



David City, Nebraska Wellhead Protection Plan

July 2022

Supported by:



LOWER PLATTE NORTH
Natural Resources District

Funding provided by:

NEBRASKA
DEPT. OF ENVIRONMENT AND ENERGY



THIS PAGE LEFT INTENTIONALLY BLANK



Tami Comte
City of David City
557 N 4th Street
P.O. Box 191
David City, NE 68632

Re: City of David City – Wellhead Protection Plan Approval
NDEE ID: 999161
Program ID: NE3102301

Ms. Comte and Board Members,

It is my pleasure to approve the Wellhead Protection (WHP) plan you have developed for your public water supply. My approval is based on the requirements of the Nebraska State Statute § 46-1506, namely, the WHP area boundaries are reasonably defined, the controls are reasonably related to groundwater protection, and the approval is in the public interest.

Congratulations on a job well done. We strongly encourage you to continue working with the Natural Resources District and other entities in developing best management practices to protect groundwater within your WHP area. It is also important to remember that this plan is a fluid document and therefore should be updated and revised regularly. Good luck in the implementation of your plan and the protection of your drinking water.

Please call Tatiana Davila of my staff at 402-471-3376 if we can be of assistance to you.

Sincerely,

A handwritten signature in blue ink, appearing to read "Jim Macy".

Jim Macy
Director

Cc: Daryl Anderson, Lower Platte North NRD (electronic)
Marie Krausnik, Upper Big Blue NRD (electronic)
Adam Rupe, JEO Consulting (electronic)

THIS PAGE LEFT INTENTIONALLY BLANK

David City, Nebraska



Wellhead Protection Plan

Prepared: April 2022

Adopted by David City: May 2022

Approved by NDEE: July 2022

Acknowledgements

Preparation of this plan was made possible by funding assistance provided by the Nebraska Department of Environment and Energy Source Water Protection Grants Program.



Prepared for: David City, Nebraska

Prepared by: JEO Consulting Group, Inc.

JEO Project Number: 201288.00

PRIMARY WELLHEAD PROTECTION PLAN CONTACTS

Entity	Name	Title	Phone/Email
David City	Tami Comte	City Clerk	402.367.3135 tcomte@davidcityne.com
David City	Aaron Gustin	Water Dept. Supervisor	402.367.3132
Nebraska Department of Environment and Energy	Tatiana Davila	Wellhead Protection Coordinator	402.471.3376 Tatiana.davila@nebraska.gov
Lower Platte North NRD	Daryl Andersen	Water Dept. Manager	402.443.4675 dandersen@lpnrd.org
Upper Big Blue NRD	Marie Krausnick	Water Dept. Manager	402.362.6601 mebel@upperbigblue.org

This wellhead protection plan has been prepared to assist David City to proactively protect and manage the aquifer that is the source of community drinking water. It has been written with guidance published by the Nebraska Department of Environment and Energy (NDEE).

JEO Contact Information:



Adam Rupe | Natural Resources Specialist

JEO CONSULTING GROUP INC

2000 Q Street, Suite 500 | Lincoln, Nebraska 68503

phone: 402.435.3080

arupe@jeo.com

TABLE OF CONTENTS

List of Tables.....	iv
Table of Figures	iv
List of Appendices.....	v
List of Abbreviations and Acronyms.....	v
Nebraska’s Wellhead Protection Program Summary	vi
Chapter 1. Introduction	1
1.01 About This Plan	1
1.02 Future Updates to The Plan	1
1.03 Community Background.....	2
1.04 Natural Resources Districts	3
1.05 Nebraska Groundwater.....	4
1.06 Groundwater Pollution in Nebraska	6
1.07 Groundwater Aquifer	11
Chapter 2. Community Water System.....	17
2.01 Nebraska’s Public Water System Program.....	17
2.02 Water System Information.....	17
2.03 Community Well Nitrate Sampling.....	21
Chapter 3. Wellhead Protection Area	23
3.01 Delineation	23
3.02 Land Use.....	25
Chapter 4. Potential Contaminant Source Inventory	29
4.01 Existing Groundwater Contamination.....	36
Chapter 5. Regulatory Authority	41
5.01 David City	41
5.02 Natural Resources Districts	44
5.03 State of Nebraska	45
Chapter 6. Emergency, Contingency, and Long Term Planning.....	47
6.01 Emergency and Contingency Planning.....	47
6.02 Drought Planning	48
Chapter 7. Management Strategies	51
7.01 Activities Completed to Date	51
7.02 Planned Activites for the Near Future.....	51
7.03 Potential Activities for Consideration	52
7.04 Best Management Practices for Consideration	52
Chapter 8. Public Education and Notification	55
8.01 Opportunity for Public Input	55
8.02 Planning Stakeholder Committee	55
8.03 Meeting Summary.....	56
References.....	57

USB (located in binder cover pocket) - Digital copy of the plan, appendices, and GIS data.

LIST OF TABLES

Table 1: Municipal Water System Information	18
Table 2: Municipal Water Supply Well Information	19
Table 3: David City Well Discharge Summary (2016-2019)	20
Table 4: 2020 Land Use in the WHP Area	26
Table 5: Summary of David City Contaminant Source Inventory	32
Table 6: Summary of Existing Groundwater Contamination in the David City WHP Area	36
Table 7: Required Well Setback Distances, by Nebraska State Titles	42
Table 8: NRCS Source Water Protection Priority Practices	53
Table 9: David City Wellhead Protection Stakeholder Committee Members	55

TABLE OF FIGURES

Figure 1: Location of David City	2
Figure 2: Historical Population of David City	3
Figure 3: Lower Platte North and Upper Big Blue NRD Boundaries	4
Figure 4: Density of Active Registered Irrigation Wells – December 2015	5
Figure 5: Groundwater Level Changes – Predevelopment to Spring 2019.....	6
Figure 6: Illustration of the Root Zone, Unsaturated Zone, and Groundwater	8
Figure 7: Most Recent Nitrate Concentrations from Wells Sampled 2000-2019	9
Figure 8: Typical Routes of Groundwater Contamination	12
Figure 9: Geologic Cross Section Locations.....	13
Figure 10: Hydrogeologic Cross Section G-G'	14
Figure 11: Hydrogeologic Cross Section S-S'	15
Figure 12: Active Municipal Well Locations	18
Figure 13: Bruno Water Line	19
Figure 14: Average Water Use Between David City and Other Populations	21
Figure 15: Nitrate Concentrations in David City Treatment Plant	22
Figure 16: Official David City WHP Area Map	24
Figure 17: Varying Types of Land Use. (A) Irrigated Row crops; (B) Urban setting; (C) Natural vegetation.	25
Figure 18: 2020 Land Use and Irrigated Acres in the David City WHP Area	27
Figure 19: Common Types of Potential Contaminant Sources. (A) Leaking Fuel Drums; (B) Livestock Waste; (C) Abandoned Wells; (D) Parking Lot Runoff.....	30
Figure 20: Contaminant Source Inventory in the David City WHP Area	33
Figure 21: NDEE Regulated Facilities in the David City WHP Area.....	34
Figure 22: Registered Wells in the David City WHP Area	35
Figure 23: David City ETJ and WHP Area.....	44

LIST OF APPENDICES

APPENDIX A: GROUNDWATER MODELING DOCUMENTATION AND MAPS

APPENDIX B: PUBLIC WATER SYSTEM DOCUMENTS

APPENDIX C: SELECT ORDINANCES AND MUNICIPAL CODES

APPENDIX D: CONTAMINANT SOURCE INVENTORY

APPENDIX E: EMERGENCY RESPONSE INFORMATION

APPENDIX F: PLAN ADOPTION MATERIALS

APPENDIX G: DOCUMENTATION OF STAKEHOLDER INVOLVEMENT

LIST OF ABBREVIATIONS AND ACRONYMS

BMP	Best Management Practice		
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act	NeDNR	Nebraska Department of Natural Resources
CSI	Contaminant Source Inventory	NEWARN	Nebraska Water/Wastewater Agency Response Network
Database	Quality Assessed Agrichemical Contaminant Database	NPDES	National Pollutant Discharge Elimination System
EA	Environmental Assessment	NRCS	Natural Resources Conservation Service
EPA	Environmental Protection Agency	NRD	Natural Resources District
ETJ	Extraterritorial Jurisdiction	NPS	Nonpoint Source
ft bg	feet below grade	ppb	Parts per billion
Gal	Gallon	PWSS	Public Water Supply System
gpcpd	Gallons per customer per day	SARA	Superfund Amendments and Reauthorization Act
GWMA	Groundwater Management Area	SDWA	Safe Drinking Water Act
GWMPA	Groundwater Management and Protection Act	The city	David City
LPNNRD	Lower Platte North Natural Resources District	TOT	Time of Travel
MCL	Maximum Contaminant Level	UBBNRD	Upper Big Blue Natural Resources District
mg/L	milligrams per liter	UNL	University of Nebraska-Lincoln
NDA	Nebraska Department of Agriculture	USDA	United States Department of Agriculture
NDEE	Nebraska Department of Environment and Energy	USGS	United States Geological Survey
NDHHS	Nebraska Department of Health and Human Services	UST	Underground Storage Tank
		WARN	Water/Wastewater Agency Response Network
		WHP	Wellhead Protection

NEBRASKA'S WELLHEAD PROTECTION PROGRAM SUMMARY

A WELLHEAD PROTECTION AREA IS THE SURFACE AND SUBSURFACE AREA SURROUNDING A COMMUNITY DRINKING WATER WELL OR WELL FIELD, THROUGH WHICH CONTAMINANTS ARE REASONABLY LIKELY TO MOVE TOWARD AND REACH SUCH WATER WELL OR WELL FIELD (§46-1502).

NEBRASKA'S WELLHEAD PROTECTION PROGRAM

The Nebraska Department of Environment and Energy (NDEE) administers the Wellhead Protection (WHP) Program, which began after the Nebraska Legislature passed LB 1161 in 1998 (Neb. Rev. Stat. §46-1501 – 46-1509), authorizing the Wellhead Protection Area Act. The Act sets up a voluntary process for public water supply systems to implement a local WHP plan. The intent of this WHP planning process is to establish guidelines for communities and other public water suppliers to develop local WHP plans. A WHP plan does not provide any new powers to a community; it serves as a guide to local decision makers tasked with protecting the community drinking water supply. All community public water supplies in Nebraska have a Wellhead Protection Area map as of October 1, 2004.

WELLHEAD PROTECTION PLAN REQUIREMENTS

1. **Delineate the WHP Area** – A WHP area map that shows the area that is critical for protecting a community's drinking water supply source.
2. **Perform a Contaminant Source Inventory (CSI)** - Conducting a CSI involves locating and documenting activities, structures, and locations which could affect the quality of the drinking water source.
3. **Manage potential contaminants** - After identifying potential contaminant sources within the WHP area, the community can develop projects or other management tools to ensure a safe drinking water supply. This can include: zoning, local ordinances, working with landowners to implement best management practices (BMPs), and public outreach education.
4. **Develop emergency and contingency plans** - These plans assist a community in responding to events such as natural disasters, contamination, and drought.
5. **Educate and involve the public** - Community awareness helps provide citizens with the information they need to protect drinking water, reduce pollution, and increase their participation in wellhead protection efforts.

CHAPTER 1. INTRODUCTION

1.01 ABOUT THIS PLAN

This planning document is prepared for the David City (the city) as a general guide to manage the source of their drinking water, particularly as it relates to water quality. Adoption of the document is indicative to water system users, the community, and outside agencies that the city values its water system and desires systematic and proactive protection for its drinking water sources. This plan confers no new legal requirements or regulatory authority to the city, or any other entity. Projects and programs implemented through the plan are voluntary.

The planning process is an opportunity to continue to build and develop relationships between all stakeholders while also developing projects and programs. It is a valuable component through which communities engage with the public and project partners to develop source water planning documents. Source water refers to water used as drinking water for public or private water supplies. This can include surface water from streams, rivers, and lakes, as well as groundwater from aquifers. David City's source of drinking water is from local groundwater. Protecting source water reduces risks to public health from contaminated water exposures (EPA, 2022). This planning process brings together community leaders, agency representatives, landowners, and technical specialists – many of which may have competing interests, differences in viewpoints, conflicting terminologies, or a general lack of knowledge about water management. This process challenges stakeholders to re-evaluate their own ideas and continue learning more about source water issues.

1.02 FUTURE UPDATES TO THE PLAN

It is recommended that the plan, goals, and action items be reviewed annually by the WHP Stakeholder Committee. Groundwater and WHP related actions should be documented, reported, evaluated, and revised during this time. Five-year updates should include any changes to potential sources of contamination or land use within the WHP area or the addition of a municipal well. Long-term water quality and use trends should be evaluated and extrapolated into future projections to ensure sustainability of the source water is maintained.

NDEE, the Nebraska Department of Health and Human Services (NDHHS), the Lower Platte North Natural Resources District (LPNNRD), and Upper Big Blue Natural Resources District (UBBNRD) should be consulted during each update to determine if additional information has been developed or if any related regulations or other requirements require a review of the plan.

1.03 COMMUNITY BACKGROUND

David City is located in eastern Nebraska, in Butler County, south of the Platte River (Figure 1). The population of David City, now approximately 2,852, has seen moderate growth throughout the 20th century (Figure 2).

In addition to David City, private drinking water systems within the WHP area will also benefit from this plan. Approximately 33 rural homes and 9 privately owned registered domestic wells currently exist throughout the WHP area. Proper management of water resources within the WHP area is vital to the city’s future.

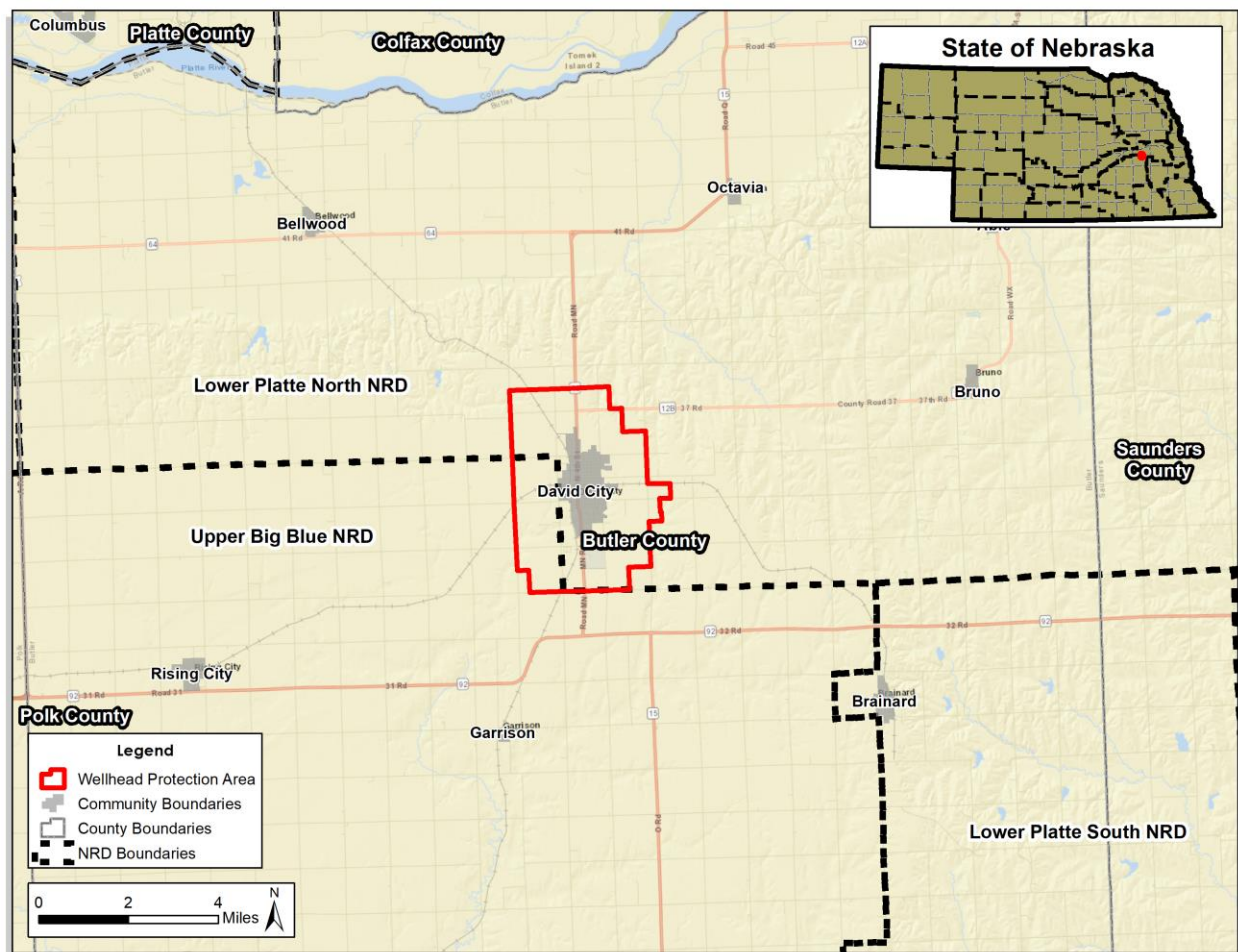
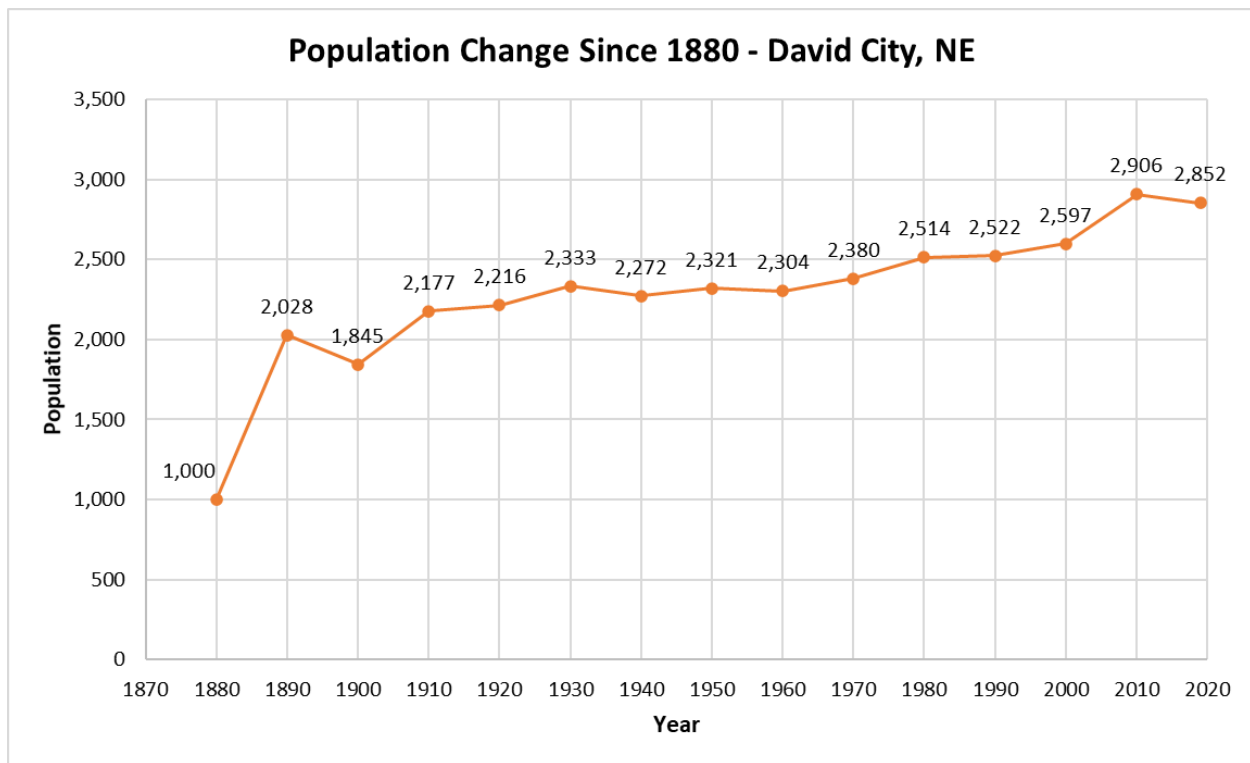


Figure 1: Location of David City



Source: U.S. Census Bureau, 2018

Figure 2: Historical Population of David City

1.04 NATURAL RESOURCES DISTRICTS

Natural Resources Districts (NRDs) are government entities, led by a locally elected board of directors, with broad responsibilities to protect natural resources. Major Nebraska river basins form NRD boundaries, enabling districts to respond best to local needs. Nebraska's NRDs are involved in a variety of projects and programs to conserve and protect the state's natural resources, especially groundwater. The board of directors governs each district and much of their funding is provided by local property taxes. The city's WHP area falls within both the LPNNRD and UBBNRD boundaries (Figure 3).

