443501	2035606.013	882978.139	USGS	Sand and Gravel	1041	9/20/1963	10/9/1964	8	Yes
442523089401301	2054621.433	883349.242	USGS	Sand and Gravel	1052	5/29/1964			Yes
442529089331501	2084957.133	884098.607	USGS	Sand and Gravel	1068	9/23/1953			Yes
442529089400301	2055344.843	883959.8	USGS	Sand and Gravel	1053	11/27/1973			Yes
442541089373501	2066081.145	885220.817	USGS	Sand and Gravel	1062	6/1/1963			Yes
442542089364301	2069854.578	885339.405	USGS	Sand and Gravel	1054	8/1/1965			Yes
442542089394601	2056573.368	885281.378	USGS	Sand and Gravel	1042	5/28/1964			Yes
442554089395701	2055770.178	886493.463	USGS	Sand and Gravel	1051	11/27/1973			Yes
442554089395702	2055770.178	886493.463	USGS	Sand and Gravel	1051	11/27/1973			Yes
442554089395703	2055770.178	886493.463	USGS	Sand and Gravel	1049	11/27/1973			Yes
442555089322001	2088934.425	886753.562	USGS	Sand and Gravel	1072	4/23/1984			Yes
442555089323801	2087628.161	886746.35	USGS	Sand and Gravel	1071	5/1/1960	7/15/1980	3	Yes
442610089385101	2060553.017	888133.712	USGS	Sand and Gravel	1049	9/8/1950	12/1/1968	850	Yes
442617089274401	2108949.374	889102.074	USGS	Sand and Gravel	1092	11/5/1971			Yes
442618089333901	2083189.134	889051.841	USGS	Sand and Gravel	1066	4/1/1964			Yes
442620089354001	2074408.096	889209.753	USGS	Sand and Gravel	1058	7/1/1962			Yes
442622089302901	2096958.306	889583.615	USGS	Sand and Gravel	1080	11/15/2006	5/1/2013	152	Yes
442622089390901	2059241.773	889343.522	USGS	Sand and Gravel	1056	8/6/1958	8/19/1958	2	Yes
442623089302701	2097118.126	889636.333	USGS	Sand and Gravel	1086	12/1/1959	4/3/2006	1040	Yes
442627089372801	2066568.201	889881.825	USGS	Sand and Gravel	1045	4/16/1974			Yes
442628089343701	2078975.377	890042.764	USGS	Sand and Gravel	1060	9/6/1984			Yes
442643089270101	2112052.203	891755.68	USGS	Sand and Gravel	1102	5/1/1970			Yes
442650089365001	2069314.697	892223.848	USGS	Sand and Gravel	1043	10/20/1976			Yes
442700089313001	2092525.503	893356.954	USGS	Sand and Gravel	1074	10/30/1966			Yes
442713089284801	2104270.082	894743.953	USGS	Sand and Gravel	1093	10/10/1950	1/12/1955	29	Yes
442714089260401	2116166.474	894923.027	USGS	Sand and Gravel	1079	7/17/1958	5/2/1960	2	Yes
442719089305201	2095271.14	895297.142	USGS	Sand and Gravel	1084	12/29/1965			Yes
442727089262801	2114416.646	896227.822	USGS	Sand and Gravel	1098	7/27/1950	2/16/1960	19	Yes
442727089352201	2075680.839	896001.723	USGS	Sand and Gravel	1046	10/2/1953			Yes
442730089310001	2094684.368	896407.804	USGS	Sand and Gravel	1074	4/4/1964			Yes
442730089314701	2091275.084	896388.245	USGS	Sand and Gravel	1071	7/21/1971			Yes
442754089254501	2117517.094	898983.518	USGS	Sand and Gravel	1102	7/20/1951	8/29/1951	2	Yes
442815089300501	2098646.742	900988.836	USGS	Sand and Gravel	1078	6/3/1970			Yes
442817089302401	2097267.61	901183.18	USGS	Sand and Gravel	1079	8/24/1961	10/15/1961	53	Yes
442822089290801	2102776.151	901723.021	USGS	Sand and Gravel	1092	12/1/1959	8/10/1968	351	Yes
442825089314901	2091098.655	901957.67	USGS	Sand and Gravel	1073	10/1/1959			Yes
442826089314301	2091533.2	902061.412	USGS	Sand and Gravel	1083	6/13/1960	6/28/1961	145	No
442827089271101	2111257.683	902283.662	USGS	Sand and Gravel	1102	5/31/1958	10/10/1962	3	No
441527089450901	2017830.546	847483.91	USGS	Sandstone	1005	7/1/1949			Yes
441709089530201	1998875.258	833169.551	USGS	Other	919	10/1/1979			Yes
441750089530501	1998651.292	837321.325	USGS	Other	929	12/14/1978			Yes
441901089522201	2001767.962	844516.208	USGS	Other	950	11/1/1979			Yes
441910089522301	2001693.86	845427.536	USGS	Other	945	8/29/1973			Yes
442004089524701	1999940.966	850893.59	USGS	Other	945	2/27/1976			Yes
442031089500901	2011420.659	853647.833	USGS	Other	966	11/14/1969			Yes
442040089485101	2017087.757	854571.331	USGS	Other	970	9/6/1978			Yes

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Water Level Data

Well ID[1]	X-Coordinate (feet)[2]	Y-Coordinate (feet)[2]	Source[3]	Unit	Target Value	Date of First Measurement	Date of Last Measurement	Count	Included as Target
442040089491901	2015052.772	854566.839	USGS	Other	970	4/30/1980			Yes
442048089490301	2016213.856	855379.566	USGS	Other	974	12/1/1932			Yes
442125089492101	2014897.714	859123.806	USGS	Other	984	4/23/1979			Yes
442139089493201	2014095.47	860539.935	USGS	Other	998	6/29/1982			Yes
442158089472701	2023172.931	862485.263	USGS	Other	1011	4/12/1983			Yes
442209089504701	2008640.524	863567.285	USGS	Other	986	5/8/1973			Yes
442210089505301	2008204.429	863667.752	USGS	Other	989	12/27/1965			Yes
442215089503901	2009220.578	864176.027	USGS	Other	988	8/23/1973			Yes
442223089460901	2028832.757	865032.233	USGS	Other	1018	9/12/1973			Yes
442226089433001	2040381.924	865371.364	USGS	Other	1022	5/1/1968			Yes
442226089435601	2038493.264	865365.18	USGS	Other	1018	6/6/1964			Yes
442253089472901	2023013.697	868054.984	USGS	Other	1015	12/9/1967			Yes
442355089460401	2029170.058	874350.546	USGS	Other	1031	12/23/1982			Yes
442420089473401	2022628.653	876865.028	USGS	Other	1020	10/10/1979			Yes
442425089471801	2023789.036	877374.359	USGS	Other	1026	8/9/1972			Yes
442427089471801	2023788.522	877576.904	USGS	Other	1030	5/10/1973			Yes
442433089464901	2025892.365	878190.076	USGS	Other	1024	4/22/1977			Yes
442441089472601	2023204.174	878993.286	USGS	Other	1004	10/10/1977			Yes
442558089443201	2035811.883	886827.328	USGS	Other	1026	7/14/1967			Yes
442702089441701	2036880.067	893312.52	USGS	Other	1023	12/1/1979			Yes
442705089435201	2038692.801	893622.152	USGS	Other	1028	6/1/1977			Yes
442705089440701	2037604.604	893618.661	USGS	Other	1039	9/11/1973			Yes
442716089441201	2037238.355	894731.563	USGS	Other	1041	5/1/1970			Yes
421232089284401	2105116.9	805526.291	USGS		1101	4/24/1975			Yes
421232089284402	2105116.9	805526.291	USGS		1098	5/6/1975			Yes
440642089482901	2018881.548	769712.665	USGS		989	9/22/1964	10/9/1964	2	Yes
440642089483001	2018808.61	769712.497	USGS		989	9/22/1964			Yes
440652089340001	2082277.867	770964.291	USGS		1056	9/3/1958	11/6/1958	2	Yes
440705089390301	2060166.86	772176.517	USGS		1030	10/14/1976			Yes
440715089375001	2065487.837	773212.194	USGS		1038	10/12/1976			Yes
440724089331601	2085470.624	774221.667	USGS		1057	6/2/1969			Yes
440755089360201	2073346.836	777299.194	USGS		1054	7/16/1962	8/26/1963	2	Yes
440843089324101	2087980.083	782235.267	USGS		1080	6/13/1973			Yes
440848089331501	2085498.189	782728.134	USGS		1059	10/3/1958	11/6/1958	2	Yes
440901089311101	2094532.207	784094.952	USGS		1092	5/18/1979			Yes
440903089332401	2084833.876	784243.573	USGS		1071	6/11/1968			Yes
440910089353401	2075351.975	784903.872	USGS		1057	4/4/1964			Yes
440910089385501	2060697.267	784836.894	USGS		1040	11/9/1981			Yes
440929089325201	2087152.783	786889.004	USGS		1067	7/8/1960			Yes
440929089332701	2084601.213	786875.261	USGS		1064	9/1/1958			Yes
441008089365401	2069492.228	790749.36	USGS		1041	6/19/1969			Yes
441019089313001	2093101.995	791985.563	USGS		1073	4/12/1976			Yes
441035089334401	2083326.868	793552.127	USGS		1067	6/9/1977			Yes
441059089313001	2093078.954	796036.135	USGS		1087	11/4/1980			Yes
441114089330901	2085856.523	797515.05	USGS		1077	4/3/1962			Yes
441138089373001	2066827.32	799851.187	USGS		1042	12/15/1978			Yes
441220089301501	2098495.656	804270.544	USGS		1091	7/2/1966			Yes
441230089320601	2090404.278	805236.434	USGS		1088	7/7/1970			Yes
441231089474201	2022224.073	805062.281	USGS		993	5/18/1967			Yes
441233089304901	2096011.285	805572.355	USGS		1087	4/1/1966			Yes
441236089370401	2068694.792	805733.262	USGS		1050	4/1/1963			Yes
441242089295001	2100303.354	806509.332	USGS		1094	8/3/1982			Yes
441243089361801	2072042.043	806457.822	USGS		1057	7/11/1964			Yes
441248089295801	2099717.025	807113.407	USGS		1095	11/16/1949			Yes
441248089355201	2073933.389	806973.248	USGS		1060	7/1/1958			Yes
441300089320001	2090824.357	808276.865	USGS		1090	5/3/1971			Yes
441307089324201	2087761.588	808968.749	USGS		1073	4/8/1964			Yes
441328089435901	2038449.506	810880.803	USGS		1021	9/25/1964			Yes
441339089365401	2069393.79	812116.432	USGS		1048	9/1/1976			Yes

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Water Level Data

Well ID[1]	X-Coordinate (feet)[2]	Y-Coordinate (feet)[2]	Source[3]	Unit	Target Value	Date of First Measurement	Date of Last Measurement	Count	Included as Target
441406089304901	2095956.47	814990.113	USGS		1097	12/7/1963			Yes
441406089341701	2080812.206	814906.674	USGS		1080	7/26/1978			Yes
441420089284701	2104830.273	816461.671	USGS		1100	10/8/1976			Yes
441430089311501	2094049.484	817409.517	USGS		1094	4/15/1977			Yes
441430089323001	2088589.431	817378.693	USGS		1083	4/30/1971			Yes
441430089364601	2069952.4	817283.773	USGS		1058	7/23/1964			Yes
441432089315801	2090917.92	817594.208	USGS		1087	3/29/1965			Yes
441440089320001	2090767.803	818403.53	USGS		1087	6/3/1977			Yes
441450089301501	2098405.486	819460.497	USGS		1093	5/1/1961			Yes
441503089501001	2011413.182	820430.909	USGS		965	4/2/1981			Yes
441505089285701	2104073.99	821014.139	USGS		1094	5/1/1961	3/1/1964	2	Yes
441505089290301	2103637.281	821011.423	USGS		1094	6/25/1969			Yes
441509089423301	2044676.653	821129.944	USGS		1034	7/12/1965			Yes
441521089321801	2089434.512	822548.175	USGS		1085	5/28/1971			Yes
441525089321501	2089650.605	822954.459	USGS		1082	4/15/1967			Yes
441527089302101	2097946.573	823204.778	USGS		1092	4/20/1971			Yes
441546089391801	2058854.861	824931.317	USGS		1048	11/16/1973			Yes
441546089394801	2056671.603	824922.346	USGS		1045	11/13/1973			Yes
441558089293401	2101348.224	826364.694	USGS		1100	11/9/1965			Yes
441558089304701	2096035.96	826332.903	USGS		1085	1/7/1959			Yes
441603089425601	2042983.895	826592.649	USGS		1039	7/11/1978			Yes
441610089294501	2100540.398	827575.035	USGS		1169	4/4/1964			Yes
441616089281201	2107303.851	828224.765	USGS		1098	12/1/1970			Yes
441617089334201	2083290.923	828186.052	USGS		1066	4/17/1977			Yes
441618089312301	2093404.631	828343.061	USGS		1086	6/28/1976			Yes
441618089315101	2091367.252	828331.455	USGS		1079	5/16/1979			Yes
441630089281501	2107076.574	829641.113	USGS		1105	3/27/1977			Yes
441630089283001	2105985.18	829634.205	USGS		1096	10/18/1971			Yes
441635089285901	2103871.993	830127.31	USGS		1101	4/9/1974			Yes
441636089280301	2107945.82	830254.315	USGS		1095	4/16/1960			Yes
441637089280401	2107872.411	830355.11	USGS		1097	5/1/1959			Yes
441646089520101	2003316.671	830847.075	USGS		951	3/22/1977			Yes
441648089293501	2101244.725	831427.647	USGS		1107	6/27/1975			Yes
441649089271001	2111793.344	831595.861	USGS		1102	8/13/1980			Yes
441649089285801	2103935.99	831545.503	USGS		1090	5/23/1958			Yes
441649089285802	2103935.99	831545.503	USGS		1090	9/28/1958			Yes
441649089314101	2092077.128	831474.891	USGS		1075	7/9/1964			Yes
441652089322001	2089238.042	831762.763	USGS		1070	5/1/1959			Yes
441702089301201	2098544.39	832829.137	USGS		1088	11/14/1978			Yes
441702089301301	2098471.633	832828.704	USGS		1087	6/21/1968			Yes
441703089314401	2091850.87	832891.403	USGS		1074	10/13/1959			Yes
441714089285701	2103993.04	834077.679	USGS		1099	4/30/1958			Yes
441715089303001	2097227.156	834137.843	USGS		1078	8/10/1959			Yes
441729089320201	2090526.689	835517.022	USGS		1073	5/30/1965			Yes
441730089283101	2105874.242	835709.834	USGS		1099	11/17/1953			Yes
441731089273301	2110092.48	835838.17	USGS		1094	4/1/1959			Yes
441741089285801	2103903.36	836811.48	USGS		1094	6/1/1958	3/1/1964	2	Yes
441744089283501	2105574.389	837125.767	USGS		1096	4/12/1974			Yes
441744089283502	2105574.389	837125.767	USGS		1082	5/4/1960			Yes
441750089300201	2099242.822	837694.395	USGS		1090	5/1/1959			Yes
441755089283201	2105785.604	838241.105	USGS		1091	5/19/1965			Yes
441807089434601	2039304.683	839137.95	USGS		1034	3/20/1980			Yes
441809089253501	2118649.263	839743.958	USGS		1100	6/3/1961			Yes
441811089285101	2104393.662	839852.729	USGS		1090	4/26/1971			Yes
441833089274301	2109324.639	842112.128	USGS		1065	6/1/1961			Yes
441836089283401	2105614.104	842392.22	USGS		1083	7/1/1964			Yes
441855089523001	2001187.176	843907.679	USGS		953	11/3/1980			Yes
441858089522101	2001841.141	844212.505	USGS		952	12/23/1977			Yes
441901089303701	2096654.985	844869.379	USGS		1080	8/19/1968			Yes

Table C-1

Water Level Data

Well ID[1]	X-Coordinate (feet)[2]	Y-Coordinate (feet)[2]	Source[3]	Unit	Target Value	Date of First Measurement	Date of Last Measurement	Count	Included as Target
441914089294101	2100718.733	846210.291	USGS		1079	5/29/1965			Yes
441922089274101	2109438.066	847075.276	USGS		1094	4/27/1978			Yes
441929089283401	2105580.443	847759.53	USGS		1105	7/22/1966			Yes
441941089295301	2099829.867	848939.291	USGS		1066	5/25/1961	3/1/1964	2	Yes
441952089272501	2110581.566	850120.971	USGS		1080	8/20/1959			Yes
441959089523601	2000741.322	850388.421	USGS		942	5/1/1975			Yes
442015089300001	2099300.375	852379.43	USGS		1066	6/13/1970			Yes
442036089463601	2026900.375	854190.566	USGS		960	8/1/1975			Yes
442045089304501	2096011.844	855398.121	USGS		1069	12/17/1976			Yes
442054089473301	2022753.118	856002.662	USGS		985	9/27/1983			Yes
442056089462201	2027912.369	856218.8	USGS		994	9/2/1977			Yes
442104089492001	2014974.912	856997.235	USGS		981	10/12/1982			Yes
442105089300401	2098979.383	857441.248	USGS		1069	6/25/1976			Yes
442110089255101	2117360.741	858065.839	USGS		1095	4/1/1963			Yes
442116089472201	2023546.916	858232.697	USGS		984	4/1/1953			Yes
442118089300404	2098971.535	858757.778	USGS		1070	11/18/1976			Yes
442118089315001	2091269.211	858712.892	USGS		1065	5/3/1977			Yes
442118089322601	2088653.347	858698.26	USGS		1064	10/23/1978			Yes
442119089290301	2103403.354	858886.138	USGS		1071	5/26/1971			Yes
442119089394601	2056680.939	858646.124	USGS		1045	5/15/1979			Yes
442121089460201	2029358.751	858754.682	USGS		993	6/1/1981			Yes
442122089492701	2014462.381	858819.063	USGS		991	8/2/1982			Yes
442123089304501	2095989.38	859246.455	USGS		1062	3/1/1964			Yes
442124089470001	2025143.464	859047.032	USGS		1004	11/1/1944			Yes
442128089481501	2019692.76	859438.492	USGS		996	4/1/1953			Yes
442129089464701	2026086.743	859555.898	USGS		990	4/1/1953			Yes
442130089280001	2107973.958	860029.05	USGS		1101	3/1/1964			Yes
442130089431501	2041490.51	859703.675	USGS		1028	6/19/1968			Yes
442133089255301	2117199.544	860394.084	USGS		1094	5/19/1970			Yes
442134089475701	2020999.224	860049.287	USGS		1001	4/1/1953			Yes
442135089302601	2097362.779	860469.852	USGS		1066	11/17/1976			Yes
442141089473201	2022813.942	860762.689	USGS		1007	4/1/1953			Yes
442142089481801	2019471.476	860855.814	USGS		1008	4/1/1953			Yes
442145089272301	2110652.45	861565.561	USGS		1081	4/1/1959			Yes
442145089464901	2025937.172	861175.891	USGS		1009	4/1/1953			Yes
442147089372001	2067276.985	861527.461	USGS		1056	4/25/1979			Yes
442155089464401	2026297.761	862189.601	USGS		1018	4/1/1953			Yes
442156089371601	2067563.456	862440.248	USGS		1036	4/30/1979			Yes
442157089300301	2099020.591	862707.823	USGS		1074	11/15/1976			Yes
442158089454701	2030438.101	862504.905	USGS		1014	4/1/1953			Yes
442159089465701	2025352.198	862592.185	USGS		1020	4/1/1953			Yes
442210089292801	2101555.313	864039.792	USGS		1077	7/29/1966			Yes
442213089490401	2016122.378	863987.657	USGS		1013	8/20/1957			Yes
442214089481701	2019536.552	864096.737	USGS		1020	4/1/1953			Yes
442215089364301	2069952.003	864375.524	USGS		1057	4/23/1979			Yes
442217089300901	2098572.608	864730.65	USGS		1069	12/15/1976			Yes
442219089503801	2009292.47	864581.26	USGS		983	3/1/1965			Yes
442231089390201	2059847.609	865951.037	USGS		1042	9/24/1959			Yes
442237089394701	2056576.39	866545.156	USGS		1038	10/20/1970			Yes
442240089394001	2057083.622	866851.054	USGS		1048	10/18/1968			Yes
442250089272501	2110464.351	868147.303	USGS		1085	6/1/1961			Yes
442252089394601	2056642.89	868064.553	USGS		1042	9/24/1959			Yes
442252089403301	2053229.195	868050.947	USGS		1043	5/20/1969			Yes
442303089282501	2106098.139	869435.778	USGS		1084	4/13/1978			Yes
442304089402301	2053950.748	869269.1	USGS		1045	9/15/1971			Yes
442309089264901	2113066.348	870088.753	USGS		1126	4/19/1977			Yes
442311089483801	2017997.874	869865.84	USGS		998	1/1/1940	9/20/1963	2	Yes
442311089483802	2017997.874	869865.84	USGS		993	9/20/1963			Yes
442312089391001	2059249.226	870100.837	USGS		1048	5/1/1959			Yes

