Upper Loup
Natural Resources District

Groundwater Management Plan

Approved by ULNRD: July 2022

Prepared for: *Upper Loup Natural Resources District*

Prepared by: *JEO Consulting Group, Inc.*

JEO Project Number: *210907.00*

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Name	Representing
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Name	Title
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Shane Young	Resources Technician
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Lexi Spurlin	Information & Education / Resources Technician
Jamie Green	Administrative Secretary
Spud Rowley	Recycling Coordinator
Pam Petersen	Field Office Secretary

This Groundwater Management Plan update has been prepared for ULNRD per Nebraska Revised Statue 46-709. The plan was written to assist the ULNRD to proactively protect and manage the groundwater resources and was developed using the best available information.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACE Camp	Adventure Camp about the Environment
CENEB	Central Nebraska
CFS	Cubic feet per second
CSD	Conservation and Survey Division
DRASTIC	Depth, Recharge, Aquifer, Soil, Topography, Impact, Conductivity
EQIP	Environmental Quality Incentive Program
GIS	Geographic Information System
GWMA	Groundwater Management Area
GWMP	Groundwater Management Plan
LPRBC	Lower Platte River Basin Coalition
LPRCA	Lower Platte River Corridor Alliance
MAF	Million Acre Feet
Mg/L	Milligrams per Liter
NARD	Nebraska Association of Resources Districts
NDEE	Nebraska Department of Environment and Energy
NeDNR	Nebraska Department of Natural Resources
NPDES	National Pollutant Discharge Elimination System
NRC	Natural Resources Commission
NRCS	Natural Resources Conservation Service
ULNRD	Upper Loup Natural Resources District
UNL	University of Nebraska-Lincoln
UNL-Extension	University of Nebraska – Extension Education
USGS	United States Geological Survey
WHP	Wellhead Protection

CHAPTER 1. INTRODUCTION

1.01 UPPER LOUP NRD BACKGROUND

The Upper Loup Natural Resources District (ULNRD) is part of the Loup River Basin and is comprised of 6,690 square miles, or 4,275,000 acres, and includes all of Blaine, Grant, Hooker, Logan, Thomas, and parts of Brown, Cherry, and McPherson Counties. The distance of the ULNRD from east to west is 120 miles, and from north to south is 78 miles. Most of the ULNRD lies within the Nebraska Sand Hills and is shown in Figure 1.

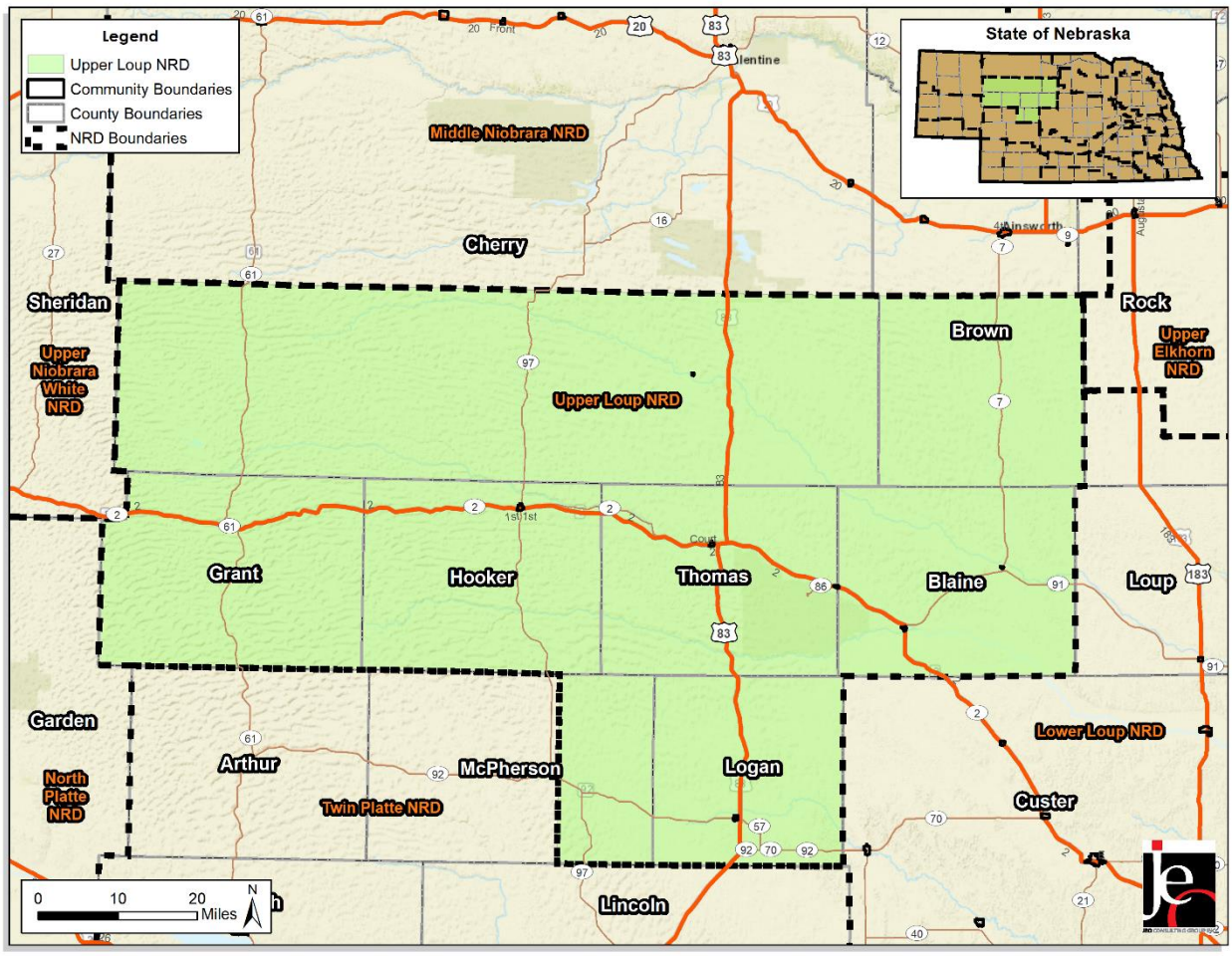


Figure 1: Location of the ULNRD

1.02 AUTHORITY AND STATUTORY REQUIREMENTS

The declaration, intent, and purpose of NRDs were established by the Nebraska Groundwater Management and Protection Act as outlined in Nebraska Revised Statue Chapter 46, Article 7. Management of groundwater, seen as one of the most valuable natural resources in the state, is a major component of the authority granted to NRDs. The Nebraska Legislature in 1984 required NRDs to prepare a Groundwater Management Plan (GWMP) by January 1986. The original plan was prepared in 1985, was updated in 1991, and again in 1994. Each version of the plan is intended to meet requirements laid out in Sections 46-709 through 46-712 of the Nebraska Groundwater Management and Protection Act.

1.03 AGENCY RESPONSIBILITIES AND SERVICES

There are 23 NRDs each governed by a locally elected Board of Directors. The ULNRD has 11 Board of Directors members spread throughout five sub-districts, and one at-large member. The sub-districts are shown in Figure 2 below. Each NRD shares a common set of legislative responsibilities, shown below, but each also establishes its own additional priorities.

- Erosion prevention and control
- Soil conservation
- Flood prevention and control
- Prevention of damages from flood water and sediment
- Water supply for any beneficial uses
- Development, management, utilization and conservation of groundwater and surface water
- Pollution control
- Solid waste disposal and sanitary discharge
- Drainage improvement and channel rectification
- Development and management of recreational and park facilities
- Forestry and range management

ULNRD SPECIFIC SERVICES

The ULNRD has identified a list of primary services that the staff provides to ULNRD constituents.

- Chemigation permitting and inspections
- Community arboretum
- Community, county, and school educational projects
- District Multi-jurisdictional Hazard Mitigation Plan Lead
- Districtwide recycling program
- Drip well cost share
- Envirothon
- Gopher machine rental and bait
- Groundwater management
- Hunter and boater education
- Nebraska Soil and Water Conservation practices cost share
- No till drill rental
- Notary services
- Noxious weed control cost share
- Public use of learning center and meeting room
- Range and land judging
- Soil testing cost share
- Sponsor camp scholarships
- Stewardship program and awards
- Tree and shrub sales
- Tree planning and planting
- Trees for newborns and memorials
- Water quality and quantity monitoring
- Weed barrier sales, planning, and installation
- Well decommissioning cost share
- Wildlife habitat improvement cost share
- Yard enhancement cost share

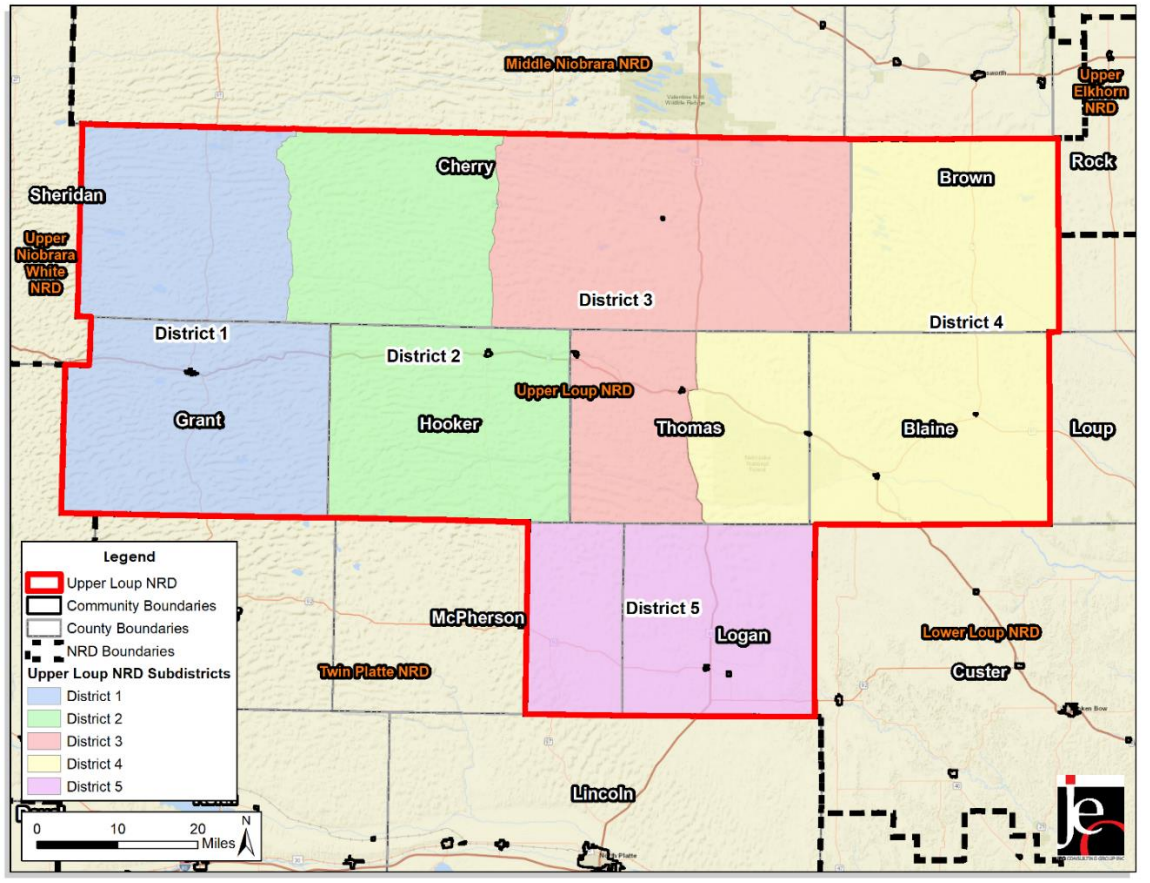


Figure 2: ULNRD Board of Director Sub-Districts

1.04 LOWER PLATTE RIVER BASIN COALITION

In 2017, seven NRDs partnered to form the Lower Platte River Basin Coalition (LPRBC). This Coalitions is guided by the Basin Water Management Plan, published in October 2017, and updated in 2022. The Basin is one of Nebraska's most valuable resources and is integral to the state's development and sustainability – from an agricultural, social, industrial, and municipal perspective (LPRBC, 2017). The ULNRD, along with the Lower Platte South, Lower Platte North, Lower Loup, Papio-Missouri River, Lower Elkhorn, and Upper Elkhorn NRDs, are working with the Nebraska Department of Natural Resources (NeDNR) and Nebraska Association of Resource Districts (NARD) to protect and sustain the long-term balance between the water users and water supplies in the Basin (Figure 3). Key groundwater elements of the Basin Water Management Plan have been integrated in this GWMP update.

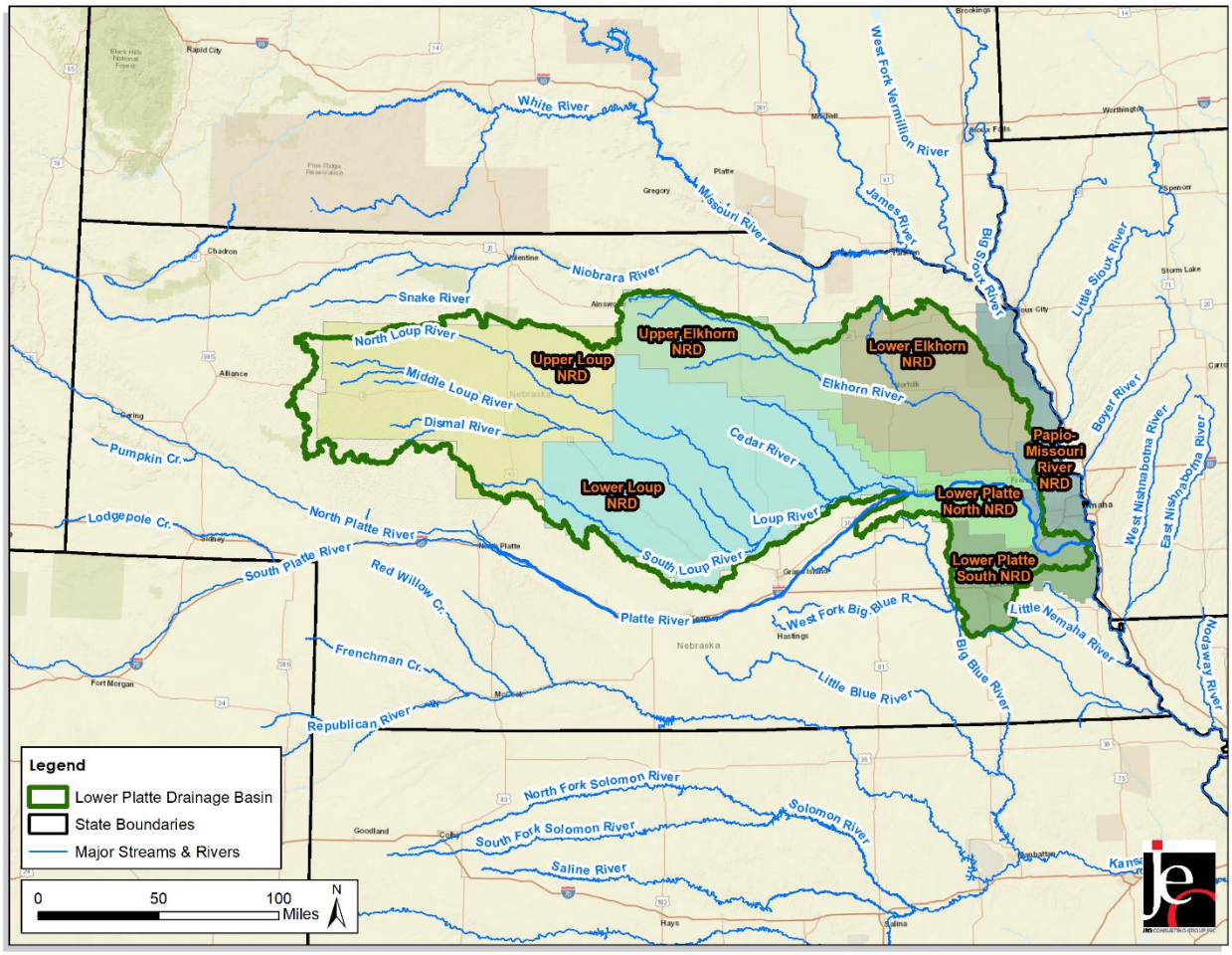


Figure 3: Lower Platte River Basin Coalition

1.05 INTEGRATED MANAGEMENT PLAN

On April 15, 2004, Nebraska Legislative Bill (LB) 962 was approved, which set the stage for the NeDNR and the NRDs to collaborate on the management of groundwater and surface water as a single, integrated resource. LB 962 requires the development of an Integrated Management Plan (IMP) if a river basin, subbasin, or reach is determined to be fully appropriated by the NDNR. However, many NRDs completed an IMP on a voluntary basis. The ULNRD completed a Voluntary IMP in 2016 to investigate and manage hydrologically connected surface water and groundwater (Olsson, 2016). Goals, objectives, and actions applicable to groundwater management were considered as part of this GWMP.

1.06 RULES AND REGULATIONS

The ULNRD is currently under a single Groundwater Management Area (GWMA), thus abides by the same Rules and Regulations.

Quantity management activities in the ULNRD include:

- Any groundwater user who irrigates with groundwater is required to have obtained certification.
- Applications for the construction of a high capacity commercial / industrial wells shall provide a hydrogeological evaluation as well as the permit fee to the ULNRD.
- No new high-capacity wells (>50 gallons per minute) shall be drilled within 300 feet from any active domestic well or within 1,320 feet of any other high capacity well.
- All active high-capacity wells, irrigation / commercial / industrial wells shall be equipped with a flowmeter.
- Records on all active and inactive high-capacity registered wells will be maintained by the ULNRD.
- Annually approving not more than 2,500 irrigated acres across the entire ULNRD.
- Annually collecting, tracking, evaluating, and reporting of:
    - Groundwater level measurements
    - Municipal, commercial, industrial, and agricultural water use
    - Certifying irrigated acres and any changes to certifications
    - Well water construction permits approved, cancelled, or denied
    - Variances granted, cancelled, or denied
    - Retired irrigated acres
    - Water transfer permits granted, cancelled, or denied
- Incentive programs to encourage water conservation practices.
- Provide information and education on water conservation and use to all water users, both rural and urban.

Quality management activities in the ULNRD include:

- Administering the Nebraska Chemigation Act program.
- Cyclic Districtwide water quality sampling of active registered domestic wells, irrigation wells, and any requested livestock wells and unregistered domestic wells, for nitrates.
- Bacteria and/or manganese testing on any requested wells.
- Annually collecting, tracking, evaluating, and reporting of contaminants to monitor trends in concentration and determine severity of groundwater quality concerns.
- Continuing to provide cost share for decommissioning of abandoned wells, deep soil testing for residual nutrients, and drip well systems on oil lubed turbine pumps.
- Maintaining the Districtwide recycling program.
- Providing information and education on water quality to all water users.

CHAPTER 2. DESCRIPTION OF THE NRD

2.01 PARTNERS AND PROGRAMS

There are several partnering agencies and organizations that assist the ULNRD with groundwater management. A summary of the primary agencies and partners, and the programs they support, are listed below:

U.S. Geologic Survey (USGS)

The USGS has assisted with data collection, analysis, and reporting to better understand the hydrologic connection between groundwater and surface water and streamflow trends.

