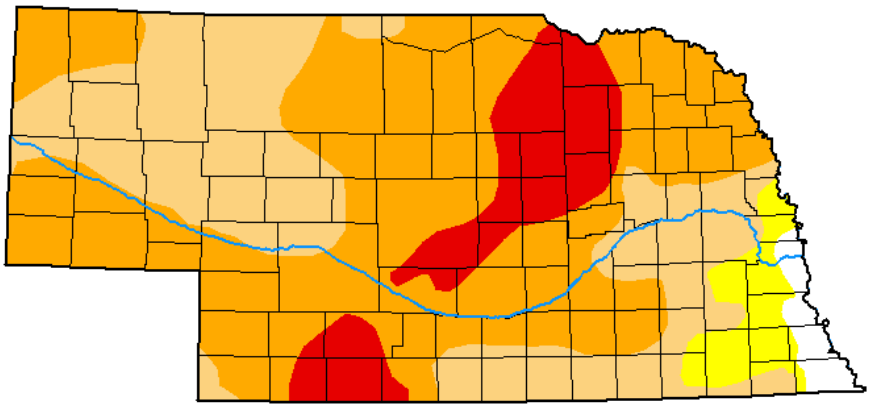
DROUGHT MANAGEMENT PLAN

LOWER LOUP NATURAL RESOURCES DISTRICT

NOVEMBER 2022



U.S. Drought Monitor Effective Map for May 3, 2022

Plan developed by
JEO Consulting Group

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Lower Loup
Natural Resources District

Drought Management Plan

Prepared: August 2022
Adopted: September 17, 2022

ACKNOWLEDGEMENTS

This drought management plan was prepared by JEO Consulting Group to help guide the Lower Loup Natural Resources District (Lower Loup NRD) in developing and implementing future projects to improve resilience to future droughts across the district. While a planning team consisting of project staff guided the effort, significant efforts were taken to involve a wide array of stakeholders to provide input and feedback during plan development.

Preparation of this plan was made possible with funding assistance provided by the Nebraska Water Sustainability Fund (WSF), which is administered by the Natural Resources Commission (Commission) to provide financial assistance to eligible projects, programs or activities that lead to sustainability of Nebraska's water resources.

PLANNING TEAM

The following individuals consisted of the project planning team:

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JEO Consulting Group

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LOWER LOUP NRD BOARD OF DIRECTORS

The Lower Loup Natural Resources District Board of Directors is made up of 21 members. The Directors are elected for four-year terms on a non-partisan basis.

The Lower Loup NRD Board of Directors meets at 5:00 p.m. on the fourth Thursday of the month at the NRD Headquarters, 2620 Airport Drive, in Ord, Nebraska. The meetings are open to the public.

At the time this plan was prepared, the following individuals were serving as Directors.

- Sub-District 1
  - Tim Bartak
  - Jim Adams
- Sub- District 2
  - Alan Petersen
  - Henry Thoene (Secretary)
- Sub-District 3
  - Todd Nitsch
  - Rollie Amsberry (Treasurer)
- Sub-District 4
  - Randy Kauk
  - Rick Vlach
- Sub-District 5
  - Dean Thede
  - Matt Lukasiewicz
- Sub-District 6
  - Jerry Smith
  - Jim Eschliman (Vice-Chairman and Nebraska Association of Resources Districts (NARD) Representative)
- Sub-District 7
  - Larry Mohrman
  - Gary Kruse
- Sub-District 8
  - Alan Vlach
  - Chad Podolak
- Sub-District 9
  - Bob Bauer
  - Beth Boesch
- Sub-District 10
  - Darwin Anderson
  - John Coffey
- At-Large
  - N. Richard Hadenfeldt (Natural Resources Commission – Loup Basin)

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AEM	Airborne Electromagnetic
BMP	Best Management Practice
BOR	Bureau of Reclamation
CFS	Cubic Feet per Second
Commission	Natural Resources Commission
CRP	Conservation Reserve Program
DAG	Drought Advisory Group
DI	Drought Indicators
DL	Drought Level
DMP	Drought Management Plan
DZ	Drought Zone
ELM SDF	Elkhorn-Loup Model Stream Depletion Factor
FEMA	Federal Emergency Management Agency
FSA	Farm Service Agency
GW	Groundwater
HMA	Hazard Mitigation Assistance
HPA	High Plains Aquifer
HUC	Hydrologic Unit Code
IAP2	International Association of Public Participation
JEO	JEO Consulting Group, Inc.

Lower Loup NRD	Lower Loup Natural Resources District
MAR	Managed Aquifer Recharge
NARD	Nebraska Association of Resources Districts
NCEI	National Centers for Environmental Information
NDEE	Nebraska Department of Environment and Energy
NDMC	Nebraska Drought Mitigation Center
NeDNR	Nebraska Department of Natural Resources
NET	Nebraska Environmental Trust
NGPC	Nebraska Game and Parks Commission
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NRD	Natural Resources District
PDSI	Palmer Drought Severity Index
RMA	Risk Management Agency
SDF	Stream Depletion Factor
SWL	Static Water Level
UNL	University of Nebraska-Lincoln
USDA	United States Department of Agriculture
USDM	United States Drought Monitor
USGS	United States Geologic Survey
VIMP	Voluntary Integrated Management Plan
WSF	Water Sustainability Fund
WFPO	Watershed and Flood Prevention Operations

EXECUTIVE SUMMARY

BACKGROUND

Drought is the second costliest natural disaster in the United States, and rural communities are especially at risk of drought's negative impacts. Drought is defined as a natural hazard resulting from a substantial period of a lack of precipitation. Although many incorrectly consider it a rare and random event, drought is, in fact, a normal, recurrent feature of climate.

This drought plan has been prepared to assist the Lower Loup Natural Resources District (Lower Loup NRD), prepare for, and mitigate against future drought. While preparation of this plan was a voluntary action taken by the NRD, it clearly falls within the 12 areas of responsibility granted to NRDs across Nebraska, by the State Legislature. Authority to implement the recommendations within this plan are also well established by Nebraska statutes, and mitigation actions identified within are in-line with other policies, plans, projects, and regulations the Lower Loup NRD has implemented.

PLAN COMPONENTS

This drought plan provides an overarching review of the risks and vulnerabilities that drought presents to the district (See Section 4), and lays out two very important components to help the NRD become more drought resilient:

1. **A Drought Response and Monitoring Protocol** (See Section 5). Identifying and responding effectively to droughts as they occur is both technically and politically challenging. This pre-established protocol will enable the NRD to proactively monitor and predict when drought conditions threaten the district, as well as better enable the district to respond in an informed, predictable, and transparent way. The protocol was developed using stakeholder input and recommendations to ensure it is specific to the needs of the residents within the NRD.
2. **Mitigation and Management Actions** (See Section 6). Drought mitigation actions were identified through stakeholder input, review of other NRD planning documents, and identification of other best management practices. These actions are presented not as a required set of actions, but as a "playbook" of options and ideas for the Lower Loup NRD to consider to increase drought resilience.

It should be noted that while Lower Loup NRD staff continuously monitor drought indicators and may recommend drought declarations or management actions, the ultimate responsibility and authority of declaring drought levels and corresponding responses rest with the Lower Loup NRD Board of Directors. This plan provides the board a guide to help make those decisions.

PUBLIC INVOLVEMENT

Development of this plan received significant guidance and feedback from the public – especially in the development of the response and monitoring protocol, and in identifying mitigation actions. The overarching purpose of these efforts were to craft recommendations that have public buy-in.

The planning process utilized industry-leading principles and strategies from the International Association of Public Participation (IAP2), which allowed for multiple levels and opportunities for stakeholder input and led to a diverse representation of perspectives throughout the planning process.

Robust stakeholder engagement and participation took place across multiple meetings (see below), where 42 stakeholders participated and provided feedback (See Section 2). Not only did this group give a good representation of the district geographically it also had varying backgrounds to give diverse perspectives. Stakeholders represented included farmers, ranchers, biologists, communities, industry, irrigation districts, emergency managers, regulatory agencies, and others.

- September 9, 2021: Drought scenario workshop
- November 30, 2021: Establishing drought monitoring and response protocols
- February 17, 2022: Establishing mitigation actions and timelines

Ultimately, this comprehensive approach has helped to strengthen and enhance relationships between stakeholders (Figure 1) that will ease implementation of drought mitigation actions and serve the district during response to future periods of drought.

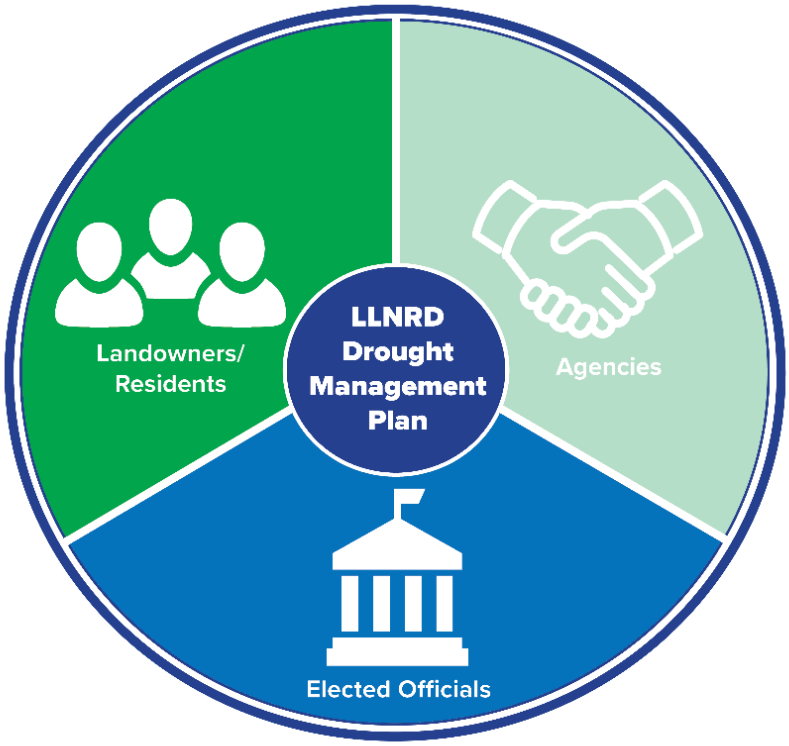


Figure 1: Relationships Established by the Planning Process

SECTION 1. INTRODUCTION

1.01 HYDRO-ILLOGICAL CYCLE

The Lower Loup Natural Resources District (Lower Loup NRD) has taken meaningful steps toward reducing vulnerability to drought since it was created by legislation in 1972. From their responsive groundwater management practices tailored to each part of their jurisdiction to numerous studies examining water quality and quantity, Lower Loup NRD leaders have prioritized drought mitigation. The development of the Lower Loup NRD Drought Management Plan (DMP) is another effort the district has undertaken to better prepare for drought.

Traditionally, many water users have reacted to drought in the manner shown in Figure 2. During normal or wet years, people are often apathetic to the possibility of drought. When a drought does occur, people are not sufficiently prepared and often respond too late. As a result, drought impacts are much more severe than if people had planned ahead. Once the drought is over, people are glad to resume business as usual. The Lower Loup NRD is attempting to break the hydro-illogical cycle by taking a proactive approach to drought planning.

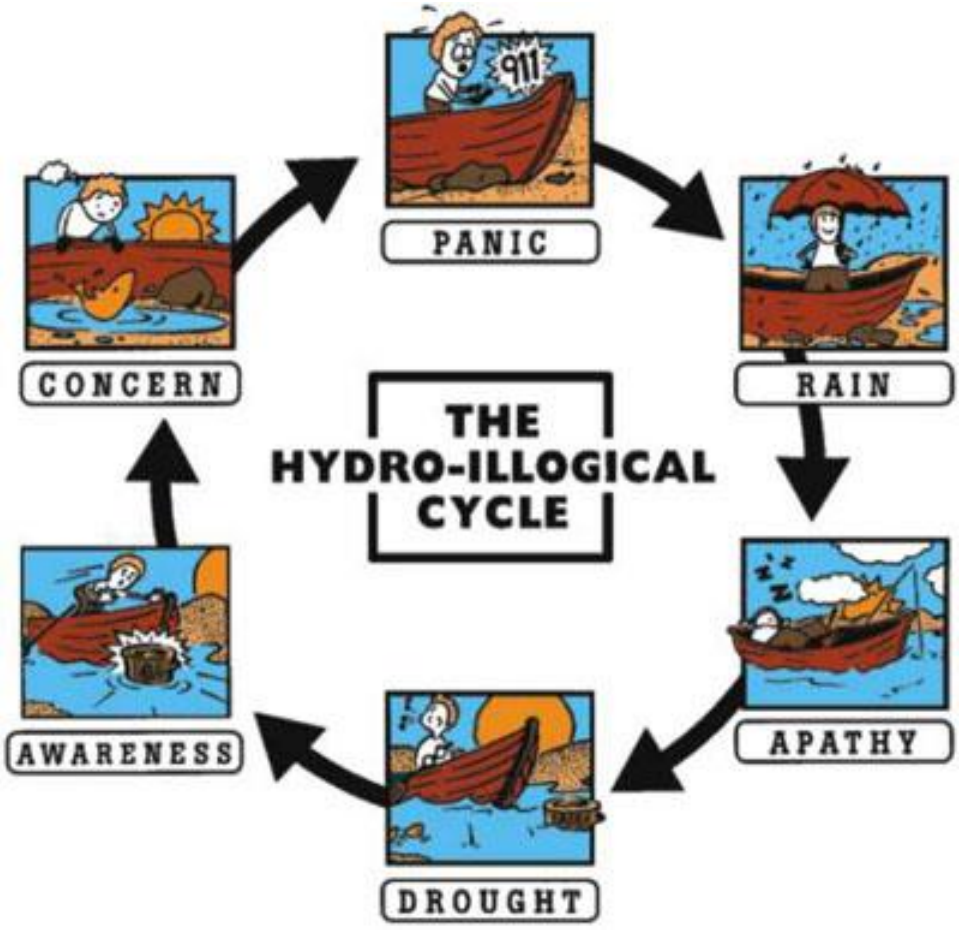


Image Source: National Drought Mitigation Center

Figure 2: The Hydro-Illogical Cycle

1.02 PLAN PURPOSE

The Lower Loup NRD Drought Management Plan's purpose is to define drought locally and identify processes to effectively respond to and manage the impacts of future drought events. The Drought Management Plan is a tool that will assist the Lower Loup NRD in long-term resource management and policy development.

This plan is intended to be a district-wide plan, thus, the analysis and management tools are presented at relatively high level. However, the recommendations and protocols have been more finely detailed to assist in the implementation of this plan and be useful at multiple jurisdictional levels.

1.03 DEFINING DROUGHT

Drought is the second costliest natural disaster in the United States with each event costing the US economy approximately 9.7 billion dollars[1]. Because of their unique features, rural communities are especially at risk of drought's negative impacts. Compared to urban areas, rural communities may have a less diversified economic base. Livelihoods often center on natural resources and ecosystem services, so a decline in water resources can have disastrous and far-reaching consequences. A lack of government capacity, limited fiscal resources for planning and mitigation actions, antiquated public infrastructure, and a limited demographic base can amplify the difficulties that smaller and more rural communities face in preparing for and responding to disasters. On the other hand, the self-reliant nature, keen sense of community, tightly connected family networks, and knowledge of and ties to natural resources—characteristics common in rural communities—can enhance drought resilience[2].

Drought is defined as a natural hazard resulting from a substantial period of a lack of precipitation. Although many incorrectly consider it a rare and random event, drought is, in fact, a normal, recurrent feature of climate. It occurs in all climatic zones, but its characteristics vary significantly from one region to another. A drought often coexists with periods of extreme heat, which together can cause significant social stress, economic losses, and environmental degradation.

Drought is typically a slow-onset, creeping phenomenon, and its impacts are environmental rather than structural. Drought normally affects more people than other natural hazards, with impacts spread over a larger geographical area. As a result, the detection and early warning signs of drought conditions and the subsequent assessment of impacts are more difficult to identify than quick-onset natural hazards (e.g., flood and severe thunderstorms) that result in more immediate impacts. In addition, drought has more than 150 definitions. The lack of a universal definition

[1] Smith, A.B., Katz, R.W. "US billion-dollar weather and climate disasters: data sources, trends, accuracy and biases." Nat Hazards 67, 387–410 (2013). https://doi.org/10.1007/s11069-013-0566-5

[2] Jedd, Theresa; Bathke, Deborah J.; Gill, Duane; Paul, Bimal; Wall, Nicole; Bernadt, Tonya K.; Petr, Jacob; Mucia, Anthony James; and Wall, Milan, "Tracking Drought Perspectives: A Rural Case Study of Transformations Following an Invisible Hazard" (2018). Papers in Natural Resources. 1277. https://digitalcommons.unl.edu/natrespapers/1277

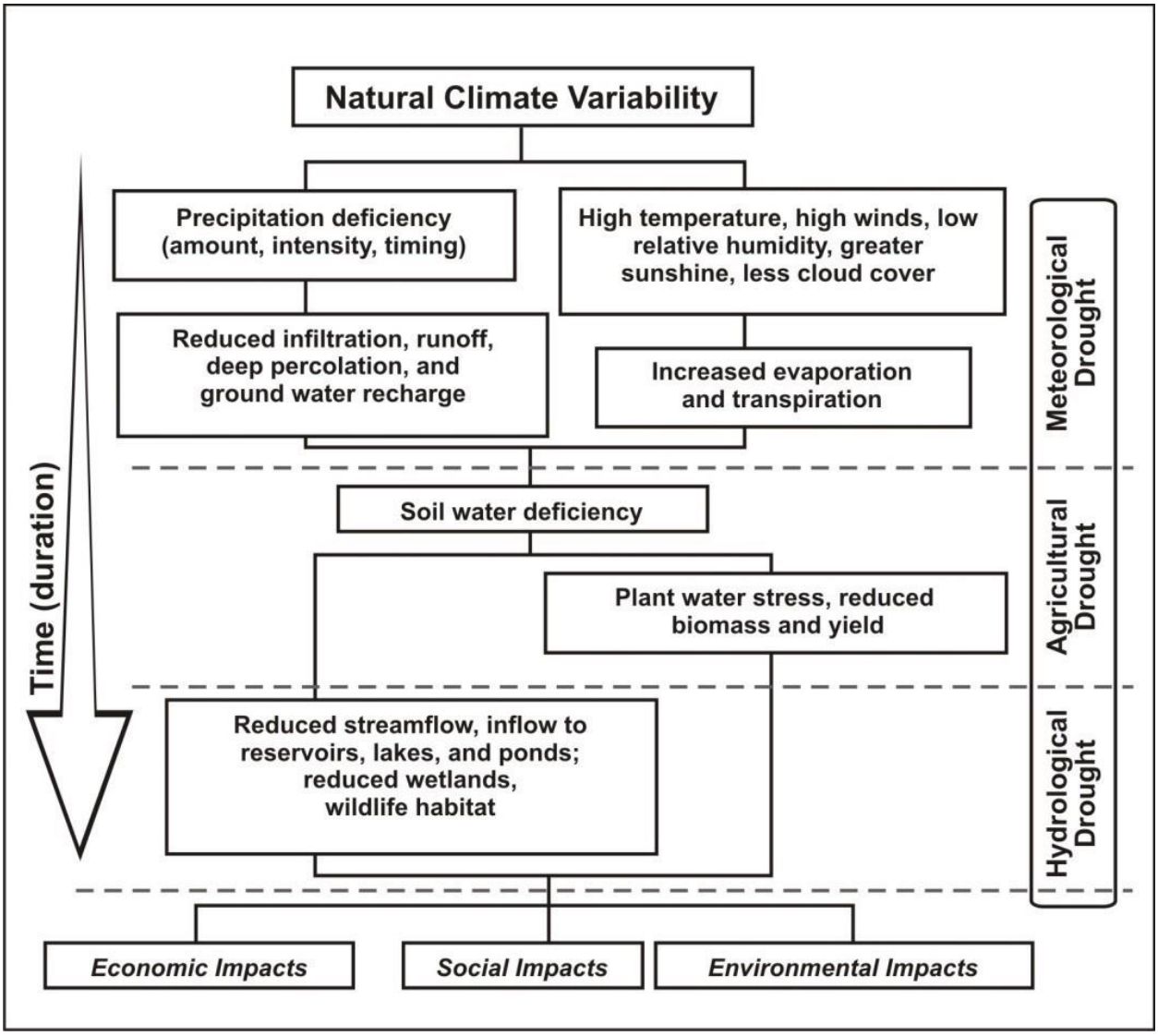
makes it even harder to indicate drought's onset and ending. According to the National Drought Mitigation Center (NDMC), droughts are classified into four major types:

- Meteorological drought is defined by the degree of dryness and the duration of the dry period. Meteorological drought is often the first type of drought to be identified and should be defined regionally as precipitation rates and frequencies ("norms") vary.
- Agricultural drought occurs when there is deficient moisture that hinders plant germination, leading to low plant population per hectare and a reduction of final yield. Agricultural drought is intricately linked with meteorological and hydrological drought as agricultural water supplies are contingent upon the two types.
- Hydrological drought occurs when water available in aquifers, lakes, and reservoirs falls below the statistical average. This situation can arise even with average precipitation. This is due to water reserves diminishing from increased water usage, usually from agricultural use or elevated levels of evapotranspiration, resulting from prolonged hot temperatures. Hydrological drought often is identified later than meteorological and agricultural drought. Impacts from hydrological drought may manifest themselves in decreased hydropower production and loss of water-based recreation.
- Socioeconomic drought occurs when the demand for economic goods exceeds supply due to a weather-related shortfall in water supply. The supply of many economic goods includes, but is not limited to water, forage, food, grains, fish, and hydroelectric power.