Table C-1

Water Level Data

Well ID[1]	X-Coordinate (feet)[2]	Y-Coordinate (feet)[2]	Source[3]	Unit	Target Value	Date of First Measurement	Date of Last Measurement	Count	Included as Target
442313089400001	2055617.558	870187.22	USGS		1046	9/13/1971			Yes
442313089474301	2021119.13	870582.169	USGS		1024	1/1/1950	11/1/1983	719	Yes
442316089274201	2109212.639	870772.367	USGS		1099	5/20/1966			Yes
442327089272501	2110439.982	871894.412	USGS		1089	8/6/1980			Yes
442327089290601	2103105.415	871847.671	USGS		1067	5/28/1967			Yes
442340089272501	2110431.433	873210.966	USGS		1082	4/22/1965			Yes
442349089283501	2105342.646	874089.772	USGS		1107	5/10/1968			Yes
442351089371101	2067873.661	874088.409	USGS		1056	8/18/1975			Yes
442351089374501	2065404.849	874077.254	USGS		1054	9/10/1975			Yes
442410089362501	2071204.779	876028.202	USGS		1057	9/17/1971			Yes
442411089301001	2098431.242	876275.382	USGS		1079	1/13/1961			Yes
442413089265501	2112587.797	876567.353	USGS		1102	7/26/1950	1/12/1955	24	Yes
442419089263101	2114326.229	877186.637	USGS		1087	5/18/1976	8/6/1980	2	Yes
442422089283601	2105249.112	877431.352	USGS		1081	7/26/1950	1/12/1955	25	Yes
442430089303501	2096604.822	878188.811	USGS		1081	7/26/1950	11/8/1951	99	Yes
442436089302301	2097472.411	878801.612	USGS		1075	7/26/1950	11/7/1951	6	Yes
442438089375701	2064512.555	878833.31	USGS		1058	4/29/1960			Yes
442443089401201	2054710.019	879298.486	USGS		1053	1/20/1961			Yes
442444089350601	2076923.515	879499.445	USGS		1063	4/20/1978			Yes
442446089264901	2113001.286	879912.291	USGS		1083	8/22/1966			Yes
442446089375101	2064944.548	879645.445	USGS		1060	9/11/1978			Yes
442447089320601	2089988.757	879872.502	USGS		1067	10/18/1976			Yes
442448089391001	2059208.809	879823.242	USGS		1051	11/1/1969			Yes
442451089301101	2098334.546	880325.924	USGS		1063	5/1/1959			Yes
442451089304701	2095721.247	880310.452	USGS		1078	4/1/1963			Yes
442452089393201	2057610.109	880221.724	USGS		1057	8/20/1971			Yes
442455089364901	2069441.152	880577.403	USGS		1057	8/27/1971			Yes
442500089274101	2109217.329	881305.312	USGS		1090	10/16/1974			Yes
442500089342901	2079601.248	881133.454	USGS		1064	9/23/1976			Yes
442500089350001	2077350.987	881122.046	USGS		1060	9/30/1976			Yes
442500089413001	2049041.267	880998.399	USGS		1048	11/13/1964			Yes
442502089413501	2048677.579	881199.605	USGS		1050	8/16/1965			Yes
442503089352201	2075752.545	881417.919	USGS		1059	7/1/1962	7/2/1980	2	Yes
442505089292501	2101665.084	881764.015	USGS		1085	5/17/1958			Yes
442507089300501	2098760.408	881948.931	USGS		1084	11/16/1944	1/11/1952	362	Yes
442512089272401	2110443.435	882528.649	USGS		1099	7/7/1975			Yes
442513089341101	2080901.056	882456.746	USGS		1058	11/11/1975			Yes
442513089354001	2074441.035	882424.255	USGS		1057	11/16/1975			Yes
442515089323701	2087722.876	882695.727	USGS		1070	6/15/1961			Yes
442515089391001	2059197.426	882557.692	USGS		1057	6/1/1961			Yes
442516089373601	2066019.871	882688.588	USGS		1057	3/1/1964			Yes
442516089394601	2056583.987	882648.188	USGS		1049	3/1/1964			Yes
442517089290101	2103399.642	882990.083	USGS		1117	4/1/1966			Yes
442517089304901	2095560.726	882942.745	USGS		1081	10/11/1966	7/18/1967	2	Yes
442519089402601	2053679.452	882940.413	USGS		1050	5/1/1958			Yes
442520089330401	2085760.403	883191.424	USGS		1063	5/20/1965			Yes
442520089345501	2077703.801	883149.379	USGS		1060	10/3/1976			Yes
442522089363301	2070589.809	883317.289	USGS		1060	7/23/1968			Yes
442525089313601	2092144.739	883733.249	USGS		1075	10/31/1968			Yes
442525089391201	2059048.067	883569.836	USGS		1054	9/15/1959			Yes
442528089352101	2075812.665	883950.17	USGS		1059	8/21/1968			Yes
442532089283901	2104986.962	884519.187	USGS		1086	6/18/1965			Yes
442541089325801	2086184.407	885320.554	USGS		1068	6/29/1966			Yes
442542089342701	2079724.744	885387.76	USGS		1067	10/5/1959			Yes
442542089350301	2077112.053	885374.534	USGS		1063	4/18/1962			Yes
442542089353401	2074862.23	885363.387	USGS		1057	6/30/1978			Yes
442551089264001	2113610.866	886499.511	USGS		1123	4/13/1972			Yes
442551089264002	2113610.866	886499.511	USGS		1119	6/1/1967			Yes
442555089382201	2062663.981	886623.601	USGS		1057	8/6/1953			Yes

Table C-1

Water Level Data

Well ID[1]	X-Coordinate (feet)[2]	Y-Coordinate (feet)[2]	Source[3]	Unit	Target Value	Date of First Measurement	Date of Last Measurement	Count	Included as Target
442558089345801	2077466.817	886996.77	USGS		1060	6/13/1969			Yes
442600089263001	2114330.466	887415.848	USGS		1093	11/10/1976			Yes
442604089360601	2072529.213	887580.199	USGS		1063	4/5/1973			Yes
442605089364301	2069843.768	887668.762	USGS		1059	8/1/1965			Yes
442605089384501	2060990.561	887629.166	USGS		1054	3/25/1976			Yes
442606089350801	2076737.107	887803.349	USGS		1059	3/17/1977			Yes
442607089383101	2062005.615	887836.093	USGS		1052	5/21/1979			Yes
442608089344401	2078477.684	888014.662	USGS		1062	10/22/1959			Yes
442612089390001	2059899.064	888333.501	USGS		1050	8/20/1970			Yes
442617089264001	2113593.326	889132.658	USGS		1120	10/1/1962			Yes
442617089290701	2102926.698	889063.891	USGS		1082	4/13/1974			Yes
442619089341401	2080648.927	889139.848	USGS		1062	8/24/1970			Yes
442621089353901	2074480.169	889311.374	USGS		1059	5/22/1967			Yes
442623089390901	2059241.352	889444.805	USGS		1049	1/11/1960			Yes
442624089283801	2105026.561	889785.975	USGS		1178	5/20/1968			Yes
442626089345401	2077742.89	889833.971	USGS		1057	3/23/1976			Yes
442629089272401	2110392.686	890326.844	USGS		1091	4/6/1976			Yes
442630089365001	2069324.073	890198.309	USGS		1045	3/27/1976			Yes
442631089304301	2095952.422	890439.683	USGS		1084	10/30/1966			Yes
442631089362701	2070992.443	890307.409	USGS		1049	12/22/1959	3/1/1964	2	Yes
442633089282801	2105746.436	890702.047	USGS		1096	7/23/1980			Yes
442633089344501	2078392.366	890546.206	USGS		1061	7/1/1980			Yes
442635089312601	2092830.114	890826.704	USGS		1076	11/16/1959			Yes
442642089315301	2090867.115	891524.5	USGS		1075	4/27/1960			Yes
442644089300601	2098629.228	891772.218	USGS		1085	4/10/1968			Yes
442645089354301	2074178.138	891740.61	USGS		1061	3/26/1973			Yes
442656089293701	2100725.894	893000.26	USGS		1091	12/17/1965			Yes
442658089322001	2088899.204	893133.953	USGS		1072	3/1/1964			Yes
442658089341401	2080628.617	893089.636	USGS		1059	9/21/1976			Yes
442702089302201	2097457.56	893588.252	USGS		1086	7/17/1980			Yes
442712089324201	2087295.401	894543.045	USGS		1066	8/31/1951			Yes
442715089310001	2094693.145	894888.638	USGS		1074	8/16/1973			Yes
442716089283801	2104993.604	895052.338	USGS		1121	5/21/1968			Yes
442737089333801	2083219.6	897053.101	USGS		1057	9/14/1971			Yes
442737089333802	2083219.6	897053.101	USGS		1049	6/15/1969			Yes
442740089301101	2098232.699	897441.536	USGS		1093	10/13/1959			Yes
442750089311601	2093512.138	898426.628	USGS		1076	4/22/1974			Yes
442800089310001	2094666.787	899446.119	USGS		1084	11/7/1966			Yes
442803089272601	2110185.711	899845.861	USGS		1095	7/4/1961			Yes
442817089302701	2097050.054	901181.887	USGS		1079	7/7/1959	10/29/1961	719	Yes
442820089264001	2113510.48	901589.66	USGS		1124	6/3/1981			Yes
442822089314301	2091535.49	901656.299	USGS		1075	6/14/1960	10/29/1961	402	Yes
442838089263901	2113570.856	903413.138	USGS		1110	4/19/1977			No

[1] Well ID number is USGS site number

[2] Datum: NAD83, Stateplane, Wisconsin South, FIPS 4803

[3] Source: USGS (http://waterdata.usgs.gov/nwis/gw)

Attachment D

Stream Flow Data

Attachment D
Stream Flow Observations

Significant stream flow data are available within the model domain. Daily flow data are available for Tenmile Creek at Highway 13 at a gage maintained by the U.S. Geological Survey for the periods May 1965 through September 1979, October 1987 through September 1994, and February 1998 through the present (station 5401100). Tenmile Creek is in the center of the model domain and this 84 square mile drainage comprises about fifteen percent of the entire model domain. Other locations with at least several years of daily data include the following U.S. Geological Survey gages[1]:

- Buena Vista Creek near Kellner with daily data from March 1964 through September 1967 (station 5400853). The drainage area upstream of this gage is 53 square miles.
- Fourmile Creek near Kellner with daily data from March 1964 through September 1967 (station 5400870). The drainage area upstream of this gage is 51 square miles.
- Tenmile Creek ditch #5 near Bancroft with daily data from June 1964 through September 1973 (station 5401020). The drainage area upstream of this gage is 9.7 square miles.
- Big Roche a Cri near Hancock with daily data from October 1963 through September 1967. The drainage area upstream of this gage is 9.1 square miles.

Long-term hydrographs of flows in Tenmile Creek and Fourteen Mile Creek are shown on Figure D-1 and annual hydrographs for Tenmile Creek for years 2002 through 2012 are shown on Figure D-2. Average and median annual flows in Tenmile Creek for various periods of record are tabulated below. Hydrographs of flows for USGS gages with only a few years of data are shown on Figure D-3.

	1963-1967	1987-1994	1998-2001	2001-2011
Median Flow (cfs)	54	58	47	47
Average Flow (cfs)	63	62	55	44
Count	1461	2558	5084	4020

The Center for Watershed Science and Education at the University of Stevens Point/Extension has been monitoring periodically a number of the streams in the model domain since the mid-2000's, including Big Roche a Cri at 1st Avenue, Fourteenmile Creek, Buena Vista Creek at 100th Road, Buena Vista Creek Ditch #2, Fourmile Creek at 100th Road, Tenmile Ditch #5, Fourmile Creek at JJ&BB, and North Branch of Tenmile Creek. Available stream flow data are listed on the Table D-1 and hydrographs of the stream flow data are shown on the attached figures. Hydrographs for the period 2007 through September 2012 for these gaging locations are shown on Figure D-4.

[1] All of these U.S. Geological Survey gages were established to support a study of groundwater conditions in the Central Sand Plain. The major report published as part of this effort was "Effects of Irrigation on Streamflow in the Central Sand Plain of Wisconsin" by Weeks and Strangland (1971).

A summary of gaging locations and estimated base flows are listed below.

Gaging Location	Latitude	Longitude	USGS Number	Base Flow Estimate (cfs)	Comments
Big Roche-A-Cri at 1st Ave	44.176	-89.598	05401510	9.0	0.8 miles downstream from USGS site
Fourteen Mile Creek near New Rome	44.204	-89.808		20?	at USGS site
Buena Vista Creek at 100th Rd	44.378	-89.687	05400853	30 to 40	0.8 miles upstream from USGS site
Buena Vista Cr. Ditch #2 N.Fork @ Isherwood	44.40	-89.51		6.0	first bridge south of Birch Dr on Isherwood Rd
Fourmile Creek at 100th Rd	44.37	-89.68	05400870	40 to 45	0.9 miles upstream from USGS site
Tenmile Cr. Ditch #5 at Taft	44.30	-89.55	05401020	8.0	at daily site: Tenmile Creek Ditch 5 near Bancroft
Fourmile Creek at JJ&BB	44.37	-89.47		1.2	first bridge on Cty Hwy JJ after it splits from Cty Hwy BB
NB Tenmile at Isherwood/Harding	44.29	-89.51		0.7	first bridge north of 3rd Ave on Harding Rd
Tenmile Creek Near Nekoosa	44.26	-89.81	05401050	55	USGS Site

Inquiries were made at the UW-Stevens Point and WDNR files were reviewed to obtain historical flow data from Sevenmile Creek. A single measurement of the flow in Sevenmile Creek was found in the files at the WDNR; a flow of 1.62 cfs where the stream crosses Hollywood Road measured on July 14, 1999.

Flows in Sevenmile Creek were measured as part of the work in preparation of this EIR in late spring of 2012 (May-June), on August 28, 2012, on October 3, 2012, on May 24, 2013, on August 30, 2013 and on September 4, 2013. In addition, flows were measured by the WDNR on August 7, 2012. All of the available flow data are listed on Table D-1.

On a site visit on May 24, 2012, flow was measured at two locations in Sevenmile Creek; at County Road Z (just upstream of the Wisconsin River) and at Rangeline Road about 2.5 miles upstream of the Wisconsin River. Measured flows at these two locations were 5.5 cubic feet per second (cfs) and 4.8 cfs, respectively. A picture of Charles Andrews measuring flow at the downstream location is shown to the right.

The flow of Sevenmile Creek was also measured on June 14, 2012 at Highway U (80th Street), 52nd Street, and at Highway Z using the same procedures. Measured stream flows were approximately 2 cfs at the two upstream locations and approximately 5.6 cfs at Highway Z just upstream of the Wisconsin River. These flows represented average late spring conditions.

During the hot and droughty summer of 2012, flows in Sevenmile Creek were measured in August and in October. On August 7th and 28th, the measured flows at Rangeline Road were 0.45 cfs and 0.38 cfs, respectively. On August 7th, the measured flow downstream at County Road Z was 2.1 cfs.

On October 3 and 4, 2012, Sevenmile Creek was traversed from Rangeline Road to the Wisconsin River and flows were measured at several locations to determine the amount of

groundwater discharge occurring to Sevenmile Creek downstream of Rangeline Road. The results of these flow measurements are shown on Figure D-5. Stream flows varied from 0.6 cfs at approximately 2,000 feet downstream of Rangeline Road to 2.3 cfs just upstream of County Road Z. Just upstream of Hollywood Road a flow of 1.8 cfs was measured but downstream of Hollywood Road, just below a dam for the nearby cranberry operation, very little flow was observed. Flow then increased downstream of the dam to about 2.3 cfs at County Road Z.

Spring Branch was observed on five occasions. During each field reconnaissance the channel was observed where the stream crosses Akron Road, which is located about 3,000 feet upstream of the upper bay of Upper Camelot Lake (this upper impounded area is known as Walden Pond). No water was present in the channel on June 14, July 17 and August 16, 2012, or on July 4, 2013. Water was present on May 30, 2013; however, it was in discrete, non-flowing puddles. The channel at Akron Road was also observed to have significant vegetation growing in the channel, including woody plants. Based on these observations, it is concluded that this portion of the stream is typically dry. A picture of Spring Branch at Akron Road on June 14, 2012 is shown below.

