LOWER PLATTE SOUTH
natural resources district

2018 Ground Water Management Plan Review

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LOWER PLATTE SOUTH NATURAL RESOURCES DISTRICT
GROUND WATER MANAGEMENT PLAN
2018 ANNUAL REVIEW

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Foreword

The following report fulfills the Lower Platte South Natural Resources District's responsibility to conduct a review each calendar year assessing the District's actions, activities, and effectiveness under the Rules and Regulations for implementation of the Ground Water Management Plan approved by the Nebraska Department of Water Resources on June 26, 1995. This report is issued in a format which will hopefully make it easy for the reader to gain information about ground water quality and quantity within the District. The 2018 Annual Review was presented to the Water Resources Subcommittee on March 13, 2019 and to the Board of Directors on April 17, 2019.

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Please Note: This report is organized by major ground water program areas. The applicable rules and regulations governing those program areas are cited in the text for each area where appropriate. These rules and regulations were substantially revised effective January 1, 2017; the applicable sections cited in this document reflect those updates.

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LIST OF ACRONYMS

AEM	Airborne electromagnetic
BMP	Best management practice
CPA	Crete-Princeton-Adams
CWSPA	Community Water System Protection Area; equivalent to Wellhead Protection Area (WHPA)
DV	Dwight-Valparaiso
DVB	Dwight-Valparaiso-Brainard
ENWRA	Eastern Nebraska Water Resources Assessment
gpm	Gallons per minute
GWMA	Ground Water Management Area
GWMP	Ground Water Management Plan
GWR	Ground Water Reservoir
HCA	Hydrologically Connected Area
IMP	Integrated Management Plan
IWMPP	Interrelated Water Management Plan Program
LSC	Lower Salt Creek
MCL	Maximum Contaminant Level
mg/ℓ	Milligrams per liter; equivalent to parts per million (ppm)
MR	Missouri River
NDEQ	Nebraska Department of Environmental Quality
NDNR	Nebraska Department of Natural Resources
NHHS	Nebraska Health and Human Services
ppb	Parts per billion; equivalent to micrograms per liter (ug/ℓ)
ppm	Parts per million; equivalent to milligrams per liter (mg/ℓ)
PR	Platte River
QA/QC	Quality Assurance/Quality Control
RA	Remaining Area
RPD	Relative percent difference
RWD	Rural Water District
SID	Sanitary Improvement District
SMA	Special Management Area
SOP	Standard operating procedure
TDS	Total dissolved solids
ug/ℓ	Micrograms per liter; equivalent to parts per billion (ppb)
UNL	University of Nebraska-Lincoln; these are UNL subdivisions: CSD: Conservation and Survey Division SNR: School of Natural Resources WSL: Water Sciences Laboratory
USEPA	United States Environmental Protection Area
WHPA	Wellhead Protection Area; equivalent to Community Water System Protection Area (CWSPA)
WQMP	Water Quality Management Plan
WSF	Water Sustainability Fund

Phase Determination Criteria

Ground Water Quality Triggers

Phase I: Entire NRD

Phase II: contaminants in ≥50% of network wells are ≥50% of the MCL (5 ppm for nitrate-nitrogen)

Phase III: contaminants in ≥80% of network wells are ≥80% of the MCL (8 ppm for nitrate-nitrogen)

(Note: the MCL for nitrate-nitrogen is 10 ppm)

Ground Water Quantity Triggers

Phase I: Entire NRD

Ground Water Quantity Triggers for CPA, DV, MR, and PR GWRs, and RA

Phase II: saturated thickness in ≥30% of network wells is ≥8% below average

Phase III: saturated thickness in ≥50% of network wells is ≥15% below average

Ground Water Quantity Triggers for LSC GWR

Phase II: saturated thickness in ≥30% of network wells is ≥15% below average

Phase III: saturated thickness in ≥50% of network wells is ≥30% below average

Equations

Relative Percent Difference (RPD):

$$RPD = \left[\frac{(Sample1 - Sample2)}{(Sample1 + Sample2)/2} \right] \times 100$$

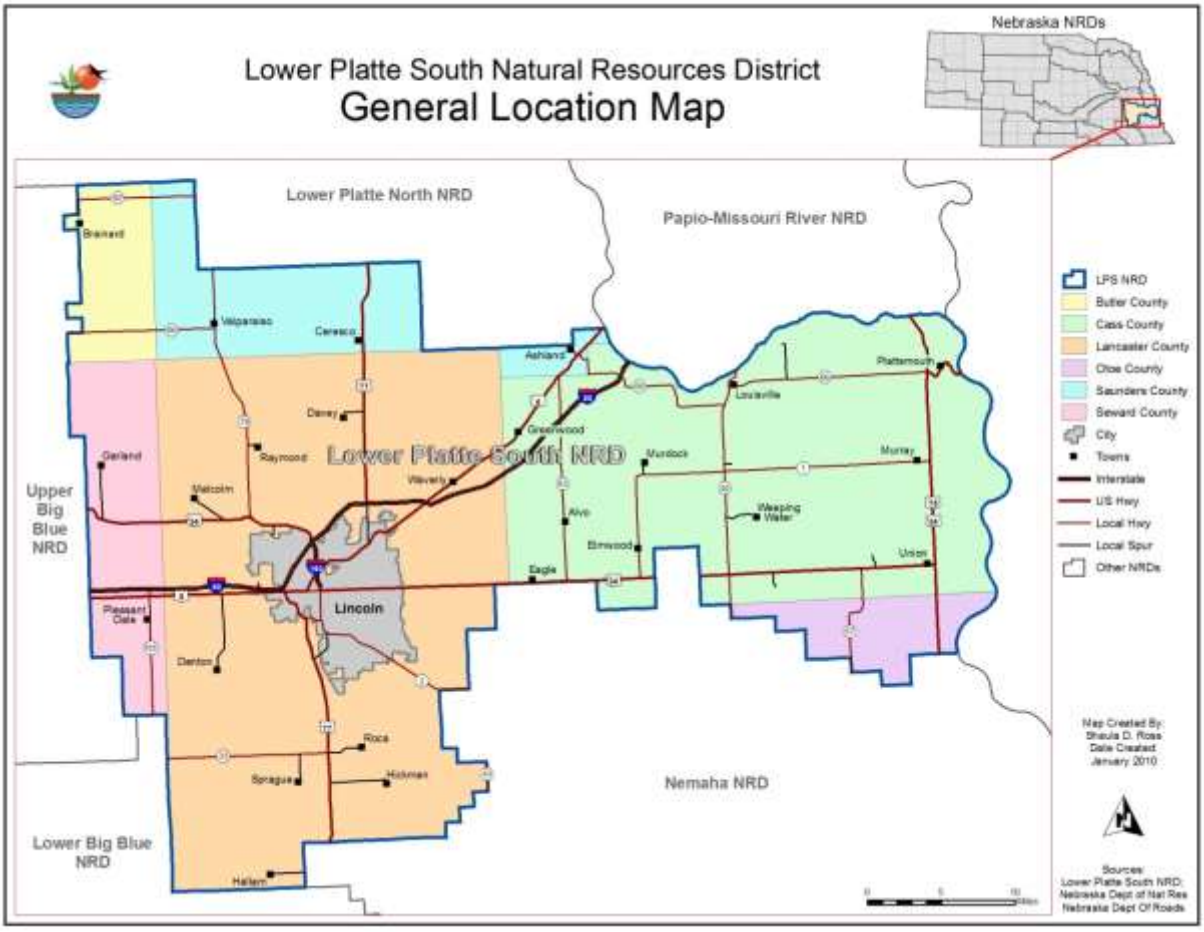
(used to calculate % difference between two samples)

1. INTRODUCTION

1.1. Background

The Lower Platte South Natural Resources District (LPSNRD or District) is one of 23 Natural Resources Districts in Nebraska. When created in the early 1970s, Nebraska's Natural Resources Districts (NRDs) were delineated according to major surface water drainage boundaries, and were given broad responsibilities in conservation and management of natural resources. The LPSNRD is located in the southern portion of the Lower Platte River Basin, and encompasses slightly more than one million acres or more than 1,500 square miles in parts of Butler, Saunders, Seward, Lancaster, Cass, and Otoe Counties in southeast Nebraska (Figure 1).

Figure 1 – General Location Map



One of the primary areas of responsibility delegated to NRDs is the management and conservation of ground water, both in terms of its quality and quantity (see below). In Nebraska, some 85% of the state's population relies on ground water as the primary source of drinking water. Many of the state's rivers, streams, and wetlands are fed by

ground water discharge, and the aquatic and terrestrial plants and animals associated with them depend on ground water of adequate quality and quantity. Ground water for irrigation is also fundamental to the state's agricultural economy, and a wide variety of industries depend on its availability and quality. Clearly, ground water is one of Nebraska's most precious resources, and the Lower Platte South NRD is committed to implementing protective programs for the good of its citizens.

1.2. Authority for Ground Water Programs

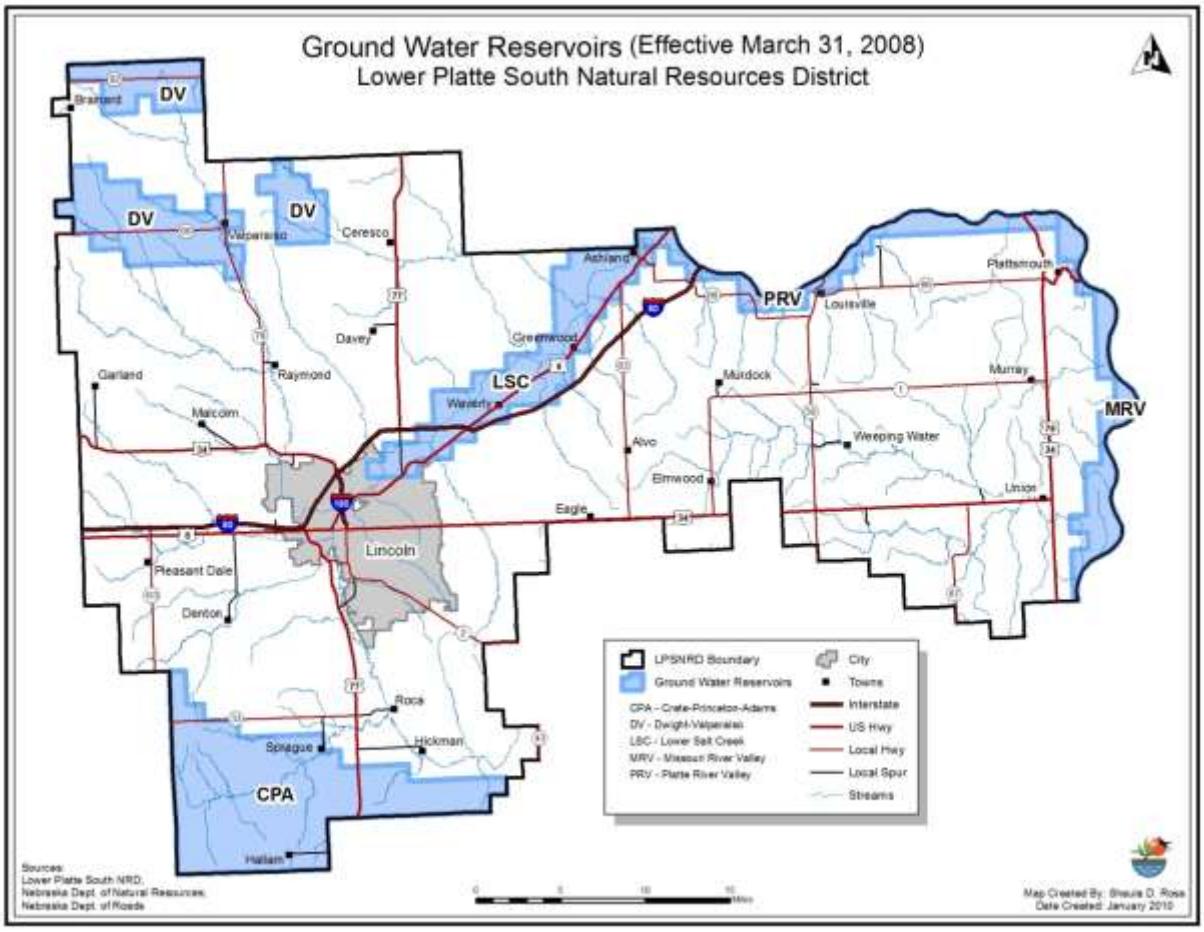
Natural Resources Districts are given a wide variety of responsibilities for the management of ground water quantity and quality by Nebraska statutes. Those authorities can be found mostly in Chapter 46 of the Nebraska Revised Statutes. As required by law, in 1995 LPSNRD developed and adopted a Ground Water Management Plan (GWMP) to govern its ground water management programs (LPSNRD, 1995). In addition, LPSNRD has adopted Ground Water Rules and Regulations (Revised Effective Date: January 1, 2017) as per the authority granted in statutes.

1.3. Ground Water Reservoirs

Applicable Regulations: Section B, Rules 2 and 3

As is common in most of eastern Nebraska, the geologic setting of the LPSNRD means that ground water resources in the District are quite variable from place to place. The District has therefore delineated five major ground water reservoirs (GWRs) in its jurisdiction. The GWRs represent areas which useable amounts of good quality ground water are generally available. Typically, the GWRs consist of sand and/or gravel deposits in buried paleovalleys or present-day river valleys. The location of the GWRs can be seen in Figure 2. The remainder of the District has been designated as the Remaining Area (RA), which includes the Dakota Formation aquifer and other small aquifers not designated as part of any GWR. Ground water in the RA is discontinuous spatially, and variable in both quality and quantity. Figure 2 also shows the location of the RA in LPSNRD (the RA is indicated by the area in white—that is, everything that is not in a GWR).

Figure 2 – Ground Water Reservoirs

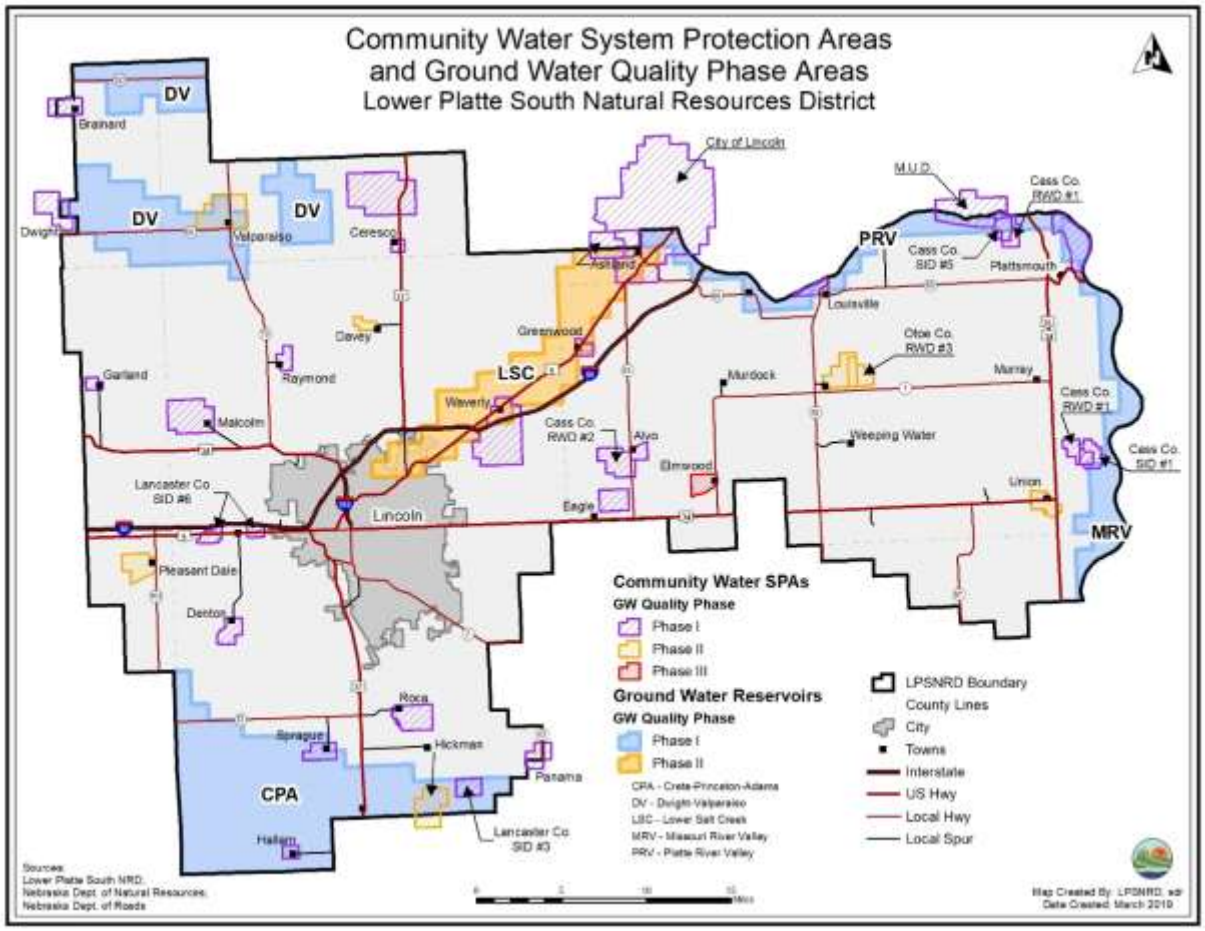


1.4. Community Water System Protection Areas (CWSPAs)

Applicable Regulations: Section B, Rule 2

Drinking water supplies in LPSNRD come primarily from ground water sources, just like most of the rest of Nebraska. The Nebraska Department of Environmental Quality (NDEQ) delineates Wellhead Protection Areas (WHPAs) for all public water supply systems in the state. These WHPAs generally correspond to the predicted 20-year time-of-travel zone for the supply wells in those systems. In other words, the WHPAs represent the area from which ground water could be expected to be extracted during 20 years of normal water use for those public water supplies. LPSNRD has adopted the boundaries of the delineated WHPAs as additional areas for ground water management under the current GWMP. In the LPSNRD, these areas are referred to as Community Water System Protection Areas (CWSPAs); the locations of CWSPAs as well as Phase areas (see Section 3) in the District are shown in Figure 3.

Figure 3 – Community Water System Protection Areas



2. REGISTERED WELLS

Applicable Regulations: N/A

As is the case in most of Nebraska, the majority of water for municipal, domestic, irrigation, and other uses comes from ground water sources. As already described, availability of ground water across LPSNRD is highly variable, with some areas containing considerable supplies while others have little or almost no ground water (for more information, see Section 4.1.1). As a result, the distribution of ground water wells across the District is also variable. Figure 4 shows the locations of registered domestic and public water supply wells in LPSNRD, while Figure 5 shows the locations of registered irrigation wells. Note that, prior to 1993, domestic wells were not required to be registered in Nebraska, and so Figure 4 is only a partial representation of the location of these types of wells. That is, domestic wells completed prior to 1993 may or may not show up on this map.

Figure 4 – Locations of Registered Domestic and Public Water Supply Wells

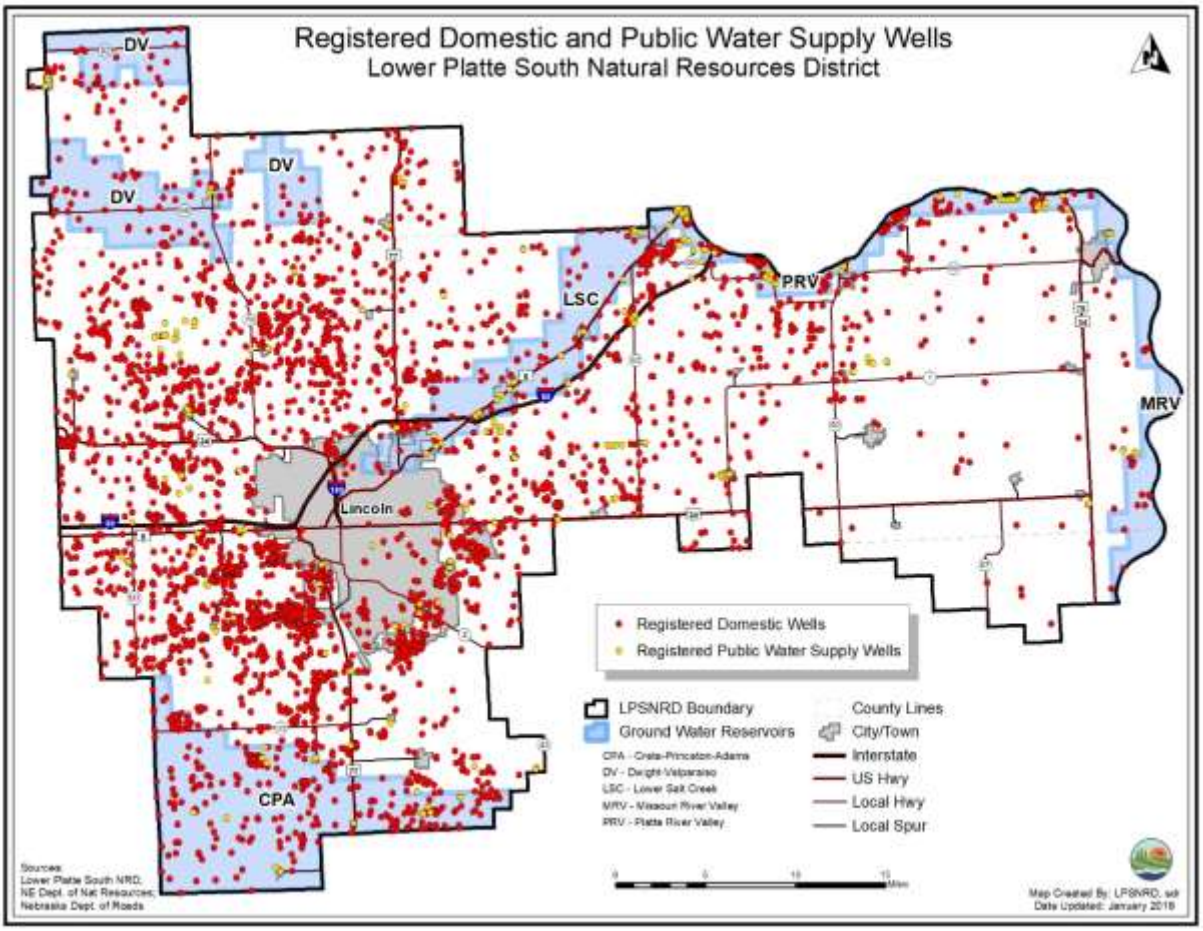
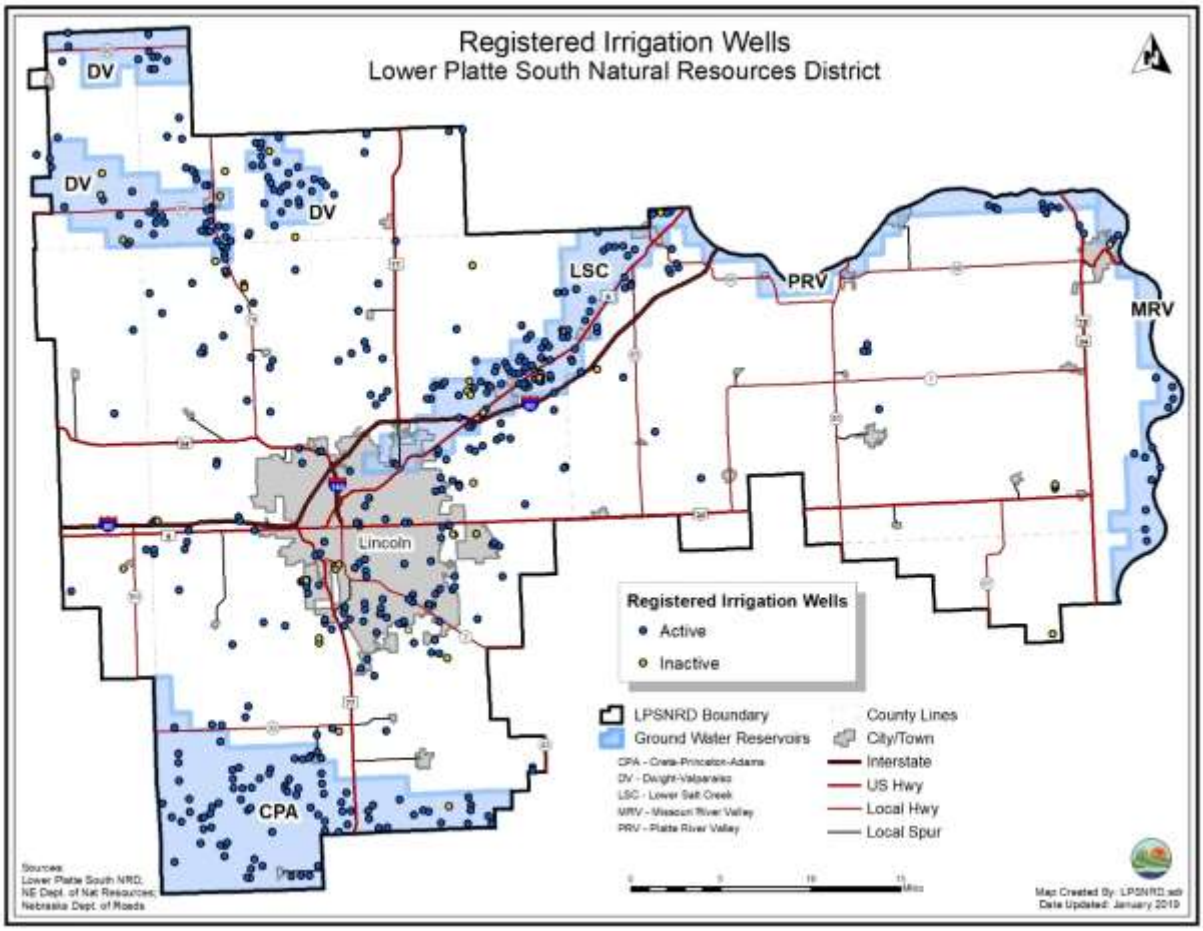


Figure 5 – Locations of Registered Irrigation Wells



3. GROUND WATER MONITORING NETWORK

Applicable Regulations: Sections F, G

The District's ground water monitoring networks are designed to provide a grid-like network of monitoring sites for each of the Ground Water Reservoirs and the Remaining Area, and to provide additional information about each CWSPA. LPSNRD's GWMP allows for the designation of various phases to deal with increasing ground water contamination and/or decreasing ground water levels. The entire NRD is currently in at least a Phase I Ground Water Management Area (GWMA), and in this phase the District establishes various information and education programs, and requires permits for all new wells which pump more than 50 gallons per minute (gpm) in a GWR or CWSPA, and 20 gpm for non-domestic wells in the RA. Higher levels of phased management have been implemented in some parts of the District to deal with concerns over ground water quality and quantity (see below). Progress in developing LPSNRD's monitoring well network is shown in Table 1.

Ground Water Reservoir	# Network Wells Needed	# Quality Network Wells/% Complete	# Quantity Network Wells/% Complete
Crete-Princeton-Adams	33	32/97%	30/91%
Dwight-Valparaiso	23	23/100%	24/104%
Lower Salt Creek	19	19/100%	21/110%
Missouri River Valley	10	5/50%	5/50%
Platte River Valley	12	10/83%	3/25%
Remaining Area	58	43/74%	33/57%

Table 1 – Status of Ground Water Monitoring Networks

For ground water quality, if levels of a contaminant exceed 50% of the federal maximum contaminant level (MCL) for that contaminant in 50% of the District's ground water monitoring network wells for two consecutive years, the NRD can designate a Phase II GWMA, and adopt rules and regulations for management of that contaminant. If contaminant levels exceed 80% of the MCL in 80% of the NRD's network wells, again for two consecutive years, the NRD can designate a Phase III GWMA, and adopt additional, more stringent rules and regulations for dealing with the situation. Currently, the Lower Salt Creek GWR and the Valparaiso, Otoe County RWD #3/Weeping Water, Davey, Hickman, Pleasant Dale, and Union CWSPAs are in Phase II management, and the Elmwood CWSPA is in Phase III management for ground water concerns due to elevated nitrate levels (see Figure 3).

For ground water quantity, LPSNRD's GWMP lays out a similar procedure for designating phased management areas to deal with ground water declines. If spring static water level elevations in 30% of the District's ground water monitoring network wells have declined from the established upper elevation of the saturated thickness by 8% (15% in the Lower Salt Creek GWR), the NRD can designate a Phase II GWMA, and adopt rules and regulations to manage ground water declines. If spring static water level elevations in 50% of the District's network monitoring wells decline by 15% (30% in the Lower Salt Creek GWR), the NRD can designate a Phase III GWMA, and again can adopt additional and more stringent rules and regulations for management of ground water declines. Currently, there are no Phase II or III GWMAs for ground water quantity in the LPSNRD, but due to concerns over seasonal declines, LPSNRD is implementing management actions in a Special Management Area in the Dwight-Valparaiso-Brainard area (see Section 4.2).

3.1 Ground Water Quality Monitoring Program

Staff collected 222 samples and 42 quality assurance/quality control (QA/QC) samples from 222 different wells in 2018. The total number of samples collected in 2018 was slightly lower than in past years as wet weather during the irrigation season meant that some irrigation wells could not be sampled as they were used very little if at all. Samples were collected from monitoring network wells, CWSPA wells, and other wells that the District samples on an annual basis. Samples were analyzed for a variety of parameters, including nitrate-nitrogen, major ions, dissolved metals, pH, specific conductance, hardness, alkalinity, and total dissolved solids. Since 2005, pesticide analyses have been rotated annually between different GWRs, and in 2010, the District adopted a similar rotation for major ions. Community water supply wells were tested for radon and arsenic in addition to the basic parameters. CWSPA monitoring network wells were tested for radon, arsenic, and volatile gasoline constituents (benzene, toluene, ethylbenzene, and total xylenes) in addition to the basic sample parameters.

Over the past few years, the NRD has worked to outfit all of its dedicated monitoring wells with their own pumps and sampling ports. District field staff has now completed four seasons of using these dedicated systems. Future monitoring well installations are planned to include dedicated pumps as a part of the original construction. As a result, the District has realized a considerable increase in efficiency of sampling these wells, along with a lowered risk of well cross-contamination, resulting in higher quality ground water data.

3.1.1 Nitrate-Nitrogen Results

Nitrates in drinking water have been a concern for many years in many parts of Nebraska, the United States, and the world. Nitrate (often expressed by the term "nitrate as nitrogen" or "nitrate-nitrogen") is naturally present in ground water at low levels, usually less than 2 parts per million (ppm; this is essentially equivalent to milligrams per liter or mg/ℓ), and at such levels typically does not present any health concerns. However, nitrogen fertilizers, manure, or other nitrate-containing material applied to farm ground or lawns and gardens can supply additional nitrate which can infiltrate with natural recharge and lead to higher than natural levels of nitrate in ground water. Nitrate in drinking water at elevated levels of several tens of ppm can cause acute health problems especially in infants by causing a condition in which the oxygen-carrying capacity of the blood is inhibited. High nitrate levels have also been associated with health and gestational problems in livestock, and may have long term chronic effects on humans as well. The United States Environmental Protection Agency (USEPA) has established an MCL of 10 ppm for nitrate-nitrogen in drinking water.