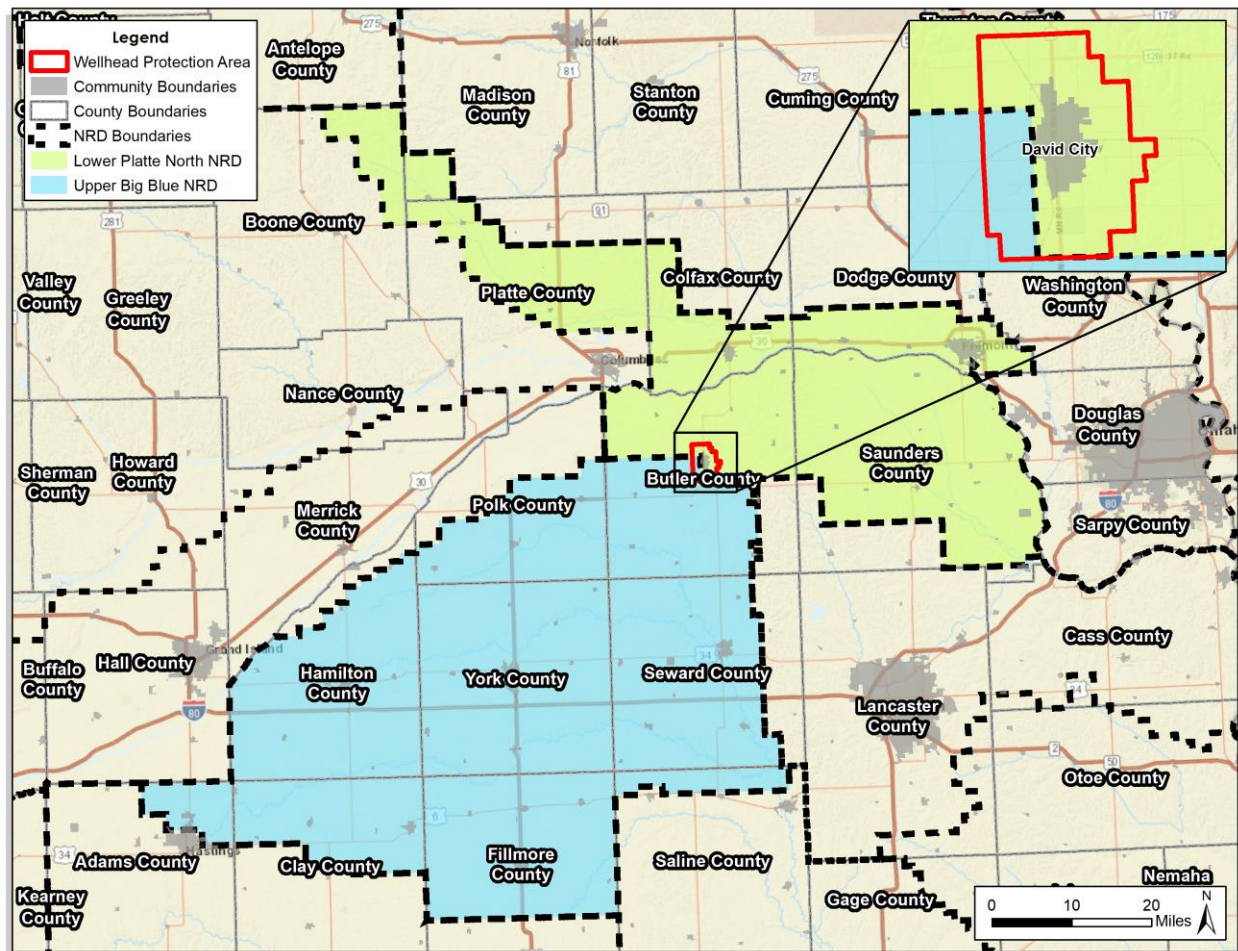
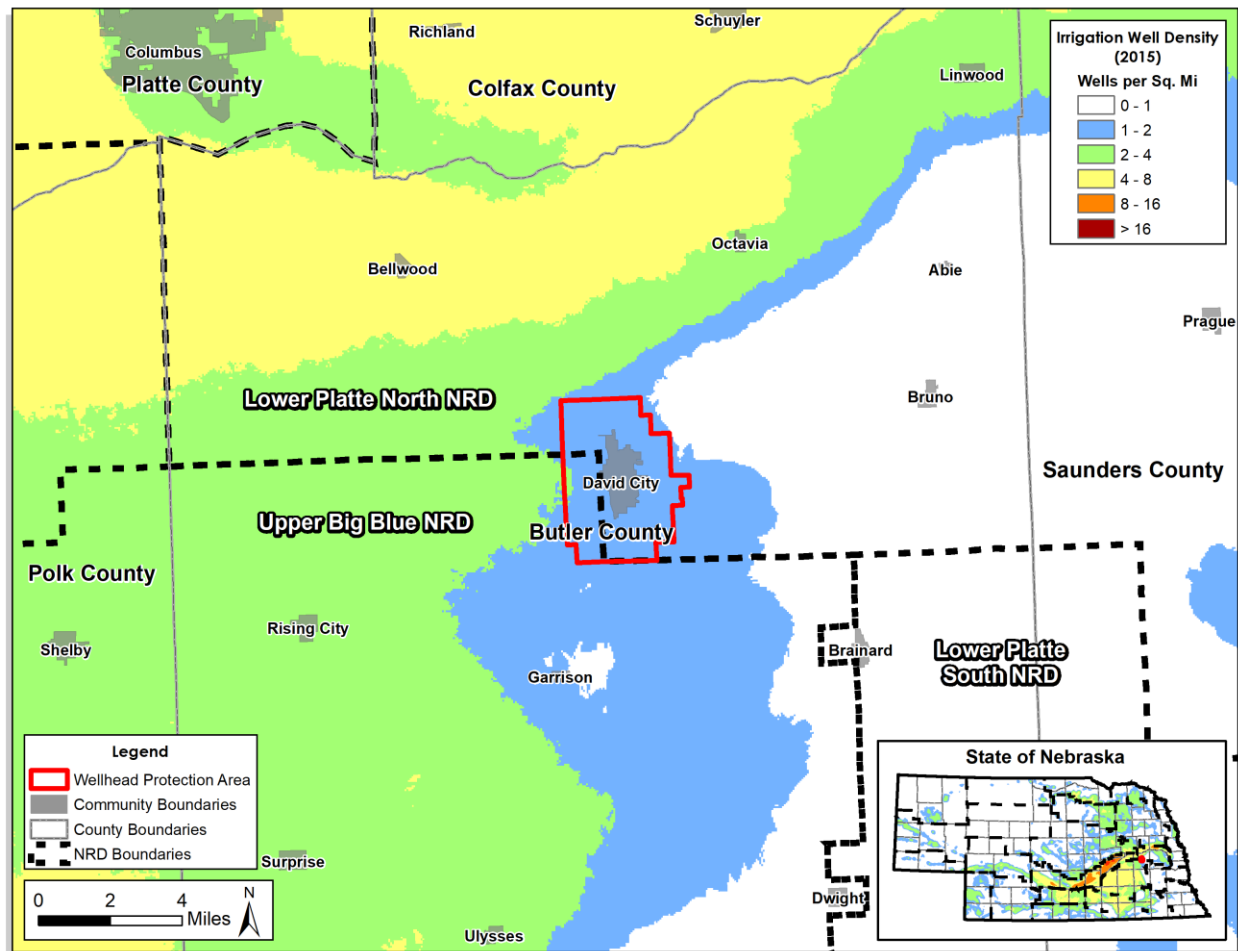


Figure 3: Lower Platte North and Upper Big Blue NRD Boundaries

1.05 NEBRASKA GROUNDWATER

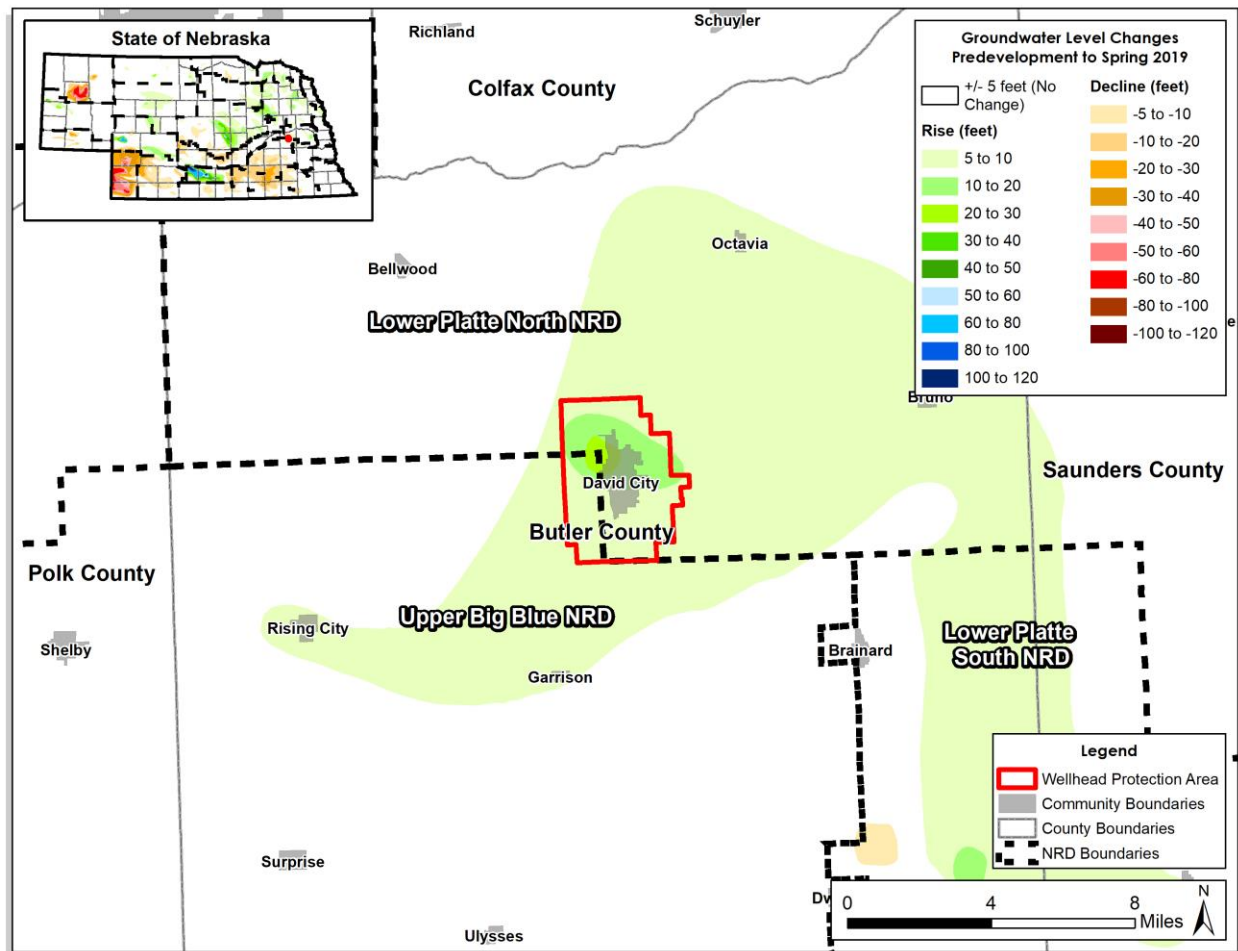
Nebraska has significant groundwater sources throughout the state. Groundwater uses include irrigation, water supply for humans and animals, and uses for commercial and industrial activities. Nebraska receives nearly 88% percent of its public drinking water and nearly 100% of its private water supply from groundwater sources (Miesbach and others, 2019). Agriculture, the state’s largest industry, is dependent on this resource as well. As of November 2019, the Nebraska Department of Natural Resources (NeDNR) listed over 96,000 active irrigation wells and over 31,000 active domestic wells registered in the state (Miesbach and others, 2019). Figure 4 displays the density of registered irrigation wells near David City. Domestic wells were not required to be registered with the state prior to 1993, therefore thousands of unregistered domestic wells also exist in unknown locations.



Source: UNL Conservation & Survey Division

Figure 4: Density of Active Registered Irrigation Wells – December 2015

In respect to groundwater withdrawal, aquifer elevation is measured to establish trends in groundwater level and availability. Figure 5 characterizes the change in groundwater levels from pre-development to the spring of 2019. Most of Nebraska, which is underlain by the High Plains Aquifer, has groundwater available in adequate amounts. However, other areas, primarily those in the east and northwest regions of the state, have difficulty providing adequate yields. Groundwater in the east can be more limited because glaciation and erosion have deposited many geologic formations with variable properties. The region in and around David City has seen moderate increases in groundwater levels.



Source: UNL Conservation & Survey Division

Figure 5: Groundwater Level Changes – Predevelopment to Spring 2019

1.06 GROUNDWATER POLLUTION IN NEBRASKA

Groundwater pollution throughout Nebraska varies by the type of pollutant and scale of the contamination. Generally, three types of pollutants are of concern to water quality in Nebraska: nitrates, pesticides, and bacteria (coliforms, *E. coli*, etc.). The presence of pesticides in water supplies is an increasing concern. Atrazine is one of the commonly detected pesticides found in drinking water wells of Nebraska which is consistent with usage, as well as its relatively high mobility and persistence. Coliform group bacteria are microscopic, generally harmless organisms living in the digestive system of warm-blooded animals. Although coliform bacteria do not directly cause diseases, they are often indicators of other, more dangerous bacteria. Sources of fecal coliform are septic systems, barnyards, and animal waste lagoons (Gosselin, 1997).

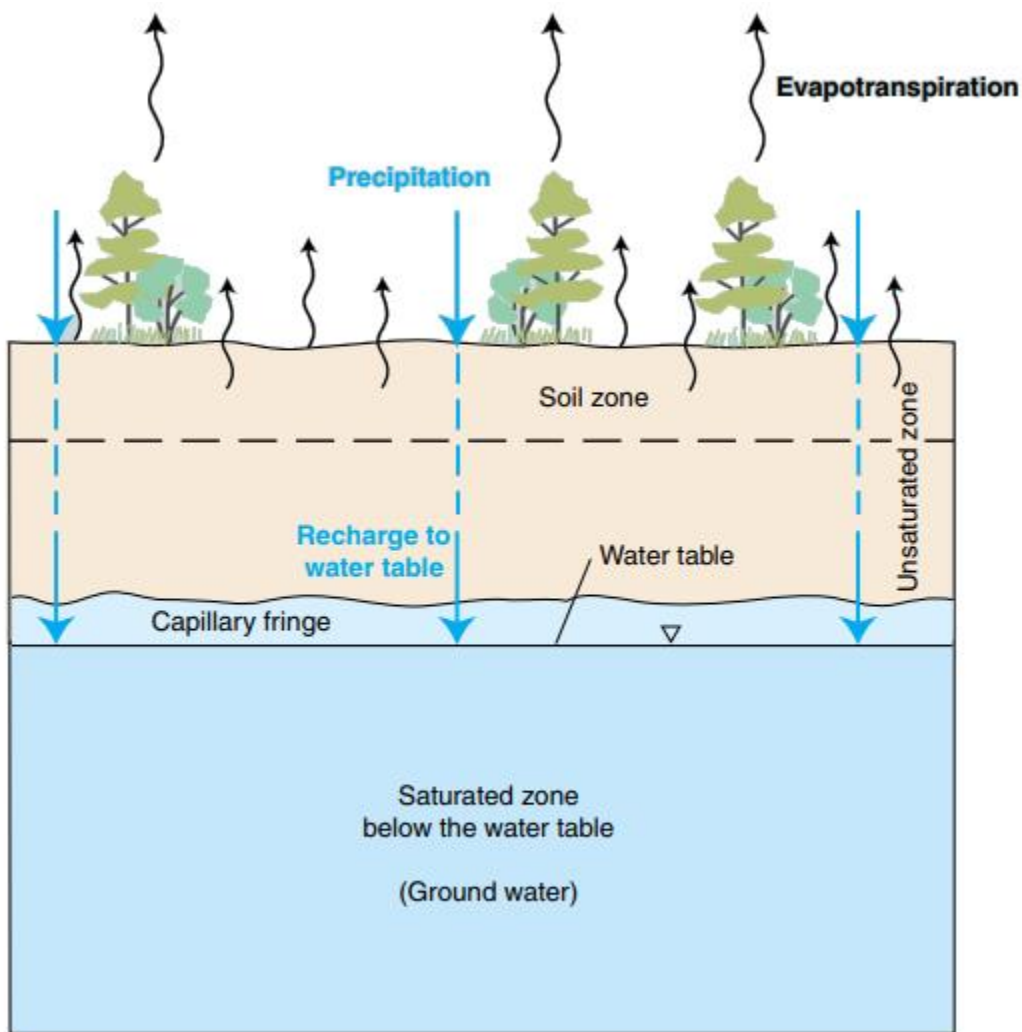
NITRATE POLLUTION

Of the three most common municipal water source pollutants, the most pervasive is nitrate-nitrogen (nitrate). Groundwater pollution, especially due to nitrate, is a growing concern for many communities in Nebraska. Nitrates in public water systems are also a concern for state agencies such as the NDEE and NDHHS, which are responsible for working with public drinking water systems.

In an undisturbed natural system, perennial vegetation utilizes nitrogen, thus limiting available nitrate that can leach into groundwater. However, agricultural development throughout the area has removed much of the perennial vegetation, replacing it with annual crops, and increased the application of both organic and inorganic forms of nitrogen as a fertilizer for crop fields. When crops do not fully utilize the nitrogen, it leaches through the vadose zone and into groundwater (Figure 6). In general, nitrates that are present below the root zone (approximately six feet below the soil surface) cannot be utilized by plants or crops. These nitrates eventually migrate to the aquifer unless they encounter a geologic formation that prevents this, such as a thick clay layer between the ground surface and the aquifer.

High levels of nitrates in drinking water are known to cause methemoglobinemia, or “blue baby syndrome” in infants and immune-compromised adults. Methemoglobinemia reduces the oxygen-carrying capacity of blood, often resulting in blue skin coloring around the mouth, hands, and feet. In severe cases methemoglobinemia can cause seizures and death from reduced oxygen levels in the body. Additionally, when nitrates in the body are broken down and converted into the chemical compound nitrite, they can react with other compounds (amines) in the body and form nitrosamines - a cancer-causing compound (National Cancer Institute, 2021). Other carcinogenic compounds have been known to become more prevalent when high levels of nitrates are present in drinking water. Due to these risks, the US Environmental Protection Agency (EPA) has set a Maximum Contaminant Level (MCL) of 10 milligrams per liter (mg/L) for nitrate-nitrogen in drinking water.

The city monitors nitrate levels in a central treatment plant annually and routine water quality testing has shown that nitrate levels have not exceeded the MCL and are generally so low as to be undetectable. As of February 2021, the water systems nitrate concentration was less than the reporting level (NDHHS, 2021).