Table D-1
Summary of Measured Streamflow Data in Model Domain

Big Roche-A-Cri at 1st Ave		Buena Vista Creek at 100th Rd		Buena Vista Creek Ditch #2 N.Fork at Isherwood		Fourmile Creek at 100th Rd		Tenmile Creek Ditch #5 at Taft		Four Mile Creek at JJ&BB		NB Ten Mile at Isherwood/Harding		Fourteen Mile Creek near New Rome	
Data Collected 2007 through 2011 by Center for Watershed Science and Eduation, Stevens Point															
6/13/07	6.3	6/13/07	22.6	6/13/07	3.7	6/13/07	29.2	11/11/10	8.7	7/13/07	0.0	8/8/07	0.0	6/13/07	4.4
7/11/07	7.5	7/11/07	11.0	7/11/07	3.4	7/11/07	13.1	1/11/11	6.7	8/8/07	0.2	9/24/07	0.0	7/11/07	4.4
8/9/07	2.4	8/8/07	8.7	9/24/07	3.1	8/8/07	7.7	5/5/11	15.0	9/24/07	0.1	10/24/07	0.0	8/9/07	2.8
9/28/07	6.9	9/21/07	24.0	10/12/07	3.6	9/21/07	31.5	6/29/11	10.8	10/12/07	0.2	11/16/07	0.1	9/28/07	25.3
10/13/07	7.4	10/24/07	31.3	11/16/07	3.6	10/24/07	41.2	7/26/11	6.4	11/16/07	0.1	12/29/07	0.1	10/12/07	2.8
11/16/07	5.8	11/20/07	28.5	12/29/07	3.8	11/20/07	39.3	8/16/11	6.2	12/29/07	0.2	3/29/08	0.1	12/31/07	12.0
12/31/07	3.3	12/31/07	22.7	3/29/08	3.7	12/31/07	26.7	9/14/11	3.9	3/29/08	0.1	6/26/08	0.5	1/25/08	22.7
1/25/08	6.8	3/29/08	45.9	6/26/08	5.1	7/29/08	53.9	10/11/11	5.5	6/26/08	1.2	7/29/08	0.1	2/23/08	17.8
3/28/08	11.7	7/1/08	35.0	7/29/08	3.5	3/13/09	49.8	11/15/11	7.8	7/29/08	1.1	8/19/08	0.4	7/1/08	67.1
7/1/08	10.5	7/29/08	43.0	8/19/08	4.8	4/17/09	48.9	12/21/11	6.9	8/19/08	0.5	10/3/08	0.4	7/28/08	40.1
7/28/08	8.8	8/19/08	20.6	10/4/08	5.4	11/10/10	73.3	1/16/12	5.9	9/27/08	0.5	10/31/08	0.1	8/19/08	10.5
8/19/08	7.0	10/4/08	20.9	10/31/08	3.3	1/11/11	53.8	3/28/12	6.4	10/31/08	0.4	11/20/08	0.1	10/3/08	38.8
9/27/08	9.0	10/30/08	21.0	11/21/08	3.9	5/5/11	114.1	5/1/12	6.5	11/21/08	0.3	1/31/09	0.2	10/30/08	6.0
10/30/08	6.6	11/20/08	22.1	12/18/08	4.2	7/1/11	57.0	5/23/12	7.1	12/17/08	0.2	2/20/09	0.3	11/20/08	8.1
11/20/08	7.5	12/18/08	15.2	1/31/09	4.6	7/25/11	44.7	6/27/12	3.9	1/31/09	0.4	3/14/09	0.3	12/18/08	9.9
12/18/08	7.2	1/31/09	12.3	2/20/09	4.7	8/16/11	46.4	7/24/12	1.9	2/20/09	0.5	4/17/09	0.2	1/31/09	12.6
1/31/09	7.3	2/20/09	30.4	3/14/09	4.5	9/14/11	29.6	8/30/12	1.8	3/14/09	0.8	11/11/10	2.0	2/21/09	13.4
2/21/09	10.1	3/13/09	32.5	4/17/09	5.2	10/11/11	40.1	9/26/12	2.1	4/17/09	0.7	1/11/11	0.9	3/13/09	14.2
3/14/09	10.3	4/17/09	36.6	8/13/09	5.0	11/15/11	56.4			11/11/10	2.1	5/5/11	3.8	4/19/09	38.1
4/17/09	10.4	11/10/10	52.1	9/4/09	4.1					1/11/11	1.6	6/29/11	1.9		
11/10/10	15.4	1/11/11	41.3	10/9/09	4.1					3/8/11	1.6	7/26/11	1.1		
1/11/11	13.4	7/1/11	43.5	11/6/09	5.1					5/4/11	4.1	8/16/11	1.5		
5/5/11	27.6	7/25/11	35.5	12/5/09	4.9					6/29/11	3.4	9/14/11	0.3		
7/1/11	15.1	8/16/11	42.8	1/5/10	4.8					7/26/11	2.6	10/11/11	1.2		
7/25/11	13.5	9/14/11	33.0	1/21/10	4.2					8/16/11	2.6	11/15/11	1.5		
8/17/11	8.9	10/11/11	43.2	2/16/10	4.6					9/14/11	2.0	12/21/11	1.5		
9/16/11	7.7	11/15/11	47.6	3/23/10	6.0					10/10/11	2.4	1/16/12	1.0		
10/12/11	9.7	12/21/11	44.4	4/12/10	6.1					11/17/11	2.5	3/28/12	1.1		
11/16/11	13.3	1/16/12	38.5	5/24/10	5.7					12/19/11	2.4	5/1/12	1.4		
12/20/11	11.7	3/27/12	48.5	6/30/10	5.4					1/17/12	2.1	5/23/12	1.3		
1/18/12	9.8	5/1/12	45.9	8/6/10	4.5					3/27/12	2.3	6/27/12	0.3		
3/29/12	11.6	5/23/12	54.5	9/9/10	6.7					4/30/12	2.1	7/24/12	0.1		
5/1/12	13.2	6/27/12	36.8	10/13/10	7.9					5/22/12	2.1	8/30/12	0.0		
5/24/12	11.5	7/24/12	11.0	11/11/10	7.4					6/28/12	1.4	9/26/12	0.0		
6/26/12	7.8	8/31/12	13.7	12/6/10	7.7					7/24/12	0.6				
7/23/12	3.7	9/26/12	12.6	1/11/11	6.9					8/29/12	0.3				
8/31/12	3.0			2/11/11	6.6					9/26/12	0.4				
9/27/12	3.7			3/8/11	6.6										
				4/29/11	11.6										
				5/4/11	10.7										
				5/19/11	10.9										
				6/29/11	9.7										
				7/26/11	8.5										
				8/16/11	9.0										
				9/14/11	7.5										
				10/10/11	8.2										
				11/17/11	8.8										
				12/19/11	8.2										
				1/17/12	7.5										
				3/27/12	8.1										
				4/30/12	8.3										
				5/22/12	8.1										
				6/28/12	6.5										
				7/24/12	4.9										
				8/29/12	5.6										
				9/26/12	5.4										
count	38		36		56		19		18		37		34		19
average	9.3		31.4		6.0		45.1		6.3		1.2		0.7		18.5
Median	8.9		32.8		5.4		44.7		6.4		0.8		0.3		12.6
Summary of Historical Data Collected by USGS															
count	1461		1309				1305		3383						5693
average	9.3		45				40		8						43
Median	7.8		33				26		6.5						30
Period	1963-1967		1964-1976				1964-1967		1964-1973						1964-1979

Table D-2

Streamflow Data for Sevenmile and Tenmile Creeks

	Measured Flow (cfs)													
Sevenmile Creek	07/14/99	05/24/12	06/14/12	08/07/12	08/23/12	08/28/12	08/29/12	09/13/12	09/20/12	10/03/12	10/16/12	05/24/13	08/30/13	09/04/13
Station 3A										2.1				
Station 3B										1.9				
County Z		5.4	5.6	2.1									2.6	2.4
Station 2A										2.3				
Station 2B										2.2				
Station 2C										2.0				
Station 2D										1.2				
Below Dam										<0.1				
Hollywood Road	1.6													
Station 1A										1.6				
Station 1B										1.2				
Station 1C										0.9				
Station 1D										0.6				
Rangeline Road		4.7		0.5		0.4						2.9	1.0	0.7
Highway 73						<0.1						1.7		
52nd Street			1.9									1.3		
64th Street						<0.1								
Highway U			2.1										<0.1	
Tenmile Creek														
Rangeline Road						32.2								
Highway 13	54.0	75.0	54.0	24.0	23.0	23.0	23.0	22.0	22.0	21.0	45.0	98.0	33.0	31.0
Bell Road						12.5								
County U				2.4	2.0	2.3	3.1	2.0	1.1		10.4			

Notes: Flow measurements for Tenmile Creek at Highway 13 from USGS gaging station 5401100; Tenmile Creek near Nekoosa. Sevenmile Creek flow measurement for 1999 from DNR files. Other data collected as follows: May 24, 2012 data collected by C. Andrews, S.S. Papadopulos & Associates; August 7th, 23rd, 29th, September 13th, 20th and October 16th, 2012 data from DNR; August 28th and October 3, 2012 data collected by staff from Eco-Resources, LLC. All other data collected by B. Nauta, RJN Environmental Services, LLC.