Nebraska Department of Environment and Energy (NDEE)

The NDEE is responsible for collecting data from statewide nitrate samples and maintaining the Nebraska Groundwater Quality Clearinghouse. The NDEE also administers the Source Water Protection and Wellhead Protection (WHP) programs which assists communities and other public water suppliers in preventing contamination of water supplies. Provide grants to help fund litter and waste reduction projects, recycling programs, scrap tire cleanups, and collections of household hazardous waste, electronic waste, and pharmaceuticals.

Nebraska Department of Natural Resources (NeDNR)

The NeDNR is responsible for maintaining the registered well database and working with NRDs to permit and register new wells or previously unregistered wells. The NeDNR also maintains a large GIS dataset often used by NRD staff. The Natural Resources Commission (NRC), a sub-agency of NeDNR, funds the Water Well Decommissioning Fund, providing resources to NRDs to close abandoned wells. The NRC also oversees the Water Sustainability Fund (WSF) which supports groundwater, surface water, and conjunctive management projects and programs.

University of Nebraska – Lincoln Extension

The University of Nebraska – Lincoln (UNL) Extension aids with education, outreach, and is working on a statewide effort to increase collaboration between project partners to address health concerns related to nitrate contamination.

Neighboring NRDs and Other Agencies

The NRDs often share data and resources to manage water. The ULNRD collaborates with Lower Loup NRD on management of the South Loup River and is active with the Lower Platte River Corridor Alliance (LPRCA) that includes LPNNRD, LPSNRD, P-MRNRD, NDEE, NeDNR, NARD, NeDHHS, NGPC, UNL, and the

Nebraska Military Department. ULNRD is also active with the LPRBC that includes LENRD, LLNRD, LPNNRD, LPSNRD, NeDNR, NARD, P-MRNRD, and UENRD.

United States Department of Agriculture - Natural Resources Conservation Service (NRCS)

The ULNRD works with NRCS to partner on implementation of natural resources conservation programs that help people reduce soil erosion, enhance water supplies, improve water quality, increase wildlife habitat, and reduce damages caused by floods and other natural disasters. Past, planned, and future actions will help protect groundwater quality and quantity throughout the ULNRD.

Nebraska Game and Parks Commission (NGPC)

The NGPC is responsible for the long-term stewardship of Nebraska's wildlife, fish, parks, and outdoor recreation resources. They are specifically responsible for ensuring projects do not have an adverse impact to threatened and endangered species. Should the ULNRD and its partners proceed with projects that may create significant changes in hydrology, streamflow depletions, altering groundwater and surface water connectivity, impacts to wetlands, potential impacts to Platte River instream flows, or any work adjacent to habitat, the NGPC will be consulted to provide guidance to ensure actions are compliant and have no adverse impacts. The NGPC also provided project sponsors with the Nebraska Conservation and Environmental Review Tool (CERT) to help understand which threatened and endangered species or biologically unique landscapes may lie within a project area.

2.02 TOPOGRAPHY

The topography of the ULNRD is critical to the compositions of its plant species, which are well known for supporting forage for grazing livestock. The landscape is dominated by the undulating dune tops and low-lying swales of the Sandhills. Elevations in the ULNRD have a range of over 1,800 feet, from the high of 4,205 feet above sea level in western Grant County, to the low of 2,399 feet in eastern Blaine County. Topography of the ULNRD, as displayed using a digital elevation model, is shown in Figure 4.

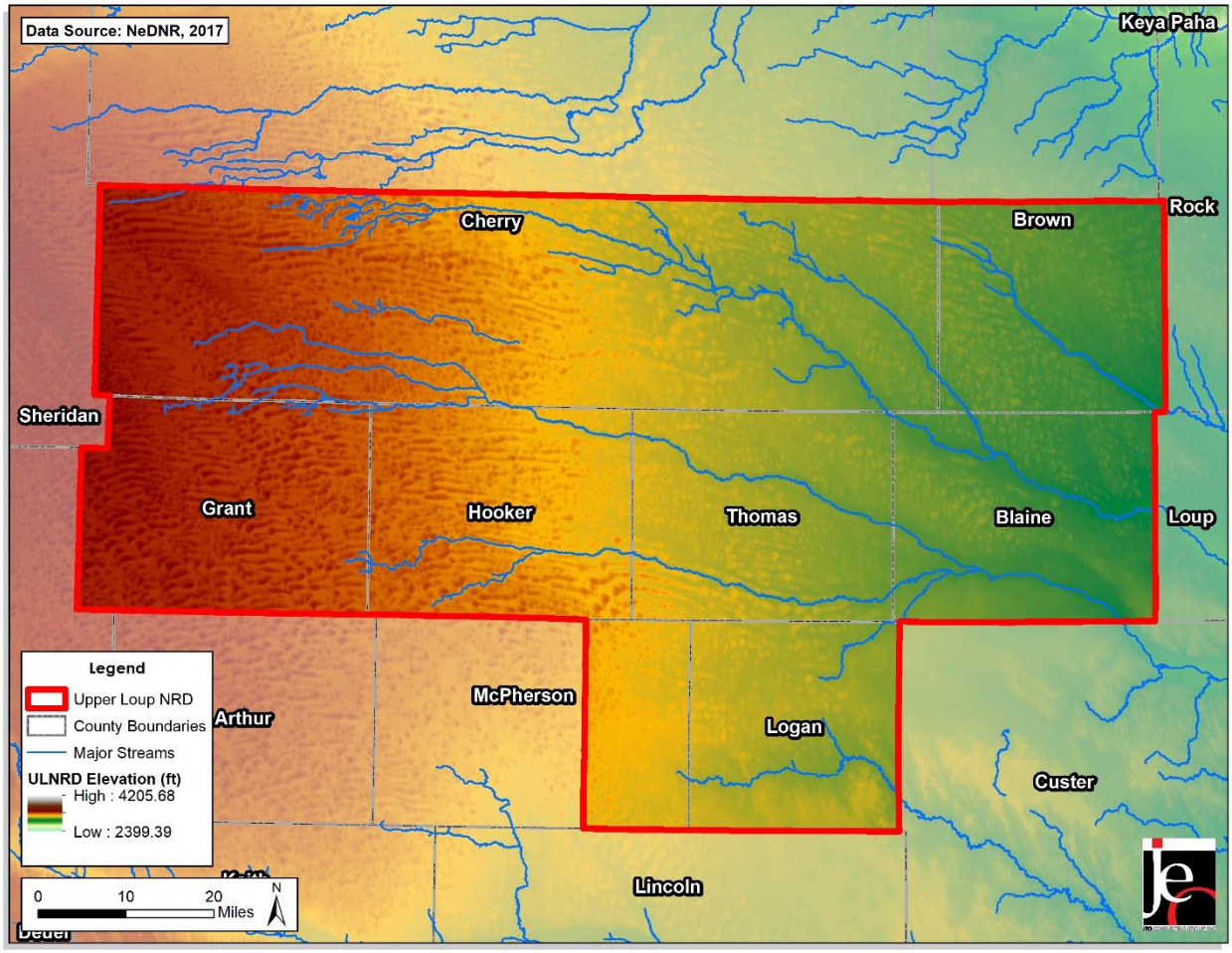


Figure 4: Topography of the ULNRD

2.03 GEOLOGY

Considerable information on the soils, geology, hydrology, and biology has been developed through test drilling, research, field investigations and data collection. What has emerged is an understanding that the land is geologically young, and the sandy soils show almost no evidence of soil profile development. The land surface, although dune mantled and sloping, is relatively flat. Very little runoff from precipitation occurs due to the high infiltration rates of the sandy soils. Consequently, the network of surface drains is poorly developed and much of the land is subjected only to internal drainage. The Sandhills geographic region is shown in Figure 5.

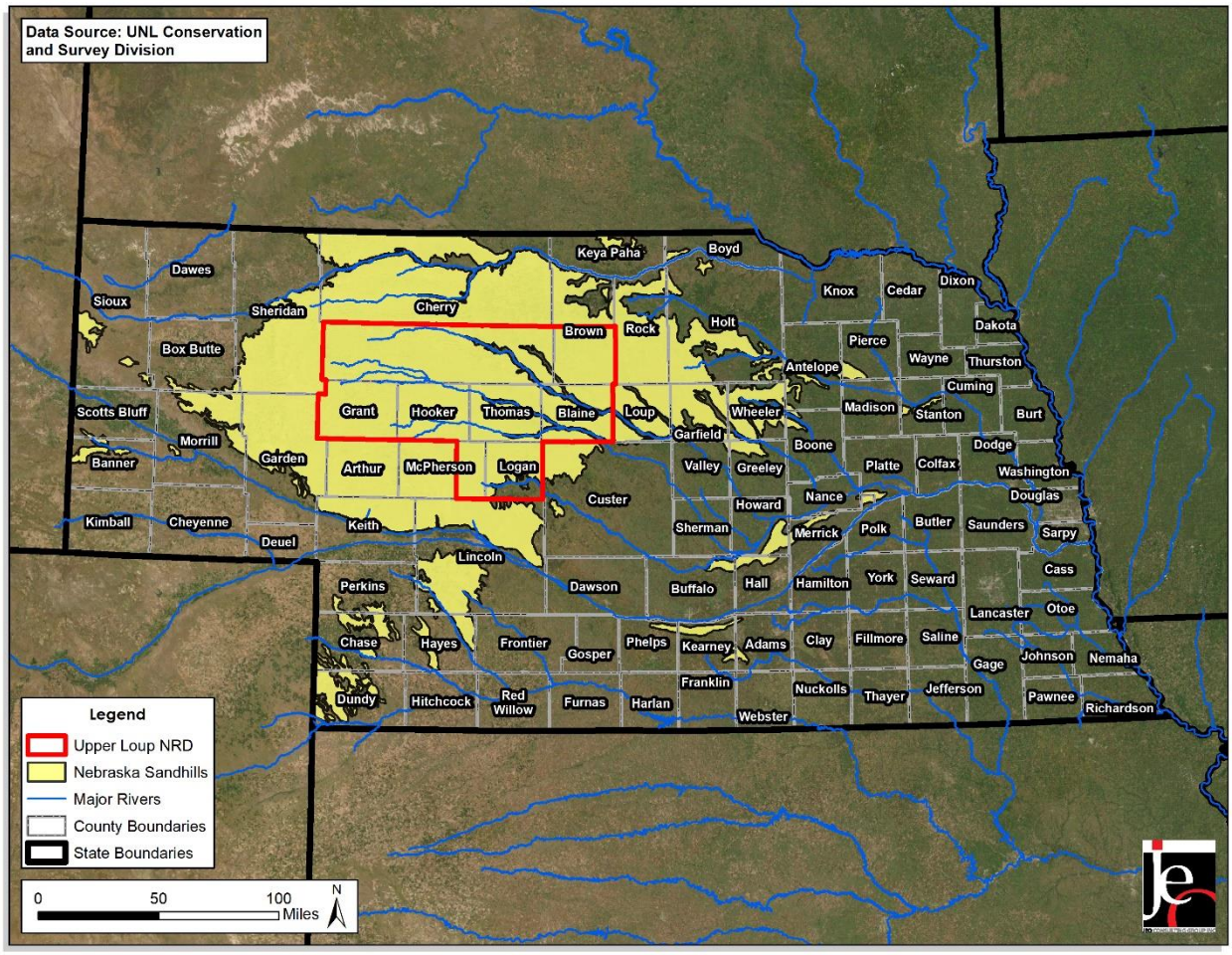


Figure 5: Location and Extent of the Nebraska Sandhills

According to *An Atlas of the Sand Hills* (Bleed & Flowerday, 1990), the 19,300 square mile Sandhills region is the largest sand-dune area in the western hemisphere. The Sandhills are composed of a thick sequence of continental deposits and sediments deposited by wind and water overlying Cretaceous shales of marine sea origin. The total thickness of the younger Tertiary sediments (about 2 million to 37 million years in

age) is as much as 2,000 feet in the southwest part of Cherry County. The Brule and the Chadron formations of the White River Group are the oldest of the Tertiary units and underlie the entire ULNRD, and generally thin from west to east. Their maximum thickness of around 1,250 feet is in southwestern Cherry County. These sediments are quite fine-textured, and their top generally coincides with the base of the groundwater reservoir.

Underlying the dunes are discontinuous deposits of Quaternary and Pliocene sands and gravels and the sands, clays, sandstones, gravels, and clay of the Ogallala Formation of Miocene Age. Although the Ogallala Formation consists mostly of fine to medium sands, the formation is thick and constitutes a major part of the High Plains Aquifer. The Ogallala ranges up to 1,200 feet in thickness and is thickest beneath the western part of the ULNRD in Hooker, Grant, and Cherry Counties, where it averages more than 600 feet as seen in Figure 6.

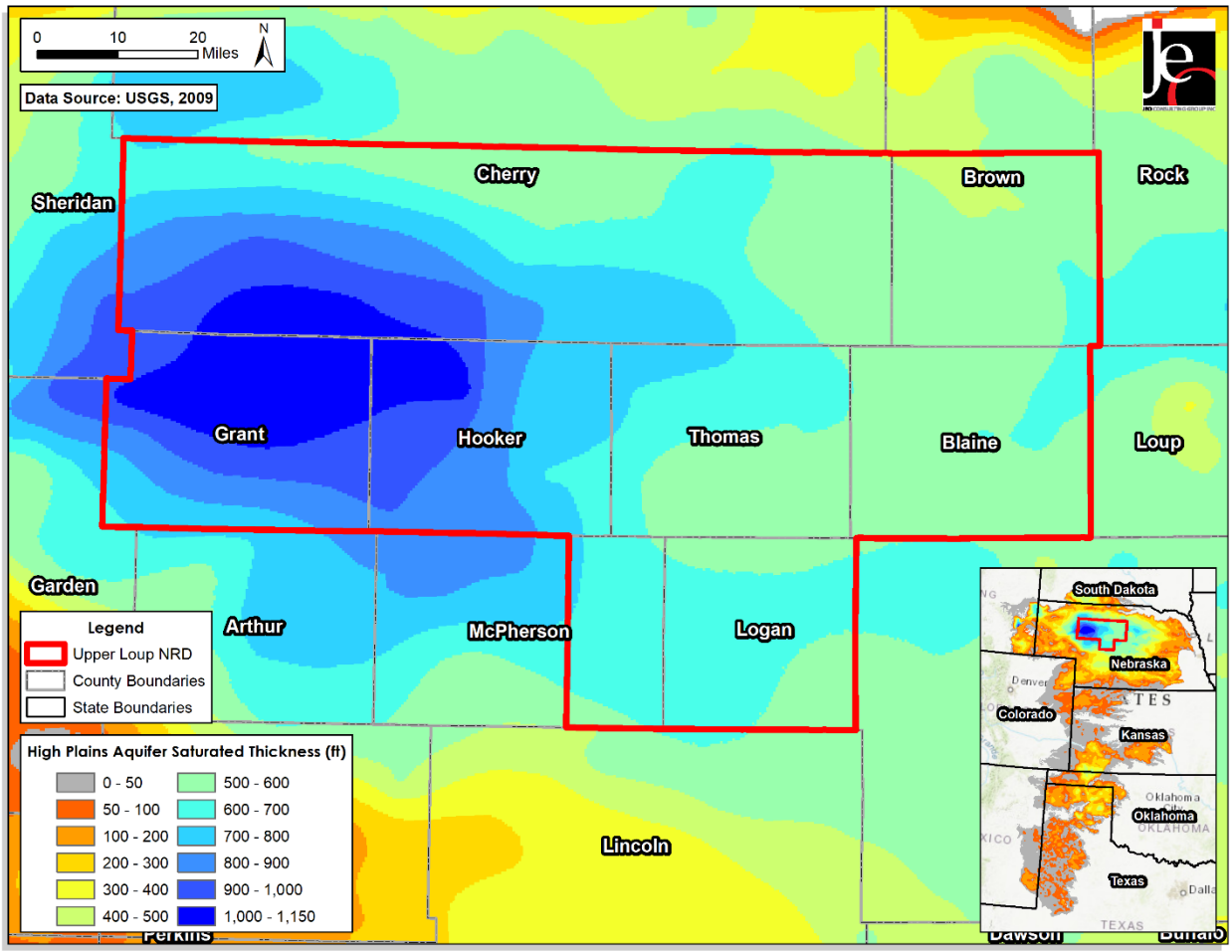


Figure 6: Saturated Thickness of the High Plains Aquifer (2009)

2.04 SOILS

Sand, principally quartz and feldspars, is the parent source of virtually all the soils in the Sandhills region. A generalized soil map is shown in Figure 7. According to *An Atlas of the Sandhills* (Bleed & Flowerday, 1990), soil on the dunes in the Sandhills have thin A horizons that contain very little organic matter. These topsoils are somewhat darkened, but only slightly. The lack of organic matter may be because of the droughty nature of these soils (Valentine Series), or it may be because the dunes have not been stable long enough for well-darkened soils to form. Soils with well-darkened topsoils containing one percent or more organic matter can be found on gently sloping, well-drained sand sheets. More moisture may be available in these areas due to minimal runoff, more water run-in, and more groundwater flow-in from higher land.

