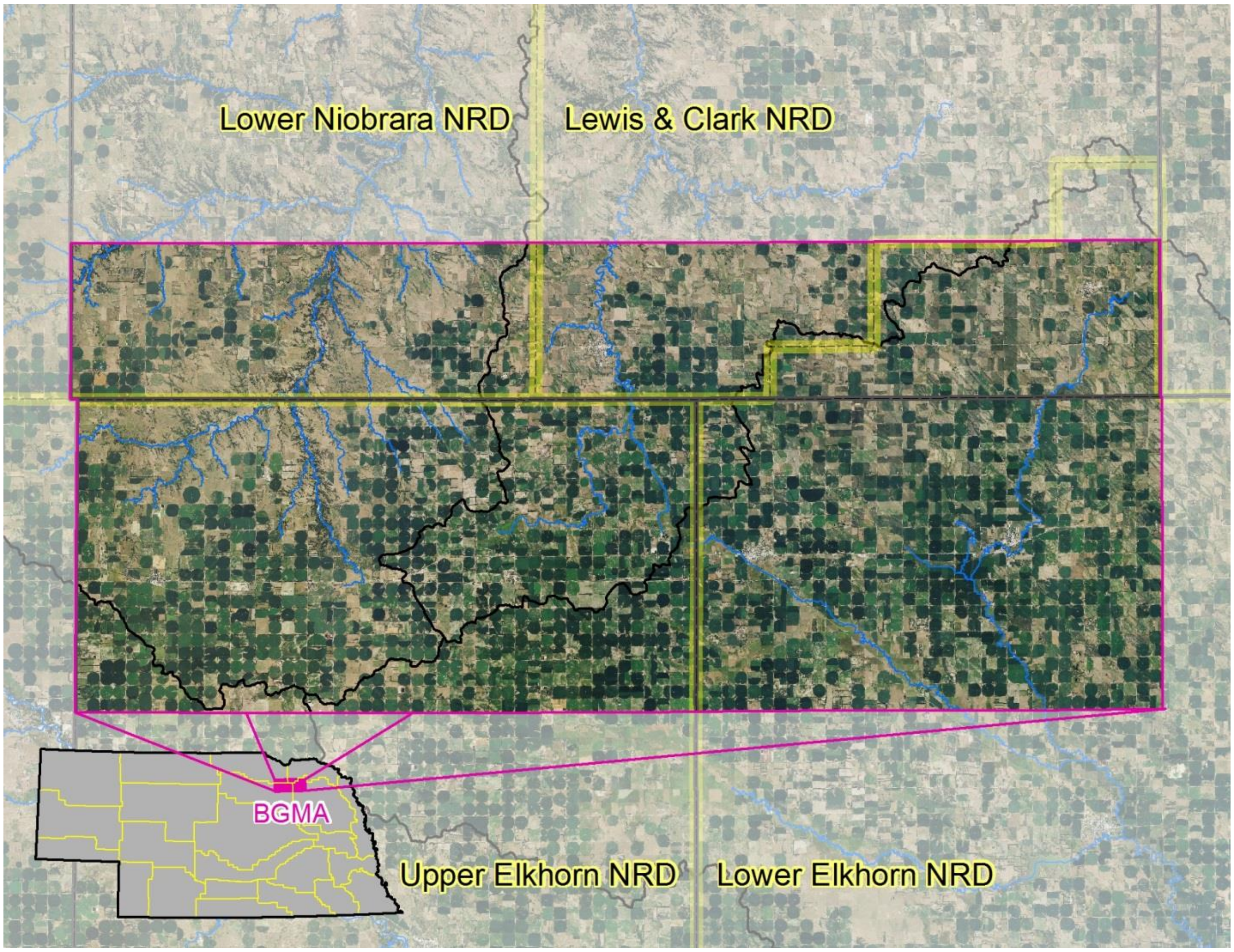
Bazile Groundwater Management Area Plan



Developed jointly by:

Nebraska Department of Environmental Quality
Lewis and Clark Natural Resources District
Lower Elkhorn Natural Resources District
Lower Niobrara Natural Resources District
Upper Elkhorn Natural Resources District

October 2016

Table of Contents

List of Figures and Tables

Figures

Tables

1.0 Introduction

The Bazile Groundwater Management Area (BGMA) is affected by high levels of nitrates in the drinking water supply. All BGMA residents rely on groundwater as their drinking water source. The BGMA is located in northeast Nebraska and encompasses twenty one townships or 756 square miles (Figure 1). The BGMA lies within three counties: Antelope, Knox, and Pierce and parts of four Natural Resource Districts (NRDs): Lewis and Clark (LCNRD), Lower Elkhorn (LENRD), Lower Niobrara (LNNRD), and Upper Elkhorn (UENRD). Precipitation and irrigation runoff feed into three major river basins: Elkhorn, Missouri, and Niobrara as well as parts of three different groundwater regions: Sandhills, North-Central Tableland, and Northeast Nebraska Glacial Drift.

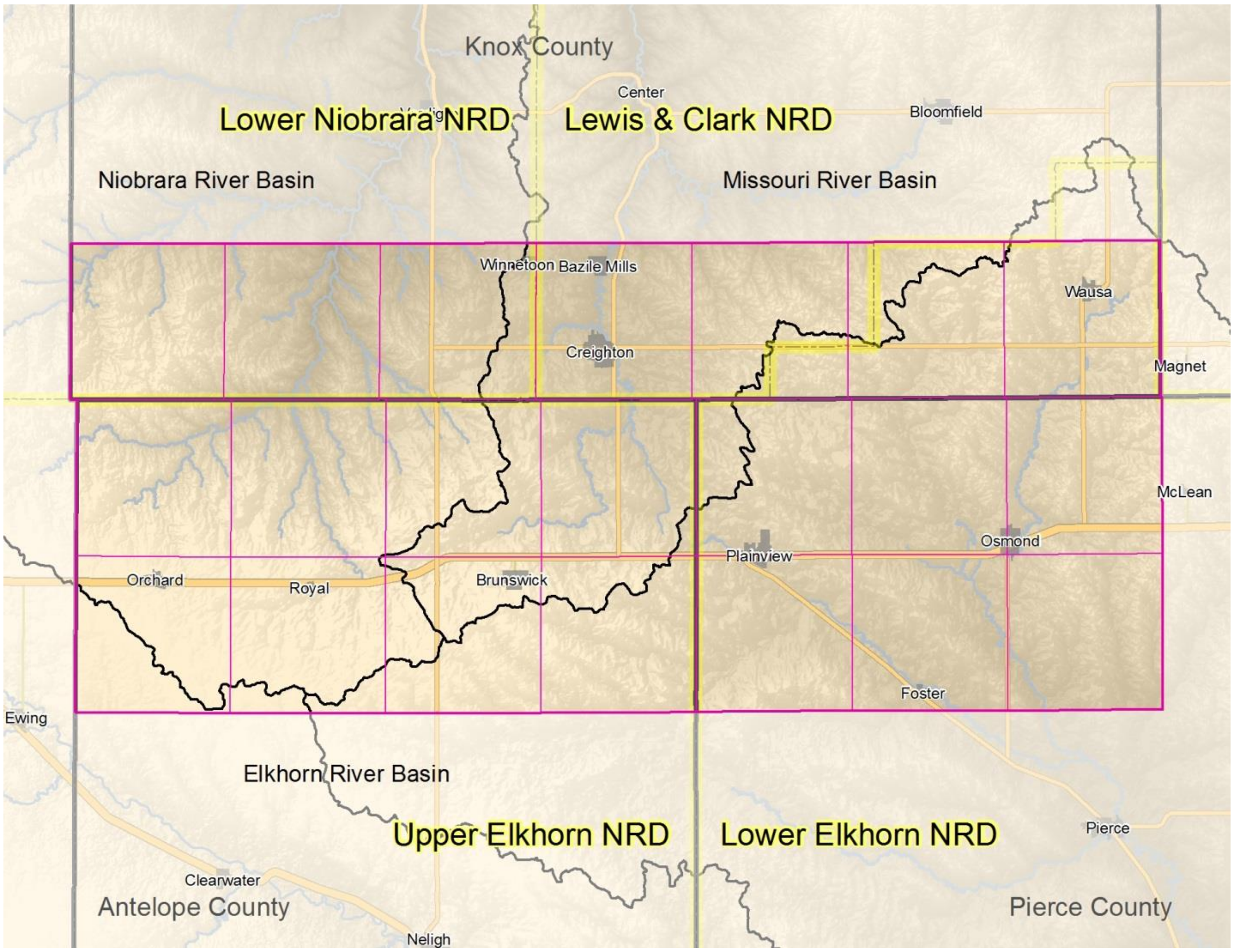


Figure 1. Bazile Groundwater Management Area (BGMA)

1.1 Background Information

Nitrogen is an essential nutrient for plant growth and crop production. To optimize crop production, supplemental nitrogen is applied to crop fields in both organic (i.e. manure) and inorganic (i.e. commercial fertilizer) forms. Nitrogen movement beyond the crop root zone can cause negative impacts to groundwater. Most nitrate that is leached below the root zone to a coarse textured soil profile eventually reaches groundwater, although not all leached nitrate directly impacts the regional groundwater. The rate and quantity of nitrate leaching is related to water infiltration and flow rates through the soil. In vulnerable areas, nitrates may enter the groundwater in less than a year while other areas may move downward only one or two feet per year. Excessive rainfall or irrigation can increase nitrate loading to the groundwater (UNL 2006).

Nitrates in Nebraska's groundwater reported in the Agrichemical Contaminant Database (Clearinghouse) (http://data.dnr.nebraska.gov/Clearinghouse/Clearinghouse.aspx) can be a concern in some areas of the state. Since 2002, the percentages of groundwater samples that exceed the 10 mg/l maximum contaminant level for drinking water have increased from 27% to 33%. That statistic is important as nearly 88% of state's residents, including nearly all of the rural residents, use groundwater as a source of drinking water (NDEQ 2012). Groundwater results reported to the Clearinghouse have been collected from many different types of wells all of which vary in depth, construction standards, and screened intervals. Monitoring is primarily conducted in areas of high crop production where studies have shown nitrate issues. Wells within the BGMA are either screened in the Quaternary sand and gravel overlying the Ogallala formation, within the Ogallala itself or across both aquifers. Dr. David Gosselin's Bazile Triangle Groundwater Quality Study provides a limited discussion on water quality distinctions between the two formations (UNL 1990). Overall the study noted finding distinctly less average nitrate concentrations in the Ogallala formation than in the Quaternary sand and gravel or both aquifers.

Nebraska's NRDs, through the Nebraska's Groundwater Management and Protection Act (revised state statutes §46-701-754), have been charged with managing the groundwater resources of the state. Along with the Nebraska Department of Environmental Quality (NDEQ), the NRDs also administer the quality aspects of the Nebraska Groundwater Management and Protection Act (NGMPA). Each NRD has Ground water Rules and Regulations that outline enforcement within their district. See Appendix D for additional information on NRDs and their authority.

Nitrate management and control can achieve desired results; however, it should be recognized that changes may not be realized instantaneously. For example, in the Central Platte NRD, areas of high groundwater nitrates had been increasing at a rate of 0.5 ppm annually reaching an average concentration of 19.24 ppm by 1987. Following the implementation of the groundwater management plan's higher phase regulations, including flow meters, soil sampling, nitrogen credit application, and reporting forms, average nitrate levels gradually decreased to approximately 15.05 ppm by 2012 (CPNRD 2014). These same regulations are included in each of the BGMA's NRDs phase requirements, however the determination of each phase is currently NRD specific along with the management actions. For example, Phase I criteria for the Lewis and Clark NRD could be different than the Phase I criteria for the Upper Elkhorn NRD. The same goes for the management actions associated with each Phase. One of the first priorities for the NRDs is to create a special section in each of their Groundwater Management Plans that will align triggers and phase requirements in portions of each District within the BGMA.

Groundwater management plans in each NRD have been implemented; unfortunately, improvements are not being achieved as quickly as desired. It should be noted that even aggressive actions taken to reduce nitrates in the groundwater supply require multiple years to recognize results. Recharge rates from the surface to the aquifer vary greatly due to soil types, topography, and the depth to groundwater. Nitrate contamination currently observed in the water supply may be the result of nitrogen applied several years or even decades ago. Each plan was developed, subjected to public review and comment, adopted by the NRD board, and reviewed and approved by the State, according to the NGMPA. Each plan addresses both groundwater quantity and quality concerns and meets the minimum statutory requirements; however, each of the districts were allowed to tailor their plans to address the local needs and situations. These differences will be discussed later in the Groundwater Quality Regulations (Section 5) and Best Management Practices **(**Appendix E).

Each of the BGMA NRDs expressed interest in developing a master plan for the Bazile area on which future projects or other actions will be based. Municipalities in the area are also interested stakeholders as drinking water providers for the perspective entity. In order to develop a master plan, a community based planning process was utilized, whereby all stakeholders had an opportunity to identify concerns. Working collaboratively with technical advisory agencies, stakeholders are able to make decisions that will protect and restore groundwater quality of the area.

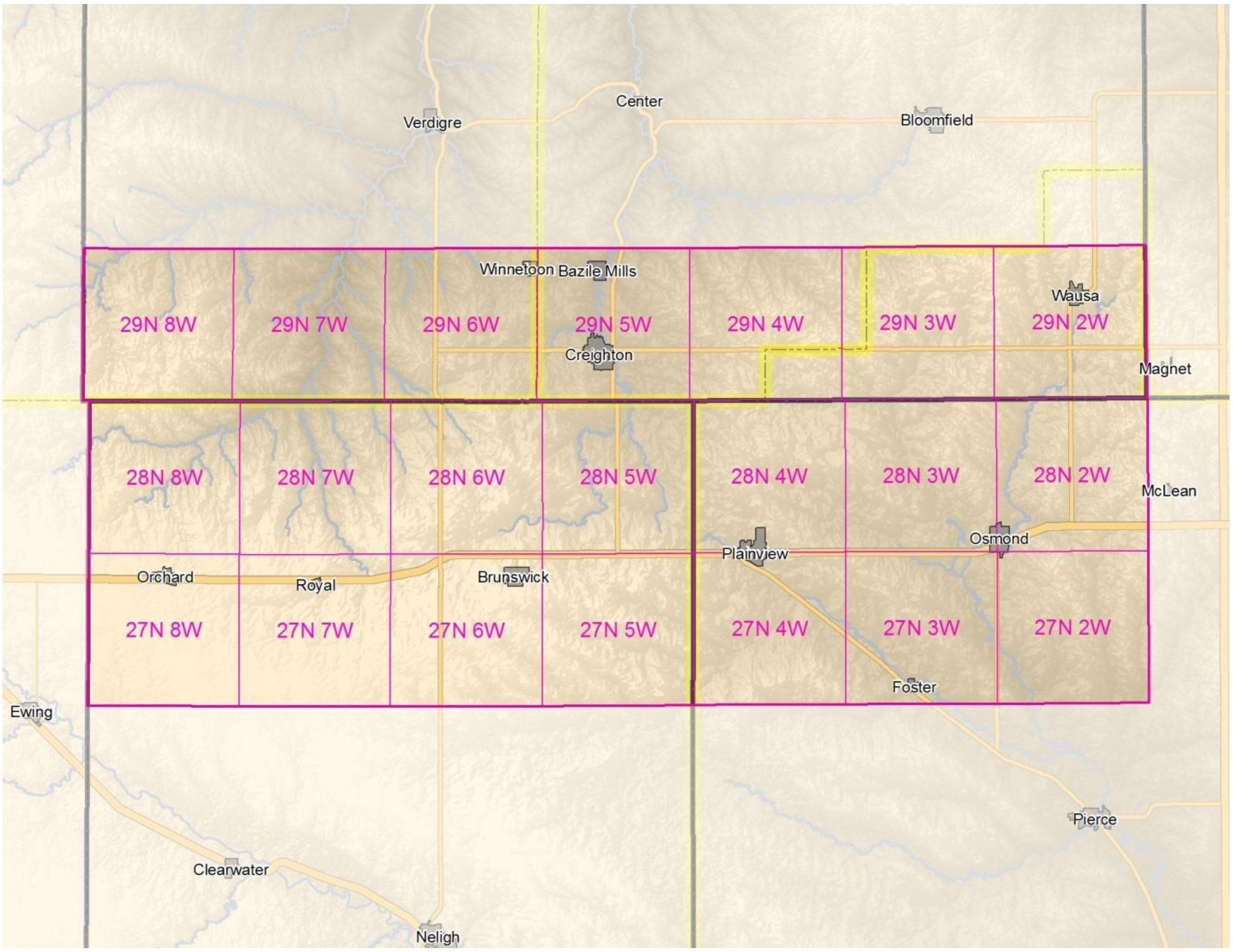


Figure 2. Communities and Townships

The BGMA encompasses 21 entire townships for a total of 756 square miles as shown in subsequent Figure 2. The BGMA was originally identified as the Bazile Triangle area of concern in the late 1980s as a result of nitrate contamination affecting municipal wells in the vicinity of the Villages of Brunswick, Creighton, Orchard, Osmond, Plainview, Royal, and Wausa Nebraska. The BGMA as outlined above encompasses the Bazile Triangle as well as the rest of each township the original triangle cut in half (Figure 3). Groundwater in the BGMA currently supplies water resources to ten communities and over seven thousand area residents. The area was given the informal name "Bazile Triangle" due to the Bazile Creek drainage in the center.

Dr. David G. Gosselin with the University of Nebraska's Conservation and Survey Division studied nitrate contamination in the area of concern in 1990 and reported his findings in the *Bazile Triangle Groundwater Quality Study*. The conclusions of this report indicated the aquifers appeared to be contaminated with nitrates to varying degrees and the source was likely related to fertilizer application and irrigation practices. The report also concluded there was insufficient data to implement a specific groundwater management strategy at that time (UNL 1990).

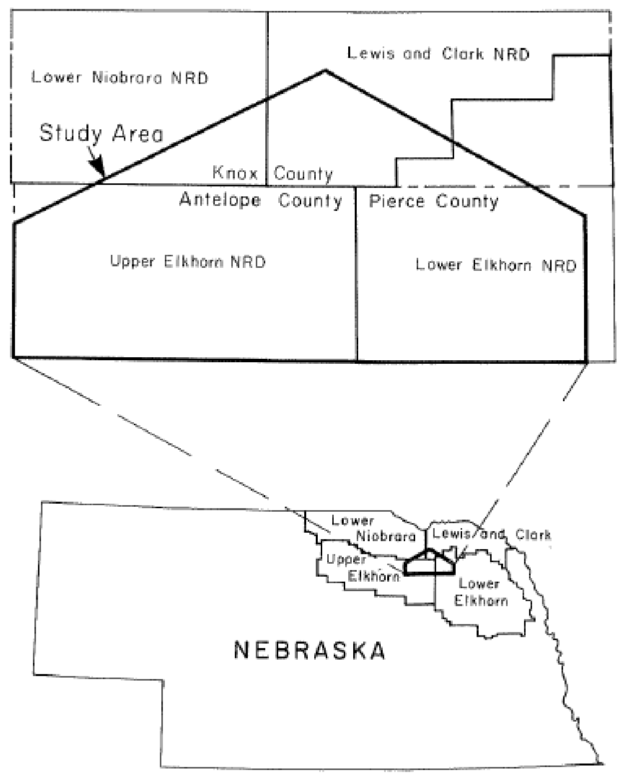


Image compliments of UNL's Conservation and Survey Division

Figure 3. Location of the Original Bazile Triangle (UNL 1990)

In 2000, Dr. Mark Burbach and Dr. Roy F. Spalding with the University of Nebraska's Water Sciences Laboratory preformed an evaluation and assessment of agrichemical contaminants near Creighton, NE. Nitrogen isotope analysis confirmed that the source is predominately commercial fertilizers. A large area of groundwater affected by high levels of nitrogen lying east-southeast of Creighton, NE was identified and estimated to be within the 20-year travel period to impact Creighton's municipal wells. However, a discharge area between the leading edge and the municipal wells may intercept a portion of the plume (UNL 2000). A detailed analysis of these studies can be found in section 4.1.

The East Branch Verdigris Creek Watershed Management Plan (EBVC) was approved by EPA in 2005 to address documented water quantity and quality issues in both groundwater and surface water supplies. The EBVC lies entirely within the BGMA. Stakeholders were concerned with high levels of nitrogen, phosphorous, and sedimentation occurring in the surface waters, particularly Grove Lake and Grove Trout Rearing Station as well as elevated nitrates in the aquifer, which supplies private and public drinking water as well as livestock water. Data gathered during the development of this plan indicated that groundwater feeding the stream was a major source of pollutants (UENRD 2005). Implementation of this plan and the results are discussed further in section 4.31.

In the years since these studies were completed, the four Natural Resources Districts (NRDs) have continued to collect data and information on the groundwater nitrate concentrations. Nitrate concentrations remain a concern with the most recent readings illustrated in Figure 4. Trend lines included with the charts show an increase in the average nitrate concentrations for the period of record. Groundwater nitrate concentrations in the BGMA as a whole have been observed to be increasing over time. A direct comparison of the data from the four NRDs is not appropriate as the quantity of wells sampled, data points, and period of record differ. Within the four NRDs, monitoring is carried out according to each individual NRD's rules and regulations as dictated by their approved groundwater management plans and available resources (personnel and funds). As a result of this, the data and information available for each NRD varies in terms of the number and type of wells sampled along with the quantity, continuity of the data, and the overall period of record.

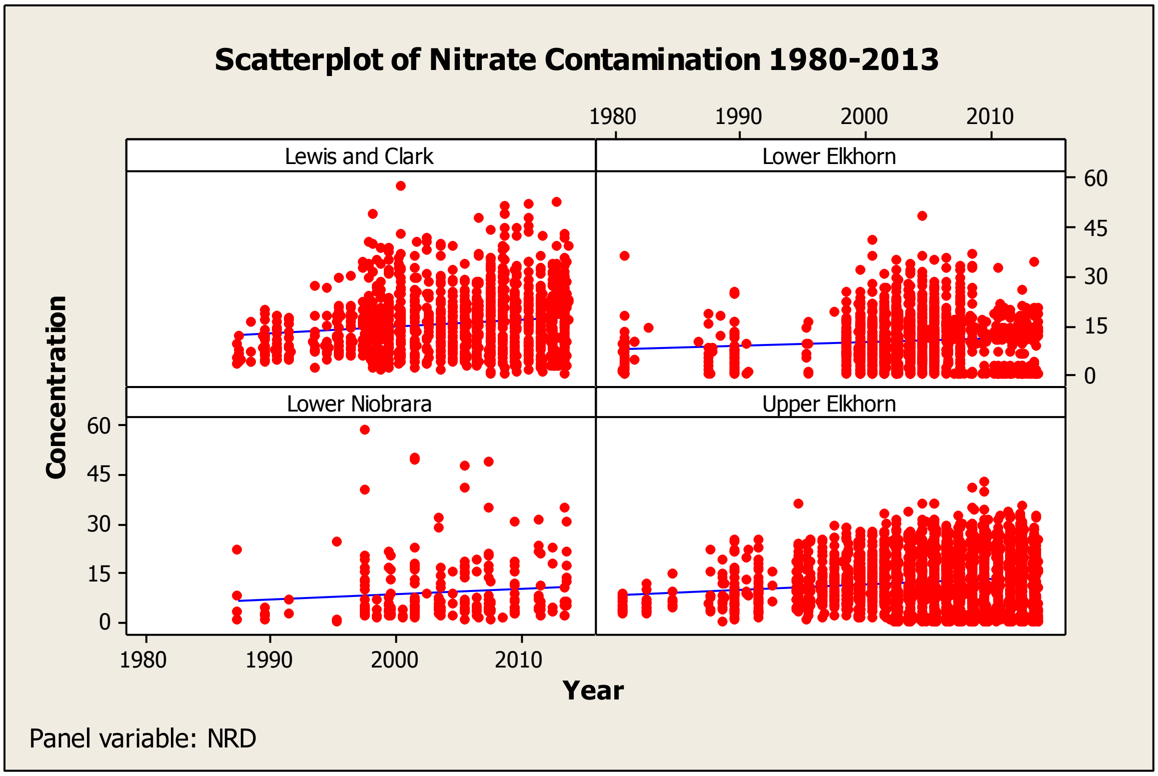


Figure 4. Scatterplot of Nitrate (mg/l) Clearinghouse Data (1980-2013) in BGMA by NRD

1.2 BGMA Description

1.2.1 Climate

Precipitation in the area averages 25 inches per year. Typically, the majority of the precipitation occurs during the spring and early summer. Temperatures in the basin range from an average high in the upper 80s ºF during the summer to average lows in the 10s º F during the winter (HPRCC 2013).

1.2.2 Topography

The Bazile Groundwater Management Area (BGMA) lies within several topographic regions (Figure 5). The Plains topographic region encompasses the largest portion – approximately 325,000 acres and is characterized by relatively flat uplands generally underlain by sandstones and stream deposited sands or gravelly sands. Soils that have formed on the mantle of wind deposited silts (loess) are friable, fertile, and allow moderate infiltration of precipitation. Runoff is low compared to the other topographic regions.

The Dissected Plain region accounts for about 69,000 acres and are regions of hilly lands that have been eroded by water and wind, resulting in landforms with moderate to steep slopes, sharp ridge crests, and remnants of the old plain. Generally the soils that have formed mostly on loess are friable and fertile. They allow comparatively good infiltration, but runoff is high because most of the land slopes (UNL-CSD 1986).

Approximately 90,000 acres lie in the Rolling Hills region characterized by hilly lands with moderate to steep slopes and rounded ridge crests. The area consists of a series of ridges and valleys formed by glaciers then modified by erosion and more recent depositions. Glacial deposits are present in the Rolling Hills region and consist largely of relatively impermeable boulder-clay tills. Loess in thick to thin deposits mantles the entire region, permitting moderate infiltration. Perched water tables occur above the clay tills at shallow depths in much of the area.

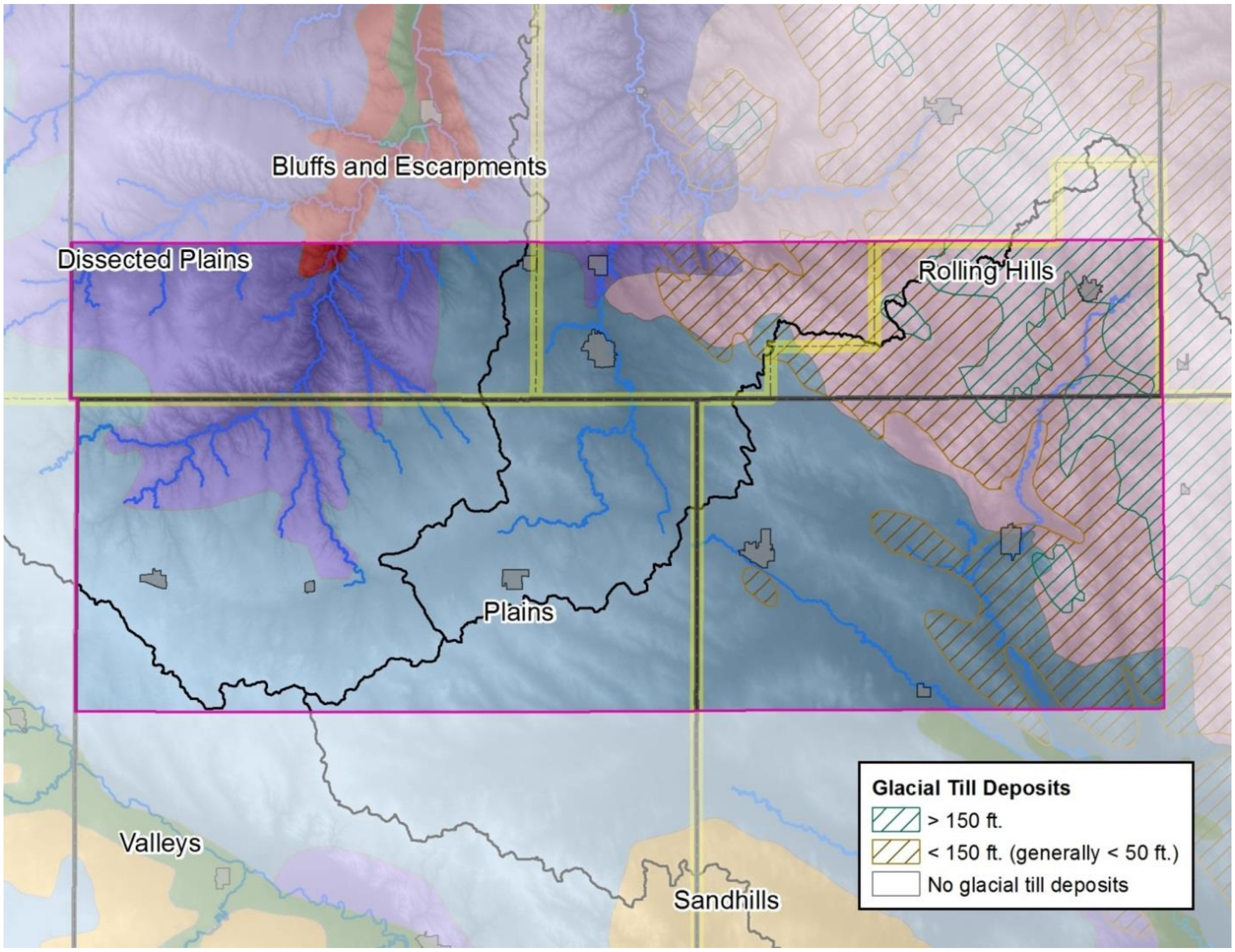


Figure 5. Topographic Regions and Glacial Till Deposits

1.2.3 Soils

There are several soil series in the BGMA with the most common being Bazile, Boelus, Brunswick, Nora, and Thurman. All of the soils are considered very deep with the exception of Brunswick which is moderately deep. All are well to excessive drained and runoff ranges from low to rapid. Permeability is slow to rapid. The series are comprised of sandy loams and/or loess. Wind and water erosion are a concern (USDA 2012). Infiltration through and/or runoff from the soils can impact surface and groundwater quality. In areas where infiltration is rapid, groundwater concerns exist whereas surface water concerns arise when runoff is increased. Understanding and grouping the saturated hydrologic conductivity (Ksat) soil characteristic is an important step in water quality management. Saturated hydraulic conductivity (Ksat) refers to the ease with which pores in a saturated soil transmit water. The estimates are expressed in terms of micrometers per second. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Saturated hydraulic conductivity is considered in the design of soil drainage systems and septic tank absorption fields.

For each soil layer, this attribute is recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used (NRCS 2015) (Figure 6).

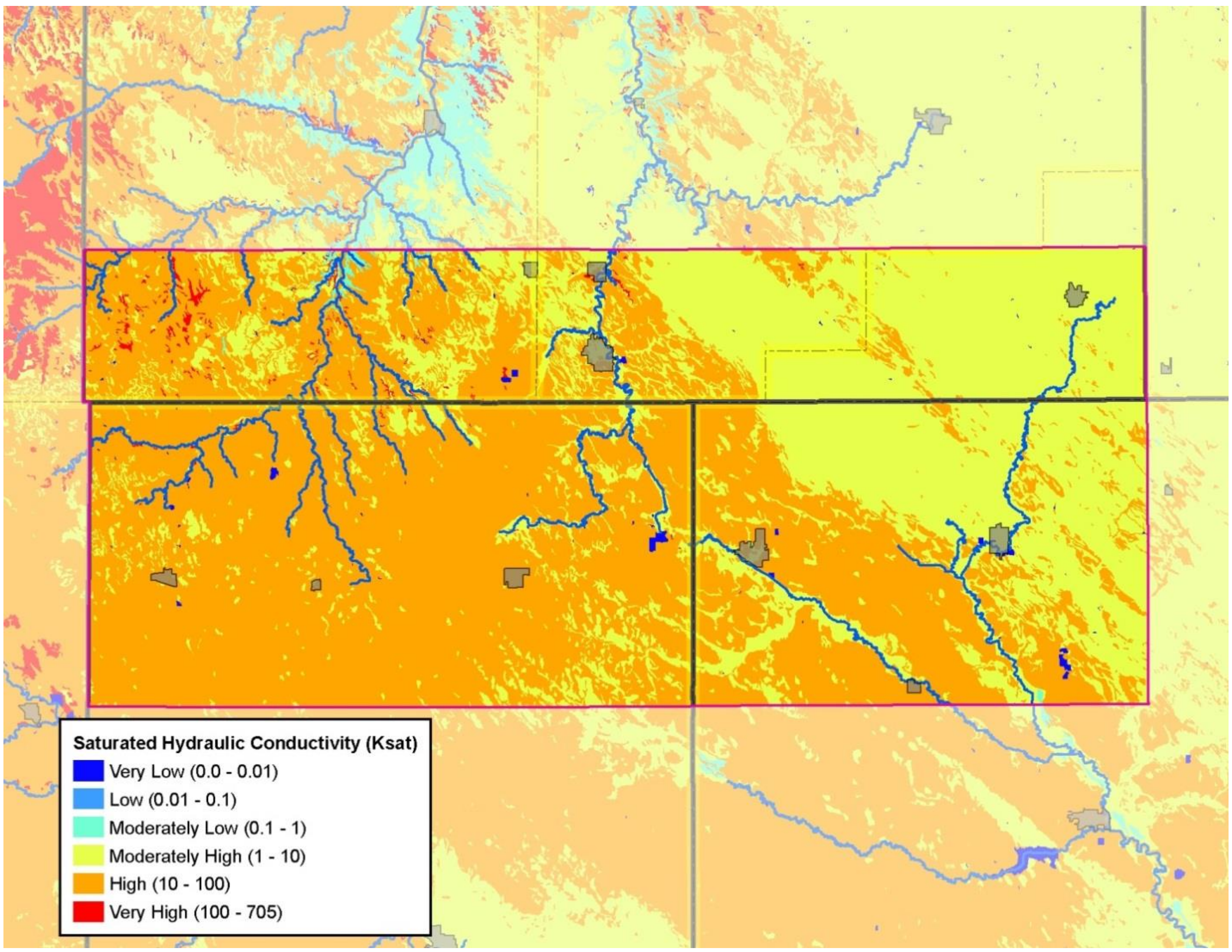


Figure 6. Saturated Hydraulic Conductivity Soil Characteristic (NRCS 2015)

2.0 Water Resources

2.1 Groundwater Resources

Three groundwater regions shown in Figure 7, underlie the BGMA; Sandhills, North-Central Tableland, and Northeast Nebraska Glacial Drift. In the Sandhills region the aquifers can support wells that produce large volumes of water. Deposits of the Ogallala Group underlie the entire region; however, the deposits become thin towards the east. Runoff in this region is limited because precipitation readily infiltrates the sandy soil. The North Central Tablelands consist of the Niobrara River and its tributaries that overlie sand and gravel deposits that generally yield small to moderate amounts of water. The Nebraska Glacial Drift is comprised of glacial till with low permeability. Quaternary deposits of sand and gravel along stream valleys are sources of groundwater but are limited in extent (UNL-CSD 1986).

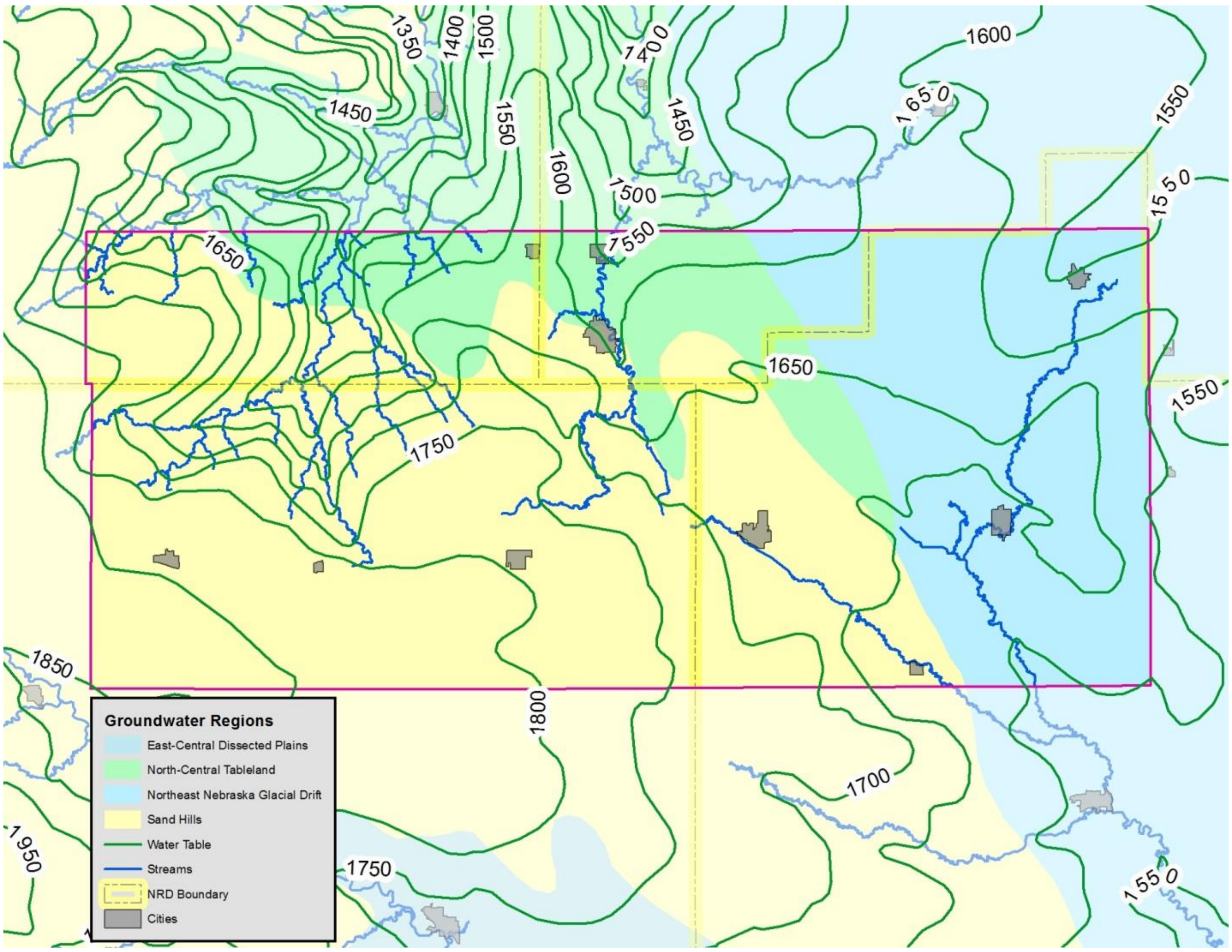


Figure 7. Groundwater Regions

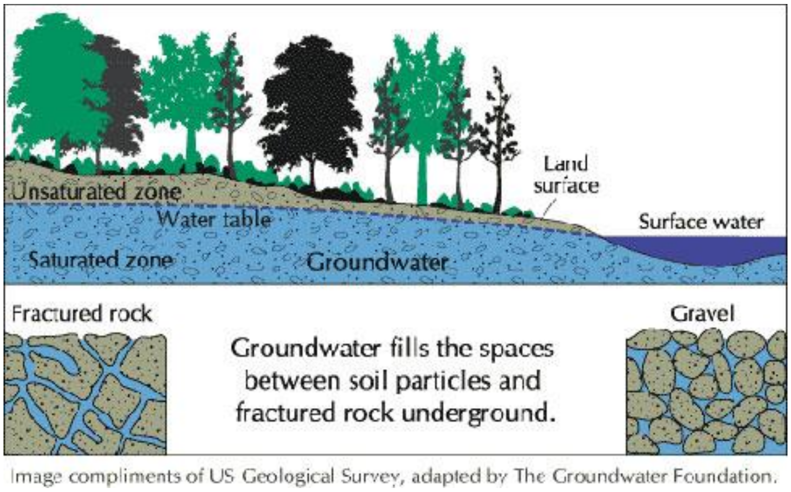


Figure 8. Groundwater Resource Diagram (USGS)

Generalized depth to groundwater is shown in Figure 9. The vast majority of groundwater in the BGMA is considered to be less than 200 feet below the land surface and approximately 50% is considered to be less than 100 feet. Depth to groundwater is shallowest in the stream valleys of Verdigris Creek, Bazile Creek, and the North Fork Elkhorn River tributaries.