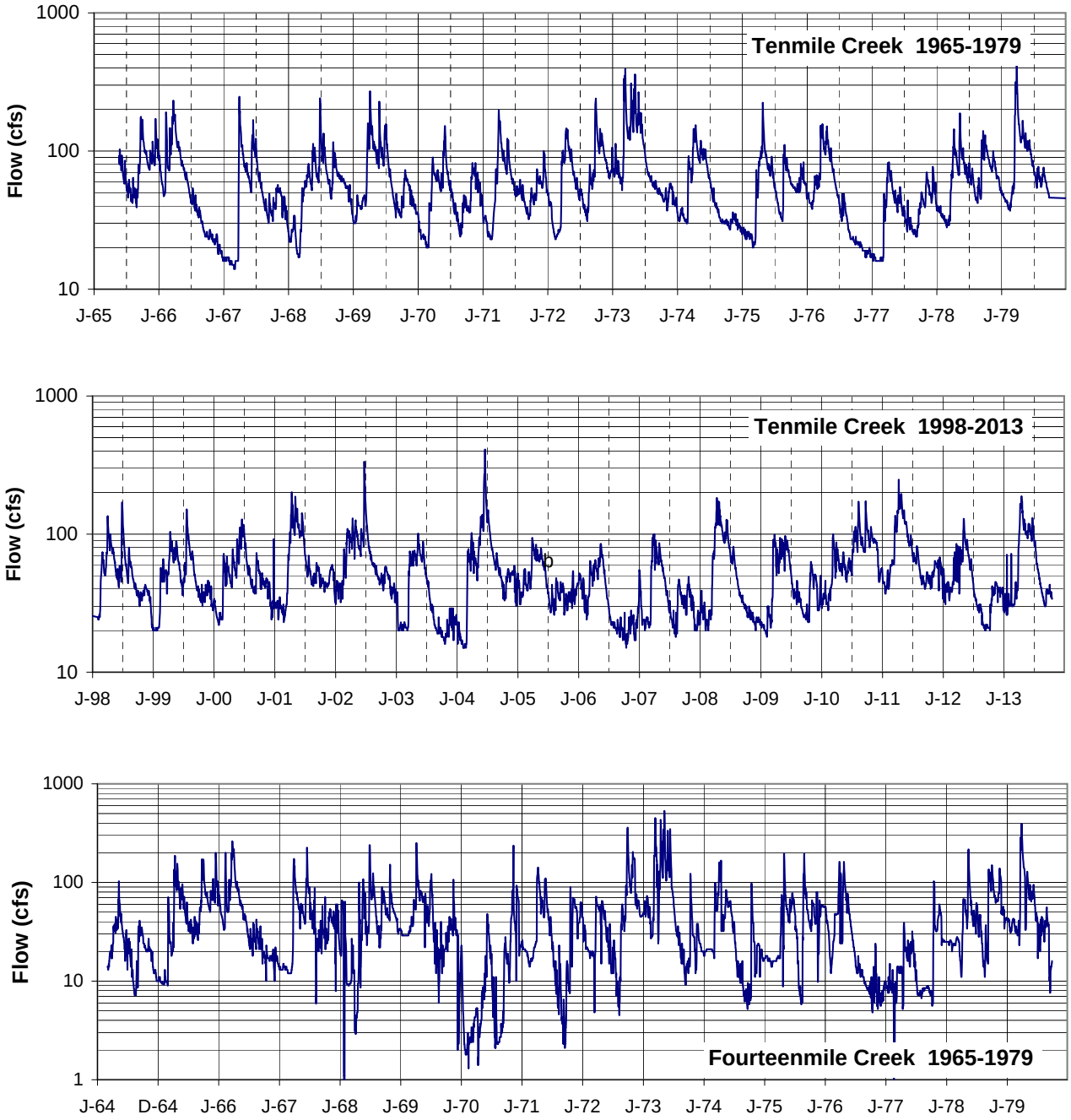

Figure D-1
Hydrographs for Tenmile and Fourteen Mile Creeks

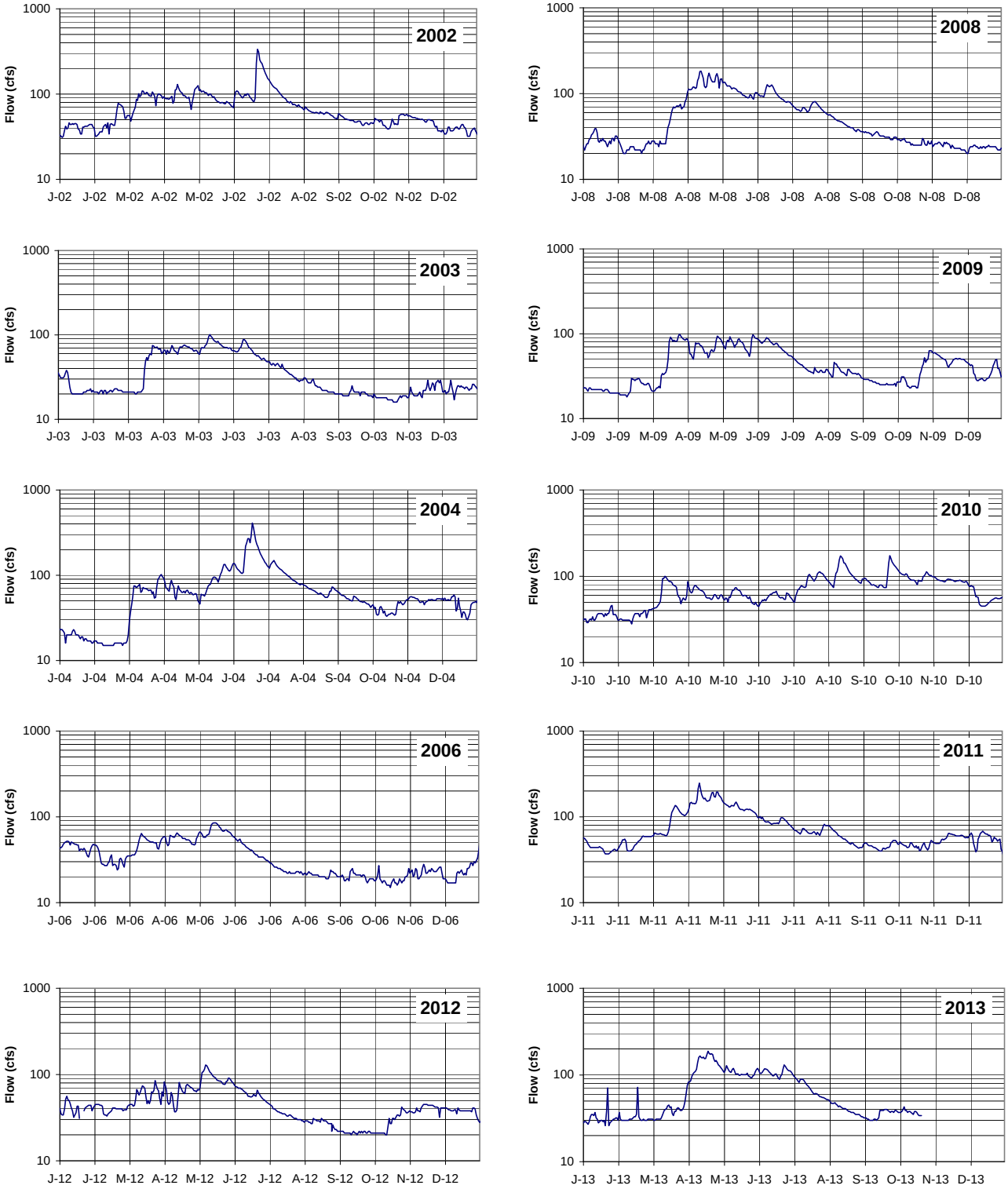

Figure D-2
Annual Hydrographs for Selected Years for Tenmile Creek

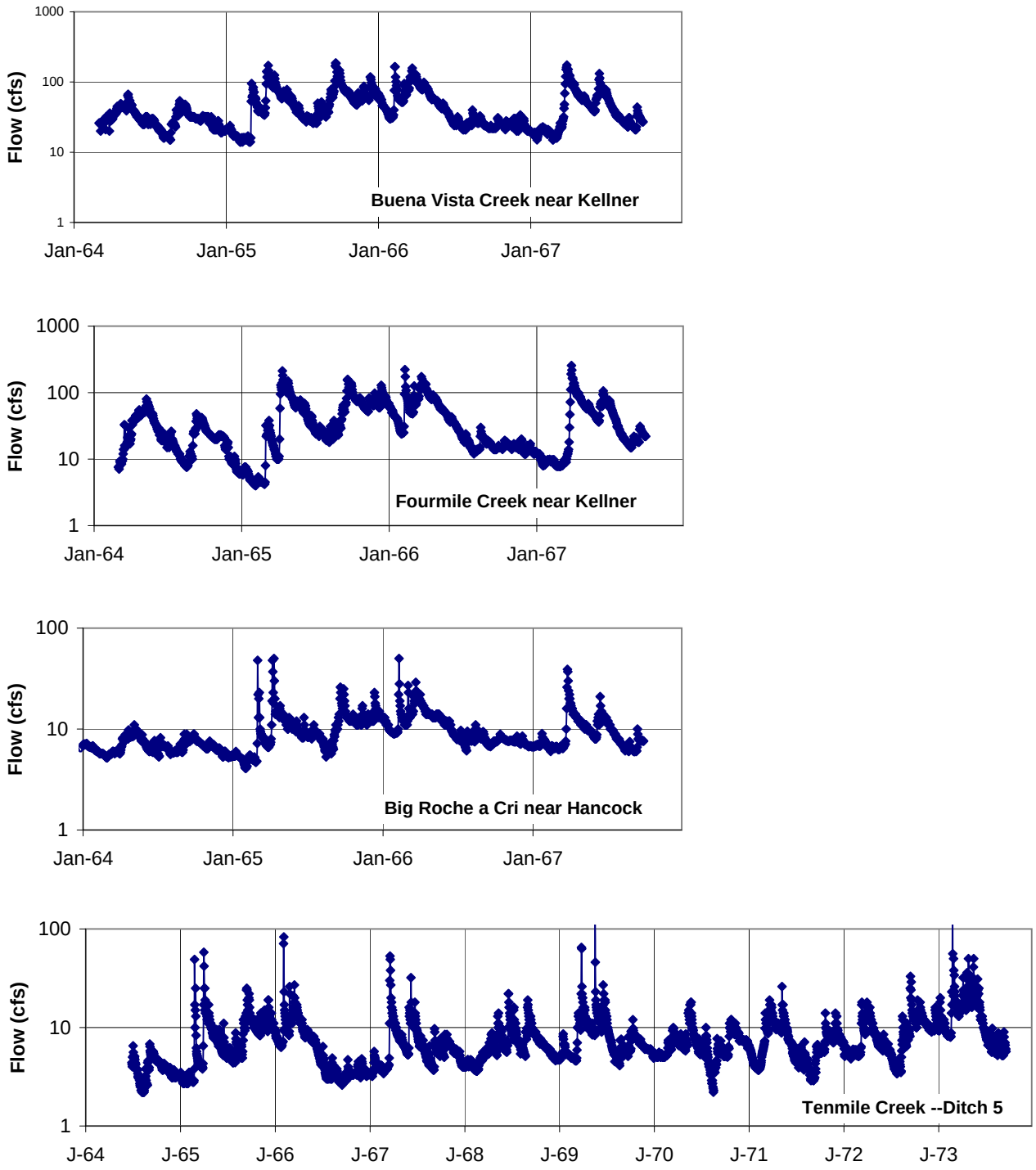

Figure D-3
Hydrographs for Historical USGS Daily Gage Data

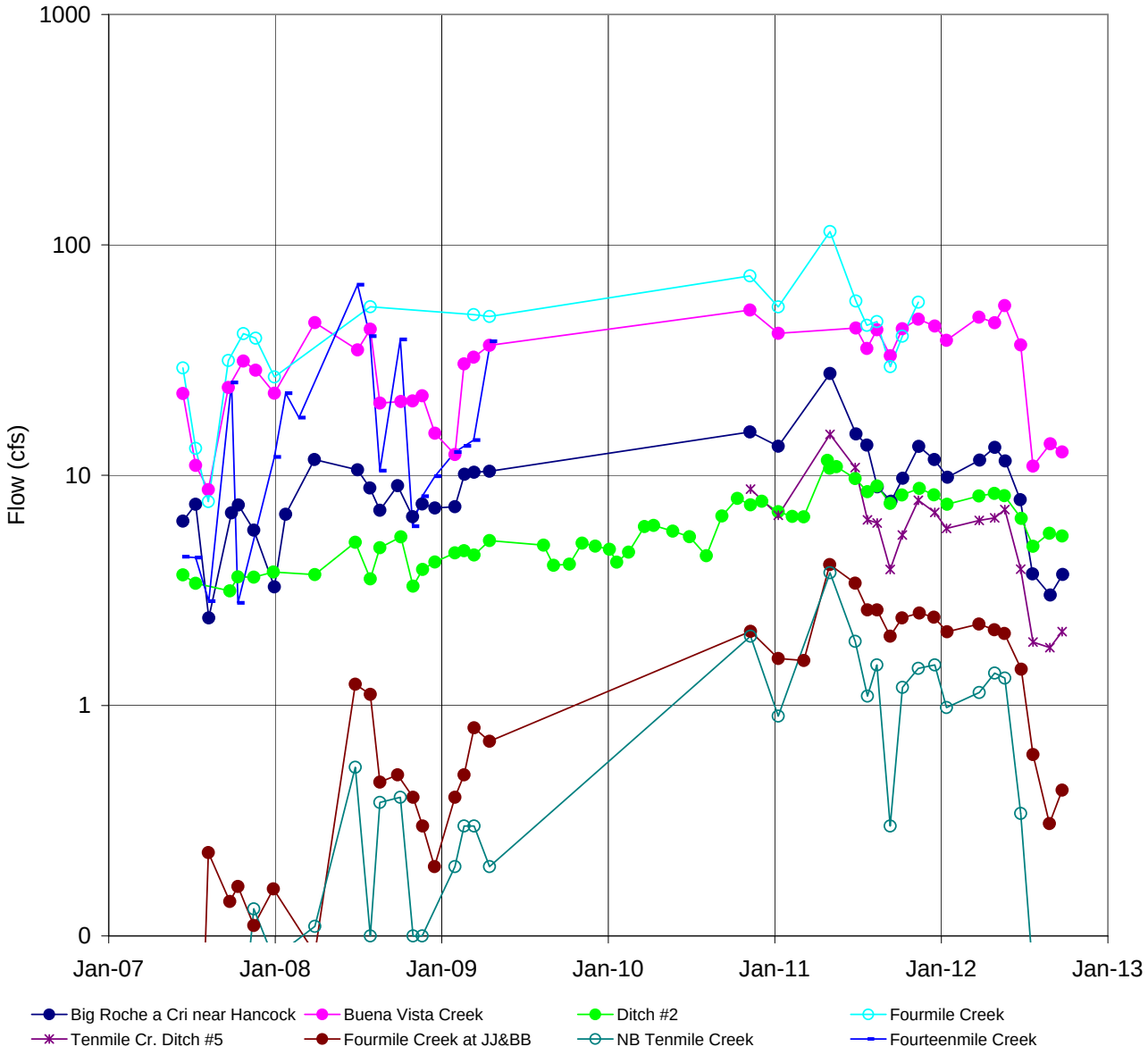

Figure D-4
Hydrographs for Gaging Location with data from 2007 through 2012

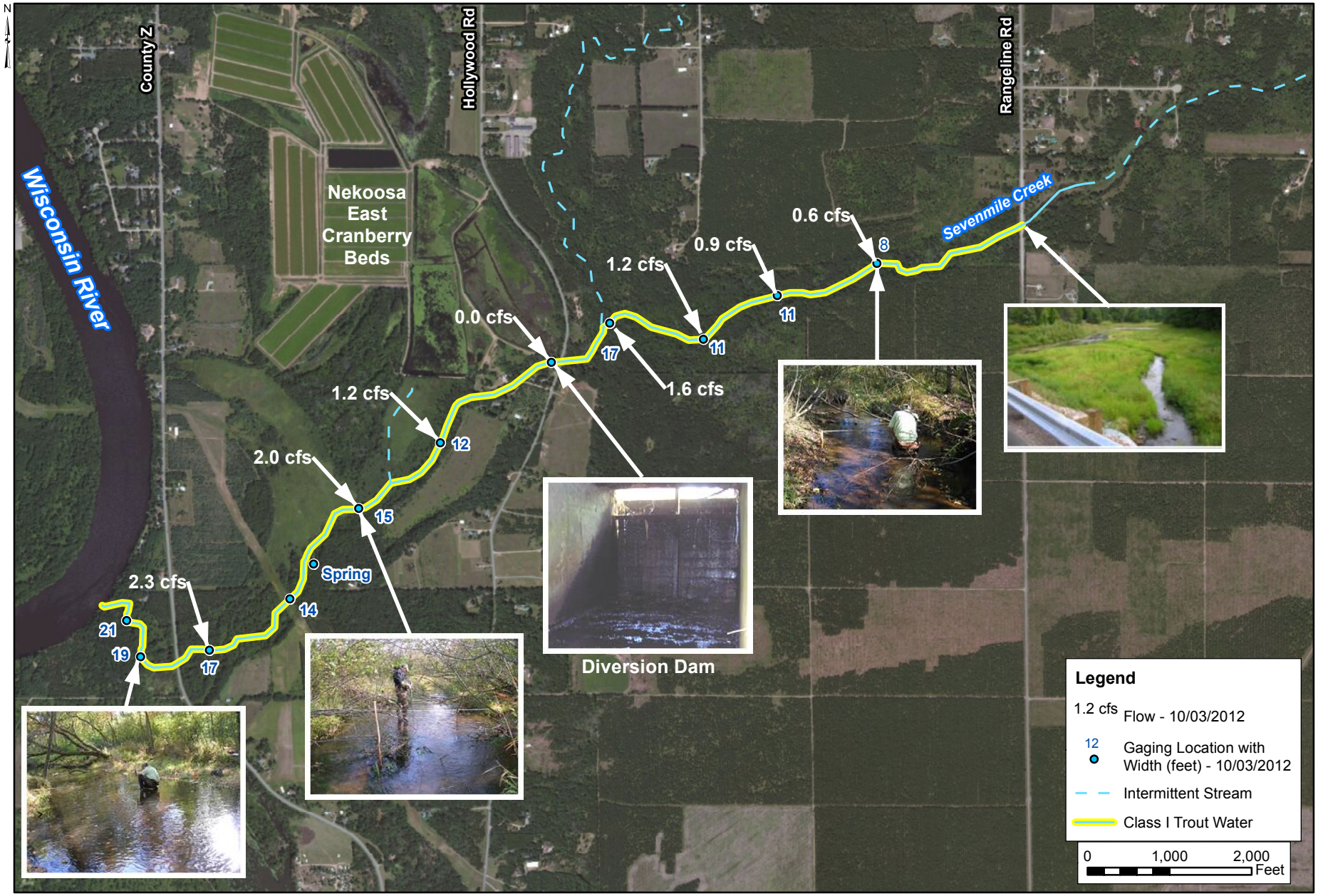

Figure D-5 October 2012 Flow Measurements along Sevenmile Creek

Attachment E

Existing High Capacity Wells and Pumping Rates

Attachment E

Existing High Capacity Wells and Pumping Data in the Model Domain

The locations and average annual pumping rates for existing high capacity wells that had pumping data reported through 2012 in the vicinity of the GSD Project are shown on Figure E-1 (and in Figure 4 of the groundwater flow model report). Average pumping rates for existing high capacity wells located in the model domain for the period 2007 through 2011 and 2012 rates are listed on Table E-1. These data were obtained from the Wisconsin Department of Natural Resources database on High Capacity wells. The average pumping rates shown in Figure E-1 are the average annual 2007 to 2011 pumping rates as reported by the WDNR; for wells that only had 2012 pumping rates reported, the 2007 to 2011 average rates were estimated based on the ratio between the 2012 pumping rates and the average rates in 2007 to 2011 reported for wells in the area. The locations of high capacity wells that were permitted in 2012 to 2013 and did not have pumping data are also shown in Figure E-1.

Most of these high capacity wells are used for irrigated agriculture, and most of the high capacity irrigation wells in the area are located to the east of the GSD Project Area.

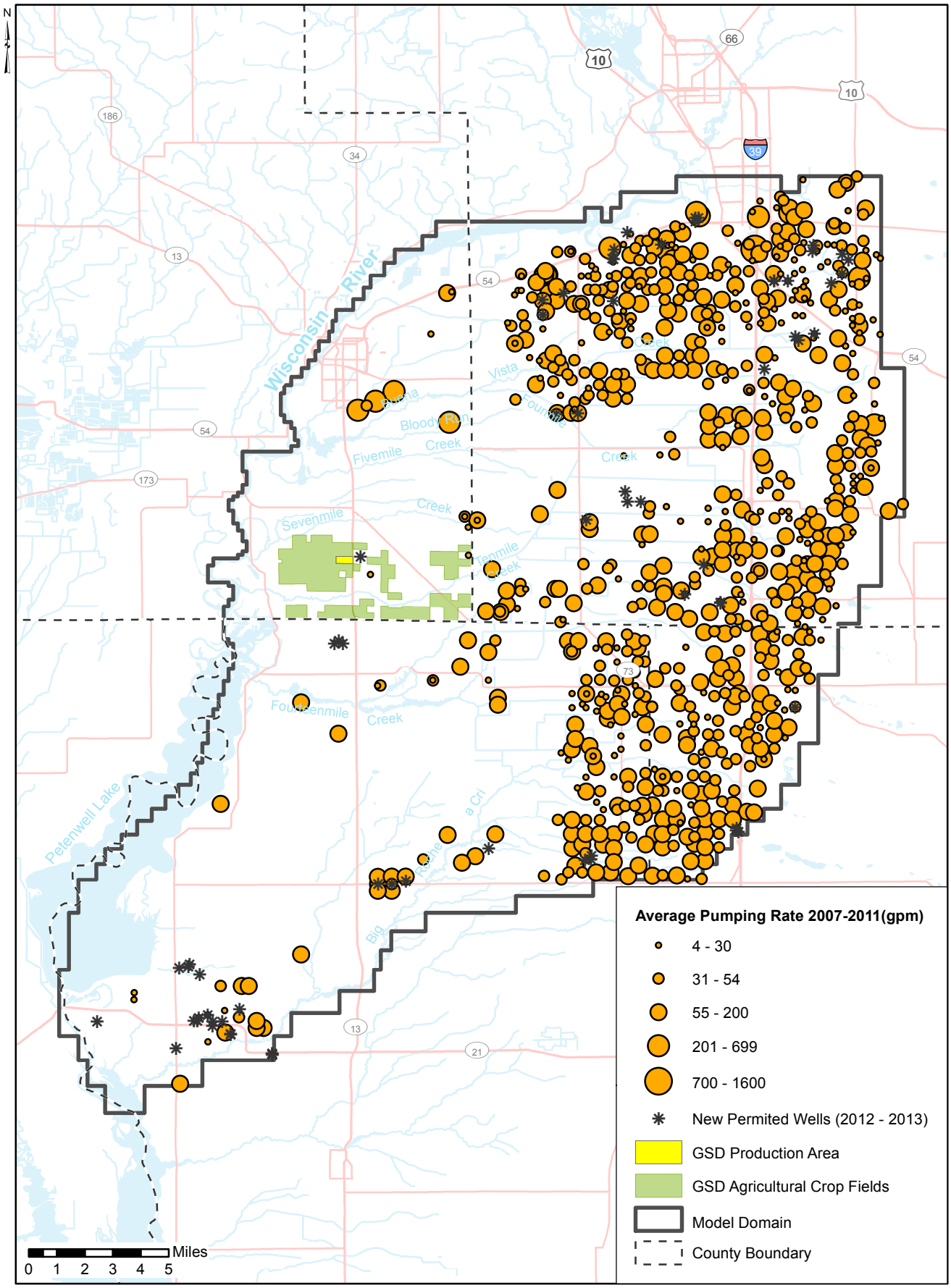

Figure E-1 Location of High Capacity Wells in Model Area

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
7	2064095	771971	41.45	78.9	45.25
8	2061468	771987	26.99	51.4	55.21
10	2069967	813754	26.67	50.7	47.88
11	2071943	814429	37.49	71.3	77.10
12	2069925	816935	27.91	53.1	43.01
13	1985555	732088	31.67	60.3	48.31
14	2073432	777300	31.06	59.1	75.00
26	2071416	784587	15.93	30.3	43.01
27	2072216	781973	16.01	30.5	51.62
30	2072150	805861	18.49	35.2	39.17
31	2038448	810840	30.93	58.9	82.27
34	2073428	790745	16.06	30.5	44.52
40	2072777	784576	29.16	55.5	43.01
45	2073459	796010	27.91	53.1	43.01
47	2063536	793945	36.57	69.6	59.47
54	2072789	803193	41.46	78.9	86.22
56	2067446	790013	14.74	28.0	14.77
57	2064149	791919	46.34	88.2	33.32
59	2064842	787341	23.29	44.3	73.61
60	2062209	787280	44.05	83.8	63.81
61	2062176	789984	12.99	24.7	8.44
62	1990799	740012	10.36	19.7	3.40
64	1993230	784953	39.14	74.5	87.32
66	2070135	788191	18.36	34.9	28.03
67	2068197	784572	29.20	55.6	106.16
68	2070130	790048	35.61	67.7	42.43
74	2068873	805643	45.73	87.0	119.03
75	2066265	802492	36.90	70.2	28.19
79	2068089	783842	27.83	53.0	53.87
81	2065107	805625	13.89	26.4	5.95
82	2064881	804421	26.35	50.1	18.15
83	2067486	808236	22.40	42.6	48.24
90	1993226	750571	16.99	32.3	50.70
91	1997198	750561	66.26	126.1	102.12
92	1998530	750561	41.96	79.8	64.67
110	2062823	795873	38.98	74.2	21.90
112	2073245	815767	27.91	53.1	43.01
115	2033278	808278	22.60	43.0	71.16
125	2073396	805208	24.63	46.9	41.24
134	2073413	788096	32.21	61.3	39.66
138	2045050	815767	27.47	52.3	42.33
142	2073448	799956	41.11	78.2	65.93
143	2062089	775630	16.55	31.5	45.96

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
144	2067433	773940	38.33	72.9	56.94
145	2070131	771307	48.12	91.5	61.73
155	2072389	879336	44.87	85.4	62.73
159	2066271	801075	38.13	72.5	89.19
160	2068892	801390	29.15	55.5	19.24
161	2068155	803799	33.91	64.5	43.47
162	2071487	807276	13.11	24.9	17.81
175	2059496	795216	47.14	89.7	45.79
192	2070098	808383	21.01	40.0	41.31
193	2062195	805742	39.14	74.5	32.36
194	2064778	811039	22.13	42.1	56.34
195	2064825	808380	21.92	41.7	50.34
196	2059557	805759	12.09	23.0	20.52
197	2059534	803116	13.53	25.7	31.60
198	2062175	803115	13.79	26.2	32.80
202	2059536	813737	47.45	90.3	153.17
203	2071258	815630	33.49	63.7	51.62
208	2043737	813602	36.61	69.7	9.64
212	2065985	815635	33.49	63.7	51.62
219	2067414	776576	41.05	78.1	58.09
222	2059576	776558	54.68	104.0	58.71
223	2059513	779261	42.88	81.6	53.77
224	2059522	781903	37.48	71.3	61.50
225	2062133	779255	38.56	73.4	51.47
226	2064760	779242	32.89	62.6	50.67
229	2067397	779229	45.26	86.1	86.46
230	2054256	771327	27.79	52.9	86.02
232	2056888	781909	21.08	40.1	20.53
237	2064782	781886	20.71	39.4	38.24
239	2066823	799853	9.70	18.5	50.72
256	2025490	768547	42.27	80.4	60.63
257	2028134	771193	41.30	78.6	77.26
258	2025505	771188	43.38	82.5	56.24
259	2022893	771178	43.71	83.2	82.36
267	2065465	783861	12.33	23.5	1.38
274	2039882	815829	31.14	59.2	47.99
276	2073297	811812	27.91	53.1	43.01
277	2057507	794552	4.50	8.6	41.52
282	2015461	798178	42.59	81.0	52.78
285	2001318	742652	42.35	80.6	51.62
288	2059479	813712	27.94	53.1	30.02
290	2043726	808291	6.11	11.6	40.32
295	2071360	809806	26.52	50.5	40.88

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
298	2069476	803816	11.73	22.3	0.00
304	2071431	801838	15.32	29.1	34.38
314	2067987	814379	9.10	17.3	25.44
315	2071979	811805	22.76	43.3	34.61
316	2070737	778593	24.36	46.3	75.19
331	2022877	768535	38.49	73.2	74.38
345	2073117	783010	29.97	57.0	51.62
355	2058767	815697	57.81	110.0	36.20
360	2061472	777270	38.83	73.9	55.39
369	2066791	771975	54.01	102.8	60.93
373	2082365	872145	41.59	79.1	59.96
374	2050723	875253	17.80	33.9	30.74
380	2089505	819849	21.30	40.5	22.64
402	2063956	885940	7.18	13.7	33.77
403	2053471	839662	29.62	56.3	57.91
411	2076861	824650	37.76	71.8	49.20
413	2111289	902193	21.91	41.7	44.32
418	2103299	890906	14.64	27.9	22.56
422	2081673	880870	23.28	44.3	11.06
442	2095780	793398	10.70	20.4	16.20
443	2063536	793945	4.59	8.7	9.07
445	2070582	888586	33.55	63.8	37.37
466	2100641	897490	103.38	196.7	88.67
467	2100640	896542	124.90	237.6	141.83
495	2041651	838486	34.77	66.2	89.72
545	2082451	869512	49.04	93.3	58.16
546	2083645	877418	72.50	137.9	46.90
551	2082482	801320	26.15	49.8	50.23
555	2062669	862106	24.82	47.2	54.75
556	2060040	859456	9.25	17.6	17.76
569	2057547	770694	24.73	47.1	71.68
571	2069566	784561	16.72	31.8	43.01
572	2111974	842140	21.41	40.7	22.38
574	2060168	773314	39.68	75.5	94.97
581	2073698	872807	23.77	45.2	48.29
613	2065421	777261	42.45	80.8	63.20
619	2044461	829259	32.74	62.3	41.54
623	2054471	823067	28.18	53.6	72.95
627	2061320	872019	14.30	27.2	18.08
649	2110311	833739	5.39	10.3	8.80
673	2075092	892602	22.16	42.2	10.28
685	2074190	835847	29.43	56.0	29.34
706	2055988	867361	18.89	35.9	21.16