All wells sampled by the District in 2018 were analyzed for at least nitrate-nitrogen. Nitrate concentrations were variable across the District (Figures 6 and 7). Based upon this data, Phase II and Phase III determinations for the GWRs are shown in Table 2. Five of 14 samples (36%) from network wells in the LSC GWR exceeded 50% of the MCL for nitrate-nitrogen in 2018. The LSC GWR average was slightly below the Phase II trigger

in 2011 through 2018, just above the trigger in 2010, and just below the trigger in 2008 and 2009. Thus, it appears that overall nitrate levels in ground water in the LSC GWR are not increasing and may be declining somewhat. As a result of the nitrate levels being consistently below the Phase II trigger for several years, in its implementation plan for Fiscal Year 2018 LPSNRD included an action item to suspend Phase II in the LSC GWR, and will continue that process if necessary in Fiscal Year 2019. No other GWRs exceeded a Phase trigger in 2018. More specific information for each GWR can be found in Section 4.

Figure 6 – Nitrate Results – Ground Water Monitoring Network

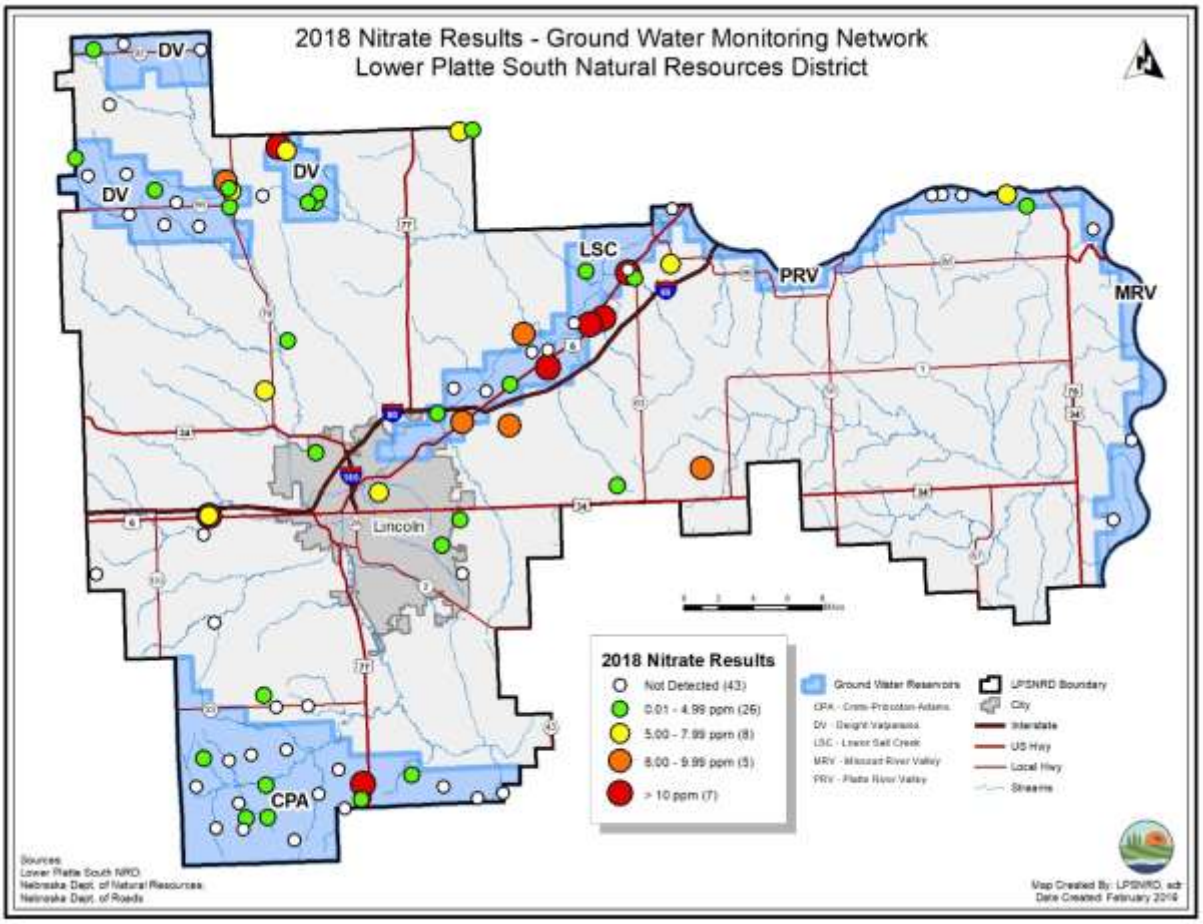
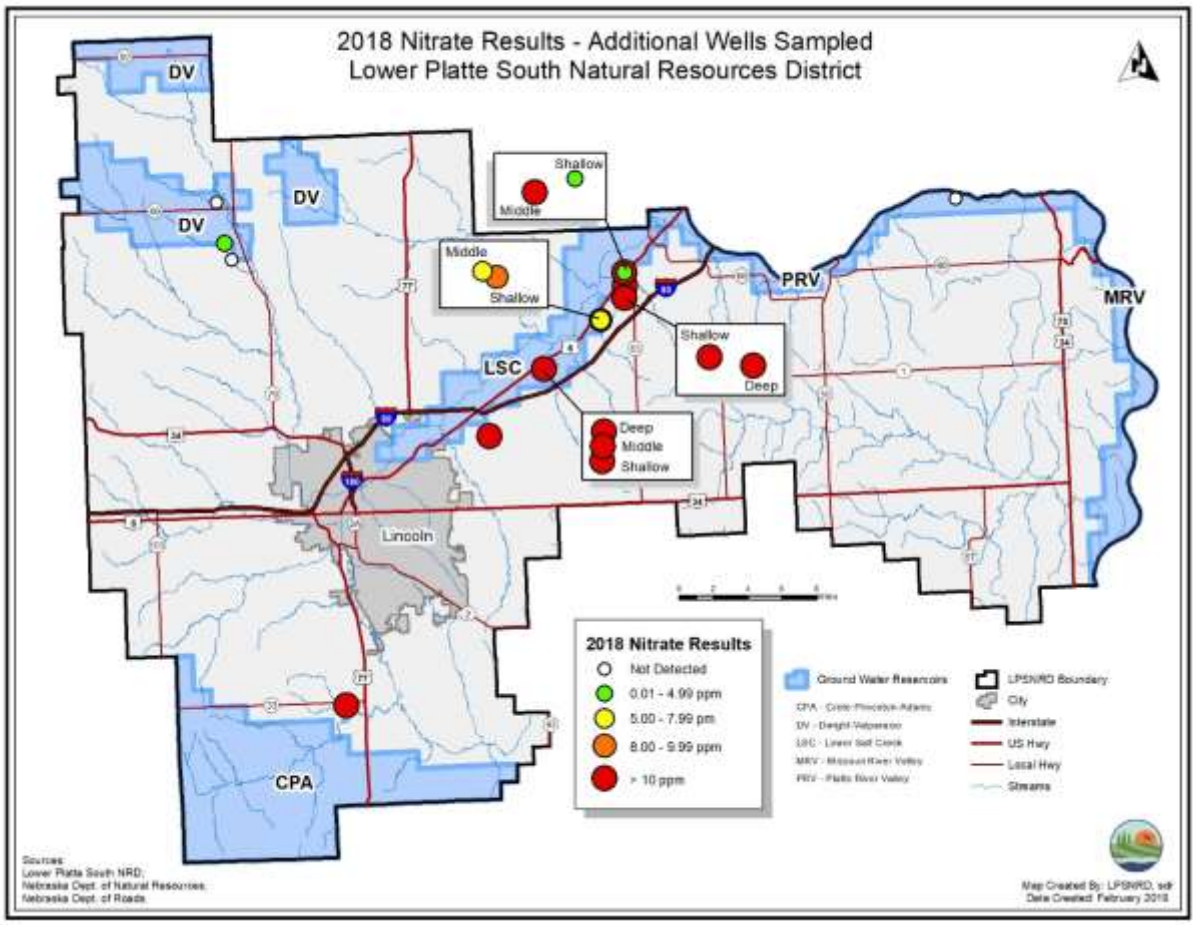


Figure 7 – Nitrate Results – Additional Wells Sampled



Ground Water Reservoir	# Network Wells Sampled	Network Samples ≥ 50% of MCL*	Network Samples ≥ 80% of MCL*
Crete-Princeton-Adams	21	5%	5%
Dwight-Valparaiso	19	16%	5%
Lower Salt Creek	14	**36% (Phase II Area)**	36%
Missouri River Valley	3	0%	0%
Platte River Valley	6	17%	0%
Remaining Area	26	38%	19%

* MCL = Maximum Contaminant Level; the MCL for nitrate-nitrogen is 10 parts per million

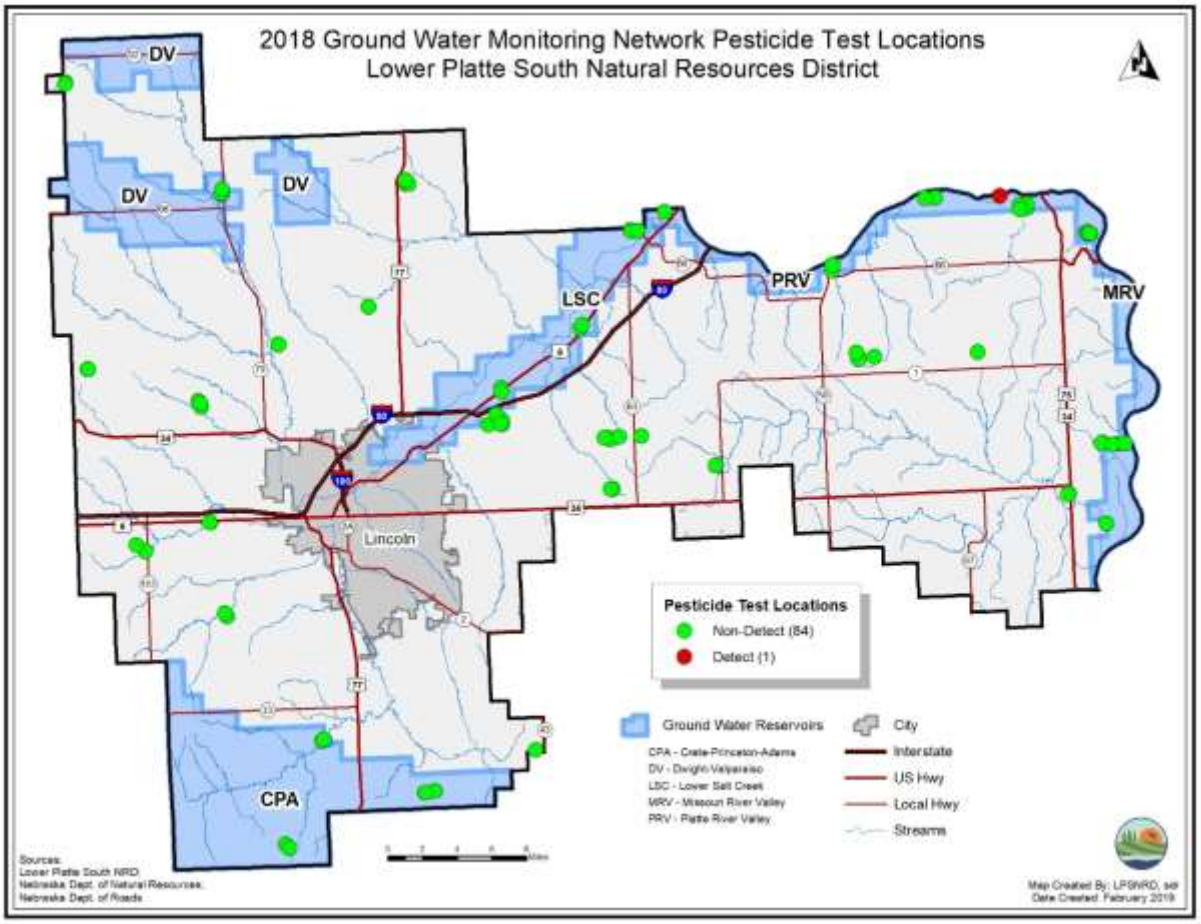
Table 2 – Phase Determinations for Nitrate-Nitrogen

3.1.2 Pesticide Results

Pesticides are compounds that are designed to control pests. Most common of these are herbicides (used to control undesirable plants) and insecticides (use to control undesirable insects). Other commonly used pesticides include fungicides, algicides, rodenticides, and grain fumigants. Residues from pesticides applied to crop ground, buildings, or lawns and gardens, or concentrated amounts from leaks and spills can move into the ground with infiltration and may eventually find their way to ground water. The possible health effects of pesticides vary widely depending upon the compound and concentration, but as a general rule it is obviously desirable to keep such compounds out of ground water and drinking water altogether, or at least to keep the levels of pesticides below any applicable health limits.

The District analyzes samples for 31 separate pesticide compounds on a rotating basis; in some cases existing agreements with public water suppliers specify annual pesticide sampling. In 2018, samples were collected from 89 wells and analyzed for these compounds. Of the wells sampled in 2018, only one sample from the Metropolitan Utilities District (MUD) public water supply well had any detections of a pesticide. This well showed a detection of the herbicide atrazine at a concentration of0.64 parts per billion (ppb; this is essentially the same as micrograms per liter or ug/ℓ). Atrazine is an herbicide commonly used for the suppression of weeds in corn and sorghum, and is detected in ground water in many areas of farmland in Nebraska. The current federal MCL for atrazine is 3 ug/ℓ , so the level of this contaminant is well below the applicable MCL. As in any case of detection of a pesticide, the owner of the well will be notified of this detection. Figure 8 shows the locations of the wells that were sampled in 2018 along with the location of the one pesticide detection.

Figure 8 – Pesticide Sample Locations



3.1.3 Other Parameter Results

Although nitrate and pesticides are often cited as ground water concerns, LPSNRD also monitors ground water for additional parameters. In 2018, District staff collected additional ground water samples which were analyzed for major ions and arsenic.

3.1.3.1 Major Ions

Analysis of major ionic species in ground water gives a general indication of water chemistry and hydrogeologic conditions. In 2018, LPSNRD had 88 ground water samples analyzed for the following ions: calcium, iron, magnesium, manganese, potassium, silicon, sodium, chloride, fluoride, and sulfate. Alkalinity and hardness expressed as calcium carbonate were also included, as was measurement of total dissolved solids (TDS). Based on previous years' monitoring, LPSNRD began a rotational system for monitoring major ions in 2011; in 2018 samples from the Platte River and Missouri River GWRs as well as several public water supplies (depending upon the NRD's agreement with those municipalities) were analyzed for these

compounds. Samples from the other GWRs will be analyzed on this rotational basis in coming years, and those from all PWS wells will continue to be analyzed.

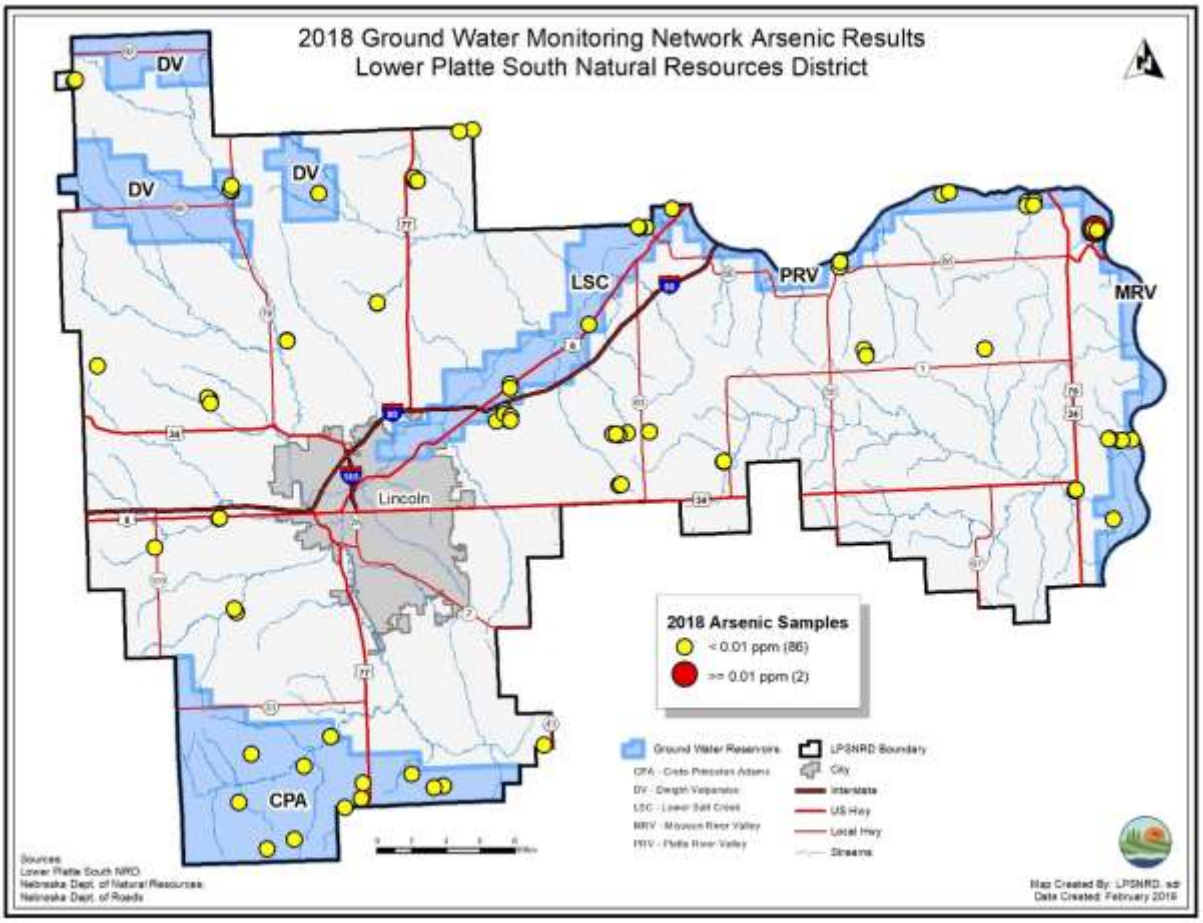
For the most part, analysis of major ions provides information regarding general water quality, and can also be used to evaluate changing ground water conditions or to help identify concerns. For example, ground water influenced by animal waste or septic tank effluent may exhibit elevated levels of sodium and/or chloride. In parts of the District, ground water contained in lower portions of the Dakota Formation may also be elevated in sodium, chloride, and TDS, and pumping of shallow ground water or various natural conditions may cause saline water to move toward the surface. Monitoring of major ions can give important information on situations such as these.

3.1.3.2 Arsenic

Arsenic is a semi-metallic element that can be found naturally in various kinds of rock and sediment, and can also be produced in agricultural and industrial processes. Acute effects from arsenic can occur at high levels of ingestion, and long-term exposure to arsenic has been linked to various forms of cancer. The USEPA has established an MCL for arsenic in drinking water of 10 parts per billion (ppb), which is equivalent to 0.01 ppm. LPSNRD collects ground water samples for arsenic analysis as a service to several community water suppliers in the District. Although arsenic is a regulated contaminant for public water supplies, in Nebraska its occurrence is most commonly as a result of naturally-occurring sources, and as such is beyond the NRDs' regulatory authority to manage.

In 2018, LPSNRD staff collected 88 samples from as many different wells in the District. The results of that sampling are shown in Figure 9. All but two of the samples had arsenic results at either non-detectable levels or levels below the MCL. Both samples above this level came from wells belonging to the City of Plattsmouth, whose wells have occasionally shown detections of arsenic at slightly elevated levels thought to be a result of naturally-occurring conditions involving the Platte and Missouri River alluvial sediment deposits. District personnel communicated the results to all cooperators, and will continue to provide information as requested.

Figure 9 – Arsenic Detections



3.1.3.3 Radon

Radon is a colorless, tasteless, odorless gas that is produced by the natural breakdown of uranium in rocks and sediments. The main health concern from radon is exposure through inhalation, as high levels of radon in indoor air have been linked with lung cancer. Most radon in indoor air comes from the soil and rock surrounding buildings, but a small amount can be released from water used indoors. In addition, there is some possibility that concentrations of radon in drinking water might increase the likelihood of stomach and other digestive cancers. However, the USEPA has not established an MCL for radon in drinking water. LPSNRD staff did not collect any radon samples in 2017 but will consider such sampling on a case-by-case basis as needed.

3.1.4 Quality Assurance/Quality Control (QA/QC)

The District continued to implement its QA/QC program in 2018. The QA/QC results are used to monitor the performance of a laboratory's analyses. There were two types of

QA/QC checks performed by District staff-- inter-lab comparability and precision. The relative percent difference (RPD) is computed for each QA/QC sample, and the results are averaged for each type of QA/QC check. Ideally, the RPD should be 0% for each of the QA/QC checks. Generally, an average difference of 10% or less is acceptable, but 5% or less is preferred.

The inter-lab comparability was checked by 'splitting' some samples into two different bottles. The 'split' samples are analyzed by separate laboratories. One sample was sent to Midwest Labs (which is the primary lab for District sample analysis) and the other to the Nebraska Health and Human Services (NHHS) Lab. In 2018, 19 split samples out of 222 total samples were taken. On average, there was a 9.36% RPD in the results reported by these two labs; in other words, results from Midwest Labs were, on average, 9.36% higher than those of the NHHS Lab. This is within the ± 10% required goal but not within the ±5% preferred goal, and represents acceptable comparability. Such inter-lab comparability is a general indicator that lab results are trustworthy, but LPSNRD staff will consult with both labs to determine if procedures can be modified to bring the comparability back to within the preferred range.

The precision, or ability to reproduce similar results, was checked by taking 'duplicate' samples for analysis by Midwest Labs. Duplicates are similar to split samples, but both samples are sent to the same lab – Midwest Labs. Nineteen samples were duplicated in 2017. The results of this QA/QC check averaged -0.26%. This is an excellent indicator of laboratory precision and is well within the District's preferred range of ±5%. These results compare favorably with duplicate results for the past several years. Again, it appears that procedures in place have resulted in proper laboratory precision, which increases confidence in the results produced.

The results of the QA/QC samples are summarized in Table 3. LPSNRD will continue to work with all labs in coming years to maintain this high level of QA/QC and to improve procedures if necessary.

	Relative Percent Difference	
Quality Assurance/Quality Control Check	**Midwest Labs (Primary Lab); NDHHS Lab (QA/QC Lab)**	**Comments**
Inter-lab comparability	9.36%	Acceptable comparability
Precision	-0.26%	Acceptable; excellent precision

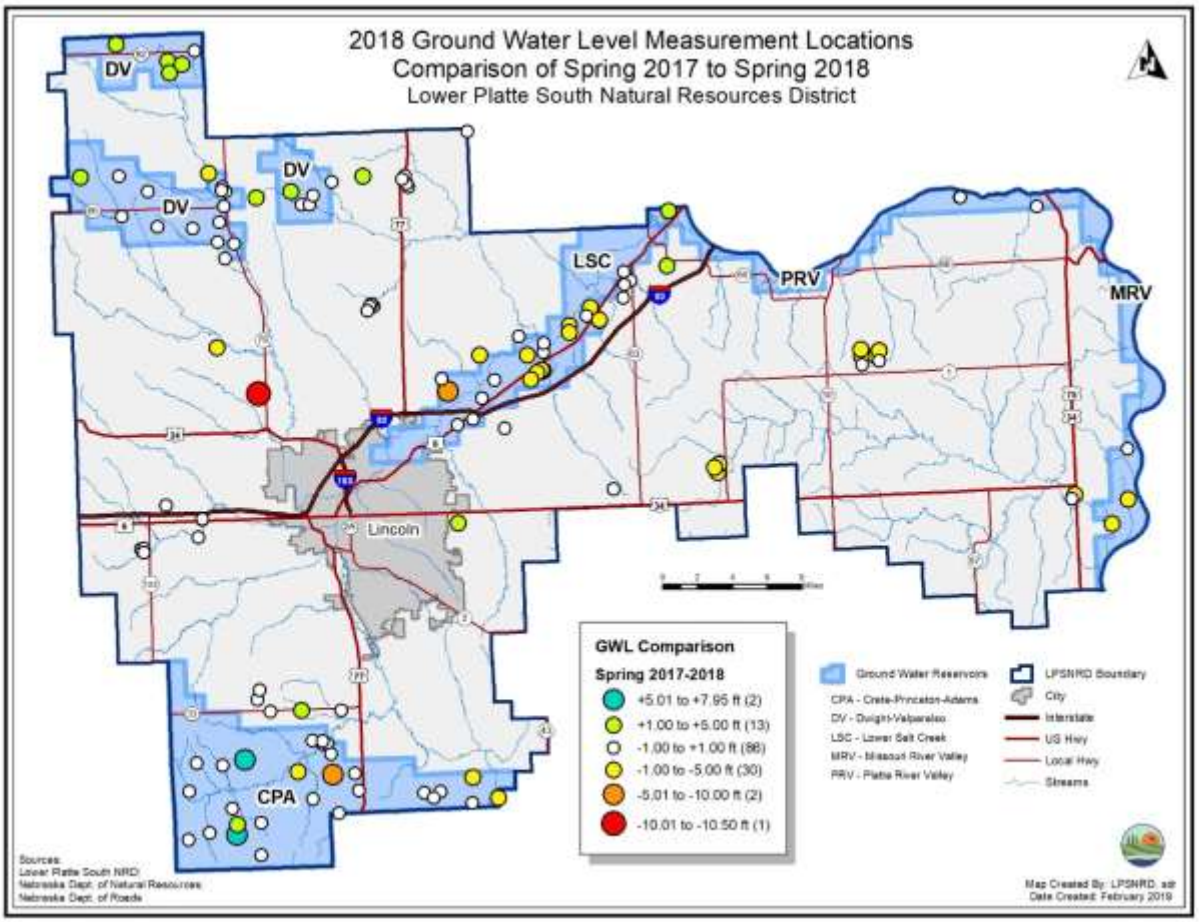
Table 3 - Results of Quality Assurance/Quality Control Sampling

3.2 Ground Water Quantity Monitoring Program

District staff measured a total of 273 water levels in 137 different wells in 2018. For purposes of quantity calculations, the NRD was able to use measurements from 134 of these wells (the other three were not able to be measured in 2017). The results have been reported to the U.S. Geological Survey and the District's cooperators. Water levels are measured in the spring (usually February and March) and fall (usually October and November). For purposes of this report and as specified in the District's Ground Water Management Plan, levels are compared from spring to spring measurements, as the spring measurement is considered to be more indicative of static aquifer conditions. Fall measurements are taken within a few months of the cessation of the irrigation season, and some aquifer units are likely still affected by that activity. Spring measurements represent aquifer conditions after the units have had several months to equilibrate, and are used for the purpose of annual comparison. However, in specific cases, comparison of spring to fall water levels can give an indication of how aquifer units are responding to comparatively intense use over the summer months.

Ground water level fluctuations are variable across the District (Figure 10). From spring 2017 to 2018, water level decreases in the NRD's 134 measured quantity network wells were more common than increases, with 81 wells showing a decrease and 53 wells recording an increase. The maximum decline in an individual well's water level was 10.5 feet, while the maximum increase was 7.95 feet between spring 2017 and 2018. The majority of water level changes in the NRD's monitoring wells are on the order of a few hundredths of a foot to a few feet (see Figure 10). District-wide, no Phase II or III triggers were exceeded in any of the District's GWRs (see Table 4). Taken as a whole, the average static water level across the District decreased by 0.39 feet from spring 2017 to spring 2018; individual GWR changes can be seen in Table 4. It's important to realize that this number is only provided for a general comparison from year to year, and doesn't apply to any individual well. As can be seen from Figure 10, water level changes in any well or GWR are quite variable, so a District-wide average does not accurately represent actual changes in ground water levels.

Figure 10 – Ground Water Level Measurement Locations



Ground Water Reservoir	Percentage of wells below Phase II %* reduction in average saturated thickness	Percentage of wells below Phase III%* reduction in average saturated thickness	Average change in Water levels, Spring 2017-2018 (ft.)
Crete-Princeton-Adams	0%	0%	-0.42
Dwight-Valparaiso	0%	0%	0.48
Lower Salt Creek	0%	0%	-1.31
Missouri River Valley	0%	0%	-1.98
Platte River Valley	0%	0%	1.46
Remaining Area	5%	0%	-0.28

*Phase II trigger for Lower Salt Creek Ground Water Reservoir is 30% of wells showing 15% reduction; for all others it is 30% of wells showing 8% reduction. Phase III trigger for Lower Salt Creek is 50 % of wells showing 30% reduction; for all others it is 50% of wells showing 15% reduction.

Table 4 – Phase Determinations for Quantity

The District continues to monitor long-term ground water level trends from representative wells from each GWR (Figures 11 and 12). Some areas of the District have experienced a decrease in ground water levels since the early 1980s, even though trigger levels as reflected in LPSNRD's GWMP have not been exceeded. As already mentioned, the difference in spring water levels serves as the trigger for management actions in the District's current GWMP. Figure 11 provides a general sense for how these spring levels have varied over time. Given the unusual drought conditions that prevailed for much of the summer in 2012 and the latter portion of the summer in 2013 (see below), the District paid special attention to ground water levels late in the summer and throughout the fall and winter of 2012 and 2013. Figure 12 shows the changes in fall water levels for the representative wells depicted in Figure 11. Note that, even with the drought of 2012 and 2013, water levels in both the spring and fall were not below some of the corresponding measurements from earlier years, particularly in the mid-1990s and mid-2000s. In addition, given the return to more normal precipitation patterns since 2014, water levels in all these wells show anywhere from a few inches to several feet of recovery. However, increasing concern over seasonal water level declines in the northwestern portion of the District has prompted the initiation of a Special Management Area to deal with well interference concerns in that portion of LPSNRD (see Section 4.2). The District has taken additional water level measurements in the past few years to gain more data regarding changes in ground water levels, and has deployed several continuous water level measuring devices in selected dedicated monitoring wells to provide additional information. All of this data will be considered carefully as the District evaluates management actions in the future.