While most droughts occur over extended periods, flash drought is the rapid onset or intensification of drought set in motion by lower-than-normal rates of precipitation, accompanied by abnormally high temperatures, winds, and radiation. Flash droughts can cause extensive damage to agriculture, economies, and ecosystem goods and services. The flash drought of 2012 was a multi-billion-dollar disaster that is believed to be the worst drought (in terms of moderate to extreme drought coverage) since the 1950s[3].

Drought can also exacerbate the impacts of other hazards or increase their likelihood. The damage caused by these other hazards is understood as cascading impacts from drought. Drought, for example, might increase wildfire risk due to the resulting dry conditions. Drought conditions can also lead to flooding, since overly dry soil cannot absorb moisture quickly, increasing the amount of runoff, and leading to flash flooding. Droughts can also weaken trees and result in greater damage during high wind events. Figure 3 illustrates the diverse types of droughts, their temporal sequence, and the several types of effects they can have on a community.

[3] Rippey, Bradley R. "The U.S Drought of 2012." 2015. Weather and Climate Extremes. Volume 10. Part A. Pages 57-64. https://doi.org/10.1016/j.wace.2015.10.004



Source: National Drought Mitigation Center

Figure 3: Sequence and Impacts of Drought Types

SECTION 2. PLANNING & STAKEHOLDER ENGAGEMENT PROCESS

2.01 PLANNING PROCESS

Development of this plan began in 2021, following a delayed start due to the Covid-19 pandemic. The importance of stakeholder engagement in the planning process was recognized from the beginning, therefore, the planning effort did not start in earnest until in-person meetings could be safely held (Figure 4 and Figure 5). To garner robust stakeholder engagement and participation, the planning process utilized industry-leading principles and strategies from the International Association of Public Participation (IAP2).

Figure 4: Stakeholders at the Drought Management Workshop Meeting

Figure 5: Discussion Taking Place at Stakeholder Meeting #2

STAKEHOLDER SUMMARY

The stakeholder list was developed by the Lower Loup NRD staff after first reviewing stakeholder lists from previous LLNRD planning efforts (multiple watershed plans, hazard mitigation plan, and the voluntary integrated management plan). JEO staff provided input on types of stakeholders to include, such as water users, water suppliers, community leaders, regulatory agencies, and others throughout the district. LLNRD staff then recruited and led communication with the stakeholders.

A total of 42 stakeholders participated, representing a diverse cross section of district residents and natural resource professionals. A record of all stakeholders that attended meetings is presented in Table 1 (based on sign-in sheets). Invitations for each meeting were provided via mailed letters, with email and phone call follow-ups as needed.

Table 1: Summary of Stakeholder Meeting Attendees

Name	Title/Jurisdiction/Organization
Alan Bartels	Information Specialist, Lower Loup NRD
Allen Chlopek	City Administrator, Fullerton
Allen Volf	Farmer/Rancher
Andy Pedley	Environmental Specialist, NeDNR
Bill Luckey	Farmer
Bryan O'Connor	Biologist, NGPC
Caitlin Kingsley	NeDNR
Chris Hobza	Lead Hydrologist, USGS
Craig Frenzen	Farmer
David Ciancio	Farmer, Fullerton
Dick Harrington	Farmer, Loup City
Don Masten	Sales Manager, Downey Drilling Inc
Doug Reiter	Emergency Manager, Wheeler County
Hank Thoene	Director, Lower Loup NRD
Hilary Maricle	Engagement Zone Coordinator, UNL Extension
Jeramie VanLeer	Utilities Superintendent, Ord
Jerry Carder	Farmer
Jerry Smith	Director, Lower Loup NRD
Jim Adams	Director, Lower Loup NRD
Jim Janda	Field Representative, Nebraska Board of Educational Lands and Funds (BELF)
Joe Novotny	Farmer, Elyria
John Krohn	Farmer, Albion
Kirk Foster	Farmer, Janesville Farm
Lex Jeffres	Farmer, Jeffres & Sons, Inc
Logan Govier	Farmer, Broken Bow
Luke Zangger	Vice President, Zangger Popcorn

Madeline Hoffer	Office Services Manager, NeDNR
Mark McGuire	Farmer
Mark Schreiber	Farmer
Matt Jeffres	Partner, Jeffres Sand and Gravel
Matt Lukasiewicz	Director, Lower Loup NRD
Michaela Wetovick	Farmer/Rancher, Fullerton
Mick Kozeal	Mayor, Sargent
Mike Archer	Biologist, NDEE
Neal Suess	President, Loup Power District
Randy Kauk	Director, Lower Loup NRD
Reece Jensen	Administrator/Utilities Superintendent/Fire Chief, Sargent
Rich Woollen	Forester
Ryan Kelly	Integrated Water Management Coordinator, NeDNR
Skip Amsberry	Director, Lower Loup NRD
Tom Klanecky	Supervisor, NeDNR, Ord Field Office
Troy Ingram	Nebraska Ag

SUMMARY OF STAKEHOLDER MEETINGS

Multiple meetings were held throughout the planning process:

1. September 9, 2021: Drought scenario workshop
2. November 30, 2021: Establishing drought monitoring and response protocols
3. February 17, 2022: Establishing mitigation actions and timelines

The overarching purpose of stakeholder involvement is to craft recommendations that are largely identified and/or refined by stakeholder input. Stakeholder-led recommendations, particularly for drought planning, generally lead to public buy-in when the plan is implemented.

Following the IAP2 framework, the level of engagement with stakeholders increased at each meeting. This approach began with informing stakeholders about the planning process and developed to collaborating and getting feedback on recommendations within the draft plan. This process is illustrated in Figure 6. The final IAP2 level of empowerment is reserved for the Lower Loup NRD Board of Directors who will make the final decision on plan adoption and implementation.

Summaries of each meeting are provided below. Copies of meeting materials (sign-in sheets, notes, presentations, etc.) can be found in Appendix A.

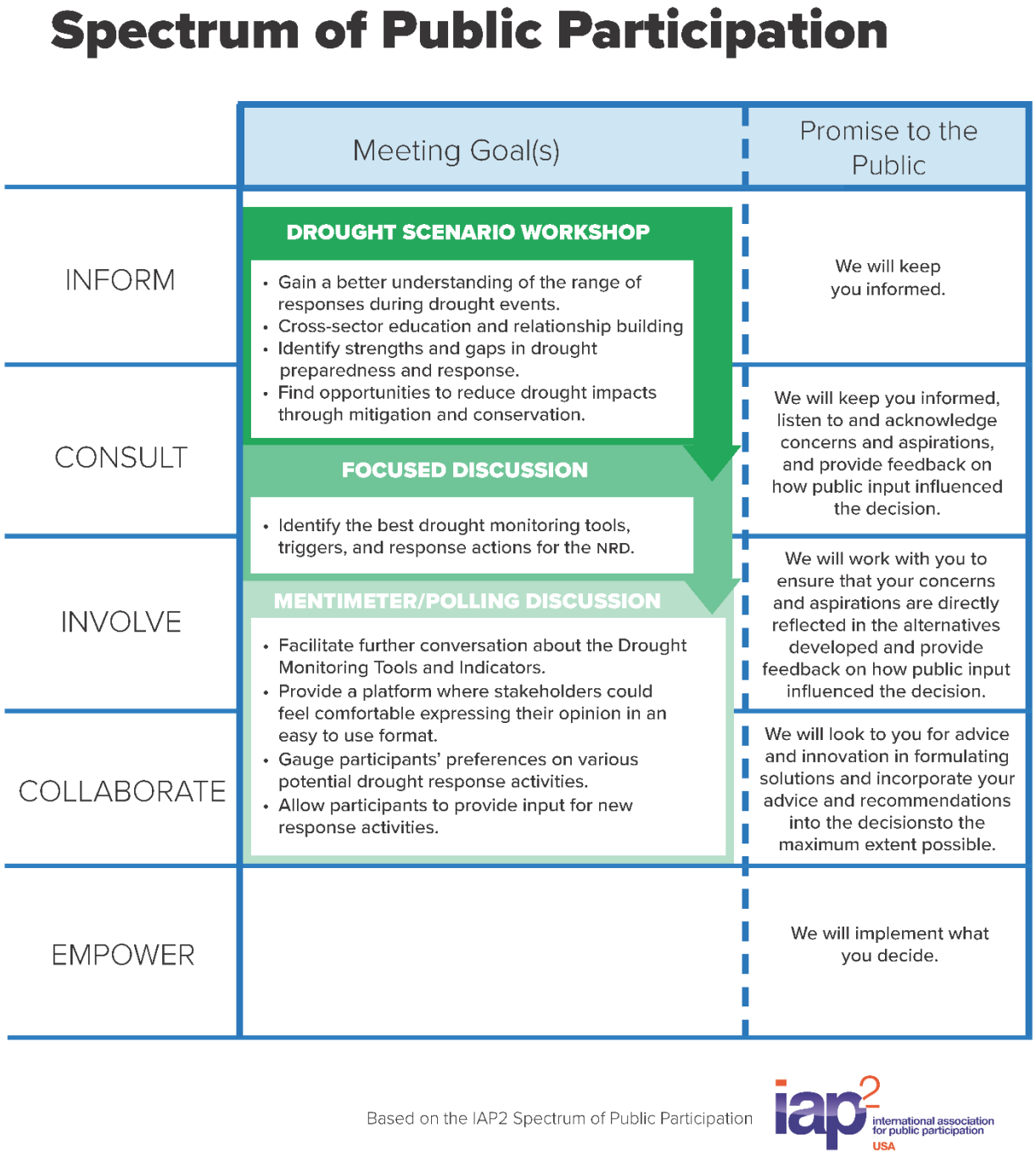


Figure 6: Illustration of the Enhanced Stakeholder Engagement Process Used

2.02 STAKEHOLDER MEETING #1

BACKGROUND

The planning team held the first stakeholder meeting, a drought scenario workshop, on September 9, 2021, in Ord, Nebraska. A total of 17 stakeholders attended the meeting. Copies of meeting materials (sign-in sheets, notes, presentations, etc.) can be found in Appendix A.

Drought scenario exercises are an innovative way to engage a wide variety of stakeholders in the planning process, especially those who do not usually participate in planning. Exercises (e.g., workshops, tournaments, tabletop exercises, games) that use scenarios—structured accounts of conditions and events—gather people together to plan and manage activities for a hypothetical event, in this case, drought. These exercises offer a way to identify and prioritize uncertainties; stimulate creative thinking for mitigation, response, and adaptation strategies; learn about differing views and perspectives of drought; and foster better communication and relationships among stakeholders[4]. The hands-on nature of these exercises make learning and collaboration more fun and compelling than a typical presentation style meeting format. What is more, they can provide a safe environment for learning, experimenting with decisions, negotiation, and consensus building among diverse stakeholders.

DROUGHT SCENARIO DEVELOPMENT

The planning team developed the drought scenario for this event based on historical data from the 2002-2003 and 2012-2013 droughts in the region. Real world data (United States Drought Monitor (USDM), USGS stream flow, etc.) were adapted for use in the scenario. Planning for this meeting centered on meeting the following objectives:

- Gain a better understanding of the range of responses during drought events
- Achieve cross-sector education and build relationships
- Identify strengths and gaps in drought preparedness and response
- Find opportunities to reduce drought impacts through mitigation and conservation
- Assist in developing a long-term vision and approach for managing natural resources

DISCUSSION SUMMARY

The planning team presented stakeholders with the drought scenario and then asked a series of questions for group discussion related to the impacts felt. Stakeholders were tasked to think about and record important response/management actions. The following questions were posed to the stakeholders.

- What is the typical response from your agency/group/entity given these circumstances?

[4] Bathke, Deborah; Haigh, Tonya; Bernadt, Tonya; and Wall, Nicole, "Drought Scenario-Based Exercises: A Research- and Experience-Based Reference Document" (2019). Publications of the National Drought Mitigation Center. https://digitalcommons.unl.edu/ndmcpub/19

- What agencies/groups do you coordinate with when drought is occurring?
- Is water conservation being encouraged at this time? If so, how and by whom?
- What actions are being taken to mitigate potential drought impacts?
- Is your entity monitoring water supplies? If so, by what means?
- What policies are enacted when drought is occurring?
- Does the price of commodities or fuel change your response and day-to-day operations?
- What management actions from various agencies are expected or necessary to mitigate drought impacts at this point?

The planning team facilitator supplemented these questions as the workshop progressed to foster a constructive conversation. The workshop consisted of five rounds of discussion as the drought scenario progressed, followed by one round of debrief discussion focused on how the regional approach to managing drought could be revised.

The following list comprises a selection of stakeholder feedback, observations, or other comments received during the first meeting. This selection represents some of the key stakeholder feedback that was used to develop the plan. For a more comprehensive summary, see Appendix A. While this is not a list of agreed-upon strategies, is a compilation of the topics or ideas brought up by one or more of the stakeholders.

- NRD is a trusted voice and needs to continue extensive data and outreach actions.
- Stakeholders need to stay in contact during drought periods.
- The more methods of communication used, the better (social media, texts, emails, phone calls, newspaper, radio, word of mouth, etc.).
- Ensure decisions are fair, equitable, and based on data.
- Producers are looking for water storage options, but dams are a polarizing topic.
- Engagement and collaboration across agencies would improve information dissemination and drought response.
- US Drought Monitor D2 drought is a trigger point for some producers to talk to the FSA office.
- Crop insurance assistance or programs are positive during times of drought – livestock feed resources can be a difficulty and relief is needed.
- Producers may not plant dryland crops and order fewer seeds.
- Conflicts potential: City vs. Urban, more control requested on urban water users.
- Technology is crucial. If technology is not being used, you are going to be behind in managing your operations during drought.
- Short term CRP option and fallowing of acres.
- Small grains may see a resurgence depending on ability to plant/harvest.
- Mental health is a continual concern.
- Continued monitoring includes phone calls, weather forecast, wind, stream gages.
- Request to not change allocation after it is officially set.

STAKEHOLDER RECOMMENDATIONS

Following the drought scenario activities and stakeholder discussion, the planning team worked with stakeholders to improve drought mitigation and response. The ideas generated by stakeholders are listed below, and as they reflect the goals and strategies of diverse stakeholders across the district, were crucial in developing the Lower Loup NRD Drought Management Plan.

- Producers and other stakeholders want access to more data and information.
- Communication during drought events will reduce conflicts and improve response.
- Common messaging is important. If multiple groups are saying the same thing, the message is validated.
- Create a group of agencies and stakeholders to coordinate drought response/management efforts.
- Work with urban areas to improve regional response.
- Push NRCS, NRD, and other agencies' available programs.
- Water storage.
- Allow producers to see how they compare to others.

2.03 STAKEHOLDER MEETING #2

BACKGROUND

The planning team held the second stakeholder meeting on November 30, 2021, in Ord, Nebraska. A total of 25 stakeholders attended the meeting. Copies of meeting materials (sign-in sheets, notes, presentations, etc.) can be found in Appendix A.

STAKEHOLDER FEEDBACK

The second stakeholder meeting focused on identifying potential drought monitoring tools, triggers, and response actions for the Lower Loup NRD. The planning team presented an overview of the planning process, as well as the following topics, to provide context for group discussion. The following is a selection of stakeholder feedback by topic, with a focus on key stakeholder feedback that was used in the development of this plan.

- Drought Monitoring Tools
    - Water quality measurements (when water quantity drops so does water quality).
    - Looking at the local economy in terms of a drop in visitors and customers.
- General Drought Response Actions
    - Actions should be implemented on a tiered basis, depending on the trigger.
    - A focus on the importance of checking the pumping rate and static water levels is important.
    - Measuring aquifer saturated thickness.
    - Collaboration among towns regarding their own water-use restriction ordinances.
    - Suggestion that the Lower Loup NRD release information on best management practices (BMPs) specific to their district.

- Lower Loup NRD Drought Response Actions
    - Would like more outreach and communication from the Lower Loup NRD (especially as part of an early warning).
    - Allocations could be used, but are not popular.
    - More metering.
    - Certified Irrigated Acres (not a preferred option).
    - Better technology and the availability of data.
    - Stream buffers and CRP are examples of true mitigation actions.
    - Potentially reduced end-gun lengths on pivots.
    - Take out some irrigated acres and provide incentives.
    - Actions should be equitable and spread around during mitigation and response, especially regarding agricultural users and manufacturing users. Also, "do not go overboard with a decision because the aquifer rebounds."
    - Actions triggered during specific stages of drought should be identified ahead of time and then followed.
- Other Feedback
    - The suggestion to ensure the Lower Loup NRD considers input from stakeholders during the implementation of drought management actions, a "drought management group," was repeatedly brought up.
        - A drought management group would be a group of stakeholders that meet when certain drought levels are hit and provide feedback on drought conditions and proposed management actions.
    - Discussion on the timing of decisions and communication of drought actions was brought up several times. The idea is to provide producers with as much warning as possible ahead of a drought or possible restrictions they will need to plan for in their business operations. The following suggestions were noted:
        - Ask for voluntary reduction in July/August and communicate that water table is dropping.
        - The timing for indicators should be March 1 or April 1.

Based on the robust discussion and input received, the planning team decided a third stakeholder meeting would be beneficial. The third stakeholder meeting would allow further discussion and refinement of ideas presented during the first two meetings.

2.04 STAKEHOLDER MEETING #3

BACKGROUND

After the second stakeholder meeting, the planning team drafted drought monitoring protocols, indicators, and response actions based on stakeholder input. A third and final stakeholder meeting was held on February 17, 2022, in Ord, Nebraska, to solicit feedback on these draft materials before they were integrated into this drought plan. A total of 26 stakeholders attended the meeting. Copies of meeting materials (sign-in sheets, notes, presentations, etc.) can be found in Appendix A.

STAKEHOLDER FEEDBACK

To help facilitate discussion about the drought monitoring protocols and response actions, the planning team used the facilitation tool Mentimeter. Mentimeter is an anonymous question and polling tool that is accessed through each participant's smartphone and provides live results for discussion during the meeting.

Stakeholders were shown the draft management actions that would be implemented by the Lower Loup NRD for each drought level. The stakeholders then voted on whether the management actions were "Not Strict Enough," "Just Right," or "Too Strict." After the voting, a discussion took place regarding any additions, changes, or thoughts people had about the various management actions. Table 2 summarizes stakeholder feedback. Overall, stakeholders supported the presented monitoring and response protocol.

Table 2: Stakeholder Polling Results

Stakeholder Response to the "Appropriateness" of the Management Actions Associated with Each Drought Level			
Drought Level	**Not Strict Enough**	**Just Right**	**Too Strict**
0: Watch	2 (8%)	22 (92%)	0 (0%)
1: Moderate	10 (40%)	14 (56%)	1 (4%)
2: Severe	14 (58%)	9 (38%)	1 (4%)
3: Extreme	7 (32%)	14 (64%)	1 (4%)

Following each round of polling, the planning team led a discussion with the stakeholders for more robust input. The following is a selection of stakeholder feedback, observation, or other comments received. This selection represents some of the key stakeholder feedback that was used in the development of this plan. For a more comprehensive summary, see Appendix A.