Source: Alley and others, 1999

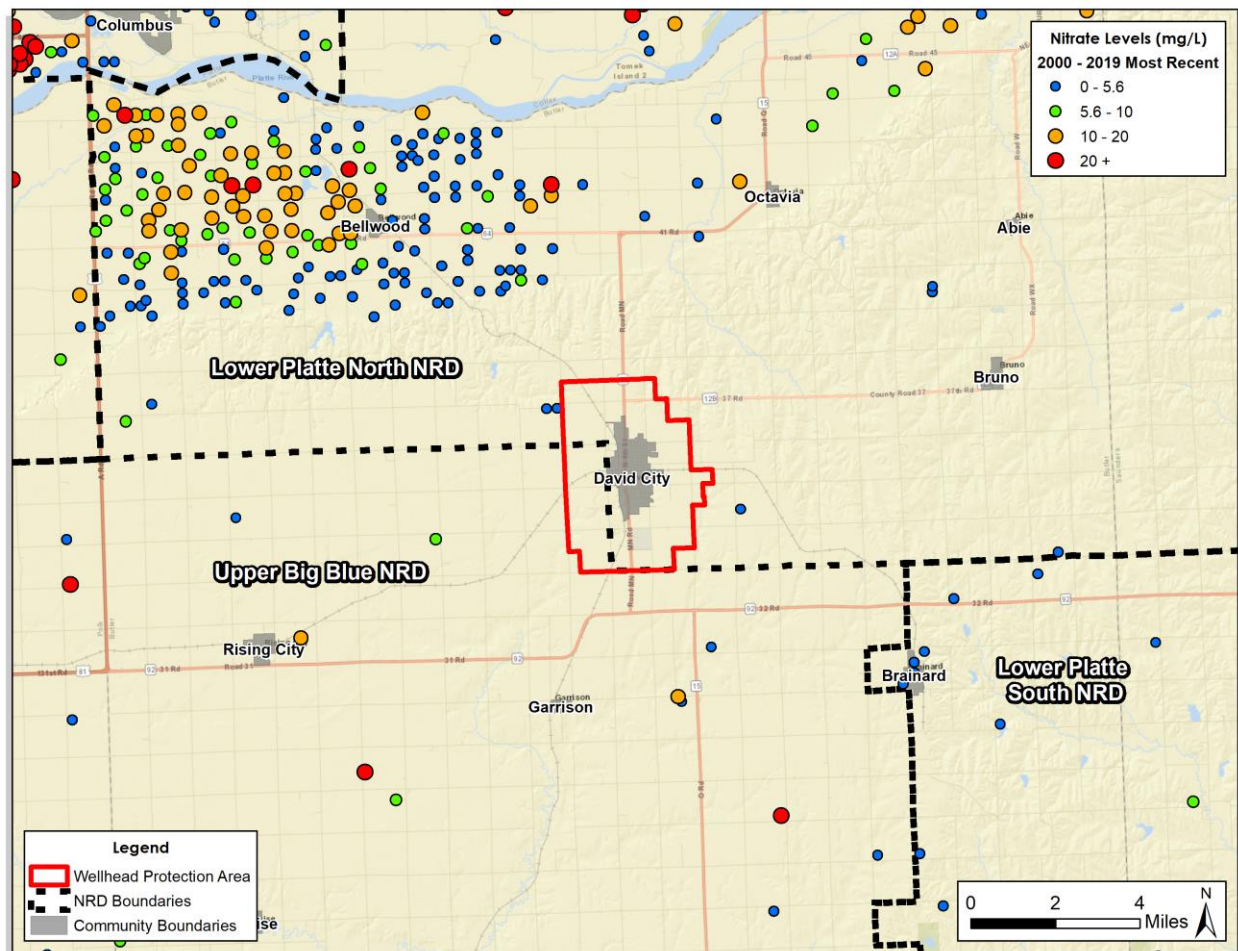
Figure 6: Illustration of the Root Zone, Unsaturated Zone, and Groundwater

An extensive network of groundwater monitoring and quantity/quality evaluation exists throughout the State. This effort involves multiple entities, including:

- Natural Resources Districts (23 in total)
- Nebraska Department of Agriculture (NDA)
- NeDNR
- NDEE
- NDHHS
- Public Water Suppliers
- University of Nebraska-Lincoln (UNL)
- United States Geological Survey (USGS)

Monitoring results are compiled in the Quality Assessed Agrichemical Contaminant Database for Nebraska Groundwater (Database). The Database compiles groundwater monitoring data from different sources and provides public access to the results. Available water quality data ranges from 1974 to the present. Monitoring data is collected from irrigation and domestic supply wells in addition to dedicated groundwater monitoring sites. The number of designated groundwater monitoring wells has increased through the past several years across the State. The Database is available online at: <https://clearinghouse.nebraska.gov/>

A review of the Database provided the most recent nitrate concentrations for each well sampled in and around the WHP area since 2000 (Figure 7). None of the wells sampled fell within the WHP area; however, the three closest wells all had nitrate levels between 0 – 5.6 mg/L. A cluster of wells to the northwest of the WHP area had nitrate levels that exceeded the MCL of 10 mg/L.



Source: Nebraska Groundwater Quality Clearinghouse (NDEE, 2022)

Figure 7: Most Recent Nitrate Concentrations from Wells Sampled 2000-2019

EMERGING CONTAMINANTS

In recent years, groundwater managers in Nebraska have become concerned that the overall groundwater chemistry is changing and naturally occurring elements in the aquifer material are being released into the groundwater. A recent study (Nolan and Weber, 2015) considered the relationship of elevated groundwater nitrate levels and uranium concentrations in groundwater. Elevated uranium concentrations are found in many regions, including those without anthropogenic uranium activity (mining, nuclear testing, etc.), indicating a source of natural uranium contamination. Research indicates that natural uranium in the subsurface may be oxidized and mobilized as the nitrate (in many forms) moves through the root zone and eventually to groundwater. Shallow groundwater was determined to be the most susceptible to co-contamination. Nolan and Weber (2015) indicated that nitrate concentrations near the MCL are correlated to elevated groundwater uranium concentrations; thus, nitrate, a primary groundwater contaminant, can be a factor leading to secondary uranium concentration.

This correlation is significant because consumption of uranium contaminated drinking water has been linked to nephrotoxicity (toxicity in the kidneys) and ototoxicity (damage to the inner ear) and, thus, poses a health risk (Nolan and Weber, 2015). Some public water supply systems treat not only nitrates, but also uranium (NDEE, 2018). In addition to drinking water concerns, food crops irrigated with contaminated water have been demonstrated to accumulate uranium, thus leading to an additional uranium exposure through food crops (Nolan and Weber, 2015).

While David City's drinking water has not yet violated the MCL for any emerging contaminants, the arsenic level in 2020 was 3.1 parts per billion (ppb), with the MCL for arsenic at 10 ppb. This is not yet a widespread issue but may become so in the future and will require close monitoring.

1.07 GROUNDWATER AQUIFER

SETTING AND CHARACTERISTICS

The availability of groundwater in an area depends heavily upon the local subsurface geology. Areas with low bedrock elevation and high saturated ground thickness are desirable for well construction, as these areas are more likely to provide high quantities of groundwater with lower effort from well pumps. The quality of groundwater will vary based on geology. The geology of the WHP area includes unconsolidated surficial aquifers comprised of gravel, sand, silt, and glacial till, referred to collectively as the Principal Aquifer, and the Dakota aquifer, formed from underlying sandstone bedrock. The Dakota and Principal aquifers are separated by shale formations to the north, west, and south of the city but are directly connected below the city itself. The Platte River Valley aquifer lies to the north of the city and is often a source of groundwater (LRE, 2021).

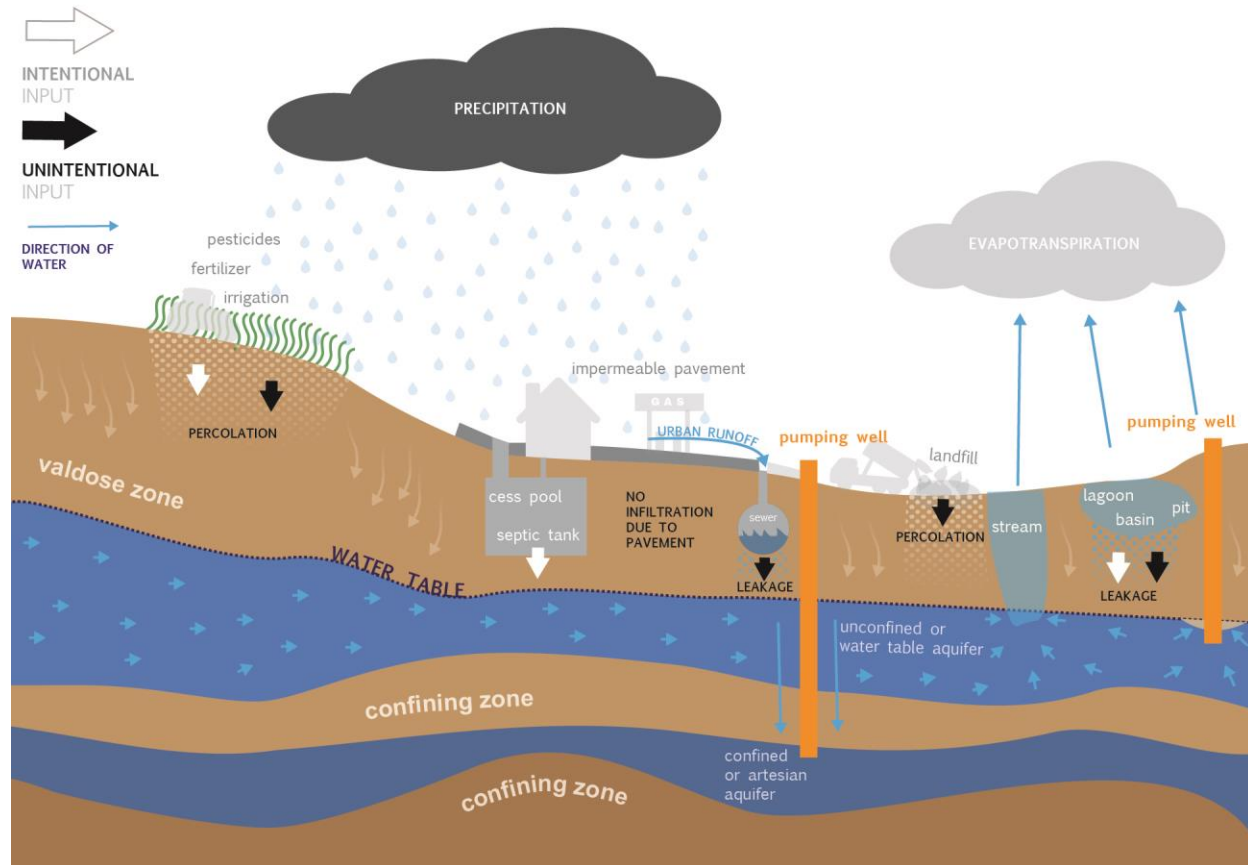
VULNERABILITY TO CONTAMINATION

Regions that are within an aquifer zone or rely on the groundwater produced by a well are vulnerable to contamination from human activities. There are various computer models available that serve as a practical visualization tool for decision making which quantify or illustrate that vulnerability. Alone, they do not fill a direct role, but cumulatively contribute to understanding the issues. In general terms, it is relatively easy to delineate areas of high vulnerability, difficult to determine that an area has very low vulnerability, and nearly impossible to reliably define fine gradations between the two.

Solely utilizing any model to address management decisions should be done conservatively and with additional information. Groundwater management requires cooperative efforts between regulatory agencies, policy makers, natural resources managers, educators, the public, and technical experts. Actions based solely on a vulnerability assessment should be tempered by the uncertainty of the assessment and the confidence of the technical experts in the assessment they have produced (National Research Council, 1993).

Groundwater vulnerability is a function of the properties in the natural system where groundwater is found; however, the risk of contamination may be relatively low or high regardless of the vulnerability. Contamination risk is assessed by the proximity or siting of a source where potential introduction of a pollutant into a vulnerable area may exist. Additional groundwater monitoring of vulnerable areas may aid in reducing the risk of contamination. It is important that decisions and management of resources distinguish between vulnerability and risk (Rahman, 2008). Figure 8 illustrates the many ways in which contamination may be introduced to a generalized groundwater system (risk factors). Contamination risk increases when there are more contaminant sources that are present, regardless of the vulnerability.

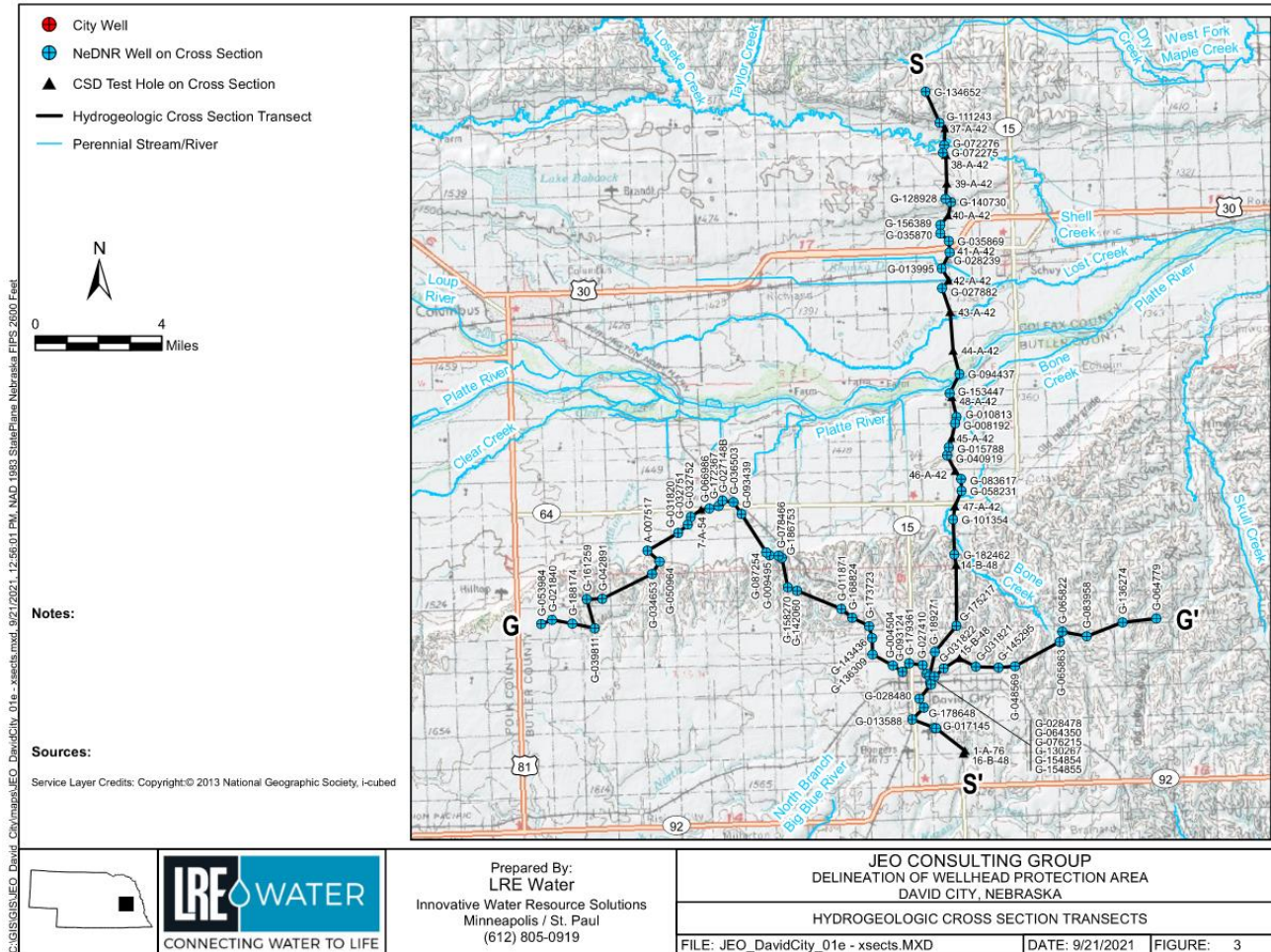
BECAUSE THE WELLHEAD PROTECTION AREA IS THE MOST CRITICAL AREA FOR RECHARGE OF THE COMMUNITY’S SOURCE OF DRINKING WATER, IT SHOULD BE CONSIDERED HIGHLY VULNERABLE AND EVERY RISK FACTOR SHOULD BE EVALUATED CAREFULLY.



Source: Adapted from University of Texas at Austin – Center for Research in Water Resources
 Note: Figure is for illustration only, not to scale and not specific to David City

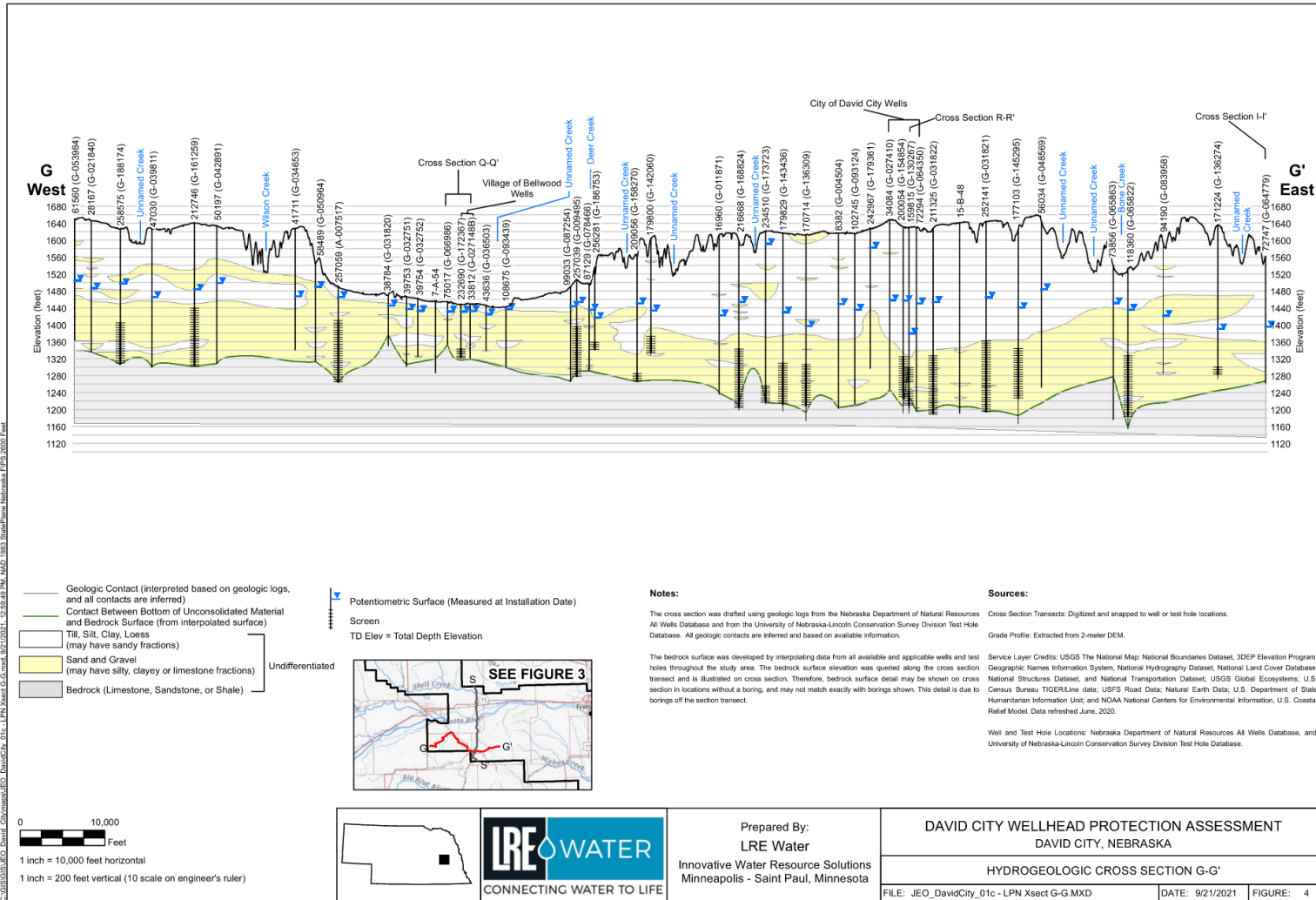
Figure 8: Typical Routes of Groundwater Contamination

A hydrogeologic assessment was completed in 2021 to delineate the updated WHP area for David City. The results of this assessment included two geologic cross sections showing the principal aquifer underlain by bedrock (Figure 9, Figure 10 and Figure 11). The complete assessment report is available in Appendix A.