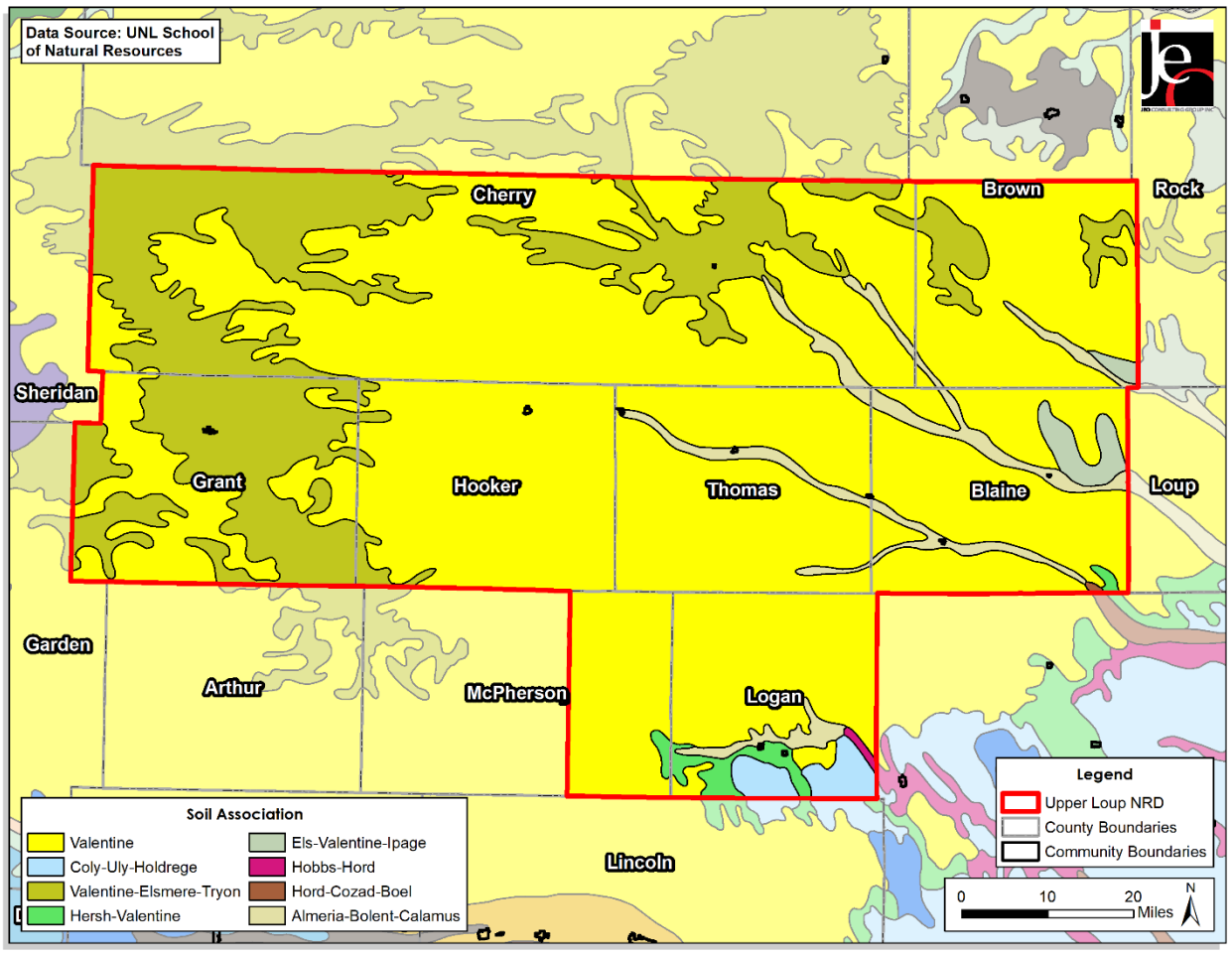


Figure 7: Soil Associations in the ULNRD

2.05 TRANSMISSIVITY

Perhaps the one hydrologic parameter which best describes the groundwater reservoir and its potential for use and withdrawal is transmissivity. Transmissivity is a measure of the volume of groundwater that will move through a given width of an aquifer under a specific slope of the water table. This describes the rate at which groundwater moves and provides a measure of the ability of the aquifer to yield water to pumping wells. Transmissivity is dependent on saturated thickness and permeability. Permeability values vary considerably for the sediments filling the groundwater reservoir in the ULNRD. In general, the coarser sediments of sand and gravel are the most permeable and the fine-grained sandstones are the least permeable.

Figure 8 shows the transmissivity of the principal groundwater reservoir for the ULNRD. This is a generalized map and should not be used for any site-specific purposes. Transmissivity varies widely across the ULNRD, from approximately 50,000 – 200,000+ gallons per day per foot. Broadly speaking, high-capacity pumping wells can be developed nearly anywhere in the ULNRD. Factors that determine the drawdown of large capacity wells in addition to transmissivity include the depth of aquifer, well construction, and well development.

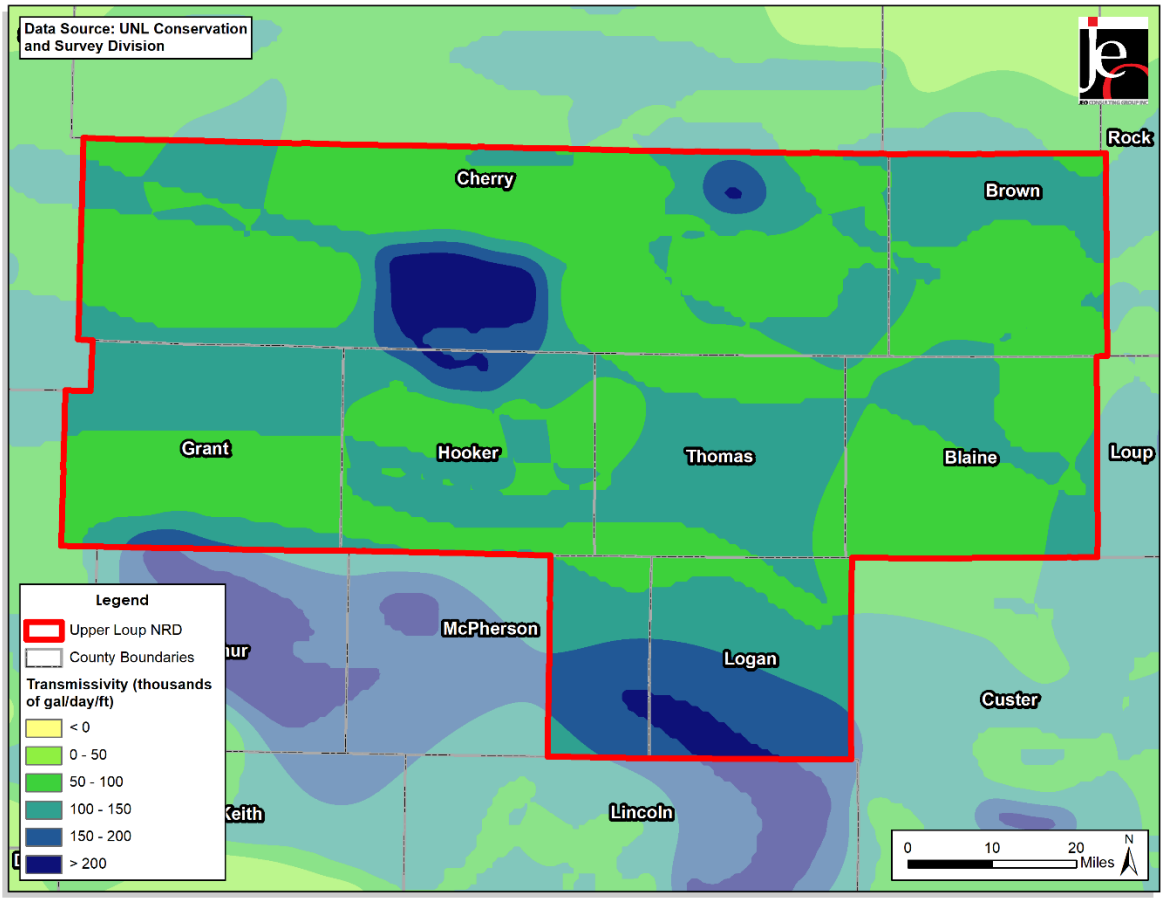


Figure 8: Aquifer Transmissivity

2.06 CLIMATE AND PRECIPITATION

Climate in the ULNRD ranges from semiarid in the west where the average annual precipitation is about 17 inches, to subhumid in the east where the precipitation is about 22 inches as shown in Figure 9. Average annual precipitation increases from west to east at a rate of approximately one inch per 25 miles traveled. Ordinarily about 80% of the precipitation falls from April through September. The average growing season (approximately April - October) precipitation in the ULNRD ranges from about 14 inches in the west to nearly 17 inches in the east. About 50% of the precipitation falls during May, June and July. However, precipitation is highly variable and seldom average. Generally, the Sandhills have been less vulnerable to the impacts of drought on vegetation and water supply, particularly streamflow, than have other parts of Nebraska.

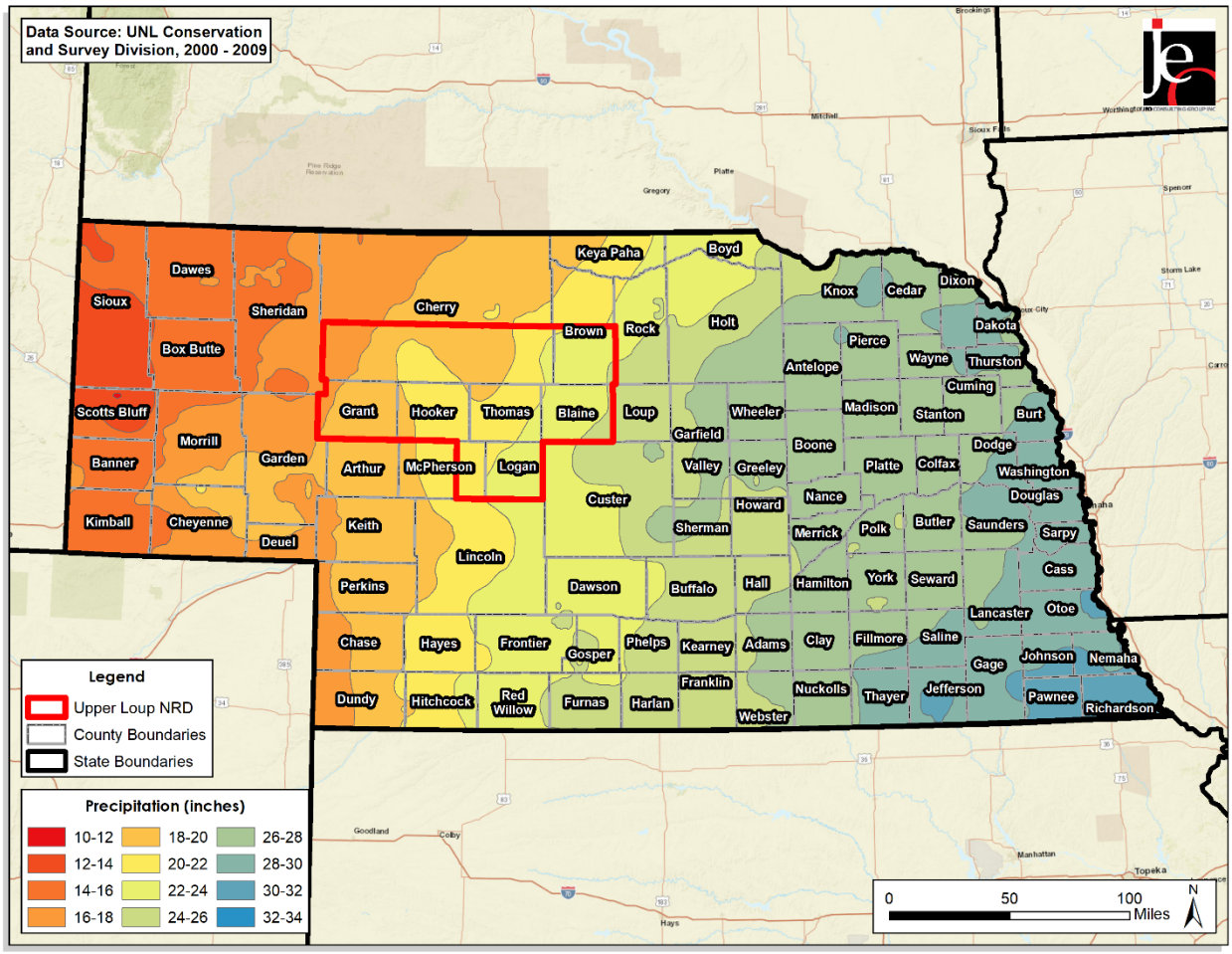


Figure 9: Average Annual Precipitation in the State of Nebraska

2.07 LAND USE

The population of the ULNRD is sparsely concentrated, land use for industry does not exist, and intensive cultivation and irrigation is minimal. The vast majority of land is used for agricultural ranching, and the land cover is dominated by grassland and pasture (Figure 10). Table 1 displays the distribution of land cover in the area, 91.8% of which is grassland or pasture (as of 2020). Portions of the grasslands are presumably sustained by subirrigation in wet meadow areas of the Sandhills. A small area of more intensely farmed row crop is present in southern Logan County, which accounts for most of the cropland in the ULNRD. Cropland breakdown by crop type is shown in Table 2.

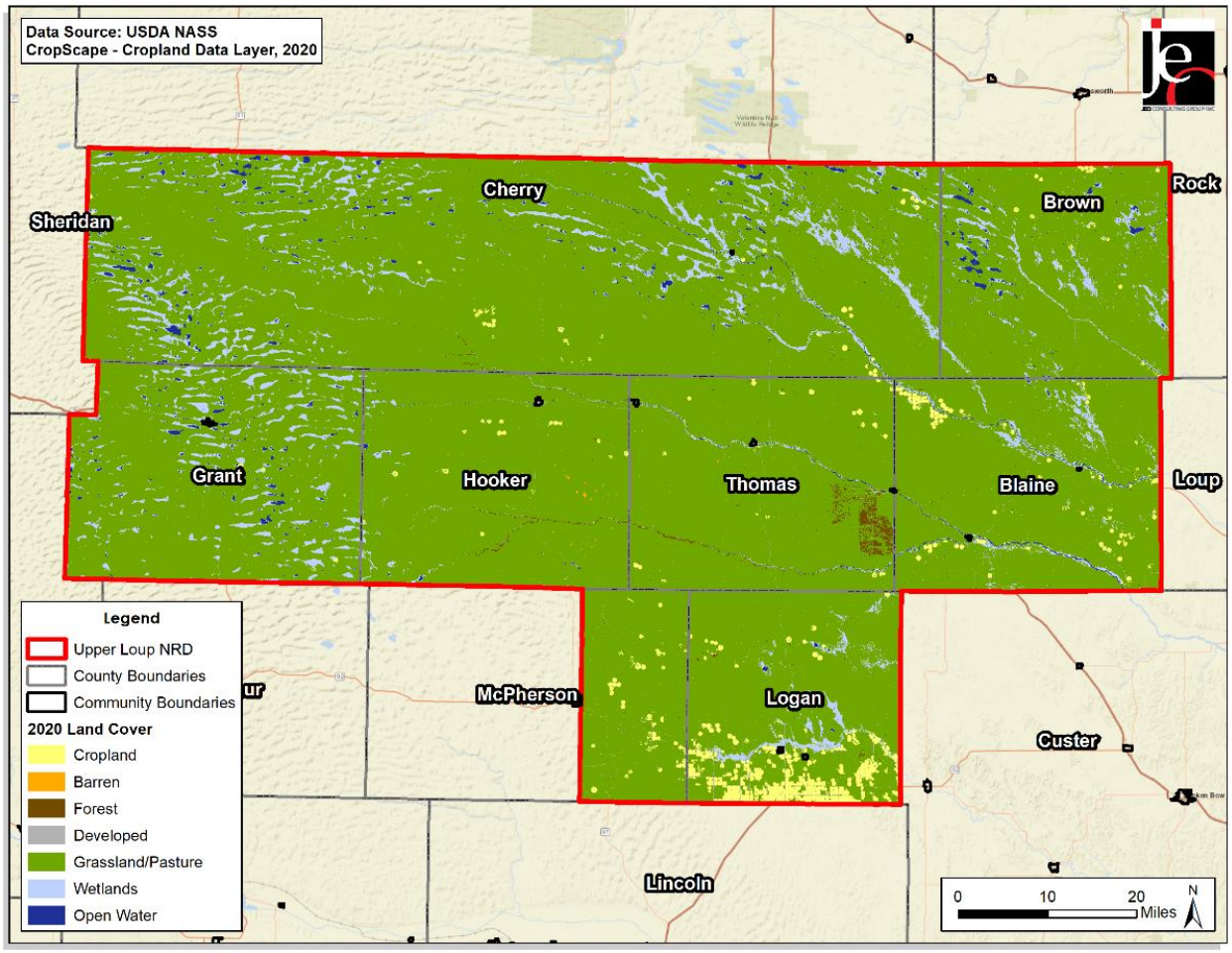


Figure 10: 2020 Land Cover

Table 1: 2020 Land Cover in the ULNRD

Category	Acres	Percentage
Grassland/Pasture	3,948,960	91.8
Wetlands	214,657	5.0
Cropland	67,509	1.6
Open Water	37,039	0.9
Forest	15,057	0.4
Developed	14,829	0.3
Barren	1,377	0.0
Total	**4,299,428**	**100.0**

Source: USDA NASS CropScape Cropland Data Layer, 2020

Table 2: 2020 Cropland Breakdown in the ULNRD

Cropland Category	Acres	Percentage
Corn	34,353.8	50.9
Alfalfa	14,455.9	21.4
Soybeans	8,424.8	12.5
Sorghum	3,240.0	4.8
Oats	1,886.0	2.8
Millet	1,689.7	2.5
Winter Wheat	1,201.3	1.8
Rye	1,022.9	1.5
Fallow/Idle Cropland	668.1	1.0
Pop or Orn Corn	239.8	0.4
Dry Beans	100.0	0.1
Triticale	34.1	0.1
Spring Wheat	20.8	0.0
Sunflower	11.7	0.0
Double Crop Winter Wheat/Corn	10.0	0.0
Other Crops	150.0	0.2
Total	**67,508.8**	**100.0**

Source: USDA NASS CropScape Cropland Data Layer, 2020

2.08 POPULATION – ECONOMIC BASE

The ULNRD community and county population trends are summarized in Table 3 from 2000 to 2020. According to the ULNRD's 2021-2022 Long-Range Implementation Plan (ULNRD, 2021b), the population was approximately 4,114 in 2020. While not all of Brown, Cherry, and McPherson Counties are included in the ULNRD, their populations are included here for reference. Please note that as unincorporated communities, official population data are not available for Brownlee, Elsmere, or Purdum. Ashby, Seneca, and Whitman lost their incorporated status between the 2010 and 2020 Census and are thus listed as N/A in the 2020 column of Table 3.

Table 3: Population Trends 2000 - 2020

Jurisdiction	2000 Population	2010 Population	2020 Population
Blaine County	583	478	431
Brewster	29	17	12
Dunning	109	103	80
Halsey	59	76	68
Brown County*	3,525	3,145	2,903
Cherry County*	6,148	5,713	5,455
Grant County	747	614	611
Ashby	117	123	N/A
Hyannis	287	182	165
Whitman	209	190	N/A
Hooker County	783	736	711
Mullen	491	509	500
Logan County	774	763	716
Gandy	30	32	34
Stapleton	301	305	267
McPherson County*	533	539	399
Thomas County	729	647	669
Seneca	51	33	N/A
Thedford	211	188	208

**Note: Not entirely within the ULNRD.*
Source: United States Census Bureau – 2000-2020

2.09 SURFACE WATER

The North Loup, Middle Loup, and South Loup rivers and their tributaries, Goose Creek and the Calamus and Dismal Rivers originate within the ULNRD. Recreational use of these streams for floating activities is popular in the region. Use of the streamflow, mostly supplied from groundwater, for irrigation or storage within the NRD is minimal. Most of the streamflow originating in the ULNRD flows out virtually unused on a consumptive basis. However, considerable quantities of water are diverted from the North Loup and Middle Loup Rivers into canals for irrigation projects downstream from the ULNRD.

Groundwater and surface water are perhaps more closely interrelated in the ULNRD than in any other NRD. Most of the surface water (lakes, marshes, and streams) originates as groundwater. Land surface profiles constructed west to east in the area compared to profiles of the water table show that many of the lakes and marshes occur where the land surface intersects the water table. The major river systems and their tributaries, along with the location of USGS streamgages, are shown in Figure 11. Stream lengths and counts / sizes of lakes int eh ULNRD are included in Table 4, broken down by county.

Streamflow information is collected by the USGS at three gaging sites within the ULNRD, and two additional sites downstream of the ULNRD. Note that the sites at Taylor and Arnold are outside of the ULNRD, but still inform us of streamflow conditions occurring upstream. Statistics for each of these streamgages are reported in Table 5, and hydrographs for each site are provided in Figure 12 through Figure 16.