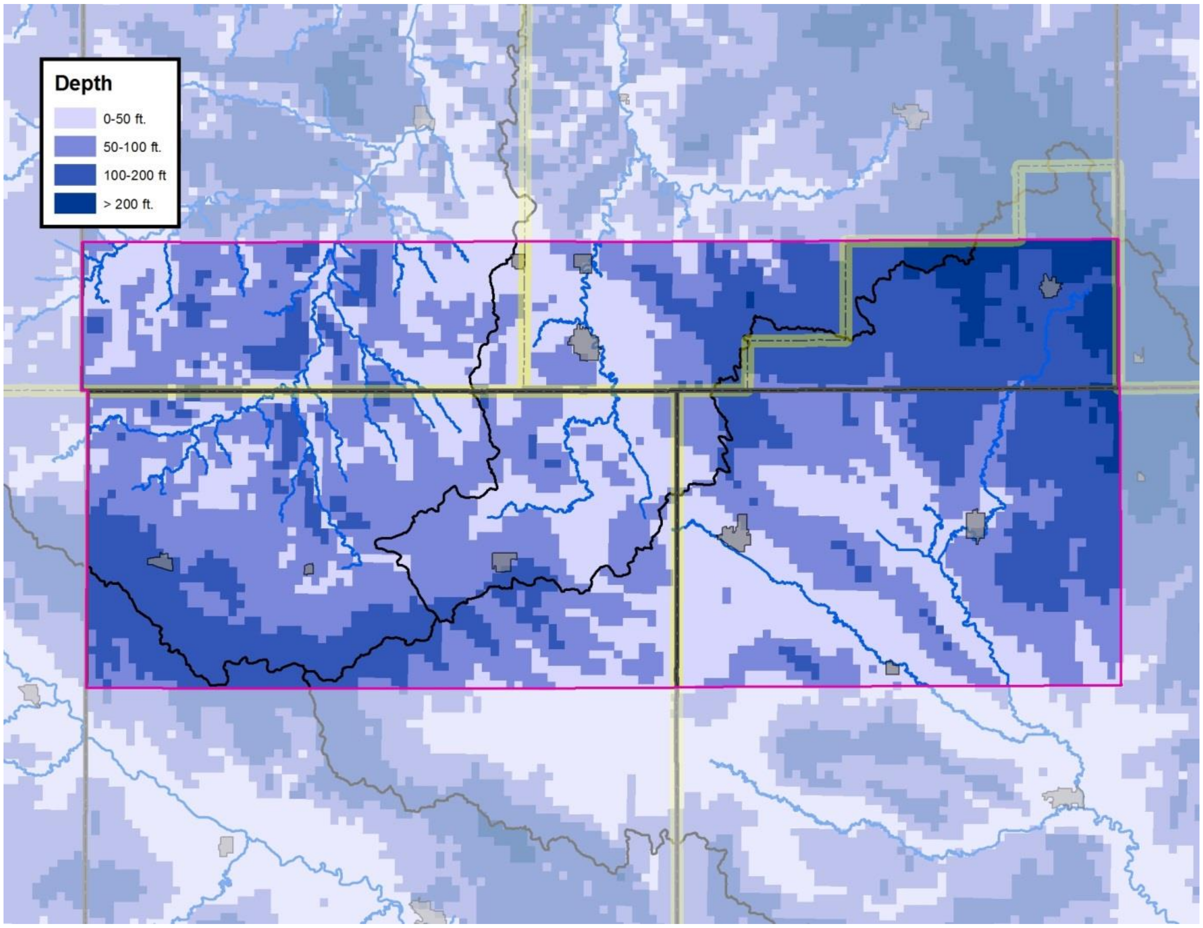


Figure 9. Generalized Depths to Groundwater

2.2 Surface Water Resources

The BGMA lies within three major river basins (Elkhorn, Missouri Tributaries and Niobrara) and surface water flows in many directions as shown in Figure 10. Stream flow volume is a component of precipitation runoff, groundwater discharge, and ground and surface water usage. Surface water quantity is managed by the State of Nebraska through the Department of Natural Resources (NDNR) and surface water quality by NDEQ. In areas where potential conflicts exist, such as reduced stream flow as a result of groundwater irrigation, an Integrated Water Resources Management Plan (IMP) (Neb Rev Stat. Sections 46-715 through 46-720) is developed to manage all water uses. It should be noted, surface water drainage in the area also includes the North Fork Elkhorn River and Verdigre Creek.

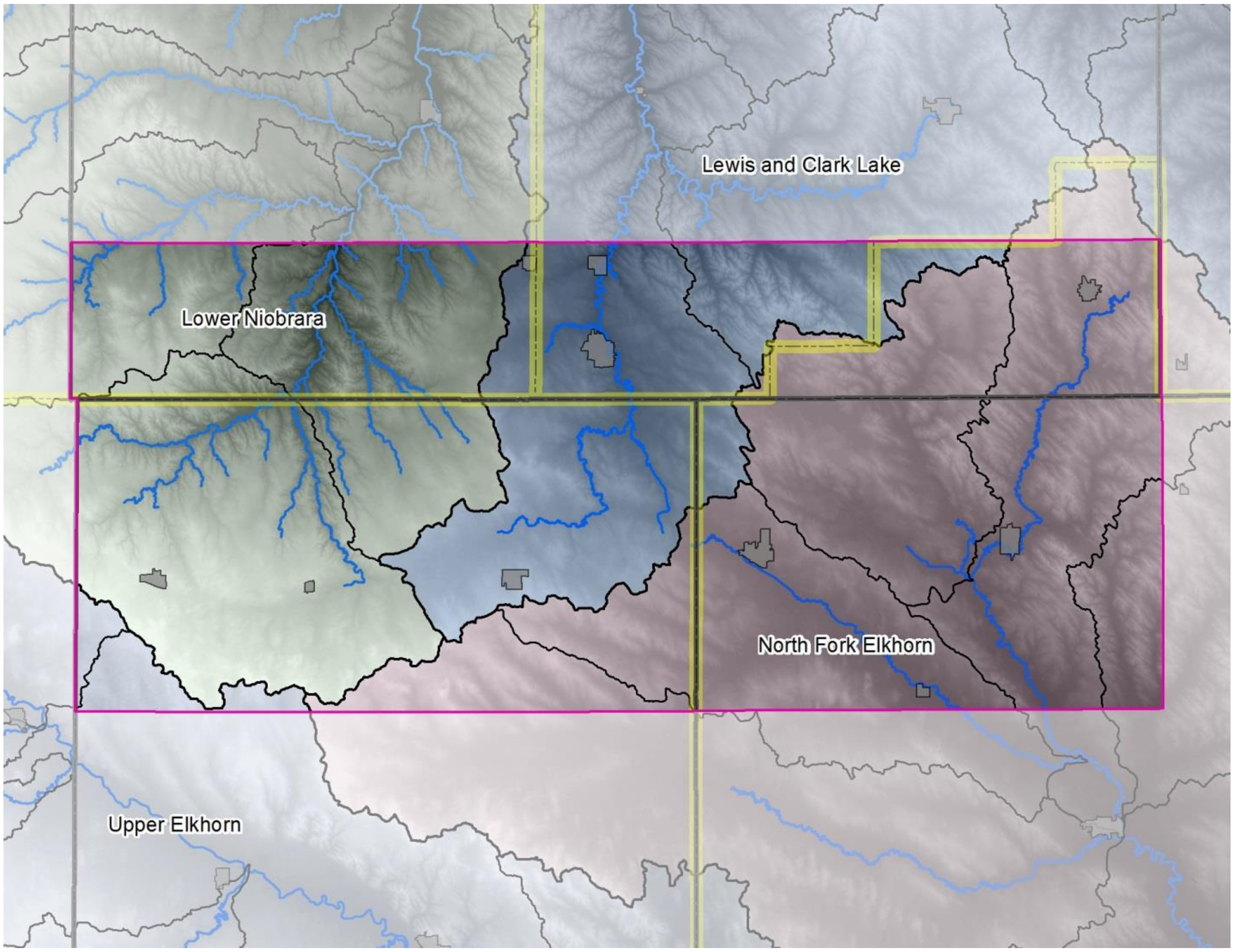


Figure 10. Surface Water Resources

2.3 Hydrologically Connected Water Resources

Nebraska legally recognized the hydrologic connection between groundwater and surface water with the passage of LB108 in 1996 authorizing the NRDs and NDNR to regulate and manage groundwater and surface water uses respectively with Integrated Water Management Plans when there is insufficient water for all uses. In 2002 the Nebraska Legislature enacted LB1003 creating a Water Policy Task Force to discuss integrated management of surface water and groundwater and make recommendations to the Legislature and the Governor regarding desirable water policy changes. In 2004 the Legislature passed

LB 962 which requires NDNR to conduct annual water balance assessments in each watershed and sub watershed and designate them as either under, fully or over appropriated while considering all sources of water.

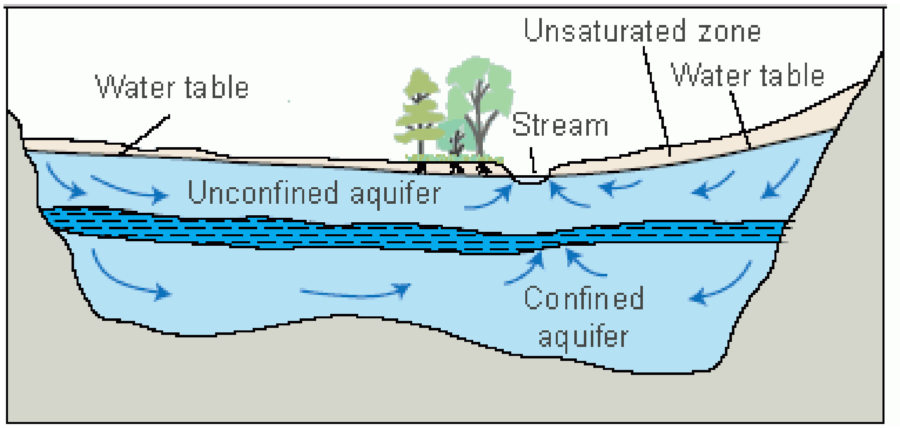


Image compliments of US Geological Survey

Figure 11. Surface Water and Groundwater Interactions for Gaining Streams Diagram (USGS)

The BGMA is outlined below in the University of Nebraska – Lincoln's Gaining/Losing Streams map in Figure 12 (UNL 2008). This map was developed with information from 1971-2000 and only shows major rivers. The entire BGMA is hydrologically connected except for the far northeast corner where glacial till is present. Within the BGMA, outlined in black, the streams are generally gaining streams meaning the base flow is attributed to groundwater feeding into the river (Figure 11). The northeast corner of the BGMA consist of glacial till less than 150 feet from the surface and generally considered to be within 50 feet of the surface (Figure 5). The surficial conditions in this region are slow to infiltrate precipitation causing a higher percentage of rainfall and irrigation water to run off the fields and enter the streams through over land run off. High sand content throughout the rest of the BGMA allows water to easily percolate through the vadose zone to the shallow water table and provide baseflow.

Excessive irrigation pushes nutrients down below the root zone and into the unsaturated vadose zone at an estimated rate of 30 to 48 inches a year (UNL 1995). This is similar to the 29 in/yr rate reported in the loess of western Iowa. This range was estimated using data from Clay Center, NE between 1985 and 1990. The Clay Center study area consist of mainly silt loam soils where between 300-400 lbs. N/acre were applied to continuous gravity irrigated corn fields (UNL 1995). Due to the coarser textured soils in the BGMA this estimated downward transport rate is likely low. Depending upon the individual producer's application scheme, the crops may not be able to utilize nutrients at the time they are applied to the field. If they are not utilized by the crop, they may remain suspended in the irrigation water and run off of the field and into surface water or again, possibly be leached below the root zone. Section 4.0 discuss specific water quality concerns documented in groundwater and surface waterbodies within the BGMA.

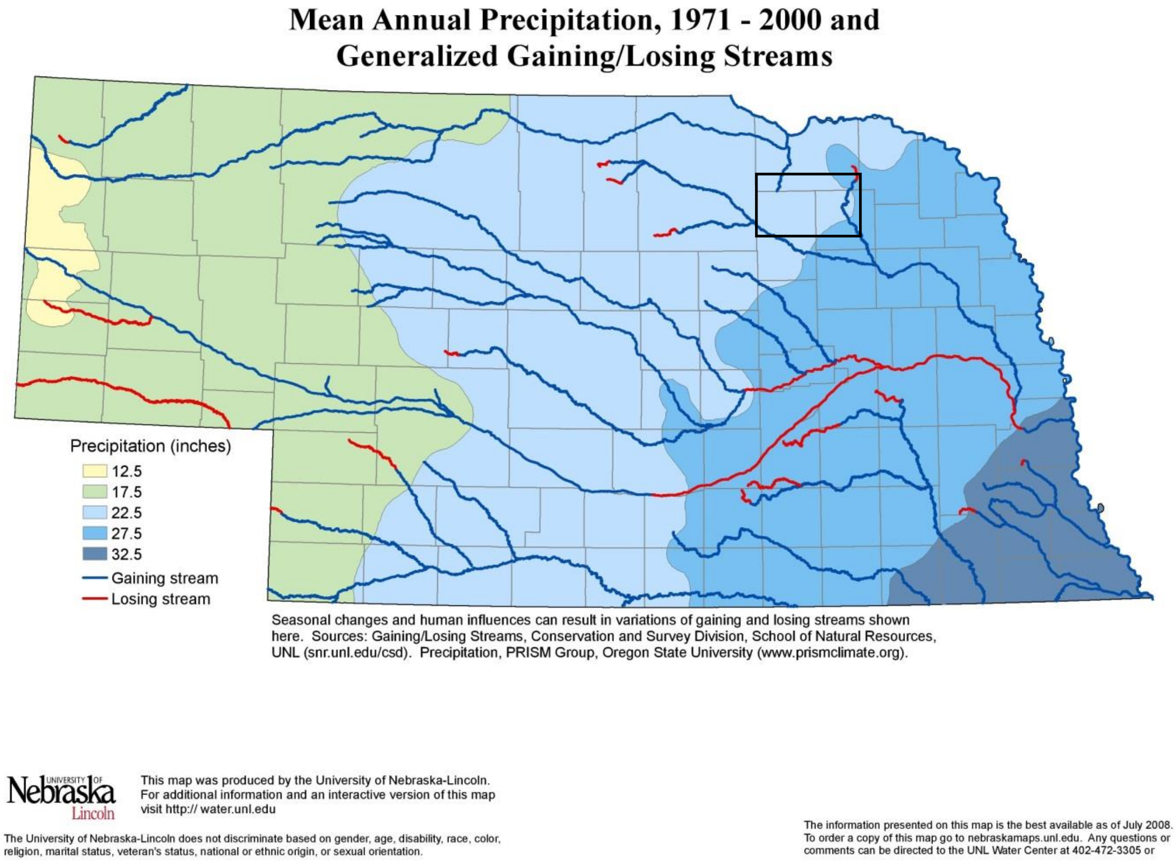


Figure 12. Gaining and Losing Streams in Nebraska with the BGMA outlined (UNL)

3.0 Water Resource Uses

3.1 Groundwater Use

Groundwater in Nebraska is governed by Correlative Rights or the concept of Share and Share Alike. Landowners must obtain a permit to drill a high-capacity well from their local NRD, if the NRD is allowing well development. If approved, the well permit allows the land owner to drill a well and pump as much groundwater as needed as long as the water is put to a beneficial use. When the well is completed, it is registered with the NDNR. As of December 2013, NDNR's water well registration database contained records for over 2,500 wells in the BGMA. Table 1 provides the total number of wells for each use type and Figure 13 illustrates their distribution. It is important to note that all rural residents in the BGMA rely on groundwater wells for domestic use. The summary in Table 1 is likely a low estimate of the total number of wells because prior to 1993 low capacity wells, designed not to exceed a pumping capacity of more than 50 gpm, were not required to be registered.

Table 1. NDNR Registered Wells by Type in BGMA through 2013

Well Use	Total
Aquaculture	2
Commercial/Industrial	7
Recovery	10
Heat Pump/Heat Exchanger/Other	35
Public Water Supply	36
Monitoring	123
Domestic	246
Livestock	155
Irrigation	1887
Total all Wells	**2501**

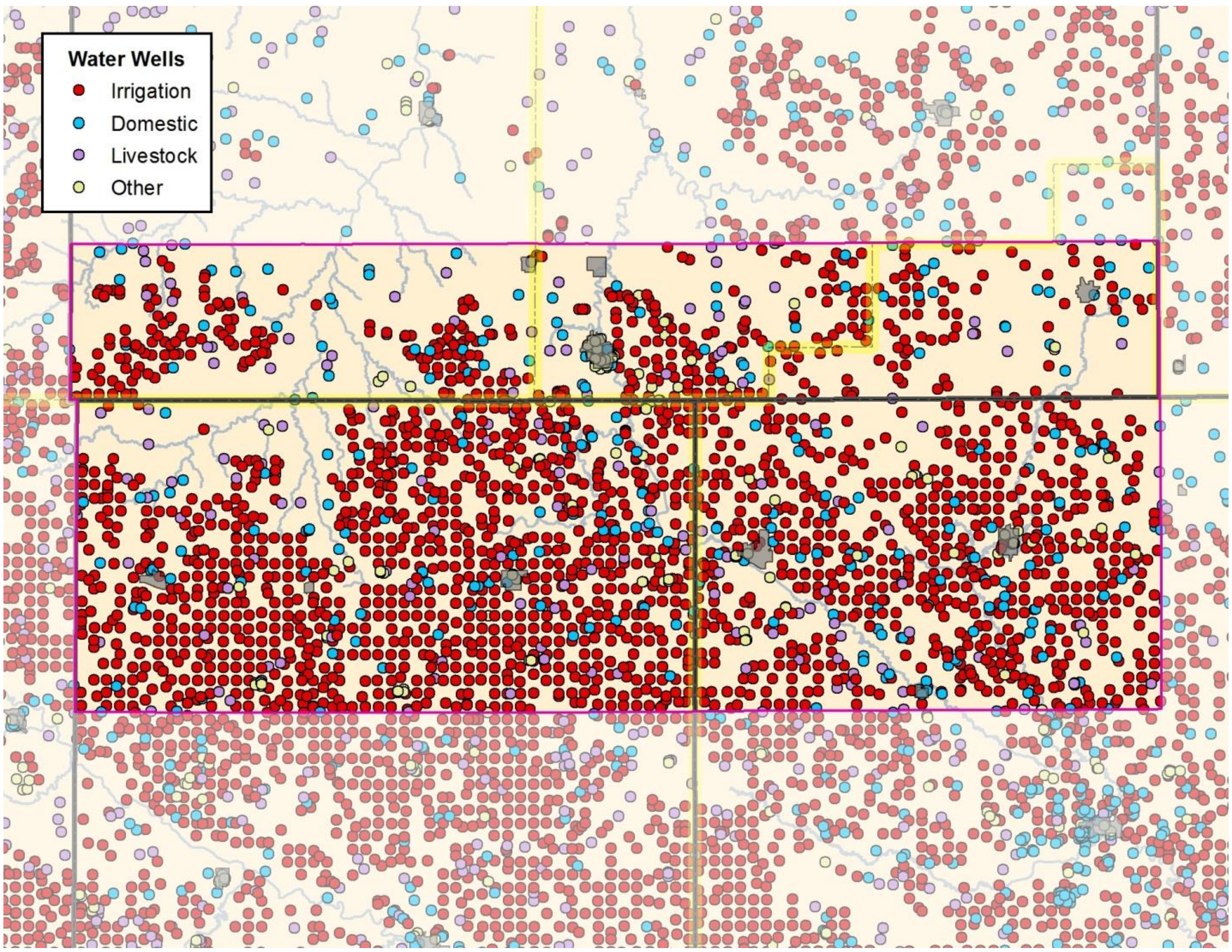


Figure 13. Registered Water Wells with NDNR

3.1.1 Municipal Groundwater Uses and Conditions

Public water supplies in the BGMA are listed in Table 2, all of which are groundwater based. Public water supply systems (PWS) are required to serve drinking water to their customers under 10 mg/l

Nitrate-N, the federal drinking water quality standard. This requirement has added significant financial burdens to PWS systems within the BGMA. Nitrates have been a known threat to the BGMA's 15 community, non-community and non-transient/non-community public drinking water systems for several decades. In 1993, the City of Creighton was the first community in Nebraska to build a reverse osmosis plant to treat for nitrates. Of the eight community public water systems in the BGMA, Creighton is the only community water system treating for nitrates. There are also seven non-community public water systems in the BGMA, three of which are currently treating water for nitrates.

Review of well logs for public water supply wells listed in Table 2 indicated key well construction issues. Although approximately 50% of the public water supply wells are drilled and screened into the Ogallala Formation, most of those wells' annulus were also gravel packed through the Quaternary to within ten feet of the surface. This type of well construction may allow shallower groundwater to intermingle with deeper groundwater which in turn speeds up the process of nitrate movement and mixing.

Table 2. Community Public Water Supply Systems in the BGMA

Community Public Water System	**Population Served**	**Groundwater Source**	**Active Well(s)**	**Emergency Well(s)**
Brunswick, Village of	179	Ogallala	1	0
Creighton, City of	1250	Quaternary	2	0
Orchard, Village of	391	Both	3	1
Osmond, City of	796	Quaternary	1	1
Plainview, City of	1157	Ogallala	3	1
Royal, Village of	91	Ogallala	1	0
Wausa, Village of	634	Quaternary	3	0
Winnetoon, Village of	75		Purchase From West Knox RWD	
West Knox Rural Water District (RWD)	480	Ogallala	2	0
TOTAL	5053		16	3

The West Knox Rural Water System worked with the Bureau of Reclamation on a feasibility study to connect the villages of Santee, Center and Niobrara to a regional water supply system in 2013. This well field would be located in the BGMA; however the delivery points would all be located north of the BGMA. This study, completed by Bartlett & West Inc., was submitted to the Bureau of Reclamation whom after review determined the project did not meet their minimum cost/benefit requirements and the funding for Regional Water Supply Projects has been eliminated from their budget. Project partners will meet to discuss future options.

The West Knox Rural Water System is also working to insure their customer will have a constant supply of quality water. To this end a new well was drilled in 2012 and second is being planned within the BGMA approximately eight miles west and a mile south of Creighton on an eighty acre tract of land owned by the Lower Niobrara NRD. This site was specifically chosen because it was thought to be low in nitrates. Initial nitrate results from the test well were promising at 3.1 mg/l. A permanent well was drilled in 2011 and results from test pump were around 6 mg/l. The second well to be constructed is also located on this track of land with the initial nitrate results being below 1 mg/l. This well field should be in operation by the end of 2016. Wellhead protection areas of the communities in the BGMA are outlined below in Figure 14 and individual Wellhead Protection Area maps can be found in Appendix B.

3.1.1.1 Wellhead Protection Areas

Wellhead Protection is a voluntary program in Nebraska (Figure 14). Public Water Supply Systems (PWSSs) have the option of developing a Wellhead Protection Plan. All PWSS in Nebraska have a delineated Wellhead Protection Area, but the Wellhead Protection Plan provides decision makers with an inventory of potential contaminant sources, general management strategies, including ordinances related to wellhead protection as well as emergency and contingency plans. While Osmond is currently the only PWSS within the BGMA to have a completed state approved Wellhead Protection Plan in place, the West Knox Rural Water System is working with the Rural Water Association to develop a state approved plan as well. In order for a management program to be successful, it must be locally-driven and involve public education.

Time-Of-Travel (TOT) rates for the PWSS wells with the BGMA have been estimated by NDEQ Groundwater Unit, Wellhead Protection Program using EPA's Wellhead Analytic Element Model, WhAEM2000, 3.2.1 which assumes steady-state flow and average groundwater travel times (Table 3). Lateral groundwater movement ranges from around 4 inches per day in the southwest corner of the BGMA near Orchard and Royal to over 30 inches per day near Creighton. This model is a representation of reality based on the best known hydrogeological, water level, and pumping information available.

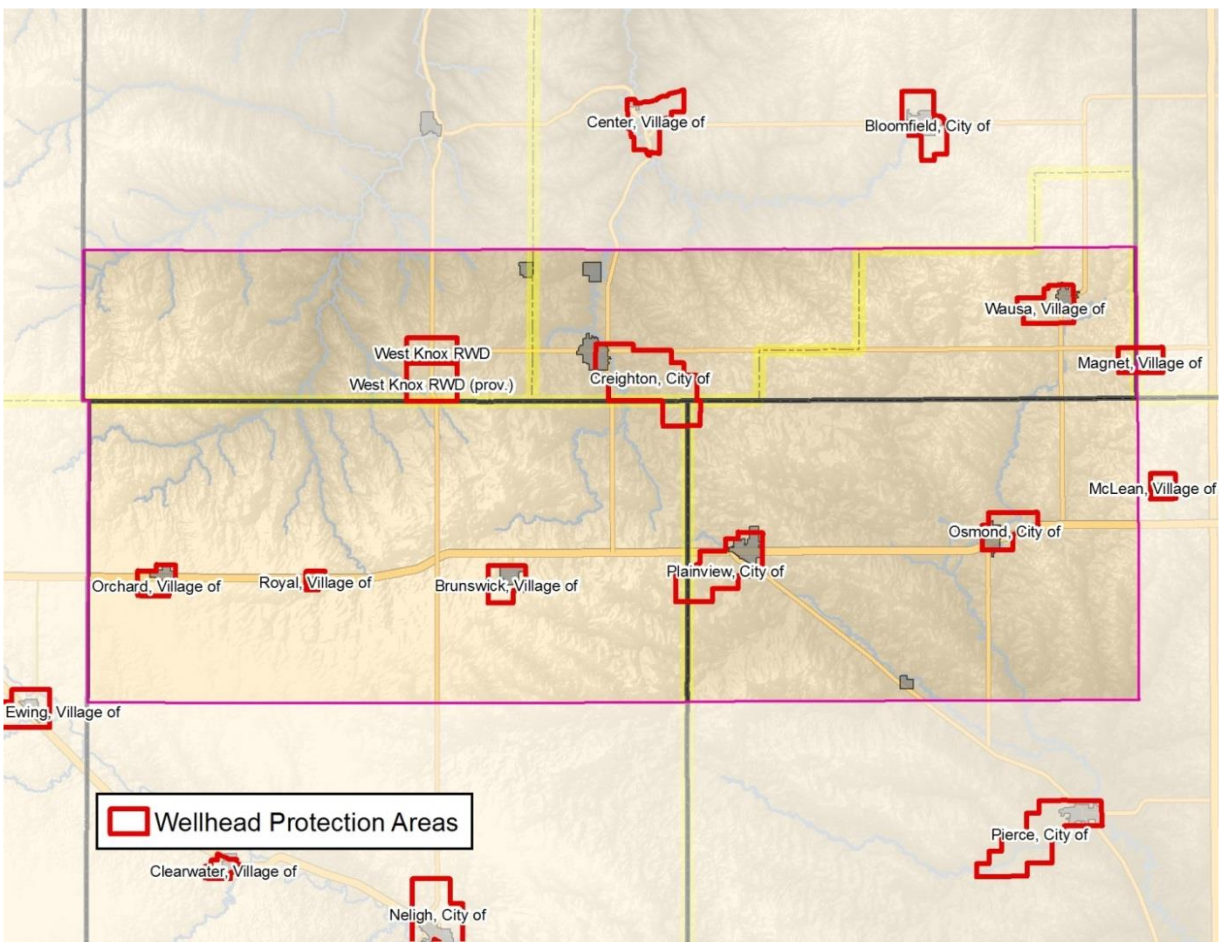


Figure 14. Wellhead Protection Areas

Table 3: WhAEM2000, 3.2.1 Time of Travel Rates

	miles	miles	miles	feet	feet	inches
	50 years	20 years	1 year	1 year	1 day	1 day
Brunswich	1.875	0.75	0.0375	198	0.54	6.51
Creighton	8.75	3.5	0.175	924	2.53	30.38
Osmond	3.75	1.5	0.075	396	1.08	13.02
Orchard	1.25	0.5	0.025	132	0.36	4.34
Plainview	6.25	2.5	0.125	660	1.81	21.70
Royal	1.25	0.5	0.025	132	0.36	4.34
Wausa	3.5	1.4	0.07	370	1.01	12.15
West Knox	3.125	1.25	0.0625	330	0.90	10.85
West Knox Prov.	2.5	1	0.05	264	0.72	8.68

The City of Creighton's raw (untreated) water nitrate concentration has ranged between 14 and 20 mg/l since 2000. Since the reverse osmosis treatment system is an energy intensive system with high maintenance requirements, the city incurs additional expenses as nitrate levels rise. The Cities of Orchard and Osmond are currently under Administrative Order (AO) for nitrates and are actively taking steps to address their contamination issues. Orchard has placed their high nitrate well on emergency status due to contamination levels reaching 9.8 ppm and Osmond is looking into drilling a replacement well. Typically, the only options for PWSS facing a nitrate problem are new well drilling, connecting to another system, or treatment.

3.1.2 Irrigation Groundwater Use

The shallow and plentiful groundwater in the area provides opportunities for usage in crop production as is evident in the land usage of the area (Figure 17). That is, 67.2% of the BGMA is dedicated to row crop agriculture where 58.8% is irrigated and the remaining 8.4% is dryland agriculture. As of the end of December 2013, there were 1887 registered irrigation wells in the area. Prior to 1970, there were 218 registered irrigation wells in the BGMA. That number increased by 742 over the next 10 year period. During the 1980s and 90s, there were 452 wells completed respectively and from 2000 through December 2013, 475 additional wells were registered (Figure 15). Table 3 shows the breakdown of the irrigation wells by NRD. Figure 13 shows the location of these registered wells not only within the BGMA but also in the area as a whole.

Well construction practices of the past were focused on maximizing the water production a well could pump. The emphasis on quantity over quality lead to many wells being drilled through multiple aquifers down to shale and the annulus gravel packed to the surface. This type of well construction may allow shallower groundwater to intermingle with deeper groundwater which in turn speeds up the process of nitrate leaching. Also, it must be noted that a majority of these irrigation wells are located in areas of high crop production where nitrogen fertilizers have historically been applied to the field. The Nebraska Water Well Industry is in the process of testing several different techniques for well rehabilitation in which plugs will be utilized to separate the different aquifers. It is estimated to be very cost efficient, costing less than two thousand dollars and may be available to the public as early as 2020.

Table 4. NDNR Registered Irrigation Wells in the BGMA by NRD through 2013

Natural Resources District	Irrigation Wells
Lewis & Clark	122
Lower Elkhorn	672
Lower Niobrara	159
Upper Elkhorn	934

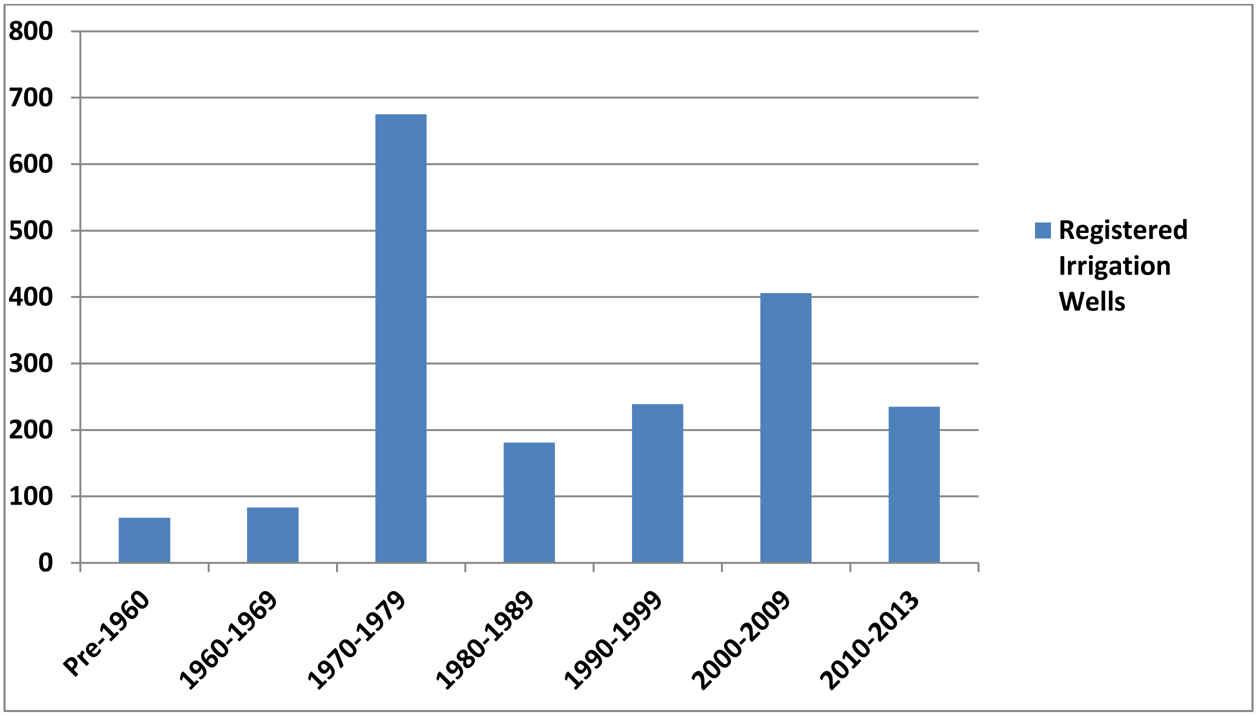


Figure 15. Irrigation Wells in the BGMA Registered with NDNR by decade through 2013

3.2 Surface Water Use

Nebraska surface water is governed by Prior Appropriation or Appropriative First-in-Time, First-in-Right. This allows the land owner or organization to utilize surface water from a specific location based upon the date the water right was obtained. Surface water rights are issued by the Nebraska Department of Natural Resources (NDNR) and are legally attached to the location listed on the permit. Table 5 summarizes NDNR approved surface water rights within the BGMA through 2013. A list of current permits as well as use codes and footnote explanations can be seen in Appendix A.

Table 5. NDNR Permitted Surface Water Diversions within the BGMA

NDNR Permitted Diversions	Type of Use	Quantity (GPM)
Tributary to Verdigre Creek	Storage	45.19
Verdigre Creek	Irrigation	1530.41
Tributary to East Branch Verdigre Creek	Storage	6.37
East Branch Verdigre Creek	Storage & Irrigation	470.96
Tributary to South Branch Verdigre Creek	Storage	8.68
South Branch Verdigre Creek	Irrigation	1507.97
Tributary to Bazile Creek	Storage & Irrigation	83.29
Bazile Creek	Storage & Irrigation	447.74
Bazile Creek West	Irrigation	2535.72
Tributary to Merriman Creek	Storage	38.44
Merriman Creek	Irrigation	372.50
West Branch North Fork Elkhorn River	Irrigation	448.80
North Fork Elkhorn River	Irrigation	821.30
Hay Creek	Storage	27.66
Tributary to Big Spring Creek	Storage & Fish Culture	228.80
Big Spring Creek	Irrigation	394.94
Eley Creek	Storage	7.87
Don Doerr Reservoir	Supplemental Irrigation	0.24
Sorensen Reservoir	Storage Water Only	4.96
Key Reservoir	Storage Water Only	0.00

3.3 Groundwater and Surface Water Use Conflicts

In January 2008, a portion of the BGMA was initially designated as fully appropriated by NDNR (Figure 16). The action meant that the basin was determined to be in a state of imbalance where hydrologically connected groundwater and surface water users and supplies were negatively impacting each other. It also meant that no further surface water permits nor groundwater expansion of irrigated acres could take place. After public hearings and submittal of additional information, the Nebraska Supreme Court reversed the January 2008 determination made by NDNR. The reversal was largely based on concerns raised by the NRDs related to the methods used in the current determination process. NDNR has since worked with the NRDs to address some of the shortcomings of the previous methodology. However, the Nebraska Legislature passed and the governor signed LB 483 in 2009 to require NRDs to develop the necessary rules and regulations for prioritizing the issuance of new well permits and limited amounts of groundwater irrigated acre expansion over the next four years following the reversal.