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
707	2061264	879366	26.00	49.5	26.78
755	2104009	827555	40.46	77.0	62.36
756	2105349	826232	35.14	66.9	54.15
767	2033261	808296	14.55	27.7	30.50
801	2062876	836837	69.18	131.6	106.62
802	2062857	838160	69.18	131.6	106.62
807	2103635	883675	9.34	17.8	14.40
809	2098266	817440	4.13	7.9	43.01
812	2114742	844795	30.40	57.8	31.36
813	2077104	869598	30.94	58.9	40.55
814	2079754	869618	27.19	51.7	36.54
838	2056732	889148	18.43	35.1	31.35
849	2096382	845493	22.50	42.8	27.24
890	2036386	856994	160.05	304.5	246.67
911	2104052	823547	41.73	79.4	64.32
921	2095122	840175	10.67	20.3	36.16
951	2115959	848361	14.68	27.9	22.63
975	2049916	885012	16.09	30.6	24.96
1011	2083940	794712	10.60	20.2	43.01
1012	2085834	795415	39.18	74.5	143.78
1149	2093885	834880	8.12	15.5	19.36
1162	2113770	879153	10.26	19.5	68.80
1192	2059326	889285	9.47	18.0	16.70
1194	2106831	819709	9.39	17.9	14.47
1242	2092512	867670	17.91	34.1	23.15
1245	2085915	787437	37.02	70.4	112.59
1251	2068770	797779	4.83	9.2	21.62
1252	2068777	795287	11.82	22.5	6.13
1253	2079872	800020	9.95	18.9	56.74
1276	2068153	806422	11.43	21.7	5.37
1277	2065913	805154	8.45	16.1	8.87
1282	2062567	774316	4.44	8.4	16.93
1286	2108052	825546	15.63	29.7	24.09
1308	2076783	829911	50.48	96.1	78.90
1314	2102097	818985	4.18	8.0	4.30
1324	2095700	864421	24.72	47.0	37.38
1340	1999994	743970	28.50	54.2	46.30
1341	2000002	742651	31.72	60.4	49.91
1367	2097332	824776	26.38	50.2	91.90
1369	2094579	787852	37.74	71.8	30.61
1379	2055989	864716	26.47	50.4	61.23
1395	2112023	839601	28.75	54.7	50.90
1443	2085240	864261	15.98	30.4	86.19

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
1457	2087425	823185	7.75	14.8	11.20
1467	2062609	884626	4.23	8.0	8.20
1483	2067949	866103	17.28	32.9	23.70
1484	2069277	866108	24.06	45.8	45.05
1514	2085305	828989	27.91	53.1	43.01
1531	2067537	794079	5.42	10.3	22.07
1533	2087260	856992	21.54	41.0	29.85
1536	2068299	827431	15.32	29.2	50.00
1538	2061672	830215	27.91	53.1	43.01
1561	2060175	799906	33.49	63.7	51.62
1581	2031456	774451	21.92	41.7	99.98
1585	2075132	791441	6.91	13.1	13.57
1586	2081619	819884	39.37	74.9	59.21
1588	2089848	866311	15.98	30.4	19.13
1590	2099740	797408	8.02	15.3	20.83
1608	2095520	857837	29.14	55.4	54.84
1617	1996662	744640	24.26	46.2	56.41
1618	1994093	741745	39.06	74.3	68.80
1641	2095345	850341	40.72	77.5	88.26
1642	2071520	889919	18.47	35.1	45.86
1643	2090394	881470	14.15	26.9	19.82
1650	2087105	800652	19.46	37.0	24.14
1657	2039274	839182	13.93	26.5	0.00
1673	2099120	840177	9.81	18.7	42.93
1675	2058842	793230	13.44	25.6	12.84
1685	2082659	777420	60.53	115.2	21.98
1771	2035943	881397	34.91	66.4	27.05
1821	2062154	781898	20.97	39.9	46.01
1825	2070999	822119	18.37	34.9	50.23
1829	2068598	876016	29.70	56.5	74.50
1830	1976879	749302	8.73	16.6	0.00
1831	1976874	747986	7.28	13.9	36.36
1852	2079739	885369	39.60	75.3	0.00
1867	2072113	773324	46.77	89.0	32.93
1871	2057065	825543	32.46	61.8	64.83
1875	2064054	814344	4.79	9.1	4.00
1885	2072807	835841	38.63	73.5	32.49
1918	2008381	804102	59.46	113.1	62.25
1970	2058863	772008	18.46	35.1	62.67
2158	2061521	803773	14.64	27.9	25.61
2185	2087993	852224	13.61	25.9	20.97
2230	2061961	866356	26.79	51.0	42.78
2255	2088514	837538	23.04	43.8	20.37

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
2361	2073779	891266	22.60	43.0	26.73
2385	2057343	862078	12.02	22.9	20.81
2602	2098839	890235	5.58	10.6	8.60
2603	2098189	888294	5.58	10.6	8.60
2650	2075074	779291	83.71	159.3	102.88
2662	2087969	843413	38.80	73.8	71.95
2663	2090514	843326	27.40	52.1	34.43
2687	1993970	745925	10.01	19.0	25.62
2750	2116378	876329	9.64	18.3	8.26
2787	2082538	866880	45.34	86.3	68.57
2840	2085268	858893	29.13	55.4	24.24
2886	2094024	889707	382.28	727.3	312.89
2891	2022852	807266	9.25	17.6	14.25
2959	2056785	844212	46.98	89.4	43.09
2967	2060031	860778	20.48	39.0	47.59
2975	2062660	863433	14.75	28.1	26.37
2986	2086409	817547	23.73	45.2	14.76
2988	2076656	790093	5.87	11.2	12.26
2996	2064158	802464	12.15	23.1	30.70
3202	2077235	866853	35.91	68.3	0.00
3203	2079923	866866	42.96	81.7	78.49
3220	2008404	756522	33.66	64.0	26.02
3239	2075089	882087	21.68	41.2	33.15
3363	2056620	882611	30.96	58.9	0.00
3451	2045561	804998	49.31	93.8	154.48
3476	2048092	875217	16.17	30.8	0.59
3519	2050743	872581	32.64	62.1	38.74
3520	2061285	884626	11.86	22.6	15.60
3675	2045560	803688	46.72	88.9	154.48
3676	2064592	880023	27.97	53.2	24.74
3767	2057817	819706	8.70	16.6	33.09
3823	2021472	828261	7.25	13.8	16.67
3907	2067285	861457	31.05	59.1	52.64
3908	2059380	858788	36.39	69.2	0.00
4000	2088687	858304	97.25	185.0	126.18
4152	2060161	797194	31.59	60.1	18.69
4209	2072489	884619	30.69	58.4	38.68
4218	2069317	850669	14.95	28.5	23.05
4274	2111254	836226	40.78	77.6	41.65
4299	2060732	815685	34.12	64.9	52.59
4596	2095876	861842	6.89	13.1	20.13
23602	2121952	841540	16.01	30.5	37.80
23606	2105938	835573	19.54	37.2	30.11

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
23607	2103328	830897	12.35	23.5	19.03
23608	2103988	834155	14.47	27.5	22.30
23609	2106047	833063	38.41	73.1	59.20
23610	2114488	896229	24.60	46.8	47.09
23621	2103949	836755	40.60	77.2	62.57
23622	2104033	838132	94.31	179.4	145.35
23624	2059280	882643	22.51	42.8	38.98
23625	2059936	879358	40.65	77.3	21.41
23626	2056623	879979	34.53	65.7	42.89
23627	2103107	902813	11.06	21.0	17.05
23629	2101690	881828	14.28	27.2	19.33
23630	2098366	880404	33.29	63.3	34.06
23631	2103268	882607	10.30	19.6	15.88
23634	2054012	879941	32.83	62.5	63.41
23638	2111289	902193	54.73	104.1	84.35
23639	2092929	890587	24.51	46.6	49.49
23640	2109325	835641	39.26	74.7	60.51
23641	2112574	836238	7.42	14.1	0.00
23642	2107950	835583	39.32	74.8	60.60
23645	2095040	898795	8.24	15.7	11.85
23646	2093573	896777	8.30	15.8	13.91
23650	2088012	835514	42.92	81.7	104.97
23652	2099869	835480	57.70	109.8	48.02
23653	2099462	898921	16.95	32.3	31.05
23654	2057316	868702	19.28	36.7	15.64
23657	2085203	838235	15.19	28.9	54.51
23658	2111312	862158	56.39	107.3	119.16
23660	2111997	848793	21.71	41.3	33.46
23661	2109194	851190	33.57	63.9	51.74
23662	2057318	867377	30.87	58.7	0.00
23664	2057316	868702	18.57	35.3	68.52
23665	2090580	831578	13.62	25.9	29.16
23666	2087920	832952	30.89	58.8	89.58
23667	2090558	835426	66.92	127.3	101.15
23668	2090646	832794	43.42	82.6	57.78
23670	2059973	868736	17.56	33.4	18.96
23671	2051997	880593	20.62	39.2	0.00
23674	2066584	884621	14.11	26.9	34.27
23677	2094855	828939	24.47	46.6	42.99
23678	2094855	828939	51.09	97.2	31.22
23683	2108651	832671	60.09	114.3	92.61
23688	2077072	889165	45.85	87.2	79.07
23689	2077430	891628	32.84	62.5	4.62

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
23690	2077658	890414	8.89	16.9	7.19
23693	2099880	857862	25.77	49.0	38.58
23694	2095826	855205	62.89	119.7	84.12
23695	2103053	877134	14.75	28.1	22.73
23701	2102533	834841	8.35	15.9	12.86
23702	2078367	890527	4.80	9.1	0.80
23703	2115959	848361	36.60	69.6	56.40
23704	2092028	832802	39.29	74.8	34.29
23710	2113771	873869	12.41	23.6	13.10
23711	2105343	830264	30.17	57.4	46.50
23713	2065250	882004	24.58	46.8	59.22
23714	2066582	881995	37.61	71.5	57.89
23718	2107904	830264	43.27	82.3	61.74
23719	2105037	860529	33.08	62.9	39.81
23720	2088935	893190	17.64	33.6	26.51
23721	2090829	890818	13.24	25.2	18.49
23722	2111031	893663	15.98	30.4	24.63
23723	2087604	886723	29.30	55.7	53.25
23724	2112616	844148	11.83	22.5	32.20
23725	2094793	832817	55.85	106.3	73.05
23726	2099068	875789	10.02	19.1	25.40
23728	2090365	882837	32.59	62.0	48.11
23729	2090365	882837	30.57	58.2	55.52
23736	2096823	819034	40.28	76.6	54.72
23739	2101365	828805	45.64	86.8	0.00
23740	2101380	826274	41.27	78.5	60.60
23741	2098672	828789	35.70	67.9	64.90
23742	2098576	832738	27.79	52.9	18.68
23743	2103947	830195	38.68	73.6	59.61
23744	2104105	820992	21.61	41.1	47.12
23745	2110536	868143	55.75	106.1	65.74
23749	2119291	840223	75.12	142.9	56.54
23750	2094907	821071	43.98	83.7	19.95
23751	2095759	877681	23.64	45.0	34.07
23752	2109621	900919	42.40	80.7	65.34
23753	2114988	897389	39.94	76.0	55.26
23755	2103290	897024	61.56	117.1	94.88
23756	2096455	875724	42.32	80.5	38.12
23757	2085588	884713	15.00	28.5	12.17
23758	2086911	884731	18.92	36.0	30.73
23759	2075107	889948	30.87	58.7	45.86
23763	2053368	868646	10.22	19.4	9.65
23764	2051518	869198	12.95	24.6	9.88

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
23767	2055990	870012	35.77	68.1	64.10
23768	2054672	868667	39.58	75.3	32.38
23775	2109356	842123	48.25	91.8	74.37
23776	2103436	880410	7.63	14.5	11.76
23777	2117967	857729	13.96	26.6	21.51
23778	2095728	880325	21.46	40.8	33.07
23783	2111869	856145	16.82	32.0	31.05
23785	2097796	838874	19.44	37.0	43.01
23787	2069930	879968	37.39	71.1	58.46
23789	2074204	826021	20.93	39.8	32.26
23790	2083645	889327	32.65	62.1	50.68
23791	2082330	887655	7.46	14.2	9.34
23792	2113986	856686	36.26	69.0	38.56
23795	2101653	877156	12.10	23.0	20.52
23796	2116645	856499	131.40	250.0	84.00
23797	2117274	853125	12.13	23.1	56.80
23798	2107812	887265	13.95	26.5	21.51
23801	2087968	830247	39.97	76.0	33.09
23805	2113999	854028	31.80	60.5	72.06
23806	2080136	825243	63.87	121.5	87.25
23807	2111108	878020	12.34	23.5	29.16
23808	2098849	888913	33.49	63.7	51.62
23810	2107760	842151	14.01	26.7	49.25
23811	2082356	882812	20.08	38.2	29.22
23814	2098841	891577	55.82	106.2	86.03
23816	2098186	897509	14.07	26.8	23.84
23817	2109781	872824	53.10	101.0	81.84
23818	2113781	872548	25.96	49.4	51.60
23820	2092394	879544	8.73	16.6	9.72
23821	2101855	856083	22.81	43.4	36.11
23822	2105880	838136	40.19	76.5	61.94
23831	2047234	822548	42.14	80.2	97.94
23832	2043312	821293	38.96	74.1	38.25
23833	2072183	882639	7.57	14.4	35.36
23834	2070581	883273	17.53	33.4	21.60
23835	2072474	883297	16.85	32.0	8.75
23836	2101490	895707	88.40	168.2	140.19
23837	2103752	893441	39.34	74.9	60.63
23840	2100433	845438	16.48	31.3	124.31
23841	2099100	846788	23.83	45.3	35.21
23842	2110587	885295	16.47	31.3	25.38
23844	2099985	824987	40.24	76.6	22.96
23845	2098073	823007	16.46	31.3	87.21

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
23851	2100165	892960	31.78	60.5	61.82
23853	2049342	881884	10.73	20.4	37.87
23855	2069914	885271	25.67	48.8	60.68
23859	2112626	845465	9.40	17.9	23.00
23860	2104780	856939	16.71	31.8	25.75
23862	2091290	830941	23.62	44.9	22.82
23864	2113755	884280	146.92	279.5	41.45
23865	2095011	882277	37.21	70.8	64.85
23866	2112458	879231	21.37	40.7	32.94
23871	2101227	863339	31.60	60.1	18.06
23872	2096204	890197	27.91	53.1	43.01
23874	2112656	858105	22.44	42.7	73.26
23878	2089467	822458	57.09	108.6	123.70
23879	2090690	824996	20.76	39.5	19.58
23885	2105120	872917	6.15	11.7	9.48
23886	2109178	878110	25.15	47.8	38.76
23888	2109023	894572	24.68	47.0	38.04
23889	2109052	894024	55.23	105.1	85.12
23890	2092447	876901	17.12	32.6	37.39
23891	2069269	877995	12.40	23.6	10.69
23895	2090360	878893	23.35	44.4	29.35
23899	2059842	822820	37.78	71.9	47.75
23901	2056410	825540	35.99	68.5	65.04
23902	2101412	821008	53.22	101.2	88.82
23903	2116614	860476	14.83	28.2	45.48
23909	2109044	890474	9.14	17.4	14.09
23910	2080385	888660	34.76	66.1	49.77
23912	2103459	859296	10.15	19.3	15.65
23914	2107335	828235	17.21	32.7	43.01
23917	2104684	840130	22.27	42.4	34.33
23918	2091788	823068	13.96	26.6	21.51
23927	2074166	828653	33.49	63.7	51.62
23928	2114553	891276	27.27	51.9	45.85
23930	2105802	889316	5.25	10.0	8.08
23933	2113985	851259	21.76	41.4	33.53
23937	2102613	889519	27.70	52.7	42.70
23942	2080372	893966	5.26	10.0	4.05
23945	2067915	884617	18.81	35.8	80.82
23946	2069916	861479	16.16	30.8	44.40
23947	2113764	883038	20.29	38.6	74.33
23948	2109813	886547	24.25	46.1	37.37
23952	2093959	838686	18.74	35.7	29.28
23953	2104073	861937	24.63	46.9	37.96

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
23958	2085996	831654	63.87	121.5	31.94
23962	2115084	884187	13.10	24.9	20.20
23963	2112460	876593	12.41	23.6	17.28
23964	2073768	882033	27.00	51.4	31.09
23965	2080367	882127	26.06	49.6	38.76
23966	2112459	875274	5.33	10.1	8.22
23967	2109852	882057	48.23	91.8	74.33
23969	2077021	880138	25.83	49.1	26.66
23970	2079659	880145	19.90	37.9	35.94
23972	2080375	892640	40.77	77.6	31.13
23973	2069268	890568	9.04	17.2	11.55
23974	2070578	892570	14.00	26.6	15.53
23975	2076425	890627	15.05	28.6	10.00
23976	2081706	884723	26.42	50.3	6.51
23977	2110405	890379	26.56	50.5	40.93
23980	2113771	876510	19.42	36.9	29.93
23981	2101480	891637	27.91	53.1	43.01
23982	2108007	826894	23.30	44.3	35.91
23984	2097610	884981	31.46	59.8	69.12
23985	2094898	888859	34.16	65.0	62.57
23986	2045945	821249	17.04	32.4	0.00
24001	2095471	820381	24.73	47.1	30.78
24005	2114378	887526	49.44	94.1	76.20
24006	2062385	825568	19.95	38.0	50.23
24007	2064356	826188	30.87	58.7	42.70
24009	2116015	851482	17.10	32.5	26.35
24012	2090360	878893	18.42	35.0	19.72
24016	2083718	885384	31.45	59.8	0.00
24018	2077083	882726	34.02	64.7	43.44
24019	2093512	827649	27.74	52.8	19.12
24024	2117688	873571	11.40	21.7	17.58
24025	2071923	826064	25.04	47.6	29.62
24026	2097394	860481	15.53	29.6	21.42
24027	2098605	864539	40.54	77.1	72.48
24028	2099944	859281	49.37	93.9	56.46
24029	2099855	861913	44.29	84.3	45.12
24030	2112442	883123	15.07	28.7	23.22
24033	2108043	880167	58.40	111.1	90.00
24034	2077648	887187	30.44	57.9	39.80
24035	2102546	837826	25.01	47.6	18.61
24036	2113771	875189	34.80	66.2	28.80
24045	2098184	893568	17.16	32.6	17.01
24049	2100156	890254	15.82	30.1	16.27

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
24051	2076841	825967	40.49	77.0	78.24
24052	2084353	880663	57.22	108.9	97.13
24055	2083959	831643	32.96	62.7	111.43
24058	2112638	846786	11.81	22.5	25.45
24062	2090864	819832	24.10	45.8	29.12
24063	2101546	885066	5.25	10.0	19.40
24068	2082764	826460	25.12	47.8	38.71
24070	2091251	858408	55.26	105.1	0.00
24071	2100474	838828	15.66	29.8	23.46
24072	2070624	875994	10.48	19.9	23.37
24073	2088525	864971	10.31	19.6	16.55
24078	2095069	844129	4.62	8.8	9.66
24081	2106049	869702	35.45	67.4	54.63
24091	2101120	880098	8.81	16.8	10.37
24098	2056727	858753	37.51	71.4	0.00
24100	2111167	871392	13.26	25.2	24.62
24104	2113968	846795	10.46	19.9	16.13
24105	2079637	877508	40.66	77.4	58.91
24107	2097827	869173	11.42	21.7	13.41
24113	2063933	884625	20.52	39.0	53.27
24115	2087986	853642	32.85	62.5	55.93
24116	2074466	885300	19.40	36.9	35.52
24119	2100463	840152	7.34	14.0	43.01
24120	2092922	875023	4.96	9.4	88.20
24124	2069918	882618	24.41	46.4	19.98
24125	2105776	890322	18.87	35.9	29.08
24130	2095129	875676	9.22	17.5	88.20
24133	2048776	871892	28.71	54.6	0.00
24136	2065304	862110	22.34	42.5	53.82
24139	2069925	864127	32.20	61.3	51.00
24140	2091960	857715	50.55	96.2	77.91
24143	2098212	832736	16.88	32.1	100.77
24146	2098441	843270	24.62	46.8	74.86
24147	2085355	856260	31.88	60.7	82.38
24148	2085296	853728	56.91	108.3	56.40
24151	2090668	827677	21.07	40.1	17.84
24152	2085543	821119	31.13	59.2	34.69
24156	2086460	867002	41.19	78.4	68.57
24159	2082705	827778	25.12	47.8	38.71
24163	2041651	838486	10.42	19.8	22.43
24165	2092939	885513	28.32	53.9	17.50
24166	2090330	885464	22.81	43.4	17.39
24168	2102032	822965	23.58	44.9	14.35