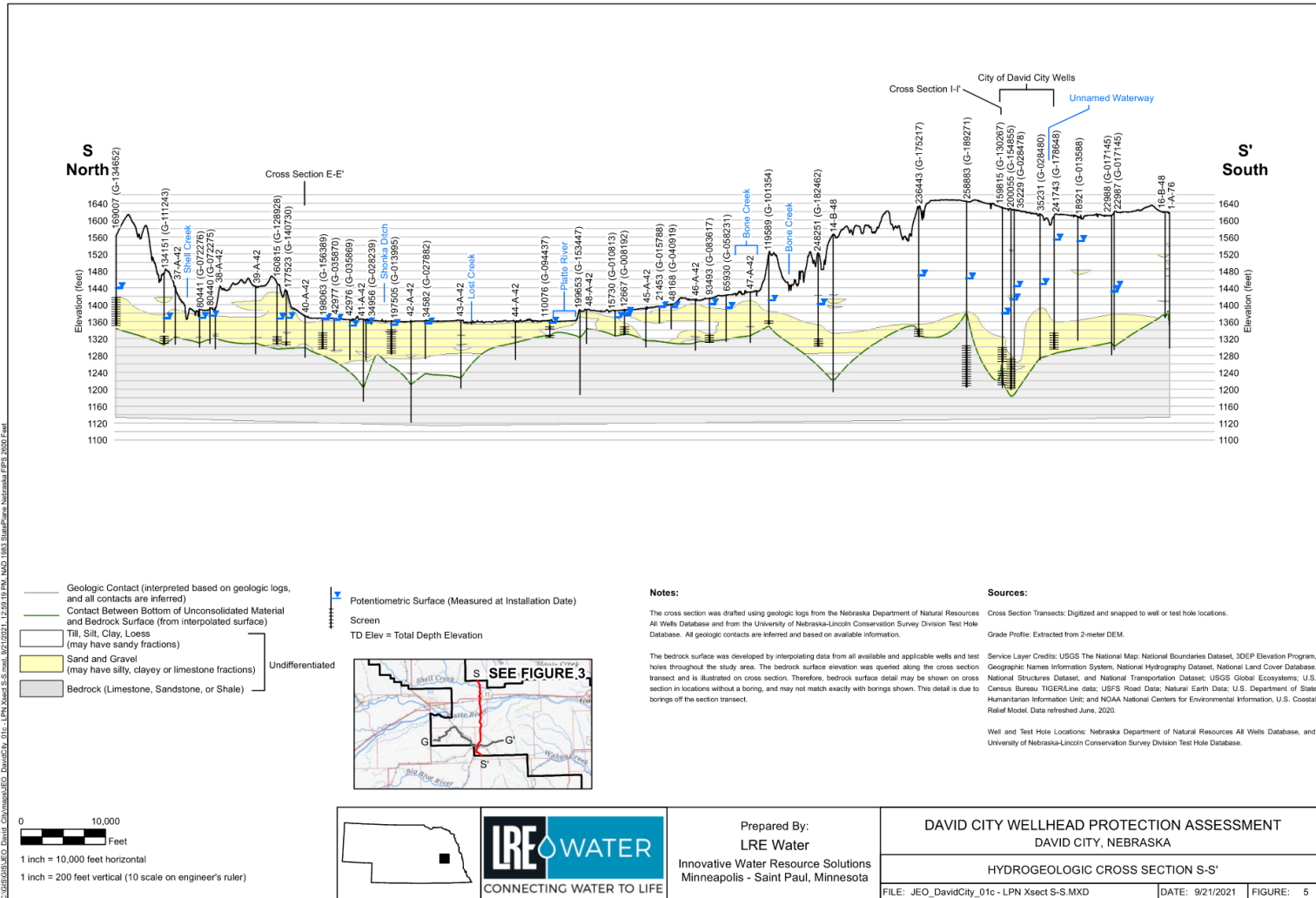
Source: LRE, 2021

Figure 9: Geologic Cross Section Locations



Source: LRE, 2021

Figure 10: Hydrogeologic Cross Section G-G'



Source: LRE, 2021

Figure 11: Hydrogeologic Cross Section S-S'

THIS PAGE LEFT INTENTIONALLY BLANK

CHAPTER 2. COMMUNITY WATER SYSTEM

2.01 NEBRASKA'S PUBLIC WATER SYSTEM PROGRAM

The EPA established the Public Water System Supervision Program under the authority of the 1974 Safe Drinking Water Act (SDWA). With the SDWA and subsequent 1986 Amendments, EPA regulates the limits of contaminant levels in drinking water nationwide to ensure that public water supplies are safe for human consumption. Within the State of Nebraska, the Division of Public Health of the NDHHS administers the Public Water System Supervision Program, under EPA guidance. The mission of the Public Water System Program of NDHHS is to protect the health and welfare of Nebraskans by assuring safe, adequate, and reliable drinking water.

PEOPLE EXPECT THEIR DRINKING WATER WILL BE SAFE WHEN THEY TURN ON THE FAUCET.

NDHHS's Department of Regulation and Licensure visits all Public Water Supply Systems (PWSSs) to conduct sanitary surveys once every three years for community water systems. A sanitary survey is an on-site review of the water source, facilities, equipment, operations, and maintenance of a public water system for the purpose of evaluating the system's adequacy and ability to reliably produce and distribute safe drinking water within the confines of regulatory requirements. The city's most recent sanitary survey was completed in 2022, and a copy can be found in Appendix B. The State of Nebraska requires communities to provide a Water Quality Report annually to residents. The report consists of a single page summary of water quality test results for the year. The most recent water quality report is included in Appendix B and is also available at the city office.

2.02 WATER SYSTEM INFORMATION

The city's drinking water supply system includes four active wells and two inactive wells located throughout the community (Figure 12), a water tower, an underground storage tank, and a distribution system serving 2,800 people (Byrkit, 2020). Water from all wells is blended at the city's treatment plant, where it is filtered, chlorinated, iron is removed, the pH is lowered, and lime is added as a softener. A summary of the water system's information is included in Table 1. Specific information about each municipal well is presented in Table 2. City Well #8, currently inactive, is in the process of being decommissioned and properly sealed.

The David City water system also serves the Village of Bruno to the east through the Bruno Water Line, shown in Figure 13. There are 10 connections to the Bruno line: 7 rural residential, two commercial, and one for the village itself, which serves approximately 120 people.

Table 1: Municipal Water System Information

General System Information	
System ID	NE31-02301
Meters Connected	100%
Maximum Daily (24-hour) Production Capability	4.204 million gallons/day
Total Production for past year	202.698 million gallons
Active service connections	1,399
Population served	2,800

Source: Byrkit (2020)

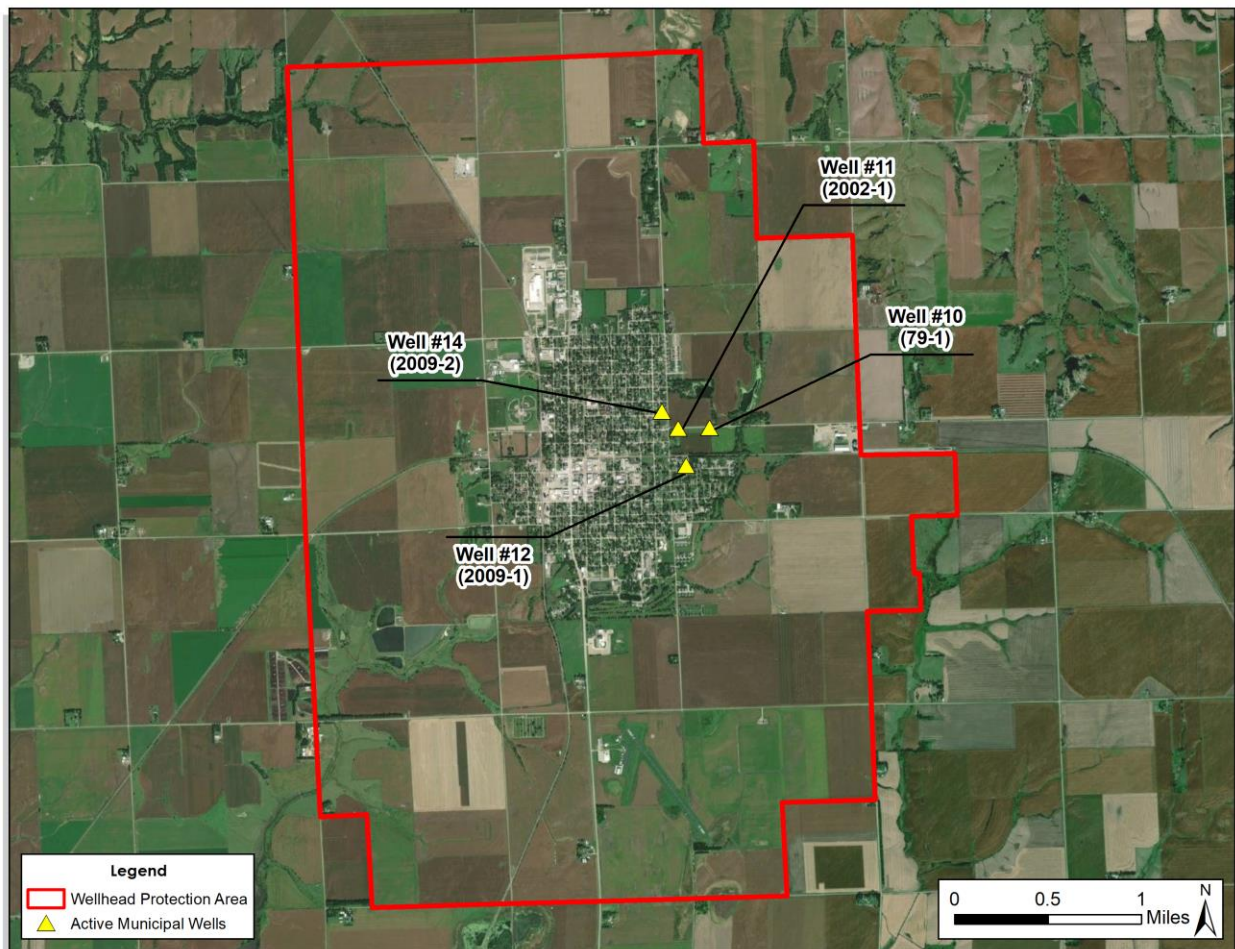


Figure 12: Active Municipal Well Locations

Table 2: Municipal Water Supply Well Information

City Well ID	Registration #	Local Name	Year Drilled	Total Well Depth (ft bg)	Screen (ft bg)
8*	G-027410	66-1	1966	405	355-405
9*	G-076215	72-1	1972	431	381-431
10	G-064350	79-1	1979	425	378-428
11	G-130267	2002-1	2002	427	330-367, 386-420
12	G-154854	2009-1	2009	508	354-424
14	G-154855	2009-2	2009	427	305-405

Source: LRE, 2021

Note: Wells 8 and 9 are currently inactive. Well #8 is in the process of being decommissioned and sealed.

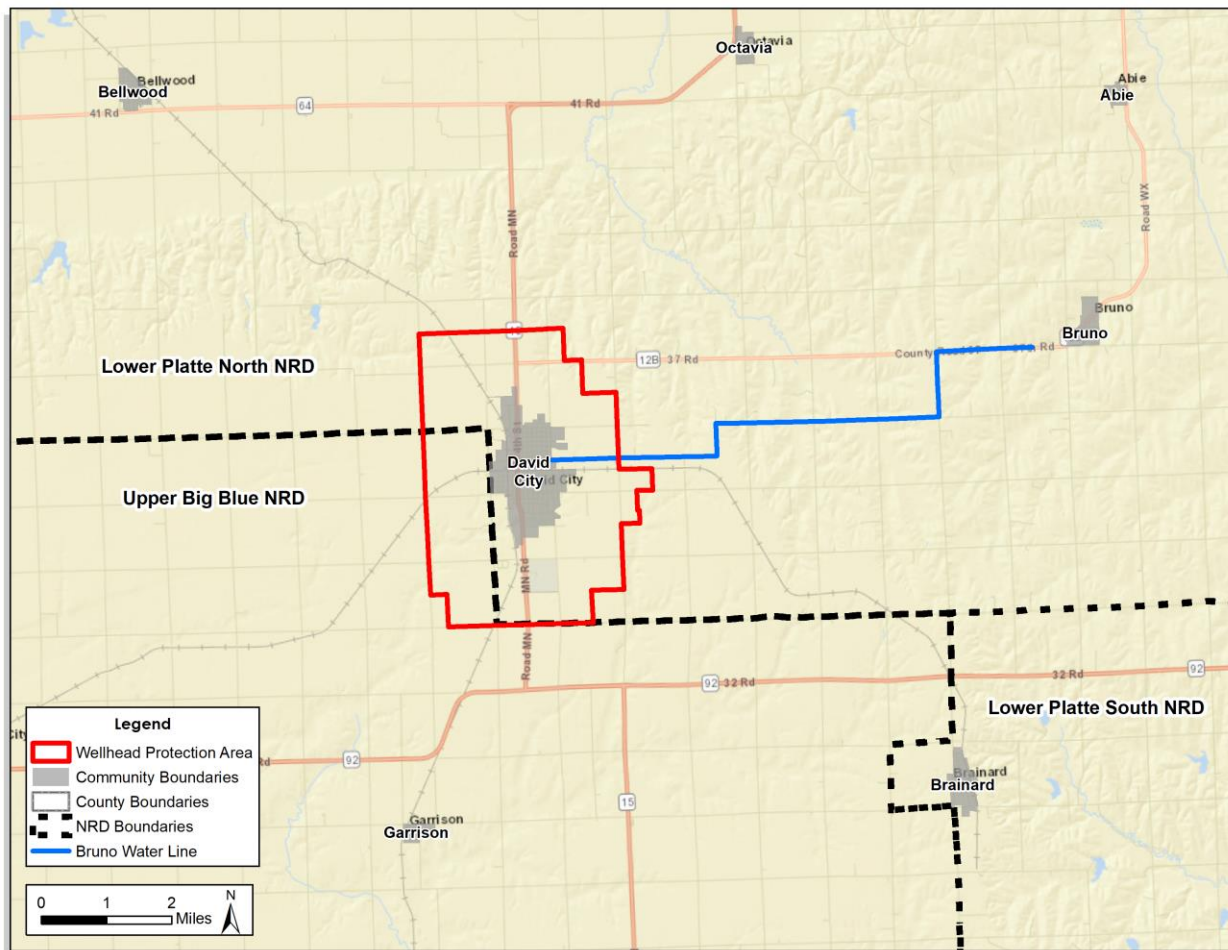


Figure 13: Bruno Water Line

MUNICIPAL WATER USE

Pumping information for each of the municipal wells is summarized below in Table 3. Based on data reported in the most recent sanitary survey, the daily water use of the city is 198 gallons per customer per day (gpcpd). This volume is greater than the typical industry-standard range of 80-120 gpcpd, and the Nebraska statewide public supply average of 160 gpcpd (Figure 14). Pumping volumes vary greatly on a local, county, and statewide basis between both public and private water supplies.

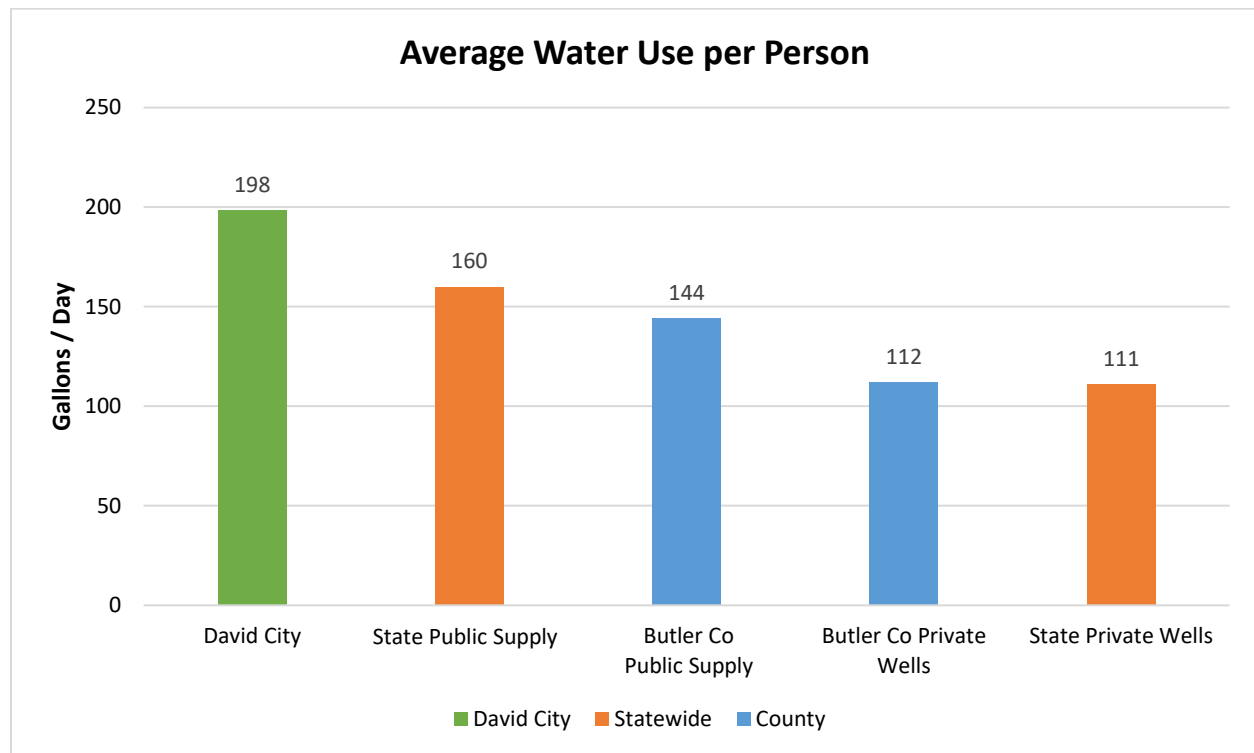
There are likely measures that David City water system customers can take to become more efficient in their uses, such as programs to provide low-flow showerheads and low-flush toilets, high-efficiency washing machines, and landscape conservation techniques like limiting lawn irrigation. Additionally, the city should look at improving their accounting of unmetered activities to identify places that savings could be made. These actions will not only reduce utility bills but will also ease the burden on the water system and groundwater aquifer during drought years. Implementing water conservation measures now could help minimize the pumping volumes necessary in the future.

Table 3: David City Well Discharge Summary (2016-2019)

City Well ID	Local Well Name	Total Max Annual Withdrawal (gal)	
		2016 – 2019	Percent of Total
8*	66-1	0	0.0%
9*	72-1	0	0.0%
10	79-1	174,881,000	21.9%
11	2002-1	200,574,000	25.1%
12	2009-1	220,996,000	27.6%
14	2009-2	203,753,000	25.5%

Source: LRE, 2021

Note: Wells 8 and 9 are currently inactive.