Figure 11 – Representative Spring Ground Water Level Graphs from Each Ground Water Reservoir

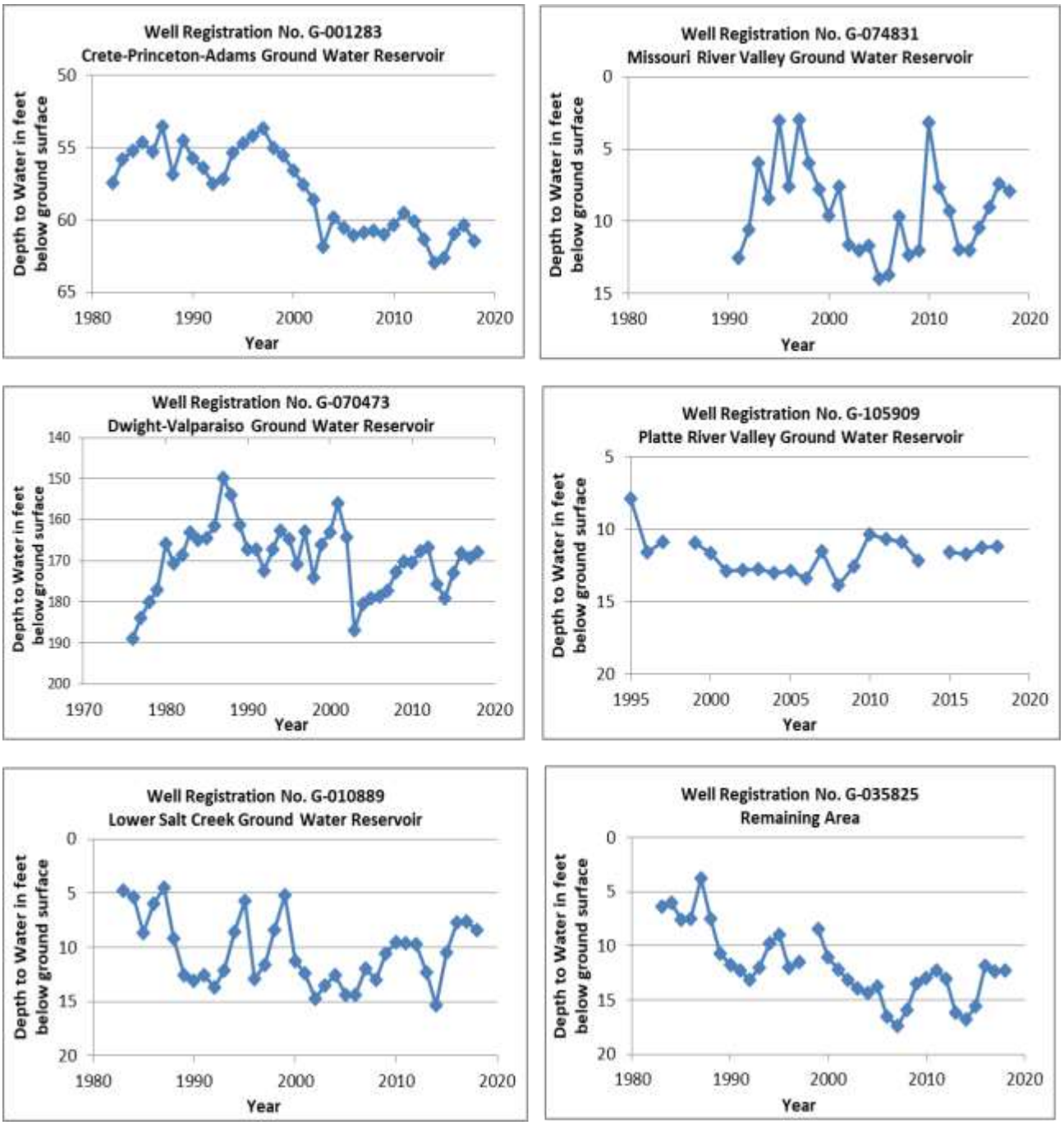
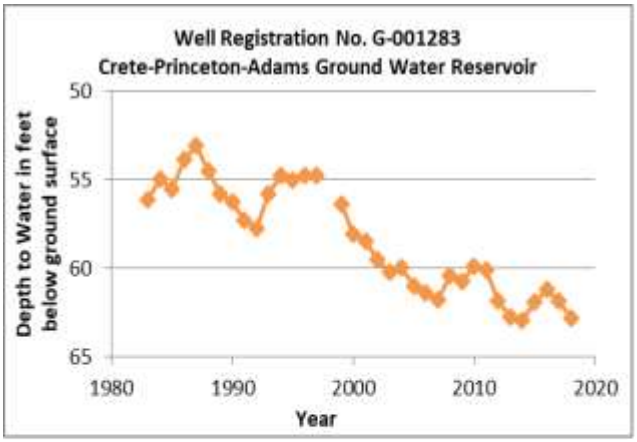
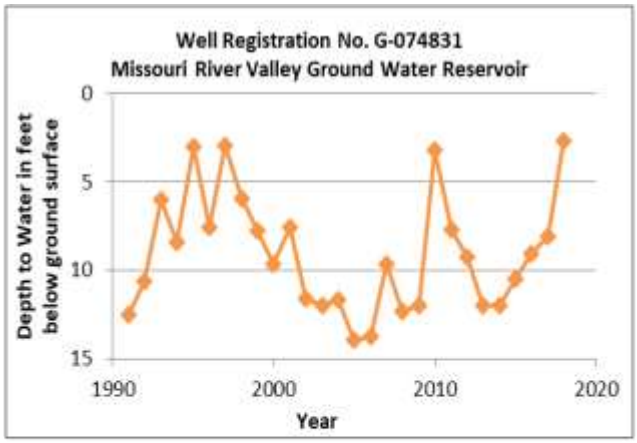
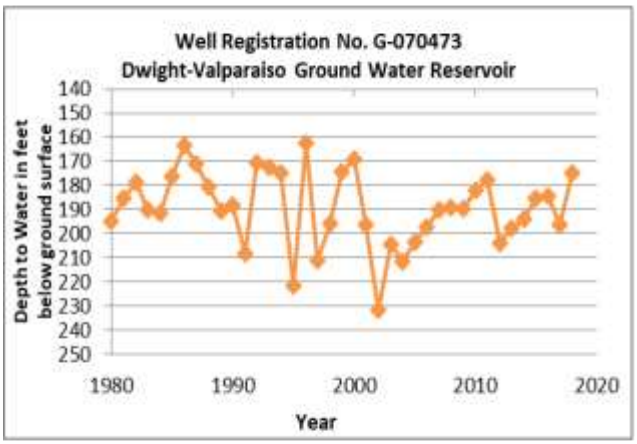
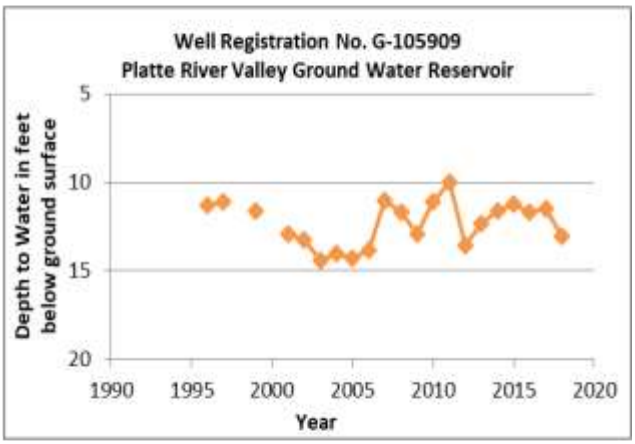


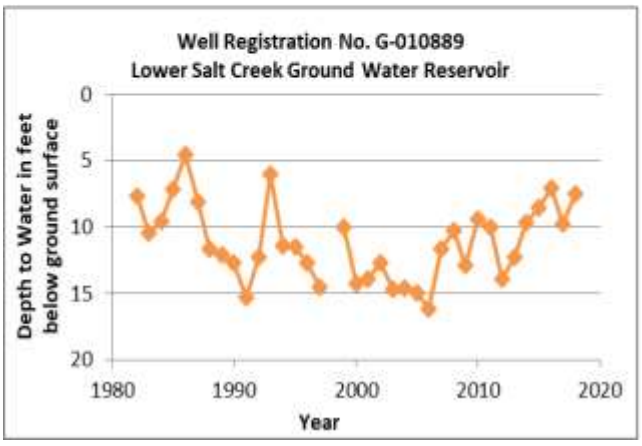
Figure 12 – Representative Fall Ground Water Level Graphs from Each Ground Water Reservoir

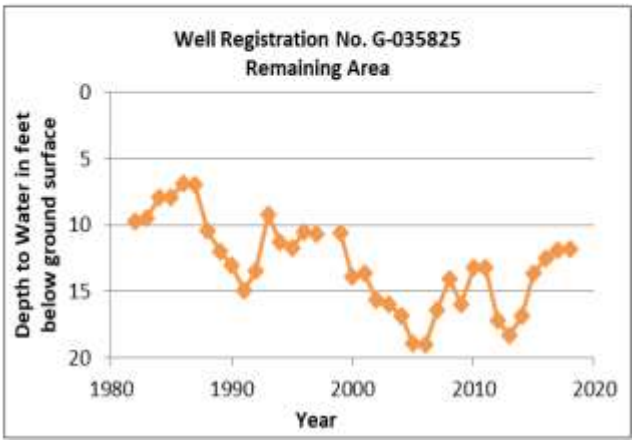












3.3 Data Management

LPSNRD's ground water database continued to be developed and maintained in 2018. The District has been working with a contractor on database improvements and revisions and these tasks were expanded upon in the past several years. Future plans for the database include improving the mailing functions to include certified acre information, and expanding the structure of the database to accommodate real time monitoring data and vadose zone information, as well as incorporating soil sample data into the database.

In 2018, the District began to utilize the information site created in 2017 that allows cooperators to view existing data for their wells and to enter new meter information based upon a preassigned login.

District staff continued to utilize the mobile database collection tools that were recently developed. Staff utilizes tablet computers for many aspects of data collection including water level data, water meter inspections, and retrieval of historical sampling information while in the field. These tools have aided staff in ensuring quality data entry and providing tools to better communicate with landowners while in the field.

4. DESIGNATED AREAS OF MANAGEMENT

Applicable Regulations: Sections B, E, F, G, I, J, K, L

The District's 1995 GWMP specifies three types of areas in which LPSNRD can pursue various management activities to deal with concerns in ground water quality and quantity. These three types of areas are Ground Water Reservoirs (GWRs), the Remaining Area (RA), and Community Water Supply Protection Areas (CWSPAs). The following sections highlight NRD activities in each area in regard to both ground water quality and quantity.

4.1 Ground Water Quality

4.1.1 Ground Water Reservoirs

Note: for more information on LPSNRD's Ground Water Reservoirs, see Druliner and Mason, 2001.

4.1.1.1 Crete-Princeton-Adams

The Crete-Princeton-Adams (CPA) GWR is located in the southwestern portion of LPSNRD (see Figure 2). The aquifer in CPA is generally semi-confined to confined, and consists of a complex sequence of glacial till, loess, sand, and gravel. Saturated thickness of sediments ranges from 50 to 250 feet, and depth to ground water ranges widely from a few feet to about 250 feet below the land surface. Results of ground water monitoring for

nitrate, pesticides, and other components in the CPA GWR are summarized in Figures 6-9 and Table 2. In addition to this routine monitoring, several important actions in CPA were undertaken as part of the Eastern Nebraska Water Resources Assessment (ENWRA). These activities are described in Section 17. Also, in addition to these activities, the District is continuing administration of a Phase II nitrate management area in the Hickman CWSPA (see Figure 3). Activities for the Hickman CWSPA in 2018 are described in Section 4.1.2.16.

4.1.1.2 Dwight-Valparaiso

The Dwight-Valparaiso (DV) GWR occupies the northwestern portion of the District (see Figure 2). The DV aquifer is mostly semi-confined to confined, and is made up of sand and gravel deposits underlying thick glacial till and loess. Saturated thickness of these sands and gravels is about 40-100 feet, and depth to water again ranges from a few feet to about 250 feet below the land surface. Due to the confining units present, significant variations in water levels can result from changes in head pressure due to ground water withdrawals. Results of ground water monitoring for nitrate, pesticides, and other components in the DV GWR are summarized in Figures 6-9 and Table 2. In addition to this routine monitoring, the District continues to administer a Phase II nitrate management area in the Valparaiso CWSPA (see Figure 3). Activities for the Valparaiso CWSPA in 2018 are described in Section 4.1.3.28.

4.1.1.3 Lower Salt Creek

Applicable Regulations: Section K(1)

The Lower Salt Creek (LSC) GWR is located in the north-central portion of the LPSNRD, roughly between Lincoln and Ashland (see Figure 2). The LSC aquifer is semi-confined to confined, and consists mostly of sand and gravel deposits overlying older bedrock units. Saturated thickness of these sand and gravel deposits is about 40 to 65 feet, and depth to water ranges from a few feet to about 50 feet below the land surface. Results of ground water monitoring for nitrate, pesticides, and other components in the LSC GWR are summarized in Figures 6-9 and Table 2.

In 2002, the LSC GWR was designated as a Phase II management area in response to nitrate levels which were determined to be above the NRD's trigger levels for that phase. As a result of this designation, a local advisory committee was formed to advise the District on adoption of rules and regulations to deal with the nitrate issue. The regulations subsequently adopted by the District required nitrogen certification training for those who apply nitrogen fertilizer to agricultural fields in the GWR, and established cost-share programs to implement Best Management Practices (BMPs) aimed at reducing nitrate in ground water. Practices for which cost-share is available (in addition to the District-wide cost-share items) include fertilizer meters and manifolds, and soil sampling and analysis for fertilizer carryover credits. More information on District cost-share in the LSC GWR as well as the remainder of the NRD can be found in Sections 6-10. However, as described above, nitrate levels in ground water in the LSC GWR have been below the Phase II trigger for the past several years. Thus, it's apparent that nitrate levels

in the Lower Salt Creek GWR appear to be decreasing at least somewhat over time. In the latest revision of the District's Ground Water Rules and Regulations (Effective Date: January 1, 2017), a procedure was included for suspending Phase II and moving back to Phase I if nitrate levels dropped below appropriate triggers for a period of not less than three years. In 2019, LPSNRD will initiate steps to suspend the Phase II designation for the LSC GWR, and will continue to consult with landowners and other interested parties in LSC to get their input on future directions for the GWR. However, recent data suggests that nitrate levels within the Waverly, Greenwood, and Ashland CWSPAs, each of which is partially contained within the LSC GWR, have exceeded the Phase II trigger. LPSNRD is cooperating with the City of Waverly, NDEQ, and UNL-WSL to implement a comprehensive drinking water protection plan to protect the City's water supply for the foreseeable future. Part of this project includes determination as to whether the nitrate levels in the Waverly CWSPA meet LPSNRD's criteria for a Phase II GWMA; upon completion of this project the NRD will determine whether to designate the Waverly CWSPA as a Phase II area. Similarly, in 2018 LPSNRD initiated a Phase II Verification Study for the Greenwood CWSPA also to determine if it should be designated as a Phase II GWMA. The District will determine whether to begin Phase II study activities in Ashland in 2019. More detail on activities in these CWSPAs can be found in Section 4.1.2 below. Finally, several vadose zone samples have been taken from sites within the LSC GWR to further evaluate the likelihood of ground water quality concerns. These efforts are also described in Section 4.1.2 below.

4.1.1.4 Missouri River Valley

The Missouri River Valley (MRV) GWR is located along the Missouri River at the eastern margin of the District (see Figure 2). The MRV aquifer is mostly unconfined, and consists of fluvial sand, gravel, and silt deposits with some local clay lenses, all overlying older bedrock formations. Aquifer thickness is on the order of 80 feet, and depth to water is generally around 5 to 10 feet below the land surface. Results of ground water monitoring for nitrate, pesticides, and other components in the MRV GWR are summarized in Figures 6-9 and Table 2.

4.1.1.5 Platte River Valley

The Platte River Valley (PRV) GWR is located in the northeastern portion of the District, along the southern edge of the Platte River (see Figure 2). The PRV aquifer is an unconfined alluvial aquifer that consists of fluvial sand, gravel, and silt overlying older bedrock. The aquifer is on the order of 70 feet thick, and depth to water also ranges from about 5 to 10 feet below the surface. Results of ground water monitoring for nitrate, pesticides, and other components in the PRV GWR are summarized in Figures 6-9 and Table 2.

4.1.1.6 Remaining Area

The Remaining Area (RA) includes all the land in the District which is not included in a GWR (see Figure 2). In the RA, the occurrence of ground water bearing units is highly variable; in some portions, practically no ground water is available. As a result of this

variability, no specific GWRs are identified within the RA. In those areas where ground water does occur, it usually comes from small, intermittent sand bodies within silt and clay deposits, or from underlying bedrock units such as the Dakota Formation, or even older limestone units. Ground water from these sand units may be of acceptable quality, but the small quantity available limits its use. Conversely, significant amounts of ground water may occur within the Dakota Formation, but salinity and mineral content of this water increases rapidly with depth, and thus the quality is a limiting factor. Ground water from limestone bedrock is usually limited to small quantities, and this water is also highly mineralized, therefore these older bedrock units are not generally considered as significant aquifers. Results of ground water monitoring for nitrate, pesticides, and other components in the RA are summarized in Figures 6-9 and Table 2.

In addition to this routine monitoring, the District continues to administer Phase II management areas in the Davey, Hickman, Pleasant Dale, Otoe County RWD #3/Weeping Water, Valparaiso, and Union CWSPAs and a Phase III management area in the Elmwood CWSPA (see Figure 3). However, recent data suggests that the Hickman, Union, and Valparaiso CWSPA nitrate levels have dropped below the Phase II trigger, so LPSNRD is evaluating if and when these Phase II areas should be suspended. However, the data from Pleasant Dale suggests that nitrate levels might have exceeded the Phase III trigger, so in 2018 LPSNRD undertook additional studies in that CWSPA to determine if Phase III designation is necessary and plans to complete these studies in 2019. Finally, nitrate levels in the Sprague CWSPA, which had been very near the Phase II trigger for the past several years, have increased to the point where they are consistently above the trigger, so LPSNRD will initiate designation of that CWSPA as a Phase II area in 2019. More detail on the activities in these CWSPAs can be found under the section for each in Section 4.1.2 below.

4.1.2 Community Water System Protection Areas (CWSPAs)

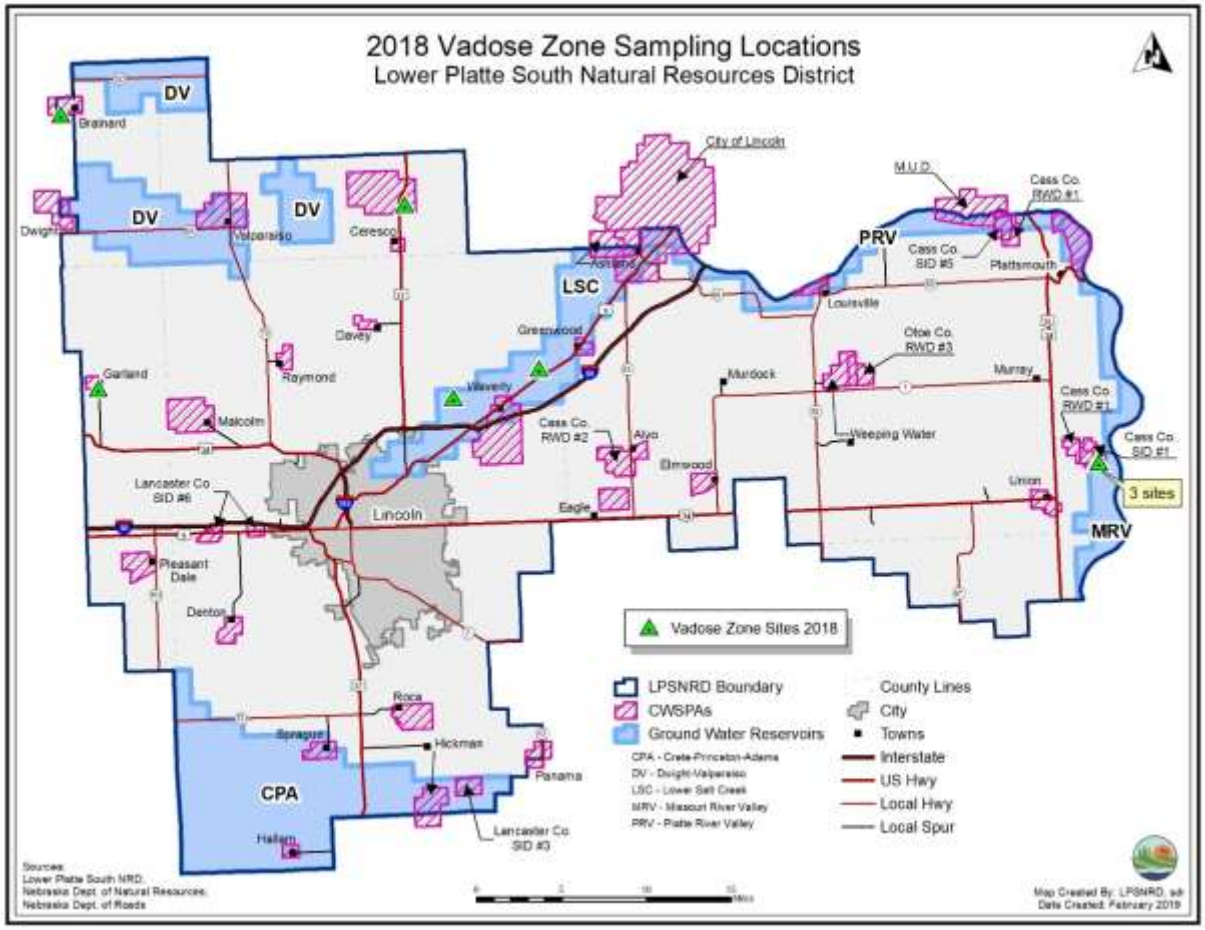
LPSNRD focuses a great deal of effort on ground water which is used for public drinking water supply. This concern has led the District to delineate Community Water Supply Protection Areas around the ground water supply wells for the 30 public water supplies (PWSs) within its jurisdiction (see Figure 3). CWSPA boundaries correspond with Wellhead Protection Area boundaries as delineated by the NDEQ, and are defined as the area which encompasses the 20-year time-of-travel zone around a given wellfield. In other words, the CWSPA is the area around a well or wellfield from which ground water can be expected to travel in a period of 20 years. NDEQ determines these boundaries by entering information on geology, aquifer characteristics, water levels, and well pumping data into a computer model, which then predicts the 20-year time-of-travel zone. Over the past several years, NDEQ has begun the process of implementing comprehensive Drinking Water Protection Programs for various WHPAs around the state. An important additional step in this program is that the capture zones of the wellfields are modeled to a 50-year time-of-travel, and more sophisticated modeling techniques are utilized. The City of Waverly project is proceeding under this program structure. Regardless of the individual circumstances, LPSNRD staff continues to work with NDEQ staff to ensure

that they have the best available geological and ground water data for this modeling effort, so the boundaries of the CWSPAs are as accurate and defensible as possible.

In general, LPSNRD samples each cooperating PWS well at least annually, and has these samples analyzed for the following components: nitrate-nitrogen, major ions, arsenic, and pesticides. Some of the systems have specific agreements with LPSNRD to perform additional analysis. Also, in 2018, District staff continued implementation of a program to collect unsaturated or vadose zone nitrate data within the confines of the NRD's CWSPAs (as well as locations outside of CWSPAs). This information, which will be similar to that collected during the various verification studies for the Phase II and Phase III delineations, consists of taking soil/sediment samples at approximately 5-foot increments from the land surface downward to the water table, or as deep as the sampling equipment will allow. These samples are analyzed for nitrate-nitrogen content (and any other constituents of concern), and a nitrate profile for the entire vadose zone is constructed. Individual sampling sites will then be re-sampled every few years (the re-sampling may vary depending upon individual results), and the nitrate profiles for each site will be compared over time. In this way, LPSNRD hopes to gain at least some qualitative data to indicate the overall amount of nitrate loading as well as estimates of transport times for various vadose zone settings. Ultimately, this data will help the District evaluate the effectiveness of its management activities, as well as provide some early indication of possible ground water nitrate problems.

Since 2014, LPSNRD has contacted with different entities to provide vadose zone sampling services. The locations of sites sampled since the inception of the program is shown in Figure 13.

Figure 13 – Vadose Zone Sampling Locations



Vadose zone samples are obtained from shallower depths down to about 75' below the land surface using a small, track-mounted GeoProbe® unit which uses a "direct push" pressure to advance the sampling equipment to the desired depth. For depths greater than about 75', it is necessary to use a more powerful, truck-mounted rotary drilling rig. Both of these units are designed to return continuous core samples of the vadose zone sediments encountered; these samples are in turn analyzed for various compounds such as nitrate-nitrogen, ammonia, and arsenic. Figure 14 shows examples of both of these pieces of machinery.

Figure 14 – Geoprobe® (left) and Rotary Drill Rig (right) Used in Vadose Zone Sampling

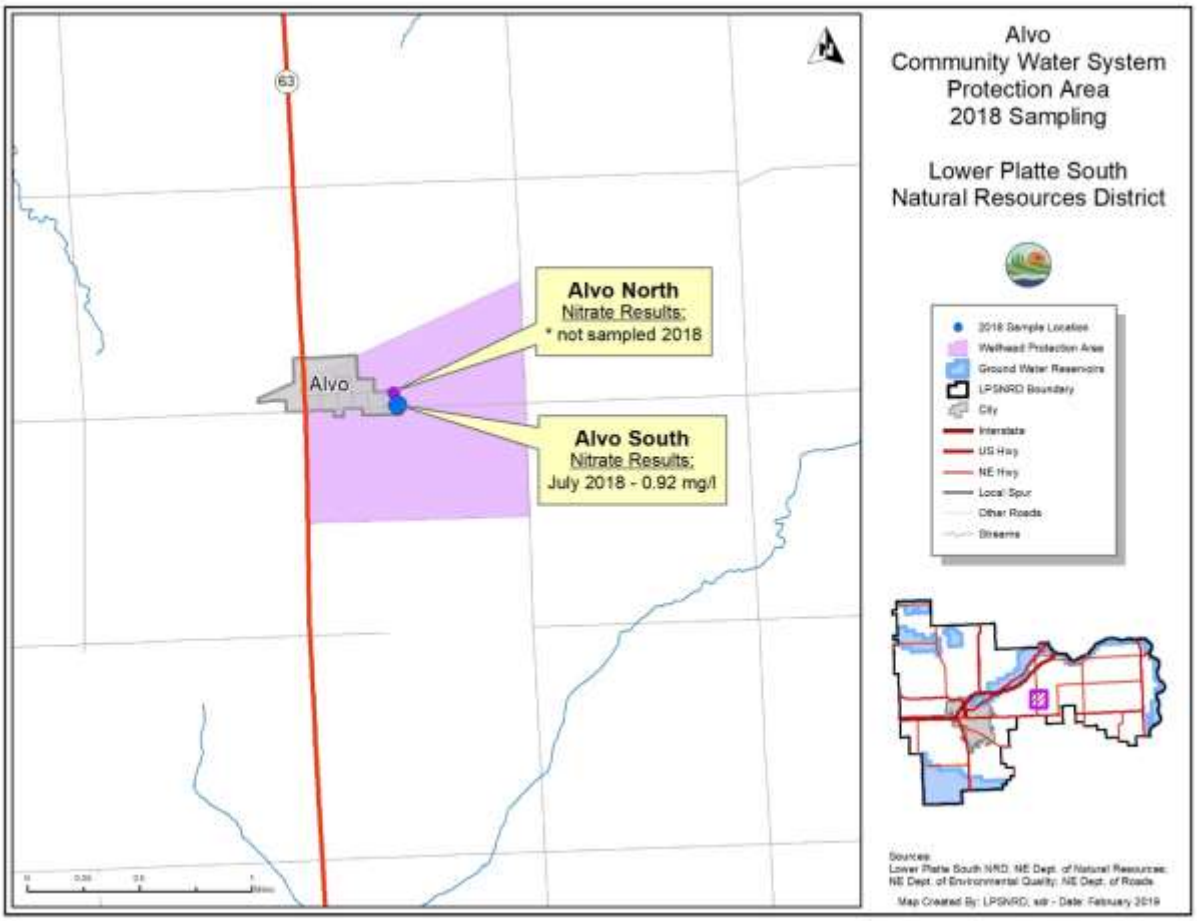
In addition, in 2016, LPSNRD began a cooperative effort with UNL-WSL to develop a more comprehensive set of standard operating procedures (SOPs) for vadose zone data collection. This project will aim to address everything from the most basic sample and data collection (e.g. the nitrate-nitrogen and arsenic characterization described above) to more advanced techniques like soil pore-water extraction and analysis, and higher level research parameter collection such as age-dating. In addition, it is anticipated that this project will provide the foundation for establishment of a statewide database or "clearinghouse" for vadose zone data collected by the NRDs, UNL, and other resources agencies. Several sites were sampled in 2017 and 2018. The technical report for this project was completed in September, 2018 (Snow, 2018), and LPSNRD continues to cooperate with UNL-WSL to develop SOPs for vadose zone sampling as well as to help establish the statewide "clearinghouse for vadose zone data.

The following sections provide an overview of the District's activities in each of the CWSPAs in 2018. The maps for each PWS show the wells sampled along with the results for nitrate sampling. Other parameters (typically major ions and pesticides) are described only if they have indicated a cause for concern, otherwise the remaining sample information is communicated to the system for their use.

4.1.2.1 Alvo

The Village of Alvo's CWSPA occupies slightly less than one square mile to the east and north of the village in east-central Cass County. LPSNRD takes annual water samples from two PWS wells for the village, but the District was unable to obtain samples from the North well in 2018. The 2018 results from Alvo's south well are shown in Figure 15.

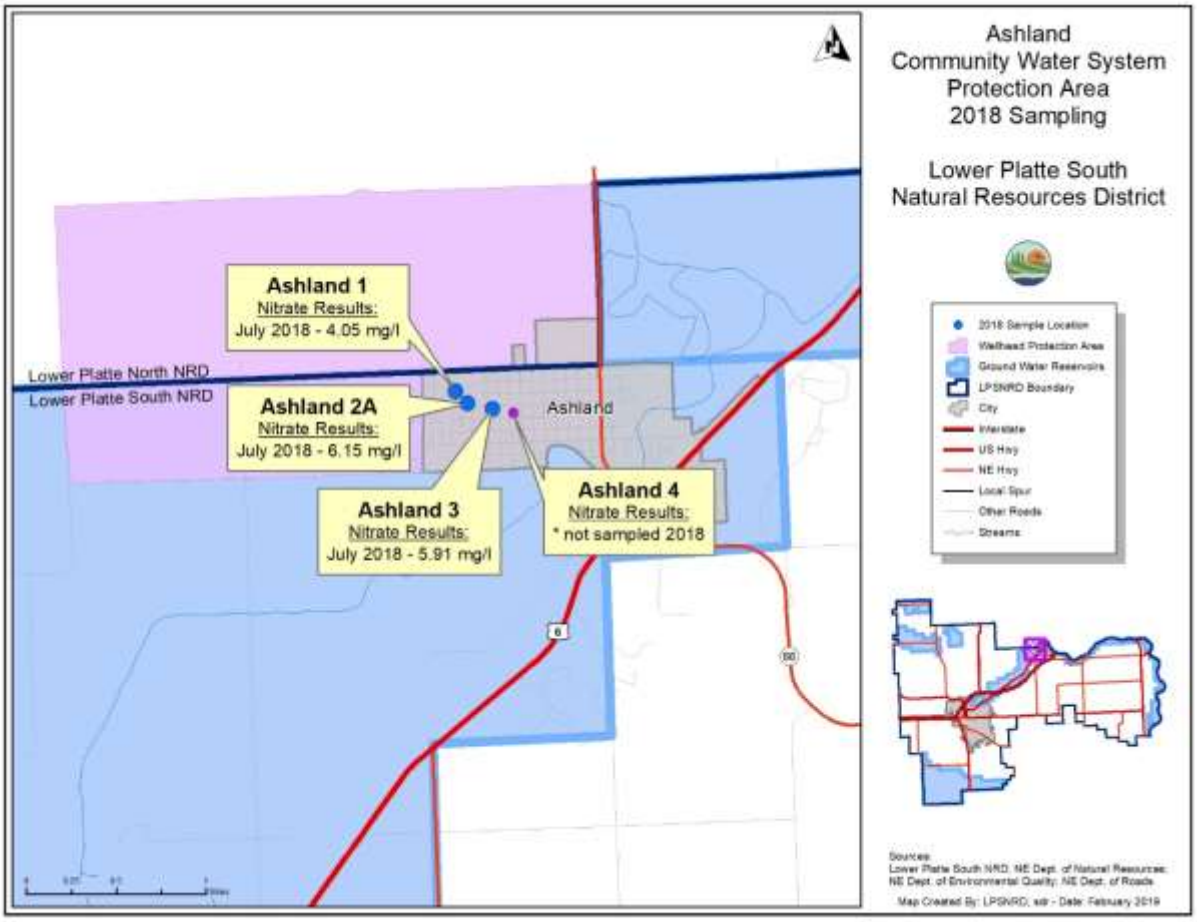
Figure 15 – Alvo



4.1.2.2 Ashland

Ashland's CWSPA encompasses about 4 ½ square miles along the northern edge of the city, located along the Platte River in southeastern Saunders County. This area straddles the boundary between the Lower Platte South and Lower Platte North NRDs; about 1 ½ square miles are located within the LPSNRD. At present, all of Ashland's PWS wells are located in LPSNRD, so the District takes annual water samples from those three PWS wells as part of its regular monitoring. The sample results for the three wells sampled in 2018 are shown in Figure 16 (Note that the LPSRND portion of the Ashland CWSPA is contained within the larger Lower Salt Creek GWR Phase II GWMA). Those results indicate that nitrate levels in the Ashland CWSPA may have exceeded the Phase II trigger; LPSNRD will determine whether to proceed with a verification study for this area in 2019. Any such activities would be coordinated with the Lower Platte North NRD.