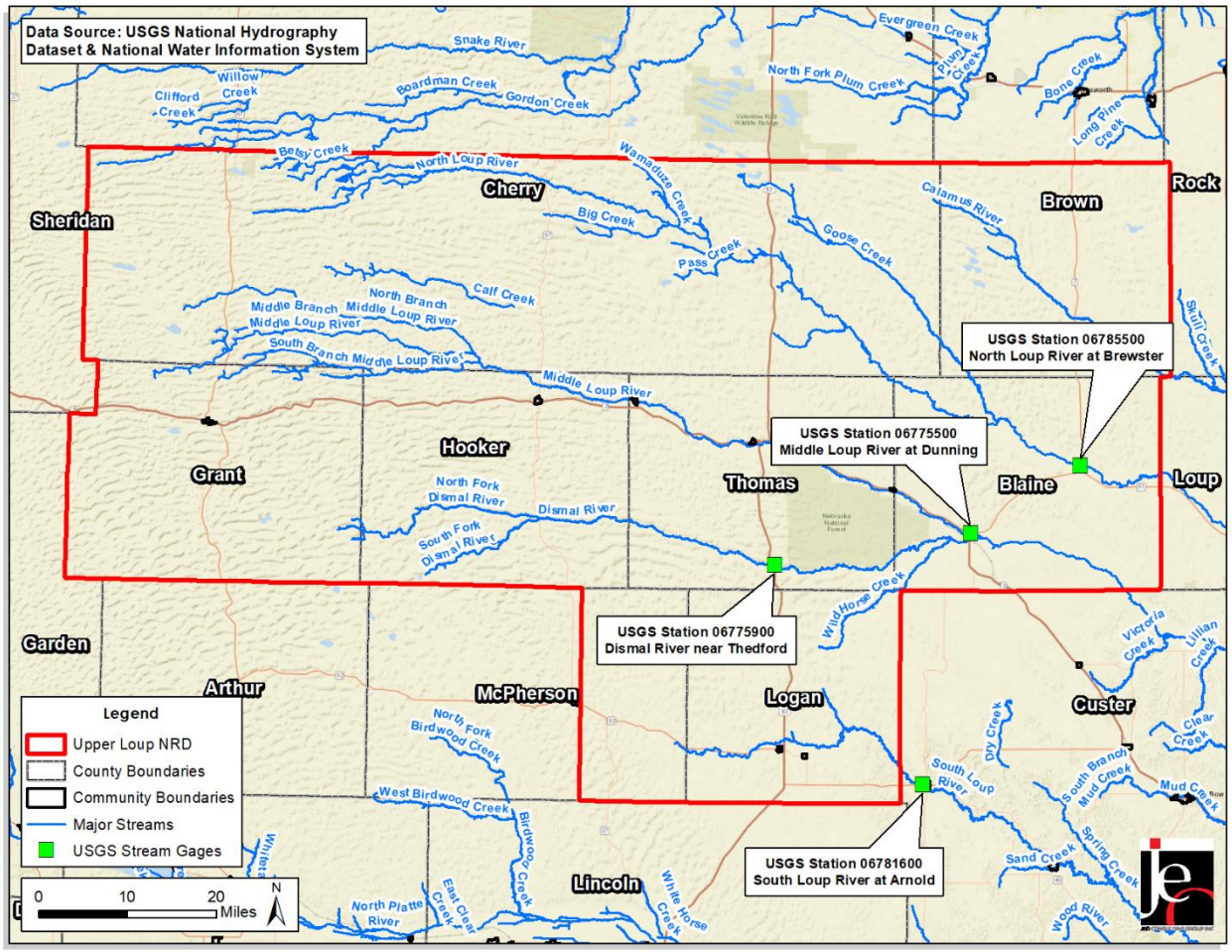


Figure 11: Major River Systems in the ULNRD

Table 4: Streams and Lakes in the ULNRD

County	Stream Length (mi)	Lakes (#)	Lake Area (Acres)
Blaine	120.4	2	127.8
Brown	87.6	39	4,378.8
Cherry	581.7	130	11,784.9
Grant	37.4	55	4,044.6
Hooker	122.1	3	240.9
Logan	80.4	13	603.6
McPherson	2.0	N/A	N/A
Thomas	91.7	N/A	N/A
Total	**1,123.5**	**242**	**21,180.7**

Source: USGS NHD streamlines, NebraskaMAP Major Lakes

Table 5: USGS Streamgage Statistics

Streamgage Site	Min. Flow (CFS)	Min. Date Recorded	Max. Flow (CFS)	Max. Date Recorded	Average Flow (CFS)	Average Time Period
Middle Loup River at Dunning	170	1/23/1969	2,480	3/25/1996	491	1996-2020
North Loup River at Brewster	100	1/26/1948	4,870	6/11/2010	540	2010-2021
North Loup River at Taylor	45	7/26/1941	16,300	6/12/2010	595	1996-2020
South Loup River at Arnold	8	8/30/2012	1,430	3/13/2019	37	2010-2021
Dismal River near Thedford	125	2/3/1989	1,160	8/23/1983	227	1996-2020

Source: USGS Water Data for the Nation

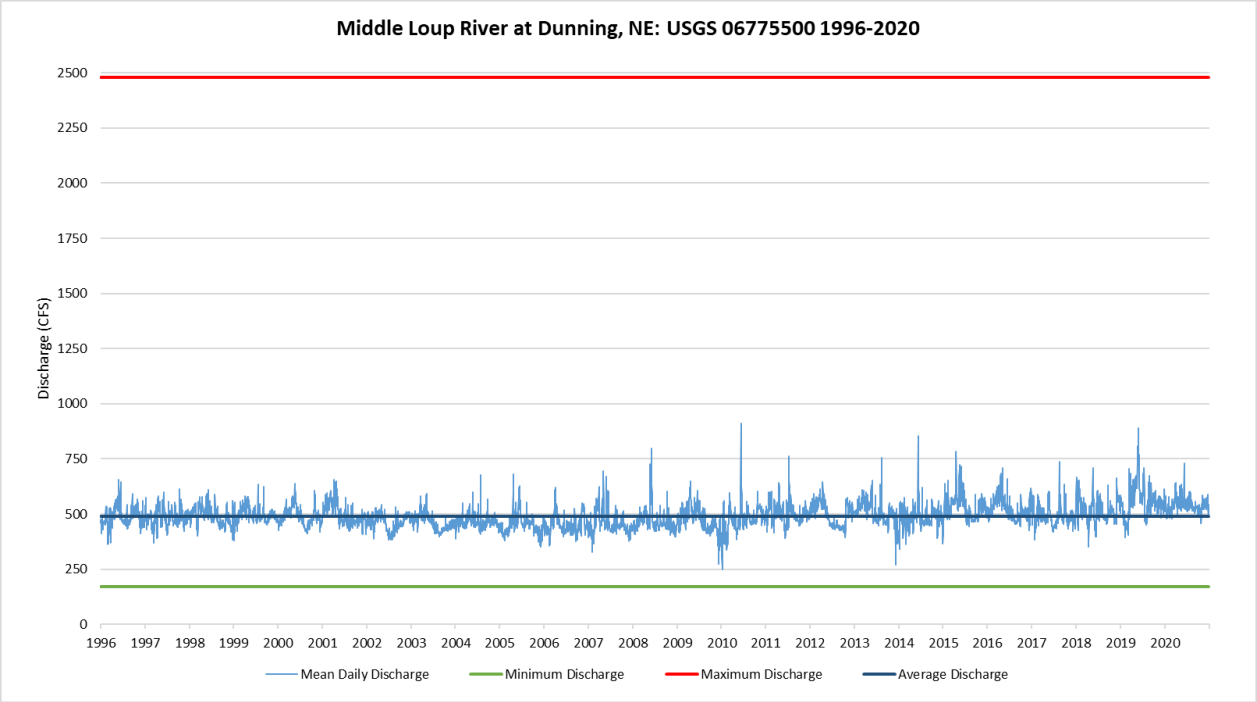


Figure 12: Hydrograph – Middle Loup River at Dunning

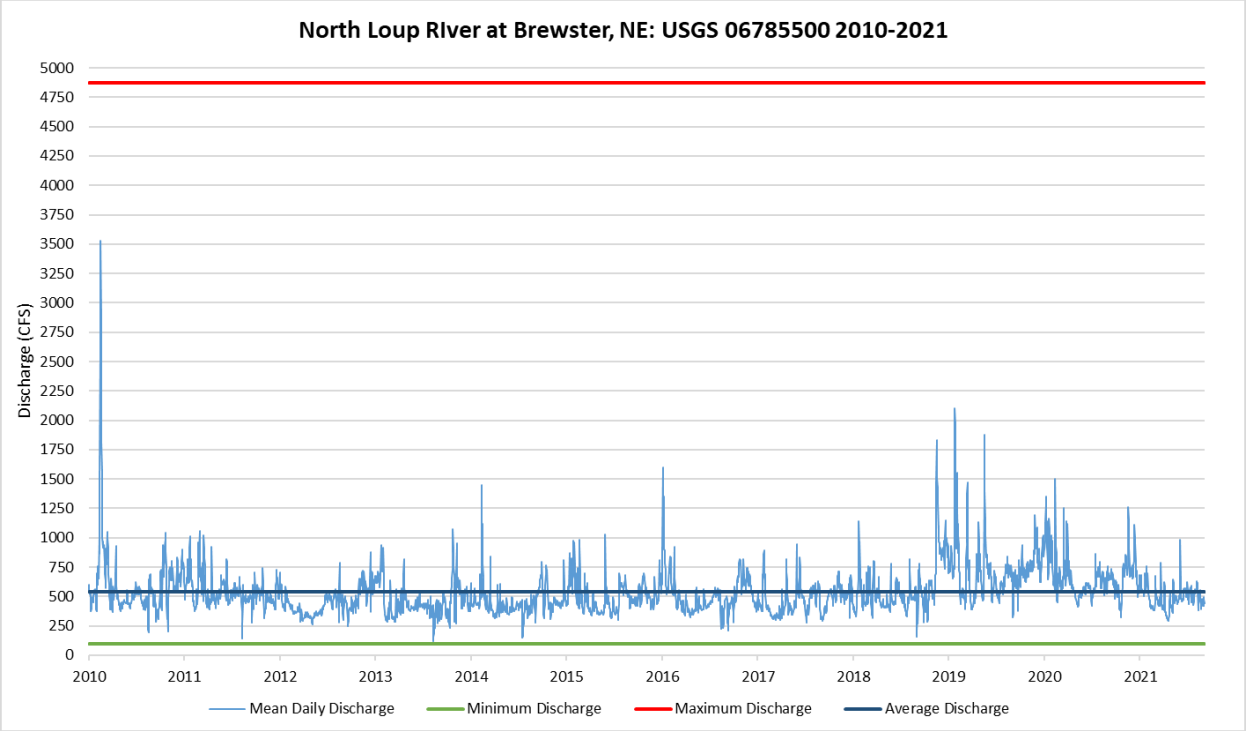


Figure 13: Hydrograph – North Loup River at Brewster

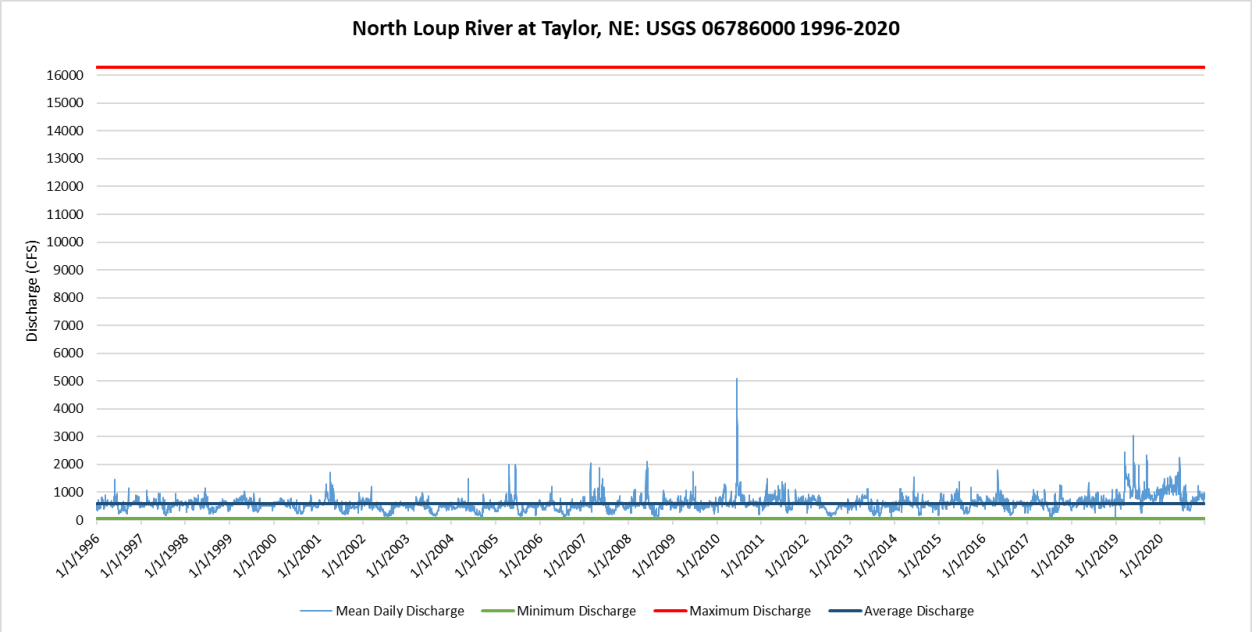


Figure 14: Hydrograph – North Loup River at Taylor

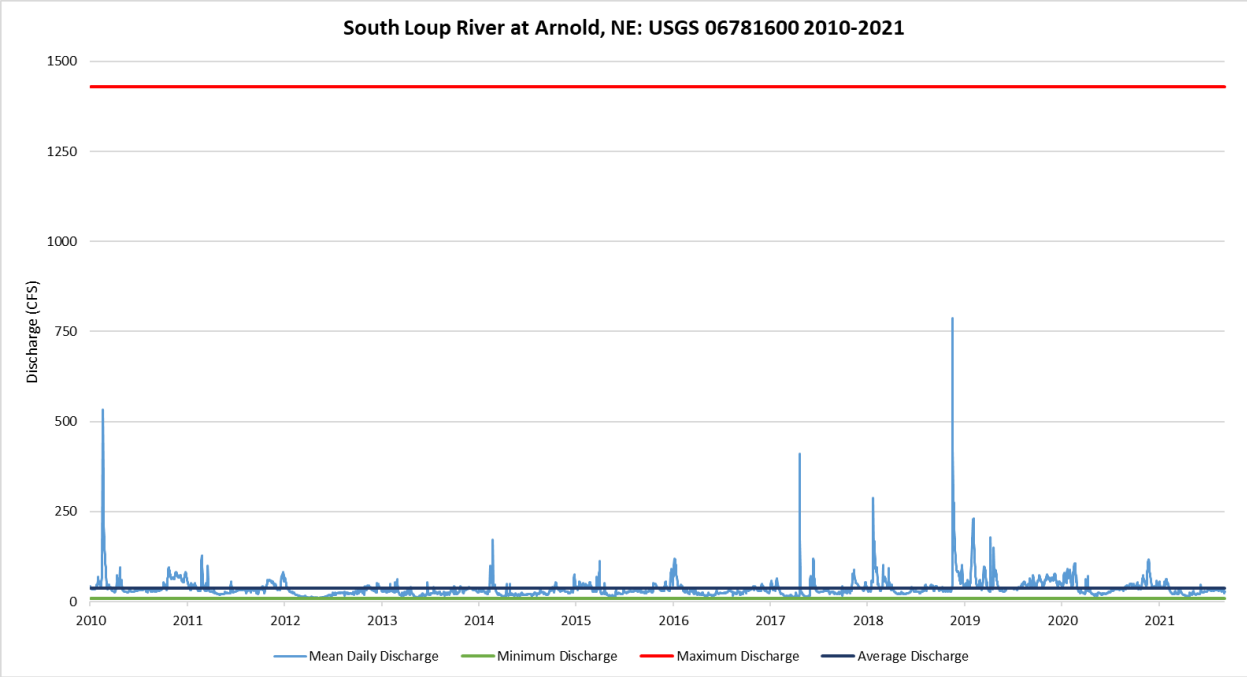


Figure 15: Hydrograph – South Loup River at Arnold

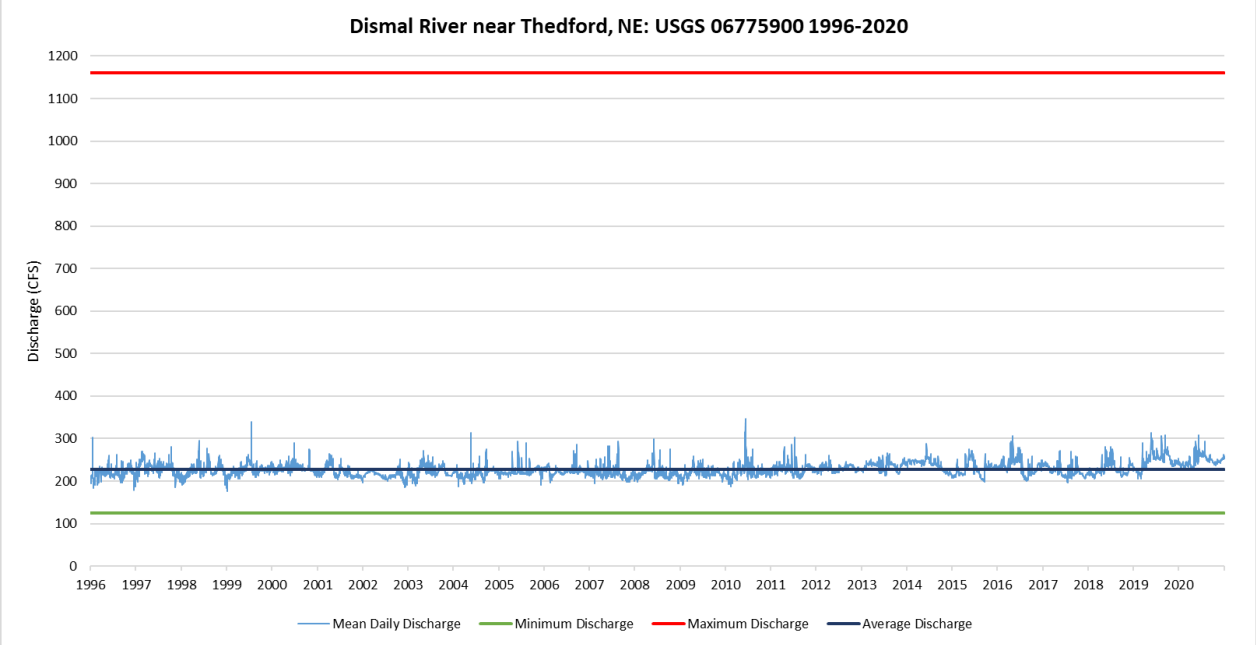


Figure 16: Hydrograph – Dismal River near Thedford

2.10 WELLS AND TEST HOLES

Because of limited rainfall and recurring periodic droughts, successful cultivation of crops without supplemental water is difficult in most years in the western part of Nebraska. The practice of irrigation from wells started to develop in the late 1940s and grew at a slow rate through the late 1960s. The oldest currently active well was completed in 1931, and approximately 70% of the registered wells have been drilled since 2000 (Figure 17). Livestock wells are commonly used throughout the ULNRD, in addition to private wells used as drinking water sources. The NeDNR began mandatory registration of domestic and low-capacity wells in 1993 and required all wells to be registered starting in 2002. Therefore, there are likely a large number of privately-owned unregistered wells still in use across the ULNRD.