Many NRDs developed a competitive point based system based on multiple factors to prioritize the development of new irrigated acres. Producers receive a base line score on their land that takes into consideration soils, slope, irrigation density, area ground water quality conditions, and proximity to surface water. Producers can then increase their scores by implementing BMPs tailored to their specific location and farming systems. LB 483 also allowed NDNR to grant new surface water appropriation with limited new irrigation appropriations during the four years following the reversal. NDNR currently has two surface water permits pending in the BGMA.

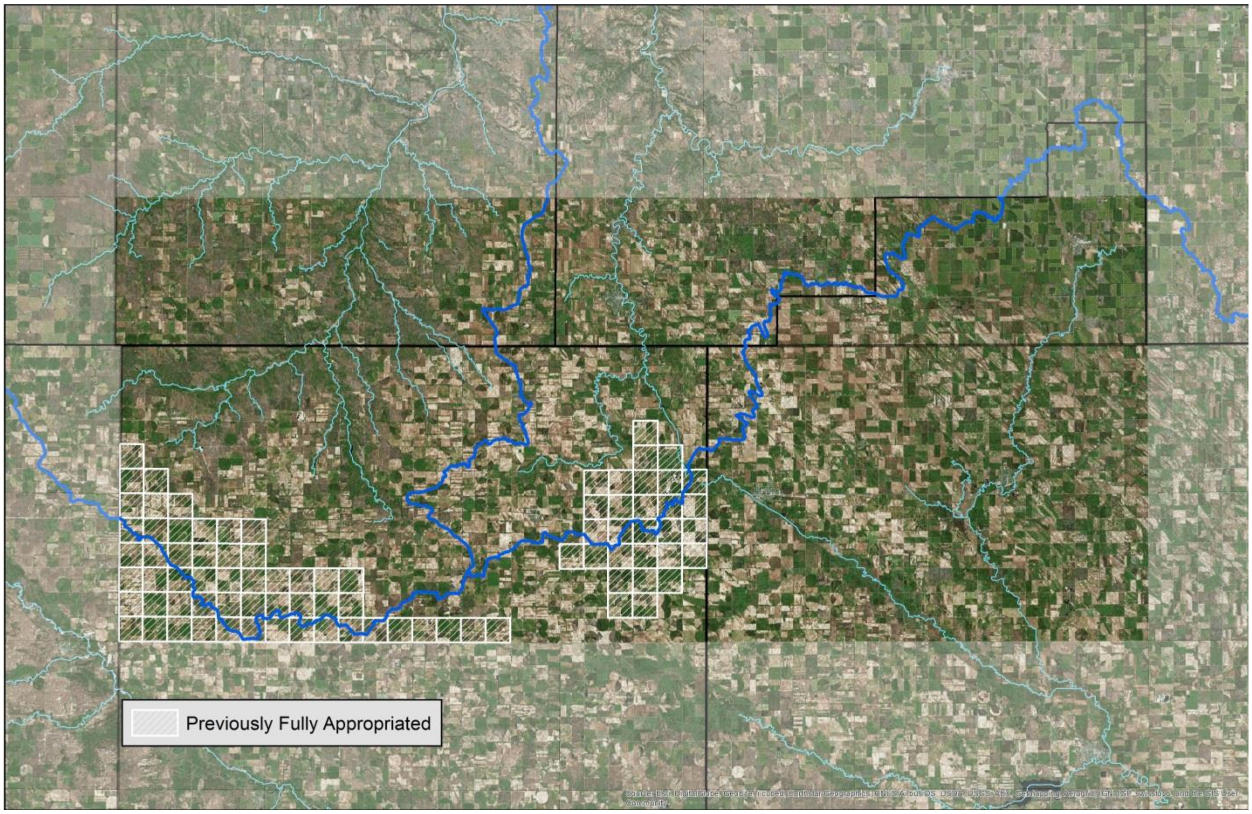


Figure 16. NDNR's Previously Fully Appropriated Areas

Currently, the NRDs are in varying stages of completing an Integrated Management Plan (IMP) with NDNR. The Lower Niobrara NRD notified the NDNR of its intent to develop a District wide IMP in accordance with LB 483 Sections 46-715 through 46-717 and Subsections (1) and (2) of Section 46-718 of LB 483 on September 30, 2011. The Lower Niobrara NRD held several stakeholder meetings to determine the concerns across the District. These concerns were drafted into an IMP with NDNR and approved in March of 2014 by both the Lower Niobrara NRD and NDNR. The IMP became effective May 1, 2014. The Lewis and Clark NRD has also completed developing their IMP with NDNR and will be effective as of September 15, 2016.

The Upper Elkhorn and Lower Elkhorn NRDs are members of the Lower Platte River Basin Coalition. The Coalition is comprised of seven NRD members who are developing a basin-wide plan for the Lower Platte Basin. The Upper Elkhorn and Lower Elkhorn NRDs were advised by NDNR in May 2016 to wait to develop their IMPs until the Lower Platte Basin plan is complete.

3.3.1 Land Use

The major land use in the BGMA is agriculture based with irrigated and dry land row crop making up approximately two thirds of the total land use or about 324,000 acres (Figure 17). Pasture and rangeland account for approximately a quarter or about 125,000 acres of the remaining land uses with the lesser acreages being urban, water, road, and woodlands. Irrigation water comes from a variety of surface water and groundwater sources including streams, rivers, and small reservoirs as well as groundwater wells at varying depths and proximities to hydrologically connected gaining and losing streams and rivers. In order to properly manage groundwater resources, NRDs require producers register their irrigated acres after validating them through irrigated tax, USDA, or FSA records with the County Assessor's office. The LCNRD is the only BGMA NRD where this is not yet required whoever the process to make this a requirement is scheduled to begin in late 2016.

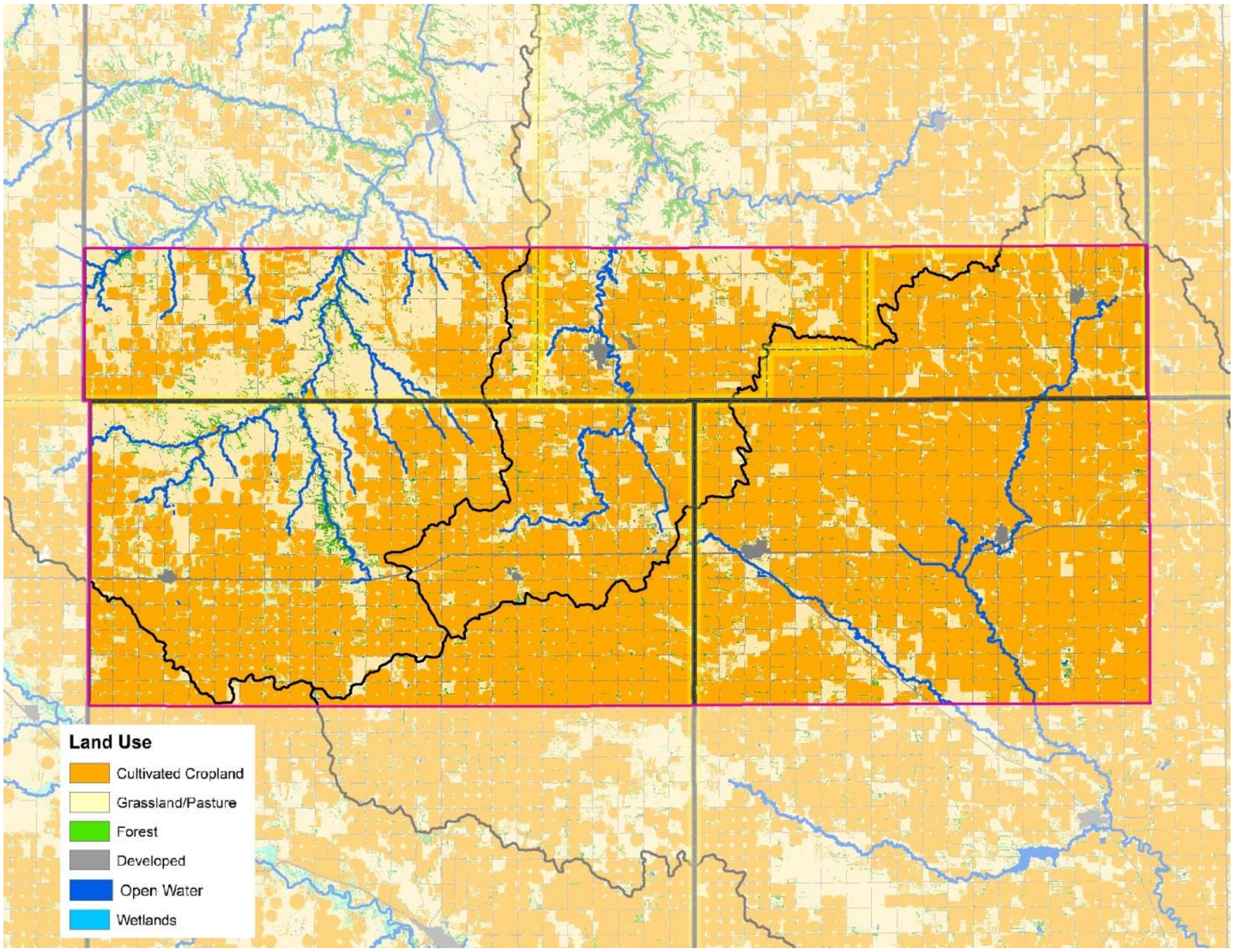


Figure 17. Land Use utilizing the 2013 Estimates from National Agricultural Statistics Service

3.3.2 Active Animal Feeding Operations

Livestock production is also a component of land use in the BGMA. As of April 3, 2015, NDEQ identified 269 animal feeding operations (AFO) currently operating in the BGMA (Figure 18). Both permitted and unpermitted facilities are represented below. Currently there are 51 small, 71 medium, and 16 large AFOs permitted and 131 unpermitted AFOs in the BGMA. The small, medium, or large designation for an AFO is determined by both the species and number of animals being fed at an operation. This specific classification criterion can be found in Title 130, *Livestock Waste Control Regulations*. Class I facilities represent an early classification system adopted by the Department which most directly correlates to a small or medium classification under the current regulations.

An AFO is defined as a location where animals are confined in an area devoid of vegetation, for a total of 45 days of more in any 12 month period. No unpermitted AFO, regardless of the size, shall discharge pollutants to waters of the State. If a discharge occurs, an inspection will be conducted to determine if the livestock waste control facility is required to contain runoff. Permitted facilities must contain runoff that is generated by storm events less in intensity that the 25-year, 24 hour rainfall event in addition to runoff averages for the month of June.

AFOs with animals which have direct access to surface waters are considered to be discharging. If the operation is not determined to be an AFO, NDEQ does not have authority under Title 130 – Livestock Waste Control Regulations to require producers keep their livestock out of streams. However, Chapter 9 Section 003 states, *"No new animal feeding operation shall be issued a National Pollutant Discharge Elimination System permit or a construction and operating permit in any part of a watershed that feeds directly or indirectly into a cold water class A stream, delineated pursuant to Neb. Rev. Stat. § 54-2421".* The East Branch Verdigre Creek (NI2-10320) is the only cold water class A stream in the BGMA; however, NDEQ actively encourages producers to fence off streams and provide an alternate source of water for their livestock. AFO complaints should be directed to NDEQ's Agricultural Section.

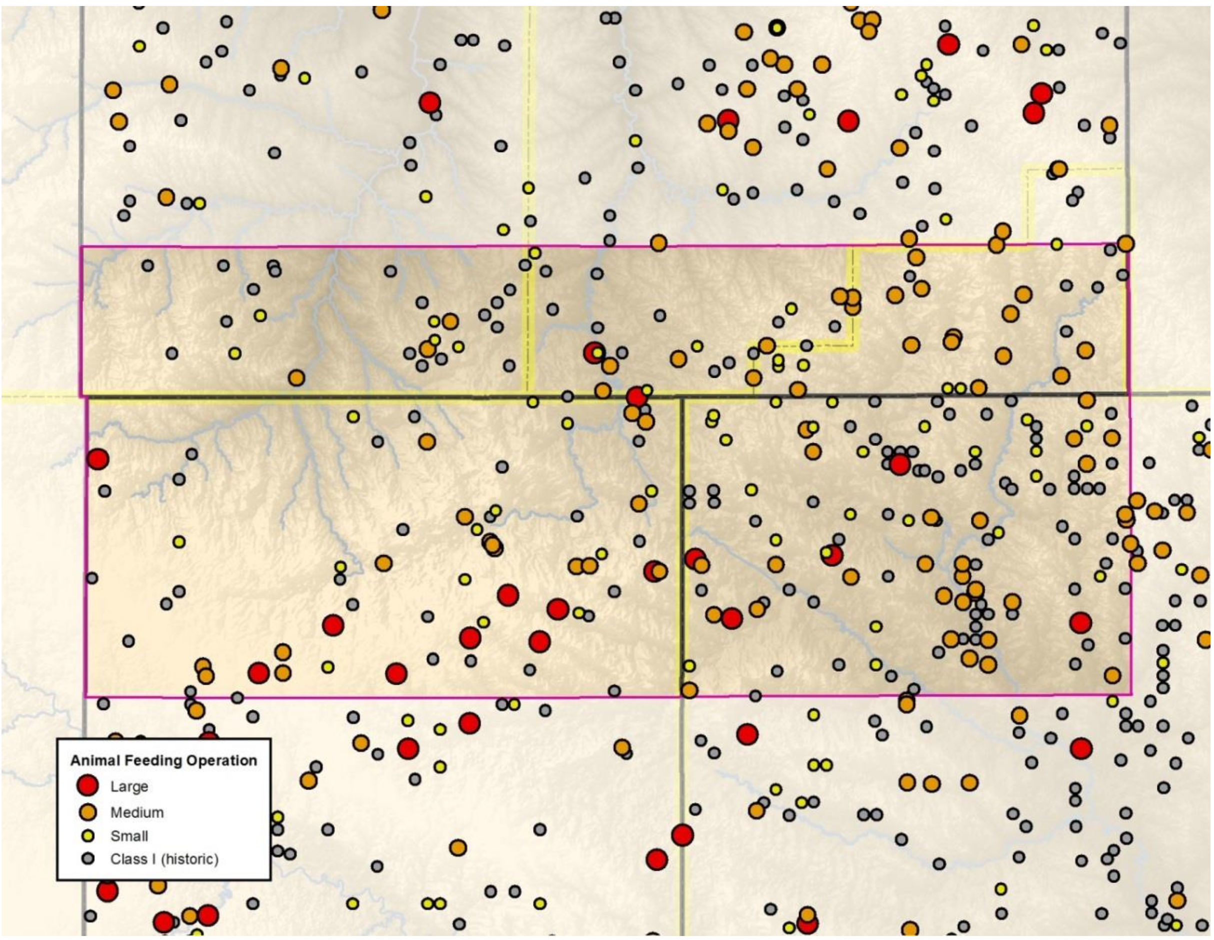


Figure 18. Active Animal Feeding Operations

4.0 Water Quality Concerns

4.1 Groundwater Quality Concerns

In 1990, the University of Nebraska's Conservation and Survey Division published results from a study of the Bazile Triangle area of concern. One hundred and seventeen irrigation and eight domestic wells were sampled for nitrates and chlorides during the late summer of 1989. Approximately 25 percent of the wells had nitrate values above 10 mg/L and an additional 45 percent had values ranging between 5 and 10 mg/L with the majority exceeding 7 mg/L. Samples from the northeast corner of the Bazile Triangle where glacial till is present, consistently ranged in nitrate values from 0-5 mg/L. The report indicated a strong correlation between nitrates and chlorides which suggests commercial fertilizer application practices as a likely source of the groundwater contamination. The report indicated the aquifers appeared to be contaminated with nitrates to varying degrees and the source was likely related to commercial fertilizer application and irrigation practices (UNL 1990).

Continued concerns of elevated groundwater nitrate levels in the drinking water supply near Creighton, NE lead the Lewis and Clark NRD to contract with the University of Nebraska-Lincoln Water Sciences Laboratory (UNL WSL) to conduct an assessment of agrichemical contaminants in the Creighton, NE area. The results of this study were published in 2000 in the "Evaluation and Assessment of Agrichemical Contaminants in the Creighton, NE Area" (UNL 2000). Eight clusters of nested wells were sampled for nitrates during the spring and fall for two years in addition to performing age dating analysis and deep vadose zone sampling up gradient of the nested wells. The study found a large area of groundwater contaminated by nitrates from commercial fertilizer exceeding 30 mg/L and dating back to the 1960s. The leading edge of this highly contaminated groundwater was found approximately 1.25 miles up gradient of the Creighton municipal well field and within the 20-year time of travel path. The area exceeding 30 mg/L was estimated to be about 830 acres in size. The study also identified a much larger area of groundwater nitrate contamination above 10 mg/L throughout the study area (Figure 19).

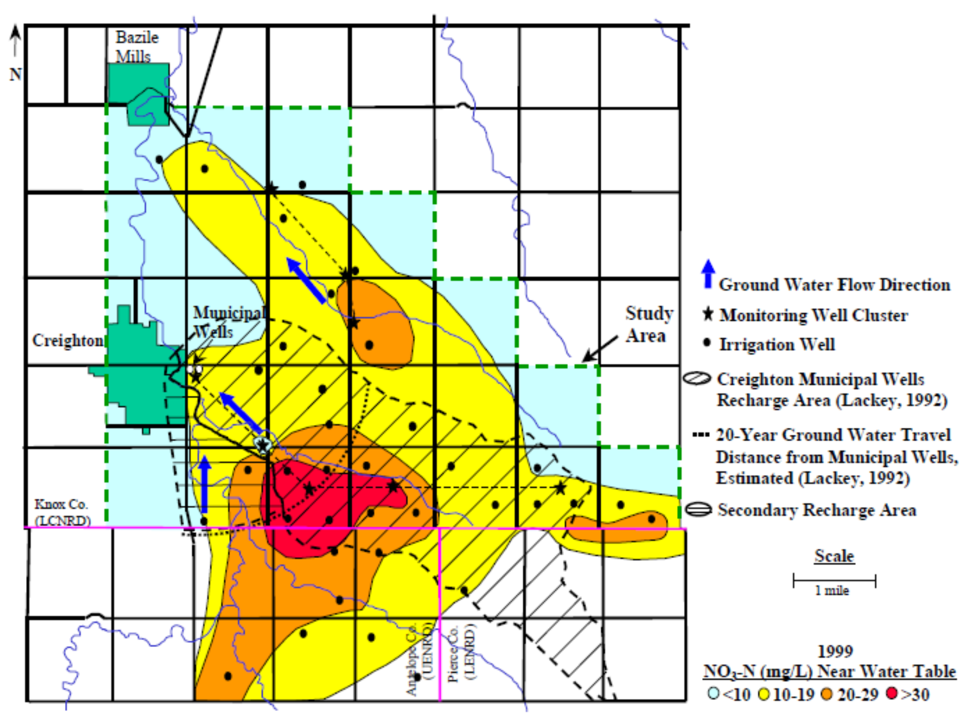


Image compliments of UNL's Water Science Laboratory

Figure 19. Groundwater Nitrate Contamination near Creighton, NE (UNL 2000)

Groundwater age dating analysis based on CFC-11 concentrations took place at five of the eight nested monitoring well clusters. The study estimated the approximate age of groundwater to range from 5 years in the shallow portion of the aquifer within the area exceeding 30 mg/L NO_3 to 36 years in the deepest portion of the aquifer below the moderately contaminated area where nitrate levels where recorded to be below 10mg/L (Figure 20). Three of the monitoring well clusters had to be vacuum pumped due to the small well diameter; therefore, samples could not be used in the CFC-11 age dating analysis (UNL 2000).

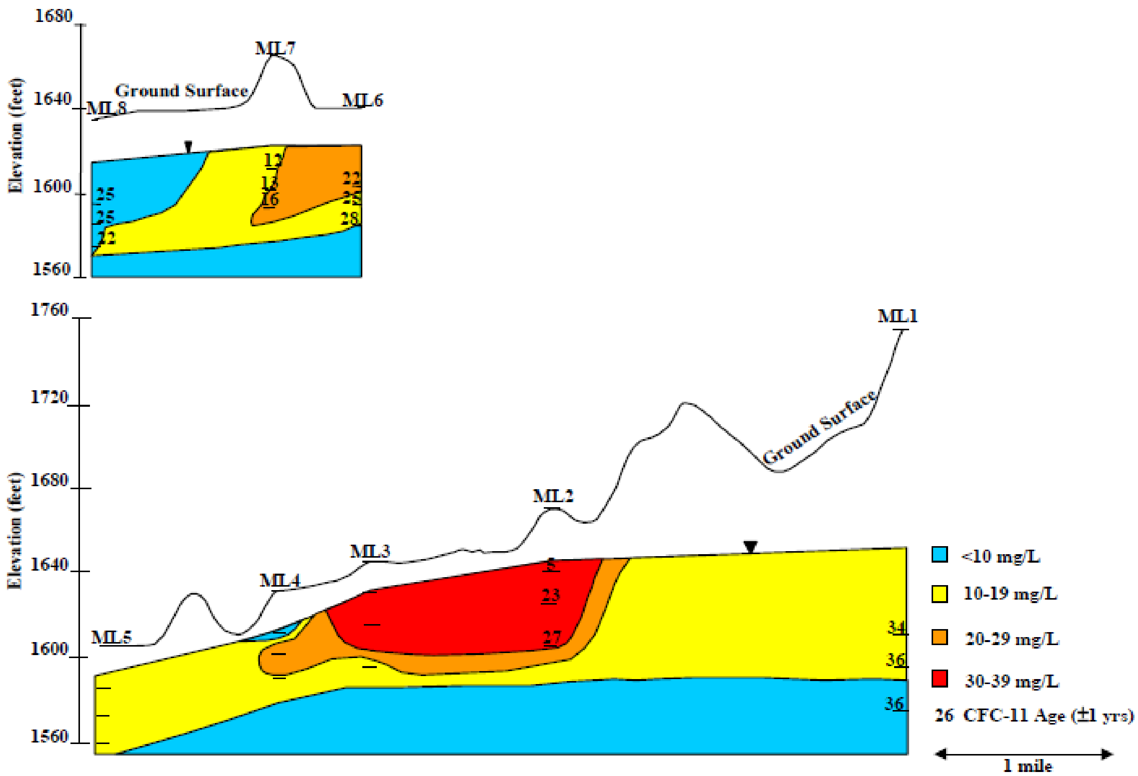


Image compliments of UNL's Water Science Laboratory

Figure 20. Groundwater Age Dating with CFC-11near Creighton, NE (UNL 2000)

Each NRD is required by statute to submit groundwater quality data to NDEQ or its identified agent (Neb. Rev. Stat. §46-1304). NDEQ has contracted with UNL to receive, compile, edit, and qualify the data. Once complete, the information is available to the public via the internet on the Quality Assessed Agrichemical Contaminant Database for Nebraska Groundwater (Clearinghouse) hosted by NDNR (http://NDNRdata.NDNR.ne.gov/clearinghouse/). For the BGMA, the database contains 6,028 entries that range from a single to multiple samples per well. Table 6 presents a summary of the information retrieved, broken down by well use type and NRD.

Because the data lacks uniformity, it is difficult to make direct comparisons from site to site. The NRDs each utilize different sampling schedules depending on the availability of staff and funds. The Upper Elkhorn and Lewis & Clark NRDs sample a selection of wells every year while the Lower Niobrara NRD samples a selection of wells in even and odd townships on opposite years. The Lower Elkhorn NRD samples a dedicated group each year in addition to phase II wells in Pierce County which are subject to once in four year sampling; therefore, data gaps may exist throughout the BGMA on an annual basis. Over the last several years these NRDs have made efforts to monitor the same wells on a year to year basis, thus creating a statewide groundwater monitoring network. Unfortunately, assessment of the data for trends, etc. is still not appropriate, given the variation of data from NRD to NRD. Efforts will continue to improve this collection process.

Table 6. Clearinghouse Nitrate Sample Data by Well Type

NRD	Domestic Well Samples	Irrigation Well Samples	Monitoring Well Samples	Livestock Well Samples	All Samples	Period of Record
Lewis and Clark	8	987	403	0	1398	1987-2013
Lower Elkhorn	18	1300	234	0	1552	1980-2013
Lower Niobrara	7	226	16	0	249	1987-2013
Upper Elkhorn	21	2064	731	13	2829	1980-2013
Total	54	4577	1384	13	6028	
% of Total	<1%	76%	23%	<1%		

Baseline data for the Bazile GWMA plan was established by taking the average of wells sampled more than once between 2004-2013. This data will provide a comparison for all future sampling. During the implementation of this project, the NRDs will continue to sample these same wells on the rotation set by each NRD until a uniform sampling method is established and approved by all four of the NRDs.

While the data and information may not all be statistically rigorous, it is useful and sufficient for assessment and reporting of the current groundwater status. For this assessment, the data was grouped by township rather than NRD as management often relies on similar grouping. An assessment is provided in Table 7 which includes: number of wells sampled, the township's first and last sample average for each well which has been sampled more than once over the years 2004-2013, the total number of wells that have shown a statistically significant increase, decrease or no change. Figure 21 shows the average nitrate concentrations per well, for all wells with more than one sample over the last ten year period from 2004 through 2013. Figure 22 utilizes data from Figure 22 to calculate the median per township and provides the sample size (n) per township.

Table 7. BGMA Township Nitrate Concentration Assessments

Township	N	Average NO_3-N of First Samples (mg/L)	Average NO_3-N of Most Recent Samples (mg/L)	Number of Wells with Increase in NO_3-N Concentration	Number of Wells with Decrease in NO_3-N Concentration	Number of Wells with No Change in NO_3-N Concentration
27N2W	20	14.7	13.5	6	6	8
27N3W	25	13.1	13.7	12	3	10
27N4W	22	9.8	9.9	3	3	16
27N5W	35	13.9	14.1	16	6	13
27N6W	29	14.3	15.3	13	8	8
27N7W	17	16.1	16.7	12	4	1
27N8W	20	15.5	17.2	12	4	4
28N2W	5	6.2	7.1	2	0	3
28N3W	20	8.4	8.0	5	7	8
28N4W	22	10.4	11.5	9	5	8
28N5W	21	14.7	14.6	11	9	1
28N6W	22	13.2	11.9	6	8	8
28N7W	12	12.8	11.2	3	7	2
28N8W	8	8.8	9.0	2	2	4
29N2W	2	0.8	1.1	0	0	2
29N3W	13	10.9	16.3	11	1	1
29N4W	42	11.0	12.2	23	6	13
29N5W	57	16.7	17.2	27	14	16
29N6W	12	16.7	14.9	5	5	2
29N7W	4	4.2	8.0	1	0	3
29N8W	15	5.7	8.9	8	4	3
Total	423			187	102	134

Of the 21 townships in the BGMA, 14 townships showed an average concentration exceeding the 10 mg/l maximum contaminant level for nitrate and more than 44% of the wells have shown an increase in nitrate concentrations over the last ten years from 2004-2013. Figure 23 shows a comparison of the average nitrate concentration per township for the composited first well samples and the most recent samples taken from 2004-2013.

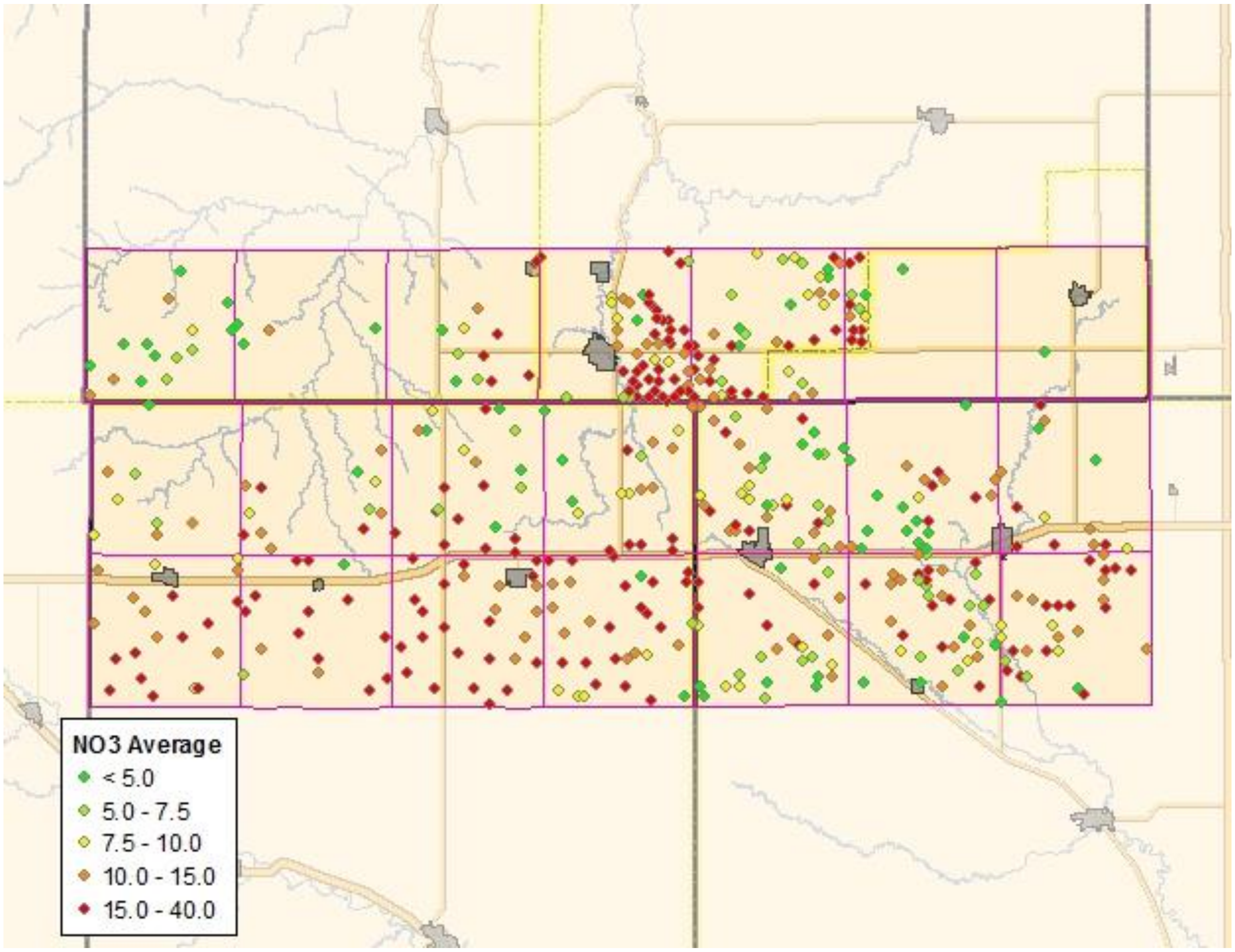


Figure 21. Average Clearinghouse Nitrate Concentrations per Well with > 1 sample (2004-2013)

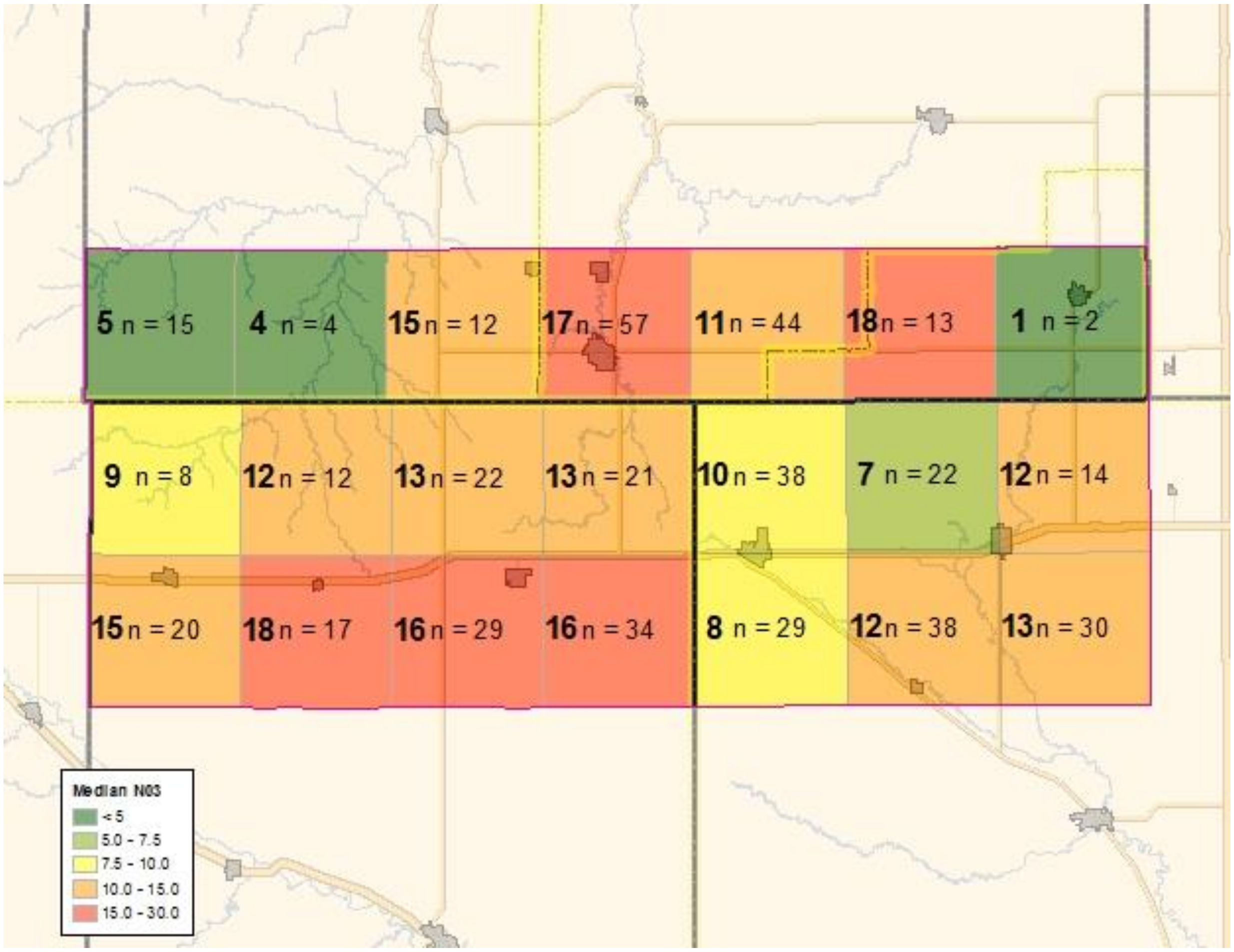


Figure 22. Median Nitrate Concentration (mg/l) per Township (2004-2013)

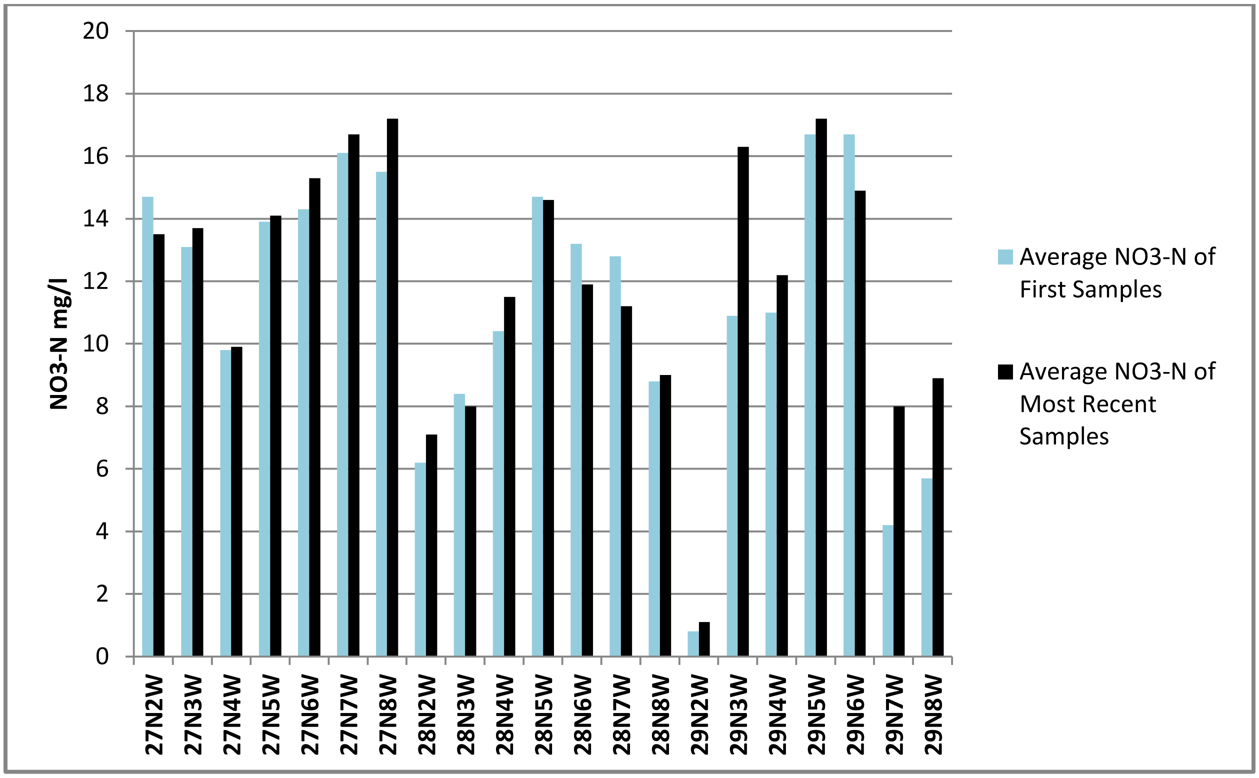


Figure 23. First and Last Sample Average Nitrate Concentrations by Township (2004-2013). *Note: this figure only represents wells that have been sampled more than once where the concentrations between the first and last sample vary from well to well.*

4.1.1 DRASTIC Index

EPA's Office of Research and Development created the DRASTIC Index in 1987, a standardized system for evaluating ground water pollution potential using hydrologic settings. The DRASTIC Index stands for the seven factors it utilizes to assess groundwater pollution potential; Depth to groundwater, net Recharge to the aquifer, Aquifer media, Soil media, Topography, Impact to vadose zone (unsaturated), and hydraulic Conductivity. The combination of these factors was used to create a pollution potential scale from 1 to 7, where 1 indicates a very low pollution potential and 7 indicates a very high pollution potential. The index accounts for a lack of data with an index rating of 0 (EPA 1987). The DRASTIC Index does not consider that farming does not occur in the alluvial/stream or that ground water in the area is moving towards the stream. The Index is included in this plan to show that the overall area has a relatively high potential to become contaminated. This figure should not be compared to the average nitrate concentrations per township; however, it does provide insight when compared to landuse, depths to groundwater, and well Clearinghouse contamination data. The BGMA was mapped using the DRASTIC Index (Figure 24) and the results reaffirm the NRD's groundwater nitrate data and previous UNL studies. This is especially evident where cultivated cropland and shallow groundwater areas overly locations with elevated pollution potential identified using the DRASTIC Index.