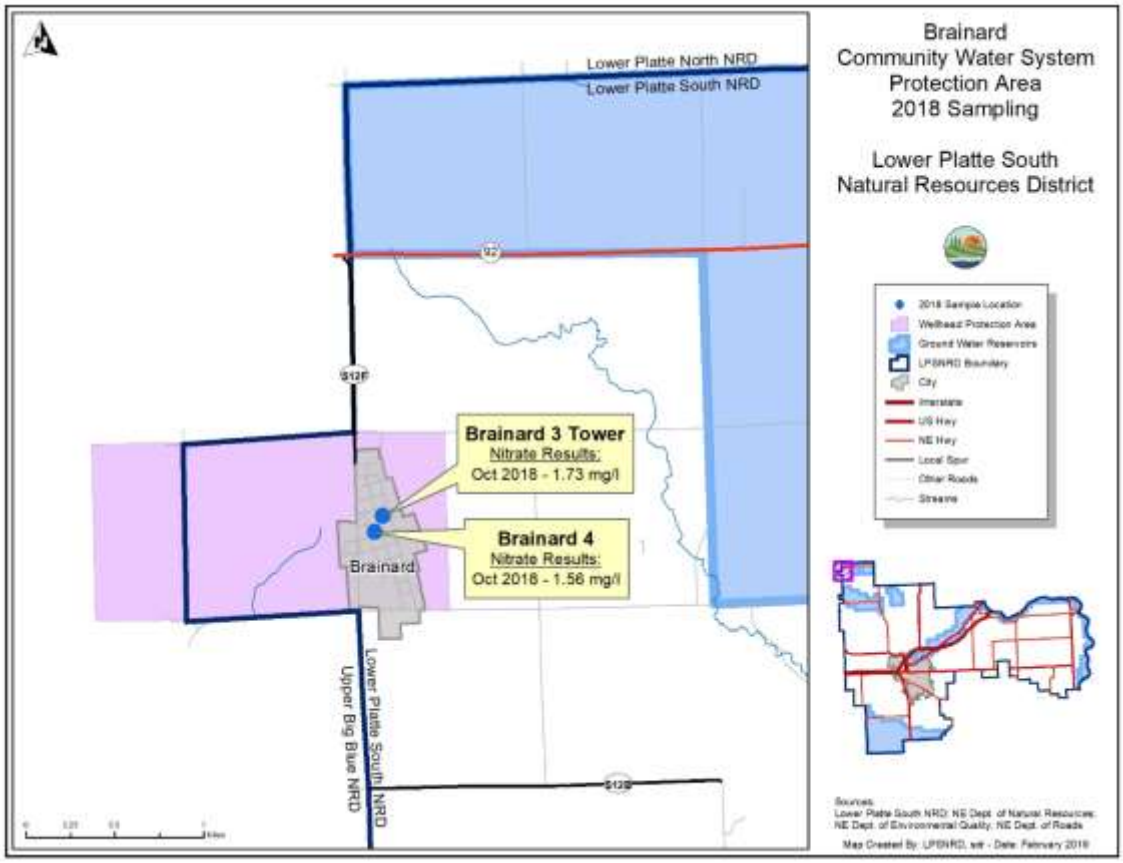
Figure 16 – Ashland



4.1.2.3 Brainard

The CWSPA for the Village of Brainard occupies slightly less than two square miles west of the village in southeastern Butler County. The area straddles the boundary between the Lower Platte South and Upper Big Blue NRDs; about 1 ½ square miles are located in LPSNRD. All three of the Village's wells are located in LPSNRD, and the District has taken annual water samples from these three wells. However, one of these wells has been taken out of service in the past several years, so the NRD is continuing to sample the remaining two in-service wells. The sample results from the two wells that were sampled in 2018 are shown in Figure 17.

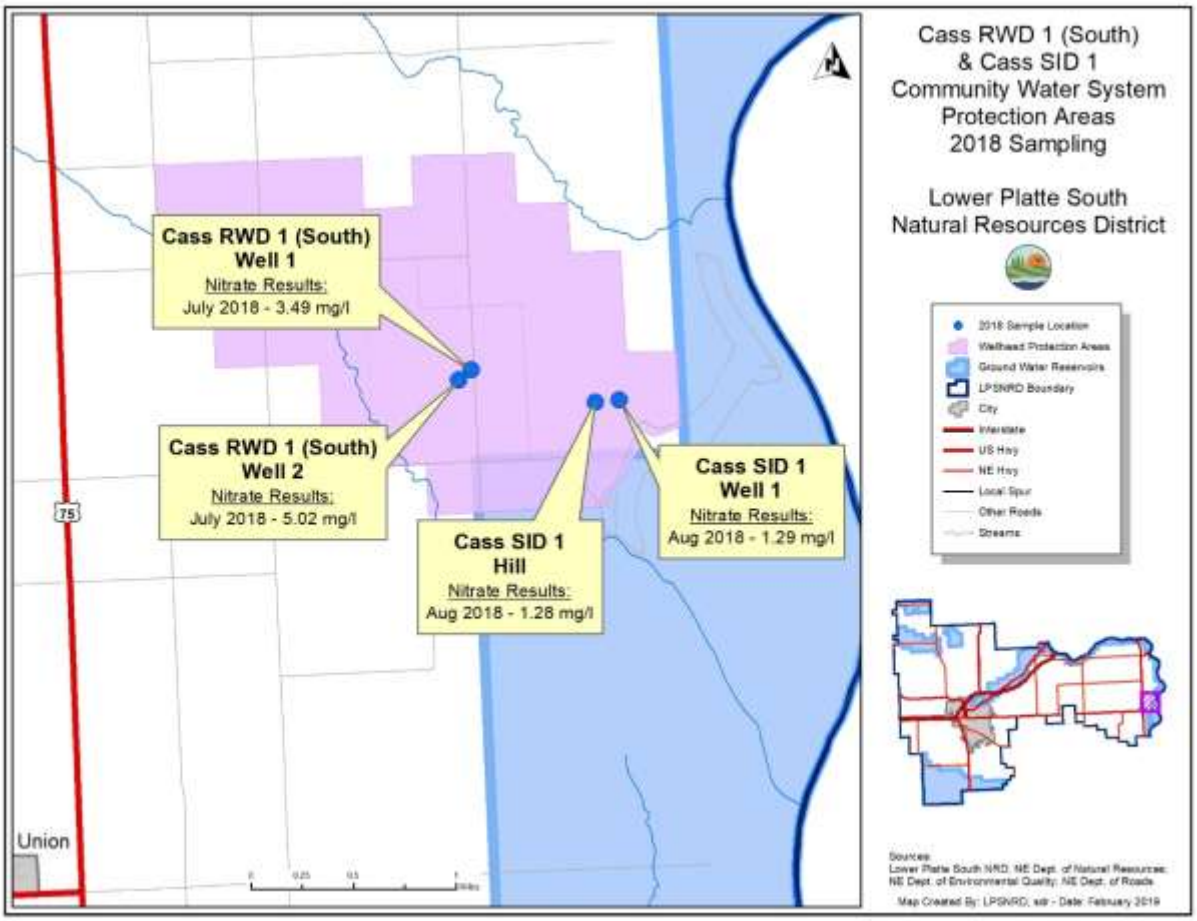
Figure 17 – Brainard



4.1.2.4 Cass County RWD #1/SID #1 (Lake Waconda)

Cass County Rural Water District (RWD) #1 and Sanitary Improvement District (SID) #1 (which serves the Lake Waconda community) are located within about one mile of each other in eastern Cass County, and the CWSPAs overlap each other. The combined area of the two CWSPAs is about 2 ¾ square miles. The NRD takes annual water samples from two PWS wells for the Cass County RWD #1, and two PWS wells for SID #1, and the 2018 results from these well samples are shown in Figure 18. Also, in 2015, Cass County RWD #1 completed a new well along the Platte River near the existing wells for Cass County SID #5/Buccaneer Bay. The results for the new RWD #1 well are shown with those for SID #5 in Figure 20.

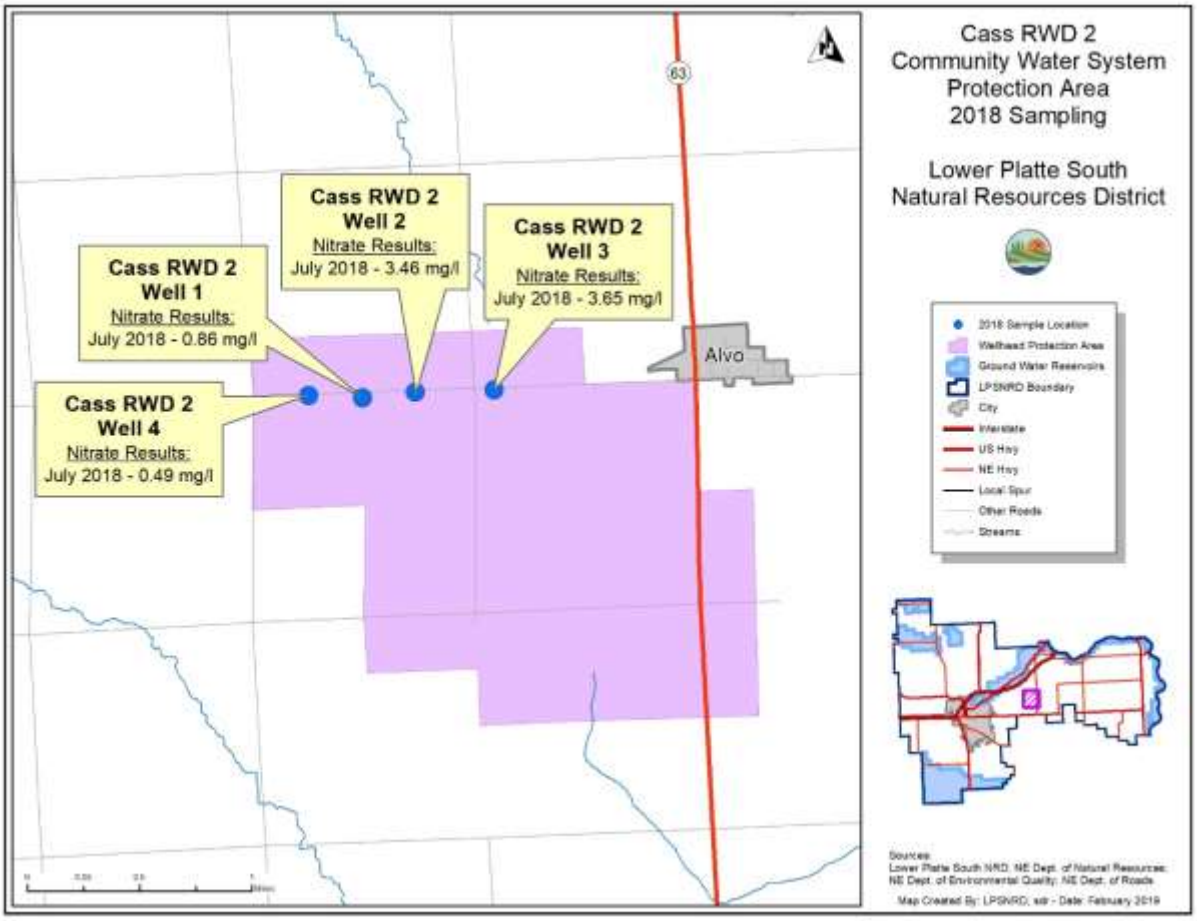
Figure 18 –Cass County RWD #1/SID #1 (Lake Waconda)



4.1.2.5 Cass County RWD #2

The CWSPA for the Cass County Rural Water District #2 takes up about three square miles, just southwest of the Village of Alvo in east-central Cass County. The CWSPAs for the Village of Alvo and the RWD do not overlap each other. LPSNRD takes annual water samples from four PWS wells for the RWD, and the nitrate results of the 2018 sampling are shown in Figure 19.

Figure 19 – Cass County RWD #2



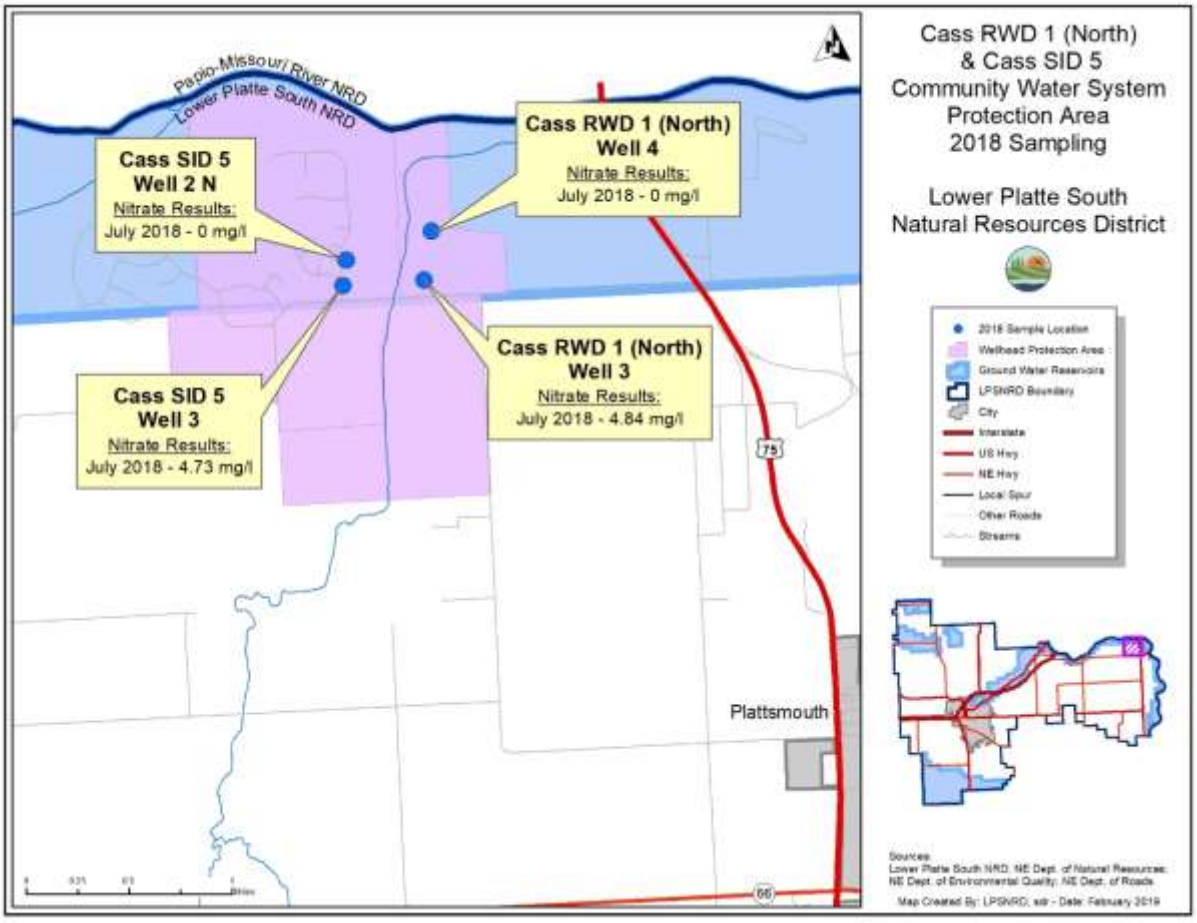
4.1.2.6 Cass County SID #1

See Cass County Rural Water District #1

4.1.2.7 Cass County SID #5/Buccaneer Bay

The Cass County SID #5/Buccaneer Bay development's CWSPA occupies about one square mile northwest of Plattsmouth in northeastern Cass County. The CWSPAs for the SID and Plattsmouth do not overlap. LPSNRD takes annual water samples from two PWS wells for the SID. As noted in Section 4.1.2.4, Cass County RWD #1 completed a new well in 2013 in the vicinity of the SID #5 wells. The 2018 sample results for all four of these wells are shown in Figure 20.

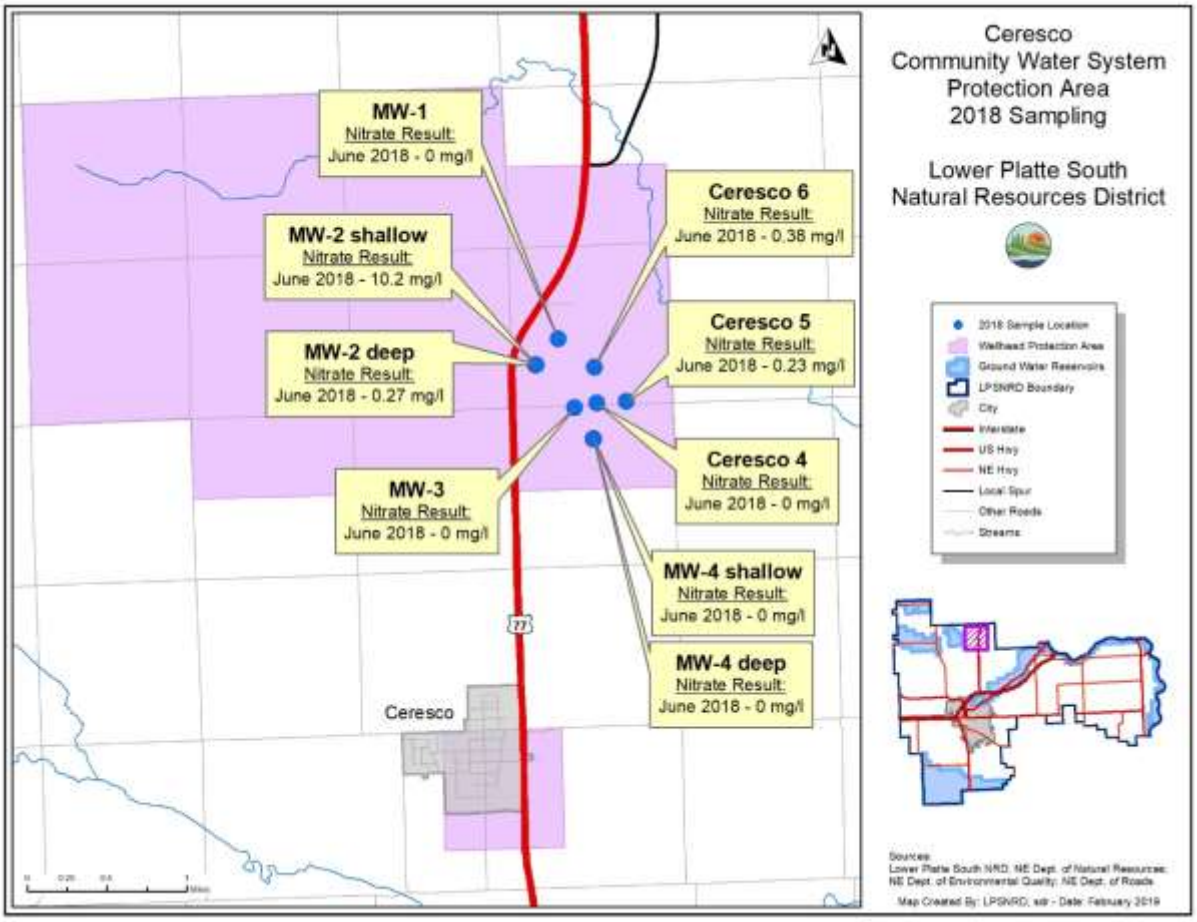
Figure 20 – Cass County SID #5/Buccaneer Bay



4.1.2.8 Ceresco

The Village of Ceresco's CWSPA takes in slightly more than nine square miles north and west of the community in southern Saunders County. In 1997, the District signed an Interlocal Agreement with Ceresco to provide structure for ongoing monitoring and water quality management activities. As a result of this agreement, six dedicated monitoring wells have been installed in the CWSPA. In addition, Ceresco has completed a contaminant source inventory for the CWSPA detailing the locations of possible sources of contamination. The results of the 2018 nitrate sampling are shown in Figure 21.

Figure 21 – Ceresco

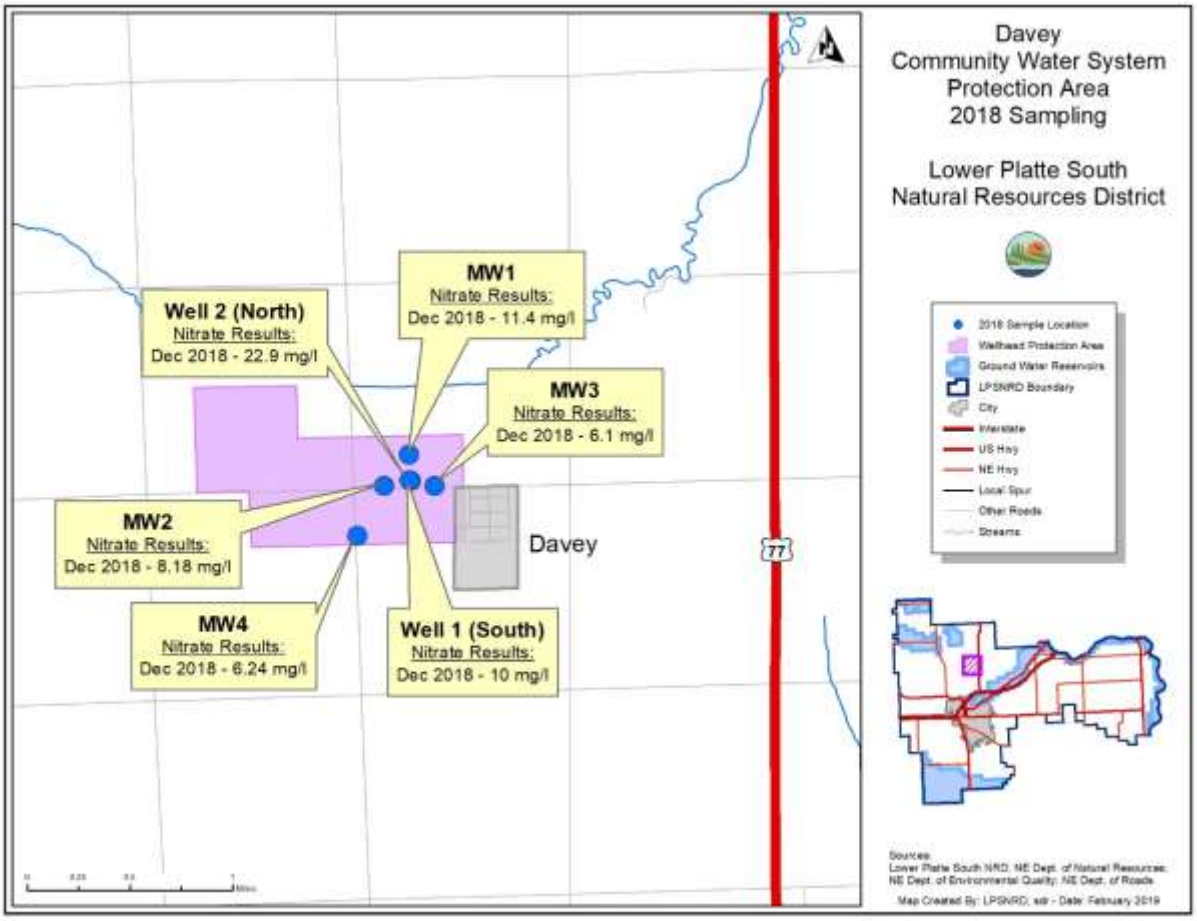


4.1.2.9 Davey

Applicable Regulations: Section K(1)

The CWSPA for the Village of Davey occupies slightly less than ½ square mile west and north of the village in northern Lancaster County. In 2006, District sampling results indicated that the triggers for a Phase II ground water management area had been exceeded in the CWSPA. As a result, a Phase II Verification Study was initiated and was completed in 2008. This study resulted in the installation of four dedicated monitoring wells in the CWSPA, as well as collection of a great deal of geologic, soil, and other data (EA Engineering, Science, and Technology, 2008a). The nitrate sampling results for the PWS and monitoring wells in 2018 are displayed in Figure 22. As a result of the verification study and subsequent sampling, the LPSNRD designated the Davey CWSPA as a Phase II GWMA in December 2009. In 2012, the NRD began assembling an advisory committee of stakeholders from Davey to advise the District as it develops rules and regulations for the implementation of Phase II, and held the first meeting of that advisory group. Regulations for the Davey Phase II area were adopted in 2013, and became effective in March 2014. As in other Phase II areas, these regulations center on requirement for nitrogen certification for those who apply nitrogen fertilizer, as well as additional promotion of cost-share programs for nitrogen management BMPs. In 2018, the Village began the process of exploring for a possible additional well site to help mitigate the high nitrate levels in the public water supply. The District provided general information for this effort and will continue to assist the Village into the future.

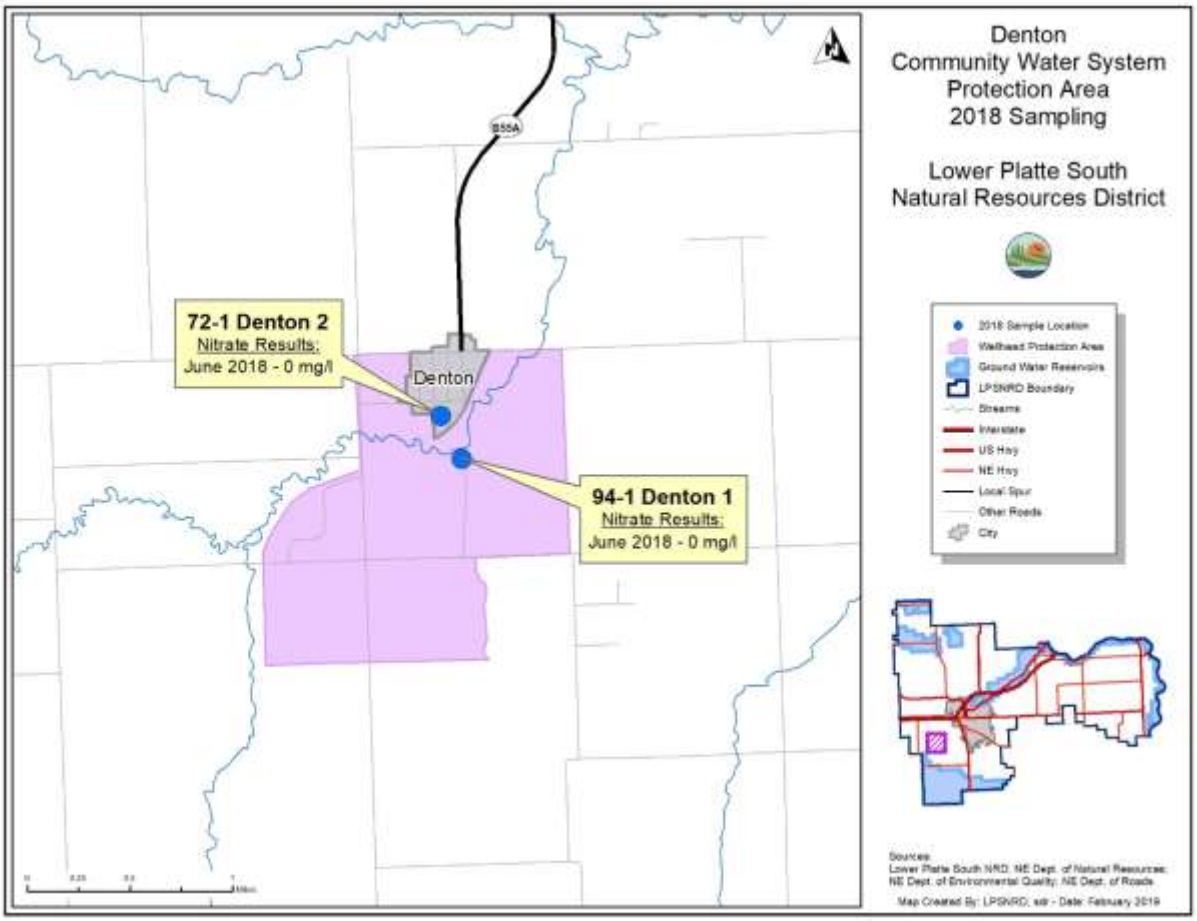
Figure 22 -- Davey



4.1.2.10 Denton

The Village of Denton's CWSPA takes up about 1 ¾ square miles around and to the south of the village in west-central Lancaster County. District staff sample two PWS wells for the village, and the 2018 sample results for Denton's wells are shown in Figure 23.