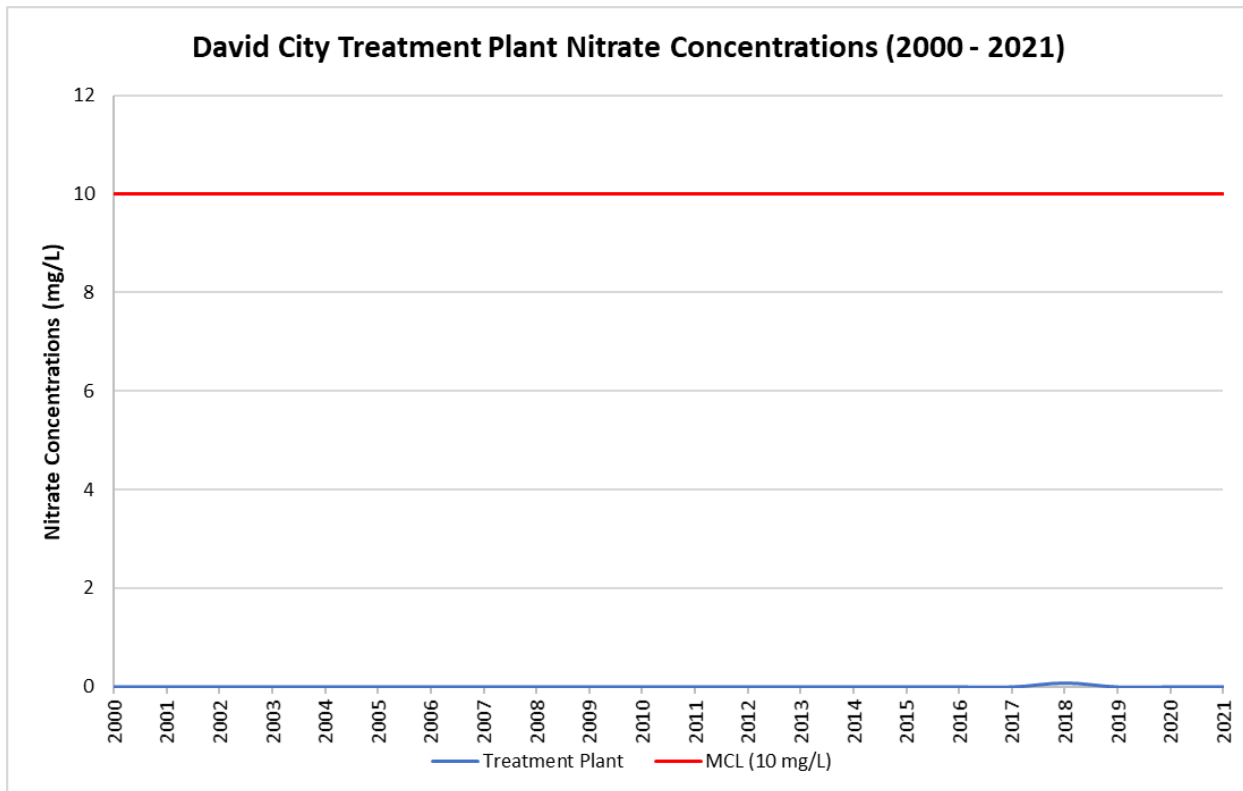


Sources: Maupin and others, 2014; Byrkit, 2020; USGS, 2022

Figure 14: Average Water Use Between David City and Other Populations

2.03 COMMUNITY WELL NITRATE SAMPLING

NDHHS maintains a database of public drinking water system data on their website through the Drinking Water Watch. Nitrate-nitrite sampling data from the last two decades has been compiled for the city and can be seen in Figure 15. The chart also displays the EPA MCL for nitrates at 10 mg/L as a red line. Nitrate-nitrite levels were measured from samples taken at a water treatment plant where well water is mixed before being delivered to customers. Nitrate concentrations were below the detection limit of 0.05 mg/L in all but one year, well below the MCL of 10 mg/L. Nitrates are known to occur naturally in groundwater, with a typical background concentration of 3 mg/L. Concentrations above 3 mg/L indicate a level of indirect human impact, while concentrations above 5 mg/L are indicative of direct human activity (Gosselin, 1997).



Source: NDHHS Drinking Water Watch

Figure 15: Nitrate Concentrations in David City Treatment Plant

CHAPTER 3. WELLHEAD PROTECTION AREA

3.01 DELINEATION

The city's previous WHP area map was provided by NDEE in June 2010. The WHP area map was updated in January 2022 (Figure 16). The updated WHP area was created by NDEE using the modeling software MODFLOW.

MODFLOW uses hydrogeologic modeling for steady pumping wells, including the influence of hydrological boundaries, annual recharge estimation, and no-flow boundaries such as rivers, recharge areas, and no-flow contacts like the local geological formations of bedrock. Groundwater flow direction and velocity, pumping volumes, and well construction data are used in the model. The modeling generates flow lines, which depict the approximate path groundwater, or a contaminant in groundwater, will take to reach a well. These flow lines are associated with an estimated time-of-travel (TOT). One set of TOT path lines are delineated for each active well: one, two, 10, 20, and 50-year.

The WHP boundary is drawn slightly larger than the time-of-travel lines shown on the map to accommodate seasonal changes and natural variability of the aquifer. The WHP area is statutorily recognized as a boundary in which a community manages potential contaminant sources through the WHP program. The WHP area is drawn around the time-of-travel along visible or easily identifiable boundaries such as roads, rivers, creeks, section, quarter-section, and quarter-quarter sections lines. This allows for easier land management and identification. Maps are periodically updated as modeling advances, the science behind aquifers advances, as wells are added/removed from use, or as well pumping volumes change.

David City's WHP area is made up of a continuous area covering approximately 8,160 acres. The city officially recognized the WHP area with an adoption ordinance on April 13, 2022. The ordinance can be found in Appendix C.

THE WELLHEAD PROTECTION AREA MAP BY ITSELF DOES NOT GIVE A COMMUNITY ANY ADDITIONAL AUTHORITY OR PROTECTION OF THE PUBLIC WATER SUPPLY. IT IS PURPOSELESS UNLESS A COMMUNITY ENACTS ORDINANCES, ZONING, OR INITIATES VOLUNTARY ACTIVITIES WITHIN THE WHP AREA.

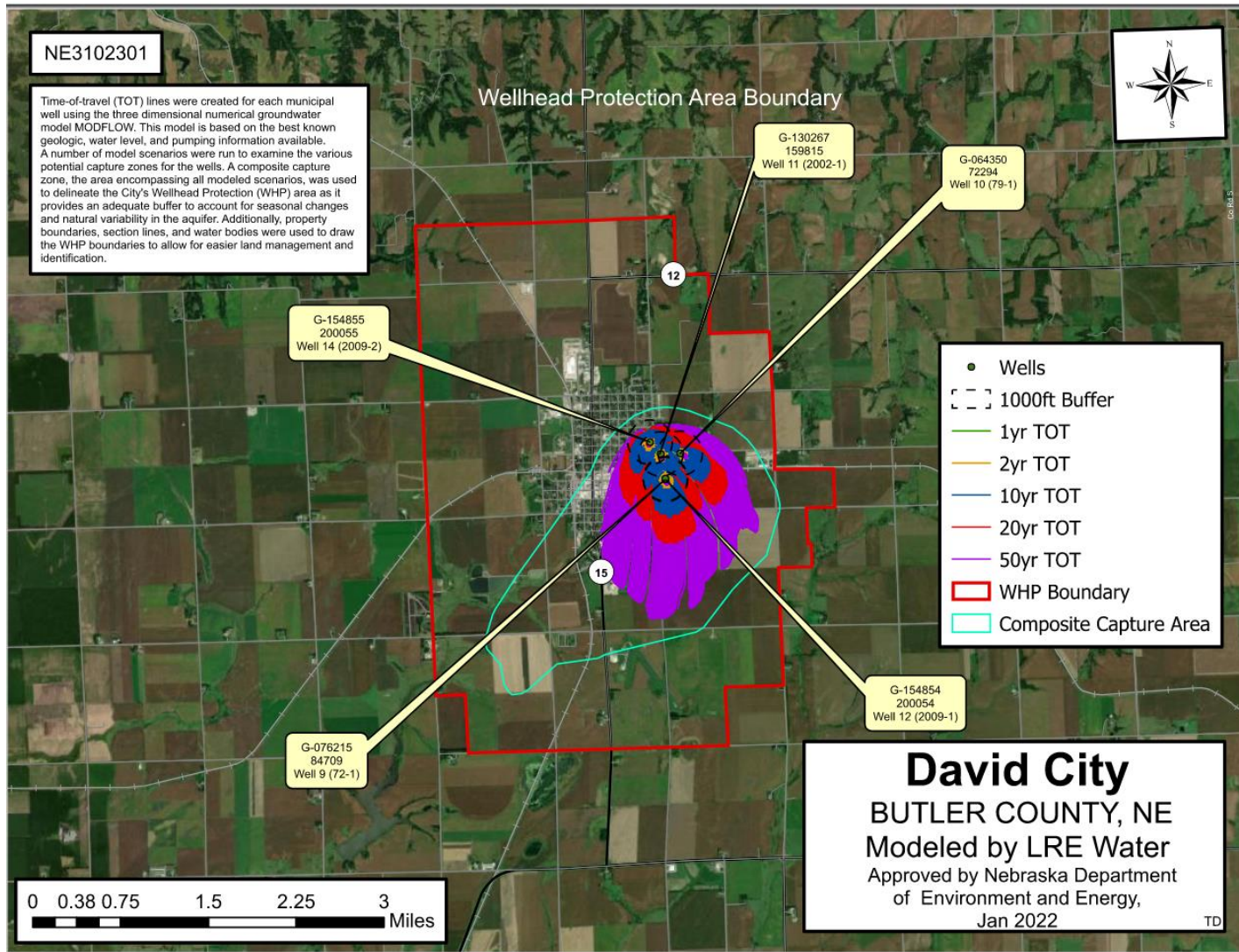


Figure 16: Official David City WHP Area Map

3.02 LAND USE

Land use and land cover are two separate terms, yet they are often used interchangeably. Land use describes how people utilize the land (i.e. urban or agriculture), while land cover describes the physical material of the earth's surface (i.e. types of vegetation). For the purposes of this plan, the term land use will be used with the understanding that intentional management of the land is implied.

Certain types of land uses are commonly associated with varying potential for different types of contaminants, as shown in Figure 17.

Agriculture areas, particularly row-crops may contribute to non-point source (NPS) pollution. They can potentially contribute to nitrates, herbicides, and other contaminants flowing into surface water and infiltrating through the soil into groundwater. Irrigated cropland is particularly vulnerable to increased nitrogen leaching.

Urban land areas, particularly areas of impervious surfaces, may contribute to NPS pollution by increased runoff, overapplication of lawn fertilizers, oils, solvents, or grease spills, or other industrial byproducts. Urban areas can contribute to water pollution at a high rate due to the high concentration of facilities or land uses which can contribute to water pollution.

Natural vegetation, such as trees, grasses, and shrubbery are generally considered to have the capability of improving or protecting water quality. Natural vegetation may serve as a buffer and filter between pollutant sources and water bodies. The vegetation often partially removes contaminants and nutrients before they enter waterbodies.

A**B****C**

Figure 17: Varying Types of Land Use. (A) Irrigated Row crops; (B) Urban setting; (C) Natural vegetation.

Land use data from 2020 was collected from the United States Department of Agriculture (USDA) National Agricultural Statistics Service CropScape – Cropland Data Layer online platform (Table 4). A majority of land in the WHP area is used to grow row crops (70.7%), especially corn and soybeans (Figure 18). The second largest land use category is developed (16.2%), which includes all urban areas (single/multi-family homes, city parks, streets/roads, etc.). This category is primarily made up of the community itself. The remainder of the WHP area is taken up by grass and pasture (10.5%), and relatively small amounts of forest, open water, and wetlands.

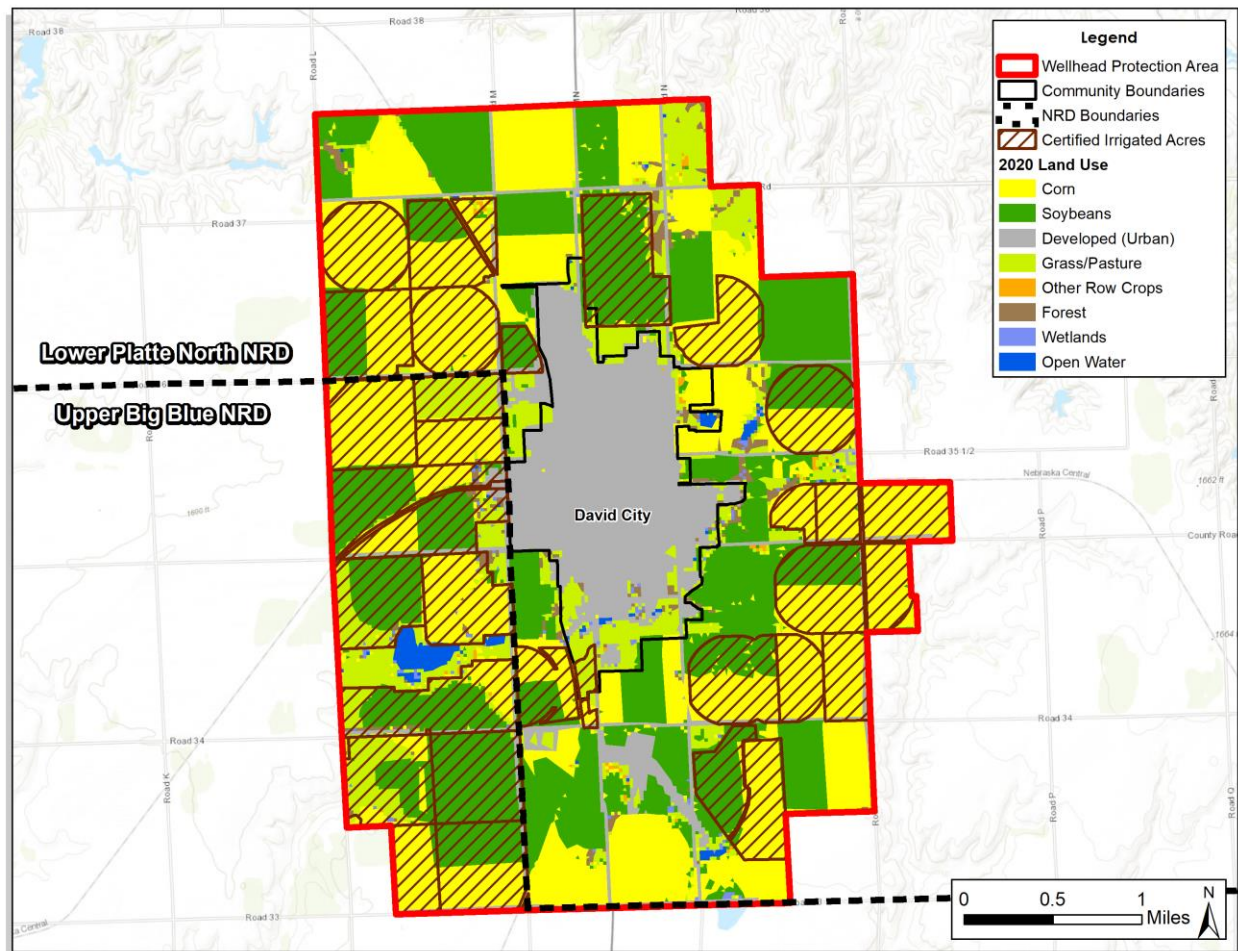
Table 4: 2020 Land Use in the WHP Area

Land Use Category	2020 Acres	% of WHP Area
Corn	3,123	38.3%
Soybeans	2,632	32.2%
Developed (Urban)	1,321	16.2%
Grass/Pasture	856	10.5%
Forest	116	1.4%
Open Water	65	0.8%
Wetlands	31	0.4%
Other Row Crops	16	0.2%
Total	8,160	100%

Source: USDA, 2020

IRRIGATED ACRES

Nitrate leaching losses from applied fertilizer and the spreading of manure can be exacerbated by irrigation water application. Identifying and utilizing BMPs that improve irrigation management and/or reduce the levels of applied nitrate fertilizer will result in decreased nitrate loading to both surface and groundwater resources. Within the LPNNRD and UBBNRD, all irrigated acres are certified by the NRDs to manage groundwater quantity and quality concerns. Figure 18 displays the certified irrigated acres in the David City WHP area. In total there are approximately 3,677 certified irrigated acres making up 45% of the WHP area. Of these, 2,027 acres are located in the LPNNRD, and 1,650 acres in the UBBNRD. In 2020, approximately 52% of irrigated acres were used to grow corn and 35% were used to grow soybeans. Irrigation wells make up 48% of all registered wells in the WHP area.



Source: USDA, 2020; LPNNRD; UBBNRD

Figure 18: 2020 Land Use and Irrigated Acres in the David City WHP Area

THIS PAGE LEFT INTENTIONALLY BLANK

CHAPTER 4. POTENTIAL CONTAMINANT SOURCE INVENTORY**BACKGROUND**

The purpose of a contaminant source inventory (CSI) is to identify potential drinking water contaminants or sources that the contaminants may originate from. The CSI is a major step in establishing a WHP plan and includes recording locations and information on potential contaminant sources such as fuel storage tanks, livestock operations, equipment storage yards, and many others (Figure 19).

A CSI allows a community to plan for and manage potential contaminant sources and decide where to focus educational and management efforts to minimize the likelihood of source water contamination. Strategies to limit pollution may vary greatly within the WHP area because of the varying types of potential contaminant sources. Several management strategies are discussed to limit NPS in Chapter 7: Management Strategies. The inventory is compiled from existing databases and on-the-ground observations. Even if identified in the CSI, a feature may not be contributing to contamination presently but may still present a risk.

UNDERSTANDING WHAT POTENTIAL CONTAMINANT SOURCES EXIST WITHIN THE WHP AREA ALLOWS A COMMUNITY TO MAKE INFORMED DECISIONS AND SAFELY MANAGE THREATS TO THEIR DRINKING WATER SUPPLY.

It is important to note that this inventory only represents a snapshot of the area's history. There may be features which have already contributed to groundwater contamination and left no record of their existence on the surface. Features recorded in the past may not be actively operating today. It is important to record historical land uses and activities due to the long period of time required for groundwater to respond to changes at the land surface. It is important to note that, even if identified in the CSI, a feature may not be contributing to contamination presently but may still present a risk.