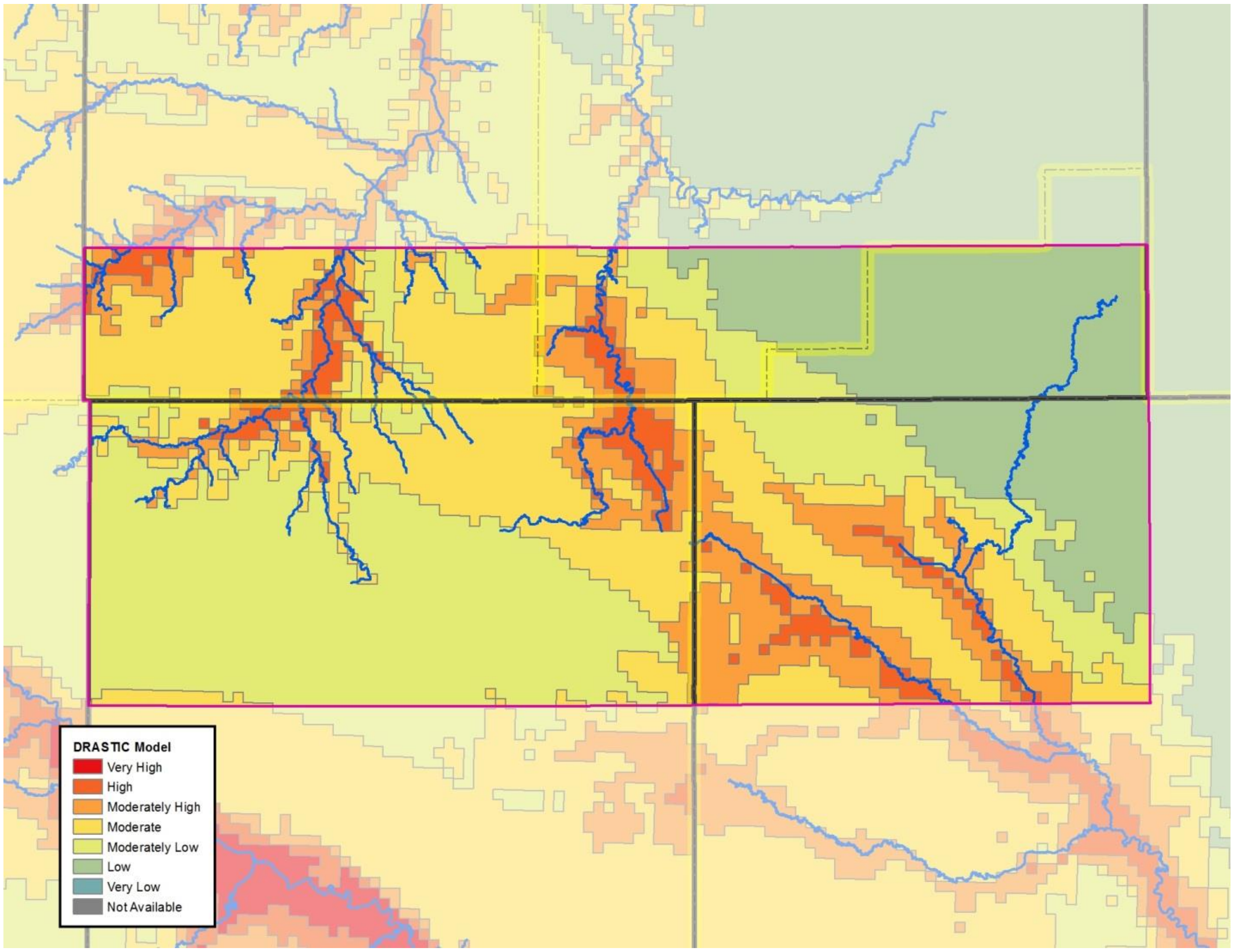


Figure 24. EPA's DRASTIC model of the BGMA

4.2 Surface Water Quality Concerns

Surface water quality is monitored and assessed against water quality standards by NDEQ. Nebraska's water quality standards are outlined in Title 117 Chapters 5 and 6 and are assigned to a waterbody based on that specific waterbody's designated uses. Table 8 outlines designated uses assigned to waterbodies within the BGMA. Monitoring results are reported to EPA and the public in the Integrated Report (IR) every even numbered year as required by the Clean Water Act (CWA). IR surface waterbody categories are explained in Table 9 and a summary of the 2016 IR for waterbodies within the BGMA is provided in Table 10.

The only nutrient impaired lake in the BGMA is NI2-L0060 Grove Lake (WMA) for TP, TN, and Chl a. Nutrient concentrations in the stream are elevated and appear to be contributing to eutrophication in Grove Lake. High nitrogen and phosphorus concentration in the stream under base flow conditions indicate that the groundwater feeding the stream is a major source of these pollutants. Within the BGMA, most streams are small tributaries running through privately owned agricultural fields. These streams would not be assigned a designated use for recreation therefore they are not assessed for E. coli bacteria. However, once the streams reach a large enough size to support a recreational use and are assessed, the monitoring data indicates the streams are impaired for *E. coli* bacteria. Every stream in Figure 25 both within and outside of the BGMA labeled as category 5 is impaired for *E. coli*.

Table 8. Title 117 Surface Water Designated Uses (NDEQ 2014A)

		Use Classification						
			Aquatic Life		Water Supply			
Waterbody Name	**WBID**	**Recreation**	**Coldwater**	**Warmwater**	**Agriculture**	**Aesthetics**	**Key Species**	**Comments**
Dry Creek - Sec 33-27N-3W to North Fork Elkhorn River	EL3-20400	X		B	A	X	10	Sensitive Species
Dry Creek - Headwaters to Sec 28-27N-3W	EL3-20500			B	A	X	10	Sensitive Species
North Fork Elkhorn River - West Branch North Fork Elkhorn River to Dry Creek	EL3-30000			B	A	X		
West Branch North Fork Elkhorn River	EL3-30100			B	A	X		
Breslau Creek	EL3-30110			B	A	X		
North Fork Elkhorn River (including Middle Branch North Fork Elkhorn River) - Headwaters to West Branch North Fork Elkhorn River	EL3-40000			B	A	X		
Plainview Country Club Lake (Sec 26-28N-5W)	MT2-L0060	X		A	A	X		Nutrient Class E
Bazile Creek - Unnamed Creek (Sec 3-28N5W) to Little Bazile Creek	MT2-12600			B	A	X		
Spring Creek	MT2-12610		B		A	X		
Unnamed Creek (Sec 21-29N-5W)	MT2-12620			B	A	X		
Unnamed Creek (Sec 3-28N-5W)	MT2-12630			B	A	X		
Bazile Creek - Headwaters to Unnamed Creek (Sec 3-28N-5W)	MT2-12700			B	A	X		
Grove Sandpit Lake (WMA) (Sec 34-28N-7W)	NI2-L0050	X		A	A	X		Nutrient Class W
Grove Lake (WMA) (Sec 27-28N-7W)	NI2-L0060	X	B		A	X		Nutrient Class W
Verdigre Creek - Confluence of South Branch & East Branch Verdigre Creek (sec 33-29N-7W0 to North Branch Verdigre Creek	NI2-10200	X		B	A	X		
Unnamed Creek (Sec 24-30N-7W)	NI2-10220		B		A	X		
Unnamed Creek (Sec 30-30N-6W)	NI2-10221			B	A	X		
Unnamed Creek (Sec 31-30N-6W)	NI2-10222			B	A	X		
Middle Branch Verdigre Creek	NI2-10230	X	B		A	X	12	Sensitive Species
Unnamed Creek (Sec 29-30N-7W)	NI2-10231			B	A	X		
Unnamed Creek (Sec 35-30N-8W)	NI2-10234			B	A	X		
Lamb Creek	NI2-10236			B	A	X		
Unnamed Creek (Sec 6-29N-8W)	NI2-10237		B		A	X	12	Sensitive Species
Unnamed Creek (Sec 6-29N-8W)	NI2-10238			B	A	X		
Unnamed Creek (Sec 2-29N-7W)	NI2-10250			B	A	X		
Unnamed Creek (Sec 11-29N-7W)	NI2-10260			B	A	X		
Merriman Creek - Unnamed Creek (Sec 25-28N-7W) to Verdigre Creek	NI2-10270	X	B		A	X	12,n	Sensitive Species
Unnamed Creek (Sec 25-28N-7W)	NI2-10271			B	A	X		
Merriman Creek - Headwaters to Unnamed Creek (Sec 25-28N-7W)	NI2-10280			B	A	X	12,n	Sensitive Species
Unnamed Creek (Sec 31-29N-6W)	NI2-10281			B	A	X		
Cottonwood Creek	NI2-10290			B	A	X		
South Branch Verdigre Creek - Headwaters to East Branch Verdigre Creek (Sec 33-29N-7W)	NI2-10300	X	B		A	X	12	Sensitive Species
East Branch Verdigre Creek - Grove Lake Dam (Sec 22-28N-7W) to South Branch Verdigre Creek (Sec 33-29N-7W)	NI2-10310	X	B		A	X	n,r	
Hay Creek	NI2-10311			B	A	X		
East Branch Verdigre Creek - Headwaters to Groove Lake Dam (Sec 22-28N-7W)	NI2-10320	X	A		A	X	e,n,r	
Unnamed Creek (Sec 6-28N-7W)	NI2-10330			B	A	X		
Unnamed Creek (Sec 12-28N-8W)	NI2-10340			B	A	X		
Big Springs Creek	NI2-10350		B		A	X	12	Sensitive Species
Hathoway Slough	NI2-10351			B	A	X		
Unnamed Creek (Sec 22-28N-8W)	NI2-10352			B	A	X		

Table 9. Integrated Report Surface Waterbody Categories (NDEQ 2016)

Category 1	Waterbodies where all designated uses are met.
Category 2	Waterbodies where some of the designated uses are met but there is insufficient information to determine if all uses are being met.
Category 3	Waterbodies where there is insufficient data to determine if any beneficial uses are being met.
Category 4	Waterbody is impaired, but a TMDL is not needed. Sub-categories within 4 outline the rationale for waters not needing a TMDL.
Category 5	Waterbodies where one or more beneficial uses are determined to be impaired by one or more pollutants and all of the TMDLs have not been developed

Table 10. Integrated Report Status for Waterbodies within the BGMA (NA = designated use not assessed, I = impaired designated use, and S = supported designated use (NDEQ 2016))

WBID	Waterbody Name	Recreation	Aquatic Life	Agriculture	Aesthetics	Overall	2016 IR	Impairments	Pollutants	Comments/Actions
EL3-20400	Dry Creek	I	S	NA	NA	I	5	Bacteria	*E.coli*	Aquatic Community Assessment
EL3-20500	Dry Creek		S	NA	S	S	2			Aquatic Community Assessment
EL3-30000	North Fork Elkhorn River		S	NA	S	S	2			Aquatic Community Assessment
EL3-30100	West Brank North Fork Elkhorn River		NA	NA	NA		3			
EL3-30110	Breslau Creek		NA	NA	NA		3			
EL3-40000	North Fork Elkhorn River		NA	NA	NA		3			
MT2-L0060	Plainview Country Club Lake	I	NA	NA	NA	I	5	Bacteria	*E.coli*	
MT2-12600	Bazile Creek		S	S	S	S	1			Aquatic Community Assessment
MT2-12610	Spring Creek		NA	NA	NA		3			
MT2-12620	Unnamed Creek		S	NA	S	S	2			Aquatic Community Assessment
MT2-12630	Unnamed Creek		NA	NA	NA		3			
MT2-12700	Bazile Creek		NA	NA	NA		3			
NI2-L0050	Grove Sandpit Lake (WMA)	NA	NA	NA	NA		3			
NI2-L0060	Grove Lake (WMA)	NA	I	S	S	I	5	Nutrients, Chl a	Total Phosphorus, Total Nitrogen	Fish Consumption Assessment
NI2-10200	Verdigre Creek	I	S	S	S	I	5	Bacteria	*E.coli*	Aquatic Community Assessment
NI2-10220	Unnamed Creek		NA	NA	NA		3			
NI2-10221	Unnamed Creek		NA	NA	NA		3			
NI2-10222	Unnamed Creek		NA	NA	NA		3			
NI2-10230	Middle Branch Verdigre Creek	I	I	S	S	I	5	Bacteria, Naturally High Temperature	*E.coli*	Aquatic Community Assessment
NI2-10231	Unnamed Creek		NA	NA	NA		3			
NI2-10234	Unnamed Creek		NA	NA	NA		3			
NI2-10236	Lamb Creek		NA	NA	NA		3			
NI2-10237	Unnamed Creek		NA	NA	NA		3			
NI2-10238	Unnamed Creek		NA	NA	NA		3			
NI2-10250	Unnamed Creek		NA	NA	NA		3			
NI2-10260	Unnamed Creek		NA	NA	NA		3			
NI2-10270	Merriman Creek	I	I	S	S	I	5	Bacteria, Naturally High Temperature	*E.coli*	
NI2-10271	Unnamed Creek		S	NA	NA	S	2			
NI2-10280	Merriman Creek		NA	NA	NA		3			
NI2-10281	Unnamed Creek		NA	NA	NA		3			
NI2-10290	Cottonwood Creek		NA	NA	NA		3			
NI2-10300	South Branch Verdigre Creek	I	S	S	S	I	5	Bacteria	*E.coli*	
NI2-10310	East Branch Verdigre Creek	NA	NA	NA	NA		3			
NI2-10311	Hay Creek		NA	NA	NA		3			
NI2-10320	East Branch Verdigre Creek	I	S	S	S	I	5	Bacteria	*E.coli*	Fish Consumption Assessment
NI2-10330	Unnamed Creek		NA	NA	NA		3			
NI2-10340	Unnamed Creek		NA	NA	NA		3			
NI2-10350	Big Springs Creek		NA	NA	NA		3			
NI2-10351	Hathoway Slough		NA	NA	NA		3			
NI2-10352	Unnamed Creek		NA	NA	NA		3			

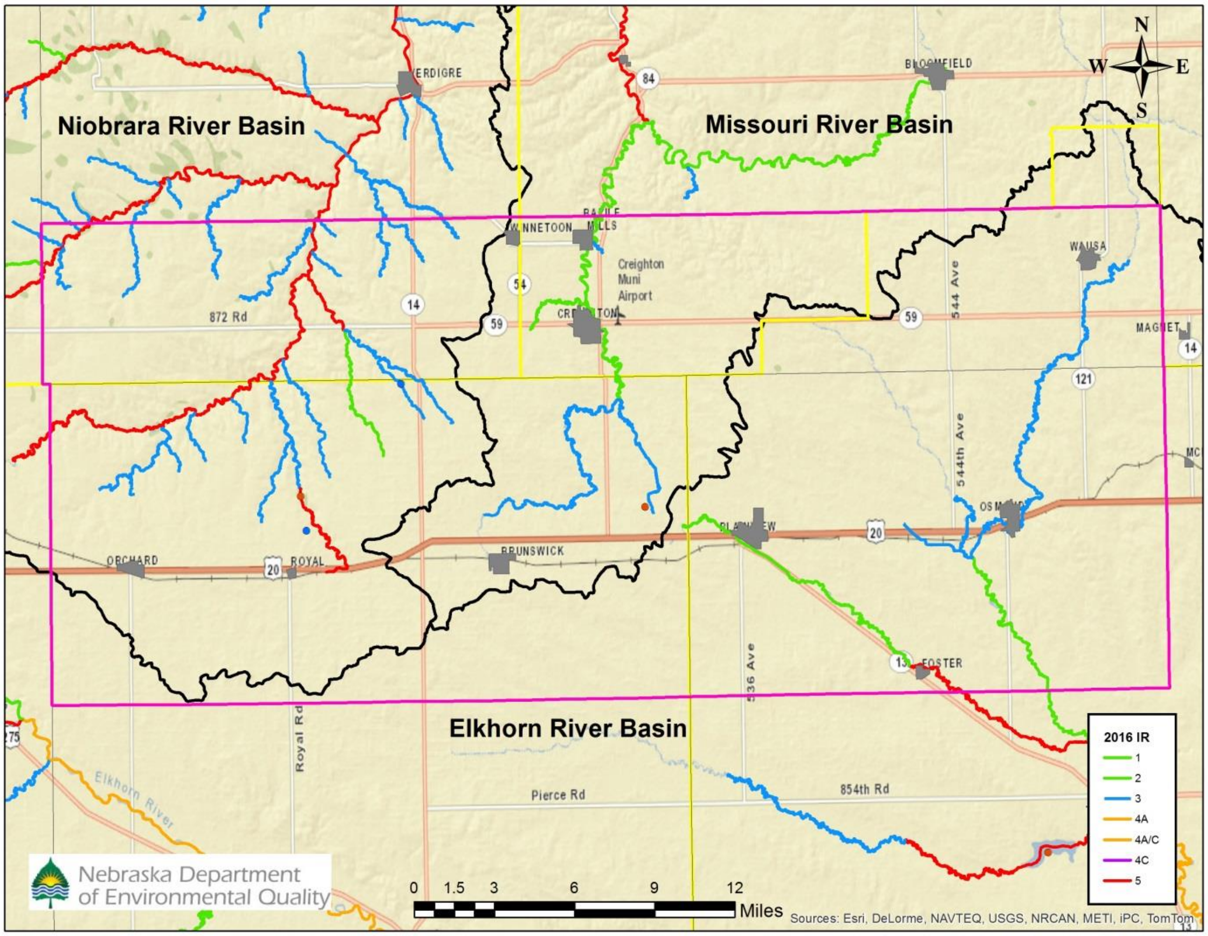


Figure 25. NDEQ's 2016 Integrated Report Status in the BGMA

4.3 Chemical Interactions of Groundwater and Surface Water

Hydrologically connected waters interact in the hyporheic zone, the saturated region beneath and alongside a stream bed where mixing of shallow groundwater and surface water occurs (Figure 26). The hyporheic zone acts as an ecotone allowing hydrological, chemical, zoological and metabolic exchange processes to take place. In their article *The Ecological Significance of Exchange Processes Between Rivers and Groundwater* Brunke and Gonser (1997) state, "The floodplain, hyporheic zone, and riverine aquifer as interconnected components of the fluvial system play a decisive role in the transfer of nitrogen in and between landscapes. These act as buffering zones between the terrestrial and aquatic environments for nitrogen compounds as well as other nutrients (e.g. orthophosphate, Fe, Ca, and Mg) because of their high retentive and transformative properties. Thus this riverine transition zone clearly has the filtering qualities of an ecotone."

In the BGMA groundwater generally contributes base flow to streams making the pollutant pathway one directional with many more outside factors effecting stream quality. Nitrogen processing occurs in hyporheic zones at the aerobic – anaerobic interface, due to the interchange of nitrification and denitrification. Under aerobic conditions, nitrifying bacteria oxidize ammonium to nitrate whereas in anaerobic zones the nitrate is either denitrified to nitrogen or reduced to ammonium. The extent of exchange processes occurring is directly related to the hydrological conductivity of the soil (Brunke and Gonser (1997)) (Figure 6).

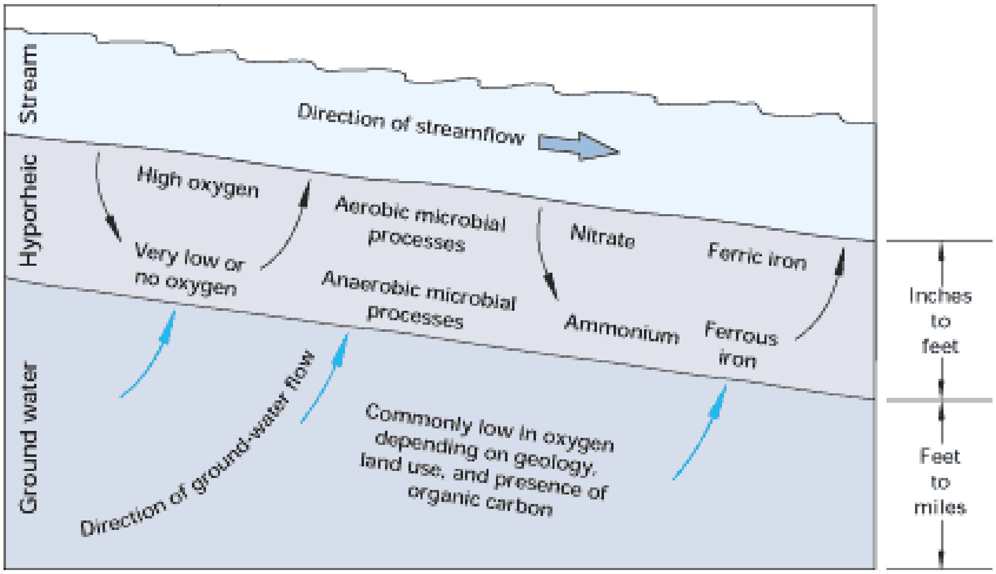


Image compliments of U.S. Geological Survey

Figure 26. Hyporheic Zone Diagram (USGS 2013)

NDEQ collected water samples on Bazile Creek downstream of Creighton in 2014 during the growing season to compare flow (cfs) to nitrogen concentration as NO_3 -N (mg/L). The data assessment included 21 weekly samples and showed a statistically significant correlation between nitrogen values and observed flow where the R^2 value was 0.0098. As flow increased from 7.8 cfs to 41.3 cfs, nitrogen values decreased from 14 mg/L to 3.3 mg/L indicating the main source of nitrates is from groundwater providing baseflow.

4.3.1 East Branch Verdigris Creek

The East Branch Verdigris Creek (EBVC) Watershed Management Plan was developed by the UENRD in 2005 to address the interaction of surface water and ground water quality and quantity in the EBVC watershed which lies entirely within the BGMA. Stakeholders were concerned with high levels of nitrates in their groundwater drinking water supplies for domestic and livestock use in addition to nitrates, phosphorous, and sedimentation in Verdigre Creek, Grove Trout Rearing Station's fish hatchery sediment basins, and Grove Lake. Sixty-four of the seventy area farmers participated in the planning process.

Groundwater data from 1980-2003 was analyzed for nitrogen trends and found to be increasing at an average rate of 0.49 mg/L per year. Nitrogen isotope analysis completed on 25 groundwater samples from 1990 and 2003 all resulted in isotopic signatures within the range of -2 to +6, that of commercial fertilizer. Samples taken from these same wells showed the age of groundwater with the highest nitrate concentrations to be 25 to 35 years old. This correlated with survey results where producers mentioned their fore-fathers applied excessive amounts of nitrogen in times where nitrogen management was not fully understood and was relatively cheap to purchase. A set of nested monitoring wells provided nitrate concentration gradient data from the saturated Quaternary sand and gravel above the Ogallala aquifer to the top and bottom of the Ogallala Aquifer. In the deep and medium depth wells screened in the Ogallala, the nitrate levels were 0.9mg/L and 1.0 mg/L while the shallow monitoring well ranged from 24.5mg/L to 30.4 mg/L.

Surface water samples where gathered by NDEQ from 2000-2002 on EBVC in the headwaters, just above Grove Lake and Grove Lake near the dam. Nitrate results were similar at both stream locations ranging from 9.19 to 12.21 mg/L with a median of 11.0 mg/L. Grove Lake samples near the dam ranged from 5.71 to 9.90 mg/L with a median value of 7.28 mg/L. The Upper Elkhorn NRD gathered additional surface water samples from 2000-2001. The results mirrored NDEQ's monitoring results listed above with the exception of additional monitoring sites near a spring. The spring samples showed nitrate values of 16.7 and 19.2 mg/L, which were significantly higher than any other surface water monitoring results. It was determined that under baseflow conditions both EBVC and Grove Lake exhibit the quality of groundwater supplying them (UENRD 2005).

A watershed coordinator was then hired for five years to assist implementation of the EBVC plan. Nutrient and irrigation BMPs were identified as the plan's main priorities. Resource assessments on 29,856 acres or 96.77% of the crop land was preformed and found that nutrient credits were not being applied correctly by producers. A $10 per acre incentive fee was used on 3,170 acres or 10.62% of the cropland to hire a crop consultant for four years where the producer would pay for the fifth year of service. The crop consultants' scouted fields, provided proper nutrient recommendations following UNL's nutrient recommendations and irrigation scheduling, and completed post-harvest nutrient and irrigation management reports. The resource assessment also found 65 illegal, inactive, or improperly designed wells throughout the watershed. A total of 41 wells, 7 of which were abandoned irrigation wells, were properly decommissioned using a 90% cost-share assistance program. Throughout the implementation of the plan, an additional 27 wells were identified as still needing attention. The final priority was to address failing septic systems identified through stakeholder interviews. A total of 11 systems were upgraded by a certified contractor with a 60% cost-share program. Overall education was conducted using stakeholder surveys, brochures continually distributed to local entities and information boxes, and promotional signs located near Grove Lake camping and picnic areas.

Through the implementation of the EBVC plan, average nitrogen recommendations, applied nitrogen, stalk nitrogen, irrigation water applied and water received by the crop all went down while at the same time available nitrogen, crop yield, nitrogen crediting, and water efficiency ratios all increased. Many insights were gained from the implantation efforts of the EBVC Plan. The most important adjustment made during the implementation period was to recognize where stakeholders were receptive to new information and ideas. Participation was somewhat low until crop consultants and a certified contractor were asked to champion proper nutrient and irrigation management as well as available cost-share programs. Another important issue was the lack of deep vadose zone and crop tissue analysis data to make informed management decisions. Data lags prohibited a post project water quality data analysis upon the conclusion of the watershed coordinator implementation project.

Due to the small geographic area of the EBVC, only seven wells were available for analysis, three of which were installed as nested dedicated monitoring wells by the UENRD in 2001. Available groundwater nitrate data for all well types over the period of record through the end of 2013 (Table 7) were separated into three categories based upon the screen interval depths (Figure 27). Shallow wells were considered anything screened through the first 164 feet and deep wells were screened from 165 feet or deeper. As discussed in section 3.1.2, a common practice in the early days of drilling was to maximize the capacity of a well and place screen through the shallow perched aquifer as well as the deep confined aquifer and gravel pack the annulus to the surface. This type of well construction provides a direct conduit for the highly contaminated shallow groundwater and the deep aquifer to intermingle. Wells that meet these conditions were considered separately as being screened at both depths and gravel packed to the surface. Figure 27 shows the groundwater contamination in the EBVC area is limited to the shallow perched aquifer and is only seen in deep wells that are also screened in the shallow perched aquifer.

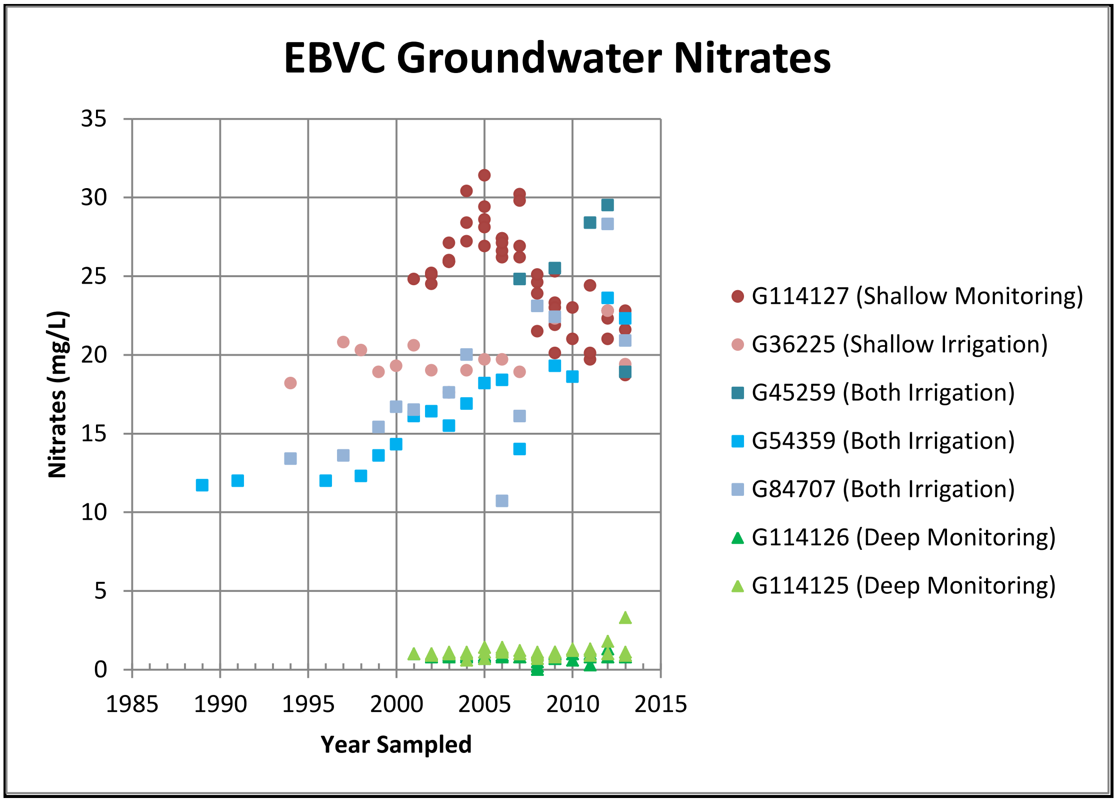


Figure 27. EBVC Groundwater Nitrates over time by Screened Interval Depths

The highest nitrate levels were observed in the shallow dedicated monitoring well (G114127) near Grove Trout Rearing Station (Figure 28) in 2005, the year the EBVC plan was approved. The data is showing a very rapid response to BMPs implemented over the following five years where observed nitrates peaked at 31.4 mg/L in 2005 and have steadily declined to 18.7 mg/l by 2013. This is a total decline of 12.7 mg/L over an eight year span with an average decline in nitrates of 1.59 mg/L each year. This well is located within a half mile of the Grove Trout Rearing Station and a little over a half mile from NDEQ's ambient stream monitoring location on EBVC. It is important to note that static water levels (SWLs), which are measured in the spring and fall, outside of the irrigation season, have not significantly changed over time.

Stream data from this ambient location (Figure 29) indicates nitrates have continued to rise reaching 15 mg/L in 2013 and 2014 from just under 12 mg/L in 2001. When the data are divided into growing season (March–August) and non-growing season (September-February), the non-growing season nitrates are consistently on average 2 mg/L higher than the growing season when nitrates are being transformed and sequestered. Corresponding flow data were also divided into growing and non-growing seasons. Growing season flows have been maintained while significant declines of 2 cfs have occurred over the last thirteen years during the non-growing season when snow melt and spring rains are not contributing to stream flow. The data are not only indicating baseflow decreases from groundwater but also the highly contaminated groundwater has begun to reach the stream. Using estimated lateral and downward groundwater movement rates for this area of 4.34 inches per day and 40 inches per year respectively, the highest levels of nitrates recorded in 2005 would have moved 1,053.2 ft. or half way to the stream and 26.66 feet deeper by 2013. By these estimates, the stream may continue to see increases in nitrates for another eight years before the effects of BMPs become evident in surface water (Figure 30). However, it must be stressed that there are many producers making landuse decisions throughout the watershed that may impact the stream. In general, groundwater moves toward the stream but time of travel rates change based on location and intensity of groundwater withdrawals as well as proximity to the stream.

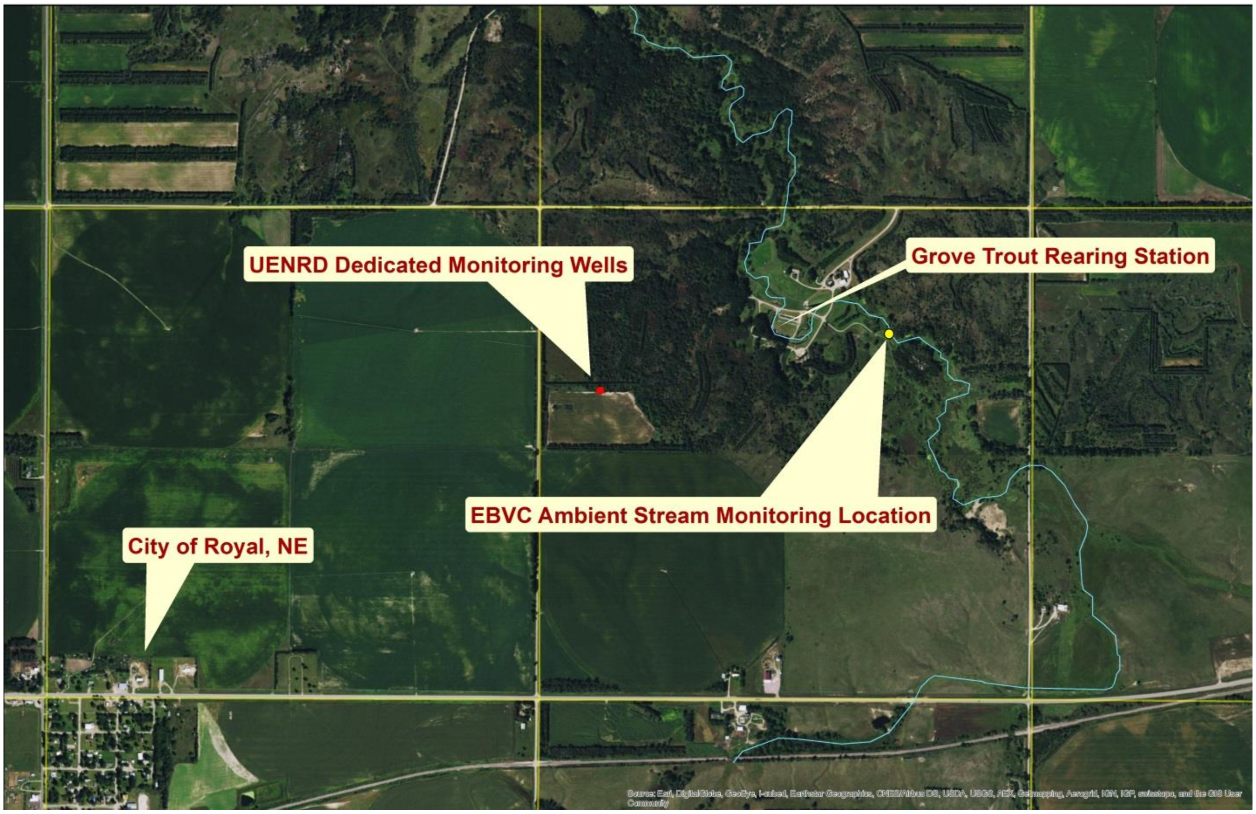


Figure 28. EBVC: Key Groundwater and Surface Water Monitoring Locations

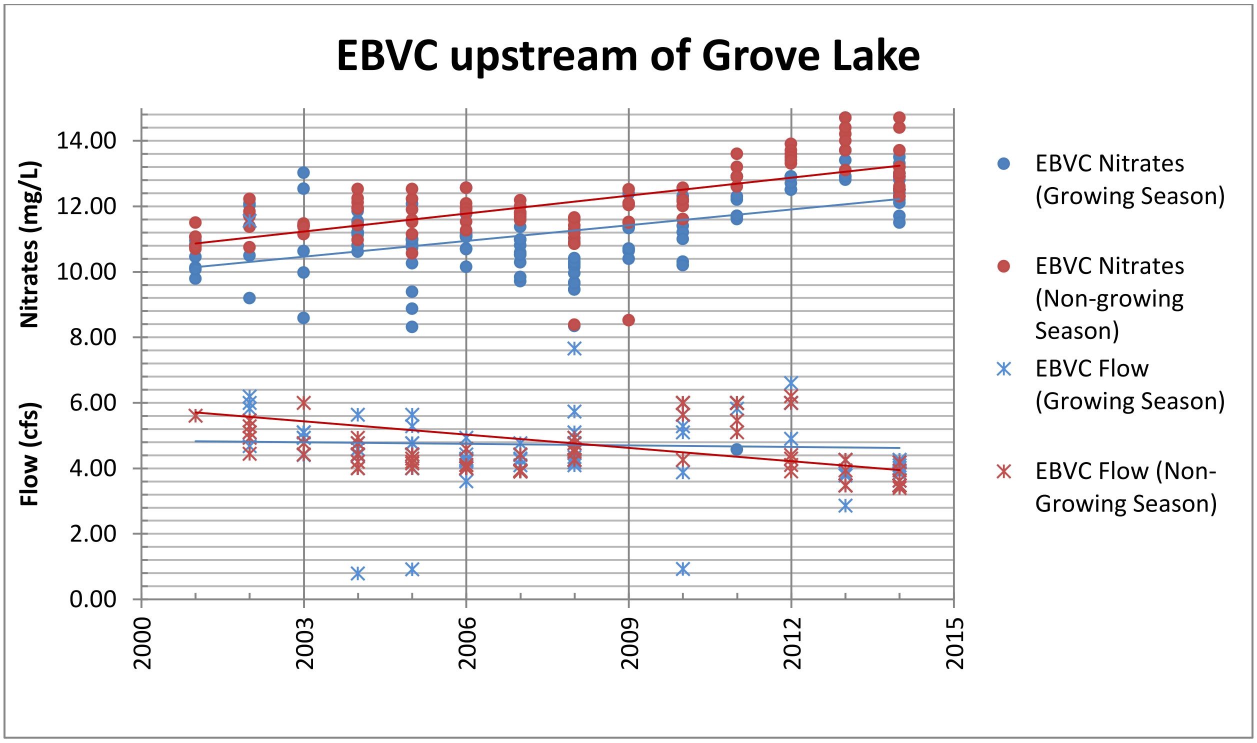


Figure 29. EBVC Ambient Stream Data (2001-2014)

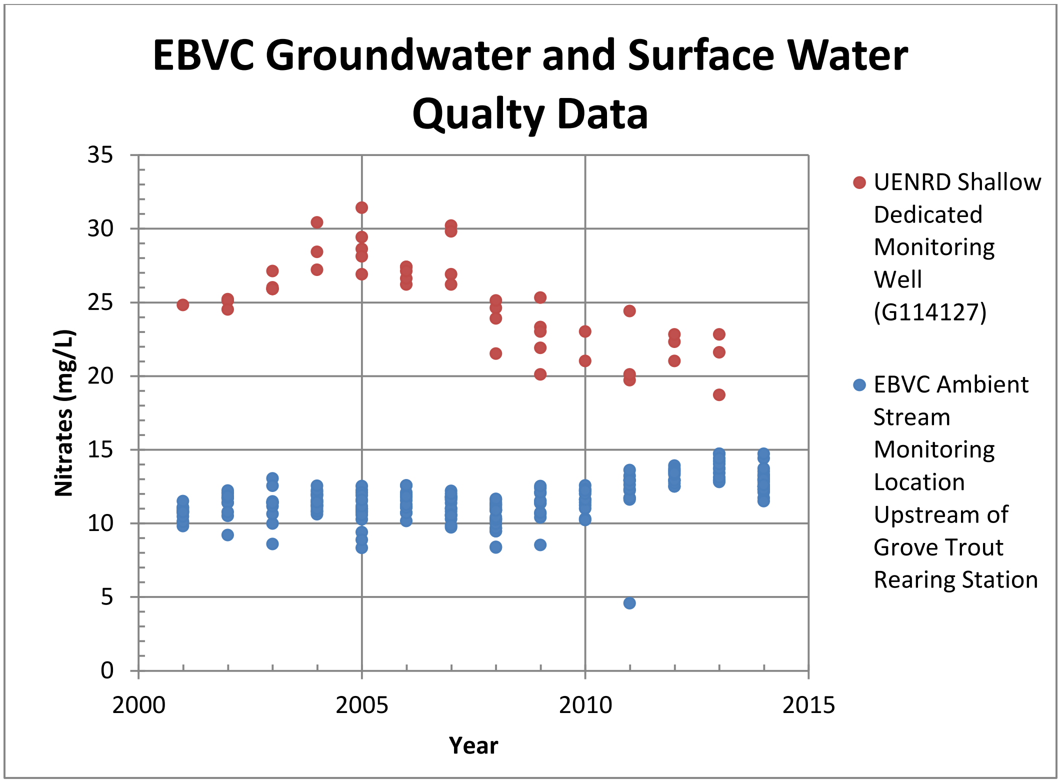


Figure 30. EBVC Groundwater and Surface Water Quality Data (2001-2014)

4.4 Nitrate Treatment Costs to the Area

The Cities of Creighton, Brunswick, Orchard, Osmond, and Plainview along with area domestic wells are dealing with high nitrates in their drinking water, with the Cities of Brunswick, Orchard, and Osmond currently under Administrative Order (AO) for nitrates. The strategies to treat contaminated water vary from utilizing reverse osmosis (RO) to replacing wells by either drilling deeper or in an area with lower nitrate levels. The cost to the area for these treatment techniques including operation and maintenance (O&M) over the last 20 years totals more than $9 million dollars (Table 11). Costs from Table 11 were either gathered from documented loan amounts through the United States Department of Agriculture (USDA), requested financial needs reported to the Nebraska State Revolving Fund (SRF), or estimated Point of Use (POU) treatment systems for domestic wells submitted by the NRDs. These communities can expect treatment costs to continue to rise into the future if the source of the contamination is not addressed. This plan is aimed at informing the public as well as educating and equipping decision makers with the necessary tools to make appropriate best management practice choices over the long term.