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
24171	2072627	822750	27.91	53.1	43.01
24172	2103036	885816	10.25	19.5	15.80
24176	2074456	887953	20.96	39.9	29.12
24177	2078992	821187	29.07	55.3	64.75
24178	2065272	874041	32.77	62.3	36.48
24179	2101940	830882	22.91	43.6	57.20
24183	2085655	878190	22.77	43.3	0.00
24190	2095863	848926	50.35	95.8	93.34
24191	2083745	872152	25.45	48.4	51.69
24192	2083758	869621	35.06	66.7	98.98
24193	2075590	822038	40.16	76.4	53.01
24194	2111595	851183	16.04	30.5	23.33
24197	2113311	903422	23.71	45.1	50.00
24200	2064626	864071	27.87	53.0	32.53
24201	2067278	864113	28.40	54.0	35.33
24204	2074025	839796	24.85	47.3	38.29
24206	2085038	874888	31.36	59.7	50.47
24207	2049824	825135	18.30	34.8	0.00
24208	2112503	869995	13.32	25.3	41.08
24211	2087747	874891	12.82	24.4	17.31
24212	2087030	876873	21.49	40.9	39.31
24214	2087837	866957	20.36	38.7	27.09
24217	2116565	864453	19.81	37.7	51.62
24218	2088482	840159	10.63	20.2	45.82
24219	2109343	846135	27.91	53.1	43.01
24221	2077330	841070	12.17	23.1	18.75
24222	2109312	848730	38.12	72.5	58.75
24223	2110512	853595	21.51	40.9	33.16
24225	2112351	889640	17.79	33.8	27.41
24227	2106505	886355	15.33	29.2	23.63
24233	2072502	868800	18.57	35.3	25.18
24234	2074839	866841	41.33	78.6	77.88
24241	2109924	844494	27.91	53.1	43.01
24242	2078042	854226	24.35	46.3	34.56
24245	2066941	830086	27.91	53.1	43.01
24247	2104565	879526	5.19	9.9	7.99
24251	2047193	825205	33.20	63.2	96.02
24252	2089023	886785	14.83	28.2	22.86
24255	2049205	821843	7.81	14.9	12.04
24256	2097731	878399	13.96	26.6	21.51
24257	2054647	877971	32.46	61.8	0.00
24258	2109369	822342	6.43	12.2	9.91
24259	2079062	889978	8.31	15.8	15.74

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
24260	2087788	880131	30.97	58.9	44.60
24261	2069943	872043	24.05	45.8	37.07
24262	2115332	852613	29.98	57.0	46.20
24263	2072267	887614	18.55	35.3	18.82
24264	2070636	874669	8.68	16.5	9.28
24266	2093598	887521	8.15	15.5	5.04
24268	2112565	866037	25.36	48.2	37.80
24270	2085037	874894	12.28	23.4	0.00
24275	2106791	822271	33.49	63.7	51.62
24289	2066597	878029	25.85	49.2	49.56
24290	2063935	876707	26.84	51.1	18.51
24291	2107737	890605	6.71	12.8	10.34
24293	2101501	887652	8.05	15.3	16.77
24295	2066602	874037	8.67	16.5	15.70
24296	2103060	871854	33.49	63.7	51.62
24298	2076992	874874	29.40	55.9	26.16
24299	2058656	866066	20.63	39.3	24.37
24306	2072459	891257	25.09	47.7	14.18
24307	2115026	889461	15.06	28.6	23.21
24311	2098922	885010	14.37	27.3	29.42
24313	2110596	830282	23.43	44.6	49.21
24315	2063924	882005	20.69	39.4	0.00
24316	2062598	882005	25.12	47.8	32.04
24319	2061264	879366	35.16	66.9	39.00
24321	2077651	878162	32.57	62.0	44.75
24322	2049795	826459	22.23	42.3	24.68
24323	2098830	899557	26.75	50.9	27.24
36322	2089058	809243	26.69	50.8	0.00
36324	2094414	797353	16.56	31.5	16.92
36326	2095097	795375	31.55	60.0	39.96
36327	2095053	799341	15.43	29.3	23.77
36328	2097710	798033	33.26	63.3	38.62
36329	2097695	800665	32.70	62.2	33.38
36330	2097733	795394	27.08	51.5	101.39
36342	2081327	770774	15.72	29.9	16.63
36350	2083940	786781	41.42	78.8	121.26
36355	2083995	770779	18.79	35.7	37.73
36358	2079991	781390	9.21	17.5	23.83
36359	2079325	782045	31.09	59.2	67.29
36360	2078661	784022	29.95	57.0	57.06
36361	2084636	782060	58.87	112.0	57.02
36371	2079296	771417	38.51	73.3	70.24
36380	2085225	798049	26.03	49.5	53.24

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
36405	2091043	813858	18.14	34.5	100.64
36407	2084471	817367	35.49	67.5	46.75
36409	2097653	816529	20.09	38.2	39.43
36410	2097669	813896	17.92	34.1	33.85
36411	2079314	787456	15.20	28.9	44.33
36412	2081970	784755	11.40	21.7	54.96
36413	2081954	787446	33.57	63.9	89.01
36420	2091088	805858	37.61	71.6	95.94
36421	2076597	798028	40.19	76.5	61.94
36422	2081217	797366	40.19	76.5	61.94
36423	2081229	796042	40.19	76.5	61.94
36426	2090368	817499	28.29	53.8	43.61
36430	2095648	814539	34.30	65.3	46.87
36432	2075781	787446	23.63	45.0	94.96
36433	2079324	790058	16.62	31.6	42.86
36434	2076655	790095	28.57	54.4	120.84
36436	2094957	817020	45.49	86.5	79.54
36437	2074650	803263	22.85	43.5	56.10
36438	2074650	803263	28.36	54.0	50.51
36439	2082660	778751	23.07	43.9	31.10
36440	2084647	779410	66.80	127.1	51.84
36444	2081961	774104	48.78	92.8	100.32
36445	2087276	782034	51.84	98.6	59.62
36446	2087296	776740	26.50	50.4	33.12
36447	2079821	803968	42.95	81.7	71.30
36448	2089748	811116	42.84	81.5	74.02
36452	2082568	793384	27.91	53.1	43.01
36454	2081325	778743	34.97	66.5	72.60
36456	2084650	776752	37.07	70.5	29.95
36460	2084551	792714	20.93	39.8	32.26
36471	2074710	784702	44.64	84.9	62.65
36472	2076674	782006	39.24	74.7	66.02
36479	2087067	808570	47.85	91.0	119.09
36480	2088404	817084	61.60	117.2	114.29
36481	2090417	808690	50.80	96.7	129.19
36482	2090427	798668	27.91	53.1	43.01
36483	2093059	799992	27.91	53.1	43.01
36485	2092571	783467	35.79	68.1	123.83
36486	2100321	808849	44.84	85.3	74.89
36489	2087911	785393	27.91	53.1	43.01
36494	2085118	801314	13.76	26.2	24.14
36502	2101666	803287	25.07	47.7	82.35
36506	2089909	784720	94.19	179.2	92.30

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
36507	2090161	787474	19.93	37.9	54.27
36510	2095095	805780	40.06	76.2	82.84
36511	2095109	803248	71.90	136.8	116.29
36512	2088466	805844	23.60	44.9	73.86
36513	2087724	810566	39.75	75.6	43.16
36514	2086363	813208	44.07	83.8	43.16
36515	2103628	810594	26.08	49.6	15.81
36516	2102306	810590	29.54	56.2	80.36
36518	2084573	790072	23.07	43.9	55.99
36524	2095681	809246	27.62	52.6	79.53
36525	2098348	803960	4.53	8.6	13.36
36526	2103024	816505	79.76	151.7	30.16
36527	2088747	792567	25.29	48.1	22.66
36528	2095780	793398	44.66	85.0	68.82
36536	2086560	789410	27.58	52.5	42.51
36540	2083961	784047	33.49	63.7	51.62
36542	2090489	793374	21.53	41.0	33.17
36543	2102294	813233	19.28	36.7	45.54
36544	2076613	776701	40.48	77.0	62.45
36548	2090384	805278	30.21	57.5	18.52
36561	2079745	810549	27.91	53.1	43.01
36562	2077144	810531	27.91	53.1	43.01
36578	2093156	792061	17.51	33.3	54.36
36588	2075269	808509	36.97	70.3	63.02
36589	2079208	807314	17.29	32.9	24.04
36590	2104380	815894	20.00	38.1	22.91
36591	2106508	815878	13.55	25.8	12.51
36598	2094368	801316	25.16	47.9	21.06
36602	2100273	815873	16.63	31.6	12.96
36642	2081034	814523	11.63	22.1	32.58
36664	2076613	779221	30.18	57.4	24.40
36665	2089728	803296	35.44	67.4	64.25
36666	2086406	805277	23.38	44.5	44.80
36667	2082517	798680	27.91	53.1	43.01
36669	2087825	794695	27.91	53.1	43.01
36670	2081801	803303	25.49	48.5	48.85
36671	2082500	800000	13.74	26.1	60.41
36672	2093875	783334	32.80	62.4	27.53
36675	2095055	812564	25.18	47.9	36.28
36678	2083720	807918	32.63	62.1	24.18
36679	2093107	796026	33.49	63.7	51.62
36682	2092421	798008	35.82	68.1	43.16
36687	2084408	805938	5.89	11.2	9.66

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
36705	2076661	771452	17.36	33.0	50.37
36708	2079778	806585	27.91	53.1	43.01
36710	2097019	803959	39.12	74.4	70.82
36711	2099679	802644	13.58	25.8	17.08
36716	2104384	817449	7.22	13.7	8.64
36720	2074712	771363	39.79	75.7	84.78
36725	2089925	782025	30.76	58.5	39.74
36732	2100384	799386	40.43	76.9	62.30
36740	2082371	790323	23.10	44.0	23.85
36750	2082655	781408	27.91	53.1	43.01
36755	2078657	780057	24.76	47.1	62.47
36759	2076783	787427	25.46	48.4	27.70
36761	2092111	805256	20.60	39.2	55.89
36762	2104366	808622	21.16	40.3	10.84
36767	2092546	818525	19.59	37.3	31.55
38603	2036820	881623	7.70	14.6	8.24
38624	2039274	839182	25.31	48.2	52.30
38632	2039986	831905	15.25	29.0	13.78
38634	2032883	873673	4.48	8.5	102.79
58405	2094729	895810	207.35	394.5	210.35
58406	2083031	896632	127.44	242.5	157.46
58407	2083564	895979	172.54	328.3	102.55
58411	2117709	887977	11.08	21.1	0.00
58412	2066666	889893	108.34	206.1	0.21
58419	2054126	884342	72.97	138.8	42.82
58420	2054529	884904	53.89	102.5	12.98
58421	2053980	884716	61.81	117.6	46.07
58422	2053979	884969	79.96	152.1	66.29
58423	2079050	893956	19.00	36.2	21.39
58425	2054785	884830	115.02	218.8	41.22
58426	2055068	884842	66.11	125.8	20.96
58427	2054886	885013	101.77	193.6	89.41
58431	2054501	885224	90.44	172.1	32.00
58432	2054528	885548	47.94	91.2	48.88
67258	2067289	887278	13.06	24.9	85.53
67259	2070605	876657	19.52	37.1	44.12
67324	2060531	787960	12.02	22.9	12.98
67369	2091325	854369	74.35	141.5	88.24
67572	2059449	864997	24.53	46.7	26.93
67574	2068779	810200	13.73	26.1	10.83
67599	2084635	774130	54.43	103.6	83.52
67656	2098499	809820	12.06	22.9	39.67
67666	2061937	877416	22.28	42.4	46.99

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
67673	2103089	881135	48.66	92.6	75.00
67738	2066303	829456	27.91	53.1	43.01
67932	2078841	850960	23.74	45.2	36.59
68014	2057338	819300	16.87	32.1	32.49
68120	2077109	885313	21.02	40.0	58.00
68215	2068570	873805	26.89	51.2	49.26
68224	2073382	867542	43.76	83.3	82.26
68269	2090805	856392	8.30	15.8	4.64
68313	2064670	866692	31.15	59.3	42.78
68331	2047358	875778	13.27	25.2	0.84
68332	2050202	877229	16.29	31.0	64.52
68333	2078458	887975	44.04	83.8	54.23
68401	2072764	833902	6.90	13.1	5.78
68489	2049965	881893	5.93	11.3	0.00
68641	2020761	860146	21.02	40.0	32.40
68729	2062317	805716	4.29	8.2	26.55
68754	2108690	832599	54.53	103.7	84.03
68772	2062233	808348	25.36	48.3	44.89
68777	2068039	876531	24.28	46.2	42.84
68848	2052696	864113	39.11	74.4	56.76
68855	2059174	889242	26.43	50.3	36.06
68856	2061981	887862	19.45	37.0	15.68
68937	2048710	881080	9.63	18.3	3.70
68940	2067249	882645	25.20	47.9	63.76
69008	2109230	840768	39.52	75.2	60.91
69043	2078705	777032	19.09	36.3	26.54
69044	2087811	872276	13.48	25.6	39.89
69046	2066140	814138	16.19	30.8	33.77
69192	2091609	840508	47.77	90.9	51.82
69252	2093156	839188	19.10	36.3	6.75
69282	2111669	896925	4.32	8.2	5.51
69484	2091451	824441	6.50	12.4	11.19
69500	2085220	840765	12.60	24.0	65.17
69548	2112687	862045	14.34	27.3	21.57
69683	2087299	779305	16.20	30.8	80.64
69725	2093020	862987	8.48	16.1	15.70
69730	2092952	863133	19.94	37.9	7.52
69789	2046019	821146	42.12	80.1	73.55
69793	2064164	785260	12.56	23.9	29.07
70035	2087158	797998	27.40	52.1	58.87
70100	2023374	807280	16.51	31.4	25.45
70188	2063260	886549	5.19	9.9	7.13
70243	2053542	865313	11.76	22.4	18.12

Table E-1

Irrigation Pumping Volumes and Rates

Well ID	X-Coordinate	Y-Coordinate	Average Pumping 2007-2011		2012 Pumping 10^6 gallons
			Annual Pumping 10^6 gallons	Average Rate (gpm)	
70439	2039926	837167	10.82	20.6	36.85
70443	2096399	879686	28.90	55.0	0.00
70500	2052838	883405	52.48	99.8	80.88
70502	2055082	881408	54.30	103.3	83.68
70822	2068033	811733	13.45	25.6	41.26
70929	2054034	874649	14.98	28.5	50.96
70997	2103518	818374	9.80	18.6	27.40
71063	2116991	888617	15.11	28.8	80.94
71064	2083951	833061	4.53	8.6	17.21
71065	2079996	838307	8.36	15.9	29.34
71167	2062058	861404	25.63	48.8	54.75
71269	2048780	871919	7.04	13.4	0.00
71371	2036069	779067	55.28	105.2	85.20
71372	2045043	779199	61.45	116.9	94.70
71373	2038746	773831	28.50	54.2	43.93
71374	2041298	775055	61.39	116.8	94.62
71442	2048854	861291	20.01	38.1	30.84
71638	2069361	780519	20.23	38.5	31.18
71653	2050785	825478	12.08	23.0	18.61
71656	2077301	891605	70.04	133.3	107.95
71718	2097005	811901	35.53	67.6	42.77
71727	2050005	884611	7.37	14.0	11.36
71734	2095841	869749	29.94	57.0	46.14
71830	2074237	841114	23.20	44.1	35.75
71831	2076125	850817	6.48	12.3	9.98
71870	2085023	877527	17.97	34.2	27.70
71929	2105312	873726	12.72	24.2	19.61
71936	2054044	877304	26.57	50.6	40.95
71946	1989045	744583	9.99	19.0	15.40
71947	1990772	745071	11.05	21.0	17.04
71991	2022917	769801	62.57	119.0	96.43
71992	2025517	769795	25.82	49.1	39.80
72022	2076382	890590	6.49	12.3	10.00
72082	2100276	883691	13.96	26.6	21.51
72167	2060674	858767	35.92	68.3	55.35
72168	2056603	858520	26.60	50.6	40.99
72230	2080787	824566	11.16	21.2	17.21
88501	2101672	806364	8.28	15.7	12.76
88502	2100277	806498	8.60	16.4	13.25
88869	2019136	859288	144.66	275.2	222.95
88870	2022444	860961	106.86	203.3	164.69
88871	2025949	862806	129.33	246.1	199.32

Attachment F

Water Balances for Model Simluations

Attachment F
Water Balances for Model Simulations

A monthly soil water balance was calculated based on the model calibrated monthly recharge rates, soil properties, vegetation characteristics and potential evapotranspiration rates derived from climatic data. These factors are briefly discussed below.

The soils at the Golden Sands Project are primarily Plainfield Sands. The available water capacity of these soils is approximately 0.07 inches per inch (amount of water held in soil between field capacity and wilting point). This is equivalent to 4.2 inches of available water in the upper 5 feet of the soil profile.

The dominant vegetation in much of the western portion of the model domain is red pine (*pinus resinosa)*. In sandy soils, mature red pine roots can penetrate to depths of greater than 10 feet (Canadell and others, 1996; WDNR, 2003). At a nominal depth of 10 feet, if soil profile was at field capacity, there would be 8.4 inches of available water to mature pines.

Average evapotranspiration rates for the GSD Project area were calculated using standard procedures. A concept called "reference evapotranspiration" or "potential evapotranspiration" is the starting point for estimating irrigated crop evapotranspiration. The "reference evapotranspiration" is the evapotranspiration that occurs from a well-watered reference surface; the reference surface closely resembles an extensive area of green grass of uniform height, actively growing, that completely shades the adequately watered ground. A number of standard methods have been developed to estimate reference evapotranspiration from climatic data. The University of Wisconsin-Extension provides real-time daily values[1] (and historical data) of reference evapotranspiration throughout Wisconsin based on the Priestley Taylor (1972) method and climatic data from atmospheric observations and satellite-derived estimates. This source was used to calculate average monthly potential evaporation rates based on the period 2000 through 2011. The actual evaporation from a specific vegetation type is related to potential evaporation by a coefficient and available water.

From a water budget perspective, the monthly recharge rate is equal to precipitation minus actual evapotranspiration minus change in water stored in soil profile. In equation format the water balance equation is:

$$R = P - ET - \Delta S \qquad (1)$$

where: R = monthly recharge rate, P = monthly precipitation, ET = monthly evapotranspiration, and ΔS = change in soil water during month (all with units of inches).