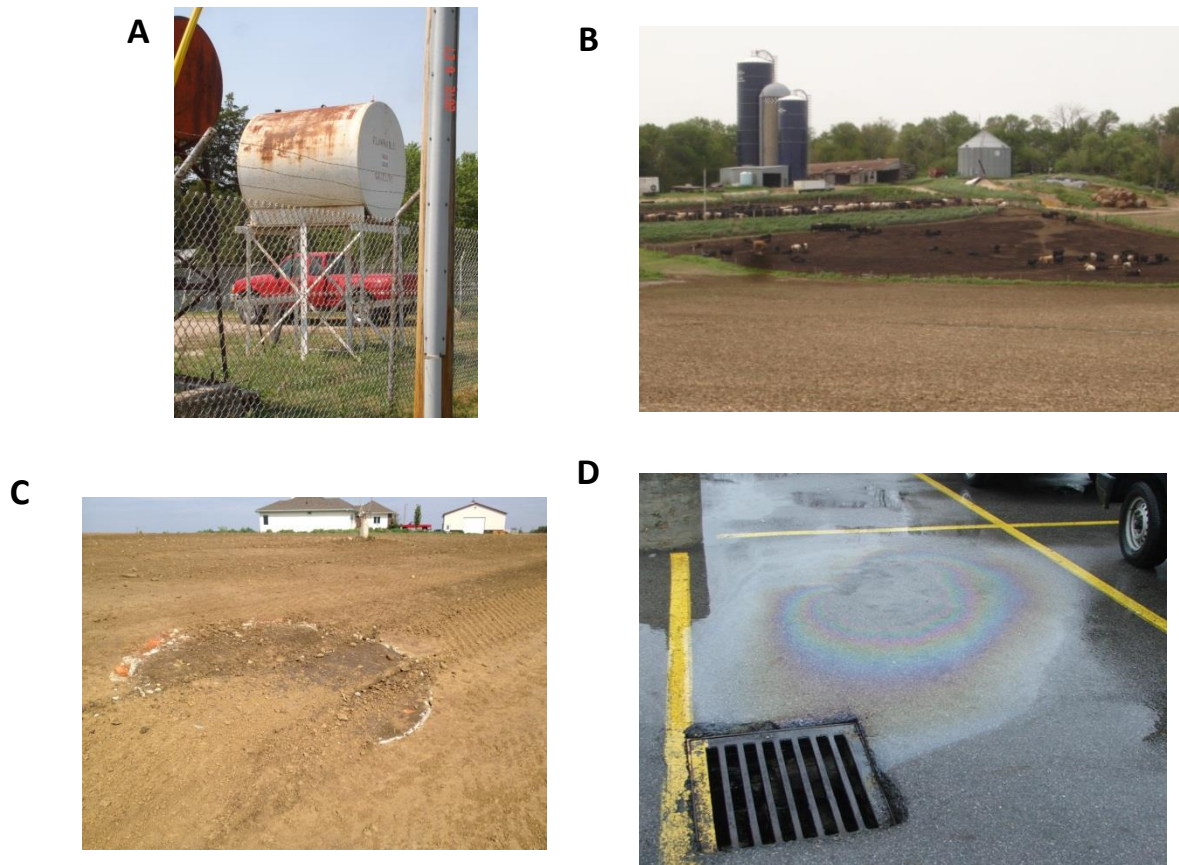


Figure 19: Common Types of Potential Contaminant Sources. (A) Leaking Fuel Drums; (B) Livestock Waste; (C) Abandoned Wells; (D) Parking Lot Runoff

Based on guidance provided by NDEE, the inventory typically consists of the following types of points:

Agricultural

- Fuel Storage
- Grain Storage
- Water Wells
- Chemigation
- Livestock
- Abandoned Wells

Commercial and Light Industrial

- Auto Repair
- Dry Cleaners
- Fuel Stations
- Machine Shops
- Rail Yards
- Large Parking Lots

Industry

- Manufacturing Plants
- Gas/Oil Wells
- Junk Yards
- Landfills
- Sewage Treatment Facilities

Other

- Cemeteries
- Golf Courses
- Highway/Road Maintenance Yards
- Other Wells

METHODOLOGY

David City's CSI is a compilation of multiple sources:

- NDEE Regulated Facilities Database
- Nebraska Department of Agriculture Registered Pesticide Dealers Database
- State Fire Marshal Underground Storage Tank Database
- Nebraska Oil and Gas Conservation Commission Gas and Oil Wells Database
- NeDNR Registered Wells Database
- JEO Consulting Group, Inc. in-field survey completed December 2021

Note that the data made available through outside agencies was furnished for interpretive reasons. To the extent possible, the data is current, accurate, and reliable. However, there may be discrepancies in the information and not all map location coordinates have been verified. In addition, JEO assumes no legal responsibility, either implied or expressed, about the accuracy, completeness, reliability, or appropriateness of this data made available through or retrieved from these agencies.

SUMMARY

A summary of all sites identified through the CSI is displayed in Table 5. CSI points are displayed in Figure 20, NDEE regulated facilities in Figure 21, and registered wells in Figure 22. Note that locations of underground storage tanks and registered pesticide dealers could not be mapped reliably.

The CSI identified 194 possible contaminant sources within the David City WHP area. Of these sites, 33 were residences, including 24 farmsteads and 9 acreages. Equipment storage (51) and grain storage (17) sites that were identified include those that are found on acreages or farmsteads and were counted separately as they pose different threats to drinking water quality. Other agricultural contaminant sources included 25 center pivots and 8 livestock operations. Various other sites included automotive service (16), machine shops (5), storage or distribution of agricultural chemicals (5), gas stations (4), medical clinics (4), cemeteries (2), a golf course, a veterinary clinic, a manure pile, and a general 'other' category (21). The 'other' category included sites such as a food processing plant, the city's wastewater treatment plant, the David City municipal airport, and multiple sports fields. Further information on the CSI, including the master table of all identified potential contaminant sources, is available in Appendix D.

There are 119 applicable NDEE regulated facilities in the WHP area (not including pesticide dealers or underground storage tank sites). Some of these facilities are regulated under multiple programs, in which case each applicable regulation was considered a discrete site. The majority of these sites are made up of leaking storage tanks (28), National Pollutant Discharge Elimination System (NPDES) compliance sites (27), Superfund Amendments and Reauthorization Act (SARA) Title III (19), release assessment (11), and resource conservation recovery (11). The remainder of the sites include integrated waste management (8), underground injection control (6), livestock waste control (three), onsite wastewater treatment systems (three), brownfield (one), remedial action plan monitoring (one), and superfund (one).

Additionally, there are four commercial pesticide applicator licenses registered to David City. There are also 28 underground storage tank facilities regulated in David City by the Nebraska State Fire Marshall, each of which may have multiple underground storage tanks.

There are 52 active registered wells in the WHP area. Of these, 25 are used for irrigation, 10 for monitoring ground water quality, and 9 for domestic water supply. The rest are used for closed loop underground heat exchange (three), livestock water supply (two), commercial or industrial use (one), open loop heat pump (one), and 'other' uses (one). Note that 'other' is a use category provided by NeDNR. There are no oil or gas wells in the WHP area. There are likely additional wells in the WHP area that are inactive, abandoned, or decommissioned. Additional studies could identify the locations of unused or abandoned wells for proper decommissioning.

Table 5: Summary of David City Contaminant Source Inventory

NeDNR Registered Wells	
Well Use	Count
Irrigation	25
Monitoring (Ground Water Quality)	10
Domestic	9
Ground Heat Exchanger well - Closed Loop Heat Pump well	3
Livestock	2
Commercial/Industrial	1
Heat Pump well - Open Loop Heat Pump Well	1
Other	1
Oil & Gas Wells*	0
Total	52

*Regulated by Oil & Gas Conservation Commission

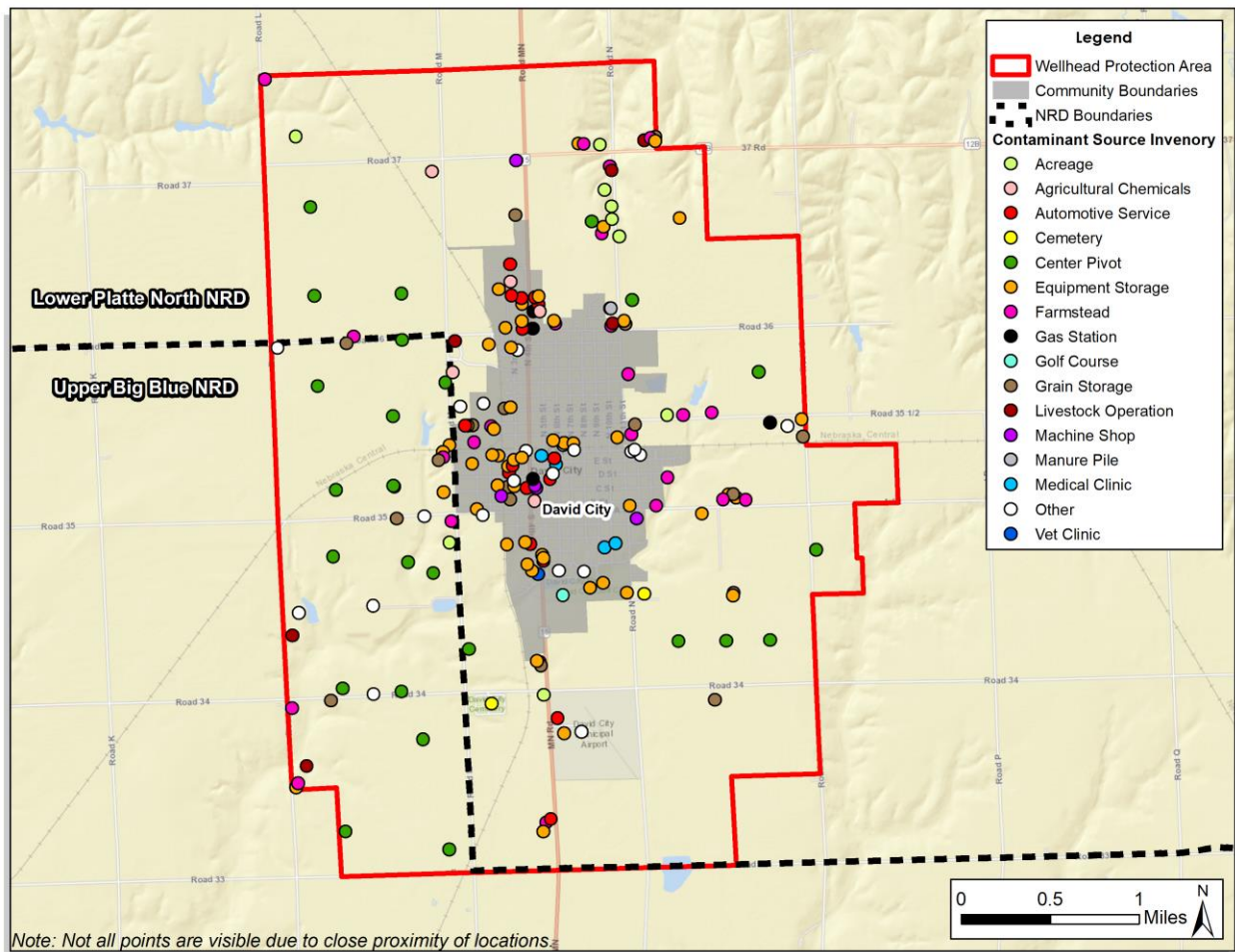
Note: Includes only active wells.

Applicable NDEE Registered Facilities	
Program	Count
Leaking Storage Tanks	28
Underground Storage Tank Sites*	28
NPDES Permits and Compliance	27
SARA Title III	19
Release Assessment	11
Resource Conservation Recovery	11
Integrated Waste Management	8
Underground Injection Control	6
Pesticide Dealers**	4
Livestock Waste Control	3
Onsite Wastewater Treatment	3
Brownfield	1
Remedial Action Plan Monitoring	1
Superfund	1
Total	119

*Regulated by State Fire Marshall. Each site may have multiple tanks.

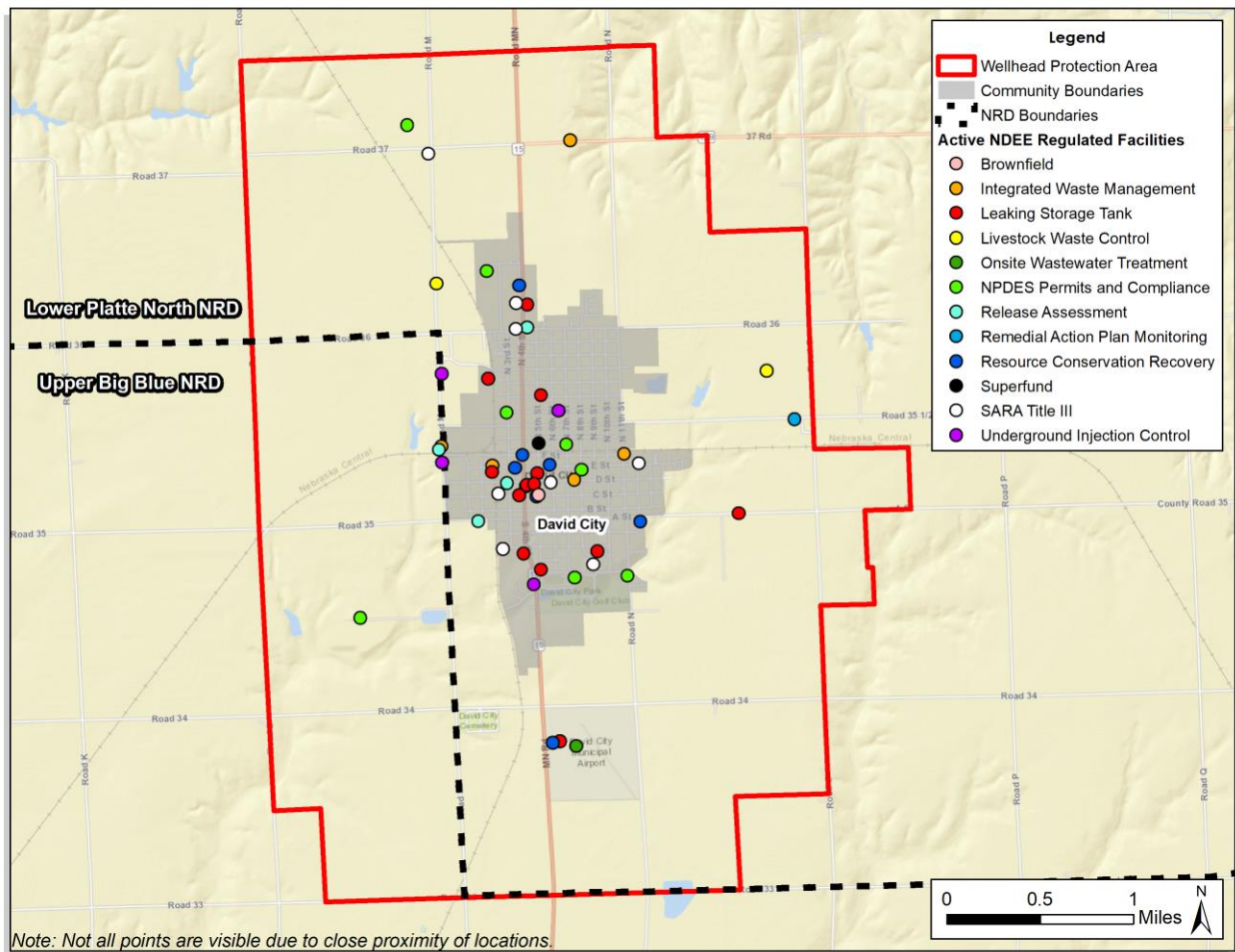
**Regulated by NE Department of Agriculture Note: Includes only active sites. Each site may be regulated by more than one program.

Contaminant Source Inventory	
Potential Contaminant Source Type	Count
Equipment Storage	51
Center Pivot	25
Farmstead	24
Other	21
Grain Storage	17
Automotive Service	16
Acreage	9
Livestock Operation	8
Machine Shop	5
Agricultural Chemicals	5
Gas Station	4
Medical Clinic	4
Cemetery	2
Golf Course	1
Vet Clinic	1
Manure Pile	1
Total	194



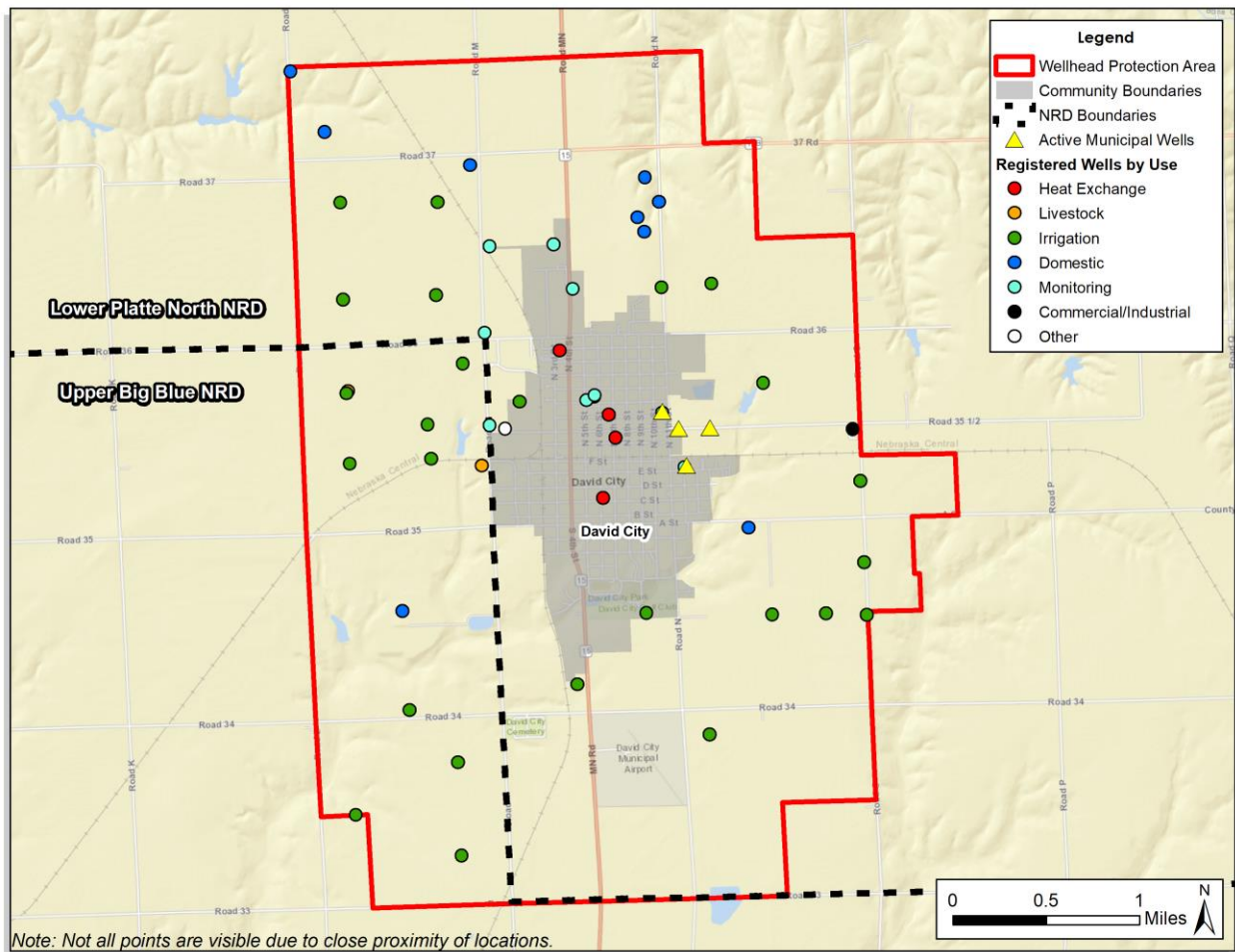
Source: JEO Consulting Group CSI – November 30 and December 2, 2021

Figure 20: Contaminant Source Inventory in the David City WHP Area



Source: NDEE, 2021

Figure 21: NDEE Regulated Facilities in the David City WHP Area



Source: NeDNR, 2022

Figure 22: Registered Wells in the David City WHP Area

4.01 EXISTING GROUNDWATER CONTAMINATION

There are existing sites, listed as NDEE regulated facilities, within the WHP area that are known to have, or have had, contamination of the potential for contamination of soil and water. These sites are under the regulatory authority of NDEE. While specifically addressing those sites or activities is not the focus of this plan, they are discussed here as their presence may play a role in the public's perception of the risks to their drinking water. Table 6 describes these facilities as provided by NDEE. Additional information can be found in Appendix D or may be obtained by contacting NDEE.

Table 6: Summary of Existing Groundwater Contamination in the David City WHP Area

Name	Status	Summary
Henninsen Foods Inc Tank Site	Inactive	On June 22, 1990, an EA was conducted. Contaminated soil and ground water was encountered. Contaminated soil was excavated and the site was closed on December 19, 1990.
Butler County Hospital	Inactive	One heating oil and one diesel backup generator USTs were removed on April 17, 1995. Soil contamination was detected. A Tier 1 investigation was conducted and the site was closed on March 10, 2004.
Diesel Rel / Overfill Generator	Inactive	50 gallons of diesel fuel was released due to an overfill of the generator UST on August 6, 2018. Sorbent material was placed on the release. The site was closed on October 11, 2018.
Farmers Co-op Oil Assn	Inactive	Two gasoline and one diesel USTs were removed on February 3, 1995. Soil contamination was detected. Tier 1 and Tier 2 investigations were conducted. After a public notice was issued, the site closed on March 17, 2011.
Harm's Aviation	Inactive	A UST removal was conducted on September 6, 1989. Overexcavation was conducted and the site was closed on December 11, 1989.
Shop E-Z	Inactive	A kerosene UST was removed on 2/2/1995. Contamination was detected. Tier 1 and Tier 2 investigations were conducted and the site was closed.
Saint Joseph's Villa	Inactive	A heating oil UST was removed on 6/7/1993. Contamination was detected but not enough to warrant an investigation. The site was closed.
Saint Mary's Grade School	Inactive	A heating oil UST was removed on 7/23/1992. Contamination was detected and a Tier 1 investigation was conducted. The site was closed after the investigation.