Table 11. Nitrate Treatment Cost to the BGMA Area

Municipalities	Population	AO	Treatment	Cost to Society
Creighton	1,250		Original RO Plant (excludes engineering and equipment)	1993 USDA Loan $606,507
			Reverse Osmosis Plant Rehab	Current SRF Loan $1,173,790
			O&M including annual depreciation over 20 years	Estimate Cost $3,492,820
Brunswick	179	AO	Replace wells, mains and meters	SRF 2014 Request $594,839
Orchard	391	AO	Place “bad well” (9.83 mg/l) on emergency use	
Osmond	796	AO	Replace wells, mains, tower and meters	SRF 2014 Request $1,682,309
Plainview	1,157		Replace wells and mains	SRF 2014 Request $1,269,667
Domestic Wells	248		POU Treatment Systems ($1,187.25 each)	Estimated Costs $294,438
	Total = 4,201			Total Cost $9,114,370

5.0 Groundwater Quality Regulations and Management

As reported previously, each NRD has a state approved groundwater management plan (GWMP) under the Groundwater Management and Protection Act to address threats to the quality of groundwater or contamination of the aquifer. Point source pollution is dealt with by the NDEQ whereas nonpoint source pollution is typically addressed by the NRDs, however, NDEQ has the authority under title 196 and the Groundwater Management and Protection Act to impose non-point source rules and regulations to protect groundwater quality. Each NRD independently developed their GWMP that includes incremental actions to mitigate pollution. The triggers set by each NRD within each plan that require additional management actions are shown in Table 12.

NRDs have several tools and options available for the protection and enhancement of groundwater. These range from voluntary programs to regulations with penalties for the failure to adhere to them. Cooperation by producers and other land owners is necessary for these actions to be effective and because of this, voluntary actions are preferred. The enforcement of regulations is more resource consuming than voluntary programs, which has to be a factor considered. Unfortunately, voluntary actions are not always undertaken and in these situations, groundwater management must move into the regulatory phase. Portions of this plan’s Actions and Task (Appendix E) are covered under regulatory requirements of the NRDs groundwater management plans shown in Table 13. These BMPs will be enforced by the NRDs’ under authority of Nebraska’s Groundwater Management and Protection Act (revised state statuses §46-701-754). For more information regarding Nebraska’s Groundwater Management and Protection Act visit http://nebraskalegislature.gov/laws/browse-chapters.php?chapter=46.

The NRDs heavily utilize education requiring each producer to regularly attend nitrogen management certification courses and complete annual crop reporting forms (Table 13). Crop reporting forms are the link between gathering data and utilizing the data to make educated nutrient management decisions. The forms require producers to document all sources of nitrogen and then use UNL's recommended nitrogen formula to make nutrient management decisions for the upcoming growing season. The formula considers previous year's crop as well as the current crop to account for possible legume credits. Organic matter and soil nitrogen analysis is credited as residual nitrogen and irrigation nitrogen water analysis as well as the quantity of irrigation water applied in inches is calculated to determine the irrigation water nitrate credit. The formula provides producers with the amount of additional nitrogen they should apply to the field in order to meet the crops needs. For more information regarding UNL's nitrogen recommendation formula visit http://ianrpubs.unl.edu/live/ec117/build/ec117.pdf.

Within an NRD's GWMP, the requirements placed on farm operations increase as the phase increases. Each of the NRDs has declared their entire district to be in Phase II of groundwater management which would include the BGMA. Phase III areas include 29N5W and the portions of 29N3-4W in the LCNRD. A map of current phase areas can be seen in Figure 31. The requirements of each of the NRDs' GWMP phases are shown in Table 13.

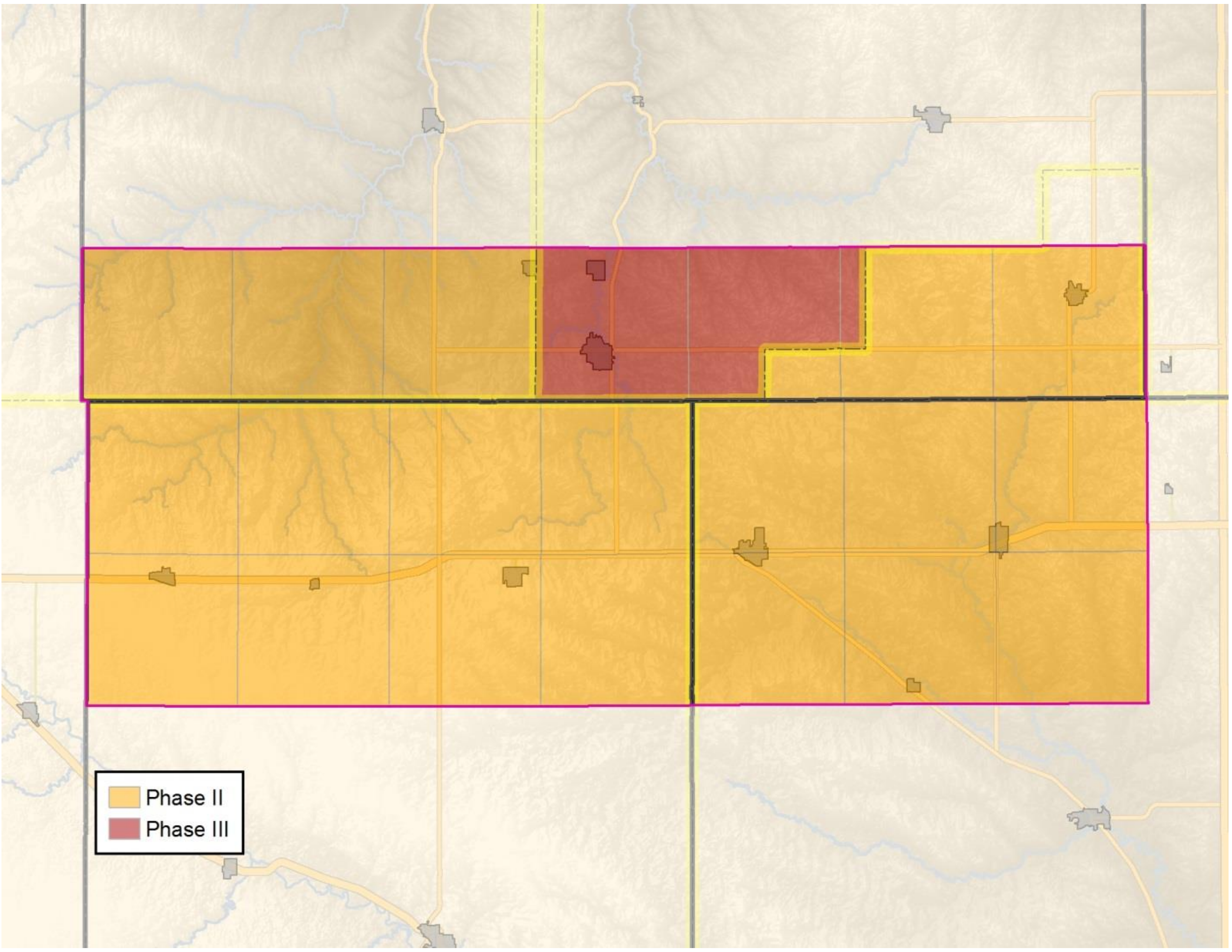


Figure 31. Current NRD Groundwater Management Phases

Table 12. NRD Groundwater Management Plan Nitrate Phase Triggers

NRD	Area Minimum Size	Phase I	Phase II	Phase III	Comments
Lewis and Clark	18 Square Miles	0-5.0 mg/l	Average reaches 50% of MCL for 2 years	50% of samples reach 90% of MCL for 3 years	MCL for Nitrate is 10 mg/l
Lower Elkhorn	9 Sq. Miles	0-5.0 mg/l	20% of area wells exceed 50% of MCL	50% of area wells exceed 90% of MCL for 5 years	
Lower Niobrara	Township or Sub-Township	0-5.0 mg/l	Average reaches 50% of MCL for 2 years	50% of samples reach 90% of MCL for 3 years	MCL for Nitrate is 10 mg/l
Upper Elkhorn	Township or Sub-Township	0-7.5 mg/l	>7.5-9.5 mg/l	>9.5 mg/l	

Table 13. NRD Groundwater Management Plan Requirements

NRD	Phase I	Phase II	Phase III
Lewis and Clark	Monitor irrigation water quality	Additional monitoring and studies	Nitrogen applicator certification
	Hydrologic studies	Voluntary preventative programs (deep soil testing cost share, well abandonment cost share)	Mandatory deep soil testing
		Increased information and education	Mandatory irrigation well monitoring
			Annual crop fertilizer report
			No fall or winter fertilizer application
			Spring application of nitrogen fertilizer encouraged to be split
Lower Elkhorn	All new wells must be permitted	Phase I requirements	Phase II requirements
	Voluntary education programs	Mandatory education program	Irrigation well volume output verified by the NRD
	Voluntary soil and water analysis and crop reporting	Mandatory soil and water analysis	Mandatory irrigation scheduling
		Periodic crop reports	Discretionary district controls

NRD	Phase I	Phase II	Phase III
Lower Niobrara	Nitrogen management certification required	Phase I requirements continued	Phase II continued – except as specified
	Fall and winter application of commercial fertilizer is discouraged	Fall and Winter application of commercial fertilizer not allowed until after November 1 and discouraged until March 1 unless applying <20 lbs/acre on Fall or Spring seeded crops	No application of commercial fertilizer until after March 1 unless applying <20 lbs/acre on Fall or Spring seeded crops
	Voluntary water analysis for all wells	Nitrogen applications >100 lbs/acre are encouraged to be split	Nitrogen applications >100 lbs/acre are required to be to be split with no more than 50% applied as pre-plant or pre-emergent unless a District approved inhibitor is used
	All new wells must be permitted	Deep soil nitrate analysis required on fields of at least 40 acres where 50 lbs of nitrogen is applied	Crop rotation plan and cover crops are required
	Recommend nitrogen fertilizer application rate be determined by UNL recommendations or a crop advisor certified by the American Society of Agronomy	Irrigation water analysis and flow meter results required for all irrigation wells supplying water to the field.	Irrigation scheduling, moisture sensors or weather stations required
	Deep soil sampling encouraged	Annual Crop reporting required	Two additional BMPs required
Upper Elkhorn	Nitrogen applicator certification	Deep soil sampling required	Town and Village residents applying nitrogen fertilizer to an area larger than one acre, must be certified, urban management classes will be offered
	Incorporate realistic yield goals	Submit annual crop report where more than 50 lbs/acre of nitrogen is applied	Annual nitrate and reporting requirements
	Encouraged to participate in annual BMP survey	Encouraged to incorporate credits for organic fertilizers and follow application rules and regulations	May require use of monitoring and distribution equipment
	Fall and winter applications discouraged. Spring applications >100 lbs/acre discouraged unless through split application	Fall application of all commercial fertilizers prohibited, winter applications discouraged	Groundwater Allocations

NRD	Phase I	Phase II	Phase III
	Groundwater analysis once/four years	Use of monitoring and distribution equipment encouraged	Annual Integrated Crop Management Report
	Encourage; domestic and stock well analysis, deep soil testing, calibration of application equipment, and implementation of alternative technology as available.		Application of commercial fertilizers prohibited until after March 1.

6.0 Community - Based Planning Process

As stated previously, NDEQ and the NRDs share the responsibility of managing groundwater quality within the state. Title 196 – Rules and Regulations Pertaining to Groundwater Management Areas (NDEQ 2002) under the statutory authority of the Groundwater Management and Protection Act describes the steps that must be taken when contamination of the groundwater has occurred and the district(s) have not completed an action plan for the designated management area or implemented protective measures. The Director must then specify specific protective measures with the enforcement of those protective measures then becomes the responsibility of NDEQ. In lieu of designating the groundwater management area, NDEQ has opted to work with the four NRDs in the BGMA to undertake a regional/community based planning process whereby local stakeholders establish the goals and objectives. This is a similar process NDEQ has utilized with other NRD's GWMAs throughout the state.

The Community-Based Planning (CBP) process is a locally driven approach to solving water quality problems. The process utilizes technical experts and area stakeholders to develop local solutions to local problems. This process has been utilized to address water quality problems in many Nebraska watersheds. By involving local stakeholders in the development of goals, objectives, applicable management efforts, and the specific cost-share/incentive programs, the potential for success is much greater. The CBP process is accomplished through a series of public meetings and interactive sessions between a Technical Advisory Committee (TAC) and Community Advisory Council (CAC) established for the project area.

The public is increasingly aware of and interested in environmental issues. They are interested in making sound environmental decisions as they relate to community development and long-term sustainability. Watershed partnerships formed through a CBP process can provide a forum for constructive negotiation and mediation, and promote opportunities for balancing environmental concerns with the economy.

These partnerships also bring groups and individuals together with agencies that have the technical expertise to support community-driven conservation initiatives. Linked to an effective funding strategy, locally led environmental stewardship can be a dynamic and responsive process with which we can protect our most valuable natural resources.

Historically, the CBP process has focused on surface water and watersheds and has been successful in the development of a local plan. The partnering NRDs all have utilized community based planning with surface water problems and desired to apply the process to a groundwater issue/region.

For the BGMA, a combined technical and community advisory council was convened to review information and establish goals and objectives for the area. The council included: NRD Board members and staff, local producers, municipal representatives, fertilizer and chemical dealers, rural water district operators, crop consultants, USDA Natural Resources Conservation Service nutrient management specialists, and representatives from the Nebraska Cattlemen Association. Several meetings were held to discuss problems and develop an action plan to address groundwater quality concerns. Table 14 provides the timeline from the planning process. The final product is this plan, which will be submitted to each NRD for appropriate action and implementation.

Table 14. Timeline for the BGMA Planning Process

Date	Event	Results
October 2011	NRD Hosted meeting with residents of the BGMA.	The NRDs and NDEQ undertake a review of the information.
December 2011	The four NRDs request groundwater management assistance from NDEQ.	NDEQ agrees to provide assistance to the NRDs and develop a community based plan.
February 2012	NRDs and NDEQ meet to discuss commitments required for community based plan.	Each NRD agrees to submit recommendations for technical and community advisory teams.
June 2012	Area description and problem defined and advisory team established.	Information distributed to advisory team for review and comment.
August 2012	Initial meeting of the advisory council.	Committee members were assigned a task of developing a list of goals and objectives.
October 2012	Advisory committee meeting.	Goals and objectives finalized; advisory committed assigned to develop a list of potential BMPs.
November 2012	Advisory committee meeting.	Developed a list of actions and tasks to be implemented.
January 2013	Advisory committee meeting.	Final draft of plan completed and the recommendation was made to present the plan to the public.
March 2013	Public meeting.	Comments received from the public and incorporated into the plan.
May 2015	Draft plan submitted.	NRDs submit draft plan to EPA for approval.
September 2015	NRDs, EPA, and NDEQ meet.	NRDs, EPA, and NDEQ agree on plan edits needed.
August 2016	Final draft plan submitted.	NRDs submit final draft plan to EPA for approval.

7.0 Plan Implementation

7.1 Priorities

For the purpose of implementing this plan, should available resources be limited, a priority ranking system has been developed to help resolve funding conflicts (Table 15). As outlined in the plan, Wellhead Protection Areas are of the highest priority due to the serious health concern for area residents and costly treatments needed to address nitrate contamination in groundwater. Tier 1 areas encompass entire sections that are wholly or partially within the 20 year time of travel (TOT) for each community public water supply system's wellhead protection area. Tier 2 includes extended wellhead protection areas beyond the 20 year TOT out to the 50 year TOT. Tier 2 priority areas have also been expanded to include entire sections for management purposes. Tier 3 areas encompass entire sections that are either within or partially within the close proximity buffer of 1 mile for the East Branch Verdigre Creek that are not already included in the town of Royal's Tier 1 or 2 areas. Tier 4 priorities include the entire outstanding BGMA which is considered a priority for both the NRDs and NDEQ (Figure 32). See Appendix C for a list of legal land descriptions within each Tier.

Table 15. Priorities (Tier 1 – Tier 4)

Priorities		Acres	Percent of BGMA
Tier 1	Wellhead Protection Areas (expanded 20 year TOT)	31,224	6.5%
Tier 2	Wellhead Protection Areas (expanded 50 year TOT)	53,112	11.0%
Tier 3	East Branch Verdigre Creek Watershed (expanded buffer)	10,167	2.1%
Tier 4	BGMA Outside of Tier 1 - Tier 3 Areas	389,337	80.5%

Table 16. Priority Area Benchmarks using Baseline Wells (See Appendix F)

Priority Area	N	Average NO_3-N of First Samples (mg/L)	Average NO_3-N of Most Recent Samples (mg/L)	Number of Wells with Increase in NO_3-N Concentration	Number of Wells with Decrease in NO_3-N Concentration	Number of Wells with No Change in NO_3-N Concentration
Tier 1	52	16.1	17.6	31	14	7
Tier 2	50	13.4	14.2	26	8	16
Tier 3	7	15.7	14.9	2	2	3
Tier 4	314	12.2	12.6	128	79	107
Total	423			187	103	133

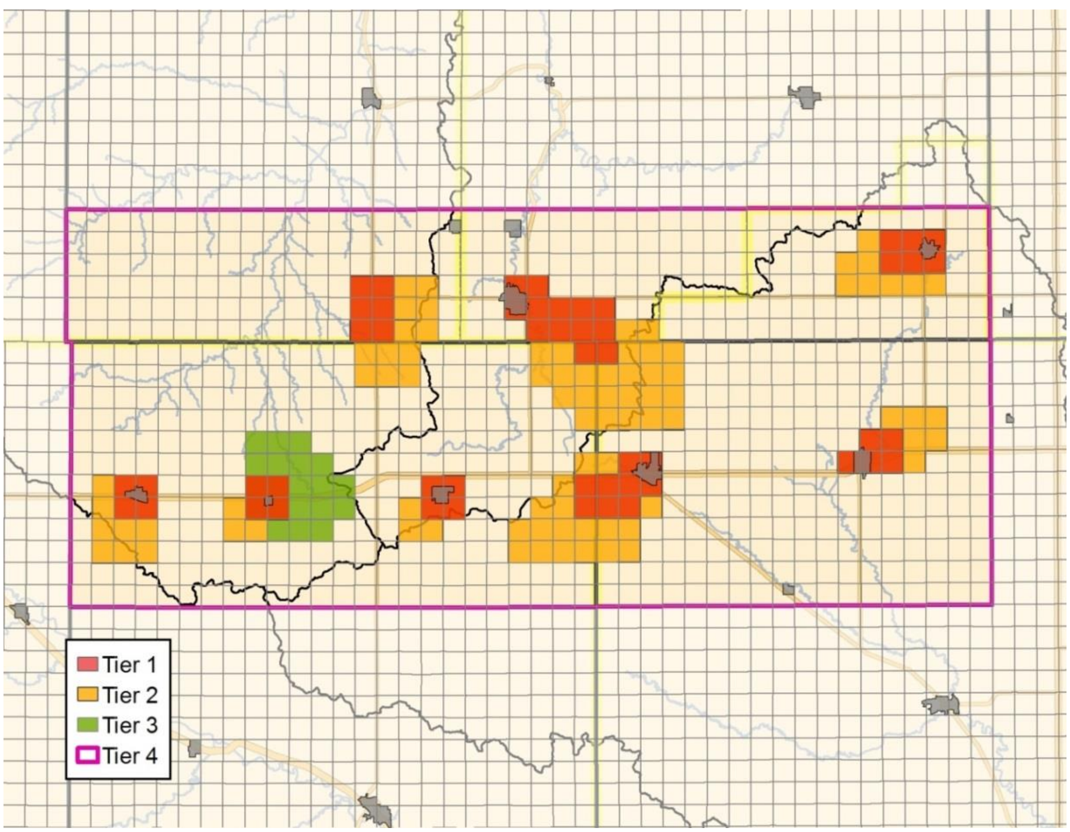


Figure 32. BGMA Priority Areas (Tier 1- Tier 4)

7.2 Load Reductions

Scientific evidence suggests that the implementation of nonpoint source management best management practices will result in groundwater quality improvements and reduction of groundwater nitrate concentrations. However, there exists a significant body of conflicting literature on the reduction of nitrate loadings to groundwater available from a variety of site-specific studies. Load reductions in groundwater are highly variable due to site-specific conditions such as land use management practice(s) selected and soil variability, lag time, hydrogeological conditions, climate, and microbial activity.

The EPA Document "National Management Measures for the Control of Nonpoint Pollution from Agriculture " (EPA-841-B-03-004) summarizes the literature, providing background information on agricultural NPS pollution of both surface and groundwater and discusses the concept of addressing water quality problems at a watershed level. Technical information and a general discussion of BMPs to protect both surface and groundwater are given in Chapter 3. Table 3.1 is a simplified table, developed from empirical data and field experience, from the NRCS Field Office Technical Guide that summarizes NRCS conservation practices and whether they are beneficial to surface and groundwater. Practices supported by evidence in literature to reduce nitrate loadings to groundwater are considered in this plan. See Appendix E for a list of priority BMPs with a summary of their corresponding surface water and groundwater benefits.

The reduction of contaminant concentrations over time is a meaningful equivalent to load reduction for surface water. For the purposes of this plan, short term load reductions will be estimated by the reduction in the amount of irrigation water and nitrogen applied based on the University of Nebraska's fertilizer recommendation algorithm reported in the annual crop reports versus historical actions. Load reductions will also be quantified and reported by the total acres enrolled in best management practices, the number of properly abandoned wells, and upgraded septic systems in addition to groundwater quality data gathered by each NRD from established baseline wells. As the plan is implemented and more data is gathered, such as vadose zone data and screened intervals of individual wells, the individual Tier 1 and 2 area targets will be refined.

Groundwater nitrate reduction targets were developed by utilizing the average NO_3-N of the most recent samples for each Tier to estimate the reduction percentage needed to meet either the drinking water criteria of 10 mg/L or a step reduction to 8 mg/L towards meeting the aquatic life criteria for Western Lakes of 0.8 mg/L. This aquatic life criterion for nitrogen is lower than the background levels documented in deep confined wells within the EBVC. It is understood that additional reductions will take place in the ecotone as groundwater becomes surface water as well as through denitrification which occurs in flowing streams. The reduction % needed was multiplied by the acres in each tier to provide the estimated number of acres needing to be addressed by BMPs (Table 17).

Table 17: Groundwater Nitrate Reduction Targets

Prioriy Areas	Acres	Average NO_3-N of most recent samples	Reduction % needed	Acres Needing BMPs
Tier 1	31,224	17.6	45%	14,051
Tier 2	53,112	14.2	30%	15,934
Tier 3	10,167	14.9	46%	4,677
Tier 4	389,337	12.6	21%	81,761
Total	483,840			116,422

7.3 Goals

Plan goals were developed by the advisory council with assistance from the technical advisors, and have been approved by all four NRDs. Overall plan goals are to reduce groundwater nitrates to below the drinking water standard and to insure groundwater is not impairing surface water beneficial uses. It is recognized that nitrate contamination of groundwater does not occur nor recover rapidly and varies from location to location depending on many hydrogeological factors, therefore, pollutant reductions are not likely to occur rapidly and will be quantified differently for both short and long term goals.

Short Term Goal (5 years)

1. The trend of rising groundwater nitrate concentrations within the Tier 1-3 priority areas will be halted.

Long Term Goal (20 years)

2. Nitrate concentration in Tier 1 areas will be below 10 mg/L and no public water supplies will be on administrative order.

3. Groundwater nitrate concentrations in Tier 2 priority areas will be reduced and maintained at a level below the drinking water standard of 10 mg/L.

4. Groundwater contamination and other nonpoint source activities will not impair surface water beneficial uses in the Tier 3 priority area.

7.4 Objectives and Tasks

The items listed below will be periodically reviewed and revised as the implementation of the plan progresses. Efforts will be prioritized for the first three Tiers which amount to 20% of the BGMA. Any funding from CWA Section 319 will focus in the Tier 1 and 2 priority areas. It should be noted that all of the practices are specific to the BGMA where some items may also be requirements of the NRDs' elevated groundwater management plan phases (Table 13); practices that go above and beyond the applicable NRD requirements will be eligible for CWA Section 319 funds. Septic system upgrades, reduced tillage, and urban BMPs will not be eligible for CWA Section 319 funds under this plan. Many practices utilized to alleviate groundwater contamination also positively impact surface water quality as outlined in Appendix E: Surface water and Groundwater BMP Benefits.

Goal 1 Objectives and Tasks

1. Contact 100% of stakeholders in Tier 1-3 areas to educate them on the importance of environmental stewardship, and high quality water as well as nitrate contamination in the groundwater.

    a. Educate 100% of the communities in the BGMA through personal contact, mailings and public meetings on current nitrate issues and efforts available to protect their public water supplies and educate communities without wellhead protection plans on the importance of developing a plan.

    b. Inform 100% of landowners and producers in the Tier 1-3 areas through personal contact, news releases, mailings, and workshops on nitrate issues in their area and opportunities available to improve and protect water quality through their personal operation.

c. Inform 100% of the crop consultants, fertilizer dealers and others agricultural service providers in the area through one on one contact, phone conversations, and mailings about water quality issues in the BGMA and BMP assistance available to their clients.

2. Implement and properly maintain agricultural and/or urban BMPs on a total of 11,542 acres or 33% of the acres needing to be treated in Tier 1-3 areas.

    a. Utilize UNL Extension Educators to assist communities identify existing and develop additional urban BMPs tailored to their individual needs.

    b. Partner with agricultural service providers to promote agricultural BMPs and assistance programs for priority BMPs outlined in Appendix E**.**

3. Identify inadequate septic systems within the Tier 1-3 areas that could be contributing to groundwater contamination and develop a priority funding system to upgrade 100% of the identified systems to current state standards.

    a. Survey landowners and collaborate with a certified contractor to identify and upgrade failing septic systems to current state standards.

4. Identify abandoned wells within the Tier 1-3 areas that could be accelerating groundwater contamination and develop a priority funding system to properly decommission 100% of the identified wells.

    a. Survey landowners to identify abandoned wells and assist the landowner to work cooperatively with NDNR and the NRD to properly decommission the wells.

Goal 2 Objectives and Tasks

1. Continue to contact 100% of stakeholders in Tier 1 areas to educate them on the importance of environmental stewardship, and high quality water as well as nitrate contamination in the groundwater.

    a. Educate Tier 1 communities in the BGMA through personal contact, mailings and public meetings on current nitrate issues and efforts available to protect their public water supplies and educate communities without wellhead protection plans on the importance of developing a plan.

    b. Inform Tier 1 landowners and producers in the Tier 1 areas through personal contact, news releases, mailings, and workshops on nitrate issues in their area and opportunities available to improve and protect water quality through their personal operation.

    c. Contact crop consultants, fertilizer dealers and others agricultural service providers in the Tier 1 area through one-on-one contact, phone conversations, and mailings about water quality issues in the BGMA and BMP assistance available to their clients.

2. Contact 100% of the community public water supply systems to assist them in developing a wellhead protection plan.

a. Contact the community public water supply systems without a wellhead protection plan and provide assistance to develop an approvable wellhead protection plan.

3. <u>Reduce and maintain groundwater nitrate concentrations below 10 mg/L in all Tier 1 Wellhead Protection Areas for community public water supply systems.</u>

   a. Implement and/or properly maintain agricultural and/or urban BMPs on a total of 14,051 acres or 45% of the Tier 1 areas.

   b. Assist landowners to properly decommission 100% of the abandoned wells in the Tier 1 areas that were identified in the landowner survey.

   c. Assist home owners to upgrade 100% of the inadequate septic systems in the Tier 1 areas to current state standards that were identified in the landowner survey.

<u>Goal 3 Objectives and Tasks</u>

1. <u>Continue to contact 100% of stakeholders in Tier 2 areas to educate them on the importance of environmental stewardship and high quality water as well as nitrate contamination in the groundwater</u>

   a. Inform landowners and producers in the Tier 2 areas through personal contact, news releases, mailings, and workshops on nitrate issues in their area and opportunities available to improve and protect water quality through their personal operation.

   b. Contact crop consultants, fertilizer dealers and others agricultural service providers in the area through one-on-one contact, phone conversations, and mailings about water quality issues in the BGMA and BMP assistance available to their clients

2. <u>Reduce and maintain groundwater nitrate concentrations below 10 mg/L in all Tier 2 priority areas.</u>

   a. Implement and/or properly maintain agricultural and/or urban BMPs on a total of 15,934 acres or 30% of the Tier 2 areas.

   b. Assist landowners to properly decommission 100% of the abandon wells in the Tier 2 areas that were identified in the landowner survey.

   c. Assist home owners to upgrade 100% of the inadequate septic systems in the Tier 2 areas to current state standards that were identified in the landowner survey.

<u>Goal 4 Objectives and Tasks</u>

1. <u>Continue to contact 100% of stakeholders in the EBVC Tier 3 area to educate them on the importance of environmental stewardship and high quality water, surface water quality and quantity issues as well as groundwater nitrates and depletions to baseflow.</u>

   a. Inform landowners and producers in the Tier 3 area through personal contact, news releases, mailings, and workshops on surface water and groundwater quality and quantity issues and opportunities available to improve and protect water quality and quantity through their personal operation.

   b. Contact crop consultants, fertilizer dealers and others agricultural service providers in the area through one-on-one contact, phone conversations, and mailings about water quality and quantity issues in the Tier 3 area and BMP assistance available to their clients

2. Reduce and maintain groundwater nitrate concentrations below the step reduction of 8 mg/L towards Westerns lakes surface water quality criteria of 0.8 mg/L in the Tier 3 priority area.

   a. Implement and/or properly maintain agricultural and/or urban BMPs on a total of 4,677 acres or 46% of the Tier 3 area.

   b. Assist landowners to properly decommission 100% of the abandon wells in the Tier 3 area that were identified in the landowner survey.

   c. Assist home owners to upgrade 100% of the failing septic systems in the Tier 3 area to current state standards that were identified in the landowner survey.

7.5 Additional Short-Term NRD Actions (5-years)

The BGMA NRDs will work together and with other agencies to continue to collectively manage and gather data needed to improve water resource management and educate decision makers by completing the following items.

1. Adopt Uniform Groundwater Management Triggers and Phases across the BGMA
   The NRDs will develop a special area within each of their groundwater management areas that will enable them to adopt uniform triggers and phases within the BGMA.
2. Vadose Zone Sampling
   The NRDs will establish baseline vadose zone nitrate conditions for each Wellhead Protection Area within the first five years and conduct re-assessments every 10 years to track nitrate movement and estimate future loads to groundwater.
3. Aquifer Source Inventory
   The NRDs will identify the screened interval(s) of all baseline wells within the Tier 1-3 areas and refine monitoring and evaluation of BMP effectiveness based on results.
   The NRDs will identify data gaps in the baseline wells for Tier 1-3 areas and identify potential locations to install monitoring wells.
4. Well Construction and Rehabilitation
   The NRDs will adopt water well construction standards to protect confined aquifers.
   The NRDs work with the NDEQ's Groundwater Section to identify poorly constructed wells and conduct a well rehabilitation demonstration in a Tier 1-3 area.

7.6 Information and Education

Public outreach and education on groundwater concepts are essential for managing the resource. Educating stakeholders is one step in protecting and improving water quality. One of the primary goals of this project is be to decrease groundwater nitrates by increasing the usage of agricultural and urban best management practices for irrigation and nitrogen management through educating decision makers. The following techniques and activities will be used to deliver information and provide hands-on learning opportunities.

- Publish the information (charts, graphs, etc) in the NRDs' newsletters.
- Present the information annually to the NRDs' Board of Directors at a public meeting.

- Continue to integrate the information into the current nitrogen and irrigation management workshops.
- Partner with agricultural service providers to develop BMP demonstration fields for priority BMPs (Appendix E) not already required by the NRDs.
- Utilize the NRD web sites, Facebook pages, and other social media to distribute information.
- Prepare and distribute news releases to media within the NRDs and surrounding areas.
- Cooperate with UNL Extension Educators to distribute information about the project.
- Utilize multi-media outlets to advertise the BGMA activities and follow-up with success stories.
- Conduct an Impact Evaluation to determine if I&E efforts have altered behavior.

Stakeholder Education – initial education to be completed within five years of plan approval and will continue annually as results are analyzed and the plan is updated.

a. Prepare biannual mailings explaining the groundwater concerns, best management practices (BMPs), cost share programs, etc. to producers, landowners and residents within the BGMA.
b. Issue periodic news releases on the status of water quality, trends, and efforts being made to improve water quality.
c. Hold a minimum of three meetings, workshops or seminars annually for the first five years to further educate producers each year on BMPs and efforts to reduce nitrate concentrations in ground water.
d. Initiate one-to-one contact, through phone call or in person visit, with producers to facilitate the implementation or further implementation of BMPs.
e. Educate communities on current issues within each Tier 1 area and the importance of wellhead protection management planning through in person attendance at individual communities' board meetings, public meetings and/or mailings.

7.7 Monitoring and Evaluation

Groundwater quality data and information is needed to determine whether or not the implementation of the management plan is effective at reducing groundwater nitrate concentrations. A representative well network was developed to form a baseline and will be utilized to determine changes in groundwater nitrate concentrations (Appendix F). Groundwater quality and static water level data will be collected at both the baseline wells and the new wells identified in Appendix F by each NRD annually in both the spring and fall. New wells were identified by each NRD in areas where little to no baseline data was available. Groundwater monitoring data will be gathered by the NRDs using a consistent and coordinated method as outlined in their SOPs. Additionally initial vadose zone samples have been collected and will be analyzed to determine a baseline to compare subsequent vadose zone sampling every ten years to track pollutant movement and estimate future pollutant loadings to groundwater. BMP implementation and results data will be submitted to the NRDs as a condition of the cost-share programs. NDEQ will continue to collect corresponding surface water quality data to track baseflow changes and insure groundwater is not impairing surface water beneficial uses in addition to furthering the understanding of the overall interplay of groundwater and surface water in the BGMA.

Additionally, data collected from soil sampling, soil moisture sensors, irrigation water sampling, flow meter readings, crop tissue analysis, and crop rotation schedules will be utilized in crop reporting forms to determine the correct amount of fertilizer to apply and will be analyzed collectively to assess the potential threat to groundwater and the impacts of best management practice implementation. Flow meters and soil moisture sensors provide the information needed for producers to apply the accurate amount of water, reducing over application of water which pushes excess nitrogen past the root zone and into the groundwater supply. Crop reporting forms will be used by the NRDs to monitor the amount of nitrogen being applied by producers. The information submitted on these forms along with vadose zone sampling results and groundwater quality data can be used jointly to determine if the right amount of fertilizer is being applied and at the right time. This also allows the NRDs to work one-on-one with producers who are potentially over applying fertilizer. Additionally, since this data more accurately represents current conditions, it will be used to monitor and evaluate progress being made to reduce nitrate loading to groundwater.