- The group discussed the timing of when decisions on drought actions are made and/or communicated, as a follow-up to the previous stakeholder meeting. The planning team asked stakeholders if June 1 for Drought Levels 0, 1, and 2 and March 1 for Drought Levels 3 and 4 were appropriate. Stakeholders agreed that these deadlines were appropriate and are necessary to allow irrigators and other stakeholders within the Lower Loup NRD enough time to take appropriate actions during drought periods.
- The group discussed a "drought management group" made up of stakeholders that would be activated during drought periods to help inform the Lower Loup NRD's management decisions. Stakeholders indicated their interest this group be comprised of individuals from the Farm Service Agency (FSA), UNL Extension, emergency management, Nebraska Department of Natural Resources (NeDNR), concerned citizens, irrigation districts, Loup Power District, large industries, well drillers, ground and surface water irrigators, and the National Drought Mitigation Center (NDMC).
- Additional points of discussion and stakeholder feedback included cost-share programs for flow meters, consideration of the different management zones and their levels of drought, and a reminder to consider mental health assistance during times of drought.

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SECTION 3. LOWER LOUP NRD PROFILE

3.01 LOWER LOUP NRD

The Lower Loup NRD is one of Nebraska's 23 Natural Resources Districts (NRDs). Unlike the county-wide districts found in most states, Nebraska's NRDs are based on river basin boundaries, enabling them to approach natural resources management on a watershed basis. The Lower Loup NRD is autonomous, governed by a locally elected Board of Directors. While NRDs share a common set of responsibilities, each district sets its own priorities and develops its own programs to serve local needs. The Lower Loup NRD has 12 areas of responsibility:

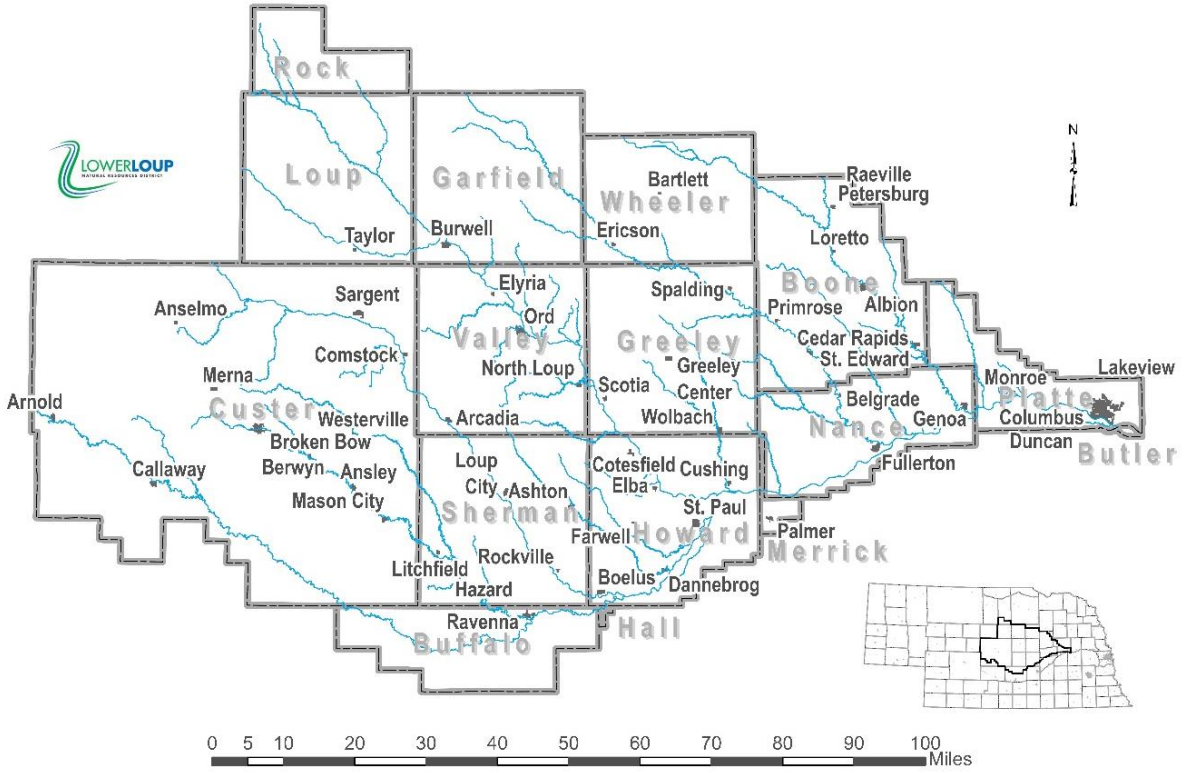
1) Erosion prevention and control
2) Prevention of damages from flood water and sediment
3) Flood prevention and control
4) Soil conservation
5) Water supply for any beneficial uses
6) Development, management, utilization, and conservation of groundwater and surface water
7) Pollution control
8) Solid 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 recreation and park facilities
12) Forestry and Range management

Nebraska Statute, Chapter 2, Article 32 establishes Nebraska's NRDs and grants them the powers and authorities that assist in their district's functioning. The Lower Loup NRD has the authority to levy property taxes to fund the district's functioning, which includes a variety of programs and incentives to facilitate the implementation of resource management activities.

The Lower Loup NRD has a wide range of statutory responsibilities and authorities, including, but not limited to, Nebraska Revised Statutes §2-3,201 through 2-3,243 and the Groundwater Management and Protection Act (Nebraska Rev. Statutes §46-701 through 46-756). Specifically, Nebraska Rev. Statutes §46-707(f) confer to the NRDs the power to "conduct investigations and cooperate or contract with ...public or private corporations, or any association or individual on any matter relevant to the administration of the [Groundwater Management and Protection] act."

The Lower Loup NRD is the largest NRD in the state (Figure 7). It is located in central Nebraska and covers 5,088,565 acres—10.3% of Nebraska—in all or parts of the following counties: Boone, Buffalo, Butler, Custer, Garfield, Greeley, Hall, Howard, Loup, Merrick, Nance, Platte, Rock, Sherman, Valley, and Wheeler. The district encompasses 514 miles of rivers, including the drainage systems of the lower reaches of the North, Middle, and South Loup River systems, as well as the Cedar and Calamus Rivers. Other major tributaries include Beaver Creek and Mud Creek.

The Lower Loup NRD is largely made up of two topographic regions: dissected plains and sandhills. Dissected plains are represented by hilly land with moderate to steep slopes and sharp ridge crests. Sandhills are hilly lands comprised of low to high dunes of sand stabilized by a grass cover.



Source: www.llnrd.org

Figure 7: Location of the Lower Loup NRD

3.02 POPULATION

Table 3 provides a summary of population trends within the Lower Loup NRD from 2010 to 2020. The percent change was used to demonstrate the general population trend across the Lower Loup NRD. This is a relatively simple method to predict population change, and it does not account for predominant age cohorts in the community, birth and death rates, or in and out migration which will likely impact the rate of growth or decline. In Table 3, the entire population of counties within the Lower Loup NRD were provided despite the fact that the district boundary only includes portion of many of these counties. This was done because the US Census Bureau does not organize data by the NRD level. The Lower Loup NRD estimates its population to be around

69,000[5] rather than the total population in Table 3.. It is important to address population trends because water use and population are positively correlated; meaning that as population increases there also is likely to be an increase in water use.

Table 3: Population Trends 2010 - 2020

County	2010 Population	2020 Population	Percent Change
Boone County	5,505	5,379	-2.3%
Buffalo County	46,102	50,084	8.6%
Custer County	10,939	10,545	-3.6%
Garfield County	2,049	1,813	-11.5%
Greeley County	2,538	2,188	-13.8%
Howard County	6,274	6,475	3.2%
Loup County	632	607	-4.0%
Merrick County	7,845	7,668	-2.3%
Nance County	3,735	3,380	-9.5%
Platte County	32,237	34,296	6.4%
Rock County	1,526	1,262	-17.3%
Sherman County	3,152	2,959	-6.1%
Valley County	4,260	4,059	-4.7%
Wheeler County	818	774	-5.4%
Total	**127,612**	**131,489**	**-**

Source: United States Census Bureau – 2000-2020[6]

**Butler, Hall, Buffalo, and Rock Counties represent very small areas of the Lower Loup NRD*

3.03 WATER SOURCES AND USE

Approximately 90% of the water consumed within the Lower Loup NRD is sourced from groundwater, whereas surface water accounts for approximately 10% of water consumption. Lower Loup NRD Figure 8 shows the location of surface water appropriations throughout the district.

[5] "LLNRD Sub-Districts 2020 Census." Lower Loup Natural Resources District. https://www.llnrd.org/assets/site/SubDistricts_2020Census_Poster24x36.pdf

[6] "Population Data." United States Census Bureau, 2000-2020. https://www.census.gov/topics/population/data.html

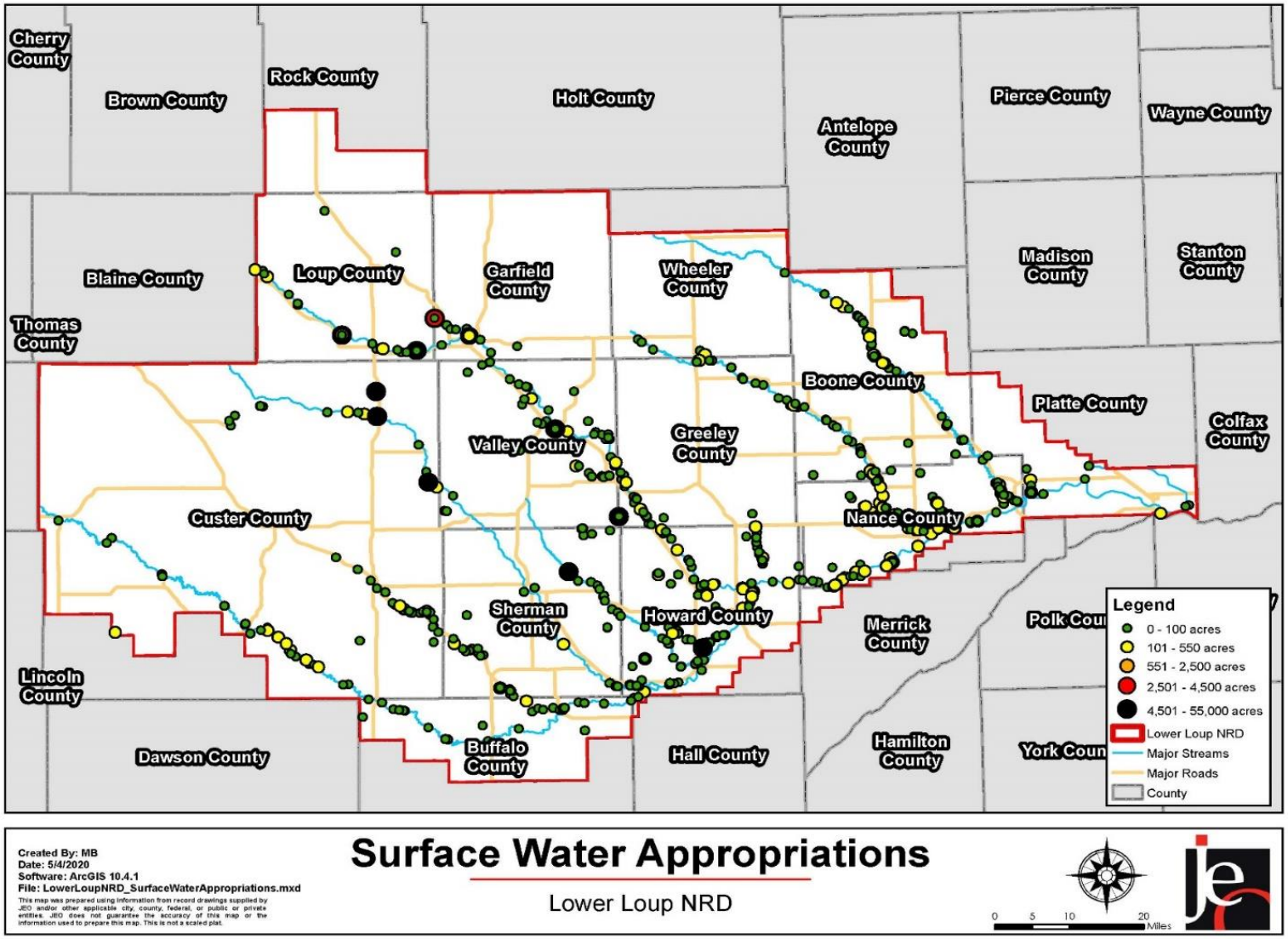
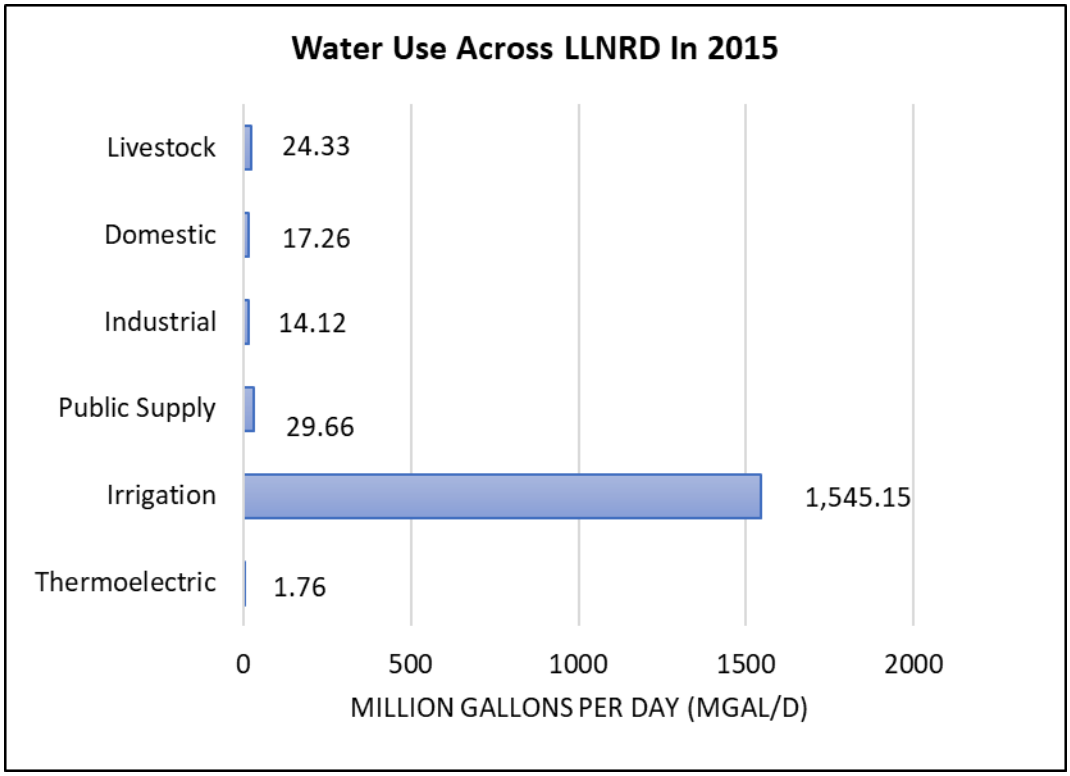


Figure 8: Surface Water Appropriations

As shown in Figure 9, the total water used in the Lower Loup NRD is 1,632.28 million gallons per day (Mgal/d). Irrigation use accounts for the overwhelming majority of water use within the Lower Loup NRD, followed by public supply. Irrigation use is seasonal in nature, with peak demands occurring (depending upon the year) during the timeframe of late June through mid-September.



Source: USGS, 2015 Water Use by County[7,8]

Figure 9: Water Use in the Lower Loup NRD (Mgal/d)

While irrigation uses the most water, it also benefits the Lower Loup NRD. The number of irrigated acres has increased across the district over time. As more acres are irrigated, recharge occurs on that irrigated ground. Because of this, irrigation can be seen as a useful tool for resource managers, as it can be allocated or restricted according to drought conditions.

The Lower Loup NRD had 19,196 active registered wells (all uses) as of March 2022 (Table 4). The registration of newly constructed domestic wells was not required until 1993; therefore, the actual number of wells within the district is likely higher, as many of the older constructed wells have never been registered but are still in service. Most wells are used for irrigation (53.64%), domestic use (18.28%), livestock (16.33%), and monitoring (6.32%).

[7] Dieter, Cheryl A., Molly A. Maupin, Rodney R. Caldwell, Melissa A. Harris, Tamara I. Ivahnenko, John K. Lovelace, Nancy L. Barber, and Kristin S. Linsey. "Estimated Use of Water in the United States in 2015." United States Geologic Survey, June 19, 2018. https://pubs.er.usgs.gov/publication/cir1441.

[8] "USGS Water Use Data for Nebraska." National Water Information System. United States Geologic Survey. https://waterdata.usgs.gov/ne/nwihttps://waterdata.usgs.gov/ne/nwis/.

Table 4: Registered Wells in the Lower Loup NRD

Registered Well Type	Percentage of Wells by Use	Number of Wells by Type
Irrigation	53.64%	10,294
Domestic	18.28%	3,509
Livestock	16.33%	3,136
Monitoring (Groundwater Quality)	6.32%	1,213
Ground Heat Exchanger	1.66%	318
Injection	0.93%	178
Other	0.78%	150
Commercial/Industrial	0.72%	139
Observation (Groundwater Levels)	0.59%	114
Recovery	0.44%	84
Heat Pump Well	0.10%	19
Pit (Excavation)	0.08%	15
Aquaculture	0.07%	13
Dewatering	0.07%	13
Geothermal	0.01%	1

Source: NeDNR, 2022[9]

3.04 INSTREAM FLOW RIGHTS

Nebraska's administrative system overseeing the orderly use of the State's surface water resources is administered by the NeDNR. All uses require a water right, which is granted through a state permit, and which has certain limitations and conditions associated with it. There are multiple types of surface water diversions, however, most are for irrigation, hydropower, and industrial use. There is also a certain type of water right that can be used to protect the flow of streams for recreation, fish, and wildlife – these are known as instream flow water rights. There are two instream flow water rights, located within or downstream of the Lower Loup NRD that need to be taken into account by this plan

- Platte River near Louisville, NE - held by NGPC
- Loup River near Cushing, NE - held by Lower Loup NRD.

[9] "Registered Groundwater Wells." Groundwater Data. Nebraska Department of Natural Resources, 2022. https://dnr.nebraska.gov/data/groundwater-data

NGPC's instream flow right on the Platte River begins at the confluence of the Platte River and the Elkhorn River and ends at the mouth of the Platte River. The priority date of the water right is November 30, 1993. The flow at USGS stream gage 06805500 near Louisville is used to monitor and administer this water right. The flows administered under this right vary by season but range from 3,100 CFS to 3,700 CFS; and are used to maintain fish communities.

Lower Loup NRD's instream flow right on the Loup River (Figure 10) begins at the confluence of the North and Middle Loup Rivers (near Cushing) and ends at the Loup Power Canal Diversion (west of Genoa). The priority date of the water right is July 28, 2017. The combined flows of USGS stream gages 06790500 and 0678500 near St. Paul are used to monitor and administer this water right. The flows administered under this right vary by season but range from 1,600 CFS to 2,400 CFS; and are used to maintain the fish community and for recreation.