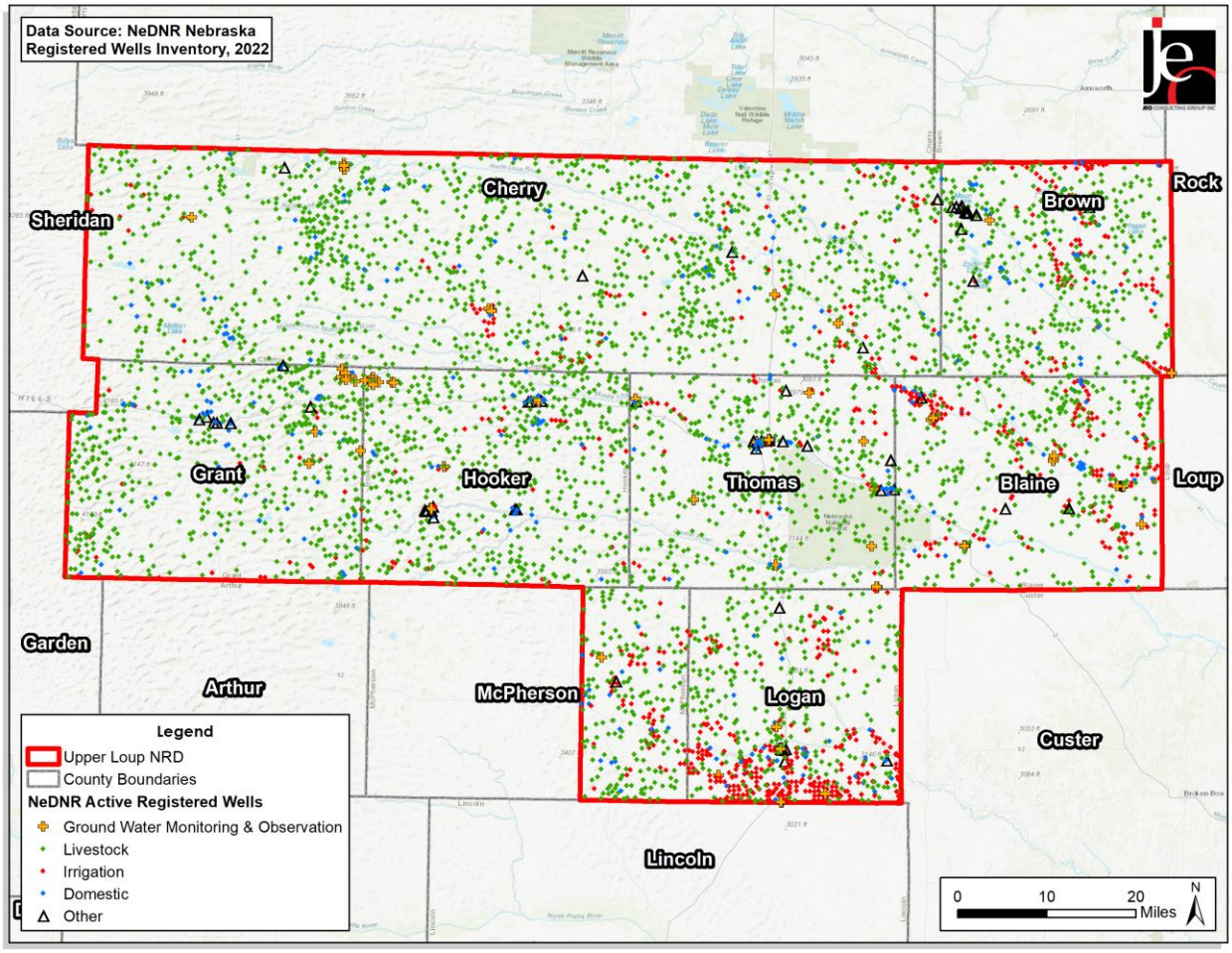


Figure 17: Registered Wells in the ULNRD

2.11 HYDROLOGICAL CHARACTERISTICS

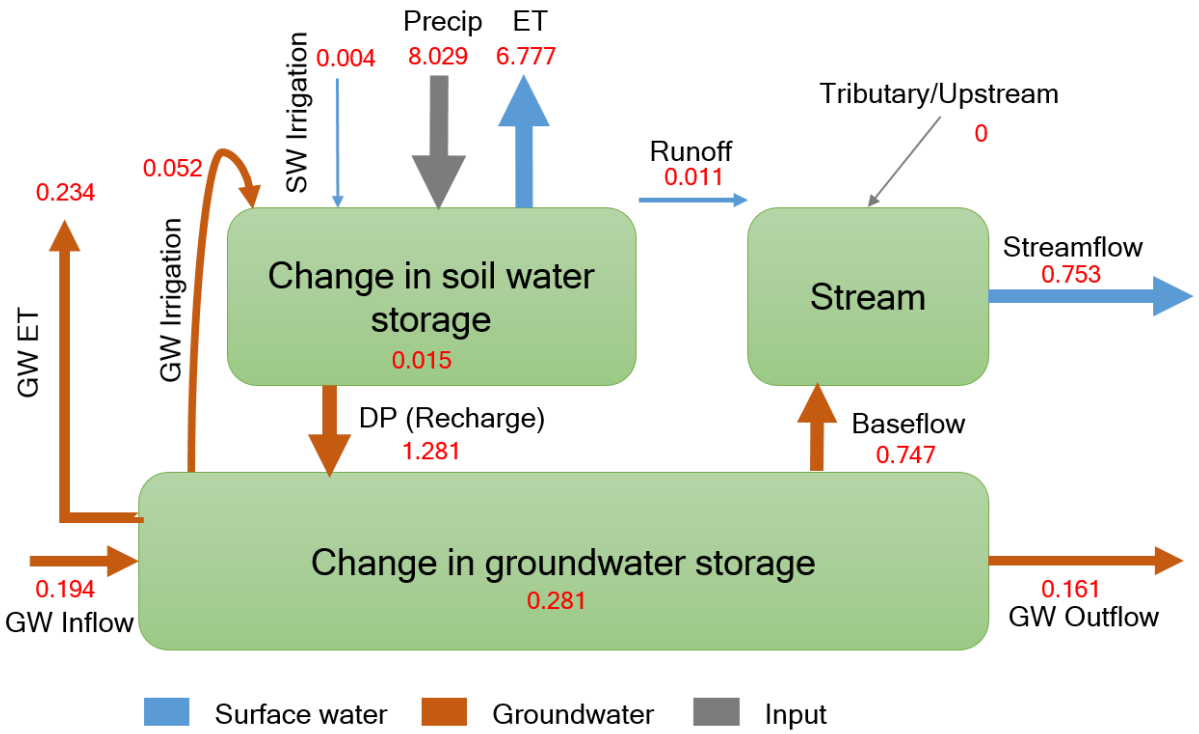
From a groundwater and surface water standpoint, ULNRD is a water-rich district. However, the Sandhills are a fragile ecosystem, and as water use in the ULNRD increases and development occurs downstream, more interest will be focused on the abundant water storage, inflow, and outflow. A shift in the ULNRD water balance, due to human disturbances, climate change, or geologic shifts, could have consequential implications on the sand dunes' protective and stabilizing vegetation layer, High Plains Aquifer, and the future water availability in the ULNRD and downstream. A continuing and evolving proactive management of the ULNRD water resources is critical, along with understanding the components of the water balance as the crucial first step in protecting the water resources in the ULNRD, the Sandhills and ultimately, the State of Nebraska (JEO, 2017).

WATER BALANCE AND BUDGET

In 2017, the ULNRD worked with JEO Consulting Group and Long Spring Consulting to develop a water budget using the Central Nebraska (CENEB) Model, which covers the entire ULNRD along with other NRDs in the area. The components of the water budget in ULNRD were inventoried, and the water balance was quantified successfully based on the CENEB model and other observations. The water budget study delineated the quantity of water in the ULNRD into three components, and they were annualized over the period of record. The components consist of:

- Changes in stored water in groundwater and soil;
- Water that enters the ULNRD from precipitation or groundwater flow (the amount of surface water in streamflow entering the District is very small and therefore assumed to be zero); and
- Water that leaves the ULNRD due to evapotranspiration, streamflow, and groundwater flow.

The summary water budget based on this assessment is shown in Figure 18.



Source: JEO, 2017

Figure 18: ULNRD Water Budget (Million Acre-Feet / Year)

Baseflow is the portion of total streamflow that comes from groundwater. It is an indicator of stream-aquifer interactions. Figure 19 shows the map of distribution, magnitude, and direction of stream-aquifer interactions. Overall, most streams are gaining groundwater annually which indicates that the aquifer is discharging baseflow into the stream. The variability of baseflow may be attributed to the streambed properties and distribution of stream stages and groundwater levels. The annual mean baseflow ranges from -7 cfs (losing stream) to 12 cfs (gaining stream). In the ULNRD, 25% are losing stream segments, while 75% are gaining stream segments. The total gaining rate is 1,231 cfs and the total losing rate is -170 cfs, leading to the net baseflow rate of 1,062 cfs.

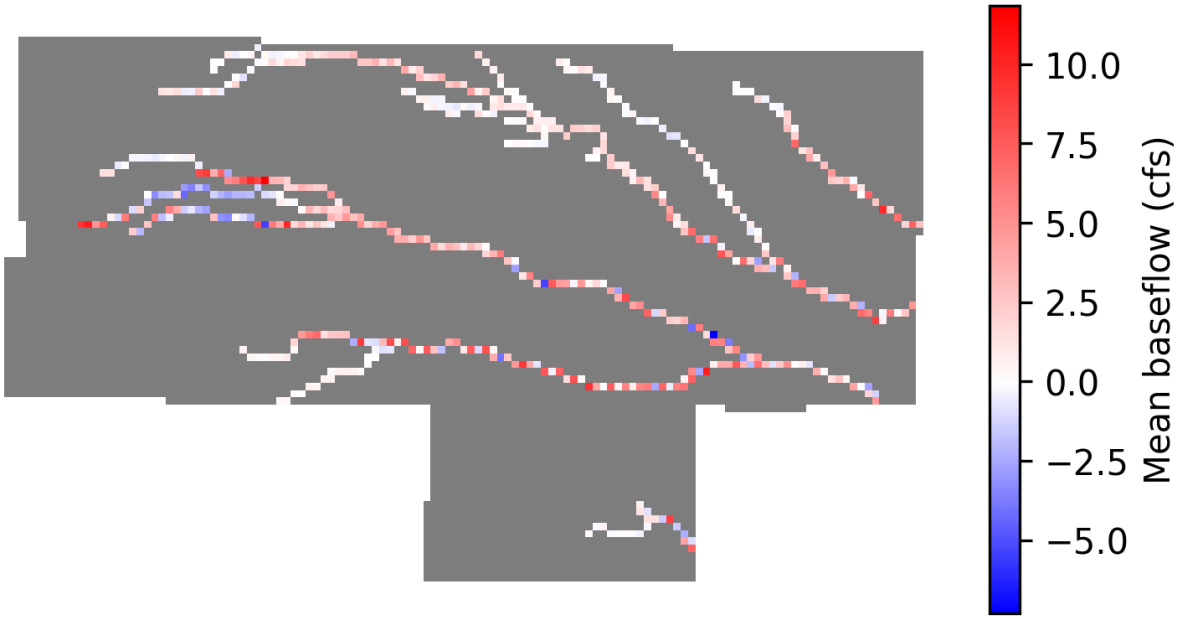


Figure 19: Distribution of Baseflow

Results show that the mean annual volume of groundwater underlying the ULNRD is approximately 533 million acre-feet (MAF), approximately 310 times the amount of water held by Lake McConaughy. The mean annual groundwater recharge is 2.91 inches. The mean annual change in groundwater storage is increasing at approximately 0.281 MAF. The largest input of water into the ULNRD is precipitation at approximately 8.03 MAF and the largest output is evapotranspiration at approximately 6.78 MAF on a mean annual basis. All streamflow on a mean annual basis leaving the ULNRD is approximately 0.753 MAF per year, or the equivalent of 34% of the Platte River flow at the Grand Island stream gage. The results clearly demonstrate the tremendous water resources in the ULNRD and the vast quantity of groundwater underlying the ULNRD (JEO, 2017).

2.12 INFORMATION AND EDUCATION

The ULNRD understands the importance of education of all its constituents and makes a full effort to inform and communicate to the public about ULNRD services, natural resources, and learning to be a steward of the environment. The ULNRD will continue to provide and update as needed:

- News articles and public service announcements
- Quarterly newsletters
- Current and easy to maneuver website available 24-7, including a Facebook page
- Publications, brochures, and pamphlets on a wide assortment of topics including NRD's duties and responsibilities, programs, services and projects, chemigation, etc.
- Annual Arbor Day and Earth Day activities with grade school students
- Elementary, junior high and high school presentations as requested
- Presentations to civic groups, presentations and trainings for area producers
- ULNRD Annual Junior High Field Day
- Host and participate in the annual ACE (Adventure Camp about the Environment) in Halsey
- Promote and assist with local County Fairs, State Envirothon, Nebraska State Fair, Husker Harvest Days, Regional Land Judging and Area Range Judging contests
- Provide scholarships for Range Camp, ACE Camp, Ranch Practicum Program, and Envirothon
- Offer a Nature in The Neighborhood Grant to all nonprofit organizations residing in the ULNRD
- Conservation Awards
- Support for various Informational and Educational projects with other agencies and organizations
- A central meeting and training room for schools, civic organizations, and other agencies to use upon request
- Attendance at various local, state, and national meetings to educate themselves and to work for necessary legislative changes

CHAPTER 3. GROUNDWATER QUANTITY

3.01 GROUNDWATER SUPPLIES, LEVELS, AND EXISTING WELLS

The groundwater supply is plentiful and evidence to date suggests that the water supply has not been measurably reduced by withdrawals (Figure 20). The present-day use of groundwater by withdrawal for municipal, industrial, and irrigation use is minimal in the ULNRD. The potential for a significantly greater use over time is high based on the large available supply. The current demand is relatively low due to several factors including economics, low population base, a sandy soil type not supporting land for row crops, and the tradition of a low water-use ranching-based economy. However, groundwater is the economic lifeblood of the ULNRD, and if supply were to deteriorate then competition would increase.

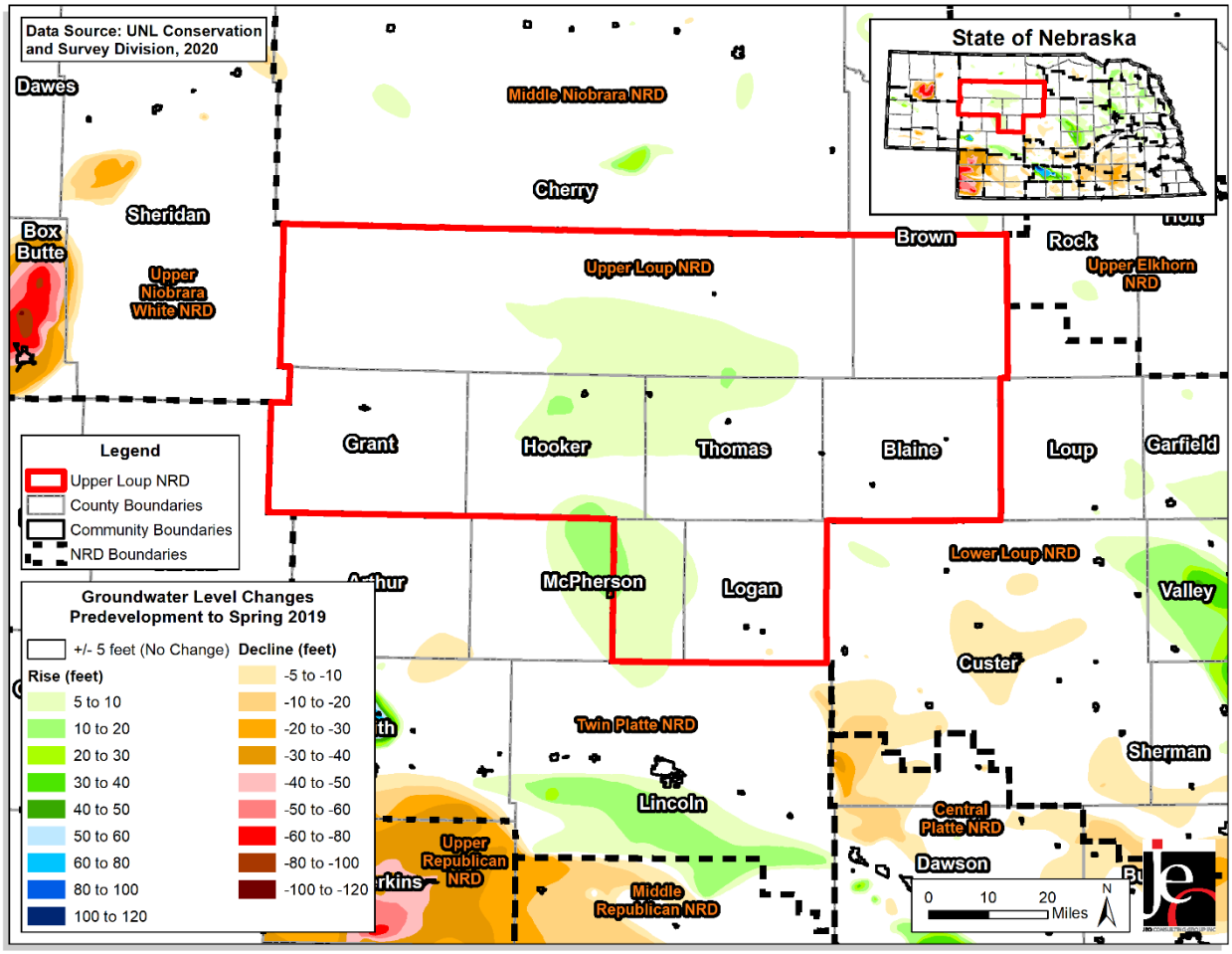


Figure 20: Groundwater Level Changes, Predevelopment to Spring 2019

The ULNRD collects spring static water levels from at least 115 wells representing all the sub-basins across the NRD (Figure 21). This information is used to track the trend of water elevation data. The ULNRD uses the water-elevation data to help determine annual and long-term changes in groundwater storage, estimate recharge rates, determine direction and gradient of groundwater flows, gain insight for efficient well construction and water extraction, and generally gain a better understanding of how the aquifer system works.