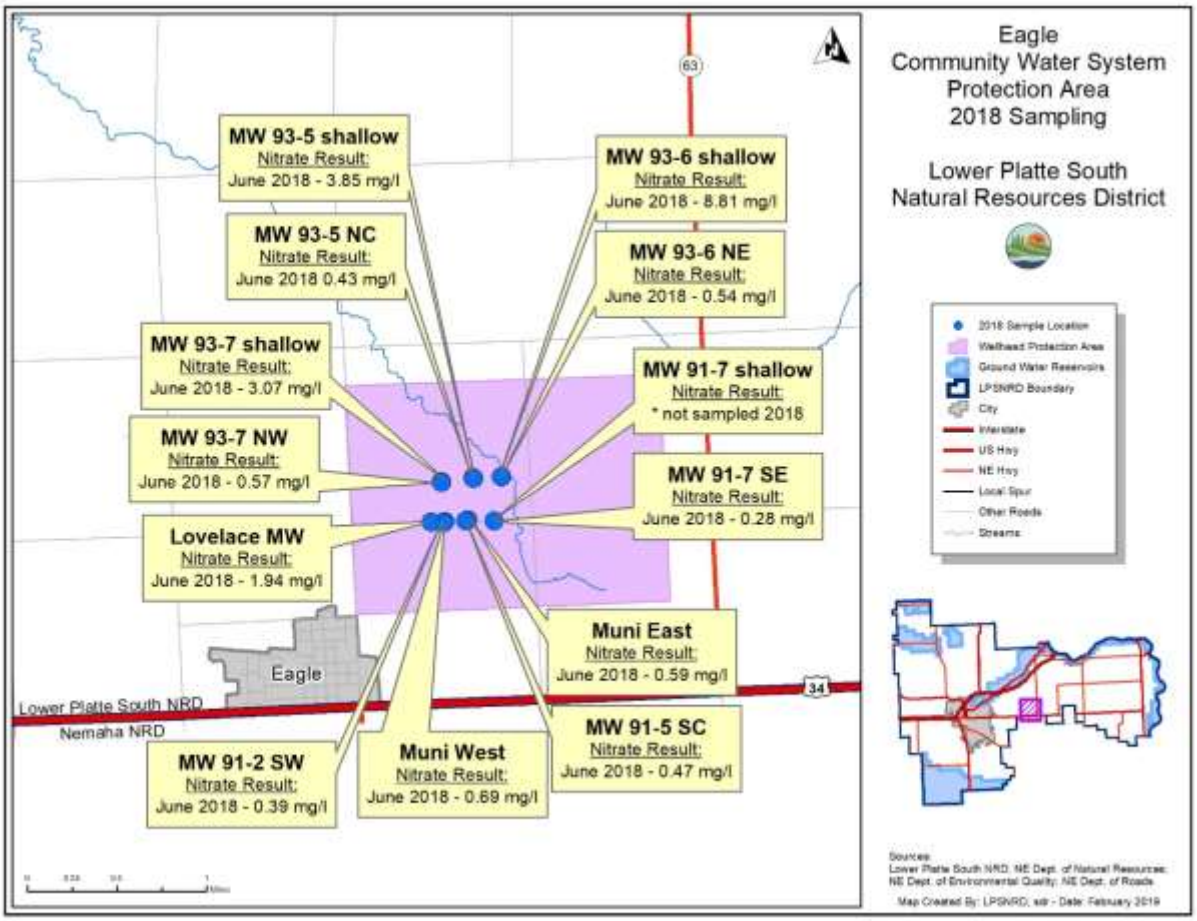
Figure 23 – Denton



4.1.2.11 Eagle

The CWSPA for the Village of Eagle takes in about 1 ½ square miles northeast of the village in southwestern Cass County. In 1998, the District signed an Interlocal Agreement with Eagle to provide structure for ongoing monitoring and water quality management activities, and this agreement was updated in 2009. As a result of this agreement, 11 dedicated monitoring wells have been installed in the CWSPA, and these wells as well as the two PWS wells are monitored by the District. The results of the 2018 nitrate sampling are shown in Figure 24.

Figure 24 – Eagle

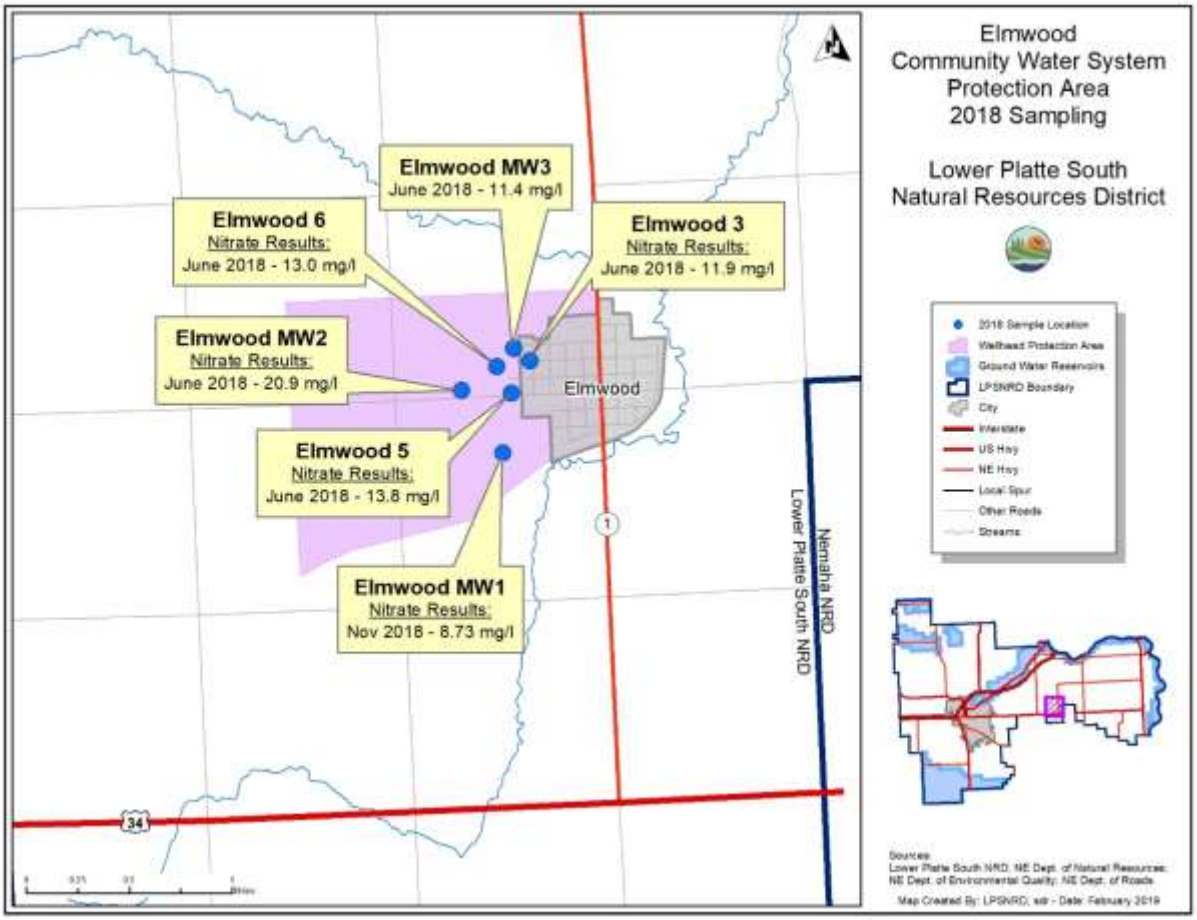


4.1.2.12 Elmwood

Applicable Regulations: Section L(1)

The CWSPA for the Village of Elmwood occupies slightly more than 1 ½ square miles west and south of the village in central Cass County. In 2006, District sampling results indicated that the triggers for a Phase III ground water management area had been exceeded in the CWSPA. As a result, a Phase III Verification Study was initiated and was completed in 2008. This study resulted in the installation of three dedicated monitoring wells in the CWSPA, as well as collection of a great deal of geologic, soil, and other data (EA Engineering, Science, and Technology, 2008b). The nitrate sampling results for the monitoring wells and three PWS wells in 2018 are displayed in Figure 25. As a result of the verification study and subsequent sampling, the LPSNRD designated the Elmwood CWSPA as a Phase III GWMA in December 2009. In 2010, the NRD assembled an advisory group for the GWMA composed of local residents and officials from the Elmwood area, and held two meetings with that group. Regulations for the Phase III area were developed and adopted in 2011. In 2012 the District began implementation those regulations for the Phase III area, including requirements for nitrogen certification, fall fertilization, and soil sampling, and increased cost-share for best management practices. In early 2012, the District held nitrogen certification classes and certified six nitrogen applicators from the Elmwood CWSPA, and those certifications were renewed in 2017. As part of the Phase III rules and regulations, any producer that intends to apply nitrogen has to conduct soil sampling and must report those results to the LPSNRD. Nitrogen fertilizer can then be applied after the results of the soil sampling have been considered by the landowner, but only after March 1 of any given cropping year (i.e. no fall fertilization is allowed in order to limit the opportunity for nitrates to leach below the crop root zone). In addition, producers must report the amount of nitrogen applied to those fields by the end of each calendar year. The District cost-shared on soil sampling with two landowners in 2018 and has received their results from those fields. LPSNRD will continue to work with these and all operators within the Phase III area to ensure that its regulations are implemented successfully.

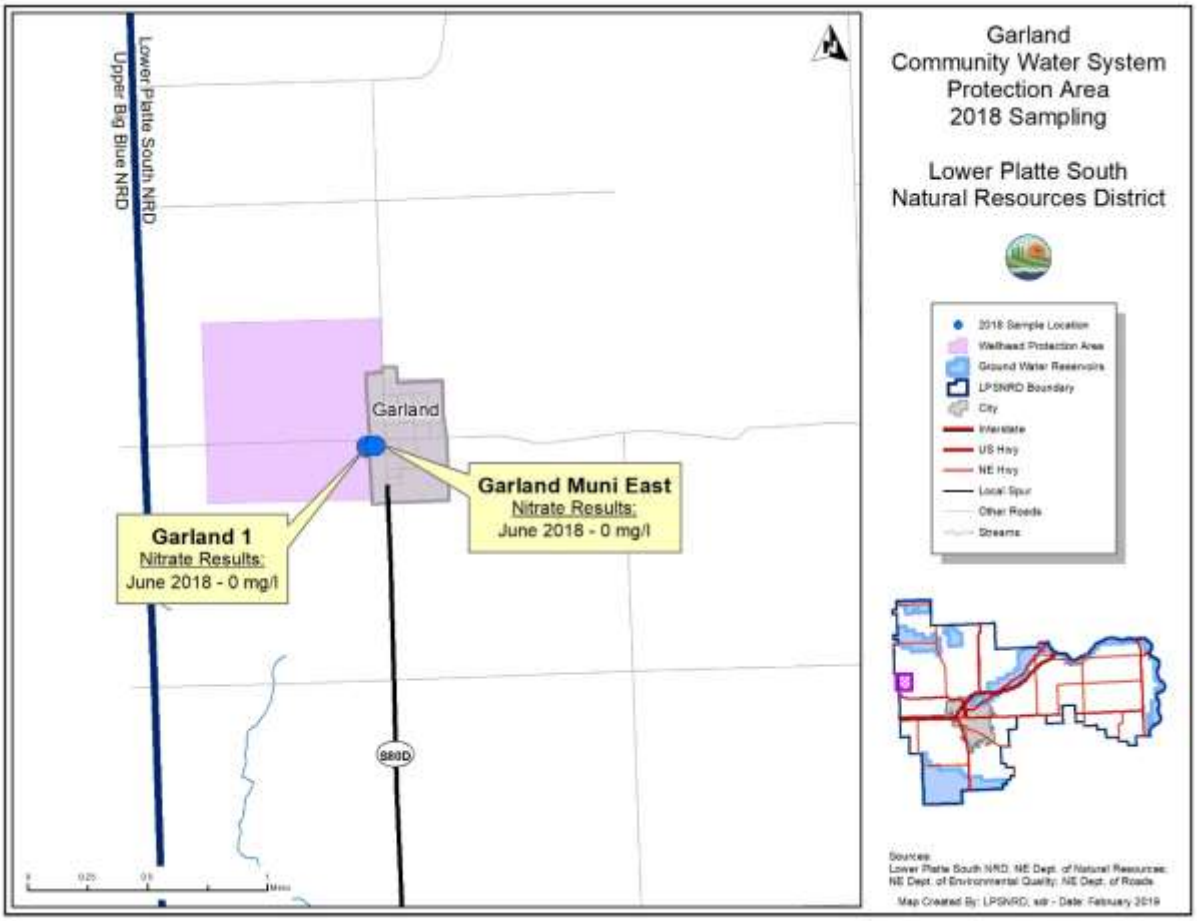
Figure 25 – Elmwood



4.1.2.13 Garland

The Village of Garland's CWSPA takes up slightly less than one square mile around and to the west of the village in northwestern Seward County. District staff sample two PWS wells for the village, and the 2018 nitrate results are shown in Figure 25.

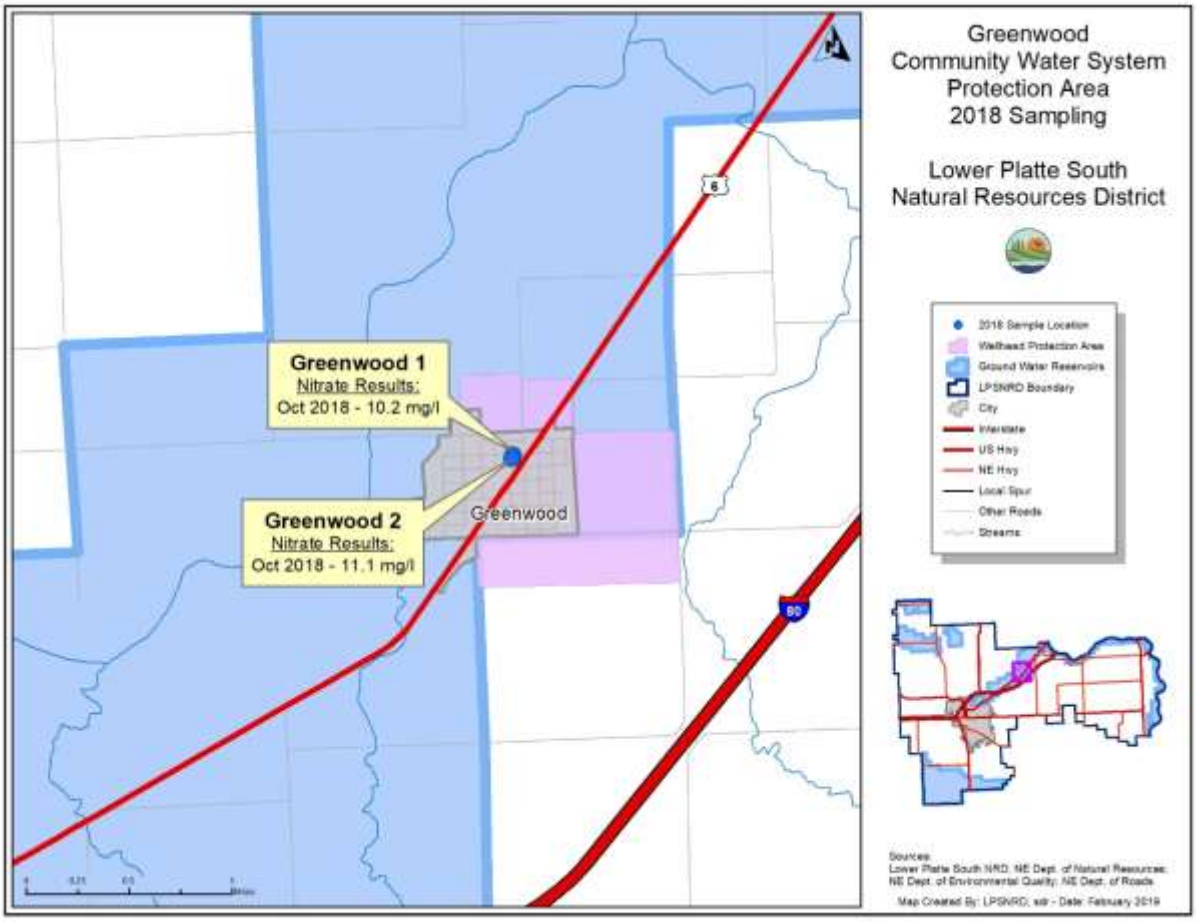
Figure 26 – Garland



4.1.2.14 Greenwood

The CWSPA for Greenwood occupies about one square mile around and to the east and southeast of the village in western Cass County. District staff sample two PWS wells for the village, and the 2018 sample results from Greenwood's wells are shown in Figure 26. This data indicates that the nitrate levels in the CWSPA have exceeded the Phase II (and perhaps the Phase III) trigger, but the majority of Greenwood's CWSPA is already contained within the larger Lower Salt Creek GWR Phase II GWMA. The District will consider suspending the Phase II designation for the LSC GWR in 2019. In 2018, the NRD began a two-year Verification Study for the Greenwood CWSPA to see if it merits designation as a Phase II GWMA. As of this writing, shallow soil sampling has been completed; deep soil sampling and monitoring well installation is scheduled for the remainder of 2019.

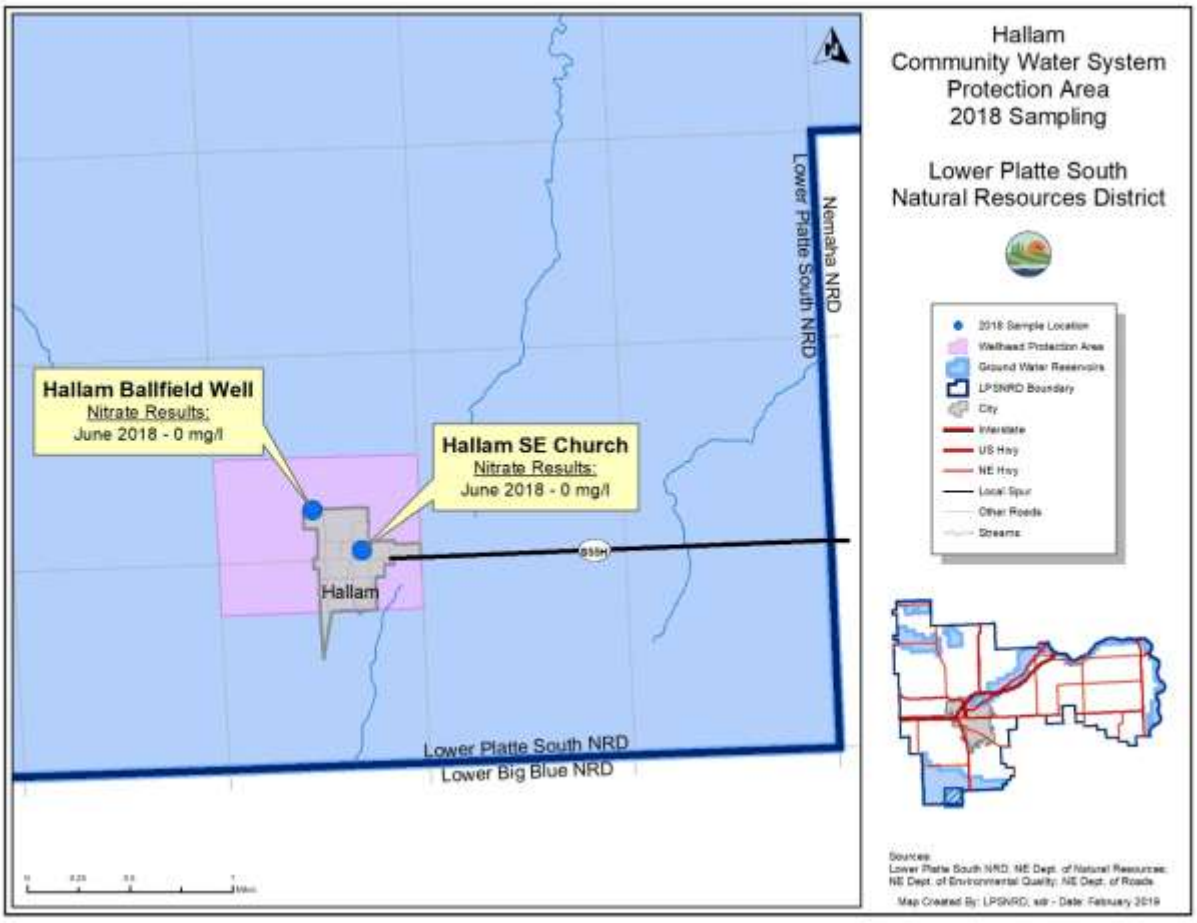
Figure 27 – Greenwood



4.1.2.15 Hallam

The Village of Hallam's CWSPA takes up about ¾ square mile around and to the north of the village in southern Lancaster County. District staff sample two PWS wells for the village, and the 2018 nitrate results are shown in Figure 27.

Figure 28 – Hallam

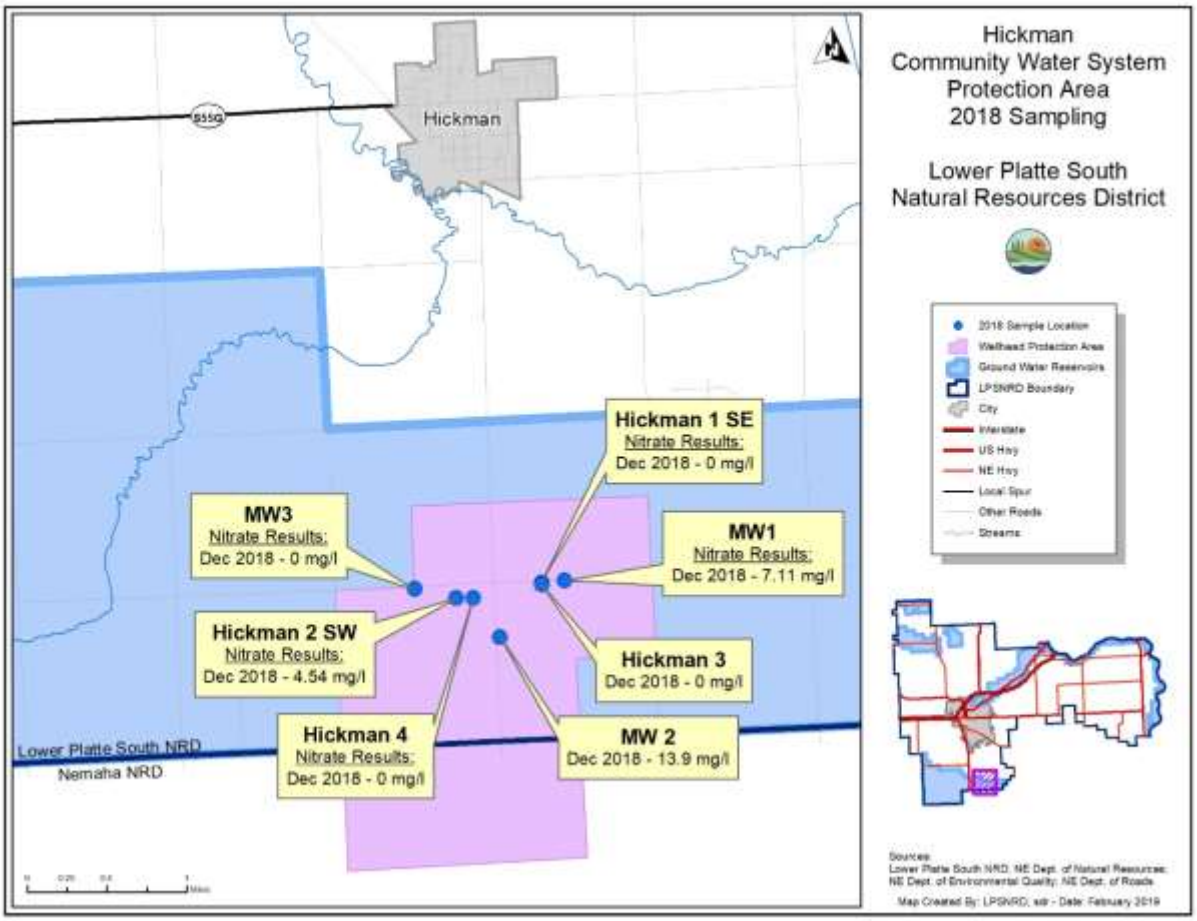


4.1.2.16 Hickman

Applicable Regulations: Section K(1)

The City of Hickman's CWSPA takes in slightly more than 3 ½ square miles south of the city in southern Lancaster County. The CWSPA for Hickman straddles the boundary between the Lower Platte South and Nemaha NRDs; about 2 ½ square miles are in LPSNRD, and the remaining one square mile is in NNRD. In 2006, District sampling results indicated that the triggers for a Phase II ground water management area had been exceeded in the CWSPA. As a result, a Phase II Verification Study was initiated and was completed in 2009. This study resulted in the installation of three dedicated monitoring wells in the CWSPA, as well as collection of a great deal of geologic, soil, and other data (EA Engineering, Science, and Technology, 2009a). The nitrate sampling results for the PWS and monitoring wells in 2016 are displayed in Figure 28. As a result of the verification study and subsequent sampling, the LPSNRD designated the Hickman CWSPA as a Phase II GWMA in December 2009. In 2012, the NRD began assembling an advisory committee of stakeholders from Hickman to advise the District as it develops rules and regulations for the implementation of Phase II; the NRD held the first meeting of that group in the fall of 2012. The second meeting of the advisory group was held in early 2013, and the District developed and adopted the Phase II regulations as of November 1, 2013. As already described, these regulations include a requirement for nitrogen certification training and additional promotion of BMP cost-share. In addition, in 2013, LPSNRD signed an addendum to its Interlocal Agreement with the Nemaha NRD to allow LPSNRD to provide BMP cost-share to producers in NNRD's portion of the CWSPA, as long as any of those producers who desire the cost-share first complete LPSNRD's nitrogen certification training requirements. However, as indicated by the results shown below, in 2018, Hickman's nitrate levels in the NRD's monitoring wells continued to stay below the Phase II trigger; these results are similar to those for 2011 through 2016. In the latest revision of the District's Ground Water Rules and Regulations (Effective Date: January 1, 2017), a procedure was included for suspending Phase II and moving back to Phase I if nitrate levels dropped below appropriate triggers for a period of not less than three years. As a result, in 2019 LPSNRD will consider beginning the process of suspending the Phase II requirements for the Hickman CWSPA.

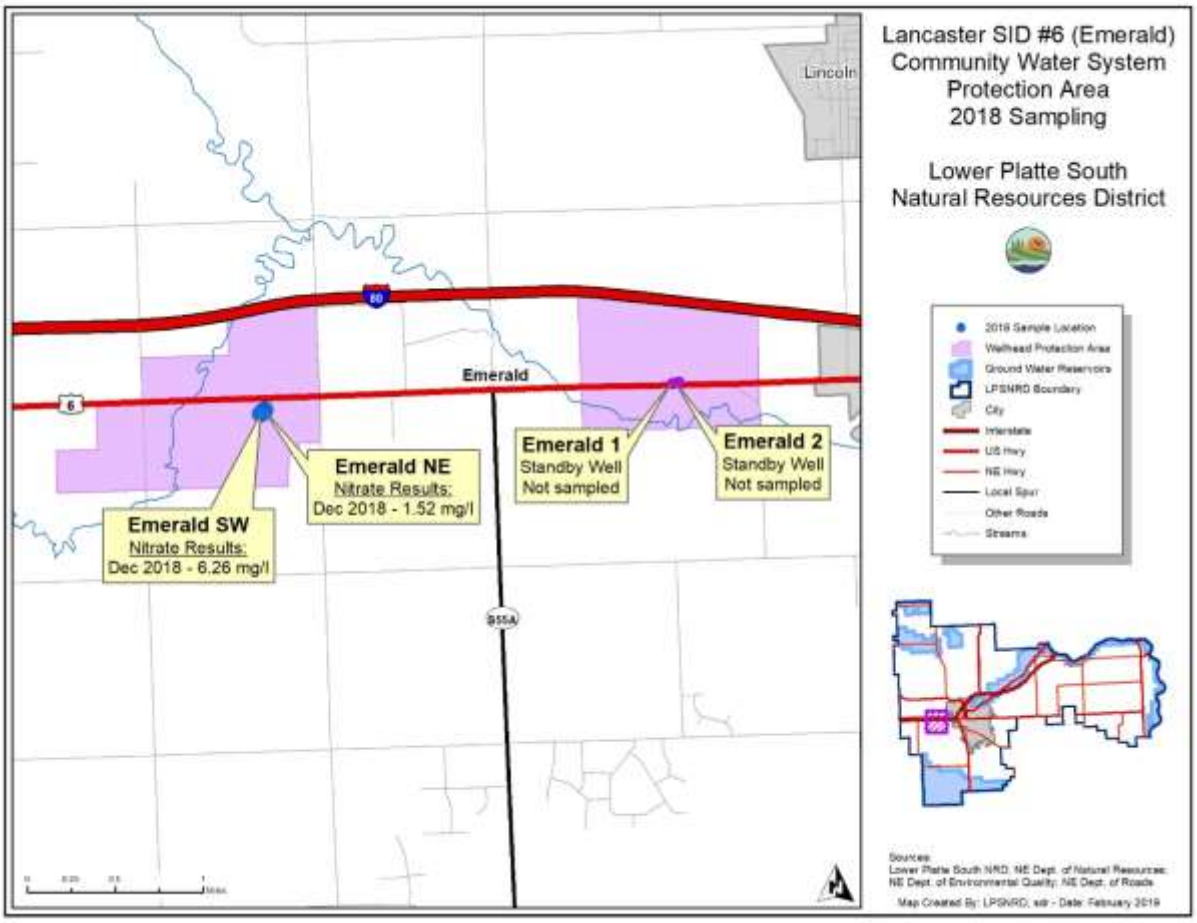
Figure 29 – Hickman



4.1.2.17 Lancaster County SID #6/Emerald

The process of installing a new public water system for the community of Emerald in west-central Lancaster County stretches back for several years. After considerable effort, the system was completed and came online in 2010. In 2011, NDEQ completed delineation of the wellhead protection area boundary for the new wellfield, and in 2013 LPSNRD arranged a sampling agreement for it. Figure 29 shows the locations of Emerald's wells and the 2018 sample results for the two active wells. Note that the wells in the eastern portion of the CWSPA are backup wells and are not typically sampled in a given year. Also the sample results for 2016-2018 indicate that the Phase II trigger has been exceeded for Emerald. In 2018, the District initiated a Phase II verification study to determine if the Emerald CWSPA should be delineated as a Phase II GWMA. As of this writing, shallow soil sampling has been completed; deep soil sampling and monitoring well installation is scheduled for later in 2019.

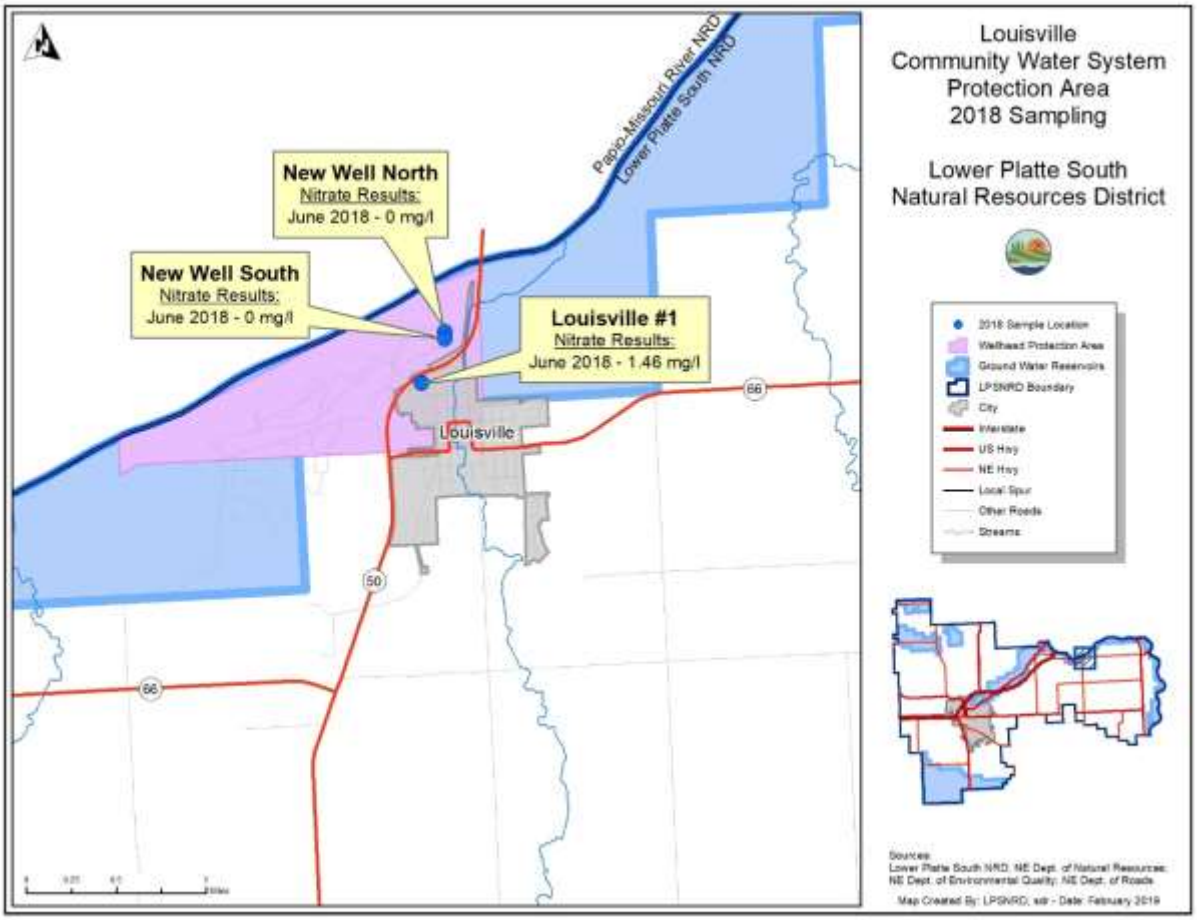
Figure 30 – Lancaster County SID #6/Emerald



4.1.2.18 Louisville

The City of Louisville's CWSPA takes up about1 ¼ square miles to the west of the city along the south side of the Platte River in northern Cass County. District staff sample three PWS wells for the city, and the 2018 nitrate results are shown in Figure 30.