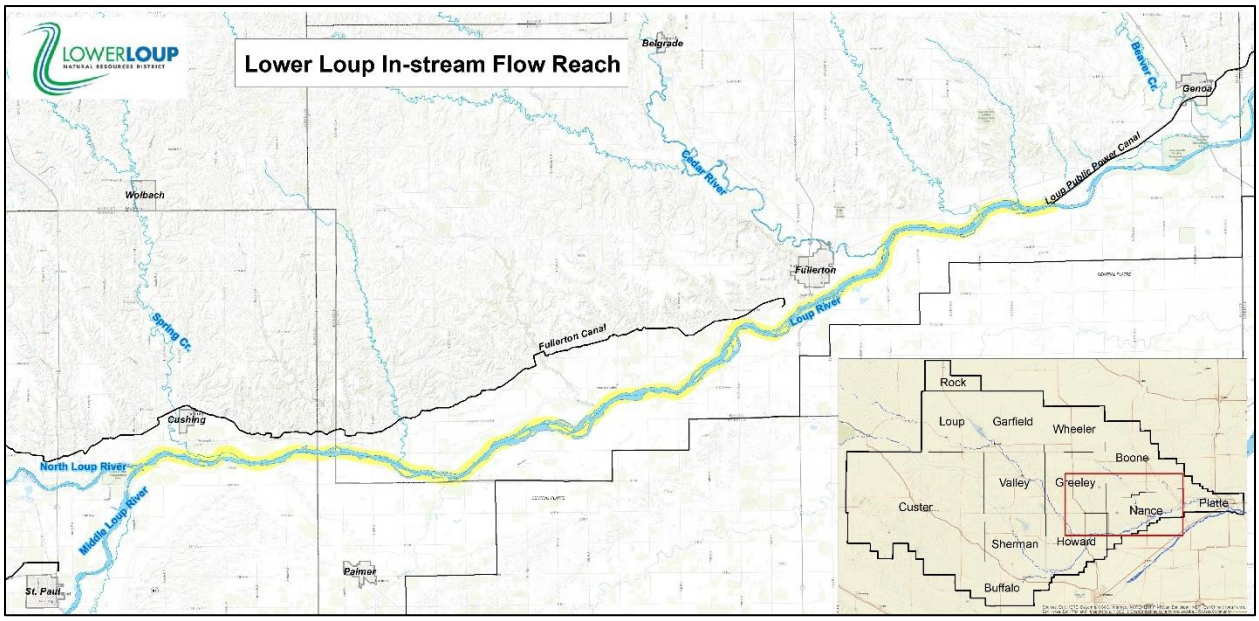


Figure 10: Location of the Lower Loup NRD Instream Flow Right on the Loup River

3.05 DROUGHT RELATED PLANNING EFFORTS

Below are actions, projects, and programs that the Lower Loup NRD has already, or is in the process of, taking to reduce the negative impacts from drought; directly or indirectly. Many of these projects serve multiple purpose objectives on top of reducing drought impacts and show how actions can have wide ranging benefits. Unless specified below, copies of each of the following reports, plans, or studies can be obtained by contacting NRD staff, or through the Lower Loup NRD's website:

https://www.llnrd.org/forms/regulations-and-plans.html

SPRING STATIC WATER LEVEL MONITORING PROGRAM

The Lower Loup NRD collects groundwater level data annually every spring. Data from 1982 represents the benchmark year to compare groundwater level changes. The most recently available data are available within the *2022 Spring Static Water Level Report*. That report found that the largest concentration of decreasing water levels is in southern Custer County and northern Buffalo County, south of the Loup River. Conversely, it shows major increases in water levels in Valley County where recharge is abundant. Additional discussion and data are presented in Section 4 of this plan.

MULTI-JURISDICTIONAL HAZARD MITIGATION PLAN

The *Lower Loup Natural Resources District Multi-Jurisdictional Hazard Mitigation Plan* was prepared in 2022 and specifically addresses hazards including drought, and subsequently proposes mitigation actions to reduce the risk from drought at the regional and local level.

MASTER PLAN

The *Lower Loup Natural Resources District Master Plan (2012 – 2022)* describes the district and outlines the NRD's goals and objectives. Actions within the Master Plan aim to address the 12 areas of responsibility previously presented. Projects identified within the Master Plan will be consistent with the projects identified within this Drought Management Plan. The Master Plan is updated by the Lower Loup NRD every ten years.

LONG-RANGE IMPLEMENTATION PLAN

The *Long-Range Implementation Plan* is updated yearly and gives the goals and objectives from the Lower Loup NRD's Master Plan timelines for completion, priority ranking, and necessary financial obligation. The Long-Range Implementation Plan is updated on an annual basis.

GROUNDWATER MANAGEMENT PLAN

The *Groundwater Management Plan (1985)* serves as a foundation for decision-making and managing groundwater resources within the district. The plan creates rules and regulations for the enforcement of the Nebraska Groundwater Management and Protection Act. Sections within the plan include groundwater use in fully and over appropriated areas, groundwater quality management controls, groundwater supply management controls, and the chemigation program. The plan also separates the district into 30 groundwater quality management areas to better identify specific groundwater issues and implement controls. The plan covers groundwater, surface water, groundwater monitoring, water quality, and conservation.

Lower Loup NRD Groundwater Rules and Regulations allow any person to transfer groundwater irrigation rights from one location to another if the acres are certified by the district. Transfers can only occur downstream or to the adjacent section and cannot have a net increase impact on any stream. Acre transfers are only allowed to occur once per year. The deadline for application for transfer is March 1 of each year.

LOWER PLATTE RIVER BASIN-WIDE WATER MANAGEMENT PLAN

The first increment of the *Lower Platte River Basin Coalition Basin-Wide Water Management Plan* was prepared in 2017. The plan, annual reports, and other related materials can be found on the DNR website: https://dnr.nebraska.gov/water-planning/lower-platte-basin-wide-plan

The plan was developed by the Lower Platte South NRD, Lower Platte North NRD, Lower Elkhorn NRD, Upper Elkhorn NRD, Lower Loup NRD, Upper Loup NRD, and Papio-Missouri NRD to provide guidance and a framework for water-use policies and practices that protect existing surface and groundwater resources, while allowing for future water development. Goals of the plan include:

- Provide guidance and a framework for Coalition members to develop water use policies and practices that contribute to the protection of existing surface and groundwater uses, while allowing for future water development.
- Assist in the development and maintenance of a water supply and use inventory, based on the best available data and analysis.
- Provide consistency and information for incorporation into individual NRD Integrated Management Plans.

Every year the Lower Loup NRD prepares a report documenting water use activities in the district as they relate to the coalition's plan. This report also identifies several of the NRD's management protocols that have been useful in returning and protecting flows to the lower Platte River and its tributaries, including, but not limited to:

- Water transfers
- Water banking
- Conversion of surface to groundwater irrigation
- Acre rotations
- Depletion accounting
- Other projects and studies

In 2022, an addendum to the Basin Plan was adopted which added a new drought related objective and four action items, under Goal 2:

Objective 4. Evaluate impacts of new development during drought condition.

A) Evaluate the balance of water supplies and uses during droughts and the potential impacts of new uses on this balance.
B) Evaluate the hydrologic impacts of drought planning activities in the basin (NRD drought plans and mitigation strategies and other plans).
C) Evaluate the hydrologic impacts of surface water administration activities through examination of closing notices issued by NeDNR.
D) Evaluate other management tools that may be available to mitigate impacts from new water uses during droughts.

VOLUNTARY INTEGRATED MANAGEMENT PLAN

The *Voluntary Integrated Management Plan* (VIMP), completed in 2016, provides a framework for how the Lower Loup NRD and NeDNR will work collaboratively to manage groundwater and surface water within the district. Unlike other districts, the Lower Loup NRD volunteered to initiate an IMP. Since the Lower Loup NRD is not in a fully appropriated basin, the goals, objectives, and action items were written with their unique designation in mind. Should their appropriation designation change, the VIMP will be updated. The plan works toward attaining or maintaining a balance between water users and water supplies.

The VIMP identifies two main action items to help the district manage ground and surface water. First, the Groundwater Action Item establishes a limit on the expansion of groundwater irrigated acres. Those in the district must contact the Lower Loup NRD to apply for new groundwater irrigated acres or to increase existing groundwater irrigated acres. Per the VIMP:

> *The limit established on the expansion of groundwater irrigated acres is for agricultural production land irrigated from a new groundwater source, typically an irrigation well, and does not include test holes, replacement wells, water wells constructed to pump 50 gallons per minute or less, monitoring or observation wells, wells constructed for the purpose of contamination treatment, municipal, industrial, or commercial wells. (9)*

Secondly, the VIMP details the Surface Water Action Item that establishes a limit on the expansion of surface water irrigated acres:

> *The annual limit on the expansion of surface water irrigated acres shall be a maximum of one-third of the amount the Lower Loup NRD will allow for the expansion of groundwater irrigated acres. NeDNR will utilize the number of additional groundwater irrigated acres in place in the VIMP area as of January 1 of each year for determining the number of additional acres for surface water irrigated for each calendar year. The limit established on the expansion of surface water irrigated acres is for agricultural production land irrigated from a new surface water appropriation and does not include other types of irrigation use, municipal use, or industrial use. (9-10)*

WATERSHED MANAGEMENT PLANS

The Lower Loup NRD has developed several watershed management plans. While the goals of these plans is to improve water quality within each respective watershed, they recognize the connection between water quantity and water quality. These plans provide a strategy for the voluntary implementation of agricultural best management practices (BMP). These BMPs can both improve water quality, water use efficiency, and have an impact on groundwater and surface water use. The following plans have been prepared to date:

- *Clear Creek-Pibel Lake Watershed Water Quality Management Plan* (2016)
- South Loup River Watershed Management Plan (2017)

3.06 COMMUNITY PLANNING EFFORTS

Community level planning efforts are largely the responsibility of cities and villages located within the district. However, coordination or consistency between efforts of these local jurisdictions with Lower Loup NRD policies can help to increase the drought resilience of the whole area. The following types of community plans were identified, and each should be considered for future opportunities to integrate plans with those of the Lower Loup NRD, such as this drought plan.

EMERGENCY RESPONSE PLANS FOR COMMUNITY WATER SYSTEMS

An Emergency Response Plan is a documented strategy describing actions that a community water system would take in response to various major events, including drought. The list of Emergency Response Plans from community water systems reviewed can be found in Appendix B.

COMPREHENSIVE PLANS

A comprehensive plan sets forth a vision and goals for a community's future and provides the overall foundation for all land use regulation within their jurisdiction. They commonly contain references to water quality and quantity and outline how communities plan to respond in case of drought or during an emergency. The list of comprehensive plans reviewed can be found in Appendix B.

Comprehensive plans are generally developed independently from one another and do not require coordination with the Lower Loup NRD. While wide-ranging in their scope, these comprehensive plans do not include enforcement mechanisms, limiting their utility, unless additional zoning regulations or other accompanying ordinances are also adopted.

Most of these local plans do not include defined triggers for drought, making the decisions to declare drought and enforce water restrictions more difficult. Drought declarations are typically politically challenging decisions as the declaration may impact some in the community economically. Pre-established triggers can help ease political pressure and enable decision makers to formulate an informed decision regarding a drought declaration. As most communities have diverse (or lacking) definitions of drought or triggers for water-use emergencies, the Lower Loup NRD Drought Management Plan could act as a comprehensive tool to coalesce these disparate efforts, improving plan integration and drought mitigation implementation.

WELLHEAD PROTECTION PLANS

Wellhead protection plans attempt to proactively protect and manage the source of community drinking water from potential contaminants. Wellhead protection plans often recommend specific actions that can be taken to protect water quality. Table 5 shows communities within the Lower Loup NRD that have a state-approved wellhead protection plan, as of May 2013.

Table 5: Wellhead Protection Plans in the Lower Loup NRD

Community	Date Approved
City of Albion	6/18/2004
Village of Ansley	1/29/2007
City of Loup City	12/17/2002
Village of Palmer	5/1/2006
Village of Primrose	6/7/2004
City of Ravenna	11/24/2004

Source: NDEE, State Approved Wellhead Protection[10]

[10] "Wellhead Protection (WHP)." Focus on Water. Department of Environment and Energy. http://deq.ne.gov/NDEQProg.nsf/OnWeb/WHPA

SECTION 4. RISK AND VULNERABILITY ASSESSMENT

This section describes the unique characteristics of the Lower Loup NRD that affect its risk and vulnerability to future drought events. The risk assessment provides the factual basis for developing specific strategies to mitigate drought impacts. This section contains a description of historical drought occurrence and extent, previous drought impacts and damages, probability of future occurrences, and a vulnerability assessment.

4.01 HISTORICAL DROUGHT OCCURRENCE AND EXTENT

PALMER DROUGHT SEVERITY INDEX

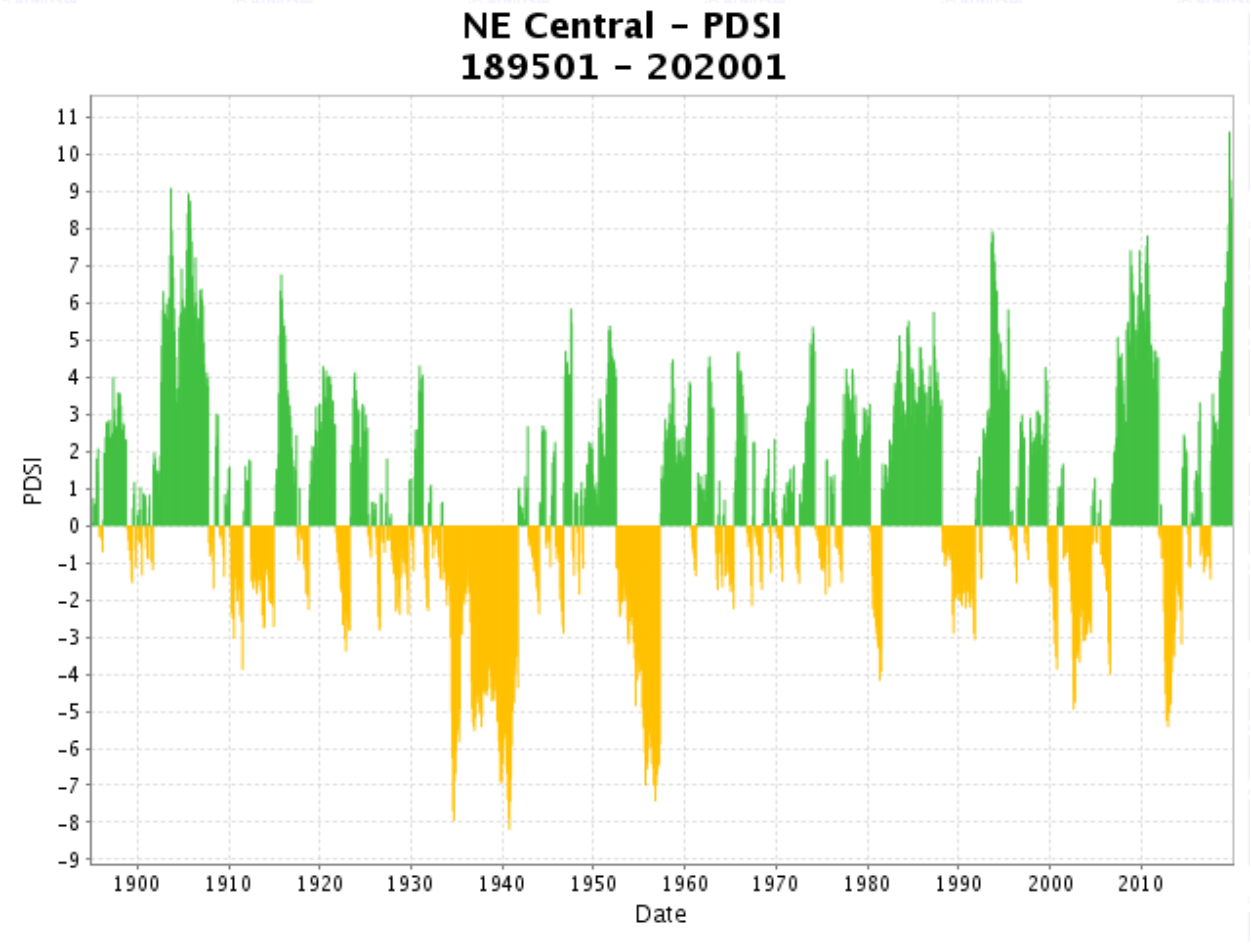
The Palmer Drought Severity Index (PDSI) was used to document historical occurrence and extent of drought across the Lower Loup NRD since 1895 (Figure 11). Among the various indices, the PDSI has been widely used by state and local governments in the United States. Table 6 depicts the percentage of months the district has experienced each level of drought classification, as defined by PDSI. An interesting observation from the PDSI data is that "Exceptional Drought" occurs more frequently than either "Extreme" or "Severe" drought. To help put level in context - the last occurrence of an exceptional drought in the district took place in 2012. Following that drought groundwater took several years to recover, which highlights the incredible impacts drought can have.

Table 6: Historical Drought Occurrence in the Lower Loup NRD

Drought Classification	PDSI Range	Total Occurrences in Month	Percent of Months
Drought	-1.0 or Less	224/1,504	14.9%
Mild Drought	-1.0 to -1.99	188/1,504	12.5%
Moderate Drought	-2.0 to -2.99	100/1,504	6.6%
Severe Drought	-3.0 to -3.99	49/1,504	3.3%
Extreme Drought	-4.0 to -4.99	41/1,504	2.7%
Exceptional Drought	-5.0 or Less	66/1,504	4.4%

Source: NCEI, PDSI 1895 to 2020[11]

[11] "Palmer Drought Severity Index Divisional Data." Historic Palmers. National Centers for Environmental Information. https://www.ncei.noaa.gov/access/monitoring/historical-palmers/



Source: PSDI 2020[12]

Figure 11: Palmer Drought Severity Index for Central Nebraska

USDA SECRETARIAL DISASTER DESIGNATIONS

Past drought events across the Lower Loup NRD have resulted in United States Department of Agriculture (USDA) Secretarial Disaster Designations, most recently in the following areas:

- In 2012 and 2013, drought was designated in all counties (Figure 12 and Figure 13).
- In 2014, drought was designated in all counties except Boone, Platte, and Nance Counties (Figure 14).
- In 2016, Buffalo County was the only county included in a designation.

[12] "Nebraska, Climate Division 2 Palmer Drought Severity Index (PDSI)." Climate at a Glance: Divisional Time Series. National Centers for Environmental Information: National Oceanic and Atmospheric Administration. https://www.ncei.noaa.gov/cag/divisional/time-series/2502/pdsi/1/7/1895-2020