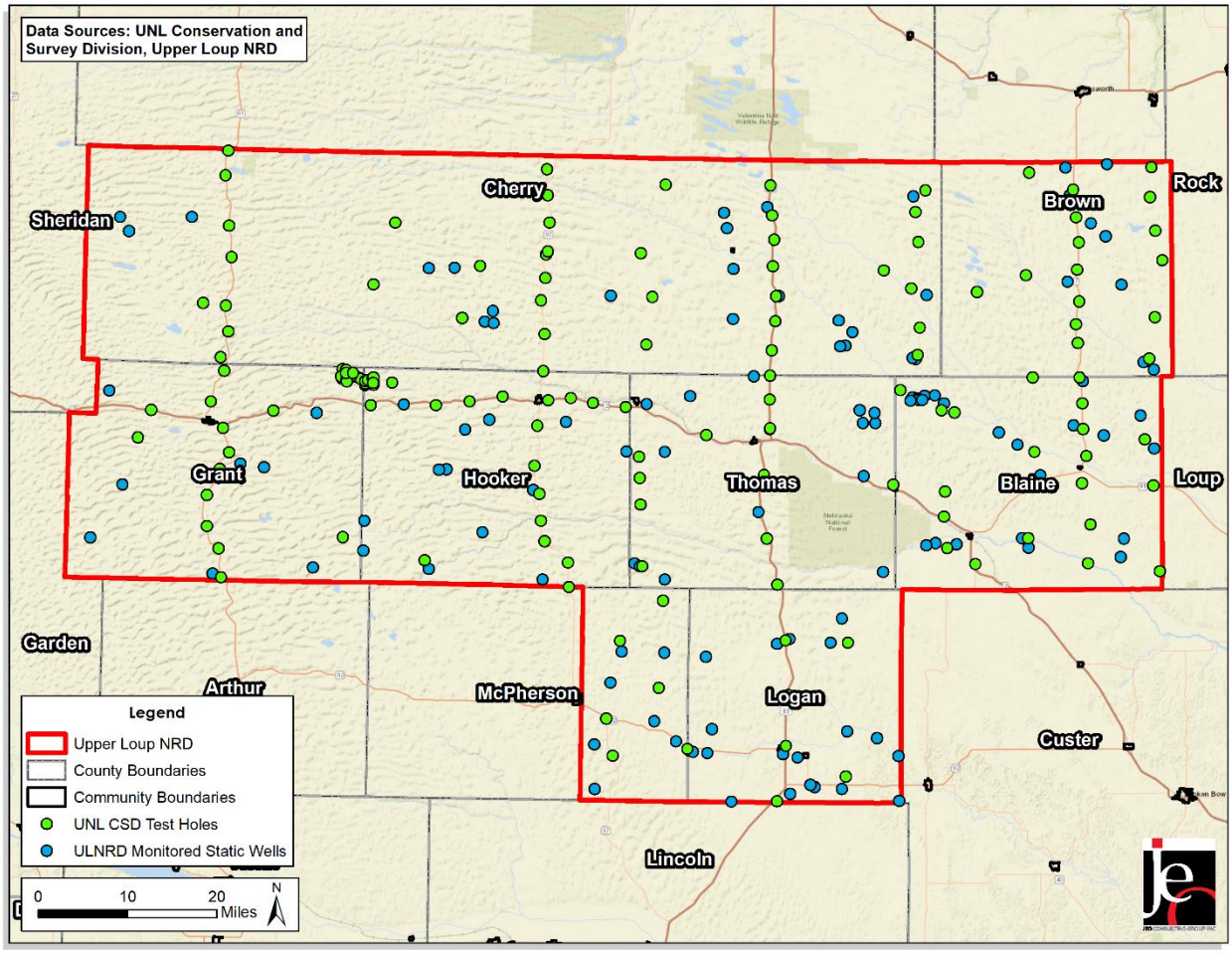


Figure 21: UNL-CSD Test Holes and Monitored Static Wells

A generalized visualization of depth to groundwater is displayed in Figure 22. Note that this information is an approximation and should not be used for any site-specific purposes. Depth to groundwater was estimated by comparing UNL CSD water table elevation information and land surface elevation information. The water table is present at relatively shallow depths across the ULNRD and is present above the ground surface at many wetlands, lakes, and wet meadows throughout the Sandhills.

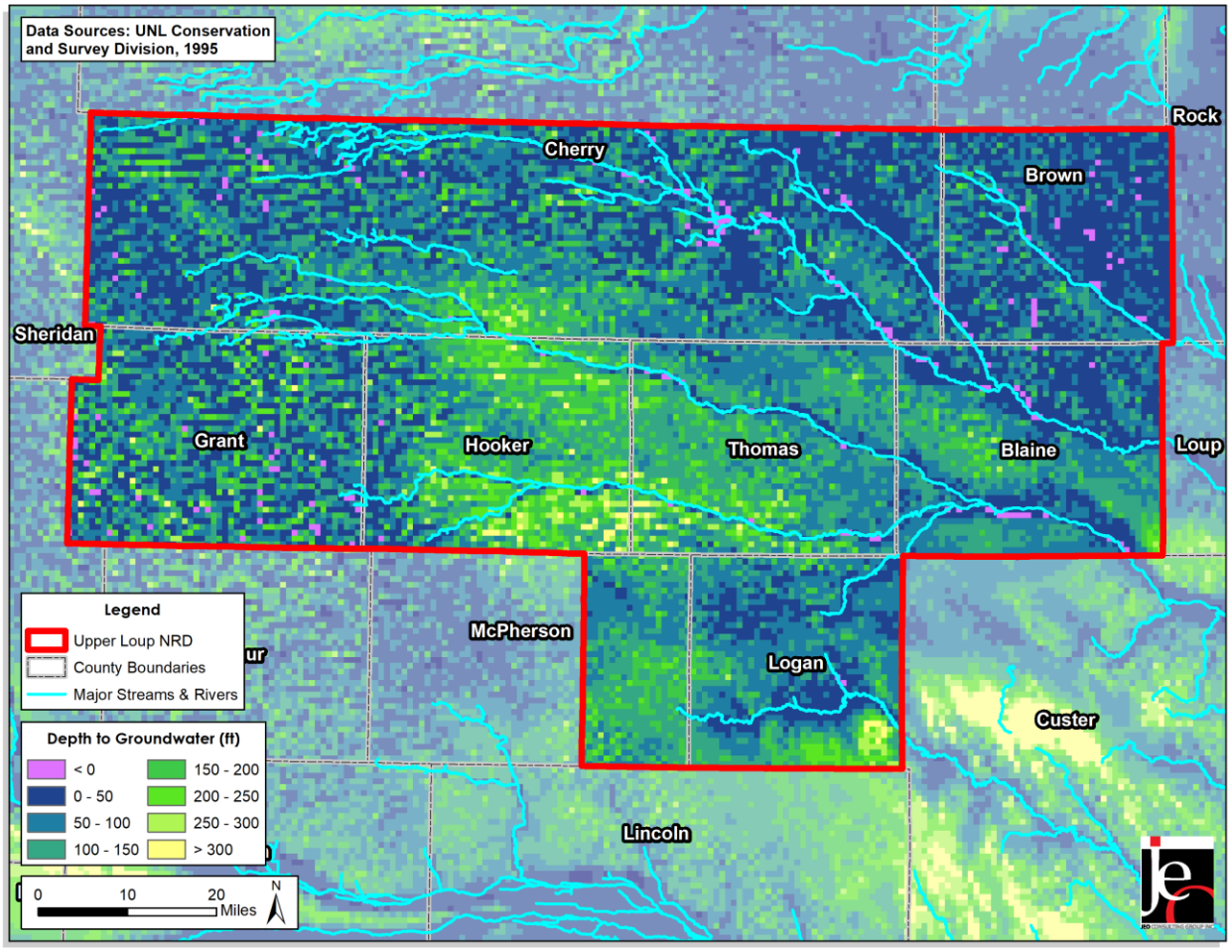


Figure 22: Approximate Depth to Groundwater

3.02 WATER USE

The ULNRD reports annually on water use as part of the LPRCA Basin Water Management Plan Annual Report (ULNRD, 2021a). This report is available by contacting the ULNRD office. Statistics from these annual reports are included in Table 6. Highlights of the reporting on water use include the following:

- The ULNRD maintains a monitoring well network which is measured each spring.
- The ULNRD requires permits for all new and replacement high-capacity groundwater wells.
- Currently the only restriction on water uses or development is a cap of no more than 2,500 acres of new irrigation development annually across the ULNRD. The ULNRD receives applications and approves requests based upon a ranking system.
- The ULNRD records and tracks retirement of groundwater consumptive uses.
- The ULNRD records and tracks the transfer of groundwater consumptive uses.
- All high-capacity wells in the ULNRD are required to be metered.
- Certifying groundwater irrigated acres was completed in 2008. As of 2021, there were 83,104 certified irrigated acres with 86% (70,980 acres) reported as active.
- While the ULNRD does not certify surface water irrigated acres, the NeDNR Surface Water Database indicates that as of 2022 there are 58 active surface water appropriations in the ULNRD. Of these, 33 are used for irrigation. There are no co-mingled certified acres.
- ULNRD requires municipal groundwater users (Villages of Hyannis, Mullen, Thedford, Stapleton and Dunning) and commercial/industrial groundwater users (19 total, 13 of which are associated with golf courses) to submit annual groundwater use amounts as part of the rules and regulations.
- There currently is no established water banking system.

The amount of water needed by vegetation varies widely (Table 7). Crop water requirements often exceed the moisture available from precipitation, and groundwater supplementation is common within the ULNRD.

Table 6: Average Annual Water Use and Depletions by County (2017-2021)

County	Municipal Water Use (gal)	Municipal Depletion (ac-ft)	Commercial Water Use (gal)	Commercial Depletion (ac-ft)	Agricultural Water Use (total inches)	Agricultural Water Use (average inches per well)	Agricultural Depletion (ac-ft)
Blaine	14,024,788	33	N/A	N/A	773	9.5	66
Brown	N/A	N/A	N/A	N/A	223	10.2	19
Cherry	N/A	N/A	N/A	N/A	352	9.5	30
Grant	48,270,760	147	17,411,800	53	65	8.5	6
Hooker	73,466,100	226	302,790,609	853	184	12.0	16
Logan	50,933,820	176	21,445,983	69	2,367	9.8	182
McPherson	N/A	N/A	N/A	N/A	469	10.5	37
Thomas	50,385,200	150	96,138,760	145	173	8.3	15

Note: Averages may be calculated from less than 5 years depending on the availability of the data.
Source: ULNRD Annual Reports on Water Activities, 2017 – 2021

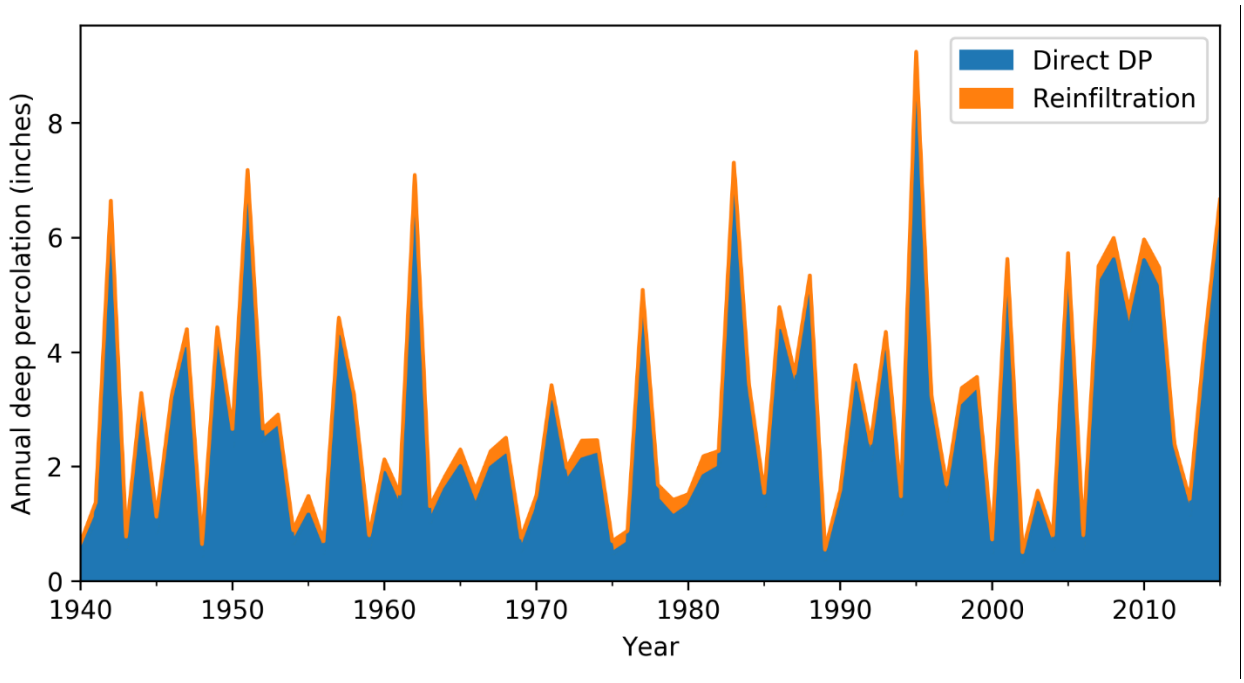
Table 7: Average Crop Water Use in Western Nebraska

Vegetation Type	Approx. Total Water Use: April 15 – October 13 (inches)
Alfalfa	32.00
Corn	27.25
Dry Bean	15.60
Small Spring Grain	18.70
Sugar Beet	29.70
Small Winter Grain	17.90
Actively Grazed Pasture	32.25
Potato	23.20

Source: Yonts, 2002

3.03 RECHARGE CHARACTERISTIC

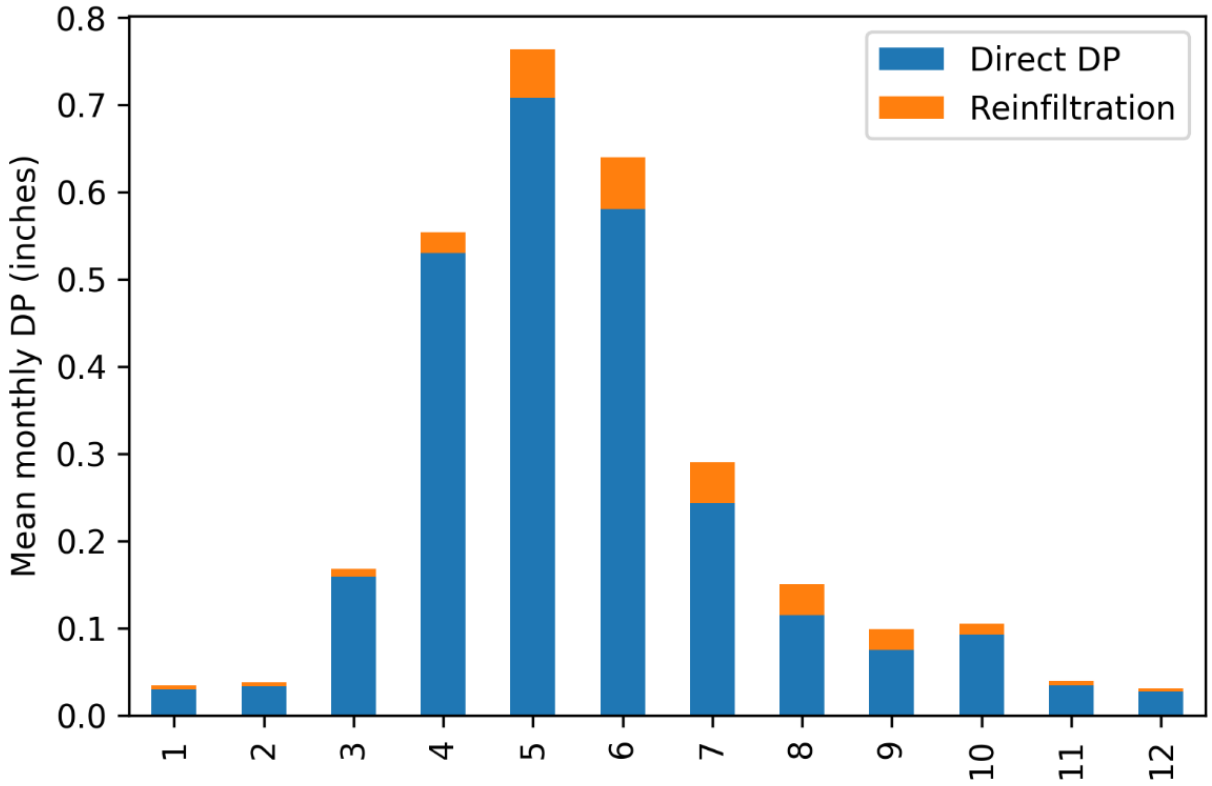
A basic principle of the GWMP is that the groundwater supply is currently of sufficient quantity to meet all needs and of appropriate quality to generally meet existing standards of regulatory agencies. This is attributed to the large amount of recharge, or deep percolation that occurs annually in the Sandhills. The primary source of water in the ULNRD is precipitation, which renders the region an important source of groundwater recharge for the High Plains Aquifer. The topography and soil characteristics allow precipitation to recharge the groundwater aquifer system during the water abundant periods. Deep percolation is the water that leaves the root zone and eventually becomes groundwater recharge. The annual deep percolation is 2.91 inches and is demonstrated in Figure 23 for the period of the CENEB model (1940 to 2015) (JEO, 2017).