Name	Status	Summary
Northside 66	Inactive	Two gasoline USTs were removed on 6/7/1990. Contamination was not detected and the site was closed.
Northside 66	Inactive	A diesel dispenser was removed on 4/3/2000. A Tier 1 investigation was conducted and the site was closed.
Butler County Courthouse	Inactive	A UST system was removed on 8/11/1989. Contamination was detected but not enough to warrant further investigation and the site was closed.
David City High School	Inactive	A heating UST was removed on 8/03/1998. Contamination was detected but not enough to warrant further investigation and the site was closed.
David City Municipal Airport	Inactive	A gasoline UST was removed on 12/18/1991. Contamination was detected and a Tier 1 investigation was conducted. The site was closed after the investigation.
David City Municipal Airport	Inactive	A gasoline UST was removed on 3/25/1995. Contamination was detected but not enough to warrant further investigation and the site was closed.
Martin Standard	Inactive	A waste oil UST was removed on 11/17/1989. Contamination was detected but not enough to warrant further investigation and the site was closed.
Front Coop 4 Tnks, Mart Stnd 2	Inactive	Six USTs were removed on 8/2/2010. The USTs contained gasoline or diesel. Tier 1 and Tier 2 investigations were conducted. The site was closed after the investigations were completed.
ALLTEL Communications	Inactive	One diesel UST was removed on 3/16/1992. Contamination was not detected and the site was closed.
City of David City Shop	Inactive	Gasoline and Diesel USTs were removed on 5/18/1999. Contamination was detected. An initial investigation was conducted. The site was closed after the investigation was conducted.
Stop Inn	Inactive	A gasoline UST was removed on 3/31/1998. Tier 1 and Tier 2 investigations were conducted. The site was closed after the investigations were conducted.
NDOR David City Yard	Inactive	A gasoline and a diesel USTs were removed on 5/9/1991. Contamination was not detected and the site was closed.
30 Gal Gasoline UST Overfill	Inactive	A trucker overfilled an UST on 1/7/1994. The gasoline was cleaned up and the release was closed.
Removed 2 Gasoline Tanks	Inactive	Two gasoline USTs were removed on 2/16/2011. Contamination was not detected and the site was closed.

Name	Status	Summary
3rd & C Sts Non Point Source	Inactive	Contamination was detected on 10/12/1990 during an environmental audit. A Tier 1 investigation was conducted and the site closed.
Hilderbrand Insurance	Inactive	Two gasoline USTs were removed on 9/13/1994. Contamination was not detected and the site was closed.
James Vandenberg	Inactive	A diesel UST was removed on 8/12/1998. Contamination was detected but not enough to warrant further investigation and the site was closed.
Butler County Roads Yard	Inactive	A gasoline UST was removed on 8/10/1989. A detailed investigation was conducted. The site was closed after the investigation.
David City Elementary School	Inactive	A diesel UST was removed on 8/16/1995. A Tier 1 investigation was conducted. The site closed after the investigation was completed.
5th & D Tank Site	Inactive	A calcium carbide UST was removed on 9/11/1995. The site was closed.
35 Gal Diesel AST Line Rel	Inactive	On 5/15/2018 a diesel product line was struck. The release was cleaned up and closed.
Oily/Gritty Substance Rel	Inactive	An unknown oily substance was spilled on 10/25/1995. The release was cleaned up and the site was closed.
30 Gal Waste Oil Rel	Inactive	30 gallons of waste oil was released on 1/3/2010. The release was cleaned up and the release closed.
16000 Gal 10-34-0 Fert Rel	Inactive	The release was cleaned up and the release closed.
Northside 66 Gasoline AST Rel	Inactive	850 gallons of gasoline was released on 3/18/1994. Tier 1 and Tier 2 investigations were conducted and the site was closed after the investigations.
Power Plant AST Release	Inactive	While digging footings on 3/12/1996, contamination was detected. A Tier 1 investigation was conducted and the site was closed after the investigation.
Transformer Oil Release	Inactive	PCB transformer oil was release 2/9/1984. The release was cleaned up and the release was closed.
300 Gal 28% Nitr Fert Soln Rel	Inactive	300 gallons of 28% nitrogen was spilled on 3/26/1992. The release was referred to the AG Section.
Diesel Rel from Semi Fuel Tank	Active	Diesel was released from a semi on 3/28/2019. The release was cleaned up and the release was closed.
Farmers Co-op AST Overfills	Inactive	On 10/9/1990, contamination was detected during an environmental audit. A detailed investigation was conducted and the site was closed.
5212 Gal 28% Liq Nitrogen Rel	Inactive	A release was cleaned up and closed.
Goodyear Building	Active	Phase I and Phase II Environmental Site Assessments were conducted in 2010. No subsurface soil or

Name	Status	Summary
		groundwater environmental impact was found. This facility is located west of the municipal wellfield in a side/down-gradient groundwater flow direction.
Frontier Cooperative	Active	This site is a former USDA grain bin storage facility. This site is located about 0.75 miles east of David City (about 0.6 miles east of the municipal wellfields in a side-gradient groundwater flow direction). No environmental sampling has been conducted to determine if there is any soil or groundwater contamination due to grain fumigation activities during the 1950s to early 1970s.
David City Grain	Active	The David City Grain Co. and the previous lessee were reportedly strictly a wholesale grain and feed supply/storage business. They also sold a "limited amount" of bagged fertilizers. USEPA conducted site investigation in 1983 and no soil or groundwater contamination were identified. The site was subsequently assigned No Further Action status under CERCLA and archived within CERCLIS by USEPA.
Private Well Sampling Project	N/A	USEPA conducted an Abbreviated Preliminary Assessment (APA) screening level groundwater investigation in 2014. 23 private wells in the vicinity of David City were sampled to identify possible sources of volatile organic compounds (VOCs). Only one private well located about 4.75 miles east/southeast of David City had a trace amount of chloroform. None of the other wells contained VOCs above laboratory reporting limits.

Source: (NDEE, written commun., January 19, 2022)

THIS PAGE LEFT INTENTIONALLY BLANK

CHAPTER 5. REGULATORY AUTHORITY

5.01 DAVID CITY

Due to the different threats and limits of jurisdiction across the WHP area, it is important that any current or future ordinances and/or zoning districts are flexible, enforceable, and developed with citizen/landowner input.

DAVID CITY MUNICIPAL CODE

Communities, including David City, have the legislative authority to implement and enforce ordinances in order to protect the public health, safety, and general welfare of its residents. This power gives the city the ability to regulate actions within the corporate limits and potentially within its extraterritorial jurisdiction (ETJ), which is discussed in detail below. Currently, Chapter 7 article 2 of the city's municipal code provides information on the Water Department's authorization, operations, and protection of the community's drinking water, within the city and its jurisdiction. Existing ordinances that may protect groundwater include:

- Section 7-203: Mandatory Hookup; Private Wells Prohibited
- Section 7-231: Restricted Use
- Section 7-233: Pollution
- Section 7-234: Wellhead Protection Area
 - Includes well setback distances

In order to enforce regulatory control over the WHP area outside of the corporate limits, zoning controls would need to be considered in cooperation with Butler County. The relevant pages of the Municipal Code can be found in Appendix C, or at the city office.

WELL SETBACK DISTANCES AND ENCROACHMENTS

Well setbacks are regulated by nine different state regulations as summarized in Table 7. The most commonly recognized setbacks are maintained by NDHHS and established in the latest version of Nebraska Title 179 – *Public Water Systems*, Chapter 7 (NDHHS, 2010). While these setbacks are identified by NDHHS, it is the responsibility of the local public water system and community to actively enforce or ensure compliance with the setback distances. Any setback distance or encroachment violations found by NDHHS must be eliminated or justified by an engineer to NDHHS. If necessary, NDHHS will take enforcement measures against the water system, but not on the violator or owner of the encroachment. This could include, but is not limited to, identifying a system as “vulnerable” or requiring additional monitoring. Essentially, if a community does not adopt and enforce these setbacks there is no active protection.

It is recommended by NDEE that communities formally recognize and enforce well setback distances through ordinance or zoning. This should be done in a way that the distances are automatically updated in accordance with any changes to the law. David City has recognized the WHP area through their code of ordinances and does enforce well setback distances. The WHP ordinance was last amended in November 2006 and this plan recommends the ordinance be updated to follow the most recent recommended setback distances and be written to automatically update with Title 179, which was most recently updated in 2017.

Table 7: Required Well Setback Distances, by Nebraska State Titles

Category	Distance (ft)	Nebraska State Title									
		179	178	119	122	123	124	126	130	198	
Water Well*	1,000	X	X								
Sewage Lagoon	1,000	X			X	X	X				
Land application of municipal/industrial waste material	1,000	X					X				
Feedlot or feedlot runoff/Livestock waste control facility	1,000	X									
Underground disposal system (septic, cesspool, etc.)	500	X			X		X				
Corral	500	X									
Pit/Vault toilet	500	X					X				
Wastewater holding tanks	500	X					X				
Sanitary landfill/Dump	500	X									
Chemical or petroleum product storage	500	X									
Sewage treatment plant	500	X									
Sewage wet well	500	X									
Sanitary sewer connection	100	X									
Sanitary sewer manhole	100	X									
Sanitary sewer line	50	X				X					
Class V domestic wastewater disposal wells	1,000				X						
Class V wells constructed above water table	1,000				X						
Class V well injecting into or constructed through uppermost aquifer	1,000				X						
Livestock waste control facility	1,000								X		
Fertilizer (paunch manure)	500							X			
Static pile or wind row paunch storage	500							X			
Paunch storage lagoon	500							X			
Paunch manure static pile or wind row storage	500							X			
Wastewater land application and effluent	500			X							
Absorption, infiltration, and evaporative systems	500						X				
CAFO manure, litter, or process wastewater applied	100								X		
New Secondary Containment/Loadout Facility	100									X	

*Only enforceable on Public Water System Wells.

Source: Nebraska Department of Environmental Quality, personal communication, May 15, 2017

BUTLER COUNTY ZONING CONTROLS

Butler County does not have any zoning authority or a planning commission. If the county was to adopt a comprehensive plan, it would have the ability to enact zoning and establish a wellhead protection overlay district.

DAVID CITY ZONING CONTROLS

The city has an adopted comprehensive plan (2005), zoning ordinance (2019), and is currently in the process of developing an updated comprehensive plan. The planning and zoning documents are available at the city office. Figure 23 illustrates the city's ETJ in comparison with the WHP area. While the majority of the WHP area is included in the city's ETJ, the southwest and southeast corners are outside of the ETJ. City zoning ordinances only apply to areas within the ETJ.

While the city's municipal code does address wellhead protection, David City's 2005 Comprehensive Plan does not specifically mention wellhead protection planning or groundwater protection, nor does it provide for a wellhead protection district. The current comprehensive plan in development may be an opportunity to incorporate wellhead protection into the future goals of the city.

Although the city currently recognizes the wellhead protection area through their code of ordinances, the area is not recognized in their zoning ordinance as a separate overlay district. The city has not indicated it intends to amend their zoning regulations and adopt a wellhead protection overlay district in the near future. Such amendment would involve a public hearing and recommendation by the Planning Commission and a public hearing and ordinance adoption by the city board. The wellhead protection overlay district will be illustrated on the Official Zoning Map and any adopted wellhead regulations would take priority over the underlying zoning district. An "overlay" district does not replace other zoning districts that may be located in the same area, it simply adds additional requirements (related to the districts purpose) that uses in the district must meet.

Nebraska Revised Statute 13-327 allows any city of the first or second class or village to request that the county board formally cede and transfer portions of the county's ETJ zoning jurisdictions to the city or village. This is a strategy that would allow the city or village more complete control over portions of the WHP area that fall outside of a city/village's traditional ETJ. However, because Butler County does not currently have a comprehensive plan or zoning resolution, this is not an option at this time for David City.

15-MILE STATUTE

Should the city need to pursue protection to their WHP area outside of their ETJ in the future, the city is able to utilize the Nebraska Revised Statute 17-536 (the 15-mile Statute). This State Law, which applies to villages and second-class cities, allows communities to protect sources of drinking water outside the community's ETJ.

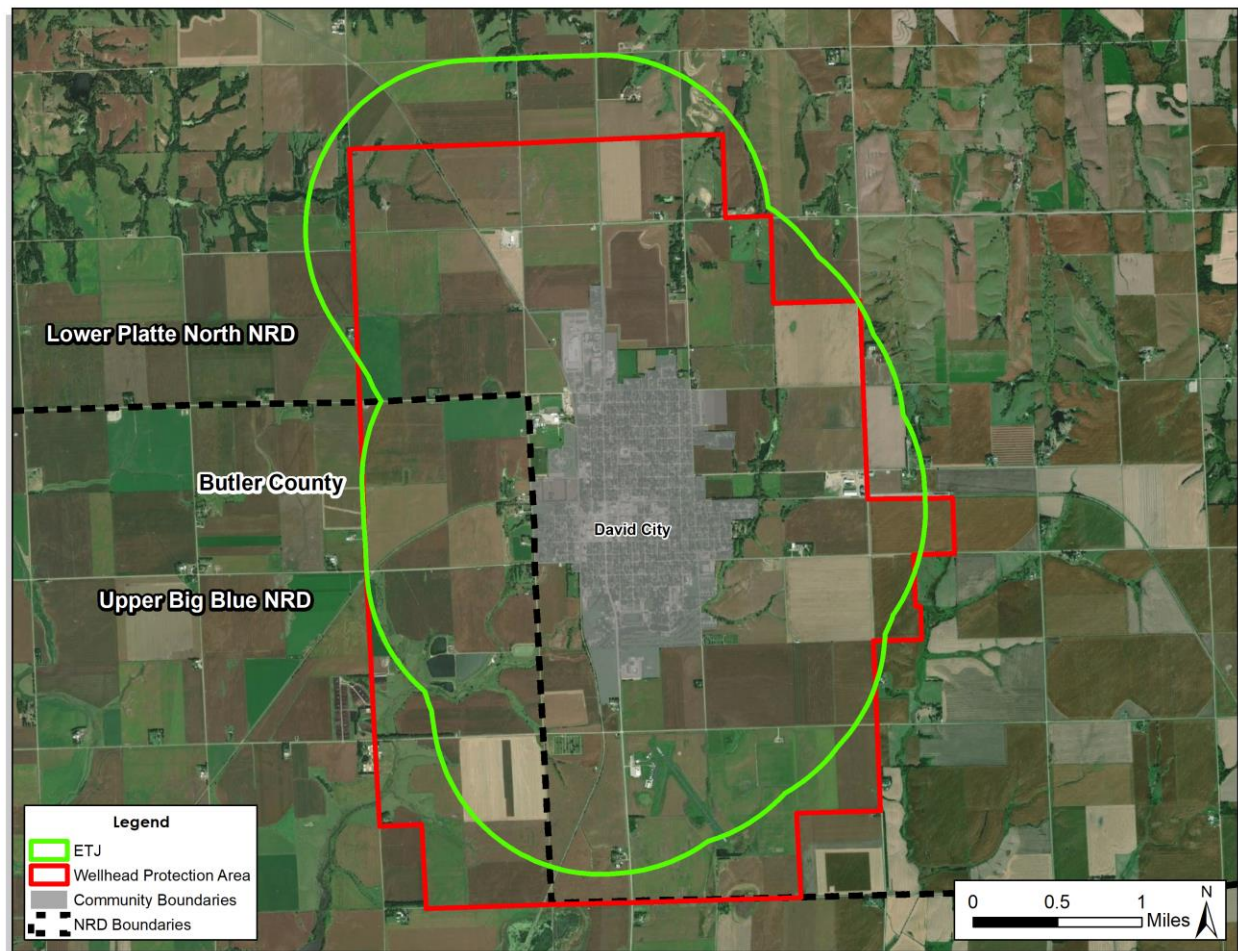


Figure 23: David City ETJ and WHP Area

5.02 NATURAL RESOURCES DISTRICTS

All NRDs have the ability to require BMPs or to regulate practices in groundwater management areas (GWMAs) to protect groundwater quality and quantity. This authority originated in the Groundwater Management and Protection Act (GWMPA), which was passed by the Nebraska Legislature in 1984. In 1985, the state passed LB 1106 which required the NRDs to prepare groundwater management plans specific to their area and submit these plans to the NeDNR. In 1991, LB 51 was enacted, requiring NRDs to expand their management plans to include ground water quality protection. The LPNNRD's policies and rules are outlined in their Groundwater Management Area Rules and Regulations available online at: <https://lpnnrd.org/downloads/>. The UBBNRD's policies and rules are outlined in Rule 5: Groundwater Management Area #1 and #2 of their Rules and Regulations, available online at: <https://www.upperbigblue.org/rules-regulations>. Pertinent information is summarized below.

GROUNDWATER MANAGEMENT PLAN SUMMARIES

Lower Platte North NRD

The LPNNRD Groundwater Management Plan was first implemented in 1997 and last amended in 2018. Groundwater quality management areas are designated in four phases of regulations, triggered by progressively increasing nitrate levels. Currently the LPNNRD has not designated the area around David City as part of a phased area for groundwater quality management. David City is also outside the groundwater quantity control area.

Upper Big Blue NRD

The UBBNRD Groundwater Management Plan was first adopted in 1978, with the most recent version being effective November 1, 2020. The plan follows a three-phase system with special designations for high-risk groundwater areas. David City is not within any of the phased areas of the NRD, although it is close to a high-risk groundwater area. Currently, 1,000 feet of space between high-capacity wells of different ownership is required within the NRD.

5.03 STATE OF NEBRASKA

State statutes and laws are summarized in Appendix C as well as a listing of Nebraska's legislature statutes that allow local jurisdictions to protect public health and safety. Generally, the regulatory authority to manage WHP areas falls to local government entities. At the state level, NDEE approves WHP areas and can assist communities with WHP planning, including funding to support certain activities such as well closures, public meetings, incentives for BMPs, etc.

THIS PAGE LEFT INTENTIONALLY BLANK

CHAPTER 6. EMERGENCY, CONTINGENCY, AND LONG TERM PLANNING

6.01 EMERGENCY AND CONTINGENCY PLANNING

David City's Operations Plan for Disaster Response and Recovery as part of the 2015 Butler County Local Emergency Operations Plan is required by NDHHS and is available in Appendix E. The plan uses an "all-hazards" approach that provides information on the roles each entity should play and the order of operations in the event of any emergency. Actions to be taken by the Water Division of the Water and Wastewater Department include:

- Can assess each house individually.
- Maintain water pressure and uncontaminated water supply.
- Where possible, ensures an adequate water supply to the fire hydrants in case of major fire.
- Is prepared to isolate the water system where there is a possibility of contamination from a hazardous materials spill.
- Repairs the water tower and/or mains, as prioritized; isolates ruptured or damaged mains until repairs can be made.
- Coordinates water testing with the State Health and Human Services System.
- Provides potable emergency water supply.
 - Locates suitable containers; fills with uncontaminated, potable water.
 - Distributes water to locations as coordinated by the EOC; is aware of prioritized facilities needing water such as the hospital or care facilities.
- Safety inspects the water system (Butler County Emergency Management Agency, 2015, p. 12-13).

NEBRASKA WATER/WASTEWATER AGENCY RESPONSE NETWORK

The city is not currently a member of the Nebraska Water/Wastewater Agency Response Network (NEWARN). NEWARN is a statewide Water/Wastewater Agency Response Network (WARN) of "utilities helping utilities" to:

- Prepare for the next natural or human-caused emergency.
- Organize response according to established requirements.
- Share personnel and other resources statewide, by agreement.