As resources allow, the NRDs will make use of analytical methods to identify sources (organic and inorganic) and the age of contaminated groundwater to insure proper management is being maintained. Such data and information will be invaluable when determining the appropriate BMP to implement.

Changes in groundwater quality are often not realized as quickly as surface water and therefore the short and long term goals are based on five and twenty year time frames, respectively. The project assessment will be jointly discussed by the NRDs and NDEQ on an annual basis. Additionally, the data and project evaluation will be shared with each of the NRDs' board of directors and presented publicly at area meetings as well as at annual Nitrogen Certification classes which are required for producers by the NRDs. Evaluation of the plan will include the following:

- Annual meetings to assess plan implementation progress and adjust where necessary
- 2017 – determine if BMPs and other activities identified in action items have been initiated
- 2021 – determine if short term goal are being met
- 2026 – determine if long term goals are on track to be met by 2036
- 2036 – determine if long term goals are being met

7.8 Implementation Schedule

Table 18. BGMA Plan Implementation Schedule

Activity (Short Term)	**2016**	**2017**	**2018**	**2019**	**2020**
I & E Development and Implementation for each Tier	X	X	X	X	X
NRDs Adopt uniform GMP Phases within the BGMA	X	X			
NRDs Develop uniform monitoring strategy within the BGMA	X	X			
Stakeholder Resource Survey Conducted	X	X			
Implement of BMPs on 11,554 acres in Tier 1-3 areas	X	X	X	X	X
Aquifer Source Inventory Completed for Tier 1-3 areas		X			
Vadose Zone Monitoring	X				
Groundwater Monitoring	X	X	X	X	X
Surface Water Monitoring	X	X	X	X	X
Assess Water Quality Data and Report on Progress	X	X	X	X	X

Activity (Long Term)	**2021**	**2026**	**2031**	**2036**
I & E Programs Developed and Delivered for each Tier	X	X	X	X
I & E Program Impact Evaluation Conducted	X	X	X	X
Stakeholder Resource Survey Conducted	X			
Vadose Zone Monitoring		X		X
Groundwater Monitoring	X	X	X	X
Surface Water Monitoring	X	X	X	X
Assess Water Quality Data and Report on Progress	X	X	X	X
Failing Septic System Rehab Program Est./Completed	X	X	X	
Well Decommissioning Program Established/Completed	X	X	X	

Implement BMPs on a total of 14,051 acres in Tier 1		X		
Implement BMPs on a total of 15,934 acres in Tier 2		X		
Implement BMPs on a total of 4,677 acres in Tier 3		X		
Maintain BMPs established in Tier 1-3 areas			X	X
Evaluate BMP Implementation/Effectiveness	X	X	X	X
Evaluate and Update the Plan every 5 years	X	X	X	X

7.9 Milestones

Table 19. BGMA Plan Milestones

Activity	2016	2021	2026
Plan Approved by NRDs and EPA	X		
Watershed Coordinator hired	X		
BMP Cost Share Program Funding Secured	X		
Illegal or Abandon Wells in Tier 1-3 areas identified		X	
Well Decommissioning Program Initiated			X
Failing Septic Systems in Tier 1-3 areas identified		X	
Septic System Upgrade Program Initiated			X
Vadose Zone Sampling and Data Assessments Completed	X		X
Aquifer Source Inventory Completed		X	
Protective Well Construction Standards Adopted		X	
Initial I & E Programs and Impact Evaluation Completed		X	
Water Quality Data Assessed and Findings Reported	X	X	X
Trend of Increasing Nitrates in Groundwater Halted in Tiers 1-3		X	
Trend of Decreasing Nitrates in Groundwater Reported in Tiers 1-3			X

7.10 Roles and Responsibilities

Several agencies, in addition to the watershed advisory council, will be responsible for various aspects of this plan. A list of the participating agencies and their role in the project is as follows:

Nebraska Department of Environmental Quality (NDEQ): NDEQ may provide funding to address nonpoint source problems. Funding comes from the EPA through Section 319 of the Federal Clean Water Act. In addition to providing technical assistance and grant administration, NDEQ can also assist with water quality planning and monitoring.

Natural Resources Districts (NRDs)**:** By statute, the NRDs are responsible for managing groundwater within the state through the implementation of groundwater management plans. The NRDs can also contribute funding for the implementation of BMPs, monitoring, and project administration.

USDA Natural Resources Conservation Service (NRCS)**:** NRCS has selected the four upper Bazile Creek HUC 12s as part of their National Water Quality Initiative (NWQI) program due to the E.coli impairment downstream (Figure 25). NRCS will provide expertise and funding to producers interested in installing conservation practices to reduce soil erosion. NRCS can contribute additional funding for the entire BGMA through the EQIP program. Funds can be used for engineering, practice installation, practice incentives and technical support. The NRCS can also provide technical expertise and support during the implementation of this plan.

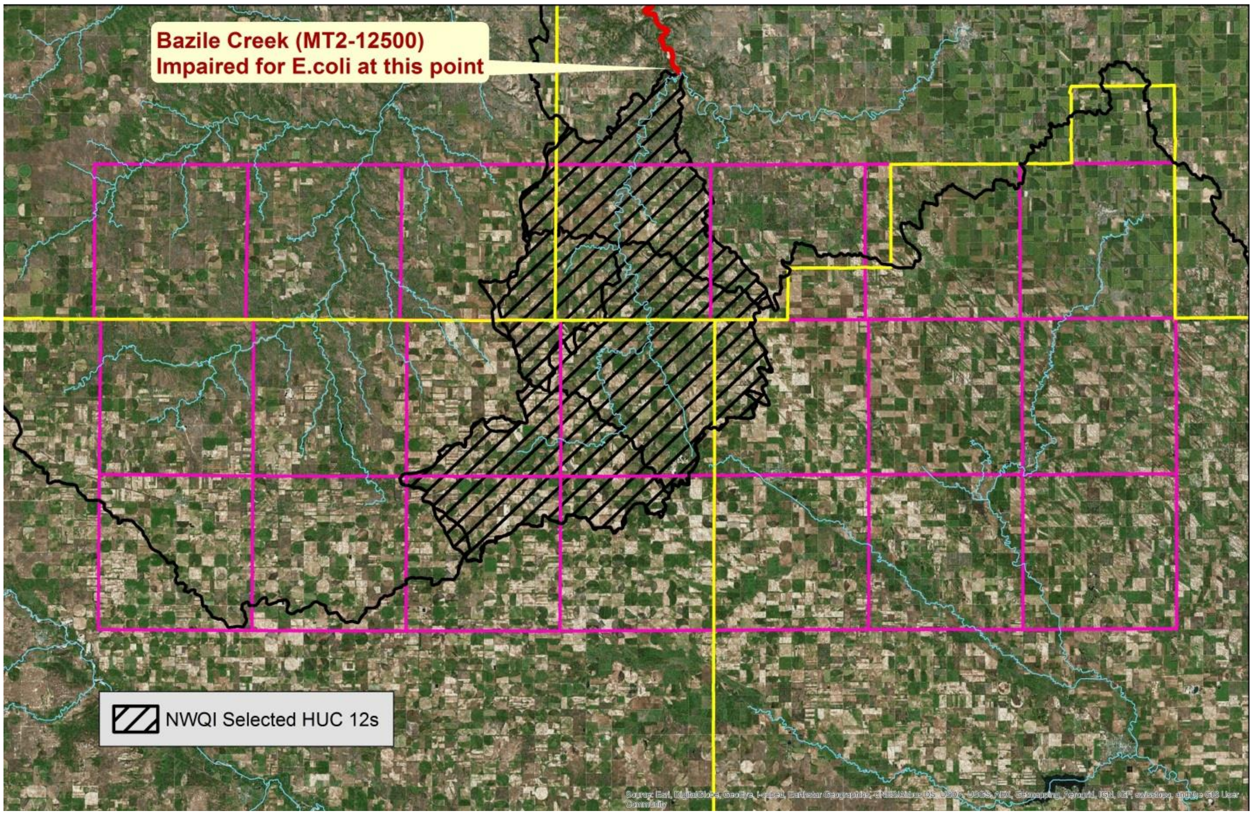


Figure 33. National Water Quality Initiative Selected HUC 12s along Bazile Creek

7.11 Potential Funding Sources

There are several potential funding sources identified below:

Nebraska Department of Environmental Quality/Environmental Protection Agency:
- Administer Section 319 Grant program for projects to reduce nonpoint source pollution
- Requires a 40% local match
- http://deq.ne.gov

Nebraska Department of Environmental Quality:
- Administer source water protection program that provides grant to small PWSS for source water protection projects
- Administer state revolving loan program that provides low interest loans of water quality improvement practices
- http://deq.ne.gov

Nebraska Environmental Trust:
- Provides grant to protect and improve water supplies and water quality
- www.environmentaltrust.org

Nebraska Department of Natural Resources:
- Administers the Natural Resources Water Quality Fund (NRWQF) and Water Well Decommissioning Fund for the NRDs
- www.NDNR.ne.gov

USDA/Natural Resources Conservation Service:
- Administers multiple programs that can be used to improve water quality and implement best management practices including; Environmental Quality Incentive; National Water Quality Initiative, Agriculture Water Enhancement Program and Conservation Stewardship Program
- Provides cost share to producers for implementation of practices
- www.ne.nrcs.usda.gov

Natural Resources Districts:
- Distribute water quality and water well decommissioning funds
- Provide cost share for the implementation of best management practices
- www.nrdnet.org

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App Number Priority Date Water Division RightID	Use Status Date Can / Dism Downstream	Source POD Facility Name County	Cur Tot Acres Grant Rate GPM	Footnotes Annotation
A-16555 **5/21/1987** **2C** **8623**	ST Active 876040	Verdigre Creek, Trib. To Sec: 10 T: 29 R: 7 W Don Doerr Reservoir Knox	0.000 64.9000 AF - -	
A-16306 **6/11/1984** **2C** **8625**	IR Active 2/16/1988 876050	Verdigre Creek Sec: 2 T: 29 R: 7 W Pump Knox	40.000 0.5700 CFS 70 255	K
A-19022 **2/13/2013** **2C** **12693**	IR Active 876050	Merriman Creek Sec: 24 T: 29 R: 7 W Portable Pump Knox	58.100 0.8300 CFS 521 520	
A-11121 **5/2/1967** **2C** **8621**	IR Active 6/18/1982 876054	Verdigre Creek Sec: 11 T: 29 R: 7 W Pump Knox	27.500 0.3900 CFS 70 175	K
A-11613 **1/14/1969** **2C** **8619**	IR Active 875500	Verdigre Creek Sec: 33 T: 29 R: 7 W Pump Knox	104.000 1.4800 CFS 70 664	
A-16263 **1/25/1984** **2C** **8622**	IR Active 876060	Verdigre Creek Sec: 11 T: 29 R: 7 W Pump Knox	65.000 0.9700 CFS 70 435	
A-16648 **5/23/1988** **2C** **8624**	SI Active 876045	Don Doerr Reservoir Sec: 10 T: 29 R: 7 W Pump Knox	75.000 0.3900 AF - -	 A-16555
A-5110 **12/15/1952** **2C** **8654**	ST Active 878700	Verdigre Creek, Trib. To Sec: 11 T: 29 R: 6 W Sorensen Reservoir Knox	0.000 8.0000 AF - -	
A-8403 **12/15/1952** **2C** **8655**	SO Active 878800	Sorensen Reservoir Sec: 11 T: 29 R: 6 W Pump Knox	165.000 8.0000 AF - -	
A-5070 **11/14/1952** **2F** **9339**	ST Active 998100	Bazile Creek, Trib. To Sec: 9 T: 29 R: 5 W Key Reservoir Knox	0.000 10.0000 AF - -	&
A-6692 **11/14/1952** **2F** **9340**	SO Active 998200	Key Reservoir Sec: 9 T: 29 R: 5 W Pump Knox	35.000 0.0000 AF - -	&
A-16991 **5/17/1990** **2F** **9332**	IR Active 997350	Bazile Creek Sec: 27 T: 29 R: 5 W Pump Knox	16.000 0.2300 CFS 70 103	&
A-11153 **5/26/1967** **2F** **9334**	IR Active 9/5/2013 997500	Bazile Creek Sec: 21 T: 29 R: 5 W Pump Knox	14.400 0.2100 CFS 70 94	K
A-13012 **4/3/1974** **2F** **9336**	IR Active 7/11/2012 997900	Bazile Creek, Trib. To Sec: 21 T: 29 R: 5 W Pump Knox	9.800 0.1400 CFS 70 62	K

A-18983 **11/7/2012** **2F** **11221**	DO Pending 997495	Bazile Creek Sec: 34 T: 29 R: 5 W Pump Knox	- - - -	*
A-17813 **2/16/2000** **2B** **6780**	IR Active 6/26/2003 709550	Elkhorn River, North Fork, West Branch Sec: 27 T: 29 R: 3 W Pump Knox	70.000 1.0000 CFS 70 449	& K
A-18877 **2/17/2012** **2B** **11096**	IR Pending 709560	Elkhorn River, North Fork, West Branch Sec: 9 T: 28 R: 3 W Pump Pierce	640.000 9.1400 CFS 70 4102	*
A-2631 **8/31/1936** **2F** **9318**	ST Active 994900	Bazile Creek Sec: 26 T: 28 R: 5 W Nye Reservoir Antelope	0.000 20.0000 AF - -	&
A-9417 **3/30/1957** **2F** **9317**	ST Active 994700	Bazile Creek, Trib. To Sec: 26 T: 28 R: 5 W Plainview Reservoir Antelope	0.000 23.0000 AF - -	F
A-7609 **5/31/1955** **2F** **9325**	IR Active 9/4/2013 996400	Bazile Creek, West Sec: 17 T: 28 R: 5 W Pump Antelope	50.200 0.3600 CFS 140 162	K
A-12701 **7/31/1972** **2F** **9322**	IR Active 6/18/1982 995600	Bazile Creek Sec: 10 T: 28 R: 5 W Pump Antelope	37.000 0.5300 CFS 70 238	K
A-17963 **3/8/2001** **2F** **9337**	IR Active 8/6/2012 996750	Bazile Creek, West Sec: 8 T: 28 R: 5 W Pump Antelope	213.800 3.0600 CFS - 1373	K REL-2380
A-11941 **5/18/1970** **2F** **9327**	IR Active 8/6/2012 996700	Bazile Creek, West Sec: 8 T: 28 R: 5 W Pump Antelope	9.100 0.1300 CFS 70 58	K REL-2381
A-18504A **4/16/2007** **2F** **10316**	IR Active 4/26/2010 996411	Bazile Creek, West Sec: 17 T: 28 R: 5 W Pump Antelope	47.900 0.6800 CFS 70 305	K
A-18504B **4/16/2007** **2F** **10367**	IR Active 4/26/2010 996412	Bazile Creek, West Sec: 17 T: 28 R: 5 W Pump Antelope	50.200 0.3600 CFS 140 161	K D A-7609
A-18439 **1/30/2007** **2F** **10202**	IR Active 4/20/2010 997560	Bazile Creek, West Sec: 8 T: 28 R: 5 W Pump Antelope	74.000 1.0600 CFS 70 475	K
A-3926 **7/12/1946** **2C** **8620**	ST Active 875600	Merriman Creek, Trib. To Sec: 5 T: 28 R: 6 W Rod & Gun Club Reservoir Antelope	0.000 62.0000 AF - -	
A-4928 **1/2/1952** **2C** **8614**	ST Active 875200	Verdigre Creek, East Branch Sec: 22 T: 28 R: 7 W Grove Lake Reservoir Antelope	0.000 592.0000 AF - -	
A-10087 **7/10/1962** **2C** **8611**	ST Active 874900	Verdigre Creek, East Branch, Trib. To Sec: 34 T: 28 R: 7 W Grove Lake Silt Reservoir Antelope	0.000 3.5500 AF - -	

A-10646 **6/28/1965** **2C** **8612**	ST Active 875000	Verdigre Creek, East Branch, Trib. To Sec: 27 T: 28 R: 7 W Grove Rearing Pond No. 1 Antelope	0.000 0.9000 AF - 	
A-10647 **6/28/1965** **2C** **8613**	ST Active 875100	Verdigre Creek, East Branch, Trib. To Sec: 27 T: 28 R: 7 W Grove Rearing Pond No. 2 Antelope	0.000 2.5000 AF - -	
A-16446 **9/16/1985** **2C** **8615**	ST Active 875300	Hay Creek Sec: 29 T: 28 R: 7 W Greg Fletcher Reservoir Antelope	0.000 13.7300 AF - -	
A-12079 **9/18/1970** **2C** **8607**	IR Active 874500	Verdigre Creek, South Branch Sec: 6 T: 28 R: 7 W Pump Antelope	50.000 0.7100 CFS 70 318	
A-14735 **2/17/1977** **2C** **8618**	IR Active 2/15/1984 875400	Verdigre Creek, East Branch Sec: 9 T: 28 R: 7 W Pump Antelope	16.000 0.2300 CFS 70 103	K
A-18608 **8/20/2008** **2C** **10628**	ST Active 875310	Hay Creek Sec: 28 T: 28 R: 7 W Clifton Brothers Res Antelope	- 30.9000 AF - -	
A-10972 **10/24/1966** **2C** **8604**	ST Active 874200	Spring Creek, Big, Trib. To Sec: 15 T: 28 R: 8 W Don McBride Reservoir Antelope	0.000 7.1000 AF - -	
A-12332 **7/26/1971** **2C** **8597**	ST Active 873800	Eley Creek Sec: 27 T: 28 R: 8 W Schleusener Reservoir Antelope	0.000 12.7000 AF - -	
A-15444 **4/5/1979** **2C** **8595**	ST Active 873600	Verdigre Creek, South Branch, Trib. To Sec: 6 T: 28 R: 8 W Schacht Reservoir Antelope	0.000 14.0000 AF - -	
D-248R **8/11/1894** **2C** **8596**	IR Active 6/18/1982 873700	Verdigre Creek, South Branch Sec: 9 T: 28 R: 8 W Pump Antelope	106.000 1.5200 CFS 70 682	K P-561, P622- 624
A-9282A **3/3/1957** **2C** **10529**	IR Active 874401	Verdigre Creek, South Branch Sec: 11 T: 28 R: 8 W Pump Antelope	67.200 0.9600 CFS 70 430	
A-9282B **3/3/1957** **2C** **10530**	IR Active 874402	Verdigre Creek, South Branch Sec: 11 T: 28 R: 8 W Pump Antelope	12.100 0.1700 CFS 70 76	
A-10997 **12/9/1966** **2C** **8605**	IR Active 6/18/1982 874300	Spring Creek, Big Sec: 14 T: 28 R: 8 W Pump Antelope	62.000 0.8800 CFS 70 394	K
A-16482 **4/7/1986** **2C** **8603**	FC Active 874150	Spring Creek, Big, Trib. To Sec: 22 T: 28 R: 8 W Fish Hatchery Antelope	0.000 0.5000 CFS - 224	
A-12436 **11/22/1971** **2C** **8608**	ST Active 874600	Verdigre Creek, East Branch, Trib. To Sec: 2 T: 27 R: 7 W Spring Pond No. 1 Antelope	0.000 1.7400 AF - -	

A-12437 **11/22/1971** **2C** **8609**	ST Active 874700	Verdigre Creek, East Branch, Trib. To Sec: 2 T: 27 R: 7 W Spring Pond No. 2 Antelope	0.000 1.5900 AF - -
A-12438 **11/22/1971** **2C** **8610**	ST Active 874800	Verdigre Creek, East Branch Sec: 2 T: 27 R: 7 W Rearing Ponds Antelope	0.000 1.2000 AF - -
A-3958 **9/11/1946** **2B** **6782**	IR Active 710200	Elkhorn River, North Fork Sec: 32 T: 27 R: 2 W Pump Pierce	256.000 1.8300 CFS 140 821

General Explanation of Fields found on the Surface Water Rights Search Form

Use: Is the use approved for the appropriation.

Code	Description
CO	Cooling
DA	Domestic, Agriculture and Manufacturing
DG	Dredge
DO	Domestic
FC	Fish Culture
FL	Flood Control
FW	Fish and Wildlife
GW	Groundwater Recharge
IF	Instream Flow
IG	Induced Ground Water Recharge
IN	Intentional Underground Storage
IR	Irrigation from Natural Stream
IS	Irrigation and Storage (an appropriation approved for both uses)
IU	Irrigation and Incidental Underground Storage
MF	Manufacturing
ML	Maintain Level of a Lake
MU	Municipal
OU	Stor-only and Incidental Underground Storage
PI	Power and Incidental Underground Storage
PR	Power
PS	Supplemental Power and Incidental Underground Storage
RD	Raise Dam
SC	Supplemental Cooling (an appropriation for water for cooling through a system that has a prior appropriation for cooling)
SD	Supplemental Domestic
SF	Supplemental Fish Culture
SI	Supplemental Irrigation (irrigation from reservoir on lands also covered by natural flow appropriation.)
SO	Stor-only (irrigation from reservoir on lands not covered by natural flow appropriation)

SP	Supplemental Power (an appropriation for water for power through a system that has a prior appropriation for power)
SR	Storage Use within a reservoir
SS	Supplemental Storage (an appropriation that has a prior appropriation for storage)
ST	Storage
SU	Storage and Incidental Underground Storage
UI	Supplemental Irrigation and Incidental Underground Storage
US	Incidental Underground Storage
WS	Waste Storage
WT	Wetlands

Footnote: (may be up to three footnotes per record) Denotes a condition, qualifier, or other item of significance that is not displayed in any other way:

Footnote:	Description
A	Supplemental storage based on increase in size of reservoir capacity or increase in amount of water diverted into reservoir.
B	Supplemental storage from different source; total grant in acre-feet not to exceed first appropriation.
C	Supplemental storage from different source; total grant is sum of two appropriations.
D	This appropriation is additional water for a prior appropriation.
E	The sources of these appropriations do not drain on the surface into the main stream of a water division, but often into lakes of the sandhills or other lakes, bogs, etc.
F	Designates beginning of separate basins in 2-F.
G	Amount affirmed by U.S. Supreme Court: 29 cfs for Nebraska and 15 cfs for Colorado.
H	The rate and grant specified in the permit are inconsistent.
I	Provides for optional diversion.
J	Dismissed or denied.
K	Cancelled in part.
L	Cancelled in full.
M	Less amount diverted under A-2293.
N	Less any amounts diverted under other appropriation so that total amount diverted at any time shall not exceed statutory limit of one cfs for 70 acres.
O	Supplemental storage from same source. total grant is sum of appropriations.
P	Total diversion under A-1853R, A-1976R, and A-2726R at the Tri-County Canal headgate is limited to 25 cfs.
Q	The natural flow together with supplemental storage water shall not exceed 1500 second-feet as a rate of diversion.
R	Combined diversion for cooling at Gerald Gentlemen units No. 1 and No. 2 is limited to 1720 cfs from all sources.
S	Adds lands but does not increase appropriation of original filing.
T	By stipulation the Loup River Public Power District is subsequent in

	priority to A-2293 filed by the Middle Loup Public Power and Irrigation District and A-2312 filed by the North Loup Public Power and Irrigation District.
U	Total allocation from Middle Loup River and Oak Creek under A-4923A and A-4923B is 68,120 acre-feet.
V	This amount less any amounts diverted under A-2312.
W	Transbasin diversion.
X	Glendo contractor.
Y	Combined gallons per day is 7,500,000.
Z	Additional withdrawal of ground water from previously approved well field.
^	This appropriation shall not be administered for either appropriation D-274, D-275.
*	Pending
#	This appropriation is first appropriation upstream from gage.
@	Temporary permit.
+	The following appropriations will not be regulated for D-1026R --- A-8266, A-9654, A-16114, A-16115, A-17064, (P-473), and A-17110.
%	This appropriation shall not be administered for either appropriation A-2293BR, P-468, or A-3979BR, P-468.
<	Less any amount withdrawn under A-10481.
>	Not subject to administration due to case law.
&	Headwater pit exempt from administration.
$	Appropriation A-1220 shall not be administered for A-186R (T-217), A-186 (T-238) OR A-937A, A-937B and A-937C.
(	Shall be limited to flows of Spring Creek for purposes of administration.
}	Shall not cause any appropriation to be administered that would not have been administered prior to relocation.
1	Central Platte NRD's Platte River instream flow appropriations
2	Game and Parks Commission’s Platte River instream flow appropriations
3	Reference appropriation file for volume limitations and accounting procedures
4	Reference appropriation file for rate limitations and administration procedures.
5	This appropriation has a power lease.
6	The low-level outlet requirement has been waived for this appropriation.
{	Combined usage under A-17825, A-17826, and A-17827 shall not exceed a total of 105.20 Acre Feet.