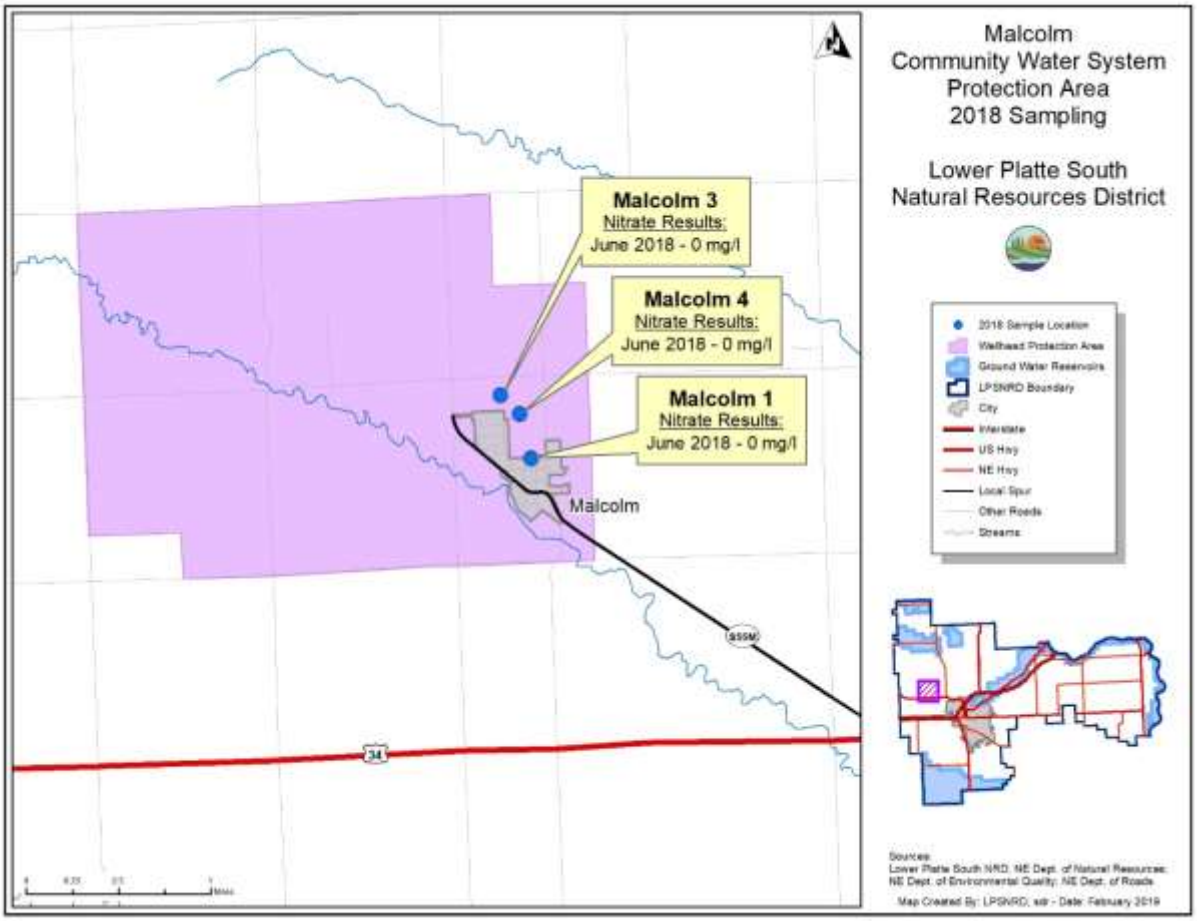
Figure 31 – Louisville



4.1.2.19 Malcolm

The Village of Malcolm's CWSPA covers about 5 square miles north and west of the village in west-central Lancaster County. District staff sample three PWS wells for the village, and the 2018 nitrate results are shown in Figure 31.

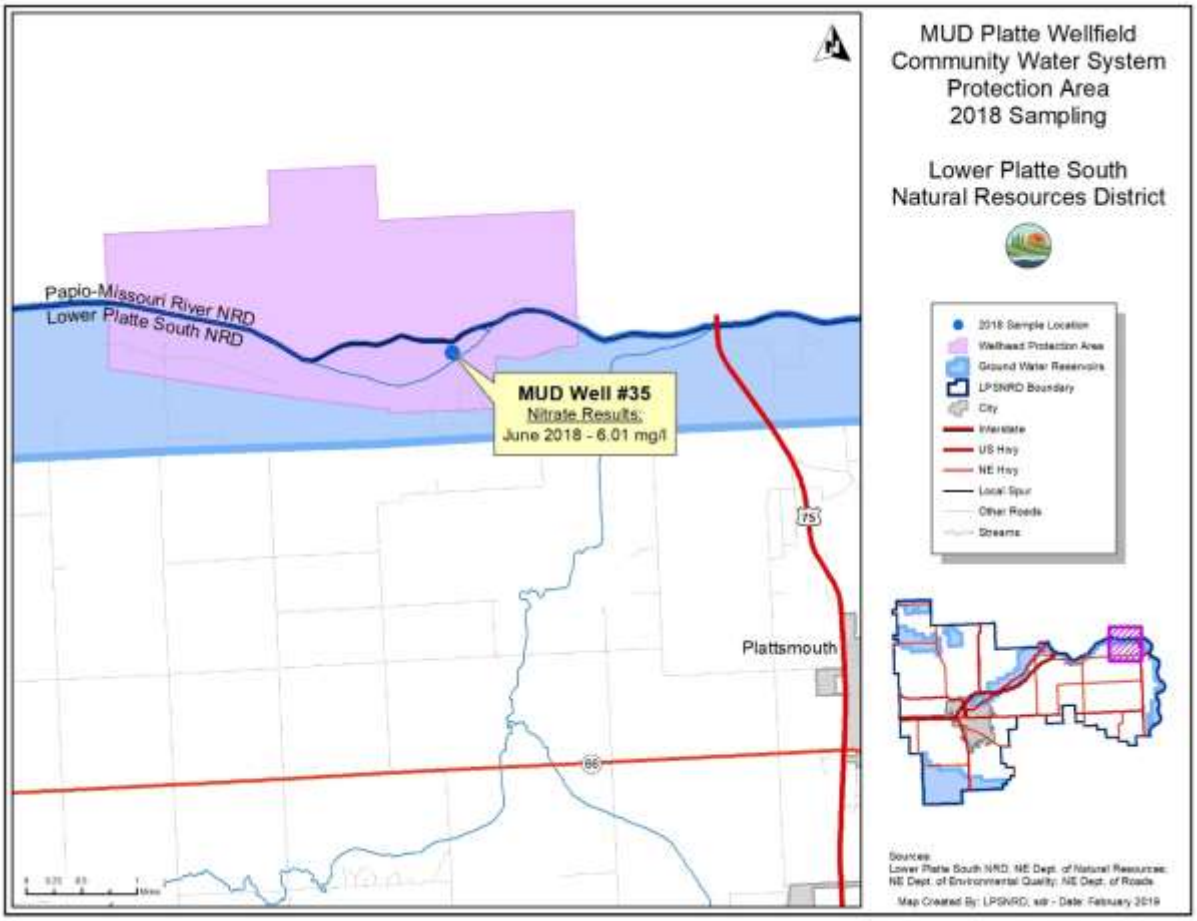
Figure 32 – Malcolm



4.1.2.20 Metropolitan Utilities District (MUD)

The Metropolitan Utilities District (MUD) serves the greater Omaha area. It gets its water supply from the Missouri River and several wellfields, one of which is the Platte wellfield just northwest of Plattsmouth along the lower reaches of the Platte River. The CWSPA for the MUD Platte wellfield occupies about 12 square miles along the Platte River, most of it on the north side of the river in the Papio-Missouri River NRD. LPSNRD staff sample one well in the wellfield, and the 2018 results are shown in Figure 32. The 2018 result for the single well sampled by LPSNRD exceeds the Phase II trigger outlined in LPSNRD's GWMP, but given that much of this particular CWSPA is outside of LPSNRD, what part of it is in LPSNRD is largely riverfront land, and there are several other wells in this CWSPA that LPSNRD does not sample, the likelihood of designation of a Phase II GWMA is uncertain at this time. LPSNRD will communicate with MUD to gather more information on nitrate levels in the other wells within the wellfield, and will evaluate how to proceed in this case in 2019.

Figure 33 – Metropolitan Utilities District (MUD)



4.1.2.21 Otoe County RWD #3/Weeping Water

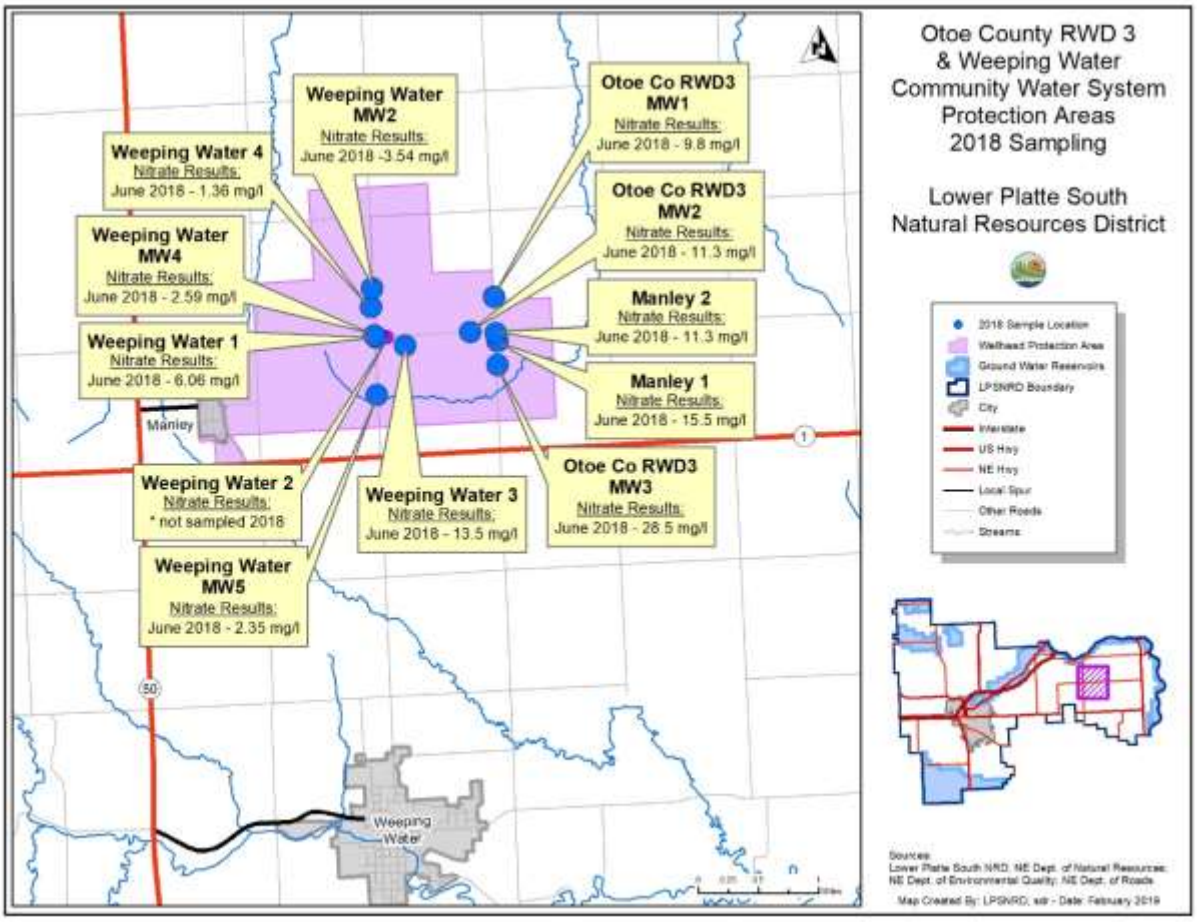
Applicable Regulations: Section K(1))

The CWSPAs for Otoe County Rural Water District #3 (OCRWD#3) and the City of Weeping Water are located within about one mile of each other just northeast of the village of Manley in central Cass County, and the CWSPAs overlap. The total area of the two CWSPAs is slightly over four square miles, and the overlap area is about one square mile. Water from the OCRWD#3 wells is combined with water from other supply wells throughout the system to supply customers in other parts of Cass and Otoe Counties, including the Village of Manley. Water from the Weeping Water wellfield is used to supply customers in the City of Weeping Water, which is about five miles south of the wellfield.

In 2006, District sampling results indicated that the triggers for a Phase II ground water management area had been exceeded in these two CWSPAs. As a result, a Phase II Verification Study was initiated and was completed in 2009. This study resulted in the installation of six dedicated monitoring wells in the CWSPA, as well as collection of a great deal of geologic, soil, and other data (EA Engineering, Science, and Technology, 2009b). Unfortunately, two of the monitoring wells for the Weeping Water investigation (MW-1 and MW-2) were inadvertently installed too close to the county road right-of-way, and had to be decommissioned in mid-2009. As a result of additional investigation, two new wells were installed in 2011-2012 to replace these wells. The nitrate sampling results for the PWS and monitoring wells in 2018 are displayed in Figure 33.

The results of the District nitrate sampling from 2006-2009 indicated that the trigger for Phase II and possibly Phase III had been exceeded. However, conversations with NDEQ late in 2009 indicated that the boundaries of the two CWSPAs might need modified based on the additional information gained in the verification study. The District supplied the information to NDEQ, and new boundaries for the two CWSPAs were proposed and adopted. LPSNRD then delineated the entire combined area of the two CWSPAs as a joint Phase II GWMA in January 2010. As part of additional work in 2012, LPSNRD also worked with a private consultant to obtain additional shallow and deep soil samples for nitrogen analysis to better characterize the portions of the CWSPA added following NDEQ's new delineation process. In 2010, the NRD assembled an advisory group for the GWMA composed of local residents and officials from the CWSPA as well as both public water suppliers, and held two meetings with that group. Using information gathered in this process, in 2011 the District held a public hearing on, adopted, and began implementation of rules and regulations for the Phase II area, including requirements for nitrogen certification, and increased levels of cost-share for best management practices. In early 2012, the District worked with UNL Extension to hold nitrogen certification classes for those required operators in the CWSPA, and began implementation of enhanced cost-share for BMPs installed in the CWSPA. Re-certification for operators was held in 2017. All this information will continue to be incorporated into LPSNRD's management efforts for the CWSPA.

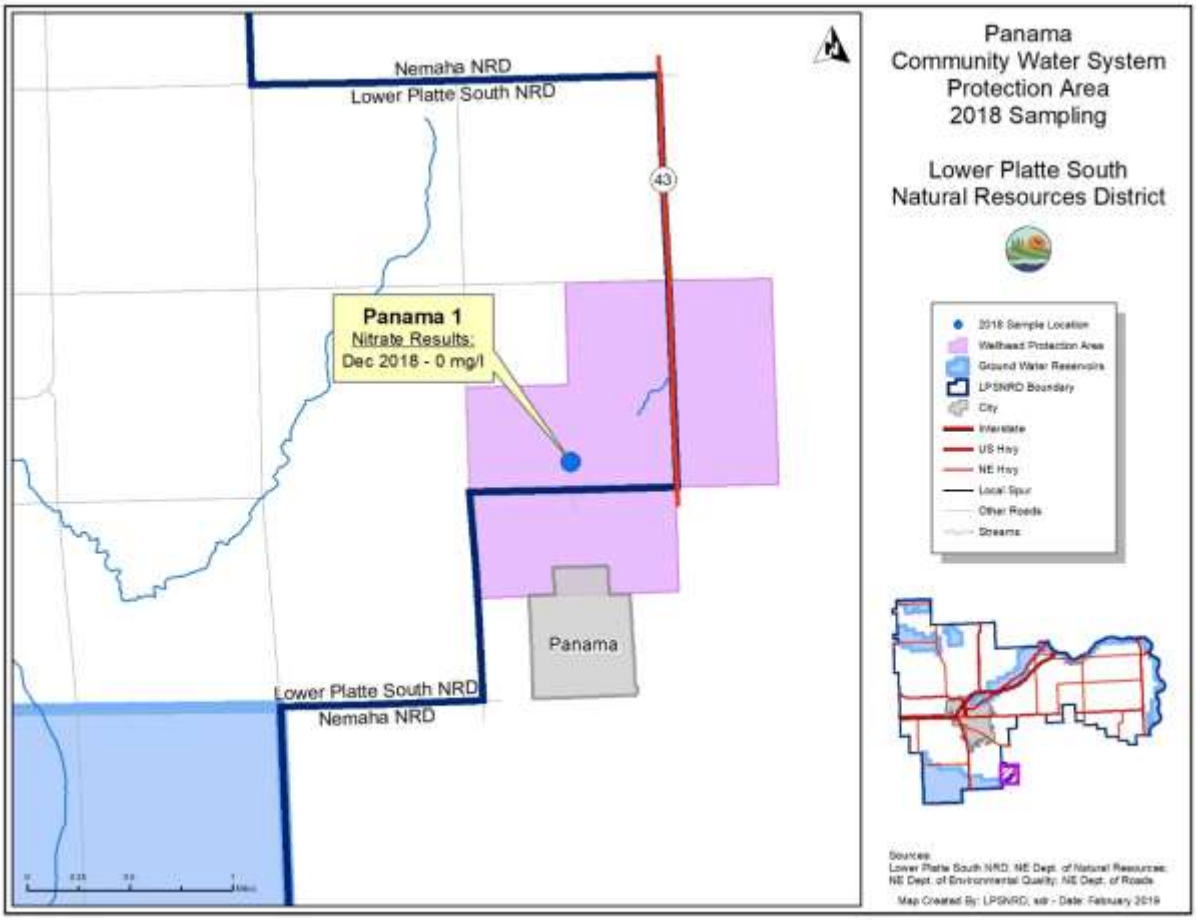
Figure 34 – Otoe County RWD #3/Weeping Water



4.1.2.22 Panama

The Village of Panama's CWSPA occupies about one square mile north and east of the village in southeastern Lancaster County; the CWSPA overlaps the boundary between LPSNRD and the Nemaha NRD, and the Village itself is within NNRD. However, the one PWS well for the Village is located within LPSNRD, and the 2018 nitrate results are shown in Figure 34.

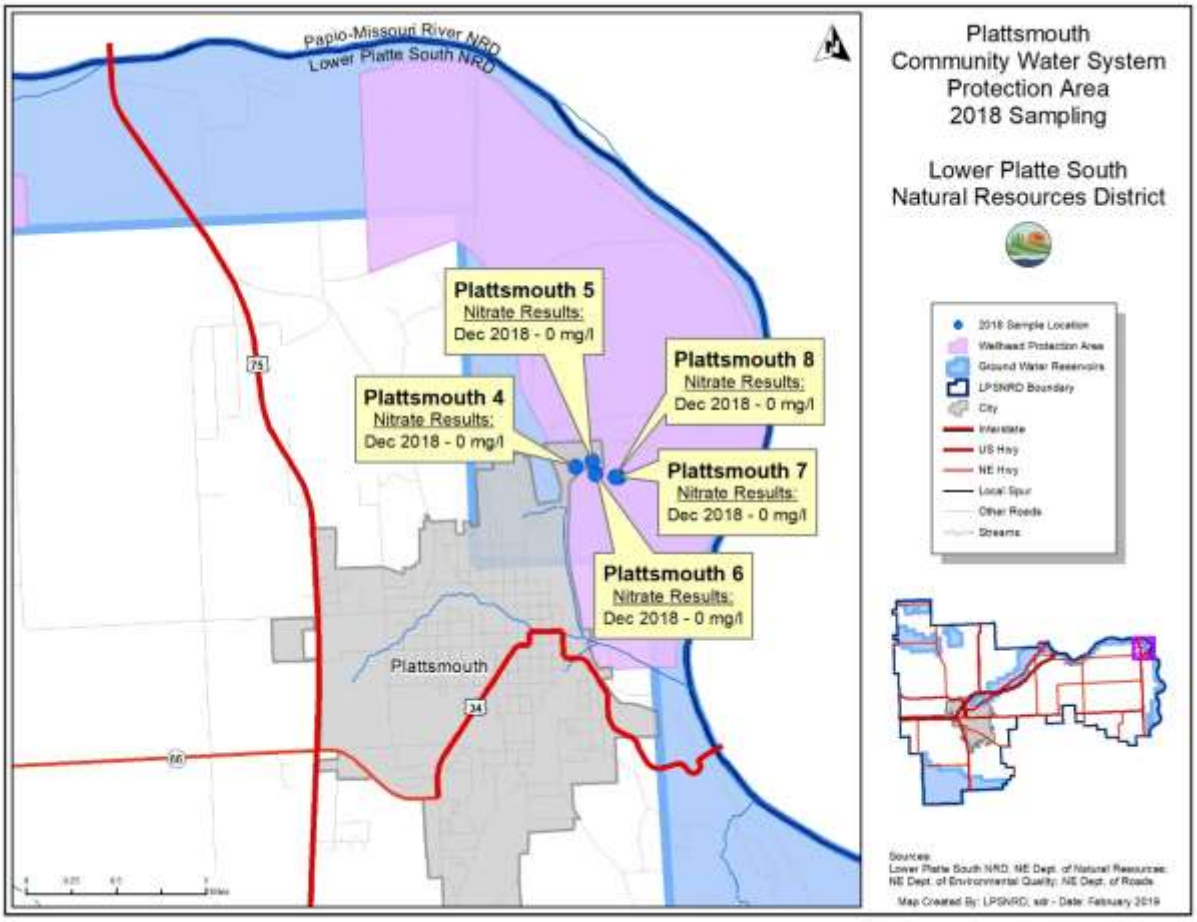
Figure 35 – Panama



4.1.2.23 Plattsmouth

The City of Plattsmouth's CWSPA occupies about 3 ¼ square miles to the northeast of the city along the Platte and Missouri Rivers in northeastern Cass County. District staff historically sampled six PWS wells for the city, but in 2011 widespread flooding along the Missouri River caused extensive damage to Plattsmouth's wellfield. In 2012, the City completed repairs to the system which included installation of one new high-capacity production well and decommissioning of three wells that were damaged. The location of the currently active wells as well as the nitrate sample results for 2018 are shown in Figure 35. Historically, some samples from Plattsmouth's supply wells have shown varying concentrations of arsenic, and as a result the City uses lime softening to deal with arsenic content. In 2018, two District samples (from Wells 5 and 6) showed arsenic levels slightly in excess of the MCL of 10 ppb, and this information was communicated to the City (see Sec. 3.1.3.2 for more information).

Figure 36 – Plattsmouth



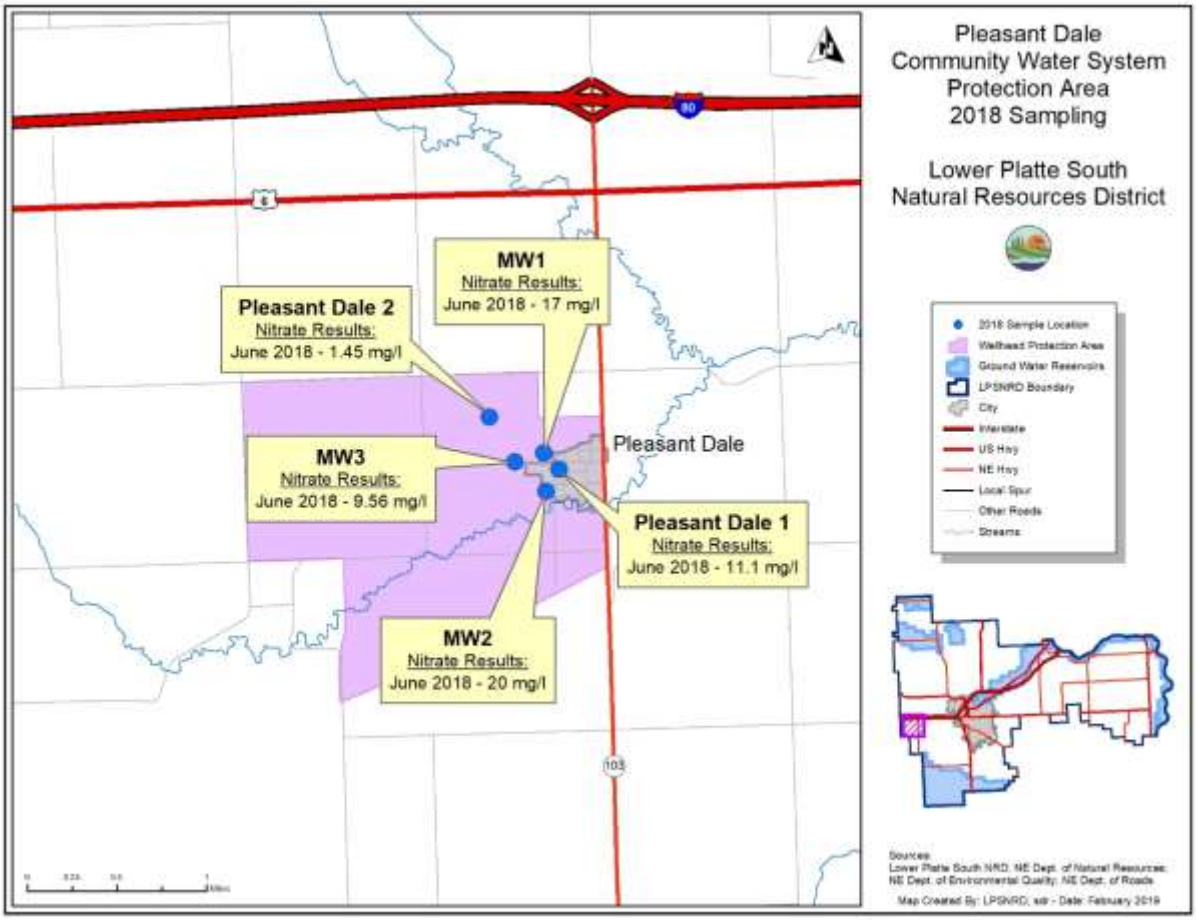
4.1.2.24 Pleasant Dale

Applicable Regulations: Section K(1)

The CWSPA for the Village of Pleasant Dale occupies about 2 ½ square miles west and north of the village in eastern Seward County. In 2006, District sampling results indicated that the triggers for a Phase II ground water management area had been exceeded in the CWSPA. As a result, a Phase II Verification Study was initiated and was completed in 2009. This study resulted in the installation of three dedicated monitoring wells in the CWSPA, as well as collection of a great deal of geologic, soil, and other data (EA Engineering, Science, and Technology, 2009c). As a result of the verification study and subsequent sampling, the LPSNRD designated the Pleasant Dale CWSPA as a Phase II GWMA in December 2009. In 2012, the NRD assembled an advisory committee of stakeholders from the Pleasant Dale area to advise the District as it develops rules and regulations for the implementation of Phase II, and two meetings of this group were held. The recommendations and input of the advisory group were considered and incorporated into the District's Phase II regulations which became effective in 2013.

The nitrate sampling results for the two PWS and three monitoring wells in 2018 are displayed in Figure 36. In 2011-2013, District monitoring indicated that nitrate levels in the Pleasant Dale CWSPA had exceeded the Phase III trigger. However, in 2015, the nitrate level in these wells had dropped back below the Phase III trigger. As shown in Figure 36, in 2018 the nitrate levels once again slightly exceeded the Phase III trigger. As the Phase II implementation process is still fairly new, LPSNRD will continue to monitor nitrate levels and evaluate additional investigation in Pleasant Dale to see if it warrants advancement to Phase III. Also, in 2018, the NRD will began a 2-year verification study to determine whether or not the CWSPA merits designation as a Phase III GWMA. This effort will involve deep soil/vadose zone sampling as well as the installation of one additional dedicated monitoring well; as of this writing, this fieldwork is scheduled but not completed.

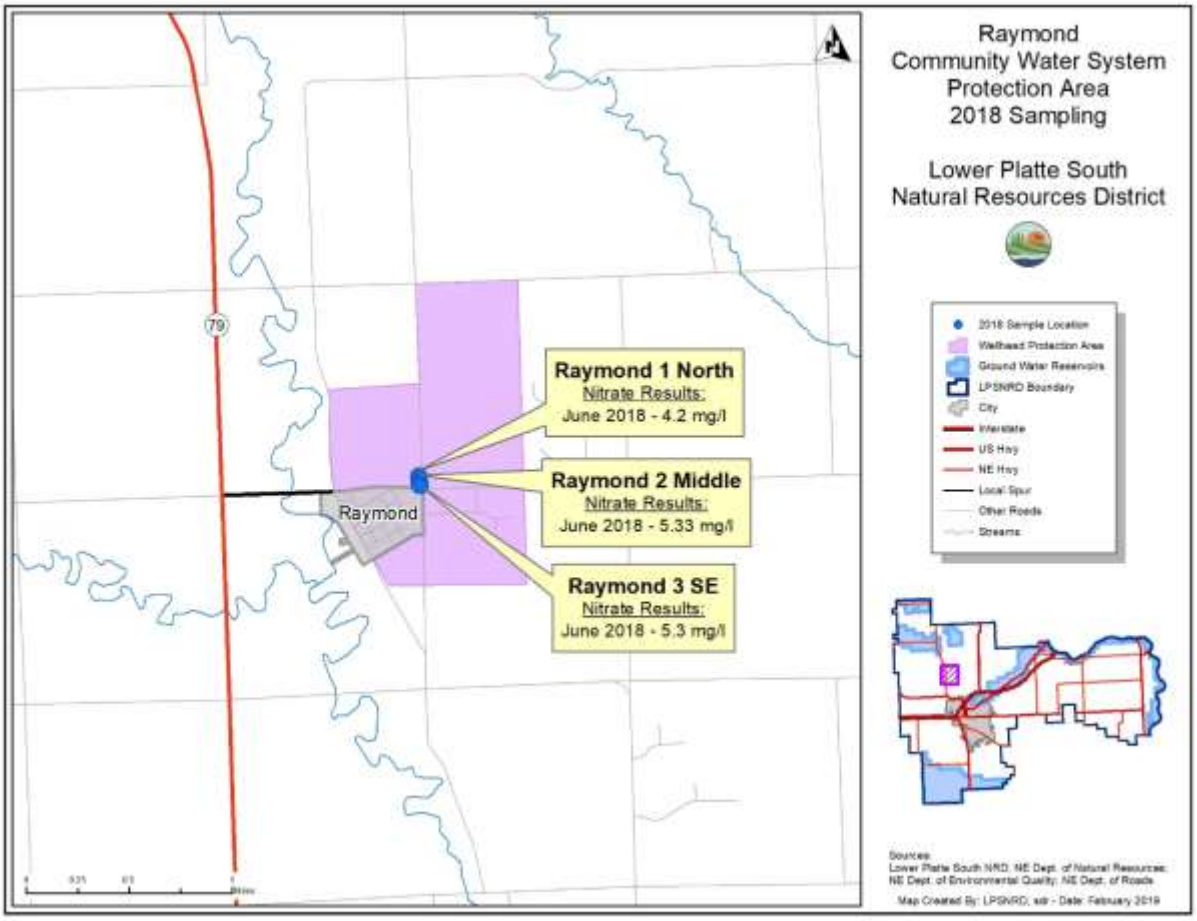
Figure 37 – Pleasant Dale



4.1.2.25 Raymond

The Village of Raymond's CWSPA covers a little more than one square mile north and east of the village in northwestern Lancaster County. District staff sample three PWS wells for the village, and the sample results for 2018 are shown in Figure 37. These results indicate that nitrate levels in the Raymond CWSPA have exceeded the Phase II trigger. LPSNRD will consider whether to begin Phase II studies for Raymond in 2019.