Source: JEO, 2017

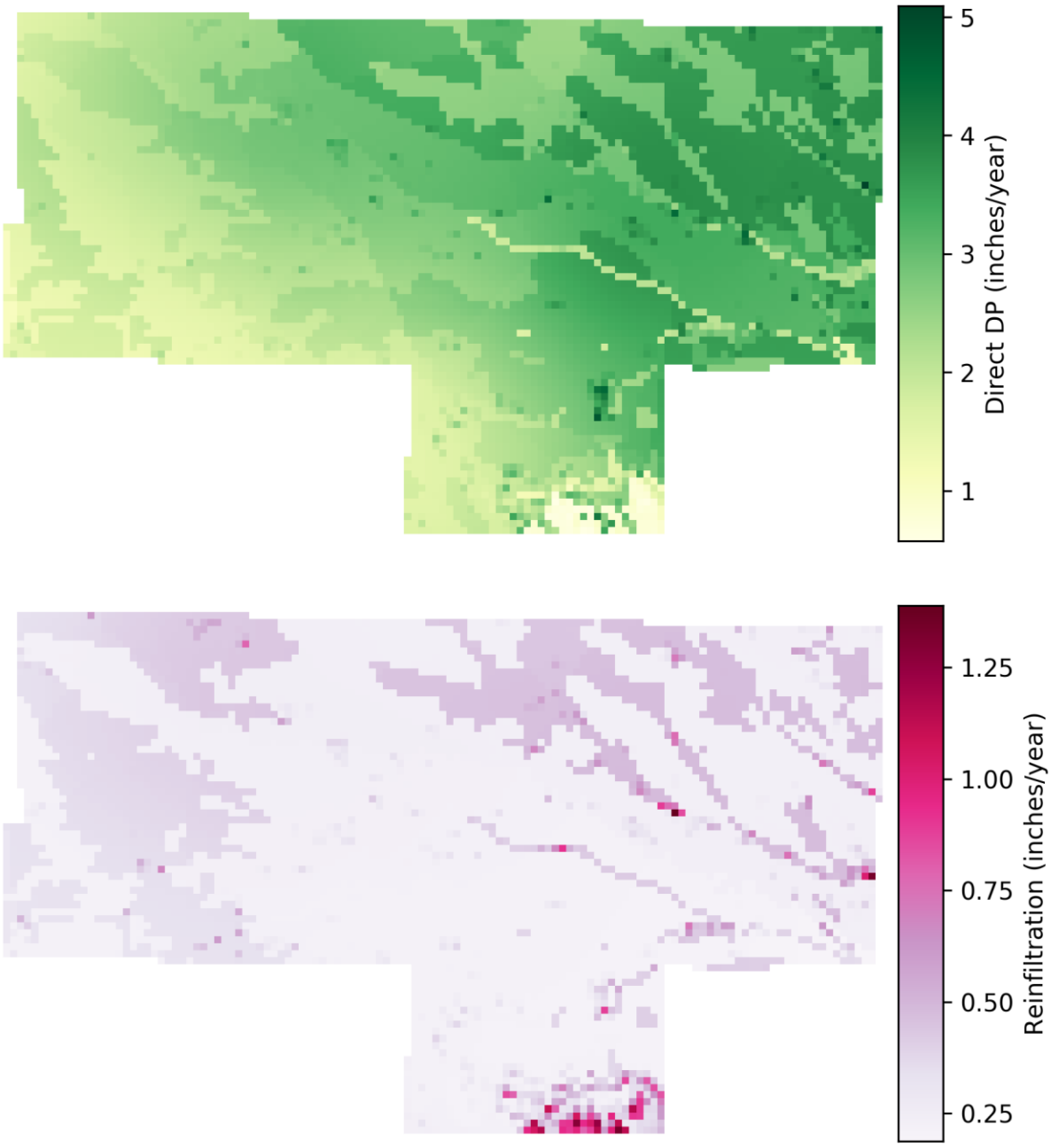
Figure 23: Annual Aquifer Recharge (1940 – 2015)

Figure 24 shows that over 86% of recharge occurs between April and September, which agrees with the monthly distribution of precipitation (JEO, 2017). The geographic distribution of recharge is shown in Figure 25. The highest monthly recharge occurs in May even though the highest monthly precipitation is in June. This may be attributed to the increasing evapotranspiration in June.



Source: JEO, 2017

Figure 24: Mean Monthly Recharge

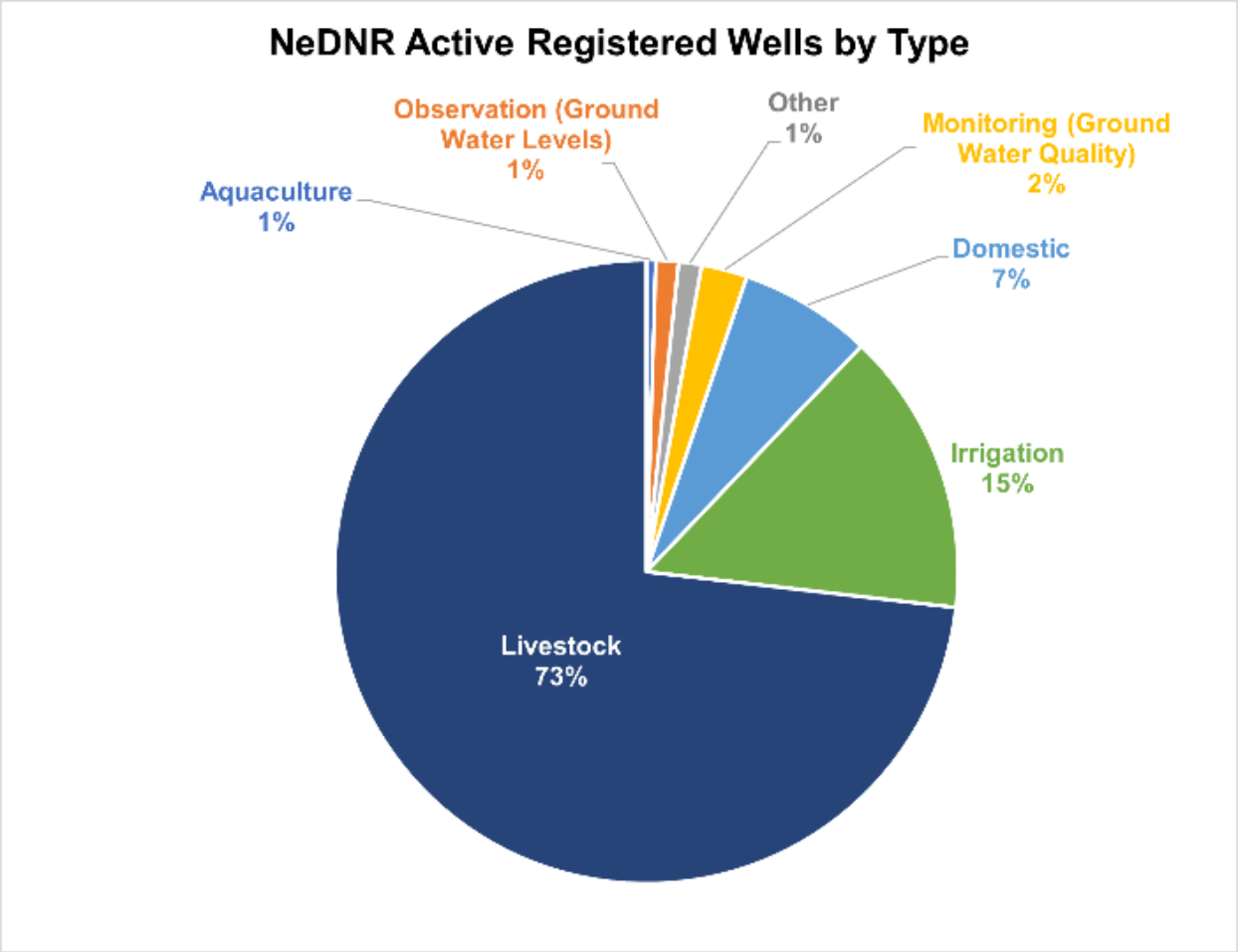


Source: JEO, 2017

Figure 25: Distribution of Mean Annual Recharge

3.04 WATER DEMAND

The majority of registered wells in the ULNRD are used for livestock water supply. As of 2022, livestock supply accounted for 4,058 wells, or 73% of all registered wells in the ULNRD. Irrigation wells totaled 816, or 15% of the total. A pie chart showing the distribution of well type by registered well is shown in Figure 26. The 'other' category includes all commercial/industrial, ground heat, heat pump, injection, other, and recovery wells.



Source: NeDNR Registered Wells Database, 2022

Figure 26: Summary of Registered Wells by Type

CHAPTER 4. GROUNDWATER QUALITY

4.01 AQUIFER VULNERABILITY

NONPOINT SOURCE POLLUTION

Excessive fertilizer and pesticide application in conjunction with over-watering, particularly on well drained soils like most of those in the ULNRD, is the major source of nonpoint source contamination. To obtain the most determinative nonpoint source groundwater quality data, selection of quality monitoring areas will be dependent upon three factors:

1) The concentration of land use practices involving nitrogen and pesticide application, particularly where supplemental water is applied;
2) The presence and proximity of domestic water wells;
3) Groundwater pollution potential based on site specific data such as needs of the crops being grown and DRASTIC map parameters.

A DRASTIC map is developed from Geographic Information System (GIS) technology and depicts potential for groundwater contamination from various parameters. DRASTIC map parameters are Depth to water, Recharge to the aquifer (net), Aquifer media, Soil media, Topography (slope), Impact of vadose zone, and Conductivity of the aquifer. All three factors involved in determining groundwater quality monitoring areas will be examined on site specific levels through the use of soils maps, well construction data, local agriculture statistics, nitrogen and pesticide use records, local crop needs, and other pertinent site-specific data. The DRASTIC model representation for ULNRD is shown in Figure 27. It is important to note that DRASTIC is a regionally based representation and more detailed vulnerability assessments would be recommended to understand risk on a more strategic basis (i.e. for a public water system).

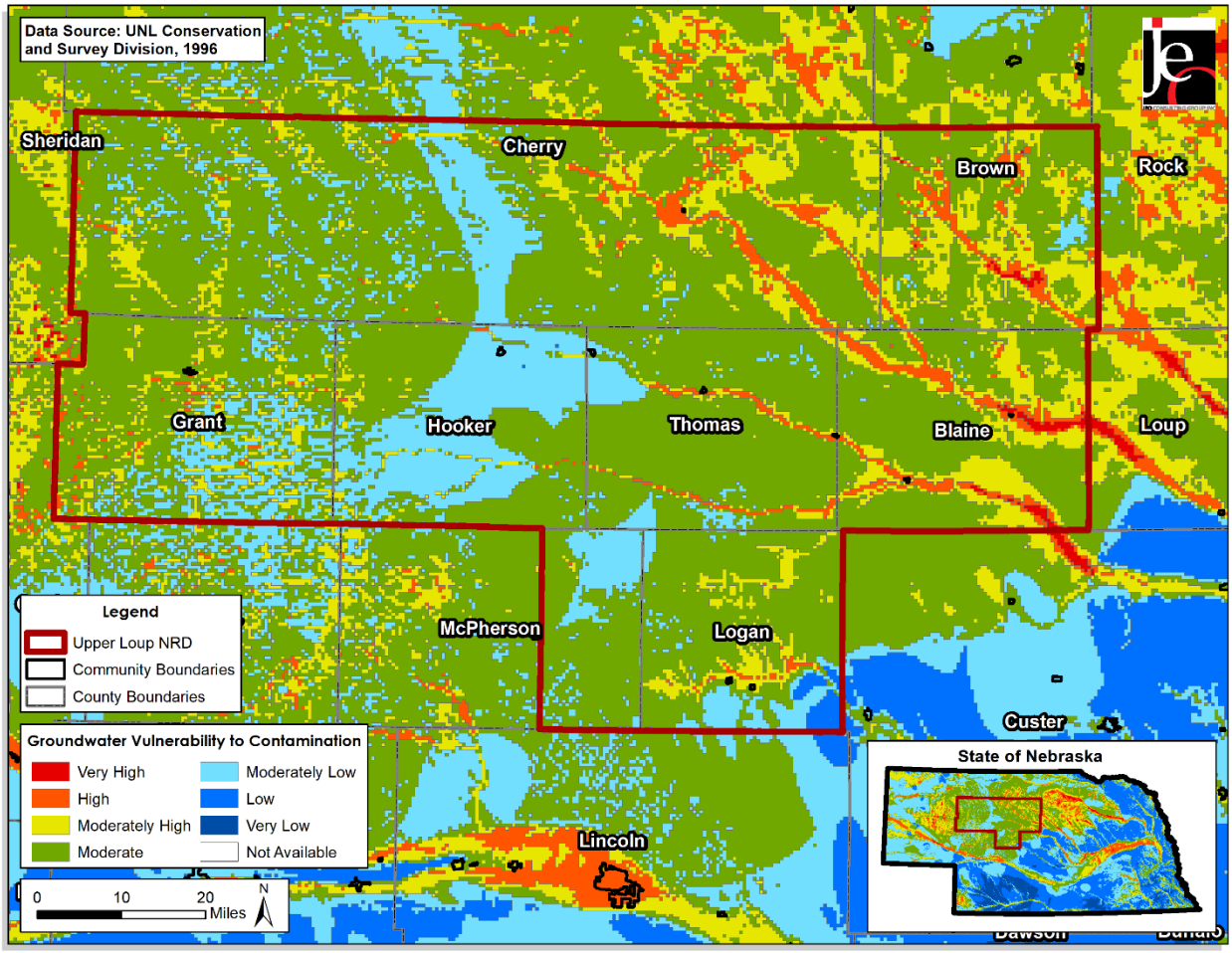


Figure 27: DRASTIC Vulnerability

POINT SOURCE POLLUTION

Point sources of groundwater contamination are many and include but are not limited to; private or community and industrial type waste disposal systems; the improper use, storage, and disposal of chemical, other industrial and petroleum products; improperly operated or abandoned livestock feed yards; and improperly sited, constructed, and abandoned wells.

The ULNRD rules and regulations define point source as any discernible, confined, and discrete conveyance, including, but not limited to, any pipe, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, vessel, other floating craft, or other conveyance, over which NDEE has regulatory authority and from which a substance which can cause or contribute to contamination of ground water is being or may be discharged. NDEE maintains a database of regulated facilities under their authority that are known to have, or have had, contamination or the potential for contamination of soil and water. A

variety of categories are included in the regulated facilities database, including the National Pollutant Discharge Elimination System (NPDES) program, as part of the Federal Water Pollution Control Act Amendments of 1972. Some of these regulated facilities represent potential point sources of groundwater contamination if full compliance is not maintained. NDEE regulated facilities that may impact groundwater are shown in Figure 28. A summary of those facilities is provided in Table 8.

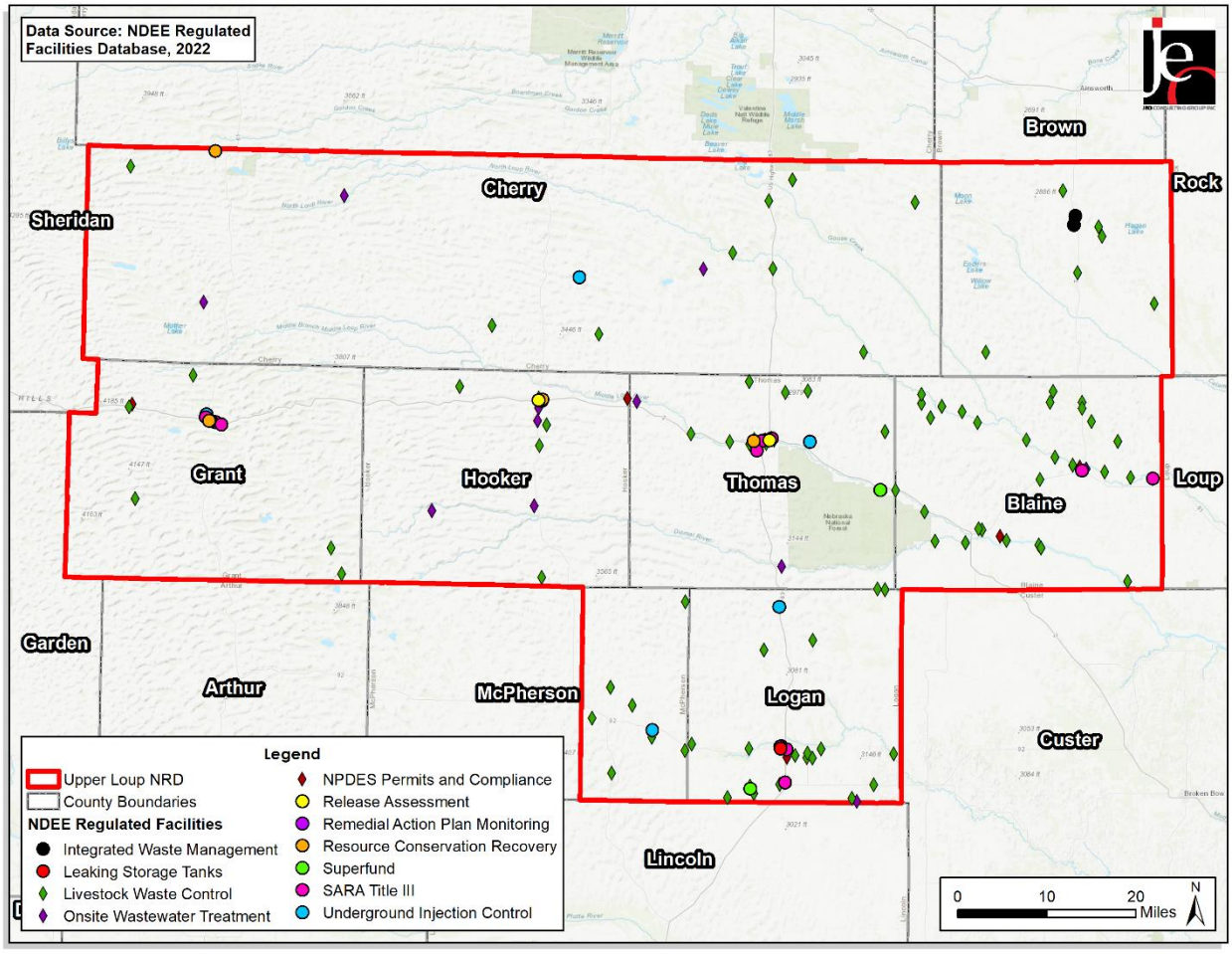


Figure 28: NDEE Regulated Facilities

Table 8: Summary of NDEE Regulated Facilities with Potential to Impact Groundwater

Program	Count
Integrated Waste Management	2
Leaking Storage Tanks	2
Livestock Waste Control	96
Onsite Wastewater Treatment	85
NPDES Permits and Compliance	22
Release Assessment	3
Remedial Action Plan Monitoring	1
Resource Conservation Recovery	4
Superfund	3
Superfund Amendments and Reauthorization Act Title III	17
Underground Injection Control	11
Total	**246**

Source: NDEE Regulated Facilities Database, 2022

4.02 CURRENT POLICIES

In 2008, the ULNRD established a GWMA to improve and protect groundwater quality in the NRD. The management area identifies where problem areas may exist with groundwater quality. Groundwater quality management areas are divided into three categories:

1) Phase 1 areas with an average of groundwater nitrate content between zero (0) and seven (7) milligrams per liter (mg/L).
2) Phase 2 areas with an average of groundwater nitrate content between six (6) and eight and a half (8.5) milligrams per liter (mg/L).
3) Phase 3 areas with an average of groundwater nitrate content over eight and a half (8.6) to ten (10) milligrams per liter (mg/L). Each phase area has its own quality phase controls and reporting.

The entire ULNRD is in Phase 1 of the Groundwater Management Program thus, no parts have been identified as having a high risk to nitrate groundwater contamination. Phase 1 controls include:

1) Having wells sampled once every five years,
2) Encouraging operators to attend classes for fertilizer and irrigation water management,
3) Encouraging the performance of deep soil testing for residual nutrients, and;
4) Not applying nitrogen fertilizer on sandy soils in the fall or winter.

Other polices include education and active outreach to ensure well drillers and contractors are educated on well construction techniques and regulations to prevent point source contamination of domestic water supplies. Currently the ULNRD administers the Chemigation Program as required by the State for all NRDs. Field inspections are made for all new permit applications, a percentage of renewals, and selected unpermitted sites to check for compliance.

4.03 MONITORING

The ULNRD staff monitors 450 private wells for water quality. The wells, which include registered and non-registered wells, are tested on a five-year rotating cycle by subdistrict, ensuring that each well is tested once within a five-year period. The location of each well monitored by the ULNRD is shown in Figure 29. Data from approved wells is provided to NDEE to be included in the statewide Groundwater Quality Clearinghouse database. Nitrate levels from the Clearinghouse are displayed in Figure 30. The Clearinghouse provides a publicly accessible data source that is continually updated with recent nitrate sampling results.