Appendix B

Figure 1. Village of Brunswick Wellhead Protection Area

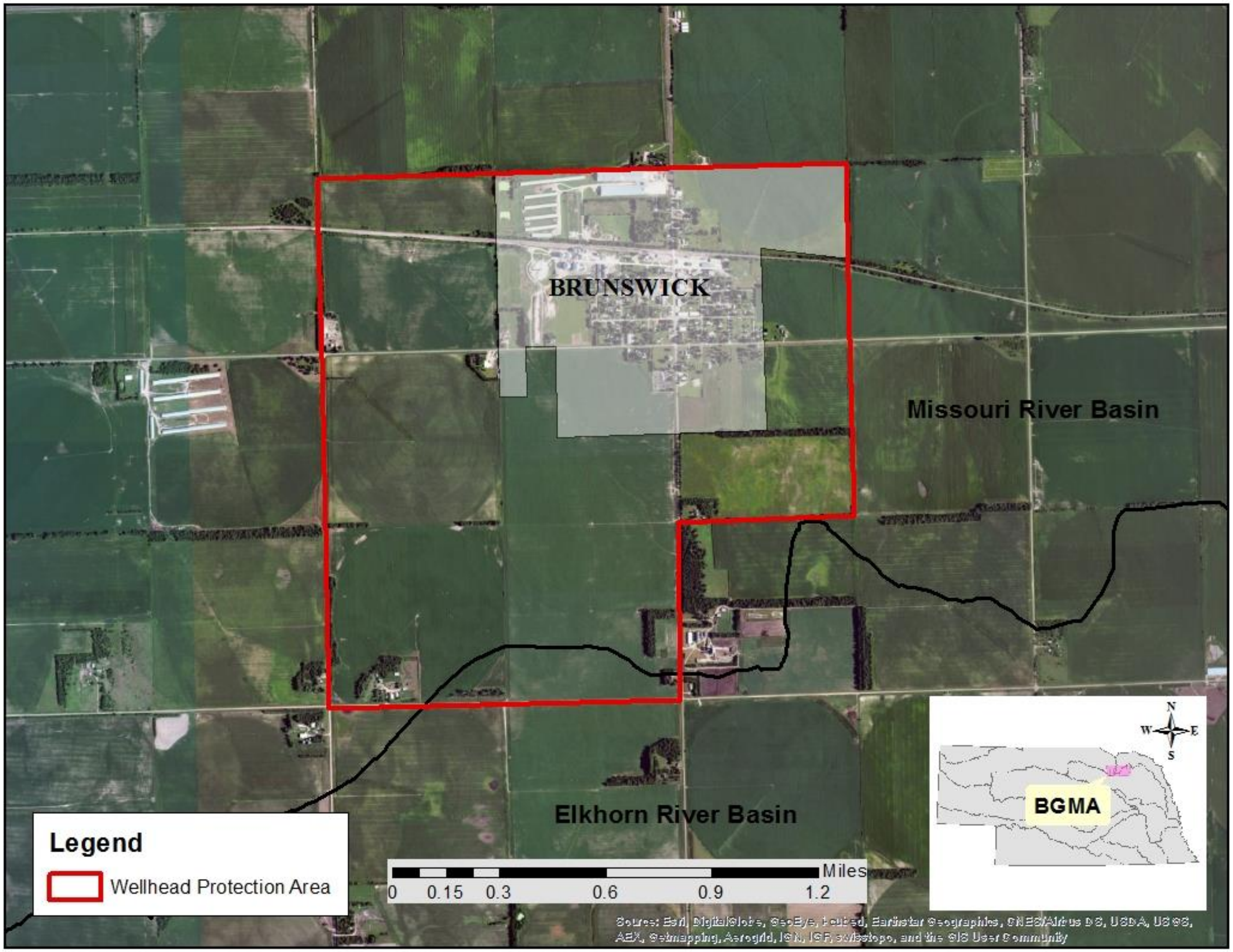


Figure 2. City of Creighton Wellhead Protection Area

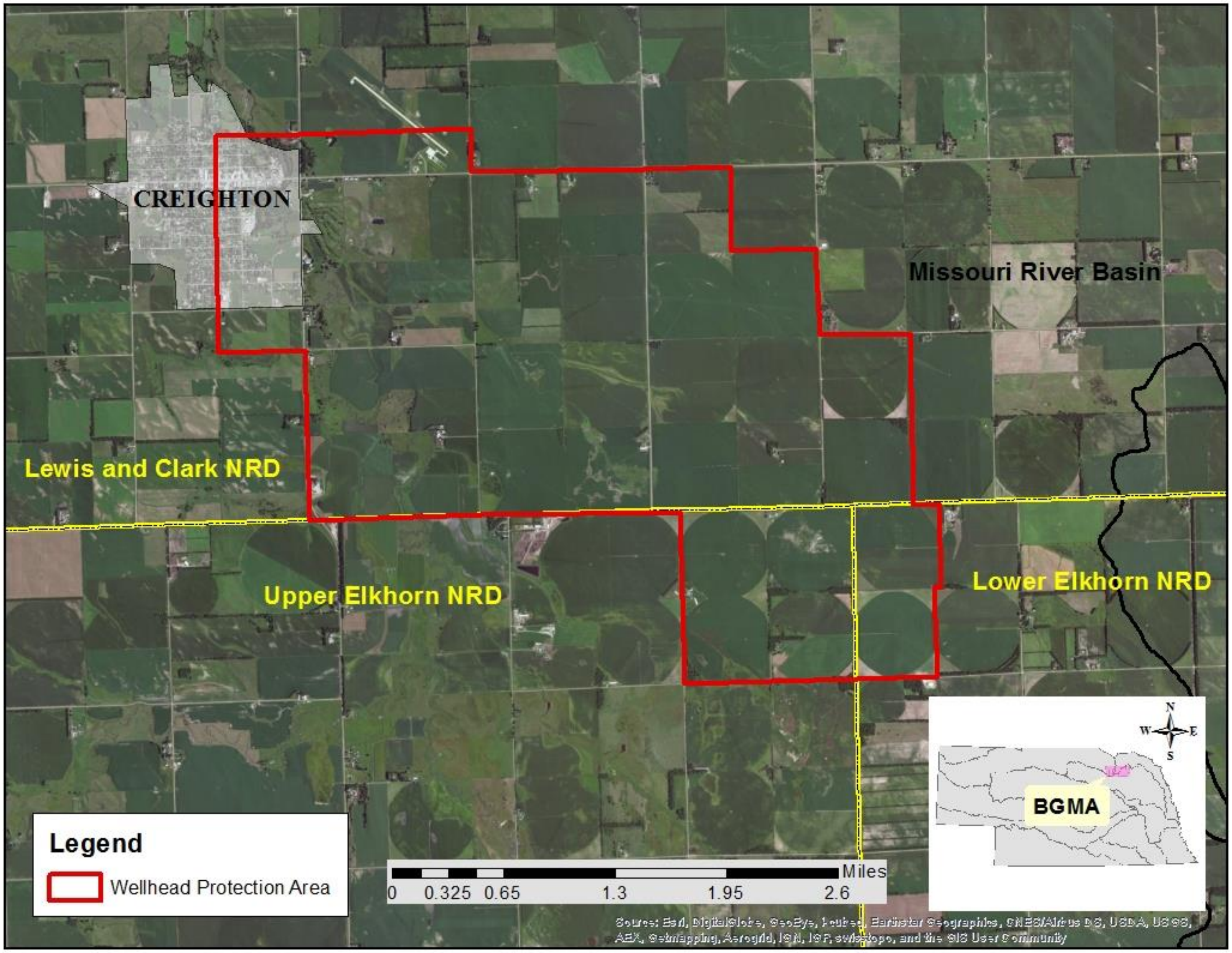


Figure 3. Village of Orchard Wellhead Protection Area

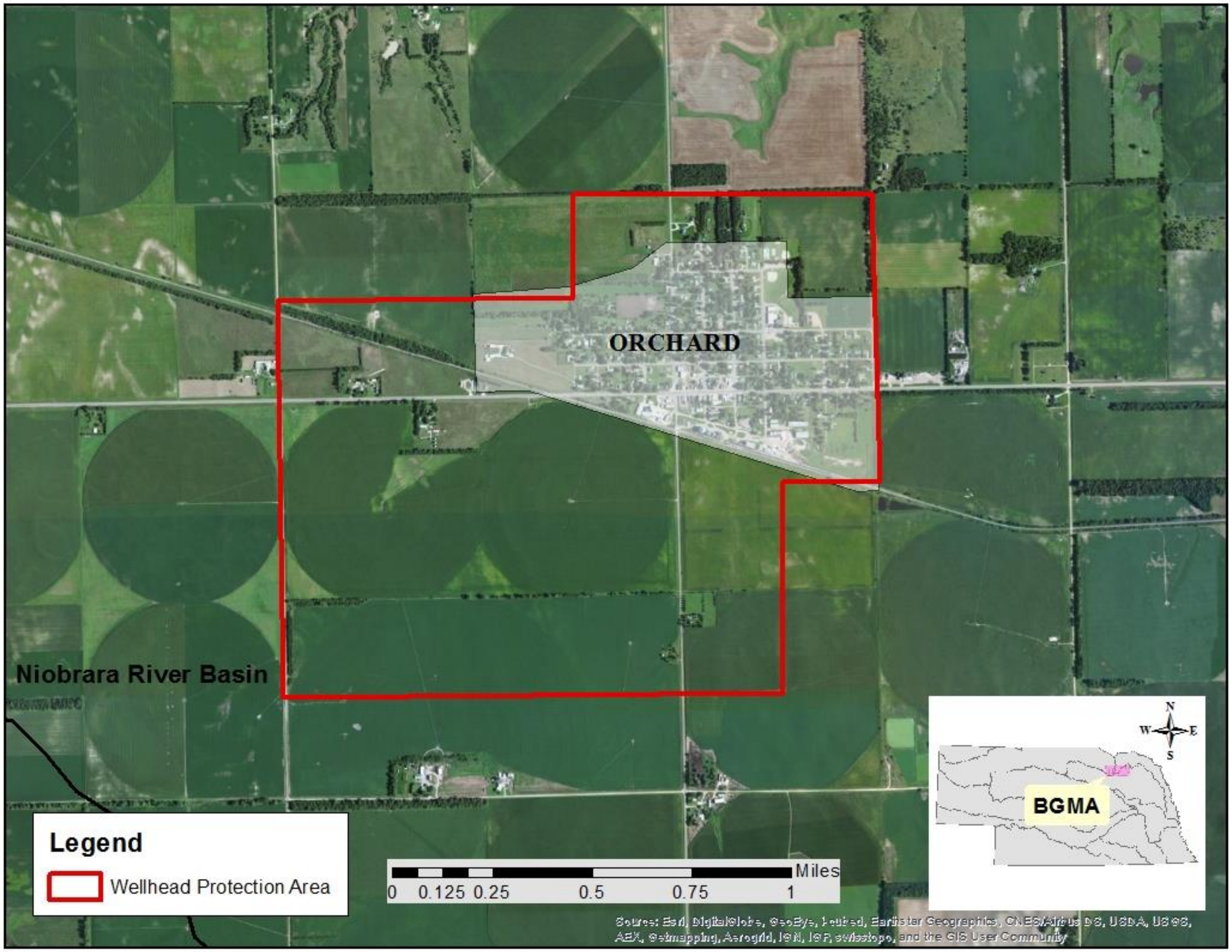


Figure 4. Village of Osmond Wellhead Protection Area

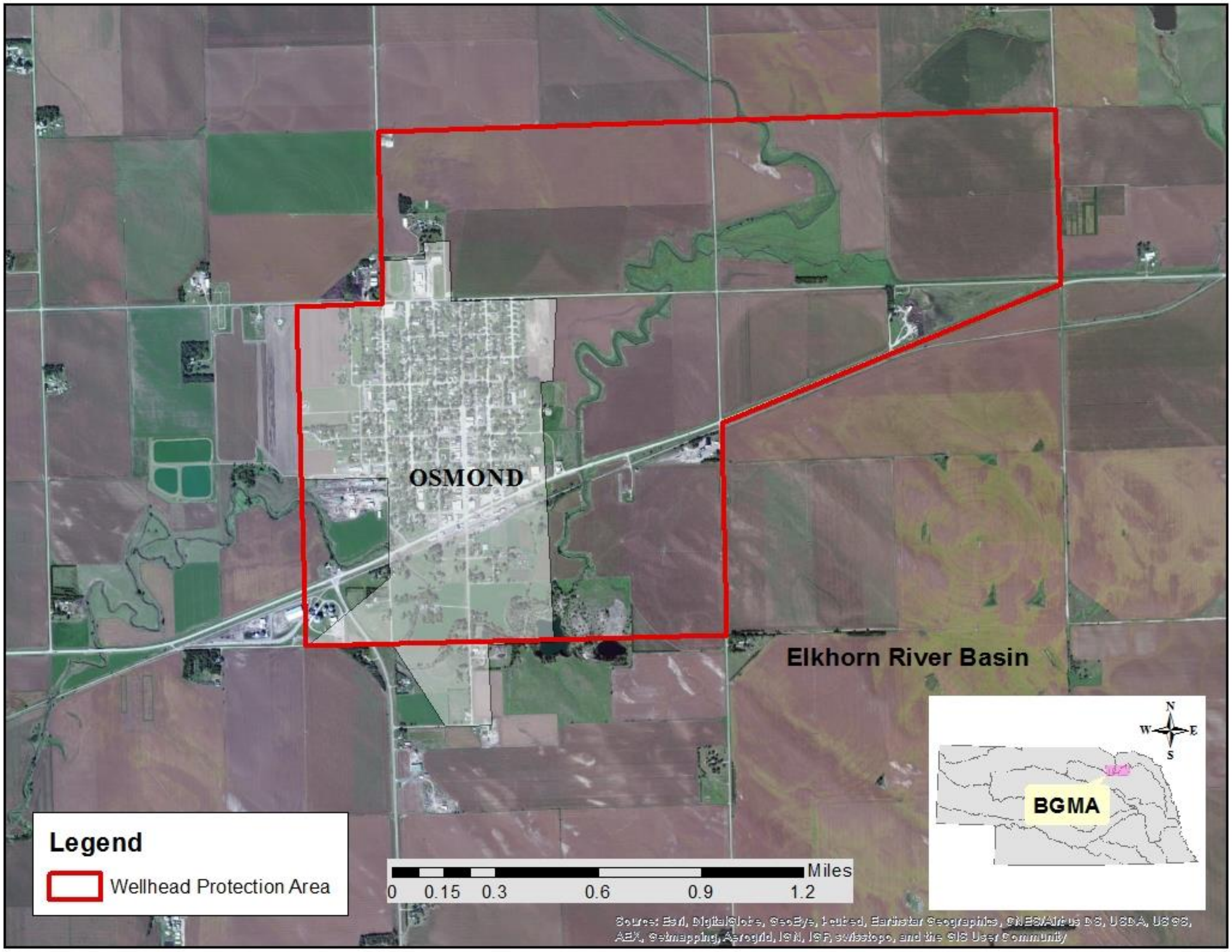


Figure 5. City of Plainview Wellhead Protection Area

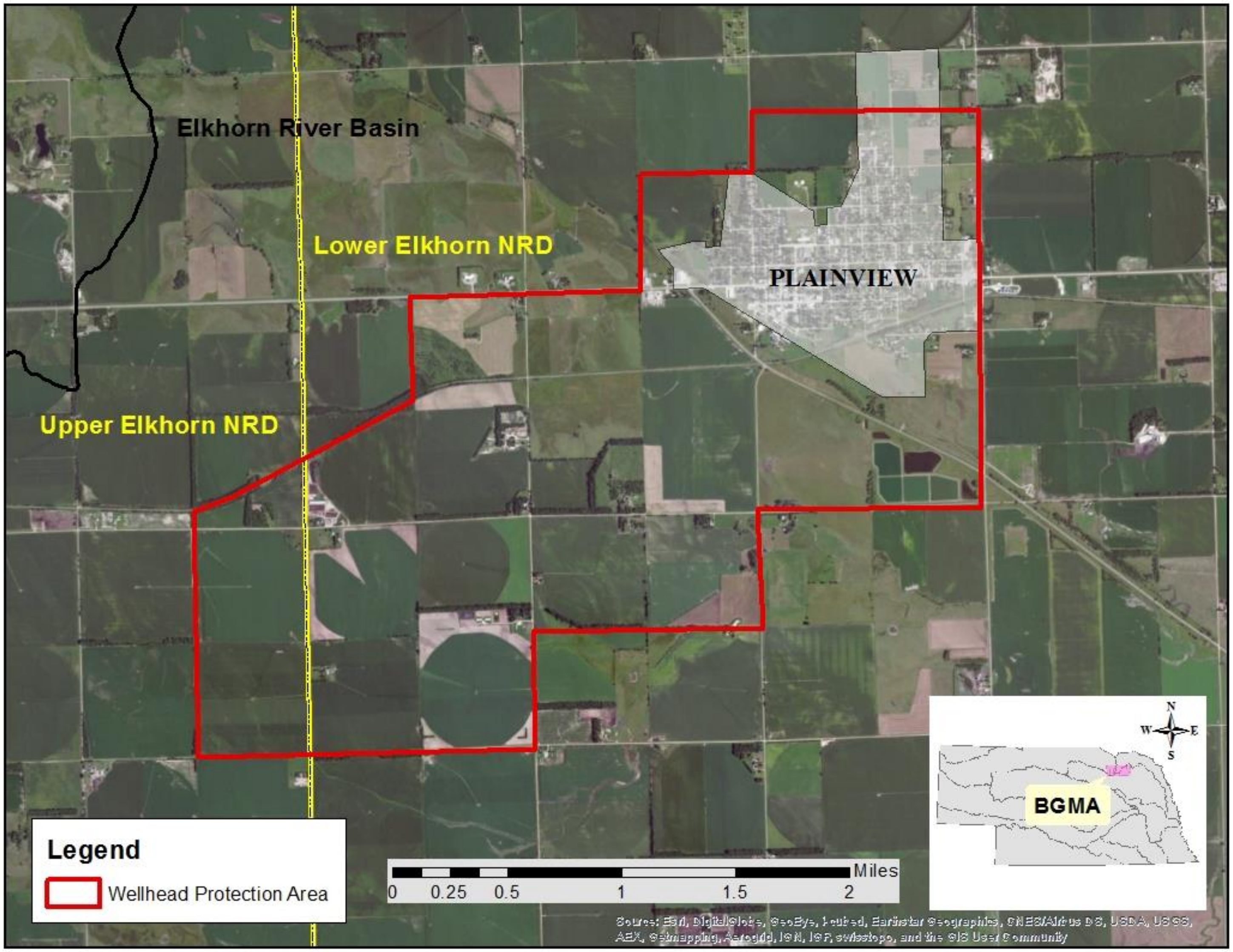


Figure 6. Village of Royal Wellhead Protection Area

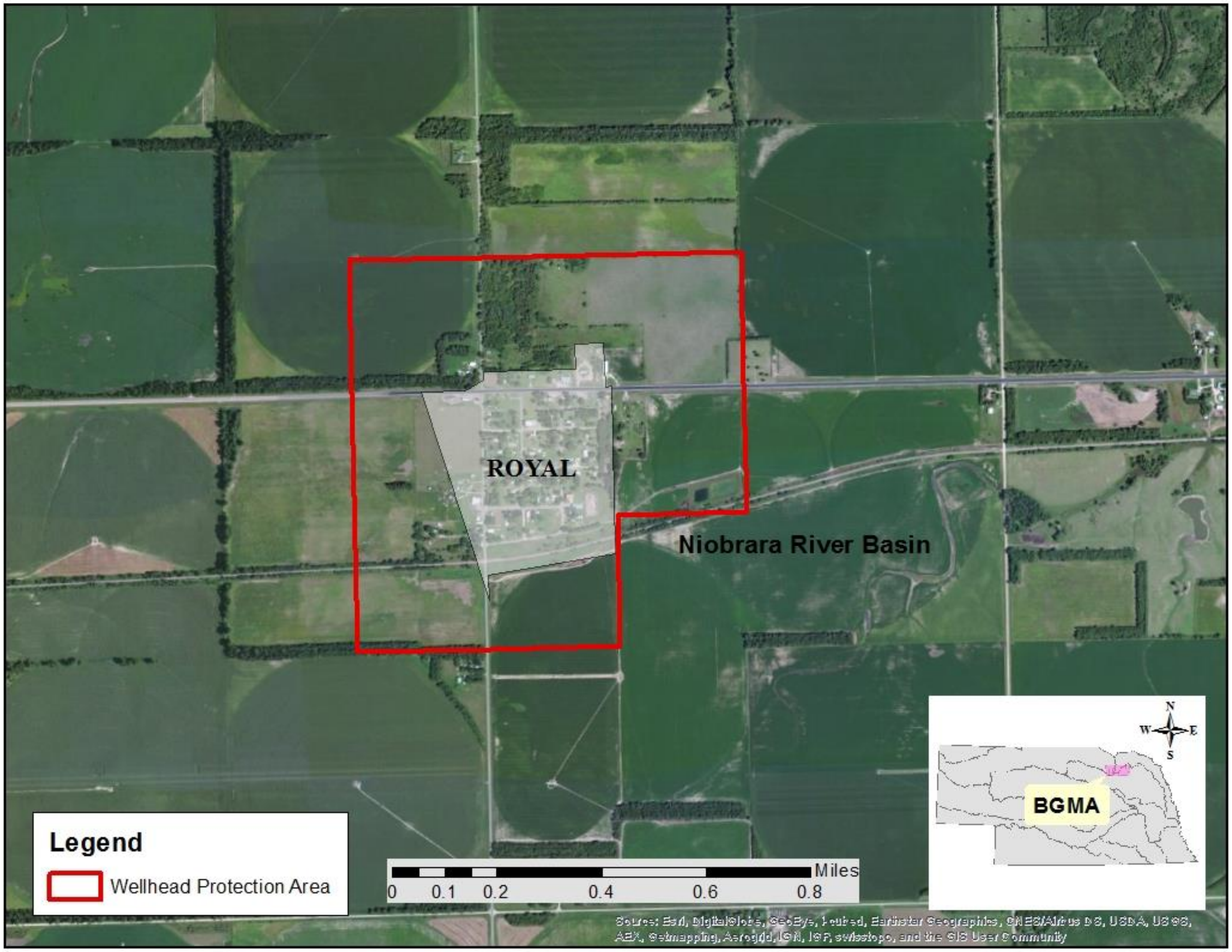


Figure 7. Village of Wausa Wellhead Protection Area

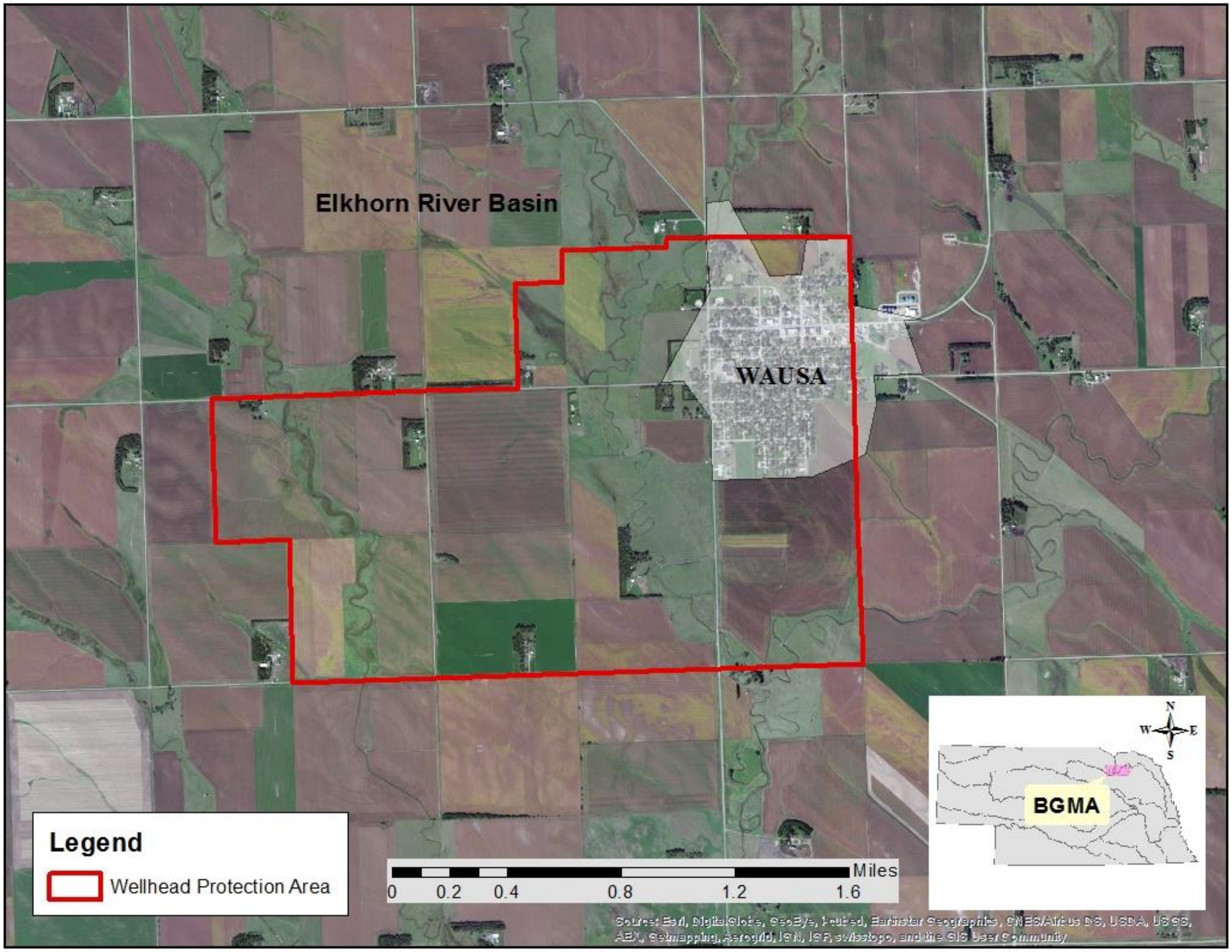
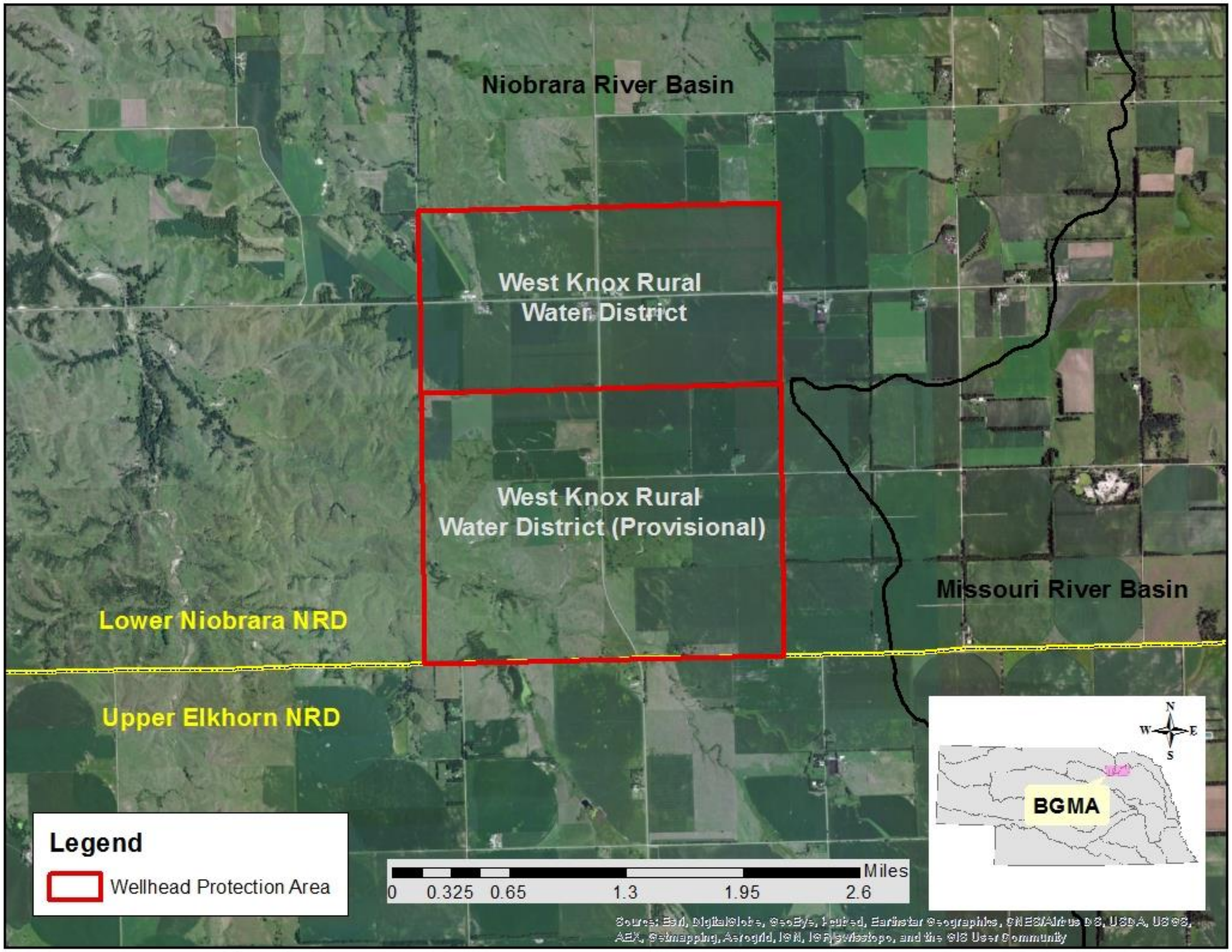


Figure 8. West Knox Rural Water District



Appendix C

Tier 1 Area – Legal Descriptions

27N4W4	27N7W9	28N4W33	29N5W26
27N4W5	27N7W10	28N5W1	29N5W27
27N4W6	27N8W3	29N2W8	29N5W28
27N4W7	27N8W4	29N2W9	29N5W34
27N4W8	27N8W9	29N2W10	29N5W35
27N5W1	27N8W10	29N2W15	29N5W36
27N5W12	28N2W29	29N2W16	29N6W20
27N6W1	28N2W30	29N2W17	29N6W21
27N6W2	28N2W31	29N4W30	29N6W28
27N6W11	28N2W32	29N4W31	29N6W29
27N6W12	28N3W36	29N5W21	29N6W32
27N7W3	28N4W6	29N5W22	29N6W33
27N7W4	28N4W32	29N5W25	

Tier 2 Area – Legal Descriptions

27N4W9	27N7W17	28N4W10	28N6W5
27N4W17	27N8W5	28N4W15	28N6W8
27N4W18	27N8W8	28N4W16	28N6W9
27N4W19	27N8W15	28N4W17	28N6W10
27N4W20	27N8W16	28N4W18	29N2W7
27N5W2	27N8W17	28N4W19	29N2W18
27N5W10	27N8W20	28N4W20	29N2W19
27N5W11	27N8W21	28N4W21	29N2W20
27N5W13	27N8W22	28N4W22	29N2W21
27N5W14	28N2W20	28N4W31	29N2W22
27N5W15	28N2W21	28N5W2	29N3W13
27N5W16	28N2W22	28N5W3	29N3W24
27N5W21	28N2W27	28N5W10	29N4W32
27N5W22	28N2W28	28N5W11	29N4W33
27N5W23	28N2W33	28N5W12	29N6W22
27N5W24	28N4W3	28N5W13	29N6W23
27N6W10	28N4W4	28N5W14	29N6W26
27N6W14	28N4W5	28N5W24	29N6W27
27N6W15	28N4W7	28N5W36	29N6W34
27N7W8	28N4W8	28N6W3	29N6W35
27N7W16	28N4W9	28N6W4	

Appendix C

Tier 3 Area – Legal Descriptions

27N6W6	27N7W11	27N7W15	28N7W33
27N6W7	27N7W12	28N7W26	28N7W34
27N7W1	27N7W13	28N7W27	28N7W35
27N7W2	27N7W14	28N7W28	28N7W36

Tier 4 Area – Legal Descriptions

27N2W1	27N7W18	28N6W12	29N4W5
27N2W2	27N7W19	28N6W13	29N4W6
27N2W3	27N7W20	28N6W14	29N4W7
27N2W4	27N7W21	28N6W15	29N4W8
27N2W5	27N7W22	28N6W16	29N4W9
27N2W6	27N7W23	28N6W17	29N4W10
27N2W7	27N7W24	28N6W18	29N4W11
27N2W8	27N7W25	28N6W19	29N4W12
27N2W9	27N7W26	28N6W20	29N4W13
27N2W10	27N7W27	28N6W21	29N4W14
27N2W11	27N7W28	28N6W22	29N4W15
27N2W12	27N7W29	28N6W23	29N4W16
27N2W13	27N7W30	28N6W24	29N4W17
27N2W14	27N7W31	28N6W25	29N4W18
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27N2W19	27N7W36	28N6W30	29N4W23
27N2W20	27N8W1	28N6W31	29N4W24
27N2W21	27N8W2	28N6W32	29N4W25
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27N2W25	27N8W12	28N6W36	29N4W29
27N2W26	27N8W13	28N7W1	29N4W34
27N2W27	27N8W14	28N7W2	29N4W35
27N2W28	27N8W18	28N7W3	29N4W36
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27N2W30	27N8W23	28N7W5	29N5W2
27N2W31	27N8W24	28N7W6	29N5W3

27N2W32	27N8W25	28N7W7	29N5W4
27N2W33	27N8W26	28N7W8	29N5W5
27N2W34	27N8W27	28N7W9	29N5W6
27N2W35	27N8W28	28N7W10	29N5W7
27N2W36	27N8W29	28N7W11	29N5W8
27N3W1	27N8W30	28N7W12	29N5W9
27N3W2	27N8W31	28N7W13	29N5W10
27N3W3	27N8W32	28N7W14	29N5W11
27N3W4	27N8W33	28N7W15	29N5W12
27N3W5	27N8W34	28N7W16	29N5W13
27N3W6	27N8W35	28N7W17	29N5W14
27N3W7	27N8W36	28N7W18	29N5W15
27N3W8	28N2W1	28N7W19	29N5W16
27N3W9	28N2W2	28N7W20	29N5W17
27N3W10	28N2W3	28N7W21	29N5W18
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27N3W13	28N2W6	28N7W24	29N5W23
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27N7W7	28N6W7	29N4W3	29N8W36

	28N6W11	29N4W4	

Appendix D

Nebraska's Natural Resources Districts and their Authority

Legislation was passed by the Nebraska Unicameral in 1969 which combined the 154 special purpose districts into 24 natural resources districts. The natural resources districts (NRDs) were established and operational in July 1972. The NRDs' boundaries were generally drawn on watershed boundaries and in 1989, the Middle Missouri River NRD and the Papio NRD voluntarily merged into the Papio-Missouri River NRD.

NRDs have statutory authority in twelve general areas.

Nebraska Revised Statute §2-3229. Districts; purposes.

The purposes of natural resources districts shall be to develop and execute, through the exercise of powers and authorities granted by law, plans, facilities, works, and programs relating to (1) erosion prevention and control, (2) prevention of damages from flood water and sediment, (3) flood prevention and control, (4) soil conservation, (5) water supply for any beneficial uses, (6) development, management, utilization, and conservation of ground water and surface water, (7) pollution control, (8) solid waste disposal and sanitary drainage, (9) drainage improvement and channel rectification, (10) development and management of fish and wildlife habitat, (11) development and management of recreational and park facilities, and (12) forestry and range management.

As to development and management of fish and wildlife habitat and development and management of recreational and park facilities, such plans, facilities, works, and programs shall be in conformance with any outdoor recreation plan for Nebraska and any fish and wildlife plan for Nebraska as developed by the Game and Parks Commission.

Nebraska Revised Statute §2-3241. Districts; additional powers.

Each district shall have the power and authority to provide technical and other assistance as may be necessary or desirable in rural areas to abate the lowering of water quality in the state caused by sedimentation, effluent from feedlots, and runoff from cropland areas containing agricultural chemicals. Such assistance shall be coordinated with the programs and the stream quality standards as established by the Department of Environmental Quality.

Each district has a locally elected board of directors, a manager, and staff. The NRDs also have authority to levy a tax on property to help fund their activities (Neb. Rev. Stat. §13-503 (general authority) and §2-3225 (specific levy limit)). Taxing authority is one of the several things that make Nebraska's NRDs unique, but also creates "rich" and "poor" districts, due to the funding available. For example, rural pasture land and dry land cropland are generally valued lower than irrigated cropland or urban developments. NRDs in areas of the state that are irrigated or dominated by the largest cities (Omaha and Lincoln) benefit from better tax revenues.

Much of the NRDs' duties and responsibilities are laid out and directed by the Nebraska Ground Water Management and Protection Act (Neb. Rev. Stat. §46-701 - 46-754).

Nebraska Revised Statute §46-704. Management area; legislative findings.

The Legislature also finds that:

(1) The levels of nitrate nitrogen and other contaminants in ground water in certain areas of the state are increasing;

(2) Long-term solutions should be implemented and efforts should be made to prevent the levels of ground water contaminants from becoming too high and to reduce high levels sufficiently to eliminate health hazards;

(3) Agriculture has been very productive and should continue to be an important industry to the State of Nebraska;

(4) Natural resources districts have the legal authority to regulate certain activities and, as local entities, are the preferred regulators of activities which may contribute to ground water contamination in both urban and rural areas;

(5) The Department of Environmental Quality should be given authority to regulate sources of contamination when necessary to prevent serious deterioration of ground water quality;

(6) The powers given to districts and the Department of Environmental Quality should be used to stabilize, reduce, and prevent the increase or spread of ground water contamination; and

(7) There is a need to provide for the orderly management of ground water quality in areas where available data, evidence, and other information indicate that present or potential ground water conditions require the designation of such areas as management areas.

Ground water management plans are required by §46-709, but all 23 NRDs have the ability to tailor their plan to their specific geographic, climate, and land use conditions. These plans are reviewed and approved by the Nebraska Department of Natural Resources (NDNR), with input from NDEQ, the Conservation and Survey Division of University of Nebraska, and "such other state of federal agencies the director shall deem necessary". Typically, Nebraska Health and Human Services – Drinking Water and Nebraska Game and Parks Commission have also offered NDNR input on the NRDs' management plans.

Nebraska Revised Statute §46-709. Ground water management plan; required; contents.

Each district shall maintain a ground water management plan based upon the best available information and shall submit amendments to such plan to the Director of Natural Resources for review and approval.

The plan shall include, but not be limited to, the identification to the extent possible of:

(1) Ground water supplies within the district including transmissivity, saturated thickness maps, and other ground water reservoir information, if available;

(2) Local recharge characteristics and rates from any sources, if available;

(3) Average annual precipitation and the variations within the district;

(4) Crop water needs within the district;

(5) Current ground water data-collection programs;

(6) Past, present, and potential ground water use within the district;

(7) Ground water quality concerns within the district;

(8) Proposed water conservation and supply augmentation programs for the district;

(9) The availability of supplemental water supplies, including the opportunity for ground water recharge;

(10) The opportunity to integrate and coordinate the use of water from different sources of supply;

(11) Ground water management objectives, including a proposed ground water reservoir life goal for the district. For management plans adopted or revised after July 19, 1996, the ground water management objectives may include any proposed integrated management objectives for hydrologically connected ground water and surface water supplies but a management plan does not have to be revised prior to the adoption or implementation of an integrated management plan pursuant to section 46-718 or 46-719;

(12) Existing subirrigation uses within the district;

(13) The relative economic value of different uses of ground water proposed or existing within the district; and

(14) The geographic and stratigraphic boundaries of any proposed management area.

If the expenses incurred by a district preparing or amending a ground water management plan exceed twenty-five percent of the district's current budget, the district may make application to the Nebraska Resources Development Fund for assistance.

Each district's ground water management plan shall also identify, to the extent possible, the levels and sources of ground water contamination within the district, ground water quality goals, long-term solutions necessary to prevent the levels of ground water contaminants from becoming too high and to reduce high levels sufficiently to eliminate health hazards, and practices recommended to stabilize, reduce, and prevent the occurrence, increase, or spread of ground water contamination.

Most NRDs have developed management plans with phased management or requirements that are progressively more stringent. Phase areas are often determined by existing contaminant levels found in wells sampled – such as 50% of the monitored wells above 50% of the Maximum Contaminant Level (MCL) for a Phase 1 area, and is a minimum of 36 contiguous square miles. In Phase 1 areas, many NRDs require educational certification for farm operators and permits for drilling a new well.

Other sources of information exist about the NRDs, their history, examples of management efforts, and NDEQ's parallel but separate nonpoint source ground water management area program (Title 196, NDEQ 2002). Please contact NDEQ for more information.

Groundwater Benefits	BGMA Plan Priority Agricultural BMPs NRD Phase II and III required BMPs in red and *. ◄──────────►	Surface Water Benefits

Nitrogen credits identified in the soil translate to less nitrogen fertilizer being applied which reduces nitrogen loading to the groundwater.	***Soil Sampling**
	• Require annual soil sampling for any crop (including turf grass) where >50 lbs per acre per year of organic or inorganic nitrogen will be applied.
	   ▪ Each sample will only be representative of 40 acres
	   ▪ Sampling depths will be 0-8" and 8"- 24"
	   ▪ Producers are encouraged to sample 24"- 48"
	• Each NRD encourages soil samples to include a cation exchange capacity and organic matter analysis.
		By reducing loadings to groundwater, less nitrogen enters the stream through baseflow contributions from groundwater and less nitrogen applied to the field leads to less entering the stream through overland runoff.

By utilizing nitrogen credits available in the irrigation water supply, less nitrogen fertilizer will need to be applied, reducing the quantity of nitrogen percolating back into the groundwater with recharge occurring under the field.	***Irrigation Water Well Sampling** • Baseline wells identified in Appendix F for each Tier will be sampled annually. • Irrigation water wells will be sampled for nitrates every other year in line with each NRDs groundwater monitoring schedules. • Irrigation water users are encouraged to sample water annually.	By reducing the quantity of nitrogen in the water leaching below the root zone and percolating back into the groundwater, the base flow provided by groundwater to streams and reservoirs will also see reduced nitrogen levels.
Having a flow meter installed on an irrigation system takes the guess work out of how much water is being applied per irrigation event. Flow meters give the producer more control over irrigation events, reducing the amount of water applied which will reduce the risk of leaching caused by overwatering.	***Water Well Flow Meters** (Required on new wells in all NRDs and on all wells in LENRD) • Each operator is required to have at least one irrigation system flow meter installed. • Larger operations (>10 systems) will be required to have at least one meter installed per 10 existing systems (i.e. 11 systems will require two flow meters) . • All new and replacement wells will be required to install a flow meter.	With less water being applied to the field the likelihood of over applying and pushing nutrients below the root zone into the groundwater providing base flow is reduced. With less groundwater pumping stress on the system, the static water level will raise resulting in more baseflow reaching the stream.
Utilizing soil moisture sensors and irrigation scheduling gives the producer more resources to make educated irrigation management decisions. This will reduce the amount of irrigation water applied, reducing the risk of nitrogen leaching caused by overwatering.	***Soil Moisture Sensors and Irrigation Scheduling** (Required in LNNRD & LENRD) • Each operator is required to install and utilize at least one soil moisture sensor for irrigation scheduling. • Larger operations (>10 irrigation systems) will be required to have installed and use at least one soil moisture sensor per 10 wells (i.e. 11 systems will require two sensors). • Implementation should be completed within five years of plan approval.	By irrigating closer to when the crop is ready to utilize water and the soil profile is no longer saturated, the soil will be able to hold excess water that is not immediately utilized by the plant and less will be lost to overland runoff into streams and lakes.

By restricting when fertilizer can be applied in the fall, less fertilizer will be leached to the vadose zone due to weather exposure outside of the growing season when no crop is utilizing the fertilizers.	***Fall Fertilizer Application Restrictions** (Required in all NRDs except in the LENRD) • No nitrogen fertilizer (organic or inorganic) shall be applied between post-harvest and November 1. • Surface applied organic nutrients will be exempted from this if the application is in compliance with future cropping needs and a nutrient management plan. T130 prohibits manure applications to frozen ground.	By restricting fertilizer applications outside of the growing season, less nitrogen will be lost to overland runoff events and to the vadose zone and groundwater providing baseflow to area streams.
By restricting winter application of fertilizer to frozen or snow covered ground less fertilizer will be leached to the vadose zone in the spring when the snow melts and the ground thaws.	***Winter Application Restrictions** • Nitrogen fertilizer applications to frozen or snow covered ground will not be allowed without district permission.	Restricting winter application of nitrogen fertilizer to frozen or snow covered ground will reduce the risk of overland runoff of nitrogen.
Conducting a nutrient analysis on manure applications gives the producer knowledge of the nitrogen content of the manure. This can allow the producer to adjust the amount of manure and other forms of nitrogen applied during the growing season which reduces the risk of over applying nitrogen and loadings the vadose zone and groundwater.	**Manure Application Restrictions** (Following T130 setbacks) • All manure applied will be based on a nutrient analysis. • Applicator will uniformly apply organic nutrients. • Application equipment will be maintained and calibrated.	By making knowledgeable decisions about manure applications, producers will apply only the necessary amounts and reduce the likelihood of contributing to over land runoff containing both nitrates and E. coli bacteria to nearby streams and reservoirs.
Tissue analysis provides information on how much nitrogen is in the crop at certain life stages and if more nitrogen is needed to carry the crop through the season. Utilizing this information, producers can insure they are not loading the vadose zone with unneeded nitrogen.	**Crop Tissue Analysis** • Each Producer will complete one growing season tissue analysis and one late season stalk nitrate test on the same field within five years of the plan approval.	Tissue analysis results will be used to adjust additional applications of nitrogen later in the growing season. This will reduce the risk of over applying late in the year when the crop is no longer utilizing nutrients which reduces the amount of nitrates available in runoff events.

Split fertilizer applications reduce the risk of leaching unused nitrates below the root zone by applying small amounts of fertilizer when the crop is ready to utilize nutrients.	**Split Fertilizer Applications** • Split application of nitrogen fertilizer will be required where the soil cation exchange capacity is <10 mg/kg. • In soil types where the cation exchange capacity is >10 mg/l, one-on-one contact with producers will be undertaken to encourage split applications.	Split fertilizer applications reduce the risk of losing unused nitrogen in runoff events throughout the growing season.
Fertigation allows producers to add water-soluble fertilizers to their irrigation systems and precisely apply nutrients in small amounts during the growing season reducing the risk of leaching nitrogen below the root zone into the groundwater.	**Fertigation** • Encourage the proper utilization of fertigation on irrigated agricultural fields, especially corn fields. • Producers will be certified and obtain a fertigation permit from their NRD. • Producers will maintain proper protective measures and fertigation equipment.	By utilizing fertigation, producers reduce the risk of over-applying nutrients and allowing large amounts of nitrogen to runoff into surface water bodies or allowing nutrients to leach below the root zone and into groundwater providing baseflow for area streams.
Nitrification inhibitors slow the release of nitrogen fertilizer so that more is available to be utilized by the plant when it needs nutrients instead of leaching below the root zone into the groundwater.	**Nitrification Inhibitors** • Encourage the use of nitrification inhibitors on all agricultural fields especially irrigated fields.	Nitrification inhibitors slow the release of nitrogen fertilizer so less is lost to leaching below the root zone into the groundwater where less nitrogen will make it to streams through baseflow.
Cover crops protect bare soil utilizing excess nutrients in the soil and preventing leaching below the root zone outside of the growing season as well as promoting healthy microbial communities and soil structure.	**Cover Crops** • Encourage the use of cover crops on all agricultural fields.	By utilizing cover crops the soil is less likely to be compacted from precipitation and allow runoff to occur carrying soil, E.coli, pesticides, and nutrients to streams and reservoirs.

Producers record the amount of nitrogen fertilizer used on NRD end-of-season reporting forms. This educational tool allows the producer to reflect on how much fertilizer was used and the corresponding yield. This information helps make fertilizer decisions for the following season. If less nitrogen could be used to obtain the same yield, this will reduce the risk of nitrogen leaching into the groundwater	***Annual Crop Reports** (Nitrogen Budgeting) • Producers will document nitrogen requirements and usage for all fields where >50lbs per acre of nitrogen is applied and submit reports to their NRD.	By utilizing NRD end-of-season reporting forms the producer is able reflect on how much fertilizer was used and the corresponding yield. This information helps make fertilizer decisions for the following season. If less nitrogen could be used to obtain the same yield, this will reduce the risk of over-applying nitrogen allowing leaching into the groundwater providing baseflow to streams and runoff into surface waters.
Variable Rate Applications and Precision Farming allows the Producer to adjust the irrigation system speed for different soil types where the system can be speed up over sandy soils or grasses water ways which reduces the likelihood of over irrigating and allowing leaching to occur.	**Variable Rate Applications and Precision Farming** • Encourage the use of variable rate applications and precision farming on all agricultural fields.	Variable rate application and precision farming results in less water being applied to areas of the field that do not require as much the rest of the field reducing both the frequency and magnitude of runoff events.
No till/reduced till practices allow roots to form natural water channels into the soil as well as increasing microbial diversity and soil health resulting in an increase in the soils ability to hold water and nutrients in the root zone where both are utilized by the microbial community resulting in less leaching.	**No Till/ Reduced Tillage** • Encourage the use of no till and or reduced tillage on all agricultural fields.	No till/reduced till practices reduce compaction and the likelihood of pan formations from heavy machines repeatedly passing over the field reducing the frequency and magnitude of runoff events.