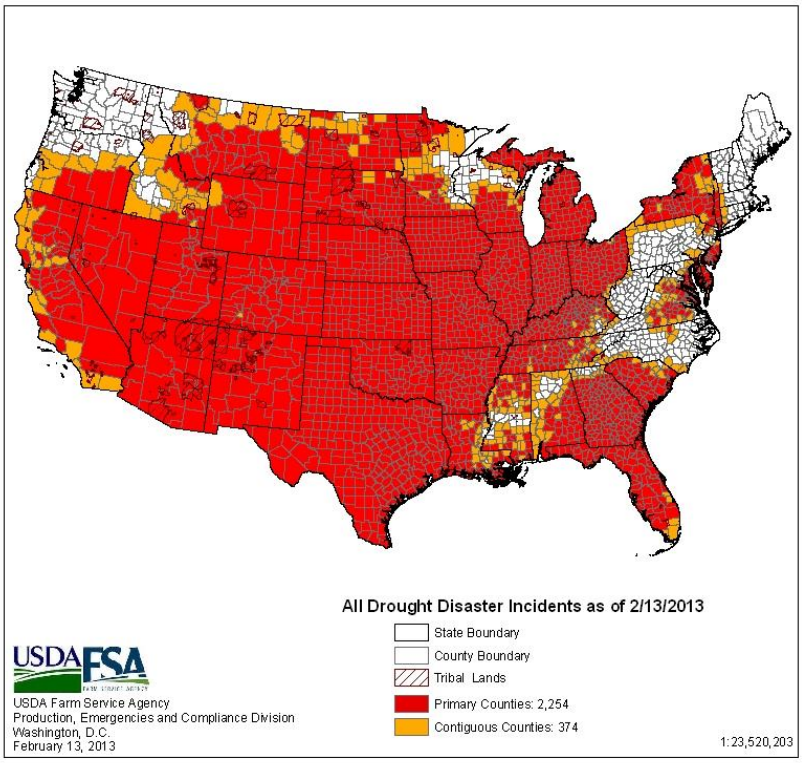


Figure 12: 2012 USDA Drought Designations

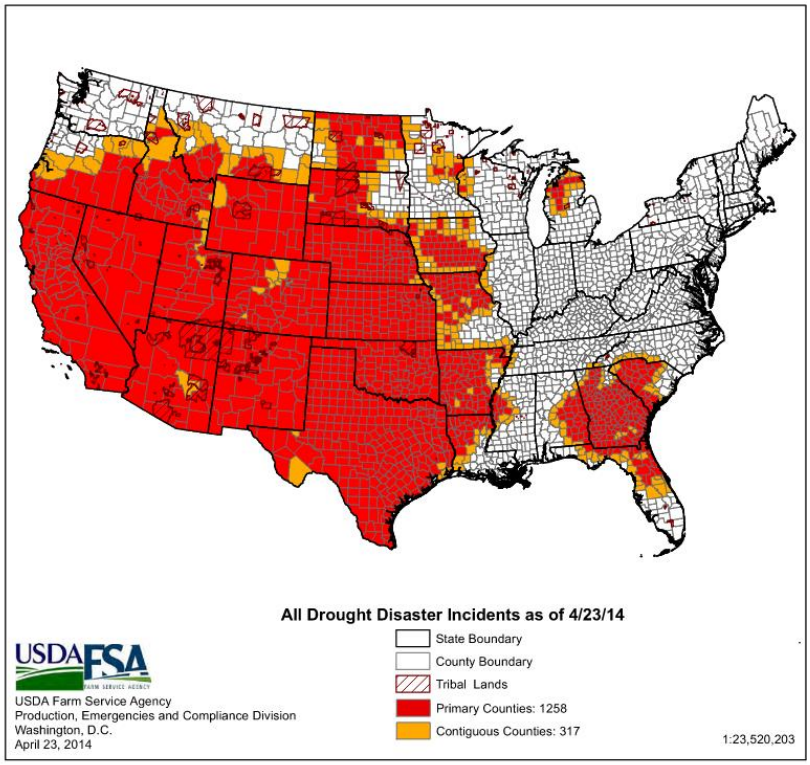


Figure 13: 2013 USDA Drought Designations

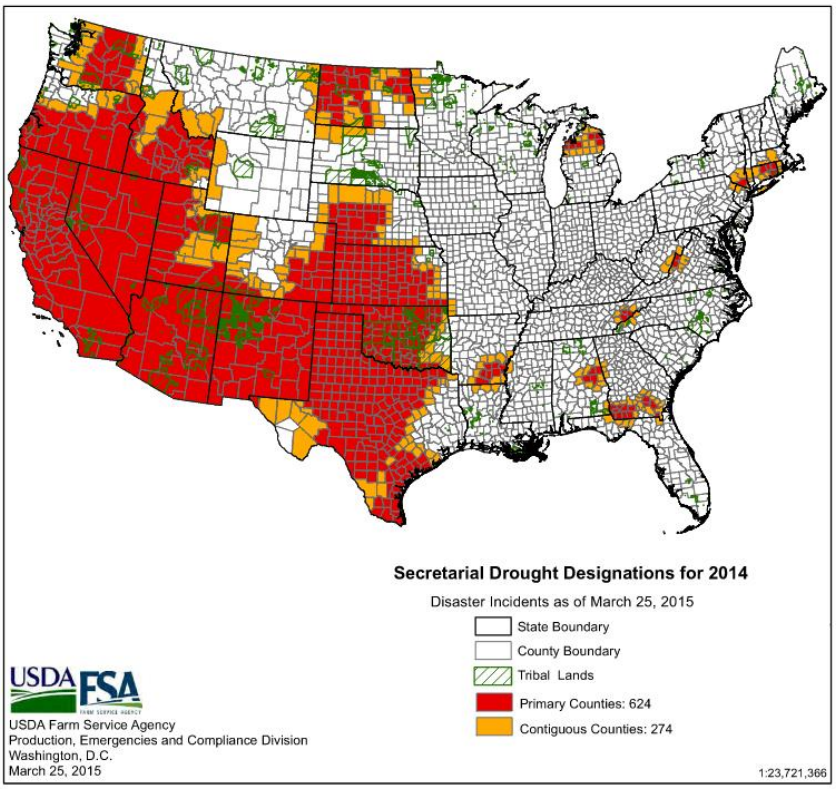


Figure 14: 2014 USDA Drought Designations

4.02 PAST DROUGHT IMPACTS

Drought causes significant economic, environmental, and social impacts. Drought impacts several sectors including agriculture, rural and municipal water supplies, fish and wildlife, tourism, recreation, water quality, soil erosion, the incidence of wildfires, electricity demand, and other sectors. Drought can also indirectly impact personal and business incomes, tax revenues, unemployment, and other areas as well.

The National Drought Mitigation Center's (NDMC) Drought Impact Reporter documents the impacts of drought throughout the United States. Table 7 summarizes, by category, the impacts within the Lower Loup NRD from 2010 to 2020. Many of these reported impacts have been in the agricultural sector.

Table 7: Reported Drought Impacts (2010 to 2020) within the Lower Loup NRD

Agricultural	Business & Industry	Energy	Fire	Plant & Wildlife	Relief, Response, & Restrictions	Society & Public Health	Tourism & Recreation	Water Supply & Quality
32	0	0	5	18	29	6	5	16

Source: NDMC – Drought Impact Reporter[13]

According to the Drought Impact Reporter, from 2010 to 2020 there have been 111 impacts reported in the Lower Loup NRD. During the 2012 drought, more than 1,100 surface irrigators across the state received a notice from NeDNR to stop pumping surface water.[14] However, the Lower Loup NRD did not receive any reports of well issues during the 2012 drought.

[13] "Drought Impact Reporter Dashboard." National Drought Mitigation Center, University of Nebraska. https://www.arcgis.com/apps/dashboards/46afe627bb60422f85944d70069c09cf

[14] Laukaitis, Algis. "State Orders Irrigators to Stop Pumping Water." Lincoln Journal Star, July 13, 2012. https://journalstar.com/news/state-and-regional/govt-and-politics/state-orders-irrigators-to-stop-pumping-water/article_98391404-9487-50b1-9820-323a19f94f42.html.

GROUNDWATER LEVEL IMPACTS

While the Lower Loup NRD did not receive reports of well issues, the drought of 2012 clearly affected water levels across the district. When considering extreme drought scenarios, this event demonstrates the hazard's ripple effects. Figure 15 shows the changes in water levels from 1982 until 2013.

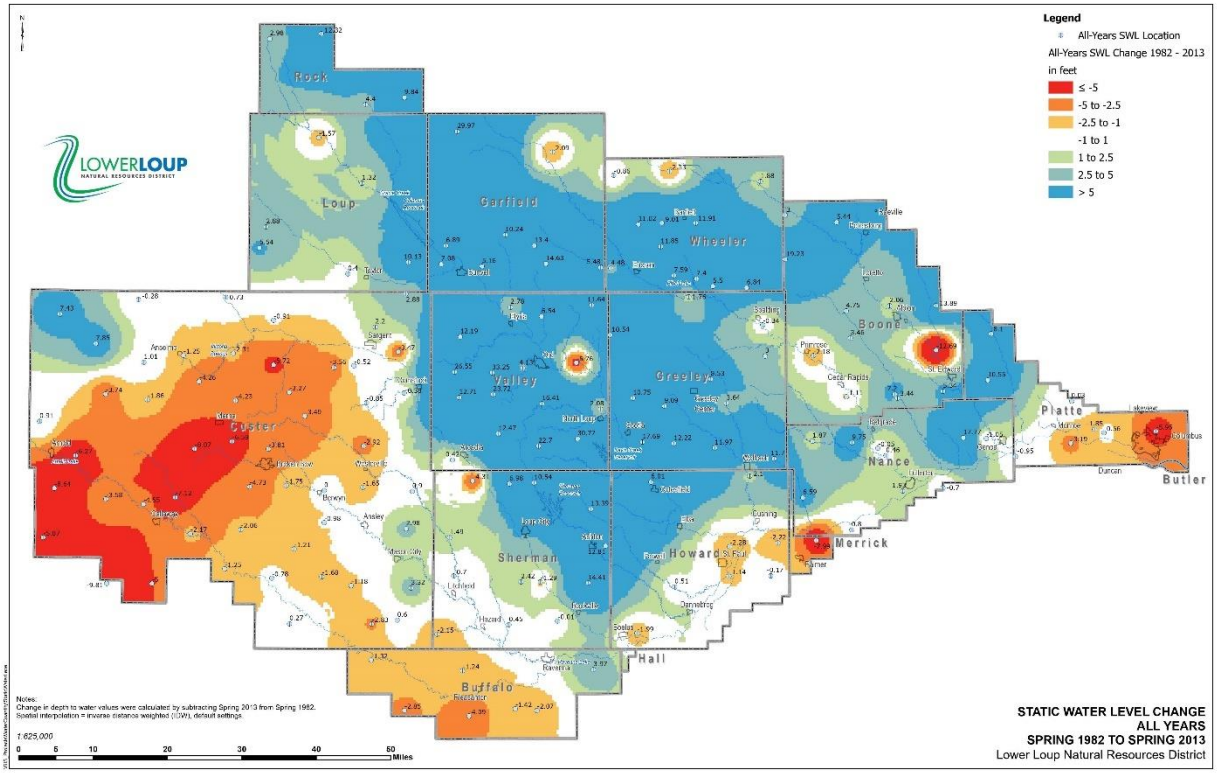


Figure 15: Groundwater Level Change Map (1982 – 2013)

STREAMFLOW IMPACTS

Because the Lower Loup NRD is comprised of diverse landscapes, each region can experience unique drought impacts. Table 8 summarizes information on all the stream gages located within the NRD.

Table 8: Stream Gages within the Lower Loup NRD

Stream Gage	Nearest City	Active	Owner	Years Operable
Beaver Creek	Genoa	Yes	USGS	1940
Beaver Creek	Loretto	Yes	DNR	1944
Calamus River	Harrop	Yes	DNR	1932
Calamus River	Burwell	Yes	DNR	1940
Cedar	Spalding	Yes	DNR	1945-1953, 1957-present
Cedar River	Fullerton	Yes	DNR	1931-1932, 1940-present
Loup River	Columbus	Yes	DNR	1894-1915, 1931, 1933-1978, 2008-present
Loup River Power Canal	Genoa	Yes	USGS	1937
Loup River Power Canal Return	Columbus	Yes	DNR	2000
Middle Loup River	St. Paul	Yes	USGS	1928
Middle Loup River	Rockville	Yes	DNR	1955-1964, 1967-1975, 2015-present
Mira Creek	North Loup	Yes	DNR	1979
Mud Creek	Sweetwater	Yes	DNR	1946
North Loup River	St. Paul	Yes	USGS	1928
North Loup River	Taylor	Yes	USGS	1936
North Loup River	Ord	Yes	DNR	1936-1938, 1948-present
South Loup at Arnold	Arnold	Yes	USGS	2010
South Loup River	Saint Michael	Yes	USGS	1943
Turkey Creek	Dannebrog	Yes	DNR	1966
Burwell-Sumter Canal	Burwell	No	DNR	1939-present
Calamus Fish Hatchery Inlet	Calamus Reservoir	No	DNR	1994-present
Canal No. 1 Pump	Sargent	No	DNR	1987-present
Canal No. 2	Sargent	No	DNR	1938-present
Canal No. 3	Comstock	No	DNR	1938-present
Canal No. 4	Arcadia	No	DNR	1986-present
Canal No. 4	Comstock	No	DNR	1938-present

Farwell Main Canal	Sherman Reservoir	No	DNR	1964-present
Farwell Sherman Feeder	Comstock	No	DNR	1963-present
Farwell South Canal	Sherman Reservoir	No	DNR	1965-present
Fullerton Canal from Davis Creek	North Loup	No	DNR	1992-present
Inlet to Davis Creek Res.	North Loup	No	DNR	1991-present
Kent Canal from North Loup	Taylor	No	DNR	1995-present
Middle Loup Canal No. 1	Sargent	No	DNR	1938-present
Mirdan Canal	Calamus Reservoir	No	DNR	1987-present
Ord-North loup Canal	Ord	No	DNR	1939-present
Platte River	Duncan	No	USGS	1895-present
Shell Creek	Columbus	No	USGS	1947-present
Sherman Reservoir	Middle Loup River	No	Farwell Irrig. District	1963-present
Taylor-Ord Canal	Taylor	No	DNR	1939-present
Taylor-Ord Canal Inlet	Elyria	No	DNR	1989-present
Taylor-Ord Canal Outlet	Elyria	No	DNR	1989-present

Low streamflow levels harm aquatic life, wildlife, natural habitat, and the communities near them. Stream gages from regionally diverse streams were selected to show the differences in stream flow during the 2012 drought as compared to 2020. Observations (discussed below) were made using the following stream flow gages (note that in corresponding streamflow figures, the y-axis values are not the same, as they represent diverse discharge levels):

- South: South Loup River at Saint Michael (USGS 06784000)
- West: South Loup River at Arnold (USGS 06781600)
- East: Loup River near Genoa (USGS 06793000)
- North: North Loup River at Taylor (USGS 06786000)

A few general observations can be seen in all the stream gages:

- Each stream experienced severely reduced flows during the 2012 drought, even leaving a dry riverbed near Saint Michael and Genoa several times.
- The 2020 streamflow readings offer higher discharge levels
- Maximum discharge levels between the two years were offered stark contrasts:
    - In 2020 the maximum discharge amounts were able to leap high above their minimum measurements.
    - In 2012, the drought kept even the maximum discharge levels barely above the minimum discharge levels, indicating the importance that rainfall has on these largely groundwater derived streams.

Data from the southern portion of the Lower Loup NRD, the South Loup River stream gage at Saint Michael, Nebraska, illustrates the impact of drought on streamflow (Figure 16). The Saint Michael gage from the drought summer of 2012 and the summer of 2020 are markedly different, even with normal variations in flow.

As the Saint Michael stream gage readings indicate, in the summers of both 2012 and 2020, the discharge levels of the South Loup River varied. The 2020 readings show significantly more cubic feet per second (cfs) of streamflow, as well as higher levels of maximum discharge, topping out around 1,800 cfs in May, and not dipping below 200 cfs. In contrast, 2012 summer readings did not reach much above 500 cfs at maximum discharge, and instead, steadily declined until the South Loup River at Saint Michael ran dry near the end of July.

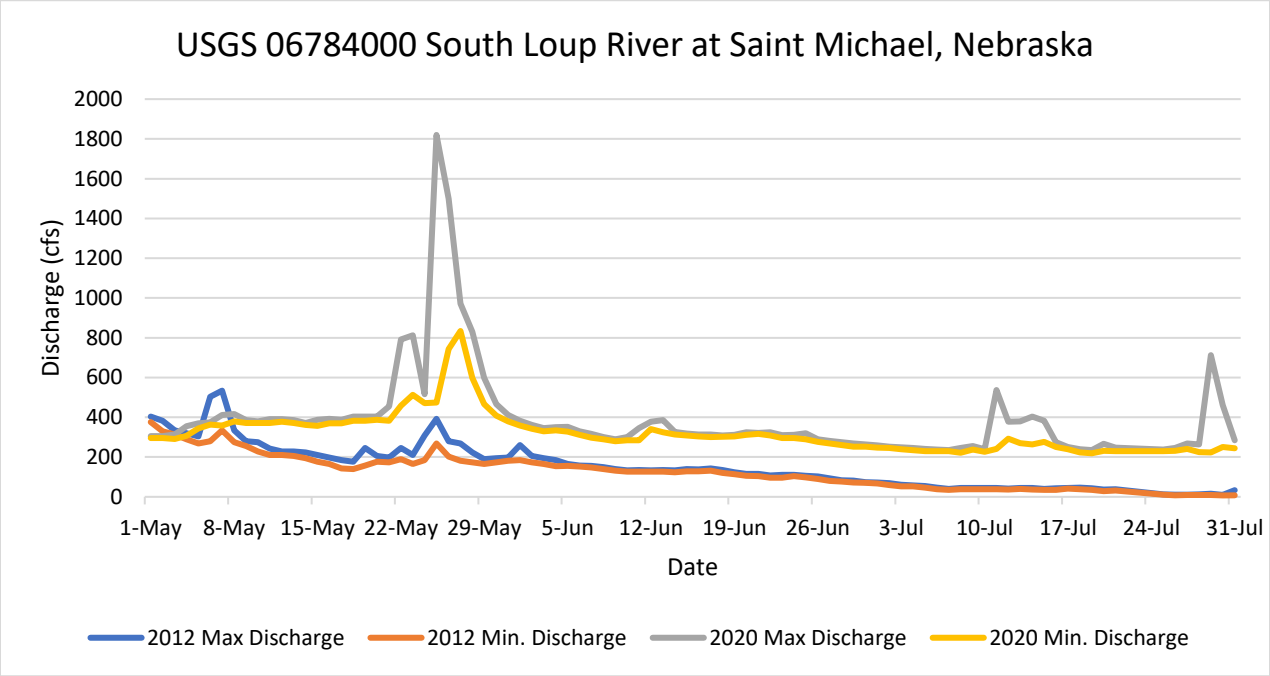


Figure 16: Saint Michael Stream Gage

On the Lower Loup NRD's western edge, the South Loup River stream gage at Arnold, Nebraska, shows streamflow levels significantly lower than at Saint Michael (Figure 17). However, the summer 2012 readings again show a slow decline in discharge, and the 2020 readings, while not drastically higher, are more dynamic than at Saint Michael.

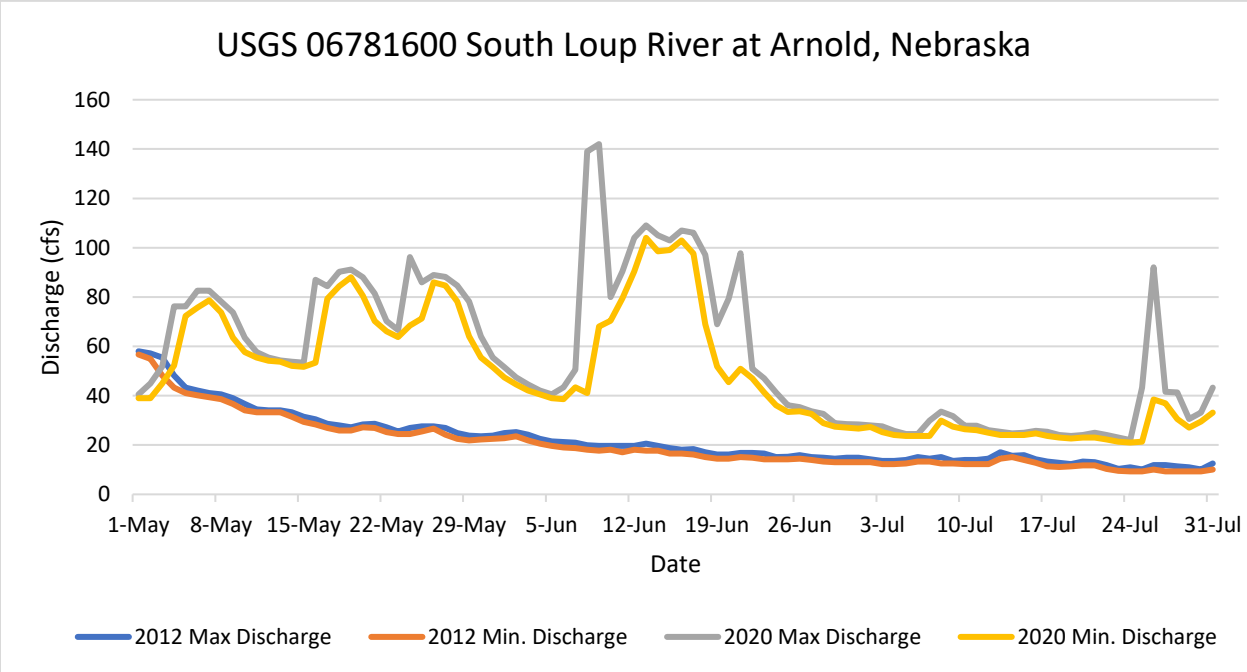


Figure 17: Arnold Stream Gage

The Loup River at Genoa, Nebraska, follows a similar discharge pattern as the Arnold stream gage, with 2012 flows from the Loup River starting relatively high, but still eventually dropping down near zero as summer progressed (Figure 18). 2020 flows at Genoa are significantly lower than stream gages, but still show much higher, and more frequent, discharge peaks than in 2012. Near the end of May 2020, maximum discharge levels towered above 12,000 cfs.