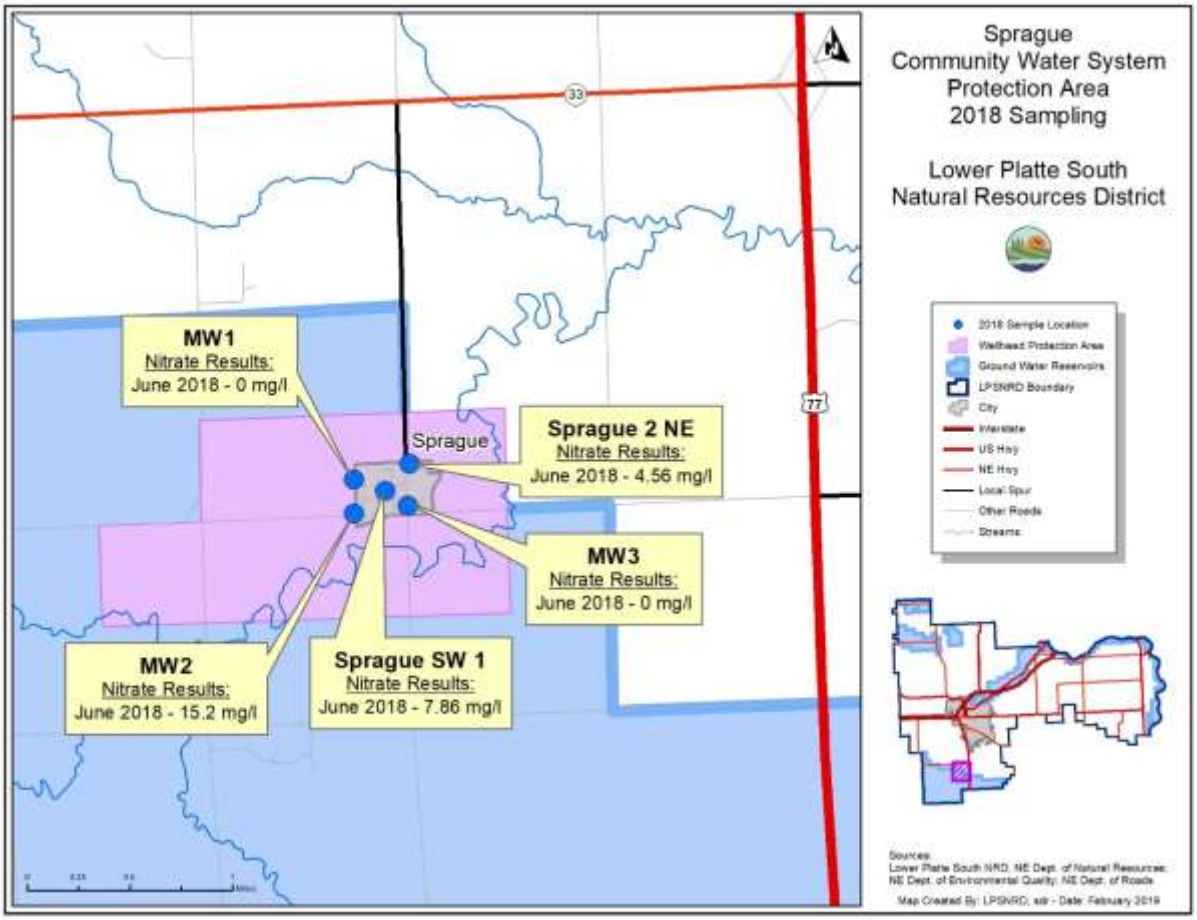
Figure 38 – Raymond



4.1.2.26 Sprague

The Village of Sprague's CWSPA occupies about 1 ¾ square miles around the village in southwestern Lancaster County. In 2006, District sampling results indicated that the triggers for a Phase II ground water management area had been exceeded in the CWSPA. As a result, a Phase II Verification Study was initiated and was completed in 2009. This study resulted in the installation of three dedicated monitoring wells in the CWSPA, as well as collection of a great deal of geologic, soil, and other data (EA Engineering, Science, and Technology, 2009d). The nitrate sampling results for the two PWS and three monitoring wells in 2018 are displayed in Figure 38. As has been the case for the past few years, these sampling results show that nitrate levels in the Sprague CWSPA are very close to the Phase II trigger, and in 2016 those results were slightly above that trigger level, as they were in 2015. In December 2009, the LPSNRD Board directed the staff to continue to monitor the PWS and monitoring wells in the CWSPA to determine if those levels are in fact being exceeded. Given that the nitrate levels in samples from the Sprague monitoring network have exceeded Phase II triggers for several years but continue to occasionally decline below the trigger, in 2019 LPSNRD will determine whether to begin the process of designating the Sprague CWSPA as a Phase II GWMA.

Figure 39 – Sprague



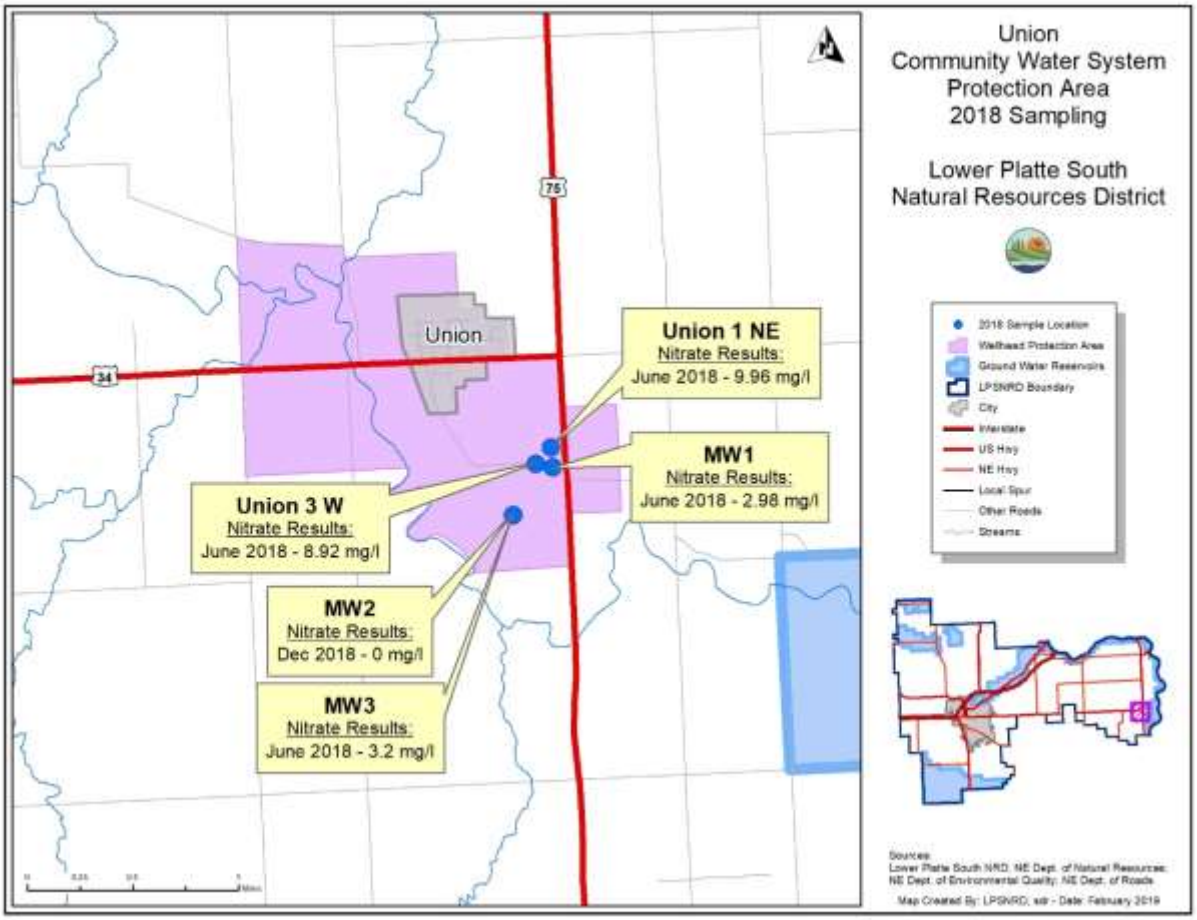
4.1.2.27 Union

Applicable Regulations: Section K(1)

The CWSPA for the Village of Union occupies about one square mile south of the village in southeastern Cass County. In 2006, District sampling results indicated that the triggers for a Phase II ground water management area had been exceeded in the CWSPA. As a result, a Phase II Verification Study was initiated and was completed in 2008. This study resulted in the installation of three dedicated monitoring wells in the CWSPA, as well as collection of a great deal of geologic, soil, and other data (EA Engineering, Science, and Technology, 2008c). For several years, LPSNRD had not sampled Union's individual public supply wells, but in 2012 the NRD coordinated with the Village to begin sampling those wells. The nitrate sampling results for the three monitoring wells and two public supply wells in 2018 are displayed in Figure 39.

As a result of the verification study and subsequent sampling, the LPSNRD designated the Union CWSPA as a Phase II GWMA in December 2009. In 2012, the NRD assembled an advisory committee of stakeholders from Union to advise the District as it develops rules and regulations for the implementation of Phase II; two meetings with this group were held in 2012. The District developed and adopted Phase II regulations for Union and three other CWSPAs which became effective on November 1, 2013, and as already mentioned these regulations include nitrogen certification requirements and additional BMP promotion. In 2011-2015, Union's nitrate levels in the NRD's monitoring wells dropped slightly below the Phase II trigger, but in 2016 those levels were once again just above the trigger, and, as shown in Figure 39, those levels were slightly below the trigger in 2018. LPSNRD will continue to monitor these wells and work with the Village to gain more complete information for evaluation of Union's Phase status.

Figure 40 – Union

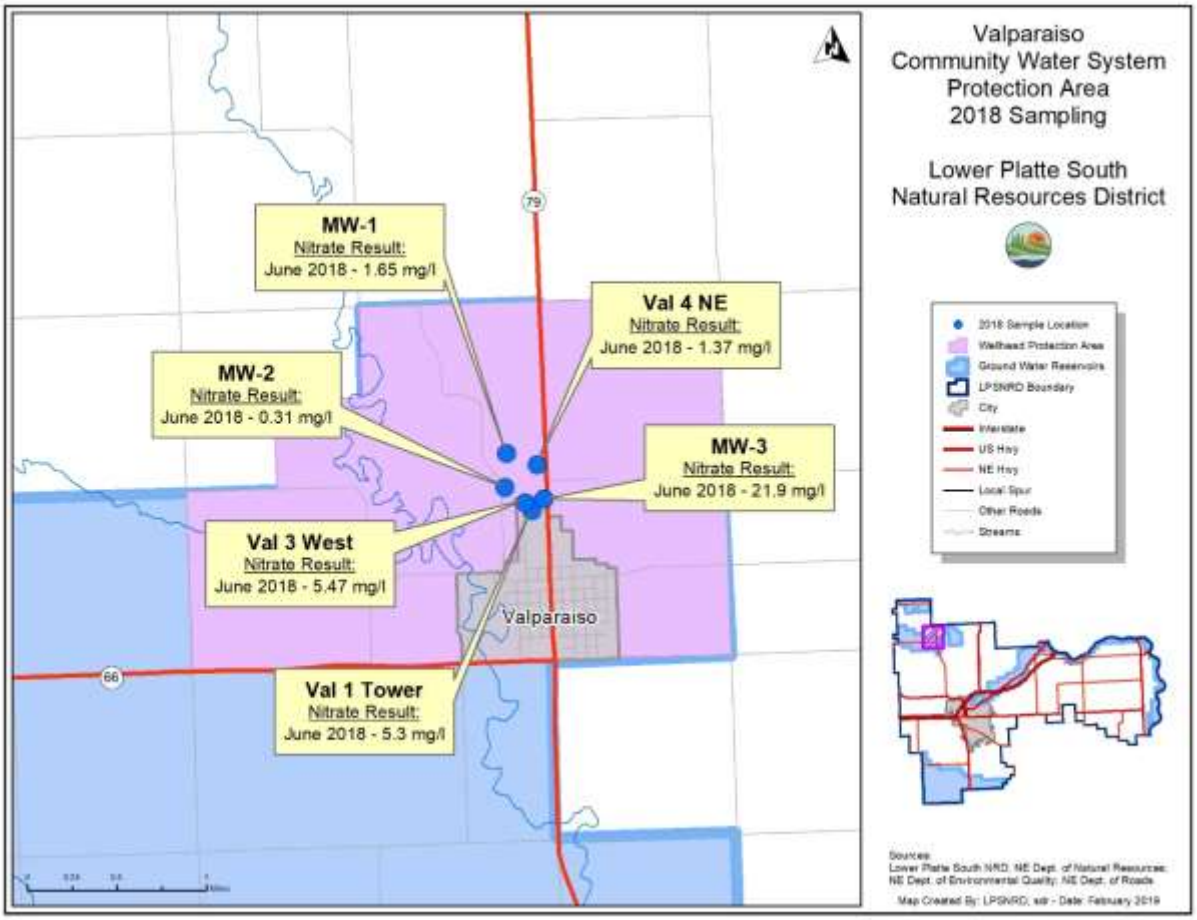


4.1.2.28 Valparaiso

Applicable Regulations: Section K(1)

The CWSPA for the Village of Valparaiso covers about 5 ¼ square miles surrounding the village in southwestern Saunders County. In 2001, District sampling results indicated that the triggers for a Phase II ground water management area had been exceeded in the CWSPA. As a result, a Phase II Verification Study was initiated and was completed in 2003. This study resulted in the installation of three dedicated monitoring wells in the CWSPA, as well as collection of a great deal of geologic, soil, and other data (EA Engineering, Science, and Technology, 2003). As a result of this study, the Valparaiso CWSPA was designated as a Phase II GWMA in 2004. An advisory group of interested parties from the Valparaiso area was formed to assist in the development of rules and regulations, which were adopted in 2004. In addition, a certification program for landowners and operators who apply nitrogen fertilizer was developed and implemented. The District held its first certification class for the Phase II area in 2007; as required by current regulations, LPSNRD held re-certification training in 2011 and 2015. Also in 2007, the District signed an Interlocal Agreement with Valparaiso to provide structure for ongoing monitoring and water quality management activities. The nitrate sampling results for the two PWS and three monitoring wells in 2018 are displayed in Figure 40. For 2018, nitrate sampling results for Valparaiso slightly exceeded the Phase II trigger However, in 2011-2017, sample results indicated that those levels had declined slightly below the Phase II trigger. In the latest revision of the District's Ground Water Rules and Regulations (Effective Date: January 1, 2017), a procedure was included for suspending Phase II and moving back to Phase I if nitrate levels dropped below appropriate triggers for a period of not less than three years. Given that the nitrate levels in samples from Valparaiso have been below the Phase II trigger for several years, but are now slightly above that trigger, in 2019 LPSNRD will consider whether to begin the process of suspending Phase II requirements for the Valparaiso CWSPA.

Figure 41 – Valparaiso

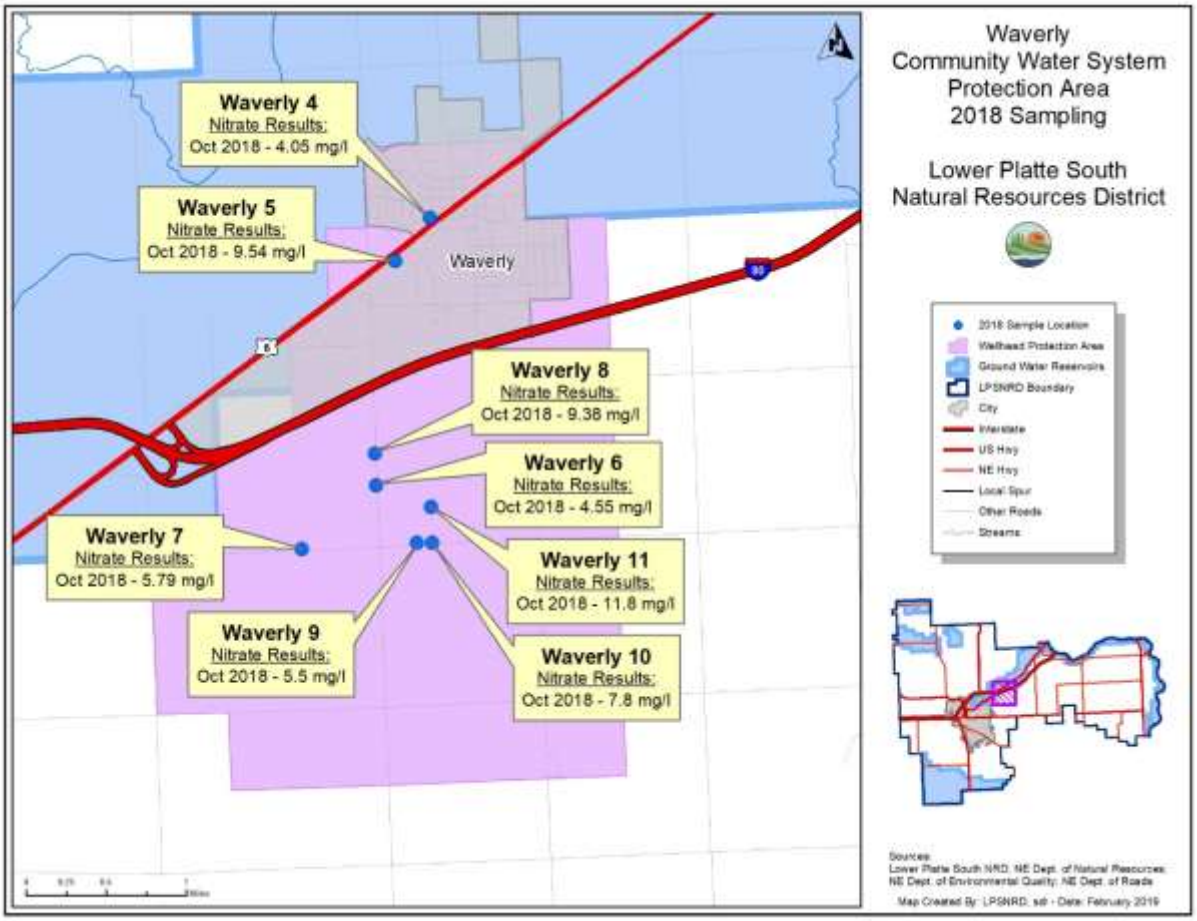


4.1.2.29 Waverly

The City of Waverly's CWSPA occupies more than eight square miles around and south of the city in northeastern Lancaster County. District staff sample eight PWS wells for the village, and the 2018 nitrate results are shown in Figure 41. The 2107 and 2018 results indicate that the Waverly CWSPA has exceeded the Phase II trigger.

In 2017, LPSNRD signed a cooperative agreement with the City of Waverly to support development of a comprehensive Drinking Water Protection Plan for the City's water supply. The project is also supported by the Nebraska Department of Environmental Quality and the University of Nebraska Water Sciences Laboratory. This two-year study will involve land use surveys, water sampling, vadose zone sampling, installation of dedicated monitoring wells, and other activities contained in a typical two-year verification study. In signing the agreement, LPSNRD specified that the results of this project will allow the District to determine whether or not the Waverly CWSPA should be designated as a Phase II GWMA. As shown in Figure 41, the northern portion of the Waverly CWSPA is contained within the current Lower Salt Creek GWR Phase II area, but as already mentioned the LPSNRD is taking steps to suspend that Phase II area due to declining ground water nitrate levels. Therefore, the two-year project with Waverly will be important to determine whether or not this area should be designated as a Phase II GWMA. An important part of the Waverly project is utilization of new airborne electromagnetic (AEM) in all study aspects, but particularly as it relates to delineation of a new CWSPA boundary. AEM data as well as all existing information will be utilized in running a more sophisticated ground water model to evaluate CWSPA boundaries, and these boundaries will be modeled on a 50-year time of travel rather than the traditional 20-year timeframe as per current NDEQ guidelines. In addition, in 2018 a mass ground water quality sampling of private domestic and irrigation wells was completed in the CWSPA, and soil samples were collected to document nitrate levels already present in the soil and vadose zone. This information will be included in a final project report scheduled to be completed in 2019. Once all these activities are concluded and the results reported, LPSNRD will determine whether the Waverly CWSPA should be designated as a Phase II area.

Figure 42 – Waverly



4.1.2.30 Weeping Water

See Otoe County Rural Water District #3.

4.2 Ground Water Quantity

Designated areas of management for ground water quantity follow the same boundaries as those for ground water quality—that is, Ground Water Reservoirs, the Remaining Area, and Community Water System Protection Areas. Spring 2016 to spring 2017 water level changes are shown for the entire District in Figure 10, and representative long-term trends are shown in Figures 11 and 12. Typically, water levels are measured from irrigation wells and dedicated monitoring wells. Public water supply wells are not usually measured. In 2018, no GWRs or areas in the RA exceeded the trigger levels for advancement to Phase II, but a majority of the wells measured showed a small decrease in water levels (Table 3).

As has been documented in earlier versions of this report, in late 2013 and early 2014, the District drafted new rules and regulations for the proposed Dwight-Valparaiso-Brainard Special Management Area (DVB SMA—see Figure 42) to respond to seasonal declines in ground water levels in the northwestern portion of the District. The District adopted new rules and regulations for the DVB SMA which went into effect on March 1, 2014. These regulations included the following:

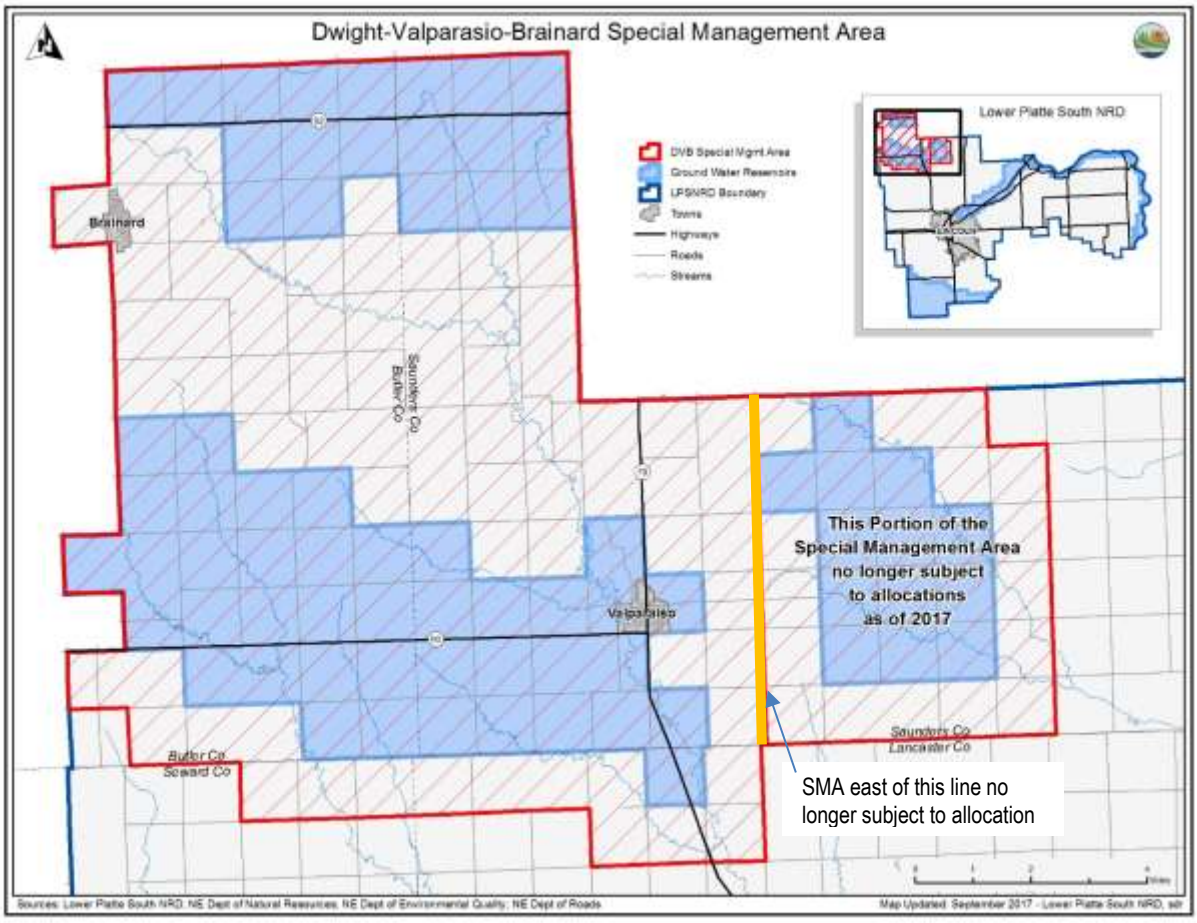
- A prohibition on new irrigated acres;
- An allocation for all certified irrigated acres as follows:
    - Pivot/sprinkler: 21 acre-inches per three years with a maximum of nine inches applied in any one year
    - Gravity/flood: 30 acre-inches per three years with a maximum of 12 acre-inches applied in any one year
- Required completion of an irrigation management certification class for all irrigators;
- Establishment of cost-share programs;
- Requirement that new wells be completed to a depth such that they are less likely to be affected by seasonal water declines; and
- Requirement that all new well permits for this area be approved by the Board of Directors.

At the completion of the 2016 growing season, the three-year allocation period described above had been completed. As a result, the District revised its Ground Water Rules and Regulations (Revised Effective Date: January 1, 2017) to account for the expiration of this allocation period. Based upon water use records submitted to the District by water users in the DVB SMA, it appeared that the allocation amounts originally adopted were adequate to maintain irrigation in the area, and so the allocation amounts were adopted for a second three-year allocation period. However, additional hydrogeologic data collected by the NRD, especially via the airborne electromagnetic (AEM) surveys conducted over the past several years, indicated that the geology of the eastern portion of the SMA is considerably different than that of the western portion. This is mainly due to the more unconfined nature of the aquifers in the eastern portion, which results in much less seasonal decline in ground water levels. As a result, the District removed the allocation amount for the eastern portion of the SMA (all of the SMA located in T13N,

R6E of Saunders County—see Figure 42), but kept the prohibition on new irrigated acres for the entire SMA.

In addition, in 2014 the District formed an advisory group to help evaluate its progress and guide implementation of the SMA in the future. This group, consisting of local irrigators, dryland farmers, well owners, business owners, and representatives of the three villages, met for the first time in December 2014, and will be convened several times over the coming months and years to help in implementation of the SMA. The advisory group met in January of 2016 to review progress and provide input on possible revisions to requirements for the SMA. The advisory group met again in March 2018. As mentioned above, current regulations require that irrigators in the SMA attend an irrigation management certification class. The NRD held its first such class in February 2015, and all 63 irrigators obtained certification by attending this class. Re-certification of these irrigators will take place in early 2019.

Figure 24 – Dwight-Valparaiso-Brainard Special Management Area



4.2.1 Irrigated Acre Certification

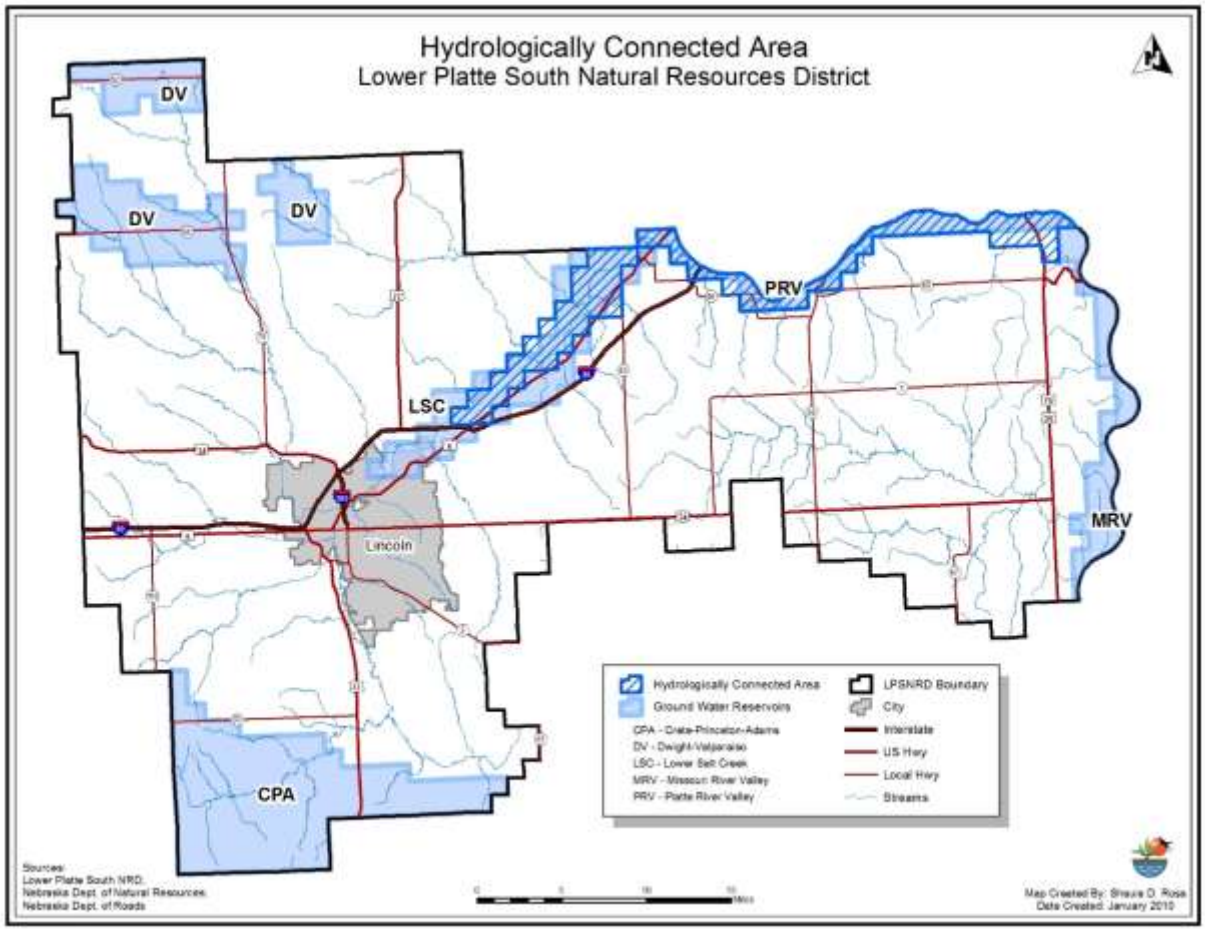
One of the tools used by LPSNRD as well as many other Districts in Nebraska to effectively manage ground water quantity concerns is the certification of irrigated acres. In an agricultural state like Nebraska, irrigation is a primary use of ground water. Therefore, accurate data as to the location and number of irrigated acres as well as the water applied to those acres is critical in making management decisions. In the Lower Platte South NRD, certification of irrigated acres is taking place in two phases, one involving what's known as the Hydrologically Connected Area (HCA), and the other involving the remainder of the District.