Appendix F

BGMA – Monitoring Wells

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
NE3113902	Pierce		Confidential	27	3	Plainview	1	New
G-007787A	Pierce	NESE	6	27	4	Plainview	1	New
G-007787B	Pierce	NWSE	6	27	4	Plainview	1	New
G-011606	Pierce	SWNE	6	27	4	Plainview	1	New
G-019656A	Pierce	SENW	6	27	4	Plainview	1	New
G-019656B	Pierce	SENW	6	27	4	Plainview	1	New
G-042487	Pierce	SESW	6	27	4	Plainview	1	New
G-003091	Pierce	NWSW	7	27	4	Plainview	1	New
G-032901	Pierce	NWNE	7	27	4	Plainview	1	New
G-041241	Pierce	SWSE	7	27	4	Plainview	1	New
G-066360	Pierce	NWNW	7	27	4	Plainview	1	Baseline
G-044037	Pierce	SESE	8	27	4	Plainview	1	New
G-092251	Pierce	SWNW	8	27	4	Plainview	1	New
G-028383	Antelope	SE	1	27	5	Plainview	1	Baseline
G-030546	Antelope	NWNE	12	27	5	Plainview	1	Baseline
G-034509	Antelope	SWSE	1	27	6	Brunswick	1	Baseline
G-088948	Antelope	NE	1	27	6	Brunswick	1	Baseline
G-045812	Antelope	NW	11	27	6	Brunswick	1	Baseline
G-072585	Antelope	NE	12	27	6	Brunswick	1	Baseline
NE3100309	Antelope		Confidential	27	6	Brunswick	1	New
G-040440	Antelope	NW	4	27	7	Royal	1	Baseline
G-053663	Antelope	NE	4	27	7	Royal	1	Baseline
NE3100303	Antelope		Confidential	27	7	Royal	1	New
G-029539	Antelope	SWNE	4	27	8	Orchard	1	Baseline
G-061978	Antelope	NESW	10	27	8	Orchard	1	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
NE3100304	Antelope		Confidential	27	8	Orchard	1	New
NE3120672	Antelope		Confidential	27	8	Orchard	1	New
G-005110	Pierce	NESE	29	28	2	Osmond	1	New
G-020066	Pierce	SWSW	29	28	2	Osmond	1	New
G-097660	Pierce	NW	29	28	2	Osmond	1	New
G-019637	Pierce	NESW	30	28	2	Osmond	1	New
G-019638	Pierce	NESW	30	28	2	Osmond	1	New
G-051975	Pierce	NE	30	28	2	Osmond	1	New
G-000890	Pierce	SENE	31	28	2	Osmond	1	New
G-005707	Pierce	SE	31	28	2	Osmond	1	New
G-036775	Pierce	SWSW	32	28	2	Osmond	1	New
G-045946	Pierce	NWNW	32	28	2	Osmond	1	New
G-130636	Pierce	SWNE	32	28	2	Osmond	1	New
G-136424	Pierce	SWSE	32	28	2	Osmond	1	New
G-153175	Pierce	SWNW	32	28	2	Osmond	1	New
NE3113903	Pierce		Confidential	28	2	Osmond	1	New
G-019152	Pierce	SESE	36	28	3	Osmond	1	New
G-064503	Pierce	NESE	36	28	3	Osmond	1	New
G-032659	Pierce	NWSW	6	28	4	Creighton	1	New
G-045945	Pierce	NW	6	28	4	Creighton	1	New
G-057435	Pierce	SE	6	28	4	Creighton	1	New
G-151888	Pierce	NE	6	28	4	Creighton	1	New
G-031438	Pierce	NWNE	32	28	4	Plainview	1	Baseline
G-051382	Pierce	SWSW	32	28	4	Plainview	1	New
G-058300	Pierce	NWSE	32	28	4	Plainview	1	New
G-082207	Pierce	NENW	32	28	4	Plainview	1	Baseline
G-098157	Pierce	SWNW	32	28	4	Plainview	1	New
G-041612	Antelope	SENE	1	28	5	Creighton	1	Baseline
G-050170	Knox	NE	8	29	2	Wausa	1	New

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-156271	Knox	SWNE	10	29	2	Wausa	1	New
G-006560	Knox	NESW	15	29	2	Wausa	1	New
G-050720	Knox	SENW	16	29	2	Wausa	1	New
NE3110711	Knox		Confidential	29	2	Wausa	1	New
G-033980	Knox	NW	30	29	4	Creighton	1	Baseline
G-048223	Knox	SWNE	30	29	4	Creighton	1	Baseline
G-048696	Knox	SW	30	29	4	Creighton	1	Baseline
G-055168	Knox	SE	30	29	4	Creighton	1	Baseline
G-035730	Knox	NW	31	29	4	Creighton	1	Baseline
G-054959	Knox	NE	31	29	4	Creighton	1	Baseline
G-089824	Knox	SE	31	29	4	Creighton	1	Baseline
G-095731	Knox	SW	31	29	4	Creighton	1	Baseline
G-075073	Knox	SWSW	22	29	5	Creighton	1	Baseline
G-160943	Knox	SWNW	22	29	5	Creighton	1	Baseline
G-047323	Knox	SESE	25	29	5	Creighton	1	Baseline
G-057889	Knox	NENE	25	29	5	Creighton	1	Baseline
G-071856	Knox	NWSW	25	29	5	Creighton	1	Baseline
G-036968	Knox	SE	26	29	5	Creighton	1	Baseline
G-044833	Knox	NE	26	29	5	Creighton	1	Baseline
G-158208	Knox	NWSW	26	29	5	Creighton	1	Baseline
G-069058	Knox	NE	27	29	5	Creighton	1	Baseline
G-074968	Knox	SESW	27	29	5	Creighton	1	Baseline
G-094128	Knox	SESE	27	29	5	Creighton	1	Baseline
G-095963	Knox	NWNW	27	29	5	Creighton	1	New
G-013982	Knox	SESE	34	29	5	Creighton	1	Baseline
G-029546	Knox	SESW	34	29	5	Creighton	1	Baseline
G-034020	Knox	SWSE	34	29	5	Creighton	1	Baseline
G-046673	Knox	SENE	34	29	5	Creighton	1	Baseline
G-066844	Knox	NWSE	34	29	5	Creighton	1	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-088078	Knox	NE	34	29	5	Creighton	1	Baseline
G-030717	Knox	SE	35	29	5	Creighton	1	Baseline
G-049156	Knox	SW	35	29	5	Creighton	1	Baseline
G-057928	Knox	NE	35	29	5	Creighton	1	Baseline
G-094129	Knox	NWSE	35	29	5	Creighton	1	Baseline
G-135689	Knox	NENW	35	29	5	Creighton	1	Baseline
G-047324	Knox	NENE	36	29	5	Creighton	1	Baseline
G-049985	Knox	SE	36	29	5	Creighton	1	Baseline
G-058090	Knox	NW	36	29	5	Creighton	1	Baseline
G-058091	Knox	SW	36	29	5	Creighton	1	Baseline
G-094130	Knox	NWSE	36	29	5	Creighton	1	Baseline
NE3110705	Knox		Confidential	29	5	Creighton	1	New
G-051600	Knox	NW	21	29	6	West Knox	1	Baseline
G-044964	Knox	NENE	28	29	6	West Knox	1	Baseline
G-030400	Knox	NE	33	29	6	West Knox	1	Baseline
G-033000	Pierce	SWSW	9	27	4	Plainview	2	New
G-047014	Pierce	NWSW	9	27	4	Plainview	2	New
G-060321	Pierce	SW	17	27	4	Plainview	2	New
G-134012	Pierce	SWNW	17	27	4	Plainview	2	New
G-138315	Pierce	SWNE	17	27	4	Plainview	2	New
G-043650	Pierce	NENE	18	27	4	Plainview	2	New
G-043651	Pierce	NWNW	18	27	4	Plainview	2	Baseline
G-050029	Pierce	SE SW	18	27	4	Plainview	2	Baseline
G-051281	Pierce	NESW	18	27	4	Plainview	2	New
G-134687	Pierce	SWSE	18	27	4	Plainview	2	New
G-033550	Pierce	SWSW	19	27	4	Plainview	2	New
G-136098	Pierce	SESE	19	27	4	Plainview	2	New
G-037370	Pierce	NE	20	27	4	Plainview	2	New
G-070779	Pierce	NENW	20	27	4	Plainview	2	New

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-053502	Antelope	NW	10	27	5	Plainview	2	Baseline
G-051515	Antelope	NENW	11	27	5	Plainview	2	Baseline
G055777X	Antelope	SESE	13	27	5	Plainview	2	Baseline
G-050156	Antelope	SWSE	14	27	5	Plainview	2	Baseline
G-143790	Antelope	SWNW	14	27	5	Plainview	2	Baseline
G-108372	Antelope	NENE	15	27	5	Plainview	2	Baseline
G-031445	Antelope	SWSE	16	27	5	Plainview	2	Baseline
G-030984	Antelope	SWSE	22	27	5	Plainview	2	Baseline
G-035257	Antelope	NESW	24	27	5	Plainview	2	Baseline
G-0352571R	Antelope	NESW	24	27	5	Plainview	2	Baseline
G-114135	Antelope	NWNW	14	27	6	Brunswick	2	Baseline
G-114136	Antelope	NWNW	14	27	6	Brunswick	2	Baseline
G-114137	Antelope	NWNW	14	27	6	Brunswick	2	Baseline
G-033333	Antelope	NESE	15	27	6	Brunswick	2	Baseline
G-090334	Antelope	SESE	8	27	7	Royal	2	New
G-059516	Antelope	NE	16	27	7	Royal	2	Baseline
G-052952	Antelope	SE	8	27	8	Orchard	2	Baseline
G-035555	Antelope	NW	16	27	8	Orchard	2	Baseline
G-032350	Antelope	SESE	20	27	8	Orchard	2	Baseline
G-046480	Antelope	NE	21	27	8	Orchard	2	Baseline
G-064508	Antelope	NE	22	27	8	Orchard	2	Baseline
G-030673A	Pierce	SE	20	28	2	Osmond	2	New
G-030673B	Pierce	SWSE	20	28	2	Osmond	2	New
G-051090	Pierce	SW	20	28	2	Osmond	2	New
G-128795	Pierce	SENE	20	28	2	Osmond	2	New
G-000931A	Pierce	NESE	21	28	2	Osmond	2	New
G-000931B	Pierce	SWSE	21	28	2	Osmond	2	New
G-072198	Pierce	NWNW	21	28	2	Osmond	2	New
G-079147	Pierce	NENE	21	28	2	Osmond	2	New

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-029719	Pierce	NESW	22	28	2	Osmond	2	New
G-041810	Pierce	SE	22	28	2	Osmond	2	New
G-072848	Pierce	NE	22	28	2	Osmond	2	New
G-072852	Pierce	NWSW	22	28	2	Osmond	2	New
G-100763	Pierce	SESE	22	28	2	Osmond	2	New
G-117574	Pierce	NESE	22	28	2	Osmond	2	New
G-139264	Pierce	NWNW	27	28	2	Osmond	2	New
G-140916	Pierce	NENE	27	28	2	Osmond	2	New
G-143563	Pierce	NENE	27	28	2	Osmond	2	New
G-066941	Pierce	NWNW	28	28	2	Osmond	2	New
G-110326	Pierce	NESW	28	28	2	Osmond	2	New
G-116064	Pierce	SWNE	28	28	2	Osmond	2	New
G-001854	Pierce	SWNW	33	28	2	Osmond	2	New
G-070942	Pierce	SESE	33	28	2	Osmond	2	New
G-072120	Pierce	NENE	33	28	2	Osmond	2	New
G-087301	Pierce	SW	33	28	2	Osmond	2	New
G-020170	Pierce	SE	3	28	4	Creighton	2	New
G-136941	Pierce	SW	3	28	4	Creighton	2	New
G-005338	Pierce	SENE	4	28	4	Creighton	2	New
G-050375	Pierce	SE	4	28	4	Creighton	2	New
G-068058	Pierce	SE NE	4	28	4	Creighton	2	Baseline
G-036551	Pierce	NWSE	5	28	4	Creighton	2	New
G-040859	Pierce	NENE	5	28	4	Creighton	2	New
G-161964	Pierce	NWNW	5	28	4	Creighton	2	New
G-041395	Pierce	NE	7	28	4	Creighton	2	New
G-076806	Pierce	NWNW	7	28	4	Creighton	2	New
G-049874	Pierce	SE	8	28	4	Creighton	2	Baseline
G-055523	Pierce	NW	8	28	4	Creighton	2	New
G-109620	Pierce	SWNW	8	28	4	Creighton	2	New

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-122662	Pierce	SWSW	8	28	4	Creighton	2	New
G-049436	Pierce	NENE	9	28	4	Creighton	2	New
G-049568	Pierce	NWNW	10	28	4	Creighton	2	New
G-131176	Pierce	NWNE	10	28	4	Creighton	2	New
G-161929	Pierce	SWSW	10	28	4	Creighton	2	New
G-066589	Pierce	SWNW	15	28	4	Creighton	2	New
G-136688	Pierce	SESW	15	28	4	Creighton	2	New
G-058301	Pierce	SESE	16	28	4	Creighton	2	New
G-065810	Pierce	NWSW	16	28	4	Creighton	2	Baseline
G-069385	Pierce	NE	16	28	4	Creighton	2	New
G-073229	Pierce	NWSE	16	28	4	Creighton	2	New
G-045857	Pierce	SESE	17	28	4	Creighton	2	New
G-051781	Pierce	SWSW	17	28	4	Creighton	2	New
G-067364	Pierce	SENW	17	28	4	Creighton	2	New
G-046233	Pierce	NENE	18	28	4	Creighton	2	New
G-047209	Pierce	SESW	18	28	4	Creighton	2	New
G-066590	Pierce	SESE	18	28	4	Creighton	2	New
G-048705	Pierce	NWNW	19	28	4	Creighton	2	New
G-056950	Pierce	SWSW	19	28	4	Creighton	2	New
G-091121	Pierce	NENE	19	28	4	Creighton	2	New
G-136665	Pierce	SE	19	28	4	Creighton	2	New
G-035352	Pierce	NE SE	20	28	4	Creighton	2	Baseline
G-065792	Pierce	NW	20	28	4	Creighton	2	New
G-032628	Pierce	SWSW	21	28	4	Creighton	2	New
G-035353	Pierce	SWNW	21	28	4	Creighton	2	New
G-0672521R	Pierce	SWSE	22	28	4	Creighton	2	Baseline
G-074855	Pierce	NENE	22	28	4	Creighton	2	New
G-149524	Pierce	NWNW	22	28	4	Creighton	2	New
G-082463	Pierce	SWSE	31	28	4	Plainview	2	New

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-031058	Antelope	NENE	2	28	5	Creighton	2	Baseline
G-034896	Antelope	SESW	10	28	5	Creighton	2	Baseline
G-050903	Antelope	NESW	11	28	5	Creighton	2	Baseline
G-135812	Antelope	SWNW	11	28	5	Creighton	2	New
G-048093	Antelope	NENW	12	28	5	Creighton	2	Baseline
G-063584	Antelope	SWSW	12	28	5	Creighton	2	Baseline
G-013028	Antelope	SWSW	36	28	5	Creighton	2	Baseline
G-013029	Antelope	SWNW	36	28	5	Creighton	2	Baseline
G-035641	Antelope	NENE	3	28	6	West Knox	2	Baseline
G-065304	Antelope	SWNE	5	28	6	West Knox	2	Baseline
G-0381431R	Antelope	NWNW	8	28	6	West Knox	2	Baseline
G-146632X	Antelope	NENW	8	28	6	West Knox	2	Baseline
G-047180	Antelope	SESE	9	28	6	West Knox	2	Baseline
G-067388	Knox	NE	20	29	2	Wausa	2	New
G-040860	Knox	SE	32	29	4	Creighton	2	Baseline
G-044834	Knox	SW	32	29	4	Creighton	2	Baseline
G-055118	Knox	NW	32	29	4	Creighton	2	Baseline
G-094123	Knox	NWSE	32	29	4	Creighton	2	Baseline
G-045036	Knox	SE	33	29	4	Creighton	2	Baseline
G-054701	Knox	SW	33	29	4	Creighton	2	Baseline
G-095368	Knox	NWNW	22	29	6	West Knox	2	Baseline
G-072501	Knox	SENW	23	29	6	West Knox	2	Baseline
G-029858	Knox	SENE	27	29	6	West Knox	2	Baseline
G-072502	Knox	NENE	28	29	6	West Knox	2	New
G-0397381R	Knox	NWNE	34	29	6	West Knox	2	Baseline
G-032040	Knox	SWNW	35	29	6	West Knox	2	Baseline
G-036225	Antelope	NENE	6	27	6		3	Baseline
G-084707	Antelope	SESE	7	27	6		3	Baseline
G-114125	Antelope	SWNW	2	27	7		3	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-114126	Antelope	SWNW	2	27	7		3	Baseline
G-114127	Antelope	SWNW	2	27	7		3	Baseline
G-054359	Antelope	SW	11	27	7		3	Baseline
G-158824	Antelope	NWNE	26	28	7		3	New
G-045259	Antelope	NENE	35	28	7		3	Baseline
G-097533A	Pierce	NWNW	1	27	2		4	Baseline
G-097533B	Pierce	NWNW	1	27	2		4	Baseline
G-056360	Pierce	SW	2	27	2		4	Baseline
G-057085	Pierce	SE	7	27	2		4	Baseline
G-070896	Pierce	SESW	8	27	2		4	Baseline
G-042528	Pierce	SWSW	11	27	2		4	Baseline
G-048199	Pierce	NWNW	11	27	2		4	Baseline
G-047396	Pierce	SWSW	16	27	2		4	Baseline
G-049437	Pierce	NENW	16	27	2		4	Baseline
G-072151	Pierce	NENE	16	27	2		4	Baseline
G-048735	Pierce	NENE	17	27	2		4	Baseline
G-051977	Pierce	SWSW	18	27	2		4	Baseline
G-040016	Pierce	SWSE	19	27	2		4	Baseline
G-046763	Pierce	SWSW	20	27	2		4	Baseline
G-074318	Pierce	SESE	20	27	2		4	Baseline
G-101515	Pierce	NWNW	22	27	2		4	Baseline
G-101516	Pierce	NWNW	22	27	2		4	Baseline
G-073134	Pierce	SESE	24	27	2		4	Baseline
G-0551931R	Pierce	NESW	34	27	2		4	Baseline
G-0551941R	Pierce	SWNW	34	27	2		4	Baseline
G-0191531R	Pierce	SWNW	1	27	3		4	Baseline
G-0323551R	Pierce	SWSW	1	27	3		4	Baseline
G-0116281R	Pierce	NWNE	3	27	3		4	Baseline
G-067169	Pierce	SW	3	27	3		4	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-068297	Pierce	SE	3	27	3		4	Baseline
G-072034	Pierce	NWNW	3	27	3		4	Baseline
G-062052	Pierce	SESE	4	27	3		4	Baseline
G-102135	Pierce	SENW	4	27	3		4	Baseline
G-102136	Pierce	NENW	4	27	3		4	Baseline
G-105865	Pierce	NENE	4	27	3		4	Baseline
G-033764	Pierce	SESE	5	27	3		4	Baseline
G-045496	Pierce	NE	8	27	3		4	Baseline
G-051979	Pierce	NWNW	9	27	3		4	Baseline
G-065737	Pierce	NENE	9	27	3		4	Baseline
G-034966	Pierce	SE	10	27	3		4	Baseline
G-054524	Pierce	NWNW	10	27	3		4	Baseline
G-054850	Pierce	SW	10	27	3		4	Baseline
G-048524	Pierce	SWSW	11	27	3		4	Baseline
G-037237	Pierce	NENE	14	27	3		4	Baseline
G-064296	Pierce	SESE	14	27	3		4	Baseline
G-045713	Pierce	NENW	15	27	3		4	Baseline
G-059084	Pierce	SE	22	27	3		4	Baseline
G-071044	Pierce	NESE	24	27	3		4	Baseline
G-039298	Pierce	NWNW	25	27	3		4	Baseline
G-121483	Pierce	NWNE	31	27	3		4	Baseline
NE3120873	Pierce		Confidential	27	3		4	New
NE3121106	Pierce		Confidential	27	3		4	New
NE3150524	Pierce		Confidential	27	3		4	New
G-044104	Pierce	NESW	3	27	4		4	Baseline
G-030682	Pierce	NE	11	27	4		4	Baseline
G-101517	Pierce	NWNE	15	27	4		4	Baseline
G-101518	Pierce	NWNE	15	27	4		4	Baseline
G-050483	Pierce	SESE	16	27	4		4	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-060271	Pierce	SW	22	27	4		4	Baseline
G-075331	Pierce	SENE	22	27	4		4	Baseline
G-049547	Pierce	NWSW	23	27	4		4	Baseline
G-041831	Pierce	SENW	25	27	4		4	Baseline
G-052515	Pierce	SESW	25	27	4		4	Baseline
G-028379	Pierce	SESE	26	27	4		4	Baseline
G-036849	Pierce	NWNE	26	27	4		4	Baseline
G-064706	Pierce	NW	26	27	4		4	Baseline
G-050235	Pierce	NW	31	27	4		4	Baseline
G-056159	Pierce	NE	32	27	4		4	Baseline
G-073467	Pierce	NW	32	27	4		4	Baseline
G-073479	Pierce	NENE	33	27	4		4	Baseline
G-0488711R	Pierce	SWSW	35	27	4		4	Baseline
G-051976	Pierce	NE	35	27	4		4	Baseline
G-114128	Antelope	SESE	3	27	5		4	Baseline
G-114129	Antelope	SESE	3	27	5		4	Baseline
G-114130	Antelope	SESE	3	27	5		4	Baseline
G-040020	Antelope	NE	4	27	5		4	Baseline
G-133702	Antelope	SWNW	5	27	5		4	Baseline
G-039140	Antelope	NW	6	27	5		4	Baseline
G-050179	Antelope	NENW	7	27	5		4	Baseline
G-049121	Antelope	NWNW	8	27	5		4	Baseline
G-046152	Antelope	NESE	17	27	5		4	Baseline
G-045783	Antelope	NENW	18	27	5		4	Baseline
G-043170	Antelope	NENE	19	27	5		4	Baseline
G-037858X	Antelope	NWNW	26	27	5		4	Baseline
G-072886	Antelope	NENW	27	27	5		4	Baseline
G-069538	Antelope	NENE	28	27	5		4	Baseline
G-040258	Antelope	NE	29	27	5		4	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-040204	Antelope	NE	30	27	5		4	Baseline
G-056954	Antelope	SWNE	31	27	5		4	Baseline
G-051203	Antelope	NESW	32	27	5		4	Baseline
G-063771	Antelope	NWSE	32	27	5		4	Baseline
G-053529	Antelope	NWNW	33	27	5		4	Baseline
G-030348	Antelope	NW	34	27	5		4	Baseline
G-031695	Antelope	SW	35	27	5		4	Baseline
G-051046	Antelope	NWSE	36	27	5		4	Baseline
G-042888	Antelope	SESE	4	27	6		4	Baseline
G-042889	Antelope	SENE	4	27	6		4	Baseline
G-057592	Antelope	NW	8	27	6		4	New
G-035506	Antelope	NWNW	9	27	6		4	Baseline
G-045692	Antelope	NE	13	27	6		4	Baseline
G-044925	Antelope	SWSW	16	27	6		4	Baseline
G-055808	Antelope	NW	17	27	6		4	Baseline
G-069757	Antelope	NESW	19	27	6		4	Baseline
G-051326	Antelope	NW	20	27	6		4	Baseline
G-033663	Antelope	SWSE	21	27	6		4	Baseline
G-052837	Antelope	NW	24	27	6		4	Baseline
G-054685	Antelope	NE	25	27	6		4	Baseline
G-053283	Antelope	NENE	26	27	6		4	Baseline
G-044250	Antelope	NENE	27	27	6		4	Baseline
G-026163	Antelope	NESW	29	27	6		4	New
G-065241	Antelope	NWSE	30	27	6		4	Baseline
G-040637	Antelope	NE	32	27	6		4	Baseline
G-049533	Antelope	NW	34	27	6		4	Baseline
G-114133	Antelope	SESE	34	27	6		4	Baseline
G-114134	Antelope	SESE	34	27	6		4	Baseline
G-032252	Antelope	SWNE	35	27	6		4	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-026354	Antelope	NWSE	7	27	7		4	Baseline
G-026306	Antelope	NW	18	27	7		4	Baseline
G-137061	Antelope	SESE	19	27	7		4	Baseline
G-140539	Antelope	NENW	21	27	7		4	Baseline
G-068882	Antelope	NE	24	27	7		4	Baseline
G-050784	Antelope	SESE	25	27	7		4	Baseline
G-126574	Antelope	SWNW	26	27	7		4	New
G-062869	Antelope	NWNW	27	27	7		4	Baseline
G-135238	Antelope	NWSW	27	27	7		4	Baseline
G-040837	Antelope	E	29	27	7		4	New
G-040072	Antelope	SWSW	30	27	7		4	Baseline
G-0595191R	Antelope	SWNW	36	27	7		4	Baseline
NE3121396	Antelope		Confidential	27	7		4	New
G-042594	Antelope	NESE	1	27	8		4	Baseline
G-131786	Antelope	NENE	1	27	8		4	Baseline
G-065922	Antelope	NESW	6	27	8		4	Baseline
G-167258	Antelope	SWNE	11	27	8		4	New
G-026353	Antelope	SESE	12	27	8		4	Baseline
G-036793	Antelope	SE	14	27	8		4	Baseline
G-059738	Antelope	SW	18	27	8		4	Baseline
G-051430	Antelope	SWSW	24	27	8		4	Baseline
G-147946	Antelope	NWNE	26	27	8		4	New
G-046740	Antelope	SWSW	28	27	8		4	Baseline
G-050518	Antelope	NWNW	29	27	8		4	Baseline
G-050426	Antelope	SENE	31	27	8		4	Baseline
G-039667	Antelope	NWSE	33	27	8		4	Baseline
G-039891	Antelope	NW	35	27	8		4	Baseline
G-091294	Antelope	SENW	35	27	8		4	Baseline
G-124987A	Pierce	SENE	15	28	2		4	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-124987B	Pierce	SENE	15	28	2		4	Baseline
G-136494	Pierce	SWSW	18	28	2		4	Baseline
G-117248	Pierce	NWNE	34	28	2		4	Baseline
G-125823	Pierce	SWSW	36	28	2		4	Baseline
G-006901	Pierce	NE	2	28	3		4	Baseline
G-033883	Pierce	SWSE	15	28	3		4	Baseline
G-050512	Pierce	SWNW	18	28	3		4	Baseline
G-050528	Pierce	SW	20	28	3		4	Baseline
G-076784	Pierce	SESE	21	28	3		4	Baseline
G-002949	Pierce	SENW	22	28	3		4	Baseline
G-101519	Pierce	NWNW	22	28	3		4	Baseline
G-101520	Pierce	NWNW	22	28	3		4	Baseline
G-101521	Pierce	NWNW	22	28	3		4	Baseline
G-081987	Pierce	SWSW	24	28	3		4	Baseline
G-088006	Pierce	SE	24	28	3		4	Baseline
G-094949	Pierce	NENE	24	28	3		4	Baseline
G-066829	Pierce	SW	27	28	3		4	Baseline
G-069327	Pierce	SE	28	28	3		4	Baseline
G-083503	Pierce	NW	28	28	3		4	Baseline
G-045712	Pierce	SWSE	31	28	3		4	Baseline
G-070316A	Pierce	NENE	31	28	3		4	Baseline
G-042529	Pierce	NENW	33	28	3		4	Baseline
G-045855	Pierce	SWSW	34	28	3		4	Baseline
G-066830	Pierce	NW	34	28	3		4	Baseline
G-055826	Pierce	SW	2	28	4		4	Baseline
G-073089	Pierce	NE	11	28	4		4	Baseline
G-082557	Pierce	SW	11	28	4		4	Baseline
G-0019221R	Pierce	NWNW	13	28	4		4	Baseline
G-0048471R	Pierce	NENE	14	28	4		4	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-049730	Pierce	SW	25	28	4		4	Baseline
G-065669	Pierce	SENW	25	28	4		4	Baseline
G-045682	Pierce	SESE	26	28	4		4	Baseline
G-090420	Pierce	NENE	26	28	4		4	Baseline
G-039217	Pierce	NWNE	27	28	4		4	Baseline
G-040426	Pierce	NESE	28	28	4		4	Baseline
G-105175	Pierce	NENE	28	28	4		4	Baseline
G-045175	Pierce	SWSE	29	28	4		4	Baseline
G-032650	Pierce	NE	35	28	4		4	Baseline
G-033728	Pierce	SE	36	28	4		4	Baseline
G-047157	Antelope	SWNW	6	28	5		4	Baseline
G-088015	Antelope	SWNW	8	28	5		4	New
G-114120	Antelope	NENE	15	28	5		4	Baseline
G-057398	Antelope	NE	18	28	5		4	Baseline
G-114121	Antelope	SWSW	20	28	5		4	Baseline
G-114122	Antelope	SWSW	20	28	5		4	Baseline
G-050962	Antelope	NESW	22	28	5		4	Baseline
G-0509621R	Antelope	NWSW	22	28	5		4	Baseline
G-104703	Antelope	NESE	22	28	5		4	Baseline
G-064964	Antelope	SENW	23	28	5		4	Baseline
G-050575	Antelope	SW	25	28	5		4	New
G-048764	Antelope	NWNW	29	28	5		4	New
G-053505	Antelope	SENW	29	28	5		4	Baseline
G-048482	Antelope	SWSE	33	28	5		4	Baseline
G-037896	Antelope	NESW	34	28	5		4	Baseline
G-044107	Antelope	NESE	34	28	5		4	Baseline
G-013028	Antelope	SWSW	36	28	5		4	New
G-013029	Antelope	SWNW	36	28	5		4	New
NE3150015	Antelope		Confidential	28	5		4	New

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-032035	Antelope	NW	2	28	6		4	Baseline
G-049319	Antelope	NENE	11	28	6		4	Baseline
G-114123	Antelope	NWSW	13	28	6		4	Baseline
G-114124	Antelope	NWSW	13	28	6		4	Baseline
G-067259	Antelope	SENW	15	28	6		4	Baseline
G-0450791R	Antelope	SWNW	21	28	6		4	Baseline
G-062097	Antelope	SWNE	22	28	6		4	Baseline
G-062808	Antelope	SWNW	24	28	6		4	Baseline
G-009481	Antelope	SWSW	26	28	6		4	Baseline
G-040363	Antelope	SENW	26	28	6		4	New
G-062098	Antelope	NWSE	28	28	6		4	Baseline
G-048697X	Antelope	NE	29	28	6		4	Baseline
G-163990	Antelope	SENE	29	28	6		4	Baseline
G-028485	Antelope	NWNW	31	28	6		4	Baseline
G-072726	Antelope	NWSW	33	28	6		4	Baseline
G-044174	Antelope	SE	34	28	6		4	Baseline
G-0139581R	Antelope	SESE	35	28	6		4	Baseline
G-052504	Antelope	SENE	35	28	6		4	Baseline
G-035897	Antelope	NWNE	11	28	7		4	New
G-029299	Antelope	SWSE	12	28	7		4	Baseline
G-115750	Antelope	SWSE	14	28	7		4	Baseline
G-151897	Antelope	NWNW	17	28	7		4	New
G-041489	Antelope	NW	19	28	7		4	Baseline
G-048777	Antelope	SENE	19	28	7		4	Baseline
G-065929	Antelope	NENW	24	28	7		4	Baseline
G-055417	Antelope	SWNW	25	28	7		4	Baseline
G-065690	Antelope	SWNE	25	28	7		4	Baseline
G-044842	Antelope	SENW	29	28	7		4	New
G047491	Antelope	SENW	30	28	7		4	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-041551	Antelope	NENE	31	28	7		4	Baseline
G-141380	Antelope	SWNW	31	28	7		4	Baseline
G-047229	Antelope	SW	32	28	7		4	Baseline
NE3120619	Antelope		Confidential	28	7		4	New
G-0686061R	Antelope	NENW	4	28	8		4	Baseline
G-134417	Antelope	NENE	11	28	8		4	New
G-051792	Antelope	NENW	17	28	8		4	New
G-068607	Antelope	SESE	17	28	8		4	Baseline
G-059324	Antelope	SE	18	28	8		4	Baseline
G-030473	Antelope	SWSW	20	28	8		4	Baseline
G-060774	Antelope	SWSW	26	28	8		4	Baseline
G-035311	Antelope	SE	28	28	8		4	Baseline
G-129140	Antelope	NESW	29	28	8		4	New
G-062797	Antelope	NW	31	28	8		4	Baseline
G-048037	Antelope	NE	33	28	8		4	Baseline
NE3121219	Antelope		Confidential	28	8		4	New
G-124964A	Knox	NENE	29	29	2		4	Baseline
G-124964B	Knox	NENE	29	29	2		4	Baseline
G-045389	Knox	SESW	4	29	3		4	Baseline
G-034206	Knox	SWNE	6	29	3		4	Baseline
G-041902	Knox	SW	6	29	3		4	Baseline
G-065917	Knox	SESW	7	29	3		4	Baseline
G-145977	Knox	SE	7	29	3		4	Baseline
G-036012	Knox	SWNE	18	29	3		4	Baseline
G-050441	Knox	NW	18	29	3		4	Baseline
G-064162	Knox	SW	18	29	3		4	Baseline
G-144526	Knox	SE	18	29	3		4	Baseline
G-052801	Knox	SWNE	19	29	3		4	Baseline
G-052986	Knox	NESW	19	29	3		4	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-053958	Knox	SE	19	29	3		4	Baseline
G-144602	Knox	NW	19	29	3		4	Baseline
NE3120621	Knox		Confidential	29	3		4	New
G-054578A	Knox	SENE	1	29	4		4	Baseline
G-054578B	Knox	SWNE	1	29	4		4	Baseline
G-054606	Knox	SESW	1	29	4		4	Baseline
G-091878	Knox	SWNW	2	29	4		4	Baseline
G-120519	Knox	NESW	2	29	4		4	Baseline
G-138577	Knox	SE	3	29	4		4	Baseline
G-135295	Knox	SWNE	4	29	4		4	Baseline
G-072904	Knox	SE	8	29	4		4	Baseline
G-172410	Knox	SENE	9	29	4		4	New
G-172468	Knox	NWSE	9	29	4		4	New
NONE	Knox	SE	10	29	4		4	New
G-054607	Knox	SE	11	29	4		4	Baseline
G-030737	Knox	SWSE	12	29	4		4	Baseline
G-034684	Knox	SW	12	29	4		4	Baseline
G-042176	Knox	NW	12	29	4		4	Baseline
G-051604	Knox	NWNW	12	29	4		4	Baseline
G-174478	Knox	SENW	12	29	4		4	New
G-056579	Knox	NW	13	29	4		4	Baseline
G-154413	Knox	SENE	15	29	4		4	Baseline
G-154414	Knox	SENE	15	29	4		4	Baseline
G-170854	Knox	SESE	15	29	4		4	New
G-170855	Knox	SESE	15	29	4		4	New
G-169867	Knox	NESW	16	29	4		4	New
G-169868	Knox	SWSW	16	29	4		4	New
G-172188	Knox	SWSW	16	29	4		4	New
G-048686B	Knox	SENE	19	29	4		4	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-088574	Knox	SWSW	19	29	4		4	Baseline
G-123223A	Knox	SWSE	20	29	4		4	Baseline
G-123223B	Knox	SESE	20	29	4		4	Baseline
G-146653	Knox	NENE	20	29	4		4	Baseline
G-135081	Knox	SWNW	21	29	4		4	Baseline
G-081892	Knox	SESW	22	29	4		4	Baseline
G-091902	Knox	SESE	22	29	4		4	Baseline
G-046918	Knox	SE	23	29	4		4	Baseline
G-066683	Knox	NE	24	29	4		4	Baseline
G-036283	Knox	SE	35	29	4		4	Baseline
G-037673	Knox	SWSW	35	29	4		4	Baseline
G-045826	Knox	NESE	1	29	5		4	Baseline
G-066707	Knox	NWSE	1	29	5		4	Baseline
G-0667071R	Knox	NWSE	1	29	5		4	Baseline
G-135690	Knox	NWNW	1	29	5		4	Baseline
G-161152	Knox	NWSE	1	29	5		4	New
G-076225	Knox	SWNW	6	29	5		4	Baseline
G-076226	Knox	SWNW	6	29	5		4	Baseline
G-060715	Knox	SE	9	29	5		4	Baseline
NONE	Knox	SW	10	29	5		4	New
G-091574	Knox	SESW	11	29	5		4	Baseline
G-094125	Knox	SWSW	11	29	5		4	Baseline
G-057927	Knox	SW	13	29	5		4	Baseline
G-031840	Knox	NE	14	29	5		4	Baseline
G-049136	Knox	NW	14	29	5		4	Baseline
G-094126	Knox	SESE	14	29	5		4	Baseline
G-152815	Knox	NWSE	14	29	5		4	Baseline
G-164611	Knox	SW	14	29	5		4	Baseline
G-001724	Knox	NWSW	15	29	5		4	New

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-032291	Knox	NENW	15	29	5		4	Baseline
G-057789	Knox	SWSW	15	29	5		4	Baseline
G-075228	Knox	SESE	15	29	5		4	Baseline
G-157769	Knox	SWNE	15	29	5		4	New
G-157770	Knox	NWNE	15	29	5		4	Baseline
G-116065	Knox	NENE	16	29	5		4	Baseline
G-168468	Knox	NESE	17	29	5		4	New
G-168469	Knox	NESE	17	29	5		4	New
G-168470	Knox	NESE	17	29	5		4	New
G-172599	Knox	SESW	17	29	5		4	New
G-040673	Knox	SW	23	29	5		4	Baseline
G-104103	Knox	SE	23	29	5		4	Baseline
G-113420	Knox	NE	23	29	5		4	Baseline
G-054198	Knox	SWNE	24	29	5		4	Baseline
G-067283	Knox	SW	24	29	5		4	Baseline
G-094124	Knox	NWSW	24	29	5		4	Baseline
G-104290	Knox	NW	24	29	5		4	Baseline
G-143669	Knox	SE	24	29	5		4	Baseline
G-168890	Knox	SWSW	31	29	5		4	New
G-169473	Knox	SWSW	31	29	5		4	New
G-159457	Knox	SWSW	32	29	5		4	Baseline
G-159458	Knox	SWSW	32	29	5		4	Baseline
G-168877	Knox	NWSW	32	29	5		4	New
NE3110703	Knox		Confidential	29	5		4	New
NE3110714	Knox		Confidential	29	5		4	New
NE3120348	Knox		Confidential	29	5		4	New
NE3120361	Knox		Confidential	29	5		4	New
G-059563A	Knox	NESE	1	29	6		4	Baseline
G-059563B	Knox	NESE	1	29	6		4	Baseline

Well Registration	County	Sub-section	Section	Township (N)	Range (W)	WH Area	Tier	Baseline/New
G-061111	Knox	SWNE	15	29	6		4	Baseline
G-031839	Knox	NWNE	36	29	6		4	Baseline
G-048715	Knox	SESW	18	29	7		4	New
G-027417	Knox	NWNW	19	29	7		4	Baseline
G-072171	Knox	SESW	19	29	7		4	Baseline
G-029332	Knox	SENW	20	29	7		4	Baseline
G-055216	Knox	NWNE	24	29	7		4	Baseline
G-054481A	Knox	SESE	3	29	8		4	Baseline
G-054480	Knox	NE	13	29	8		4	Baseline
G-050026	Knox	NENW	15	29	8		4	Baseline
G-061091B	Knox	SWSE	20	29	8		4	Baseline
G-049622	Knox	SWSE	21	29	8		4	Baseline
G-029168	Knox	SENW	23	29	8		4	Baseline
G-031598	Knox	SENE	24	29	8		4	Baseline
G-070587	Knox	NENW	26	29	8		4	Baseline
G-028659	Knox	NE	27	29	8		4	Baseline
G-073298	Knox	SENE	28	29	8		4	Baseline
G-133067	Knox	NESW	30	29	8		4	Baseline
G-067736	Knox	SESW	31	29	8		4	Baseline
G-053535	Knox	NW	32	29	8		4	Baseline
G-034170	Knox	SENW	33	29	8		4	Baseline
G-051250	Knox	SENW	34	29	8		4	Baseline