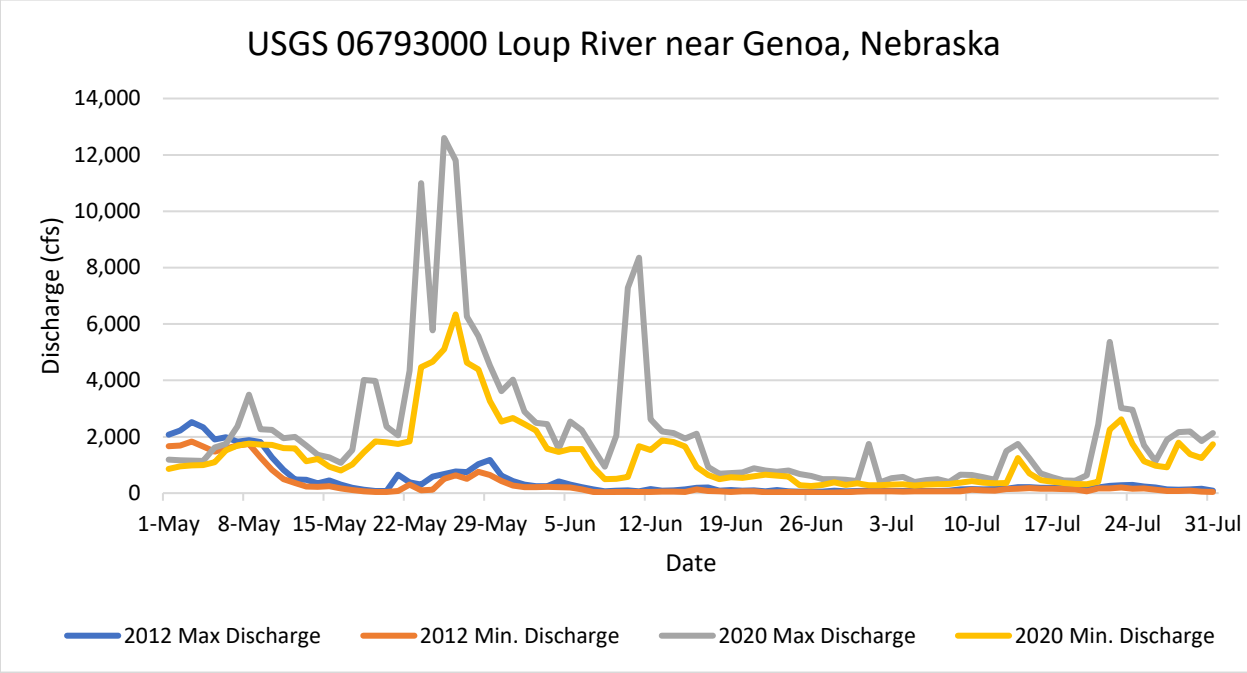


Figure 18: Genoa Stream Gage

Finally, near Taylor, Nebraska, in the northern portion of the Lower Loup NRD, the North Loup River saw more consistent flows in the summer of 2012 (Figure 19). Although the amount of discharge gradually decreased, flows did not bottom out. Streamflow measurements during the summer of 2020 varied, similar to the other featured stream gages in the district. In June, maximum discharge levels jumped above 3,250 cfs.

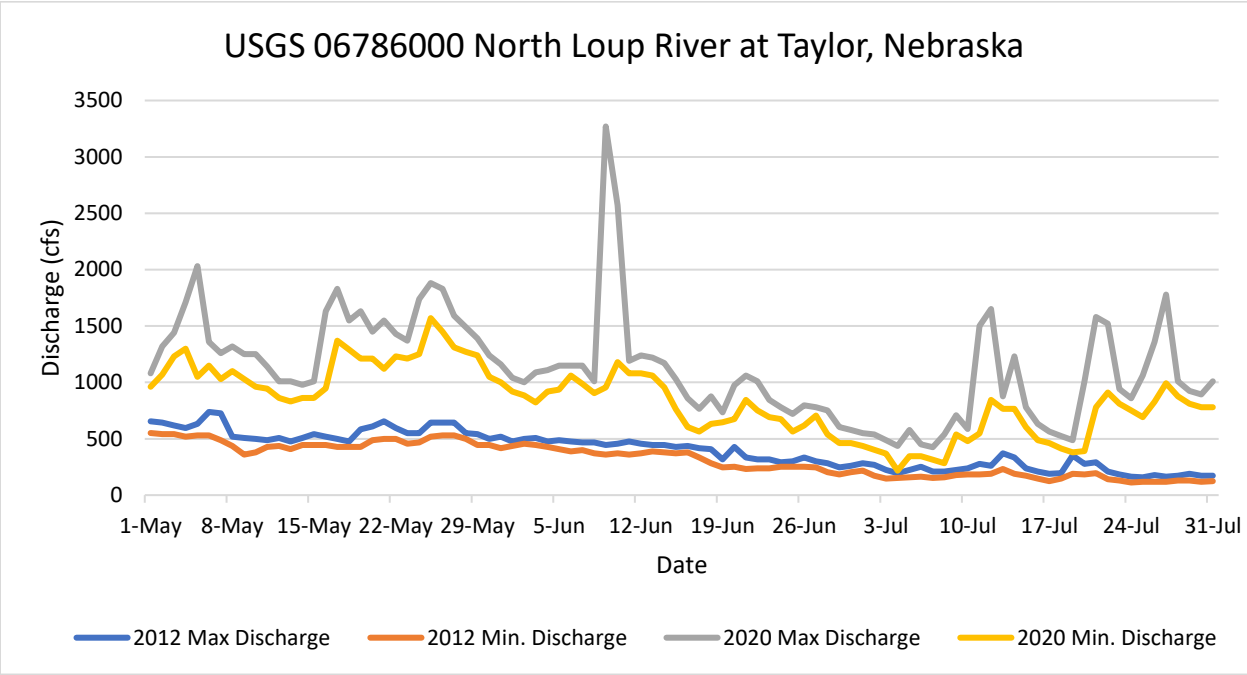


Figure 19: Taylor Stream Gage

COSTS OF DROUGHT

Drought's consequences make it one of the costliest hazard events. According to the National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI), there have been 27 billion-dollar-disasters in the United States attributed to drought since 1980. Table 9 shows the damage that drought causes in the Lower Loup NRD each year. This table does not include losses from displacement, functional downtime, economic loss, injury, or loss of life.

Table 9: Average Annual Drought Damages Across the Lower Loup NRD

Total Property Loss[1]	Average Annual Property Loss[1]	Total Crop Loss[2]	Average Annual Crop Loss[2]
$34,000,000	$1,360,000	$288,729,299	$14,436,465

Source: 1 Indicates the data is from NCEI (January 1996 to June 2020); 2 Indicates data is from USDA RMA (2000 to 2019)

4.03 FUTURE PROBABILITY OF OCCURRENCE AND VULNERABILITY ASSESSMENT

The probability for future drought events was calculated by the previous number of months in drought divided by the total months on record. The Lower Loup NRD area experienced drought 444 out of 1,504 months on record; resulting in a 29.5% chance of drought occurring each month within the Lower Loup NRD. However, according to the University of Nebraska-Lincoln report *Understanding and Assessing Climate Change: Implications for Nebraska*, the State of Nebraska can expect an increase in drought frequency and severity in the future.

As drought is a normal, recurrent feature of climate, the entirety of the area is susceptible to its impacts. However, there are some areas, industries, and populations that may experience greater impacts due to the vulnerabilities described below.

4.04 WATER QUANTITY CONCERNS

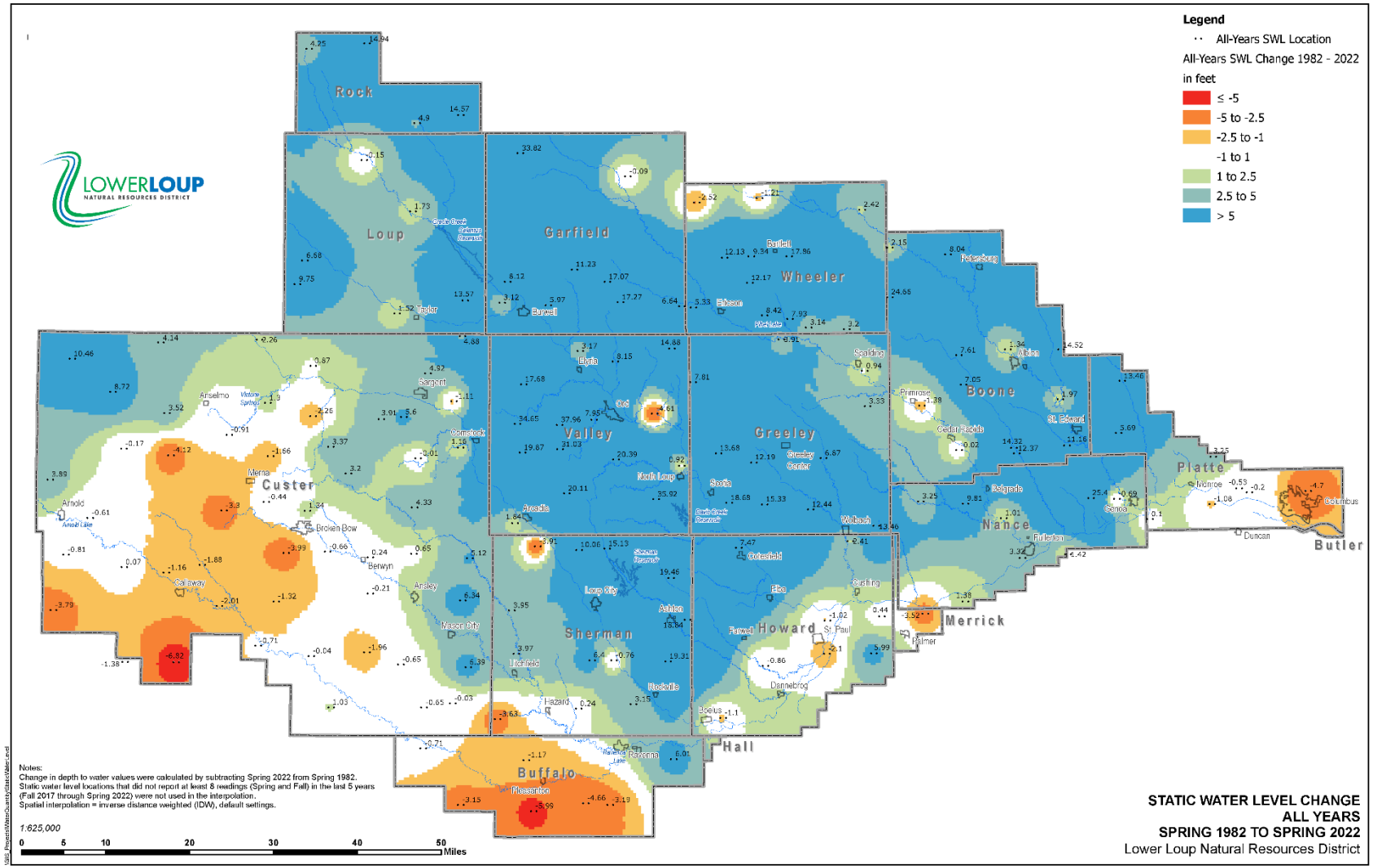
Drought conditions have a major impact on water quantity conditions for both surface water and groundwater. The effects of drought can be especially difficult on areas where there are already water quantity concerns. In 2002, the Lower Loup NRD created ten water quantity areas to monitor groundwater levels. These water quantity areas are classified by phase depending on the water quantity. These ten water quantity areas are expected to be updated to match the new drought zones from this report.

Groundwater levels in 1982 have been used by NRD as the benchmark year to compare groundwater level changes. In 2022, the Lower Loup NRD collected readings from 454 irrigation and monitoring wells during the annual spring static water collection. These data can be used to show accumulated change in groundwater levels from 1982 to 2022. While there are no over-

appropriated or fully appropriated areas within the Lower Loup NRD, these data underscore how drastic the drought effects of 2012 were.

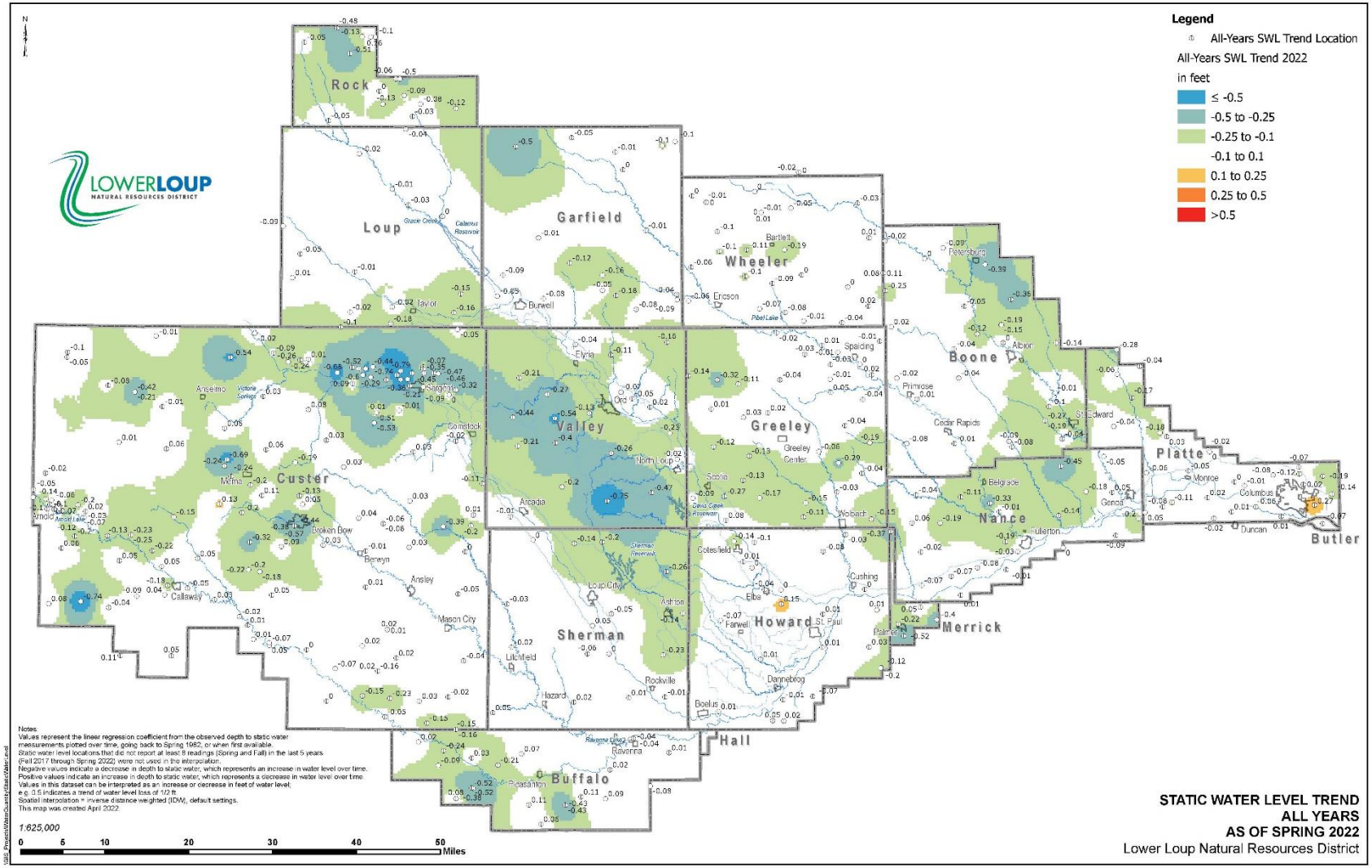
Based on 2022 well sampling, the following observations can be made:

- The largest concentration of decreasing water levels is in southern Custer and northern Buffalo Counties, which is consistent with historical readings (Figure 20). Two declines of six+ feet were located south of the South Loup River, one near Callaway and one near Pleasanton. However, there have been some major increases in water levels (30+ feet) in Valley County.
- The overall trend across the NRD shows static water levels increasing (Figure 21). However, Custer County, northern Buffalo County, and eastern Platte County have seen declines in static water level.



Source: Lower Loup NRD

Figure 20: Static Water Level Changes (1982-2022)



Source: Lower Loup NRD

Figure 21: Static Water Level Trends (1982-2022)

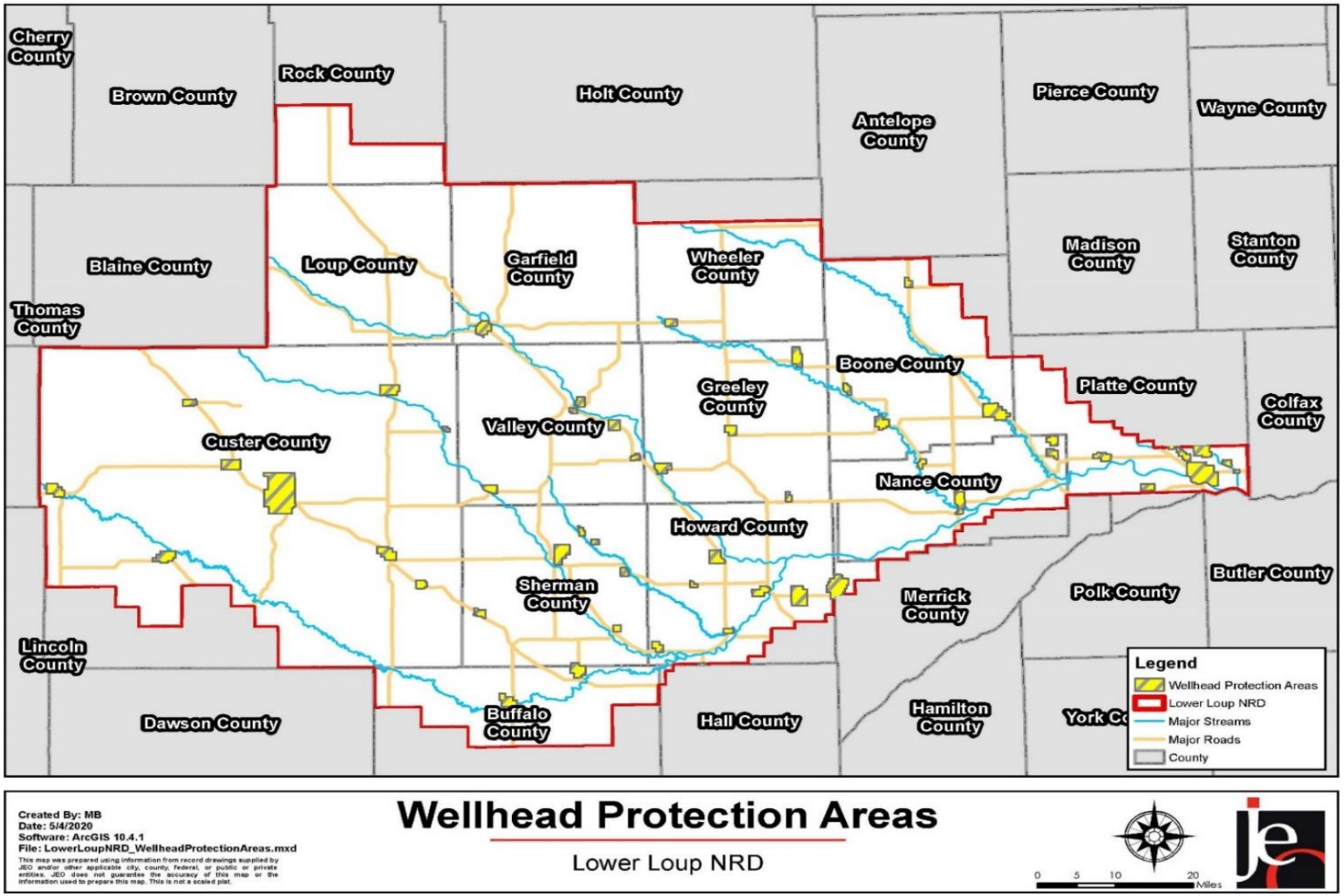
Stream depletion is the reduction in the flow rate as a result of pumping in an aquifer that is hydraulically connected to a river. The district uses Stream Depletion Factor (SDF) to represent the percentage of impact the pumping of a theoretical well in each section would have on the baseflow to a stream over a 50-year time period. The closer a section is to a stream, the higher the impact. The State of Nebraska considers anything over "10% depletion, over a 50-year time period" to be hydraulically connected to a surface water source.

Stream depletion is an important factor in determining the allocation of irrigation acres, as well as the sustainability of water resources in the region. Analyzing static water level changes as well as stream depletion can identify areas within the region that have an increased vulnerability to drought impacts. Further information can be found in the Phase 3 SDF study for the Elkhorn and Loup Basins conducted by the USGS.

4.05 WATER QUALITY CONCERNS

Water quality concerns are often exacerbated under drought conditions because contaminants can become more concentrated in a diminished water supply. Additionally, Nitrates are subject to increased mobility through groundwater due to higher levels of irrigation demand and pumping during times of drought. The Lower Loup NRD has created 30 groundwater quality management areas to monitor and manage groundwater quality. There are three potential phases which can be used to manage those activities affecting groundwater quality.

Wellhead protection areas have been mapped across the district (Figure 22). A wellhead protection area is defined by the geographic area (and flow direction) contributing water to the well or well field of a municipal water system. Maps are created for each community/public water system within this delineated area, which also include the estimated direction and time-of-travel of the groundwater as it flows towards the wellhead. Identifying the wellhead protection area allows a community to proactively protect and manage the source of community drinking water.