NEWARN provides water and wastewater utilities with:

- A Mutual Aid Agreement and process for sharing emergency resources among water and wastewater agencies statewide.
- A mutual assistance program consistent with other statewide mutual aid and assistance programs and the National Incident Management System.
- The resources to respond and recover more quickly from a natural or human caused disaster.
- A forum for developing and maintaining emergency contacts and relationships.

Additional information can be found at <http://www.newarn.org/>

6.02 DROUGHT PLANNING

Agriculture is the primary sector affected by drought; however, impacts on rural and municipal water supplies can be severe. A drought plan can be an effective means to improving information flow on drought conditions, severity, and impacts. Thus, the timelines of mitigation and emergency response actions can be adequately updated. Mitigation actions for water supply systems commonly fall under the following categories:

- Assessment programs
- Water supply augmentation/development of new supplies
- Public awareness/education programs
- Water use conflict resolution
- Drought contingency plans
- Mutual aid agreements between communities/organizations

WATER CONSERVATION PLAN

A water conservation plan is a strategy or combination of strategies developed by a public drinking water system. The intent of a water conservation plan is to identify actions to reduce water losses, waste, or consumption and increase the efficiency with which water is used, treated, stored, and transmitted. Additionally, water conservation leads to increased energy conservation and cost savings for utilities and their customers. Recommended actions/elements of a plan include:

- Conduct water use audits for consumers
- Offer fixture retrofits and replacements
- Offer rebates and incentives
- Promote water reuse and recycling
- Encourage landscape efficiency
- Reduce excessive distribution system pressure
- Identify Voluntary or Mandatory Water-Use Restrictions

The city does not currently have a water conservation plan. It is recommended that the city develop one, as discussed in Chapter 7.

DROUGHT READY COMMUNITIES

The National Drought Mitigation Center, located at UNL, has developed a program known as “Drought-Ready Communities”. The intent of the program and associated “Guide to Community Drought Preparedness” is to help communities understand and reduce their drought risk. A certified drought ready community has taken steps to:

- Involve a representative cross section of the community
- Learn how drought has affected them in the past and how it would likely affect them in the future
- Set up a system to monitor and communicate about drought conditions in the community
- Prepare and document a set of actions to take before and in response to drought
- Educate the public about water, drought, and the community's drought plan

Additional information is available online at:

<https://drought.unl.edu/droughtplanning/AboutPlanning/PlanningProcesses/Drought-ReadyCommunities.aspx>.

THIS PAGE LEFT INTENTIONALLY BLANK

CHAPTER 7. MANAGEMENT STRATEGIES

The intent of this plan is to provide a guideline for protecting the city’s drinking water source. This chapter outlines what has been done in the past and practical management alternatives that could be utilized by the city, landowners, producers, and resource managers to further protect the drinking water supply from nonpoint source pollution. Actions include a variety of approaches such as education, on-the-ground BMPs, data collection, regulatory options, and other projects.

7.01 ACTIVITIES COMPLETED TO DATE

The city has maintained a proactive stance in managing water quality in the WHP area. As summarized below, efforts completed before or during development of this plan include the following:

- The city received a NDEE Source Water Grant in 2021 to assist with decommissioning abandoned wells in 2021 and 2022.
- The city passed a zoning ordinance in 2009 that includes wellhead area protection requirements.

7.02 PLANNED ACTIVITIES FOR THE NEAR FUTURE

The merits of many potential management activities were discussed during the planning process. While no specific plans were developed, the city will explore the activities below and anticipates executing one or more in the near future:

- **Decommission Abandoned Wells** – Abandoned wells can directly channel contaminated surface water into groundwater, and so pose a considerable risk to water supplies. Abandoned wells must be decommissioned (filled, sealed, and plugged) according to state law or they are deemed “illegal”.
 - The LPNNRD will pay up to 75% of well decommissioning costs. Work must be done by a licensed well driller to qualify for cost-share, and a cost estimate must be obtained beforehand and submitted to the NRD for approval and inspection. If approved by LPNNRD, reimbursement will be provided to the well owner after work has been completed and paid for.
 - The UBBNRD will pay up to 60% of well decommissioning costs for a maximum of \$750. The NRD must provide authorization before the decommissioning takes place in order to be eligible for payment
- **Update Well Setback Ordinance** – The city currently recognizes well setback standards.
- **Ongoing Public Education** – Education is often the first step in a successful WHP program. During the process of developing the original wellhead protection report, David City hosted educational meetings for the public. There are many entities which could assist in education efforts such as local schools, LPNNRD, UBBNRD, the Groundwater Foundation, UNL Extension, and the Nebraska Rural Water Association.

- **Public education efforts may include, but are not limited to:**
 - Focus groups
 - Community workshops
 - Press releases
 - “Test-Your-Well” nights
 - Distributing brochures
 - School poster contests
 - News/information articles
 - Utility bill stuffers
- **Education could be on a variety of topics, such as:**
 - Nonpoint source pollution
 - Proper animal waste handling
 - Aquifer and groundwater basics
 - Private well and wastewater system management
 - Fertilizer and Pesticide application
 - Urban and Rural BMPs

7.03 POTENTIAL ACTIVITIES FOR CONSIDERATION

- **Drought / Water Conservation Planning & Readiness** – As previously discussed in Chapter 6.02, David City could work with the National Drought Mitigation Center to become a certified Drought Ready Community. This would further enhance water conservation, help the city prepare for times of drought or water shortages, and provide another avenue for community involvement. Part of this process would be creating a water conservation plan for the city. This could also include completing a drought mitigation plan, completing drought planning exercises, and updating the city’s existing ordinances to improve how drought is handled.
- **Test-Your-Well Nights** – Hosting “Test-Your-Well Nights” with the NRDs will provide the city with outreach opportunities for public education about the WHP plan.

7.04 BEST MANAGEMENT PRACTICES FOR CONSIDERATION

Many BMPs have proven effective in reducing nonpoint source pollution and are commonly employed in Nebraska. In 2019 the Natural Resources Conservation Service (NRCS) expanded their National Water Quality Initiative to include source water protection. In 2020, the NRCS identified a list of BMPs with the greatest impact to source water protection (Table 8). These, along with BMPs identified through stakeholder feedback, are detailed in the following sections. NRCS offers up to 90% cost share on priority BMPs implemented in source water protection areas (WHP areas) through the National Water Quality Initiative. Implementation efforts are likely to be focused on these priority BMPs; however, this does not preclude other innovative practices that may be appropriate to specific projects or site conditions from being pursued. Information and education should always accompany BMP implementation efforts.

Selection of BMPs or other actions should always consider field level characteristics, a producer's management goals, and technical or financial resources available. Additionally, because this is a voluntary plan, all BMPs will need willing landowners to implement them. The city could work in cooperation with the NRDs on a program to place nutrient reducing BMPs within the WHP area.

Table 8: NRCS Source Water Protection Priority Practices

Practice Code	Practice Name	High Priority Practice*
327	Conservation Cover	No
328	Conservation Crop Rotation	Yes
332	Contour Buffer Strips	No
340	Cover Crop	Yes
342	Critical Area Planting	No
351	Water Well Decommissioning	No
355	Well Water Testing	No
386	Field Border	No
390	Riparian Herbaceous Cover	No
391	Riparian Forest Buffer	No
393	Filter Strip	No
412	Grassed Waterway	No
430	Irrigation Pipeline	No
441	Irrigation System, Micro Irrigation	Yes
442	Sprinkler System	Yes
449	Irrigation Water Management	Yes
512	Forage and Biomass Planting	No
550	Range Planting	No
590	Nutrient Management	Yes
595	Integrated Pest Management	Yes
635	Vegetated Treatment Area	No
656	Constructed Wetland	No
657	Wetland Restoration	No
659	Wetland Enhancement	No

**High Priority Practices have the potential to receive up to 90% cost-share.
Source: (NRCS, 2020)*

THIS PAGE LEFT INTENTIONALLY BLANK

CHAPTER 8. PUBLIC EDUCATION AND NOTIFICATION

8.01 OPPORTUNITY FOR PUBLIC INPUT

There must be proper documentation of public involvement to achieve NDEE approval. Development of this plan has followed the guidance of NDEE to ensure proper opportunity for public input. The following steps below are the basic minimum requirements that must be documented:

1. Prepare a WHP Plan
2. The plan is made available for public review at least 30 days prior to the meeting where public comment will be taken on the plan
3. Public comment is taken at a regularly scheduled meeting of the “controlling entity” (meaning the village board, city council, rural water district board, etc.)

Materials documenting the fulfillment of each of these items (copies of newspaper notices, affidavit of publication, minutes, etc.) are located in Appendix F.

8.02 PLANNING STAKEHOLDER COMMITTEE

A nine-member stakeholder committee was established at the initiation of the WHP planning process (Table 9). The stakeholder committee was responsible for plan review and served as local contacts to residents to provide information during the planning period.

Table 9: David City Wellhead Protection Stakeholder Committee Members

Name	Representing	Title
Aaron Gustin	David City	Water Department Supervisor
Jessica Miller	David City	City Council Member
Jim Masek	David City	Planning Commission Member
Jim Vandenberg	David City	Planning Commission Member
Tami Comte	David City	City Clerk
Dillon Vogt	JEO Consulting Group	Natural Resources Specialist & Hydrologist in Training
Jon Mohr	JEO Consulting Group	Senior Environmental Planner & Scientist
Bob Hilger	Local Farmer	N/A
Daryl Andersen	LPNNRD	Water Department Manager
Mike Plante	LRE Water	Lead Hydrogeologist & Professional Geologist
Tatiana Davila	NDEE	Wellhead Protection Coordinator
Erinn Wilkins	UBBNRD	Water Resources Technician
Marie Krausnick	UBBNRD	Water Department Manager

8.03 MEETING SUMMARY

During the development of this WHP plan, the city established a stakeholder committee, which met multiple times, and a held public open house to offer residents and property owners an opportunity to voice their opinion or ask any questions about wellhead protection and the planning process. Below is a summary of the types and dates of meetings. Notifications for stakeholder meetings were by email, phone calls, and word of mouth. Sign-in sheets and other public notification materials are located in Appendix G. Note that some meetings were held virtually due to the COVID-19 pandemic.

Project Kickoff Meeting – February 25, 2021

City representatives met with JEO, LRE, NDEE, LPNNRD, and UBBNRD to discuss the planning process, roles and responsibilities, stakeholder group selection, public involvement needs, the wellhead protection area model, contaminant source inventory, well decommissioning, and the overall project schedule.

Notification: Attendees were invited to the meeting by email and phone calls.

Stakeholder Meeting #1 – February 17, 2022 at 12:15 PM

Stakeholders shown in Table 9 met at David City offices to discuss the wellhead protection program, a draft of the plan, well decommissioning, the public open house, and project schedule. Stakeholders had the opportunity to offer their perspectives and ask questions.

Notification: Attendees were invited to the meeting by email and phone calls.

Stakeholder Meeting #2 – March 21, 2022 at 4 PM

Stakeholders met at Hruska Memorial Public Library to review the Wellhead Protection Plan draft, discuss plans for well decommissioning, and review the project schedule and the timeline for plan approval. Attendees were able to offer input and ask questions.

Notification: Attendees were invited to the meeting by email and phone calls.

Public Open House – March 21, 2022 at 5 PM

Members of the public gathered at the Hruska Memorial Public Library to learn about the plan and meet with project partners. Presentation topics included the Wellhead Protection Program, the draft plan, WHP area delineation, well decommissioning, and the project schedule and approval process. Participants had the opportunity to ask questions and review the draft plan.

Notification: Advertisements for the open house were placed in the local newspaper and on the David City website. Flyers were also posted in at least three places around town.

REFERENCES

- Alley, W. M., Reilly, T. E., and Franke, O. L., 1999, Sustainability of ground-water resources: U.S. Geological Survey Circular 1186, accessed at <https://pubs.usgs.gov/circ/circ1186>.
- Byrkit, B., 2020, Routine Sanitary Survey, City of David City, NE3102301, Butler County: Nebraska Department of Health and Human Services, 32 p., available in Appendix B.
- Butler County Emergency Management Agency, 2015, City of David City operations plan for disaster response and recovery, *in* Butler County, Nebraska local emergency operations plan (Annex A, Tab A): Butler County, 31 p., available in Appendix E.
- City of David City, 2005, David City comprehensive plan: City of David City publication, accessed 2021 at <https://davidcitycomprehensiveplan.files.wordpress.com/2021/10/existing-comprehensive-plan-2005.pdf>.
- City of David City, 2019, Zoning Ordinance (No. 1060): City of David City, accessed 2021 at <https://www.davidcityne.com/vimages/shared/vnews/stories/5d9e117168fb2/Zoning%20Ordinance%20-%20Updated%205-8-19.pdf>.
- City of David City, 2020, Annual water quality report for January 1 to December 31, 2020: Quality on Tap! Report, available in Appendix B.
- City of David City, n.d., Municipal code, Chapter 7 – Public utilities: City of David City, accessed 2021 at <https://www.davidcityne.com/vnews/display.v/SEC/City%20of%20David%20City%7CMunicipal%20Codes>.
- Gosselin, D.C., Headrick, J., Tremblay, R., Chen, X., and Summerside, S., 1997. Domestic well water quality in rural Nebraska: Focus on nitrate-nitrogen, pesticides, and coliform bacteria: *Groundwater Monitoring & Remediation*, v. 17, no. 2, p. 77-87. <https://doi.org/10.1111/j.1745-6592.1997.tb01280.x>
- Hume, D.S., Bauer, J., Meyer, C., Plante, M., and Sopiwnik, R., 2021, Wellhead Protection Area Delineation – Department of Utilities, Wahoo, NE: LRE Water, *prepared for* JEO Consulting Group, 62 p., available in Appendix A.
- Lower Platte North Natural Resources District (LPNNRD), 2018, Groundwater Management Area Rules and Regulations: LPNNRD, accessed 2022 at <https://lpnnrd.org/downloads/>.
- Maupin, M.A., Kenny, J.F., Hutson, S.S., Lovelace, J.K., Barber, N.L., and Linsey, K.S., 2014. Estimated use of water in the United States in 2010: U.S. Geological Survey Circular 1405, 56 p, <https://dx.doi.org/10.3133/cir1405>.

-
- Miesbach, D., Capps, S., Davila, T., Chapman, R., and Link, M. (ed.), 2019, 2019 Nebraska groundwater quality monitoring report: Nebraska Department of Environment and Energy publication, 22 p. accessed at <http://deq.ne.gov/Publica.nsf/PubsForm.xsp?documentId=7AA33E82AAC4119C862584C400682884&action=openDocument>.
- Miesbach, D., Radford, S., Chapman, R., and Link, M. (ed.), 2018, 2018 Nebraska groundwater quality monitoring report: Nebraska Department of Environmental Quality (now Nebraska Department of Environment and Energy) publication, 43 p., accessed at <http://deq.ne.gov/publica.nsf/pages/WAT258>.
- National Cancer Institute, 2021, Online summary of trends in US cancer control measures – Nitrate: National Cancer Institute Cancer Trends Progress Report, accessed at <https://progressreport.cancer.gov/prevention/nitrate>.
- National Research Council, 1993, Ground water vulnerability assessment: Contamination potential under conditions of uncertainty: Washington, DC, National Academies Press, 210p.
- Natural Resources Conservation Service, 2020, Source water protection practices: *presented at* the January 2020 Nebraska Association of Resources Districts Legislative Conference.
- Nebraska Department of Agriculture (NDA), 2022, Pesticide dealers: NDA database, accessed at <http://www.kellysolutions.com/ne/Dealers/index.htm>.
- Nebraska Department of Environment and Energy (NDEE), 2022. Nebraska Groundwater Quality Clearinghouse: NDEE Data Explorer, accessed at <https://clearinghouse.nebraska.gov/?wellPageSize=50&wellPage=1&samplePageSize=50&samplePage=1>.
- Nebraska Department of Environment and Energy, 2021, Regulated facilities interactive map portal: NDEE dataset, accessed at <https://deqmaps.nebraska.gov/deqmapportal/nebraskaMapPortal.html>.
- Nebraska Department of Health and Human Services (NDHHS), 2010, Title 179, Public water systems – Chapter 7, Siting, design, and construction of public water systems: NDHHS Rules and Regulations, accessed at https://sos.nebraska.gov/rules-and-regs/regsearch/Rules/Health_and_Human_Services_System/Title-179/Chapter-07.pdf.
- Nebraska Department of Health and Human Services, 2021, Chem/Rad Samples/Results by Analyte for Water System NE3102301, City of David City: Drinking Water Branch data release, accessed at https://drinkingwater.ne.gov/JSP/AnalyteList.jsp?tinwsys_is_number=712701&tinwsys_st_code=NE.

-
- Nebraska Department of Natural Resources, 2022, Nebraska registered wells inventory: NeDNR Groundwater Interactive Maps, accessed at <https://dnr.nebraska.gov/groundwater/groundwater-interactive-maps>.
- Nebraska Oil and Gas Conservation Commission, 2016, Oil and gas well GIS data mining: Nebraska Oil and Gas Conservation Commission dataset, accessed 2022 at [http://www.nogcc.ne.gov/RBDMDataMining/\(S\(kk33lki3yidn0a2fkatmnn2l\)\)/](http://www.nogcc.ne.gov/RBDMDataMining/(S(kk33lki3yidn0a2fkatmnn2l))/).
- Nebraska State Fire Marshal, 2021, Underground storage tanks: Nebraska State Fire Marshal database, accessed at <https://sfm.nebraska.gov/fuels-safety/underground-storage-tanks>.
- Nolan, J., and Weber, K. A., 2015, Natural Uranium Contamination in Major U.S. Aquifers Linked to Nitrate: Environmental Science and Technology Letters, vol. 2, no. 8, p. 215-220, accessed at <https://doi.org/10.1021/acs.estlett.5b00174>.
- Rahman, A., 2008, A GIS based DRASTIC model for assessing groundwater vulnerability in shallow aquifer in Aligarh, India: Applied Geography, v. 28, no. 1, p. 32-53, accessed at <https://doi.org/10.1016/j.apgeog.2007.07.008>.
- U.S. Bureau of the Census, 2018, American Community Survey 5-year Estimates: U.S. Census Bureau data release, accessed at <https://www.census.gov/programs-surveys/acs/data.html>.
- U.S. Department of Agriculture, National Agricultural Statistics Service, 2020, CropScope – Cropland Data Layer for 2020: George Mason University Center for Spatial Information Science and Systems, accessed at <https://nassgeodata.gmu.edu/CropScope/>.
- U.S. Environmental Protection Agency, 2022, Basic information about source water protection: U.S. EPA webpage, accessed at <https://www.epa.gov/sourcewaterprotection/basic-information-about-source-water-protection>.
- U.S. Geological Survey, 2022, Water use data for Nebraska: USGS data release, accessed at https://waterdata.usgs.gov/ne/nwis/water_use.
- UNL Conservation and Survey Division, n.d., Nebraska GIS Data: UNL School of Natural Resources data release, accessed at <http://snr.unl.edu/data/geographygis/>.
- Upper Big Blue Natural Resources District (UBBNRD), 2020, Rule 5 – UBBNRD Groundwater Management Rules and Regulations: UBBNRD, accessed 2022 at <https://www.upperbigblue.org/rules-regulations>.

LIST OF APPENDICES

APPENDIX A: GROUNDWATER MODELING DOCUMENTATION AND MAPS

APPENDIX B: PUBLIC WATER SYSTEM DOCUMENTS

APPENDIX C: SELECT ORDINANCES AND MUNICIPAL CODES

APPENDIX D: CONTAMINANT SOURCE INVENTORY

APPENDIX E: EMERGENCY RESPONSE INFORMATION

APPENDIX F: PLAN ADOPTION MATERIALS

APPENDIX G: DOCUMENTATION OF STAKEHOLDER INVOLVEMENT