For the western portion of the model domain, the monthly water budget for a normal year is detailed on Table F-1 and the monthly water budget for a dry year is detailed on Table

[1] http://www.soils.wisc.edu/uwex_agwx/sun_water/et_wimn

F-2. The monthly water balance for the eastern portion of the model domain for a normal year is detailed on Table F-3 and for a dry year is detailed on Table F-4.

Recharge rates under irrigated agriculture, as proposed for the Golden Sands Project, were calculated using a water balance approach similar to that described above with the addition of an irrigation water term. The water balance equation is:

$$R = P - ET - \Delta S + I \qquad (1)$$

where: I is the amount of irrigation water applied in a month (expressed in units of inches).

The expected irrigation rates for the Golden Sands Dairy project are based on data for the Central Sands Dairy in Juneau County just west of the proposed Golden Sands Dairy. In addition, the rates are based on expected crop rotation of: 25% potatoes, 25% alfalfa, 17% field corn, 17% sweet corn and 17% double crop of snap beans and peas.

In the normal year, two irrigation scenarios were simulated: one in which 14-inches of irrigation water are applied to the fields during the irrigation season (this is the expected irrigation rate in a normal year) and a second in which 11.5 inches of irrigation water are applied to the fields during the irrigation season.[2] In the dry year, in the modeling analyses it was specified that 21.2 inches of water were applied during the irrigation season. The dry year irrigation rate is based on actual irrigation rates in 2012 on fields farmed by the Wysocki's east of the Golden Sands Dairy Project and fields at the Central Sands Dairy and it corresponds to the consumption by the crops of 70 percent of the applied water.

The evapotranspiration that occurs from an irrigated crop is estimated by multiplying the reference evapotranspiration (ETo) by a crop coefficient (Kc). The crop evapotranspiration differs from the reference evapotranspiration as the ground cover, canopy properties and aerodynamic resistance of the crops are different from grass. The crop coefficient incorporates the characteristics that distinguish field crops from grass and provides an estimate of evapotranspiration for crops grown in large fields under excellent agronomic and soil water conditions (refer to FAO 1998, Chapter 6 for a good discussion of crop coefficients). Typical crop coefficients for vegetable crops grown in Wisconsin are listed in Northcott (2010). As described in a publication for estimating irrigation scheduling in Wisconsin, the main factor affecting the crop coefficient is the canopy cover (Curwen and Massie, 1994), which gradually increases from time of planting until full cover is reached in early summer.

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[2] The second scenario was simulated in response to comments from DNR suggesting that 14 inches of irrigation water in a normal year was inconsistent with common practices in the Central Sands region. The irrigation rate of 11.5 inches per year is based on 80 percent of the water applied to fields during irrigation season (irrigation water plus precipitation) being consumptively used. The first scenario with 14 inches of irrigation water applied corresponds to approximately 70 percent of applied water being consumptively used.

The calculated monthly water balance used in the model simulations for irrigation in a normal year with 14 inches of applied irrigation water are detailed on Table F-5, the water balance for a normal year with 11.5 inches of applied irrigation water are detailed on Table F-6, and the water balance for a dry year with 21 inches of applied irrigation water are detailed on Table F-7.

Important to note that total annual recharge rates are significantly greater than under non-irrigated conditions as the result of a seasonal shift of when recharge occurs under irrigated conditions and infiltration of some of the applied irrigation water. Though total recharge is larger, the net recharge is smaller. In the normal year simulations with 14 inches of irrigation water, the net recharge rate is 6.5 inches, which is smaller than existing irrigation rate by 2.2 inches; in a normal year with 11.5 inches of irrigation water the net recharge is also 6.5 inches. In a dry year, the net recharge rate, as simulated, is only 2.5 inches.

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Table F-1
Water Balance for Western Portion of Model Domain -- Normal Year

	Water Balance Terms Western Model Area (inches per month) -- Normal Year						
	Precipitation	Potential ET	Coefficient	ET	∆S	AW	Recharge
Jan	1.2	0.3	50.0	0.1	1.0	8.7	0.00
Feb	1.6	0.5	50.0	0.2	1.0	9.7	0.30
Mar	3.3	1.5	50.0	0.7	-0.1	9.6	2.70
Apr	4.0	2.8	60.0	1.7	-0.1	9.5	2.40
May	4.4	4.3	75.0	3.3	-0.9	8.6	2.00
June	3.0	5.5	80.0	4.4	-2.7	5.9	1.30
July	3.4	6.4	71.0	4.5	-1.1	4.8	0.00
Aug	3.3	5.4	70.0	3.8	-0.5	4.4	0.00
Sept	2.0	3.2	65.0	2.1	-0.1	4.3	0.00
Oct	1.8	1.4	55.0	0.8	1.0	5.3	0.00
Nov	1.5	0.4	50.0	0.2	1.3	6.7	0.00
Dec	0.9	0.1	50.0	0.0	0.9	7.6	0.00
totals	30.5	31.7		21.8	0.0		8.7

Table F-2
Water Balance for Western Portion of Model Domain -- Dry Year

	Water Balance Terms Western Model Area (inches per month) -- Dry Year						
	Precipitation	Potential ET	Coefficient	ET	ΔS	AW	Recharge
Jan	1.0	0.2	50.0	0.1	0.9	8.8	0.00
Feb	1.0	0.5	50.0	0.3	0.4	9.3	0.25
Mar	2.4	0.5	50.0	0.2	0.3	9.5	1.95
Apr	3.0	3.1	60.0	1.9	-0.9	8.7	2.00
May	5.7	5.2	75.0	3.9	0.9	9.6	0.81
June	2.1	6.6	80.0	5.3	-3.2	6.4	0.00
July	0.8	7.0	71.0	5.0	-4.2	2.1	0.00
Aug	3.5	5.4	70.0	3.8	-0.2	1.9	0.00
Sept	1.6	3.4	65.0	2.2	-0.6	1.3	0.00
Oct	5.0	1.3	55.0	0.7	4.2	5.5	0.00
Nov	1.4	0.4	50.0	0.2	1.2	6.7	0.00
Dec	1.3	0.1	50.0	0.0	1.3	8.0	0.00
totals	28.7	33.8		23.7	0.0		5.0

Table F-3
Water Budget for Eastern Portion of the Model Domain -- Normal Year

	Water Balance Terms Eastern Model Area (inches per month) -- Normal Year						
	Precipitation	Potential ET	Coefficient	ET	ΔS	AW	Recharge
Jan	1.2	0.3	30.0	0.1	1.1	8.7	0.00
Feb	1.6	0.5	30.0	0.1	1.1	9.8	0.30
Mar	3.3	1.5	40.0	0.6	-0.1	9.7	2.90
Apr	4.0	2.8	50.0	1.4	-0.1	9.6	2.60
May	4.4	4.3	75.0	3.3	-1.0	8.7	2.10
June	3.0	5.5	75.0	4.1	-2.5	6.2	1.40
July	3.4	6.4	75.0	4.8	-1.3	4.8	0.00
Aug	3.3	5.4	70.0	3.8	-0.5	4.4	0.00
Sept	2.0	3.2	50.0	1.6	0.4	4.8	0.00
Oct	1.8	1.4	30.0	0.4	0.8	5.6	0.60
Nov	1.5	0.4	30.0	0.1	1.1	6.7	0.30
Dec	0.9	0.1	30.0	0.0	0.9	7.6	0.00
totals	30.5	31.7		20.3	0.0		10.2

Table F-4
Water Balance for Eastern Portion of the Model Domain -- Dry Year

	Water Balance Terms Eastern Model Area (inches per month) -- Dry Year						
	Precipitation	Potential ET	Coefficient	ET	ΔS	AW	Recharge
Jan	1.0	0.2	30.0	0.1	0.9	8.9	0.00
Feb	1.0	0.5	30.0	0.2	0.5	9.4	0.30
Mar	2.4	0.5	40.0	0.2	0.0	9.3	2.30
Apr	3.0	3.1	50.0	1.6	-0.3	9.0	1.80
May	5.7	5.2	75.0	3.9	-0.3	8.7	2.00
June	2.1	6.6	75.0	4.9	-3.0	5.7	0.12
July	0.8	7.0	75.0	5.3	-4.5	1.2	0.00
Aug	3.5	5.4	70.0	3.8	-0.2	1.0	0.00
Sept	1.6	3.4	50.0	1.7	-0.1	0.9	0.00
Oct	5.0	1.3	30.0	0.4	4.6	5.5	0.00
Nov	1.4	0.4	30.0	0.1	1.2	6.7	0.00
Dec	1.3	0.1	30.0	0.0	1.3	8.0	0.00
totals	28.7	33.8		22.2	0.0		6.5

Table F-5
Water Balance for Irrigated Fields
Normal Year with 14 inches of Irrigation Water

	Water Balance Terms GSD Agricultural Crop Fields (inches per month) --Normal Year							
	Precipitation	Irrigation Water	Potential ET	Coefficient	ET	ΔS	AW	Recharge
Jan	1.2	0.0	0.3	30.0	0.1	1.1	8.7	0.00
Feb	1.6	0.0	0.5	30.0	0.1	0.8	9.5	0.60
Mar	3.3	0.0	1.5	30.0	0.4	-1.2	8.3	4.10
Apr	4.0	0.4	2.8	45.0	1.3	-1.0	7.3	4.10
May	4.4	1.1	4.3	65.0	2.8	-0.6	6.7	3.30
June	3.0	2.7	5.5	95.0	5.2	0.0	6.7	0.49
July	3.4	4.5	6.4	95.0	6.0	0.0	6.7	1.89
Aug	3.3	3.1	5.4	95.0	5.2	0.0	6.7	1.28
Sept	2.0	2.2	3.2	70.0	2.2	0.0	6.7	2.00
Oct	1.8	0.0	1.4	30.0	0.4	0.0	6.7	1.36
Nov	1.5	0.0	0.4	30.0	0.1	0.0	6.7	1.42
Dec	0.9	0.0	0.1	30.0	0.0	0.9	7.6	0.00
totals	30.5	14.0	31.7		24.0	0.0		20.5

Table F-6
Water Balance for Irrigated Fields
Normal Year with 11.4 inches of Irrigation Water

	Water Balance Terms GSD Agricultural Crop Fields (inches per month) --Normal Year							
	Precipitation	Irrigation Water	Potential ET	Coefficient	ET	ΔS	AW	Recharge
Jan	1.2	0.0	0.3	30.0	0.1	1.1	8.7	0.0
Feb	1.6	0.0	0.5	30.0	0.1	0.8	9.5	0.6
Mar	3.3	0.0	1.5	30.0	0.4	-1.2	8.3	4.1
Apr	4.0	0.0	2.8	45.0	1.3	-1.0	7.3	3.7
May	4.4	0.0	4.3	65.0	2.8	-0.6	6.7	2.2
June	3.0	3.5	5.5	95.0	5.2	0.0	6.7	1.3
July	3.4	4.1	6.4	95.0	6.0	0.0	6.7	1.5
Aug	3.3	3.1	5.4	95.0	5.2	0.0	6.7	1.3
Sept	2.0	0.8	3.2	70.0	2.2	0.0	6.7	0.6
Oct	1.8	0.0	1.4	30.0	0.4	0.0	6.7	1.4
Nov	1.5	0.0	0.4	30.0	0.1	0.0	6.7	1.4
Dec	0.9	0.0	0.1	30.0	0.0	0.9	7.6	0.0
totals	30.5	11.5	31.7		24.0	0.0		18.0

Table F-7
Water Balance for Irrigated Fields -- Dry Year

	Water Balance Terms GSD Agricultural Crop Fields (inches per month) -- Dry Year							
	Precipitation	Irrigation Water	Potential ET	Coefficient	ET	ΔS	AW	Recharge
Jan	1.0	0.0	0.2	30.0	0.1	0.9	8.9	0.00
Feb	1.0	0.0	0.5	30.0	0.2	0.8	9.7	0.00
Mar	2.4	0.0	0.5	30.0	0.1	-0.7	9.0	3.00
Apr	3.0	0.0	3.1	45.0	1.4	-1.5	7.5	3.10
May	5.7	0.0	5.2	65.0	3.4	-0.8	6.7	3.00
June	2.1	6.9	6.6	95.0	6.3	0.0	6.7	2.69
July	0.8	8.8	7.0	95.0	6.7	0.0	6.7	2.87
Aug	3.5	3.8	5.4	95.0	5.1	0.0	6.7	2.19
Sept	1.6	1.8	3.4	70.0	2.4	0.0	6.7	1.03
Oct	5.0	0.0	1.3	30.0	0.4	0.0	6.7	4.57
Nov	1.4	0.0	0.4	30.0	0.1	0.0	6.7	1.24
Dec	1.3	0.0	0.1	30.0	0.0	1.3	8.0	0.00
totals	28.7	21.2	33.8		26.2	0.0		23.7

Attachment G

Consumptive Use

Attachment G
Consumptive Use

Wisconsin Statutes at 281.35(1)(c) defines consumptive use as *"…use of the waters of the state, other than an interbasin diversion, that results in a failure to return any or all of the water to the basin from which it is withdrawn."* Thus, for a groundwater withdrawal, consumptive use can be described as the amount of change in the water balance in a basin that results from the withdrawal of groundwater. The consumptive use coefficient was succinctly defined by Weeks and Strangland (1971, p 36) as *"This value* [consumptive use coefficient] *is obtained by dividing the estimated increase in evapotranspiration resulting from irrigation during the growing season by the reported irrigation pumpage for that year"*.

The operative words in the definition of consumptive use coefficient, as defined by Weeks and Strangland, are "increase in evapotranspiration". This definition recognizes that land cover in existence prior to conversion to irrigated agriculture results in a certain amount of evapotranspiration. Therefore, the consumptive use from Golden Sands Dairy's irrigation on land converted from pine plantation, or water loss, is not only a function of the evapotranspiration that occurs as a result of irrigation but also the evapotranspiration that occurs from red-pine plantations. The consumptive use, or water loss, from the proposed groundwater withdrawals is equal to the increase in evapotranspiration that occurs as the result of change in vegetation from red-pine plantation to irrigated crops. This increase in evapotranspiration is equivalent to the reduction in groundwater recharge that occurs within the basins in which the project is located, and the reductions in strreamflows that will occur as the result of a decrease in groundwater discharge (that is equivalent to groundwater recharge). The consumptive use coefficient is the coefficient that is multiplied by the total groundwater withdrawal to obtain the total consumptive use, or water loss.

In practice, the components of the water balance, such as evapotranspiration, recharge and irrigation pumping, are commonly expressed in units of inches per year. On an annual basis, the average evapotranspiration from the red-pine plantation in the vicinity of the Golden Sands Dairy project is about 21.8 inches per year, the average evapotranspiration from irrigated crops to be grown on the lands of the Golden Sands Dairy project is about 24 inches per year, and the average water to be applied to irrigated crops on the lands of the Golden Sands Dairy project is about 14 inches per year as described above. Therefore, the consumptive use coefficient for purposes of calculating average annual water loss is:

$$\frac{\Delta ET}{Q} = \frac{23.8 - 21.8}{14} = 14.2\%$$

where ΔET is the change in evapotranspiration and Q is the irrigation pumping rate, both in units of inches per year. The value of 14.2% is rounded to 15% for purposes of this variance request. The consumptive use over shorter periods than annual, such as the irrigation season, will be greater than 15 percent.

Attachment H

Drawdown Maps for Each High Capacity Well System

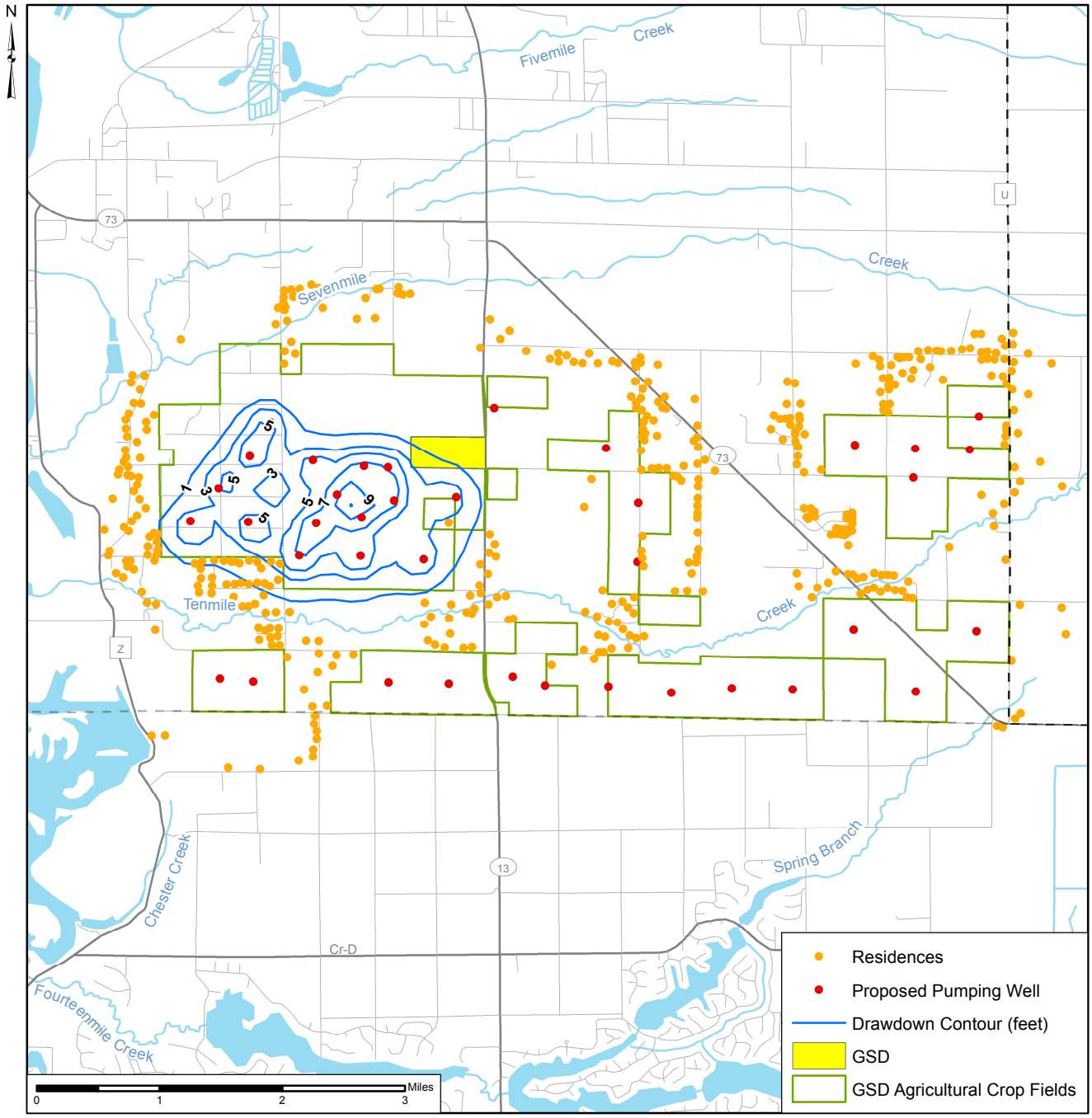

Figure H-1 Calculated Drawdowns in July in Dry Year - High Capacity Well System No. 1