Source: NDEE, 2020

Figure 22: Wellhead Protection Areas

4.06 ECONOMIC CONCERNS

Agriculture is a major industry and economic driver within the Lower Loup NRD. Drought can cause significant economic impacts in agriculturally based economies. According to the USDA Risk Management Agency (RMA), drought accounted for $288,729,299 in crop losses within the Lower Loup NRD from 2000 through 2019. Reduced income for farmers ripples into other sectors, as their ability to purchase goods and services is reduced. The State of Nebraska's economic status is heavily influenced by the Lower Loup NRD region, with agricultural production in the area accounting for $4,502,538,000 of the state's economy according to the 2017 US Census of Agriculture. For additional information on the agricultural sector's impact on the economy in the Lower Loup NRD, see Appendix B.

Outdoor-based recreational activities can also be hard hit when drought occurs. Specifically, in the Lower Loup NRD, Residents currently enjoy water-based recreation like fishing and boating in reservoirs within the district (Calamus, Davis Creek, Sherman). Other businesses and industries can also be impacted by drought, particularly if they are water-intensive, which are particularly vulnerable. Within the Lower Loup NRD, examples of these include ethanol plants, power plants, meat production, dairy production, and breweries. Finally, it is also important to point out that preparing for drought in the Lower Loup River Basin would also likely result in positive water supply effects on the downstream Lower Platte River Basin.

4.07 SEASONAL VULNERABILITIES

Seasonal vulnerabilities related to water availability and high-water demand exist across the state. The Lower Loup NRD area will also be more vulnerable to drought during these periods. These seasonal vulnerabilities may impact when a drought stage is declared. Agricultural irrigation is one key consideration directly related to monitoring and managing water use and water needs for the Lower Loup NRD. The phenology for crop development provides insight regarding times of increased water demand.

The development cycle for corn crops (Figure 23) provides an important illustration of this concept, as corn is more water intensive than the other primary crops for the region. The ideal time to sow crops in the region ranges from April 25 to May 10. Clearly, moisture is necessary throughout the growth cycle, but the most critical times for adequate soil moisture are during the pre-tasseling and tasseling phases. Critical moisture management times for 113-day maturing corn occur between weeks 10 and 15. If the assumed sowing date is May 1, critical periods with adequate soil moisture for would be during July and August. While monitoring water supplies throughout the year is helpful, it is most important for agricultural, municipal, commercial, and industrial water users to manage and develop contingency plans in case of shortage, during periods of peak demand.

The amount of irrigation required to bring crops to their full yield potential is primarily driven by rainfall and varies based on location within the Lower Loup NRD. The northwestern portion of the NRD requires a much higher level of net irrigation to produce corn (Figure 24). Data in this map

is based on NeDNR's Net Corn Crop Irrigation Requirement Map, which identifies the net amount of irrigation water that must be applied for a full yield of an irrigated corn crop.[15]

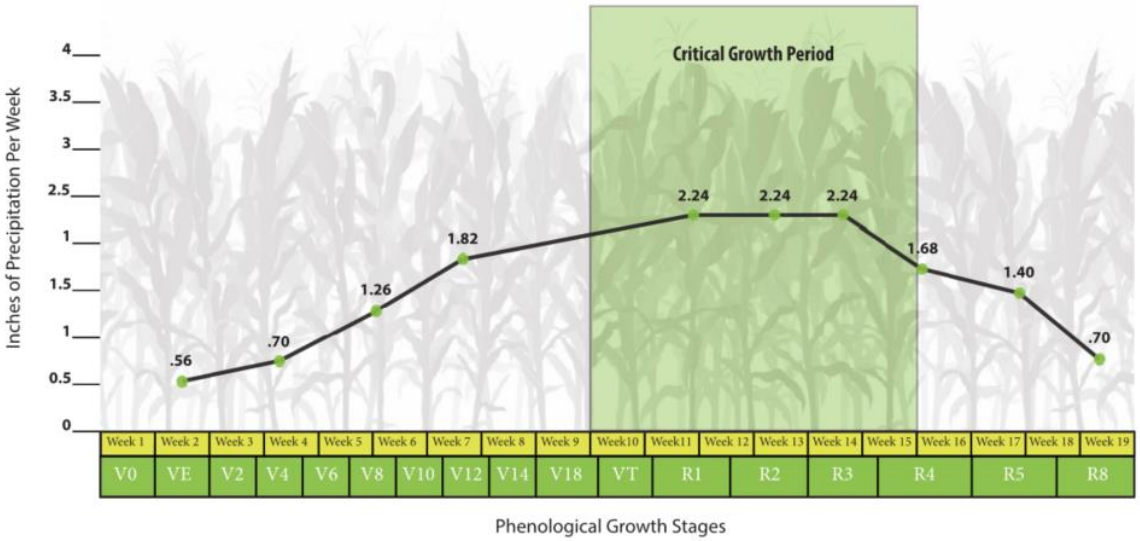
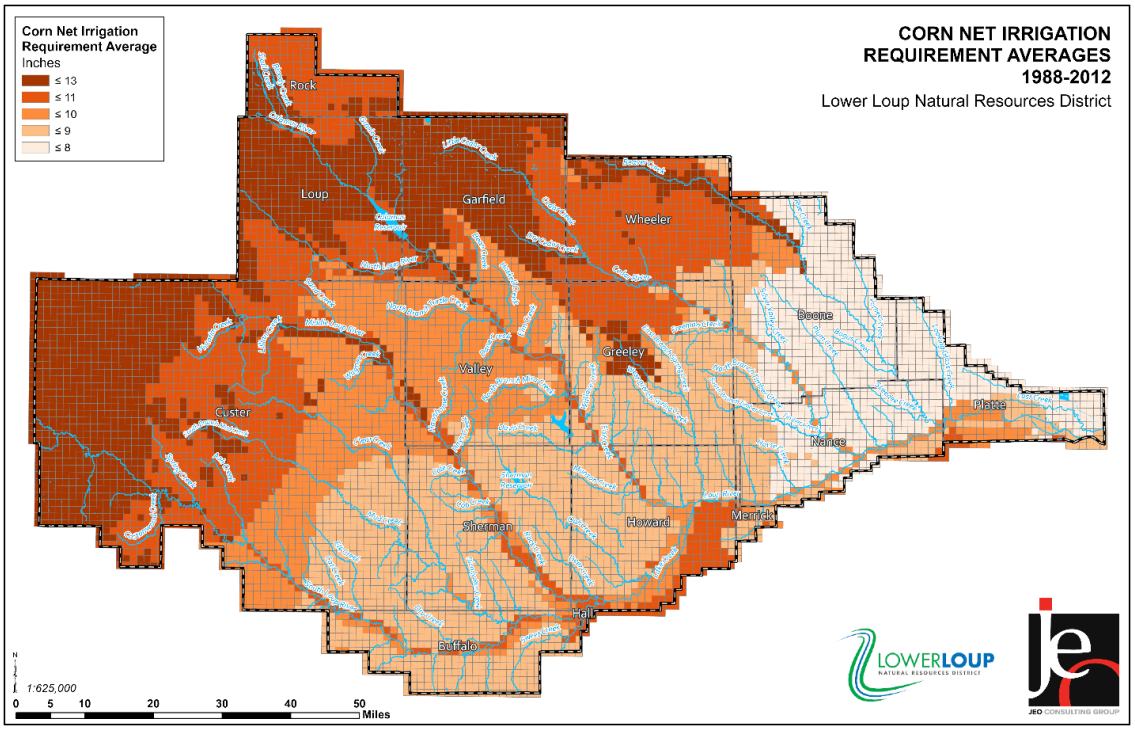


Figure 23: Example of Crop Water Use by Growth Stage (113-Day Maturity Corn)



Source: NeDNR, Lower Loup NRD

Figure 24: Average Net irrigation Requirement for Corn

[15] Martin, D., 2005, Net Irrigation Requirement: A Summary of the CROPSIM Modeling Performed to Develop the Net Corn Crop Irrigation Requirements Map for the State of Nebraska.

4.08 THREATENED OR ENDANGERED SPECIES

There are 13 species with ranges in the Lower Loup NRD that are on either the state or federal threatened and endangered species list:

- Small White Lady's Slipper
- Sturgeon Chub
- Western Prairie Fringed Orchid
- American Burying Beetle
- River Otter
- Blowout Penstemon
- Finescale Dace
- Piping Plover
- Rufa Red Knot
- Interior Least Tern
- Northern Long-eared Bat
- Northern Redbelly Dace
- Whooping Crane

Although drought will impact each species differently, in general, species will become more vulnerable during drought conditions. When a drought occurs, critical habitat and food supplies may become damaged or scarce. Certain species may also find it difficult to find adequate supplies of drinking water. Piping Plovers, the River Otter, the American Burying Beetle, and Whooping Cranes are all especially vulnerable to drought conditions affecting their habitat.

4.09 HEALTH IMPLICATIONS

In periods of limited rainfall, water bodies may become reduced in size, causing them to become stagnant. Inadequate water supplies can also cause people to collect rainwater which can lead to additional bodies of water. These stagnant water bodies provide an excellent breeding ground for certain types of types of mosquitoes (e.g., *Culex tarsalis*) which carry West Nile Virus. Outbreaks of West Nile Virus, which is transmitted to humans via mosquitoes, have an increased likelihood of occurring during drought conditions.[16]

Drought conditions may impact air quality causing acute issues as well as negatively impacting individuals who have certain chronic health conditions such as asthma. Fire and dry soil can increase the number of particulates in the air such as dust, pollen and smoke. These substances can increase the risk for acute respiratory infections like bronchitis and bacterial pneumonia.[17]

[16] "Drought and Health." Centers for Disease Control and Prevention. August 2017. https://www.cdc.gov/nceh/drought/default.htm
[17] "Drought and Health." Centers for Disease Control and Prevention. August 2017. https://www.cdc.gov/nceh/drought/default.htm

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SECTION 5. DROUGHT MONITORING AND RESPONSE PROTOCOL

5.01 INTRODUCTION

Every drought event is different with varying impacts. Identifying and responding effectively to droughts as they occur is both technically and politically challenging. A pre-established plan, developed before a drought occurs, can help ease these pressures and enable decision makers to respond in an informed, predictable, and transparent way.

This section of the plan establishes a framework for drought monitoring and response for the Lower Loup NRD to follow. Modifications and updates to this framework may be necessary as it is implemented, and as unique situations arise. The planning team recommends that after each drought event the Lower Loup NRD review how the framework was utilized and, as applicable, update it based on lessons learned.

The Lower Loup NRD Drought Monitoring and Response Protocol (protocol) identifies the specific tools the NRD will utilize to monitor drought conditions. The planning team identified specific conditions (triggers) to assist the Lower Loup NRD in declaring the severity and extent of the drought. Each drought level has corresponding management actions. To enhance the Lower Loup NRD's response efforts, the district has been divided into smaller zones to allow for a more nuanced approach to declaring drought levels and taking management actions. Additionally, based on stakeholder feedback during the development of this plan, the protocol includes the formation of a stakeholder group to provide local feedback and enhance agency coordination during droughts.

Importantly, it should be clarified again that the ultimate responsibility and authority for declaring drought levels are the responsibility of the Lower Loup NRD Board of Directors. This protocol acts as a guide to help make those decisions.

DEFINITION OF TERMS

The following list defines terms utilized within the protocol, which are discussed later in more detail:

- **Drought Zone (DZ):** Twenty zones have been mapped based on the unique features found across the Lower Loup NRD, which is a large and diverse district. At any given time, each zone could be in a different drought level declaration, allowing for nuanced and locally informed management actions, rather than a one-size-fits-all approach. To provide further management capabilities, the Lower Loup NRD reserves the right to further dive DZs into sub-zones, on an as needed basis.
- **Drought Level (DL):** Five drought levels have been identified for the Lower Loup NRD. While these levels are based on the US Drought Monitor, for purposes of this drought plan, the drought levels have been modified based on the specific water resources and other unique aspects across the district.
- **Drought Indicators (DI):** Both primary and secondary drought indicators, or monitoring tools, have been identified to provide monitoring data on drought levels within the district

at any given time. These indicators are based on the status of groundwater/surface water readings, and regional short-term and long-term drought forecasting models.

- **Drought Advisory Group (DAG):** This group will comprise local stakeholders and government agency staff and assemble during specific times of drought. The DAG will provide supplementary input and review drought conditions and management actions for the Lower Loup NRD to consider and help to enhance interagency coordination and response.
- **Triggers:** These are a set criterion that, when reached, may necessitate a change in drought level declarations. The triggers are based on the primary drought indicators, but the Board of Directors has discretion on which drought indicator to base their decision.
- **Decision Dates:** Annual dates by which the NRD will make declarations on drought levels. These are set to allow adequate time for producers and other sectors impacted by drought and management actions to adjust their own management decisions.
- **Management Actions:** These are specific short- and long-term actions the Lower Loup NRD may take based on the drought level for each individual drought zone.

5.02 DROUGHT ZONES

Twenty drought zones have been identified (Figure 25) based on multiple input factors listed below:

- Soil type, rainfall, net irrigation requirement, irrigated acres density, Elkhorn-Loup Model Stream Depletion Factor, High Plains Aquifer (HPA) saturated thickness, HPA transmissivity, GW surplus/mounding, topographic region, river basins, and stream locations.
- Consistency with existing district management: The drought zones are similar to the existing 10 Groundwater Quantity Management Areas. The planning team recommends that the drought zones replace the existing Groundwater Management Areas in a future version of the Lower Loup NRD Groundwater Management Plan.

To provide further flexibility for management actions, a DZ can also be further subdivided (as needed) into sub-zones.

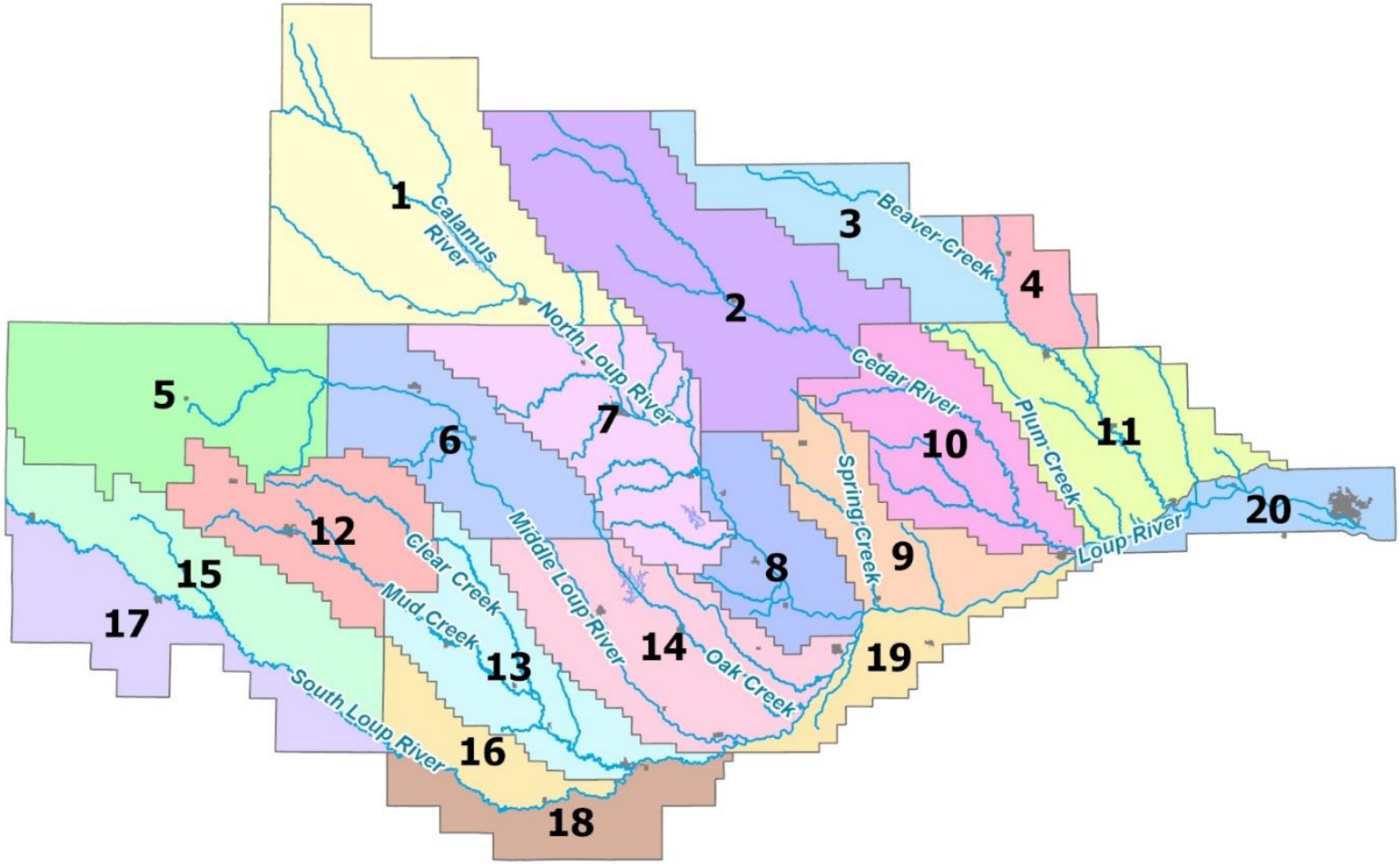

Figure 25: Proposed Drought Management Zones for Lower Loup NRD

5.03 DROUGHT LEVELS

Five drought levels have been identified for the Lower Loup NRD. While based on the US Drought Monitor, for purposes of this drought plan, the drought levels have been modified based on the unique water resources and features across the district.

At all times, the "default level" of drought within the Lower Loup NRD is set to DL00 (Monitor), unless an elevated level of drought is declared. Following the declared end of any drought, the drought level of each DZ will be returned to DL00 (Monitor).

00) Monitor
0) Watch
1) Moderate
2) Severe
3) Extreme

5.04 DROUGHT INDICATORS

Both primary and secondary drought indicators, or monitoring tools, have been identified to provide monitoring data on drought levels within the district at any given time. These include both regional and local indicators, and short-term and long-term indicators. Data from each monitoring source will be reported (or summarized) unique to each data source, but generally by drought zone when possible.

Lower Loup NRD staff will regularly monitor primary DIs and report on an annual basis (at a minimum). When an elevated drought level is declared, staff will begin reporting Primary DIs on a weekly basis. Once the Drought Advisory Group is activated, Lower Loup NRD staff will begin monitoring secondary DIs with assistance from the DAG.

PRIMARY DROUGHT INDICATORS

A) Regional Short-Term Drought Status
   1) <u>Tool:</u> US Drought Monitor
      a. The US Drought Monitor (USDM) relies on experts to synthesize the best available data and work with local observers to interpret the information.
         i. Numeric inputs include: the Palmer Drought Severity Index, the Standardized Precipitation Index, USGS weekly streamflow, and other climatological inputs; the Keech-Byram Drought Index for fire, satellite-based assessments of vegetation health, and various indicators of soil moisture; and hydrologic data, particularly in the West, such as the Surface Water Supply Index and snowpack.
         ii. It incorporates ground truthing and information about how drought is affecting people, via a network of more than 450 observers across the country, including state climatologists, National Weather Service staff, Extension agents, and hydrologists.
      b. Updated map is released weekly, on Thursdays, on USDM website

c. Regional indicator that will be overlaid with Lower Loup NRD Drought Zones and summarized by zone

2) Other tool: Lower Platte River Drought Contingency Plan online dashboard.

B) Local Long-Term Groundwater Status

1) Tool: Lower Loup NRD Annual Spring Static Water Levels (SWL)

a. Spring measurements of SWLs over last 25 years, with 80% of the measurements available

b. Following the year's spring measurements, data will be analyzed **annually by May 1** and used for the next year's status

2) Consider adding another tool, if needed, like real-time transducers, to supplement the SWLs.

3) Local indicator will be summarized directly by Lower Loup NRD Drought Zones.

SECONDARY DROUGHT INDICATORS

C) Local Surface Water Status

1) Tool: USGS Daily Streamflow Gages

a. Daily measurements of USGS gages within Lower Loup NRD using the interactive WaterWatch Streamflow Map or the National Water Dashboard

2) Local indicator to be summarized by USGS HUC 8 basins, then overlaid with Lower Loup NRD Drought Zones and summarized by zone, such that intersection is >50%. Each HUC 8 basin that intersects the district will have a representative USGS gage, if available, that will be used for reporting streamflow measurements.