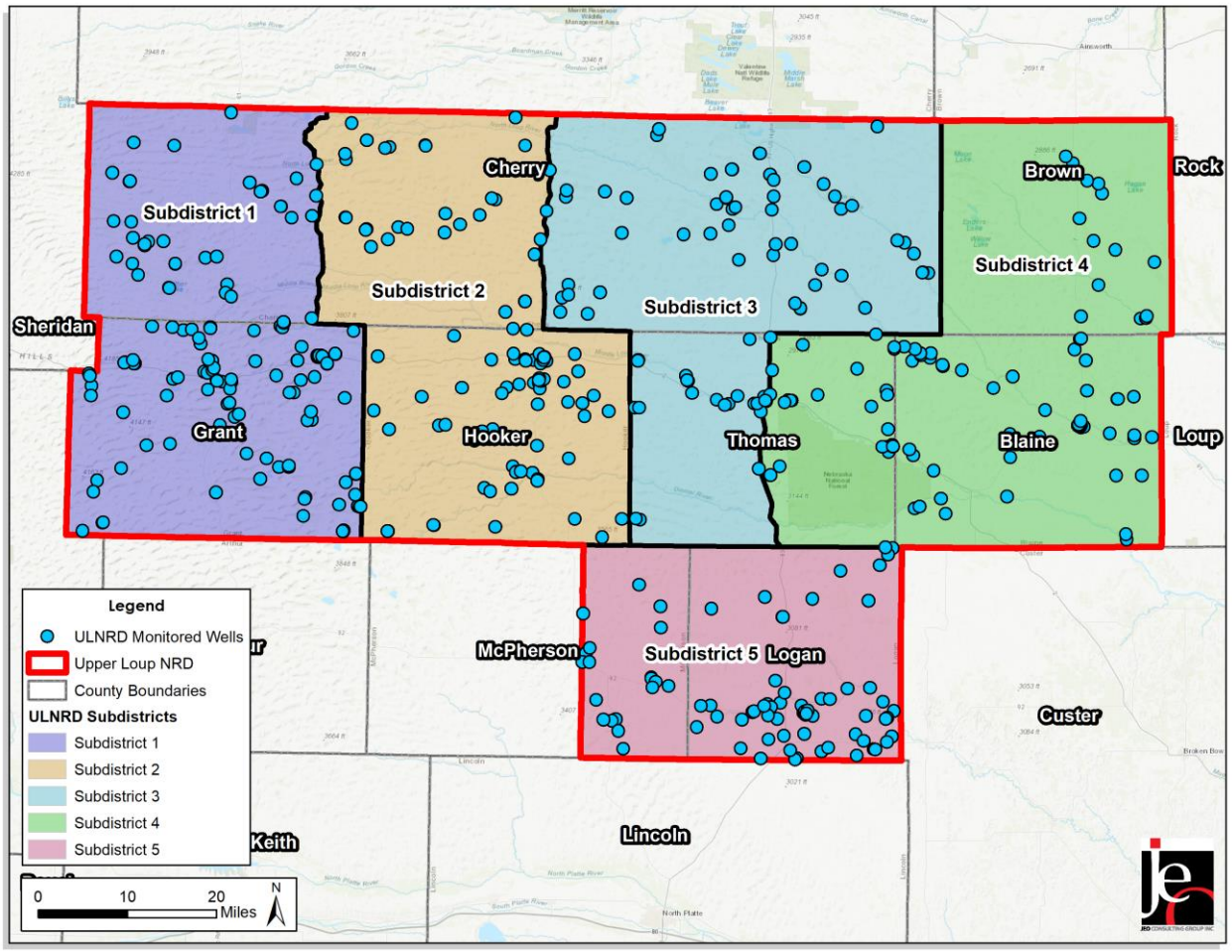


Figure 29: Wells Monitored by the ULNRD

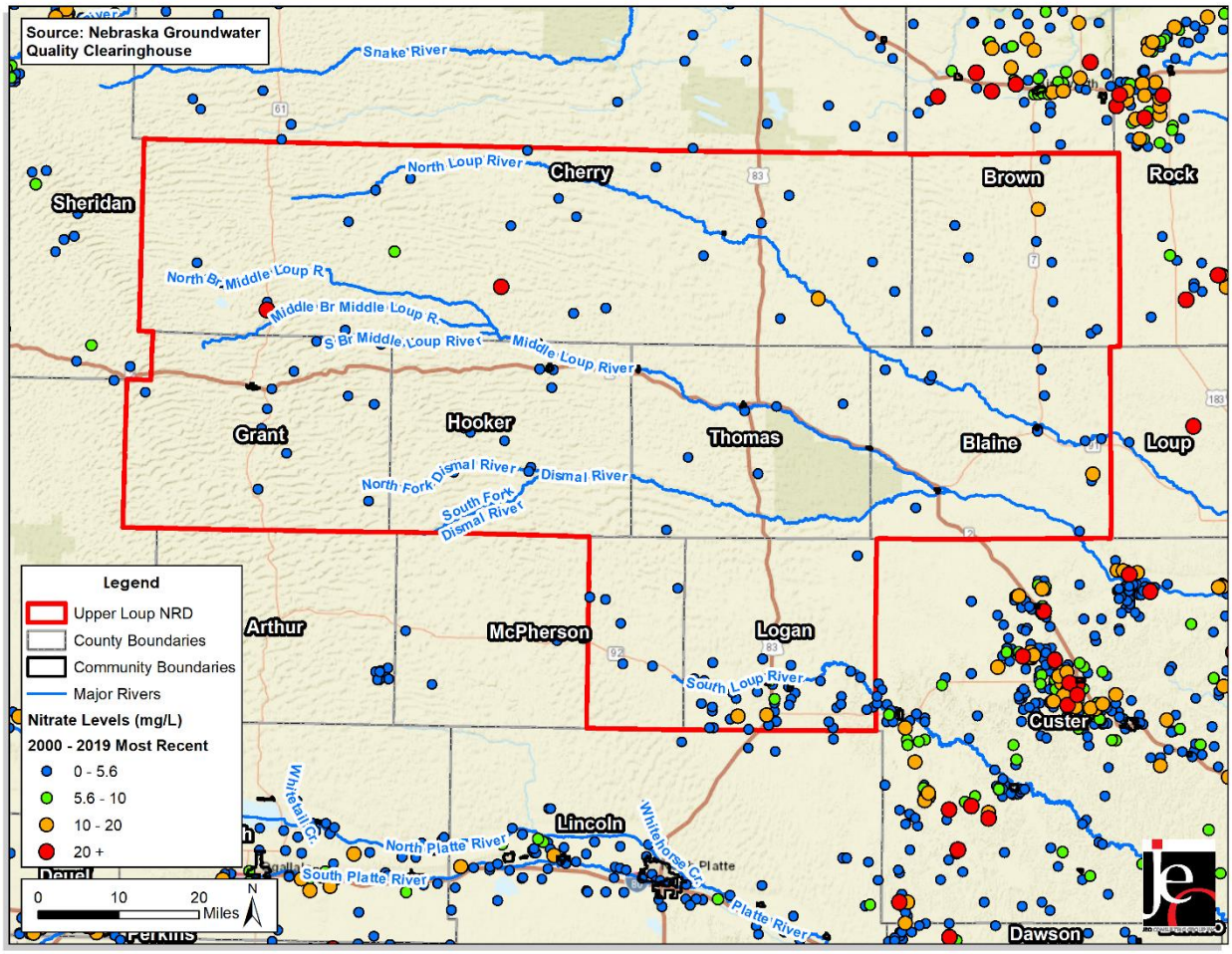


Figure 30: NDEE Nitrate Data (2000-2019)

4.01 WELLHEAD PROTECTION AREAS

NDEE administers the WHP Program, a voluntary program that provides financial and technical assistance to communities and other public water suppliers to protect water supplies from contamination. Each community with a public water supply has been provided a WHP area. The delineation of the WHP area shows the surface area surrounding a water well or well field supplying a public water system through which contaminants are reasonably likely to move toward and reach such water or wellhead area (Figure 31). As of 2022, none of the communities in the ULNRD had a WHP plan. The five steps of WHP planning are shown in Figure 32.

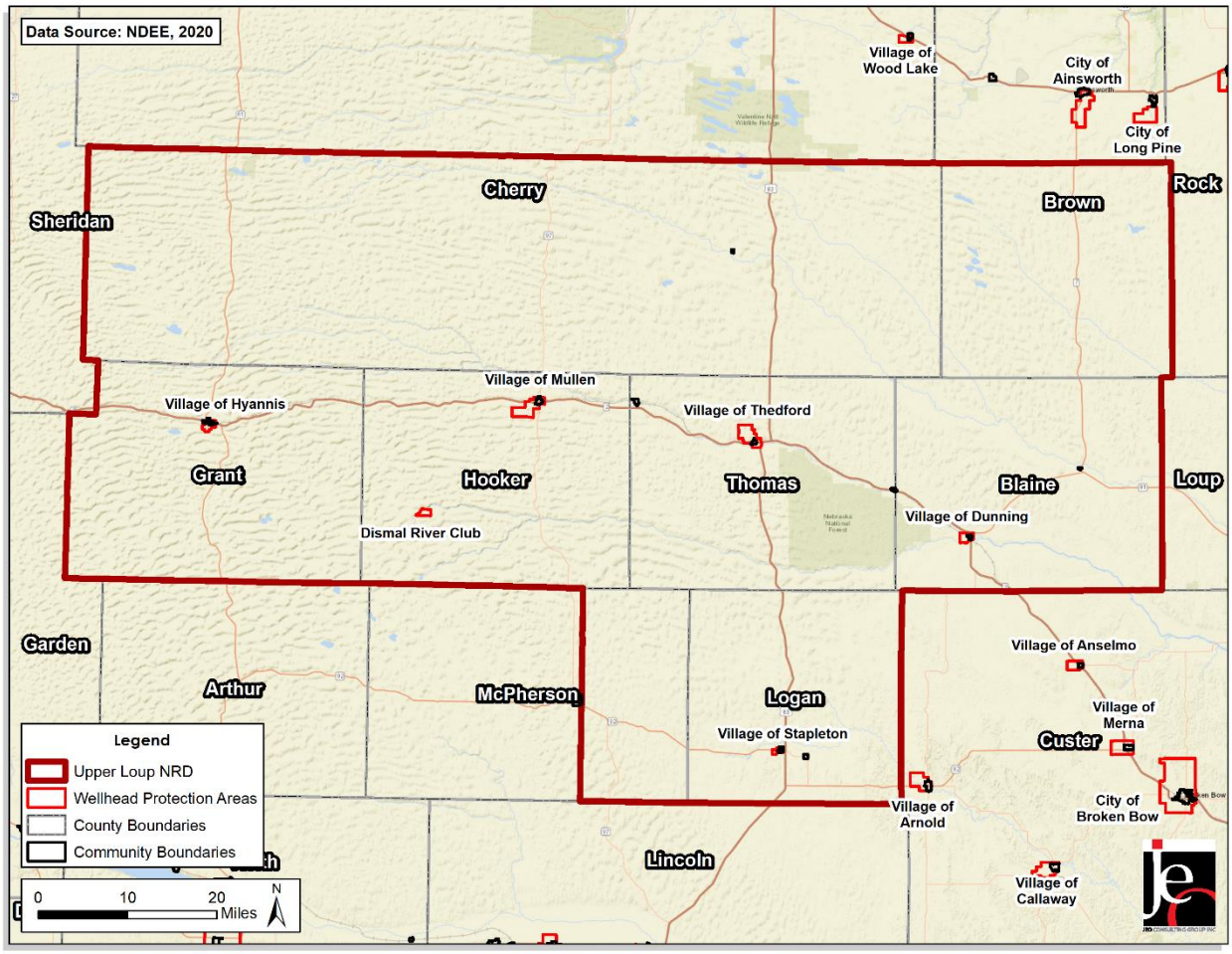


Figure 31: Wellhead Protection Areas in the ULNRD

Figure 32: Wellhead Protection Planning Process

CHAPTER 5. GOALS AND OBJECTIVES

5.01 UPPER LOUP NRD GROUNDWATER MANAGEMENT GOALS AND OBJECTIVES

The overarching target is to maintain the reservoir life and quality to meet standards appropriate to use for all current and future water users. The goals and objectives are intended to guide water resource management decision making.

There are five goals, each with several objectives that describe how the goal will be achieved. Goal categories include quality, quantity, information and education, conservation practices, and collaboration and partnership.

ULNRD Groundwater Management Vision Statement

The groundwater reservoir life goal for the ULNRD is to maintain, in perpetuity, groundwater of a quality and quantity to meet standards appropriate to its use, in an adequate supply for domestic, livestock, public, irrigation, agriculture, wildlife, and industrial uses. The goal includes minimizing, as much as possible, the adverse impact of these uses on the quantity and quality of groundwater that supports lakes, sub-irrigated lands, and streams.

The goals are in alignment with the guidelines for the NRD's rules and regulations and include key elements related to groundwater management from the ULNRD Integrated Management Plan, effective date of July 15th, 2016; as well as Lower Platte River Basin Coalition Basin Water Management Plan, October 2017. Copies of these plans can be obtained from the ULNRD office or found on our website at www.upperloupnrd.org.

GOAL 1 – TO MAINTAIN A SUSTAINABLE SUPPLY OF HIGH QUALITY, CONSUMABLE, AND SAFE GROUNDWATER FOR ALL USERS IN THE NRD.

- **Objective 1.1** – The effort to monitor and sample water quality throughout the ULNRD will be continued and expanded as necessary.
- **Objective 1.2** – Seek to understand and obtain tools to help staff understand the potential contaminants of concern and help users reduce the potential for contaminants to reach aquifers.
- **Objective 1.3** – Continue annual NRD-wide sampling of irrigation and domestic wells to help understand the extent of nonpoint source contamination and provide data to NDEE for the Nebraska Groundwater Quality Clearinghouse.
- **Objective 1.4** – Encourage the development and collaboration with municipalities to establish WHP plans to bring awareness about the importance of protecting municipal water supplies most vulnerable to nitrate contamination.
- **Objective 1.5** – Continue to offer cost share for proper decommissioning of abandoned wells, cost share for deep soil testing for residual nutrients, and cost share for drip well systems on oil lubed turbine pumps.
- **Objective 1.6** – Continue monitoring the use of chemigation through irrigation systems and continue area-wide inspections of the chemigation systems.
- **Objective 1.7** – Explore and expand efforts for cost share programs that promote water quality protection and enhancement of Best Management Practices.

- **Objective 1.8** – Promote users to adopt practices through educational programs on fertilizer and irrigation training for both rural and urban areas to reduce nitrate leaching into groundwater aquifers.
- **Objective 1.9** – Continue the recycling program and expand recycling services as demand grows.

GOAL 2 - TO ENSURE GROUNDWATER SUPPLIES ARE MANAGED IN A SUSTAINABLE MANNER AND MADE AVAILABLE FOR THE BENEFICIAL USE FOR ALL CURRENT AND FUTURE USERS IN THE NRD.

- **Objective 2.1** – Collaborate with USGS, and UNL CSD to review the existing network of wells with respect to geographical coverage to identify opportunities to install new dedicated monitoring wells, with real-time monitoring capabilities.
- **Objective 2.2** – Maintain static water level monitoring network, tracking changes in water supply and adjusting as needed.
- **Objective 2.3** – Continue reading of flowmeters and tracking groundwater use across the ULNRD.
- **Objective 2.4** – Continue funding for stream gauges on the South Loup and North Loup Rivers.
- **Objective 2.5** – Encourage development of groundwater use for beneficial purposes within the ULNRD and continue to implement rules that disallow groundwater transfers outside of the ULNRD.
- **Objective 2.6** – Maintain a system that incorporates data to assess and understand the potential impact of new groundwater uses and supplies on existing surface water and groundwater uses.
- **Objective 2.7** – Obtain and assess data that supports Board decisions for sustainable development of water uses.
- **Objective 2.8** – Improve understanding of water supplies and demands through research and studies.
- **Objective 2.9** – Review annually the ULNRD'S water management policies and procedures to best protect the NRD and maintain the best available science to support decisions.
- **Objective 2.10** – Explore and expand efforts for cost share programs that promote water conservation and enhancement of Best Management Practices.
- **Objective 2.11 –** Continue to provide cost share funds for a variety of water management activities such as conversion nozzles, soil moisture sensors, rainfall auto-shutoff valves, etc.

GOAL 3 – CONTINUE TO BE A RESOURCE TO EDUCATE YOUTH AND ADULTS ABOUT CONSERVATION AND NATURAL RESOURCES, EMPHASIZING THE IMPORTANCE OF ENSURING SUSTAINABLE WATER RESOURCES REMAIN AVAILABLE.

- **Objective 3.1** – Work with ULNRD residents both individually, and in groups, to provide necessary information and education programs on available cost-share and incentives for maintaining water quality and water conservation.
- **Objective 3.2** – Expand public education programs at all levels with the aim of increasing general awareness of water availability issues and encourage water conservation measures.
- **Objective 3.3** – Expand public education programs at all levels with the aim of increasing general awareness of water quality and safety issues as well as benefits of having WHP areas and plans.

- **Objective 3.4** – Continue to sponsor and/or participate in natural resources workshops, county fairs, camps, workshops, and classroom presentations.
- **Objective 3.5** – Educate and encourage Best Management Practices such as soil moisture probes, evapotranspiration gauges, etc., as well as support of cost share programs.
- **Objective 3.6** – Increase educational efforts at all levels in raising awareness of hydrologically connected groundwater and surface water resources and the importance of managing resources conjunctively for water quality and quantity.
- **Objective 3.7 –** Continue to provide information and education through news articles and public service announcements, quarterly newsletters, brochures, and website.
- **Objective 3.8** – Support staff attendance at various local, state, and national meetings to educate ULNRD staff and enhance opportunities to educate the public.

GOAL 4 – THE ULNRD WILL CONTINUE TO ENCOURAGE THE USE OF CONSERVATION BEST MANAGEMENT PRACTICES AT PROTECTING WATER QUALITY AND QUANTITY.

- **Objective 4.1** – Continue to provide and administer cost-share and incentive programs aimed at protecting water quality and quantity.
- **Objective 4.2** – Connect both rural and urban property owners to existing NRD programs as well as, NRCS's Environmental Quality Incentive Program (EQIP) priority source water protection areas, to implement practices such as no-till, grassed waterways, fertilizer management, conservation techniques, and similar actions that benefit water quality and quantity.
- **Objective 4.3** – Explore and assess new conservation practices with the goal of safeguarding current and future water quality and quantity.

GOAL 5– THE ULNRD WILL UTILIZE RELATIONSHIPS WITH OTHER NRDS, NEDNR, NDEE, USGS, UNL, AND OTHER SIMILAR AGENCIES TO IDENTIFY AND CONTROL GROUNDWATER CONTAMINATION AND MANAGE OF WATER SUPPLIES.

- **Objective 5.1** – Coordinate efforts with adjacent NRDs directed at groundwater reservoir management, including exchange of data, in recognition of groundwater movement both in to and out of the NRD.
- **Objective 5.2** – Continue collaboration to share information with other organizations and agencies to conserve resources and prevent duplication of work.
- **Objective 5.3** – Conduct outreach to communities and build partnerships with NDEE to establish WHP plans.
- **Objective 5.4** – Continue active participation with NeDNR and the Lower Platte River Basin partners to develop and implement water use policies and practices that contribute to the protection of groundwater uses.

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