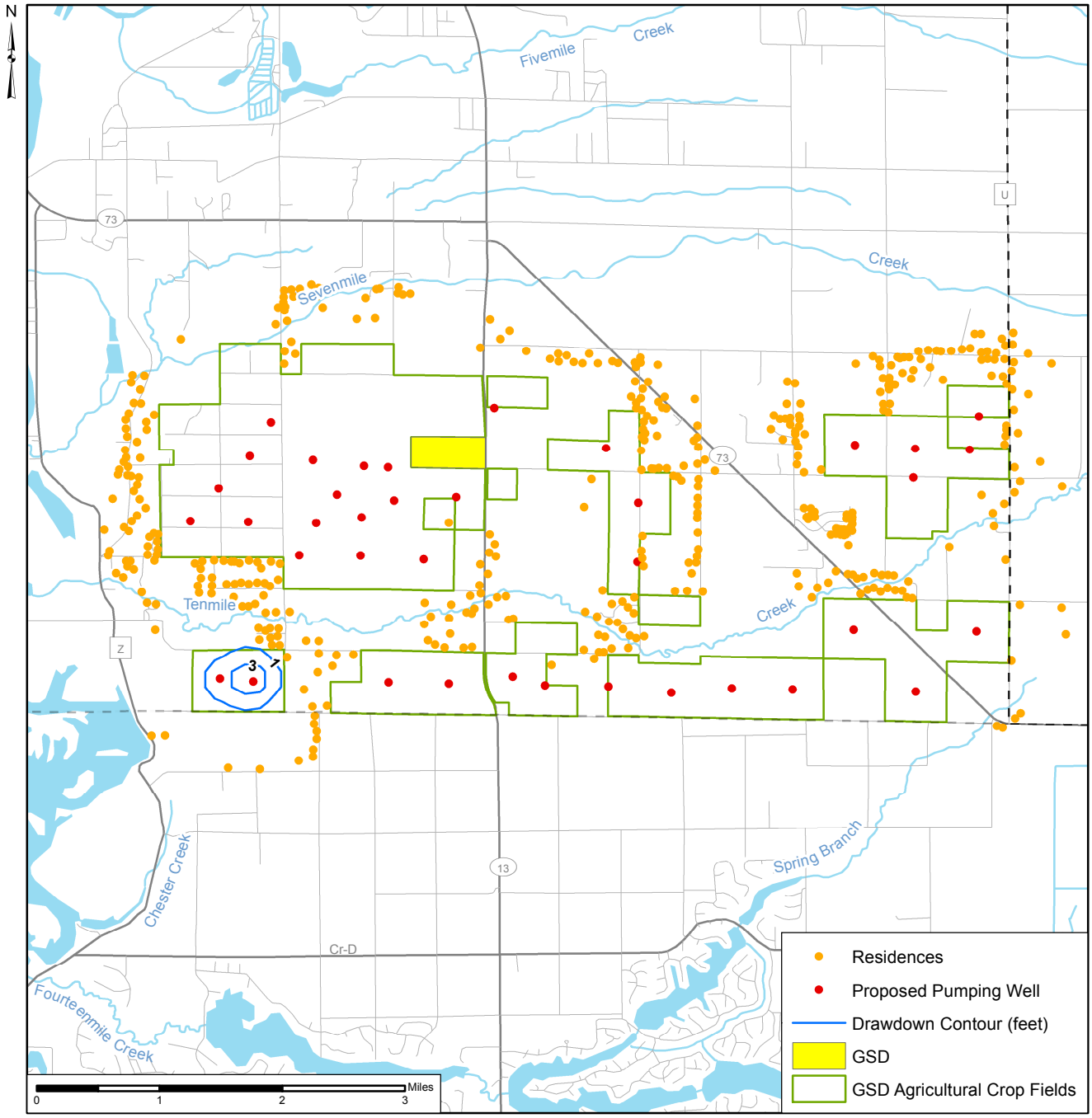

Figure H-2 Calculated Drawdowns in July in Dry Year - High Capacity Well System No. 2

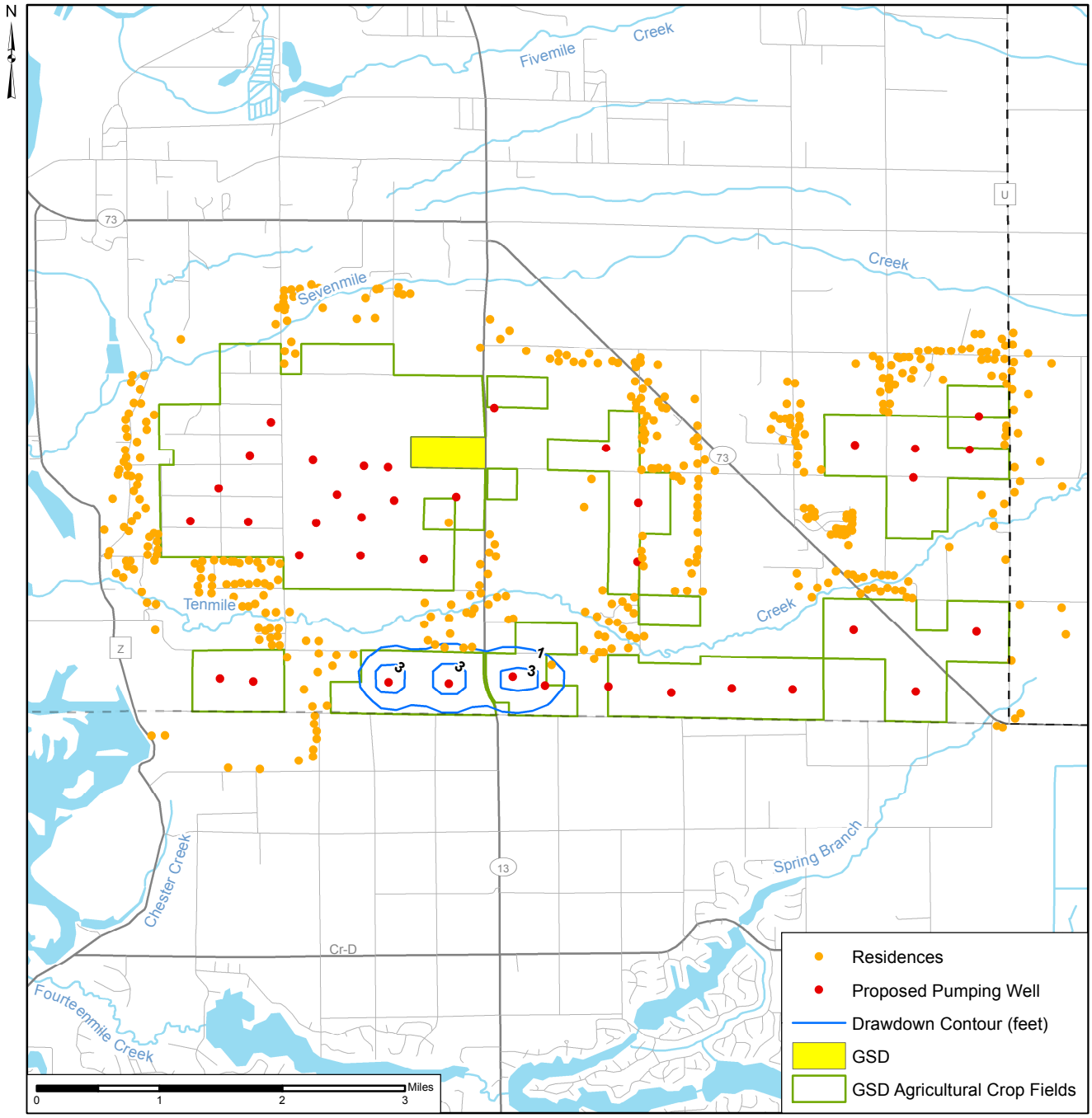

Figure H-3 Calculated Drawdowns in July in Dry Year - High Capacity Well System No. 3

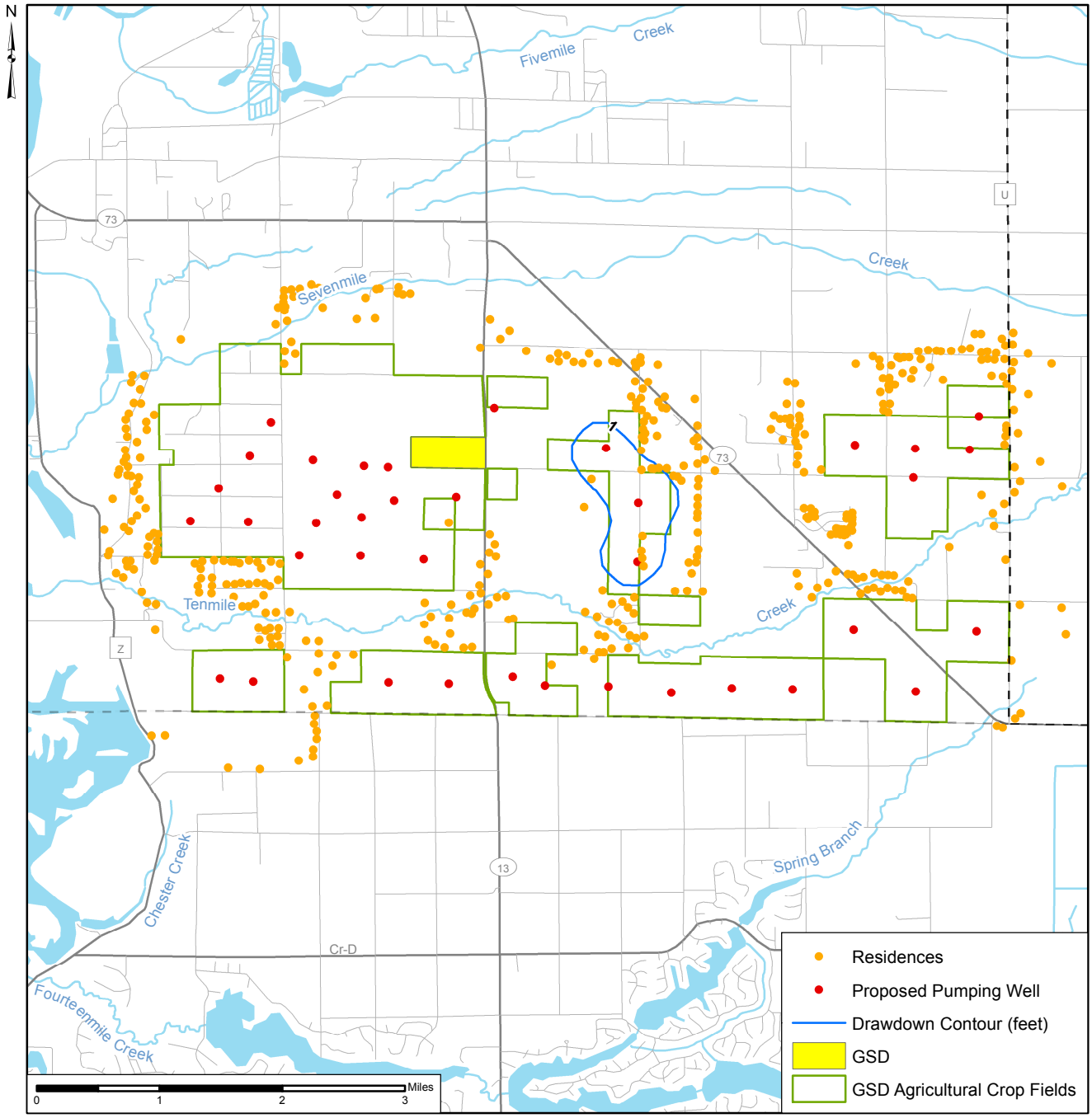

Figure H-4 Calculated Drawdowns in July in Dry Year - High Capacity Well System No. 4

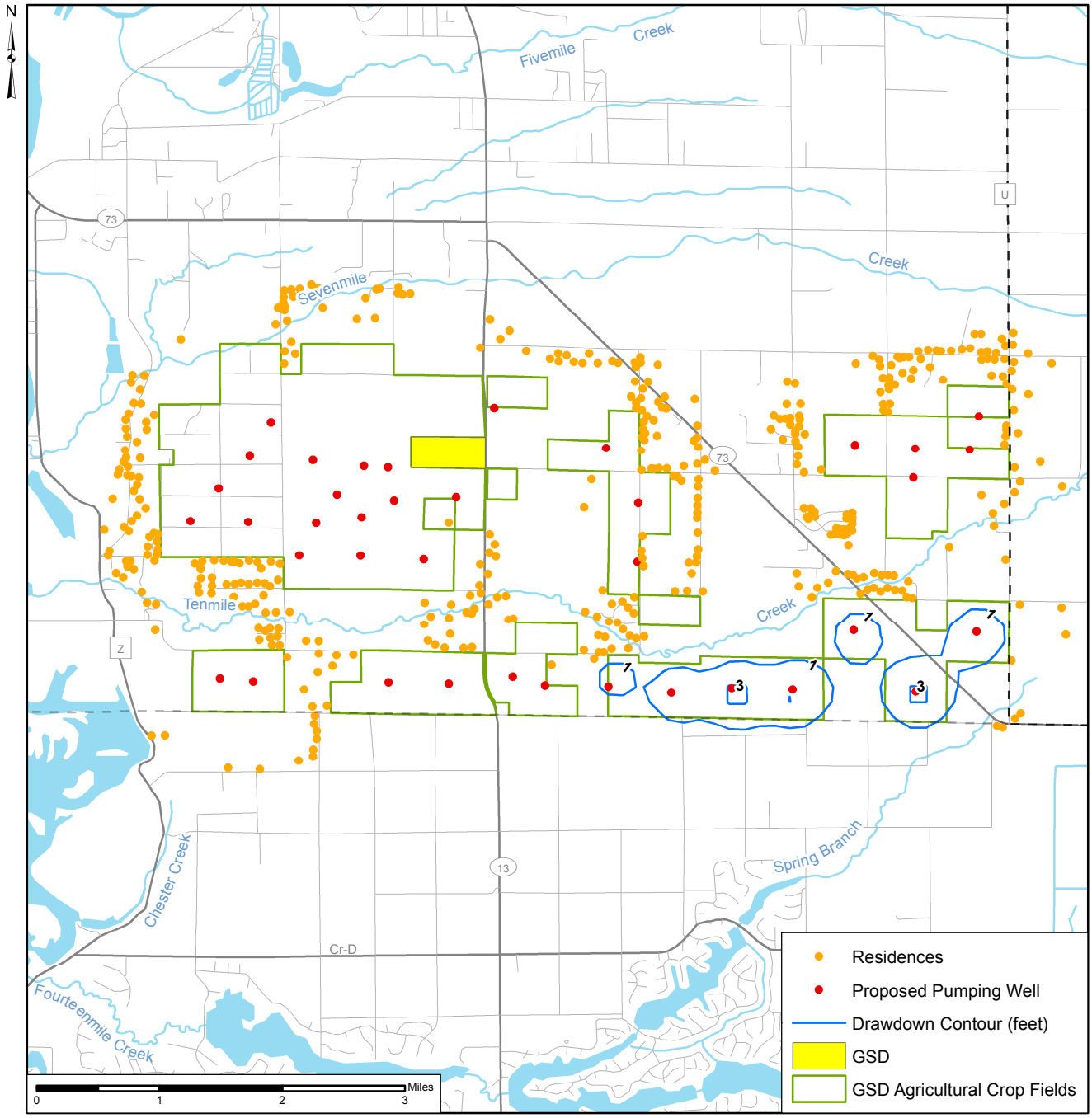

Figure H-5 Calculated Drawdowns in July in Dry Year - High Capacity Well System No. 5

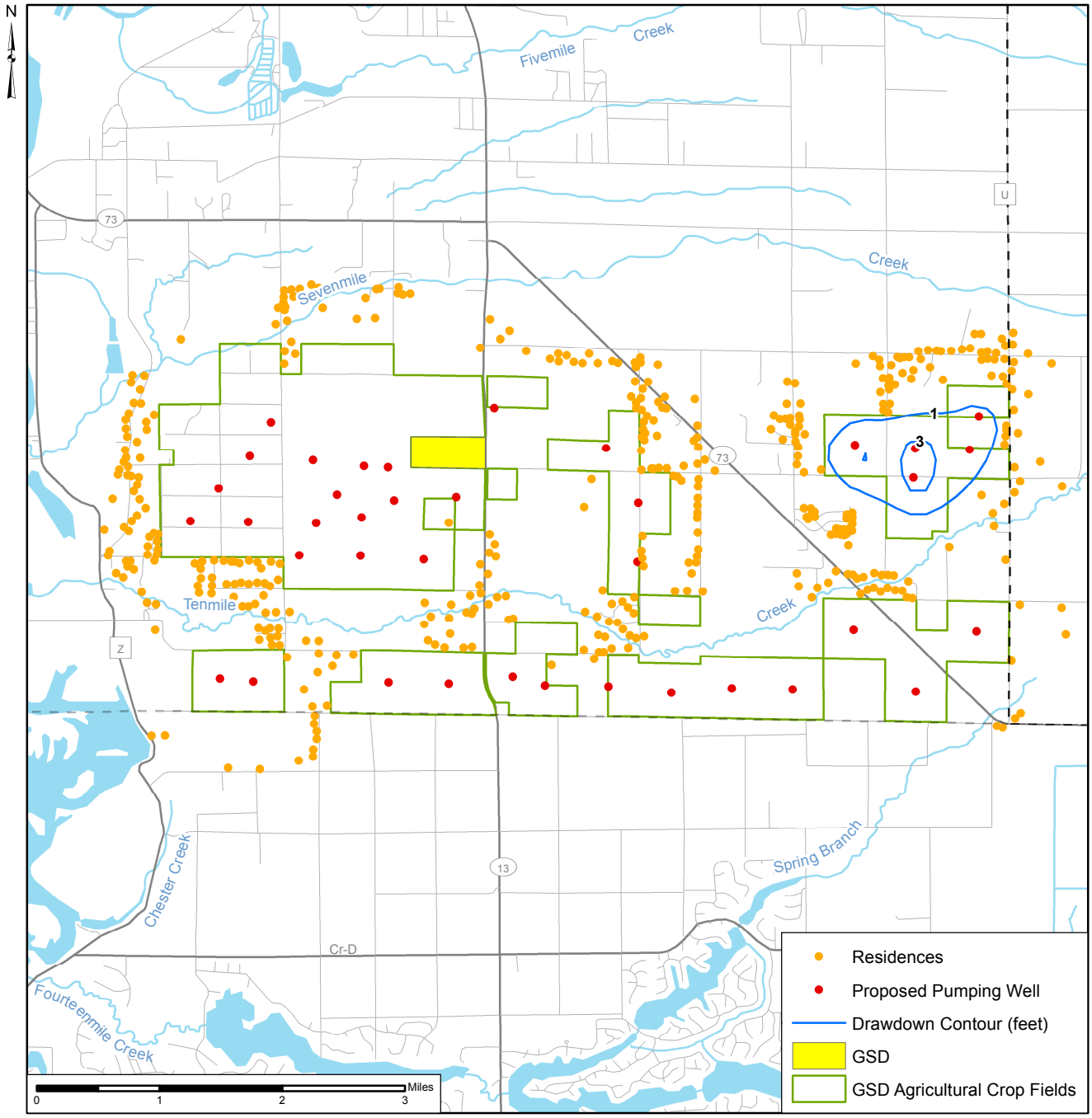

Figure H-6 Calculated Drawdowns in July in Dry Year - High Capacity Well System No. 6