D) Local Reporting of Drought Impacts

1) Tool: Includes the following issues reported directly to Lower Loup NRD from residents or other stakeholders:

a. Within Lower Loup NRD: Well interference, crop impacts, soil moisture, livestock impacts, NeDNR stream gages, water quality issues, community water restrictions, and Loup River streamflows (related to instream flow rights)

b. Outside Lower Loup NRD: NeDNR stream gages, reservoir / lake levels, snowpack, monthly climate summaries and quarterly reports from the Nebraska State Climate Office, Platte River streamflows at Louisville (related to instream flow rights

2) A form for identifying and submitting local impacts is available at the Lower Loup NRD and will be made available to the Drought Advisory Group and other residents.

E) Regional Drought Forecasting

1) Tool: NOAA's Seasonal Drought Outlook

a. The long-term drought forecast will be examined using the online map and assessment.

5.05 DROUGHT ADVISORY GROUP

The Drought Advisory Group will be organized and managed by the Lower Loup NRD. Their purpose is to assist the Lower Loup NRD in information gathering, resource sharing, and identifying mitigation or response opportunities during drought. During the declaration of DLs 2 or

3 (Severe or Extreme) in any one of the DZs within the district, the DAG will be formed and begin to meet periodically to:

- Evaluate secondary DIs,
- Provide input on elevating or downgrading DLs within DZs,
- Provide input on drought management actions, and
- Provide general input to Lower Loup NRD during prolonged drought.

The exact membership of the DAG will be identified when it is formed, however, it will likely consist of the following stakeholders:

- Irrigation districts
- Loup Power District
- Large industries
- Well drillers
- Groundwater irrigators
- Surface water irrigators
- Concerned citizens
- Coordinating government agencies:
    - Cities and villages within Lower Loup NRD
    - Farm Service Agency
    - UNL Extension
    - Local and state emergency management
    - NeDNR
    - National Drought Mitigation Center
- Others as identified

5.06 DROUGHT LEVEL TRIGGERS

Triggers are a set criterion that, when reached, may necessitate a change in drought level declarations. The triggers are based on the primary drought indicators, but the Lower Loup NRD Board of Directors has discretion on which drought indictor to base their decision.

00) Monitor

A) This is considered the “default level” status unless another drought level is declared. The NRD will always be monitoring for drought in the district, which also helps to identify baseline status.

0) Watch

A) Regional Short-Term Drought Status
    i) D0, Abnormally Dry, intensity or higher (D1-4) is >50% coverage calculated in each DZ.

B) Local Long-term Groundwater Status
    i) Static Water Level of majority (>=50%) measurement wells within each DZ at or below 50% of the well’s measured SWL range (min to max), over last 25 years.

C) Local Surface Water Status

i) N/A for this DL.

D) Local Reporting of Drought Impacts
   i) Situational. Consult Lower Loup NRD Board.

E) Regional Drought Forecasting
   i) N/A for this DL.

1) Moderate

A) Regional Short-Term Drought Status
   i) D1, Moderate, intensity or higher (D2-4) is >50% coverage calculated in each DZ.

B) Local Long-term Groundwater Status
   i) Static Water Level of majority (>=50%) measurement wells within each DZ at or below 25% of the well's measured SWL range (min to max), over last 25 years.

C) Local Surface Water Status
   i) N/A for this DL.

D) Local Reporting of Drought Impacts
   i) Situational. Consult Lower Loup NRD Board.

E) Regional Drought Forecasting
   i) N/A for this DL.

2) Severe

A) Regional Short-Term Drought Status
   i) D2, Severe, intensity or higher (D3-4) is >50% coverage calculated in each DZ.

B) Local Long-term Groundwater Status
   i) Static Water Level of majority (>=50%) measurement wells within each DZ at or below 10% of the well's measured SWL range (min to max), over last 25 years.

C) Local Surface Water Status
   i) Streamflows are below 10% of the site's full historical range on the measured day of the year.

D) Local Reporting of Drought Impacts
   i) Situational. Consult Drought Stakeholders and Lower Loup NRD Board.

E) Regional Drought Forecasting
   i) Situational. Consult Drought Stakeholders and Lower Loup NRD Board.

3) Extreme

A) Regional Short-Term Drought Status
   i) D3, Extreme, intensity or higher (D4) is >50% coverage calculated in each DZ.

B) Local Long-term Groundwater Status
   i) Static Water Level of majority (>=50%) measurement wells within each DZ at or below 0% of the well's measured SWL range (min to max), over last 25 years; i.e. the minimum SWL within 25 years.

C) Local Surface Water Status
   i) Streamflows are at or below 0% of the site's full historical range on the measured day of the year.

D) Local Reporting of Drought Impacts
   i) Situational. Consult Drought Stakeholders and Lower Loup NRD Board.

E) Regional Drought Forecasting
   i) Situational. Consult Drought Stakeholders and Lower Loup NRD Board.

5.07 DROUGHT DECLARATION GUIDANCE

The following is general guidance for the use of drought indicators during consideration of drought level designations for each drought zone. Additionally, decision dates have been developed in consultation with stakeholders. These are annual dates by which the NRD will attempt to make declarations on drought levels for the upcoming year. This is intended to give adequate time to producers and other sectors, which may be impacted by drought and management actions, as they adjust their own management decisions.

It should be noted that while Lower Loup NRD staff continuously monitor drought indicators and may make recommendations as to drought declarations or management actions, the final authority to implement this monitoring and response protocol is reserved by the Lower Loup NRD Board of Directors, who can also change a designation at any time.

USE OF INDICATORS

- If both primary drought indicators A and B fall into the same or higher drought level 0-3 (Watch-Extreme) within a drought zone, then a composite DL can be assigned to each DZ.
- Secondary drought indicators C-D-E will be evaluated if one of the primary indicators A-B trigger a DL 2 (Severe) in any DZ, and possibly used to level-up a current DL, or even assign a DL to a sub-zone within a zone. The DAG, organized during a triggering of a DL 2, will be consulted regarding use of a secondary indicator to assign a final DL 2-3.
- The exception to these rules is that the secondary drought indicator D, Local Reporting of Drought Impacts, with consultation by the Lower Loup NRD Board, can trigger a DL 0-3 by itself within a DZ or Sub-DZ.

DECISION DATES

- For drought level 3 (Extreme), a final determination will be made by **March 1** to prepare residents for current year management actions.
- For drought levels 0-1-2 (Watch-Moderate-Severe) a final determination will be made by **June 1** to prepare residents for upcoming management actions, specifically, suspending new irrigated acres development (DL 1) and flow meter requirements (DL 2).
- Before assigning final drought levels by the listed dates for the current year, Lower Loup NRD staff will make a recommendation to the Lower Loup NRD Board of Directors to accept the final drought levels.
- If approved by Lower Loup NRD Board, specific management actions related to each final drought level will be implemented in the drought zones for the calendar year.
- The Lower Loup NRD Board of Directors can, at any time, declare a change in a drought level. This gives the board needed flexibility, especially in flash drought situations where a sudden change in drought indicators or triggers can be experienced, or where drought indicators may be delayed in hitting trigger levels by the recommended decision dates.

5.08 DROUGHT LEVEL MANAGEMENT ACTIONS

These are specific short- and long-term actions the Lower Loup NRD may take based on the drought level for each individual drought zone, triggers, and DAG input. Ultimately, the implementation decision rests with the Lower Loup NRD Board of Directors.

00) Monitoring

- Drought-focused communication and public outreach in the district will occur on an as-needed basis.
- Impacts and vulnerability information related to the status of the Lower Loup NRD will be addressed during this time.

0) Watch

- *All actions inherited from DL 00 (Monitoring).*
- Information & education (I&E) activities will begin to emphasize drought and be focused towards impacted drought zones or stakeholders. Information on possible next steps (drought indicators, levels, management actions, etc.) should be provided to help producers make informed decisions.
- Increased media releases and events will take place.
- A new drought-focused newsletter will be created with the help of board members who represent areas impacted by updated drought designation.
- Increase education and outreach to encourage voluntary water conservation and best management practices, like flow meter education, voluntary flow meter installation, soil moisture sensors, and preventative or alternative planting education.

01) Moderate

- *All actions inherited from DL 0 (Watch).*
- Prohibit new irrigated acres development for current year.
- Prohibit transfer of irrigated acres into zone; variances to be considered.
- Prohibit supplemental wells; variances to be considered.

02) Severe

- *All actions inherited from DL 1 (Moderate).*
- Identify members of the Drought Advisory Group.
- Flow meters required for the DZ within the next two years, determined by Lower Loup NRD Board.
- Strongly encourage preventative or alternative planting.
- Urge other jurisdictions that manage water use to enforce their own water restrictions.

03) Extreme

- *All actions inherited from DL 2 (Severe).*
- DAG will meet regularly on drought reporting and status update.
- Water-use restrictions enacted for upcoming season.
    - Fields with flow meters will be allocated for current year.
    - Fields without flow meters will be required to install one within the next two years and will have a percentage reduction in irrigated acres allowed or other

comparable reduction (e.g., end-gun removal, cease gravity irrigation) for current year.

- Additional restrictions will be determined by the Lower Loup NRD Board and based on the net irrigation corn requirement and other available data.

SECTION 6. MITIGATION AND MANAGEMENT ACTIONS

Below are actions, projects, and programs that the Lower Loup NRD is already taking to reduce the negative impacts from drought; both directly or indirectly. Many of these projects serve multiple purposes on top of reducing drought impacts, showing how actions can have wide ranging benefits.

- Annual review and update of Groundwater Management Plan & Annual Groundwater Monitoring
- Flow Meter Cost-Share Program
- Airborne Electromagnetic (AEM) Survey
- Annual budget with $1.5 million allocated for water quantity projects
- Columbus Area Water Resources Assessment Study
- Some water quality projects and plans may also address drought or water quantity, and are discussed in Section 4

6.01 OPERATIONAL AND ADMINISTRATIVE FRAMEWORK

To manage surface and groundwater, the Lower Loup NRD must operate within the framework provided by the State of Nebraska. Below is a brief explanation of some of the frameworks for surface water administration and groundwater allocation.

SURFACE WATER ADMINISTRATION

The NeDNR governs the use of surface water in the State of Nebraska and has the authority to restrict its use. The state governs surface water through the prior appropriation doctrine which states that the oldest water rights holders get their full allocation of water before any junior rights holders can get their water.

As drought conditions develop, a senior water rights holder can contact the local NeDNR field office and request a hold to be placed on junior rights holders because the senior water right holders are not receiving their full allocation. The field office will then analyze the situation and determine how they can adjust water consumption to ensure that the senior rights holder will be able to get the water they need. If the senior water rights holder, or appropriator, is in fact not receiving the allocated amount, other surface water users whose priority date is junior will be required to cut back, or cease usage, in order to satisfy the senior appropriator.

GROUNDWATER ALLOCATION

The Lower Loup NRD is authorized by the state to manage and govern groundwater within the district per the Nebraska Revised Statute 46-739. This authority provides the NRD with the means to restrict the use of groundwater, if conditions warrant. As drought conditions develop, the Lower Loup NRD will ensure that groundwater is not being overpumped, thereby causing potential long-term harm to the aquifer.

The Lower Loup NRD will consider the climatic information from the previous year, current year, and any future forecasted drought conditions when determining any changes to the groundwater allocation for the upcoming year, as applicable.

6.02 MITIGATION ACTIONS

This section outlines drought mitigation actions identified during the development of this plan through stakeholder input and review of other planning documents, such as the 2022 Lower Loup NRD Multi-Jurisdictional Hazard Mitigation Plan. No specific priority, timeline, or costs have been identified for these actions. Those would be developed as projects are selected and detailed project plans developed.

These actions are presented not as a plan of action, but as a "playbook" of options and ideas for the Lower Loup NRD to consider during plan implementation to increase drought resilience.

PUBLIC INFORMATION AND EDUCATION (I&E) ACTIONS

Public outreach and education are a cornerstone of the implementation of this plan. This multifaceted education approach includes targeting multiple stakeholders with relevant information, attending various events, and distributing information in various formats. Two general types of actions were identified: 1) those that would be completed to assist in the general usability or execution of this plan, and 2) those that would be completed as resources to be used or delivered to stakeholders during specific drought level designations.

The Lower Loup NRD currently has an education and outreach budget of approximately $160,000 annually. The Lower Loup NRD utilizes their website, a monthly newspaper column, social media, and newsletters to conduct outreach efforts. It is anticipated that most of these actions could be completed with current I&E staff or resources that the Lower Loup NRD already has and/or with the support of other partners such as UNL Extension.

The following actions were identified:

1. Develop materials specifically related to this plan and the monitoring and response protocol, such as a "simplified" or "visually-driven" brochure that could be made available at events or available as a handout to stakeholders.
2. Create an executive summary poster that can be hung in the board room, offices, and posted online.
3. Obtain, update, or develop new materials (specific to the Lower Loup NRD) about drought and its many cascading impacts such as wildfires, water shortages, or increased flood risks following droughts.
4. Work with UNL Extension, National Drought Mitigation Center, or other stakeholders to provide I&E materials targeted to specific sectors (ranchers, irrigators, communities, etc.). This may include utilizing existing materials, modifying those to be more relevant to the Lower Loup NRD, or creating new materials. Examples of existing materials can be found here:
    a. https://droughtresources.unl.edu/

   b. https://www.ag.ndsu.edu/publications/livestock/strategies-for-managing-drought-in-the-northern-plains/r1819.pdf
5. Make stakeholders aware of existing resources that help them deal with an ongoing drought or impacts from drought. This could be a targeted action when Lower Loup NRD begins to declare elevated drought levels or even as a follow-up action after a drought passes.
   a. Examples include drought assistance funding, tax programs, emergency hay resources, herd culling, etc.
6. Develop materials, hold workshops, or field days that educate producers on various irrigation best management practices or other water management strategies.
7. Organize a yearly “Drought Awareness Week” which would include a “blitz” of media coverage, outreach events and distribution of materials to raise awareness of this plan, water conservation activities, and related resources.
8. Develop a drought dashboard on the Lower Loup NRD website, where links to monitoring tools and other mitigation or response resources can be centrally located.
9. Hold periodic drought management training workshops with UNL Extension Educators and others as needed.
10. Identify, develop, and provide targeted educational and training materials or opportunities to the Drought Advisory Group.

WATER MANAGEMENT ACTIONS

These actions include those that can be undertaken relatively easily, with minimal study or research. While the Lower Loup NRD and partners have some funding sources to implement them (such as cost-share for BMPs), additional funding resources would be required to implement them across the district or even to targeted geographical areas. Targeted I&E efforts should be paired with each one of these to increase voluntary adoption or implementation. These mitigation actions improve drought resilience through one or more of the following modes of action:

- Reduce demand
- Improve use/efficiency
- Increase supplies

The following actions were identified:

1. Identify the most vulnerable areas to groundwater declines via hydrogeologic data (AEM surveys, water level monitoring, etc.) and proactively work to increase adoption of irrigation BMPs and other water management practices.
2. Develop sample irrigation allocation guidance specific to each drought zone. This could be used during any season if producers wish, however, targeted awareness of this tool would be utilized as drought zones begin moving into worsening levels of drought.
   a. This could be paired with a pilot project or issuing a voluntary challenge to a group of producers to practice managing through an allocation system.
   b. The use or availability of flow meters may be necessary for this action to be feasible.
3. Increase adoption of flow meters through policy enhancements and grant funds to use for cost-share. This could be prioritized in areas more vulnerable to drought or that are facing other groundwater management concerns. This should be proactively completed before installation of flow meters becomes a regulatory action, which may make the activity ineligible for grant funds.

4. Identify new or existing groundwater wells to add real-time water level transducers to supplement spring water level measurements and improve drought monitoring capabilities.
5. Obtain grant funding and/or increase local levels of cost-share assistance to increase adoption rates of irrigation BMPs and other water management practices.
6. Conduct or partner with stakeholders to perform studies to:
    a. Utilize areas that have high groundwater as water sources.
    b. Capture, store, and use excess stream flow during flood events. Pairing drought management with flood management effort is a way to accomplish both of these objectives.
    c. Identify locations for stream augmentation or retiming, surface or groundwater storage, or groundwater recharge projects.
    d. Identify opportunities to use existing infrastructure (i.e. canals) to recharge groundwater supplies.
    e. Complete water balance studies in high-risk areas to identify excess supplies, activities that are overusing water, or where well interference is common (leveraging AEM data in these areas will be very beneficial).
    f. Proactively evaluate existing water storage facilities for drought resilience (low water conditions, etc.). These effects can impact the local tourism economy, irrigation, or other economic development opportunities.
    g. Complete a study to further identify and evaluate Managed Aquifer Recharge (MAR) locations using hydrogeologic framework data from the 2019 Lower Loup NRD AEM Survey Report, or future AEM studies. In addition to a review of geologic data, work to develop an MAR site may include: new boreholes with detailed geologic and geophysical logs, aquifer tests, analysis of groundwater travel times, and a determination of the suitability of MAR sites to meet the Lower Loup NRD Groundwater Management Plan goals.

PLANNING, STUDY, OR OTHER SUPPORTING POLICY ACTIONS

These actions include steps the Lower Loup NRD should consider to enhance the district's ability to implement this plan and work with outside agencies or partners. It is important to work with stakeholders prior to a drought event so that the training, relationships, and resources are ready to go when drought actually occurs. This proactive stance will make the Lower Loup NRD more effective at responding to drought and recovering more quickly. The following actions were identified:

1. Develop a schedule to routinely evaluate and update this drought plan, specifically the monitoring and response protocol.
2. Train/cross train additional team members on drought monitoring tools, such as the National Drought Monitor, drought impact reporting, etc.
3. Develop standardized or scheduled/routine meetings with National Drought Mitigation Center or other agencies to develop relationships and share new data, best practices, etc.
4. Conduct a "test" of the drought plan with active stakeholder group (hold a workshop approximately every three to four years).
5. Assist local jurisdictions in water conservation planning or drought response planning (this could also be done as part of a wellhead protection plan).
6. Develop or share example ordinances with cities and villages that encourage water conservation or water use restrictions.

7. Integrate the drought plan into other Lower Loup NRD planning and policy documents such as the Groundwater Management Plan, Voluntary Integrated Management Plan, and the Lower Platte River Basin Coalition – Basin-Wide Water Management Plan.
8. Proactively develop a protocol for reading flow meters and enforcing their use when that action is triggered through the monitoring and response protocol (DL2: Severe).

6.03 VOLUNTARY BEST MANAGEMENT PRACTICES

The Lower Loup NRD will encourage, educate, and at times provide cost-share to increase the adoption of best management practices that improve irrigation or conserve water. These practices include, but are not limited to:

- Soil moisture probes
- Sub-surface irrigation
- Variable rate irrigation
- Pivot nozzle package conversion
- Flow meters
- Irrigation scheduling
- Conversion from flood irrigation to center pivot
- Farm weather stations (rain sensors, evapotranspiration sensors, etc.)
- Water reuse systems
- Diversified or drought tolerant crop rotations
- Preventative planting (non-corn/bean rotation) during times of drought

6.04 POTENTIAL FUNDING SOURCES

The following programs or funding sources may be able to assist with plan implementation:

- General funds from Lower Loup NRD
- Funds from other local partners (villages, cities, counties, or state)
- Watershed and Flood Prevention Operations (WFPO) funding from Natural Resources Conservation Service (NRCS)
- Water Sustainability Fund (WSF) from State of Nebraska
- Bureau of Reclamation (BOR) WaterSMART grant program
- Source Water Protection grants from Nebraska Department of Environment and Energy (NDEE)
- Section 319 grant program from NDEE
- Nebraska Environmental Trust (NET)
- United States Department of Agriculture (USDA) Rural Development (various funding programs)
- Hazard Mitigation Assistance (HMA) grant program from the Federal Emergency Management Agency (FEMA)
- National Integrated Drought Information Systems (NIDIS) from National Oceanic and Atmospheric Administration (NOAA)

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SECTION 7. PLAN MAINTENANCE AND UPDATES

The Lower Loup NRD will be responsible for monitoring, evaluating, and updating this plan. Support and suggestions from stakeholders and the public will influence and enhance this process. Plan review should be conducted on an annual basis with an update occurring at least every five years. The plan may be updated more frequently at the discretion of the Lower Loup NRD Board, especially in the event of a major drought. If new, innovative mitigation strategies arise that could impact the Lower Loup NRD or elements of this plan, a plan amendment may be proposed and considered separate from the annual review.

7.01 CONTINUED PUBLIC INVOLVEMENT

To ensure plan support and input from the public as well as other stakeholders, public involvement should remain a top priority for the Lower Loup NRD. Notices for public meetings involving the discussion of or action on plan updates should be published and posted at least two weeks in advance.