4.2.1.1 Hydrologically Connected Area

Applicable Regulations: Section Q

The Nebraska Department of Natural Resources (NDNR) has designated areas within Nebraska known as Hydrologically Connected Areas (HCAs). These are defined as areas where ground and surface water resources are directly connected and have relatively immediate and substantial impacts on one another. In LPSNRD, the HCA occupies all or parts of about 70 sections along both sides of Salt Creek between roughly Waverly and Ashland, and then along the south side of the Platte River from Ashland to Plattsmouth. Figure 43 shows the location of the HCA in LPSNRD. NDNR has been working on a ground water model for the Lower Platte River basin for the past several years, incorporating a variety of additional information to further evaluate the nature of the HCA in LPSNRD and other NRDs in eastern Nebraska. It is anticipated that NDNR will publish these model results and an associated map revision of the HCA in 2019, so the HCA in LPSNRD may be modified in the near future.

Figure 44 – Hydrologically Connected Area (HCA)



Legislation passed in 2009 (LB483) required the Lower Platte South NRD and other Districts in the Lower Platte River Basin to develop regulations limiting the expansion of irrigated acres within the designated HCAs. An important consideration in this process was identification of "historically ground water irrigated acres," those acres which were under irrigation from a ground water source before the requirements of this law took effect. As a result of this requirement, the District developed and passed rules and regulations for the certification of historically ground water irrigated acres and allowing for limited expansion of these acres on an annual basis for a five-year period through 2012. Those regulations were incorporated into the NRD's Ground Water Rules and Regulations in early 2013, and the requirements were extended indefinitely.

As a natural extension of the above activities, the District developed its voluntary Integrated Management Plan (IMP) in conjunction with NDNR. Following approval by both LPSNRD and NDNR, the IMP became effective on May 15, 2014. For more detail regarding the development of the IMP, see LPSNRD-NDNR, 2014.

As part of the effort toward a more comprehensive management strategy, LPSNRD joined six other NRDs and NDNR to form the Lower Platte River Basin Coalition

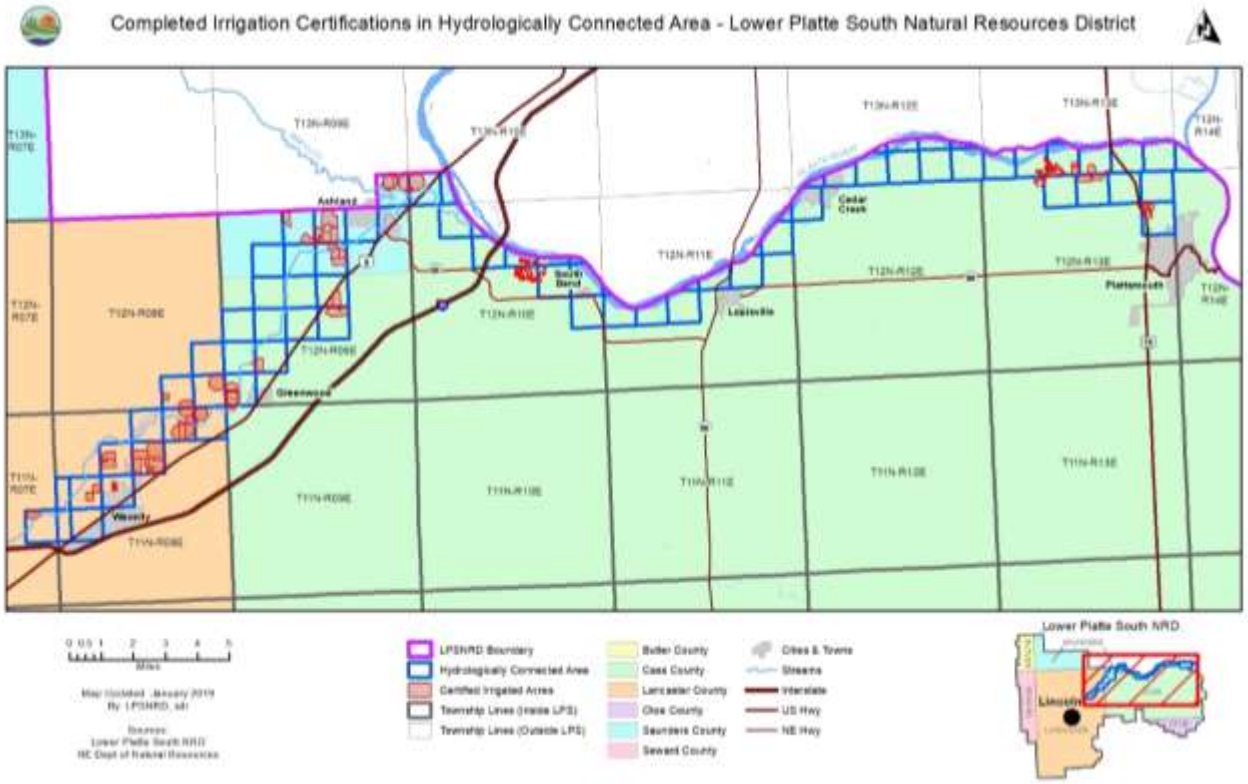
(LPRBC) to jointly develop a water management plan for the entire Lower Platte River basin. As of early 2018, all seven participating NRD Boards and NDNR had approved the Interlocal Agreement that continues the Coalition and adopts the first five-year plan. For more information on the LPRBC, refer to its website at https://lprbc.nebraska.gov/. In 2018, LPSNRD Board members, management, and staff attended several meetings of the Coalition and the technical committee.

The NRD's regulations for the Hydrologically Connected Area state that all acres historically irrigated with ground water would be certified no later than March 31, 2010. By the deadline, LPSNRD had received and verified 34 separate certifications from 27 landowners in the HCA for a total of 2,964.48 acres. Current statute also allows the NRD to approve a limited amount of new or expanded irrigated acres each year. Based on the above certification total, LPSNRD can allow a maximum of 592.9 new acres of irrigated land each year. The latest revisions to the District's Ground Water Rules and Regulations (Effective Date: January 1, 2017) removed the requirement that applications for those new acres must be received by October 1 of each year; in other words, applications for expanded acres in the HCA can be received on an ongoing basis. In 2018, the NRD did not receive any new requests to expand irrigated acres in the HCA. As of this writing, the total certified irrigated acres in to the HCA stands at 3,268.2. Figure 44 shows the locations of those acres.

A map of the certified historically ground water irrigated acres in the HCA is shown as Figure 44. The certification is summarized as follows:

Total # of Acres Certified in HCA:	3,268.2
Cass County:	931.29 acres (17 certifications from 12 separate entities)
Lancaster County:	1,351.59 acres (13 certifications from 11 separate entities)
Saunders County:	985.32 acres (10 certifications from 6 separate entities)

Figure 45 – Locations of Certified Irrigated Acres in the Hydrologically Connected Area

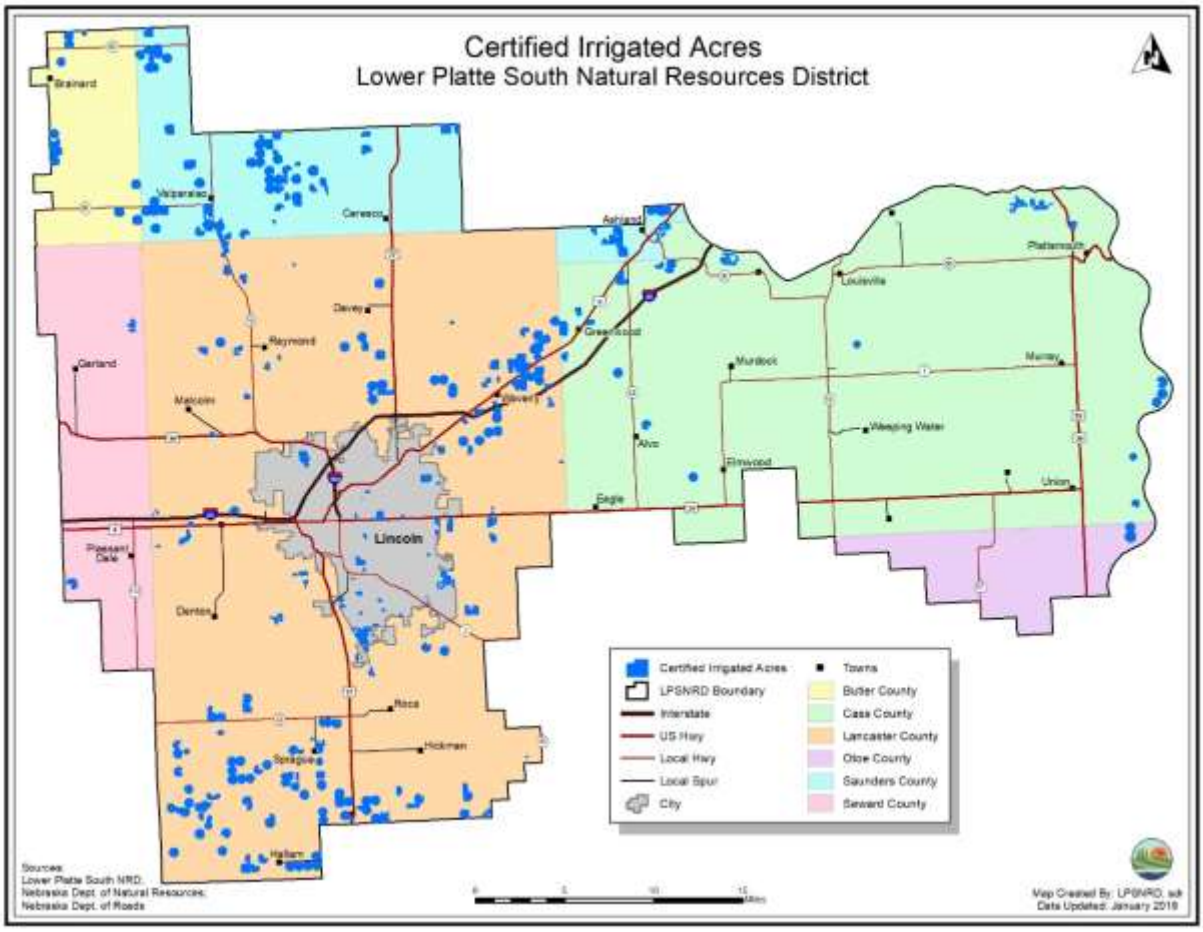


4.2.1.2 Remainder of District

Applicable Regulations: Section I, Rule 2

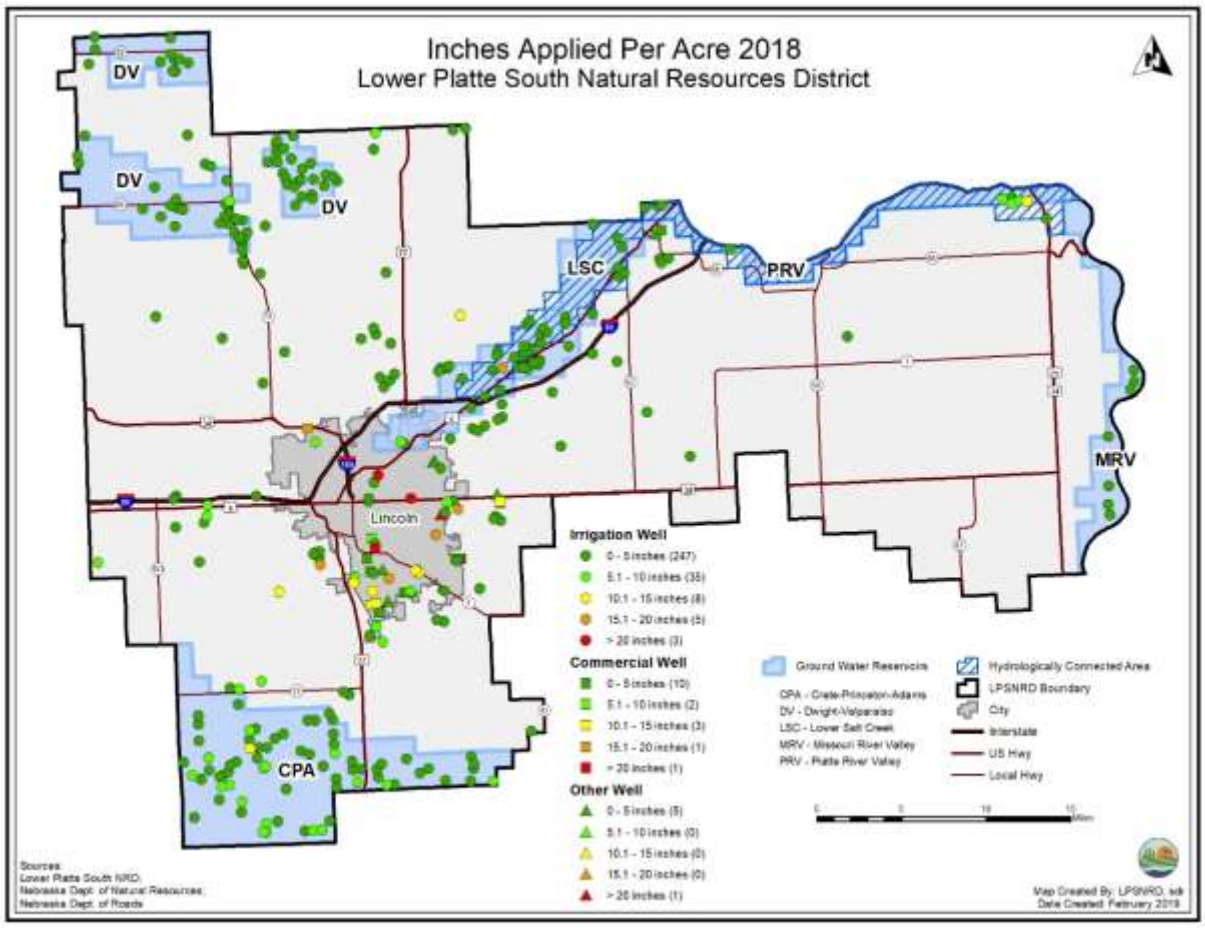
As part of its ongoing efforts at ground water quantity management, the District is also undertaking certification of irrigated acres in the remainder of the District outside the HCA. In late 2009, the District revised its rules and regulations to move the deadline for certification of irrigated acres in the remainder of the District from January 1, 2010 to January 30, 2011. On October 31, 2011, the District revised its rules and regulations again to now state that any lands irrigated with ground water shall first be certified by the District prior to those lands being irrigated with ground water. In 2018, the District received and approved four applications to certify an additional 434.23 acres, and so as of December 31, 2018, LPSNRD had certified a total of 24,225.13 acres in the non-HCA. Adding the 3,268.2 certified acres in the HCA to the 24,225.13 certified acres in the non-HCA brings the grand total to 27,492.33 ground water irrigated acres in LPSNRD as a whole. The location of those acres is shown in Figure 45.

Figure 46 – Location of Certified Irrigated Acres in the Lower Platte South NRD



In addition to gathering information about the irrigated acreage in LPSNRD, the Ground Water program also administers the water well meter program (see Section 8). Out of the readings received in 2016 and 2017, District staff was able to calculate overall usage and the amount of inches applied to a certain area. Figure 46 shows the amount of inches applied per acre in 2017 for 327 wells across the District. The wells are separated by use and the calculated usage amount, which varies from zero to greater than twenty inches.

Figure 47 – Irrigation Application Amounts



5. WATER WELL PERMITS

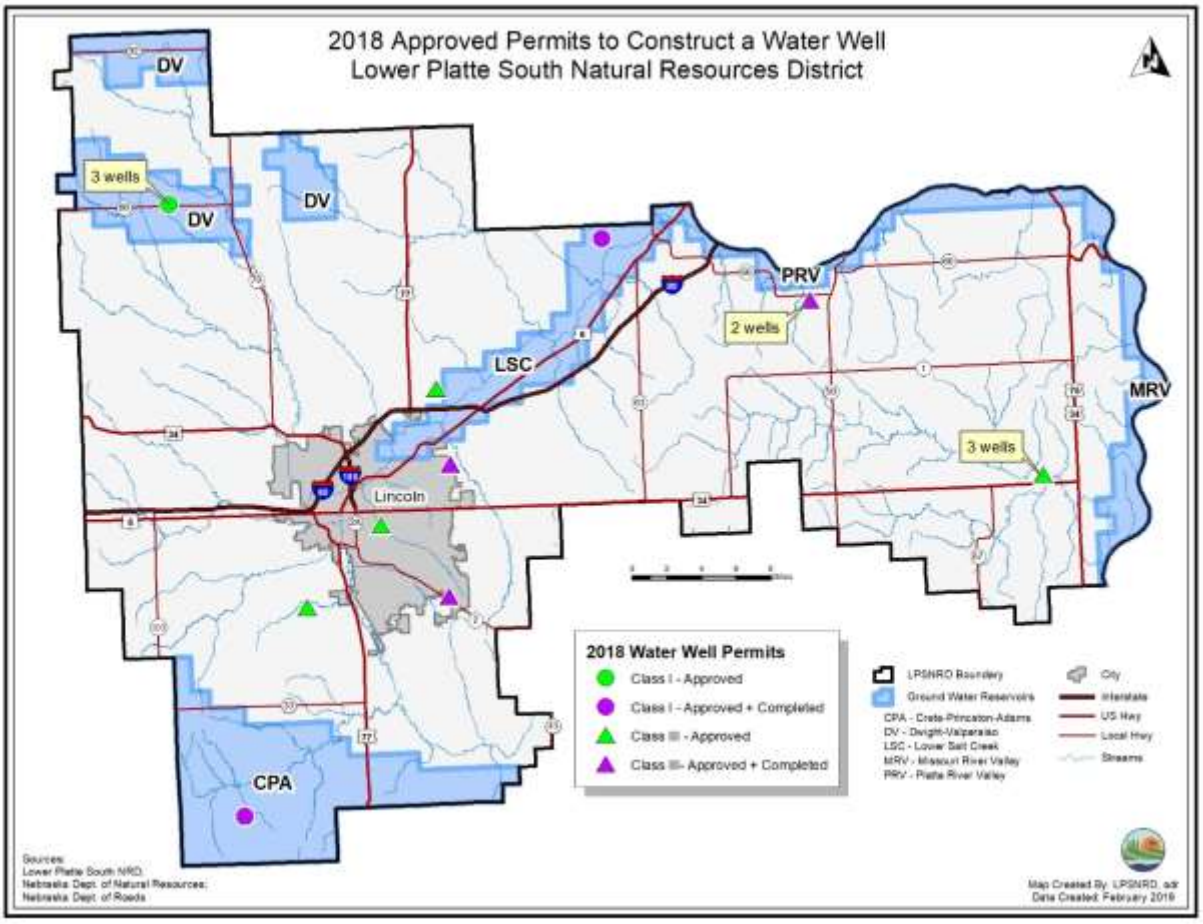
Applicable Regulations: Section B

An important responsibility given to NRDs is that of permitting new and replacement water wells within their jurisdiction. In the LPSNRD's 2008 revisions to the Ground Water Rules and Regulations, the District adopted additional requirements for the permitting of all wells which pump more than 50 gpm. These requirements vary based on the actual pumping rate and total amount of water pumped, as well as whether the proposed well is located within a Ground Water Reservoir or the Remaining Area (the District requires additional activities for non-domestic wells pumping more than 20 gpm in the RA). The regulations establish four classes of well permits (see LPSNRD Ground Water Rules and Regulations, Section C for more details): Class I is for wells in a GWR proposed to pump more than 50 but less than 1000 gpm; Class II is for wells in a GWR proposed to pump more than 1000 gpm; Class III involves wells in the RA designed to pump more than 20 but less than 250 gpm; and Class 4 IV is for wells in the RA designed to pump more than 250 gpm (again, domestic wells pumping less than 50 gpm are

exempt from NRD permit requirements). Since GWRs generally have greater supplies than the RA, the thresholds for various permit actions are higher than in the RA. Essentially, the new regulations are aimed at demonstrating that there is ground water of adequate quality and quantity in a given area before a specific well is permitted.

The District issued 11 water well permits during 2018 (Figure 47). Of these, three were for irrigation, three were for livestock, two were for domestic use, one was for commercial use, one was for geothermal use, and one was for other use (a landscape feature). Of the 11 permits issued in 2018, two have been completed. By well permit class, the District received three Class I permits and no Class II permits; these permits are for wells located within a Ground Water Reservoir. In addition, the NRD received eight Class III permits, and no Class IV permits; these permits are for wells located within the Remaining Area. All filing fees and required information were submitted for these applications. Four wells that were approved in 2017 were completed in 2018.

Figure 48 – Approved Permits to Construct a Water Well

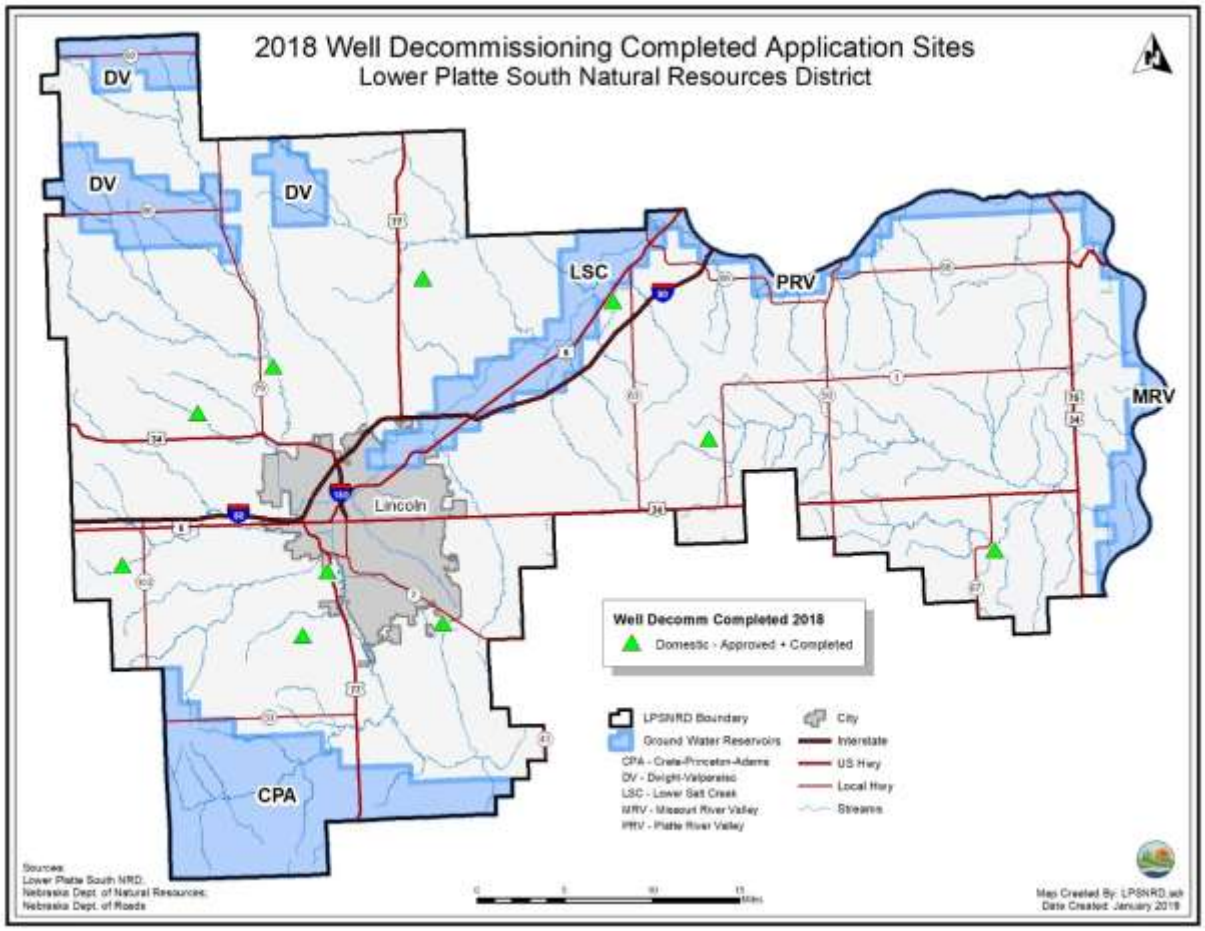


6. WATER WELL DECOMMISSIONING

If not properly sealed at the surface, water wells can be a physical safety hazard to people and animals, as well as conduits for surface runoff and pollution to make its way directly into ground water. Therefore, since the mid-1980s, Nebraska has had requirements not only for proper water well construction, but also the proper decommissioning or abandonment of unused wells to protect human health and ground water quality. The state's NRDs are charged with promotion of proper well decommissioning through cost-share programs, inspections, and information and education programs.

The LPSNRD Water Well Decommissioning Cost-Share Program decommissioned ten wells in 2018 (Figure 48). All of the wells decommissioned in 2018 were domestic wells. Since the LPSNRD's program inception in October 1990, as of December 31, 2018 **a total of 997 wells within the District have been decommissioned**.

Figure 49 – Well Decommissioning Application Sites

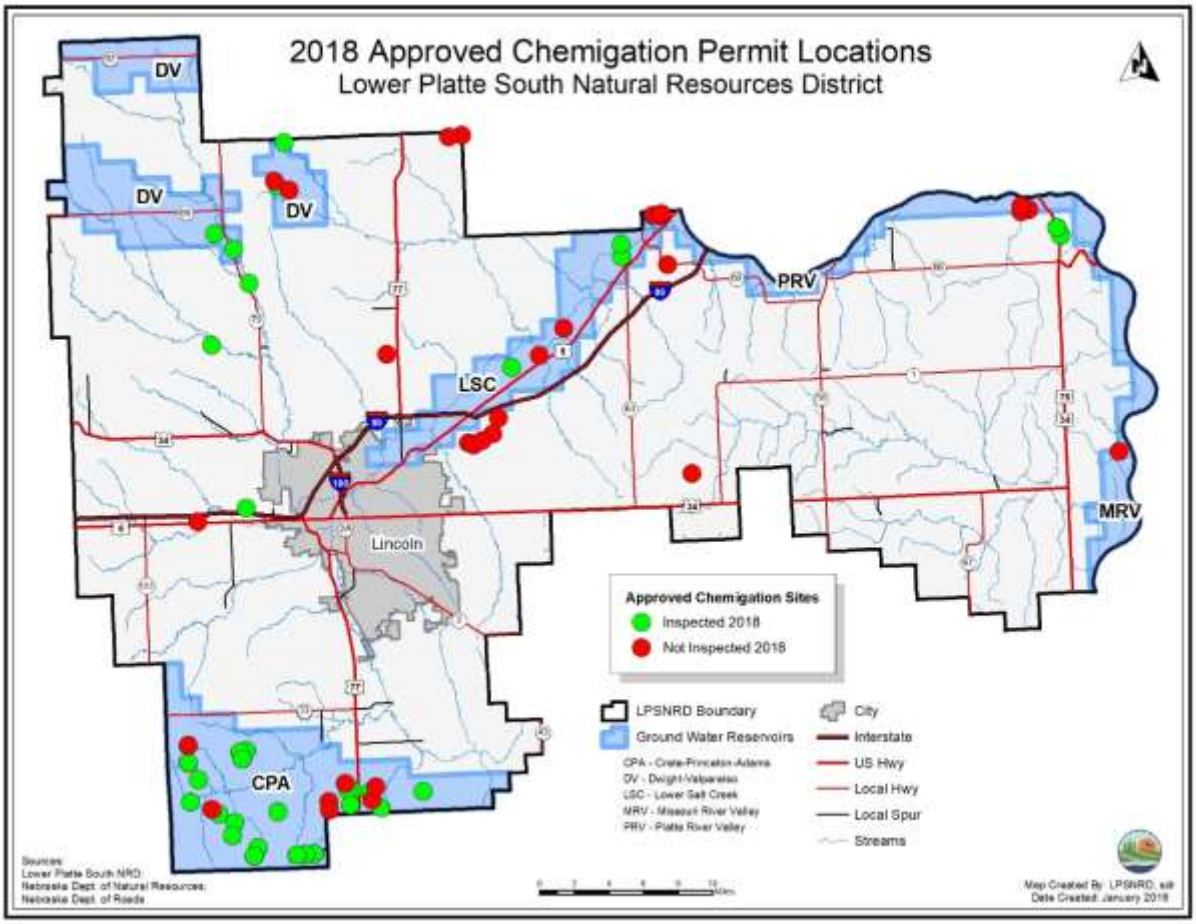


7. CHEMIGATION

Chemigation is generally defined as the application of chemicals such as liquid fertilizers, pesticides, fungicides, etc. through an irrigation distribution system. Properly done, chemigation is a safe, cost-effective, and efficient means of applying such materials. However, in order for this to be true, the irrigation system has to be fitted with appropriate safety equipment. Such equipment has been required by Nebraska law since the late 1980s, and NRDs, together with NDEQ, are charged with overseeing chemigation activities in the state. The Districts issue chemigation permits and inspect systems for proper installation and operation of the required safety equipment.

In 2018, LPSNRD continued its inspection and permitting duties pursuant to the Nebraska Chemigation Act. The District inspects systems on a three-year rotation or when modifications are made to an already permitted system. In 2018, the Lower Platte South NRD inspected 37 systems, and issued 51 renewal permits as well as 15 new permits for a total of 66 permits (Figure 49). Chemigation permits were issued for a total of 7,258 acres in 2018. A breakdown of permits and number of acres covered by ground water reservoir or area is presented in Table 5.

Figure 50 – Approved Chemigation Permit Locations



Ground Water Reservoir	# of Chemigation Permits	# of Acres
Crete-Princeton-Adams	28	3,301
Dwight-Valparaiso	6	1,667
Lower Salt Creek	5	593
Missouri River Valley	1	95
Platte River Valley	6	334
Remaining Area	20	1,268

Table 5 – Chemigation Permits and Acreage by Ground Water Reservoir or Area

District staff also performed permit compliance monitoring on systems by noting the locations of chemigation sites while in the field. The chemigation locations were recorded while performing such duties as ground water sampling and water level monitoring. The permit status for each location was verified upon returning to the office. No violations were found in 2018.

8. WATER METERS

Applicable Regulations: Section C

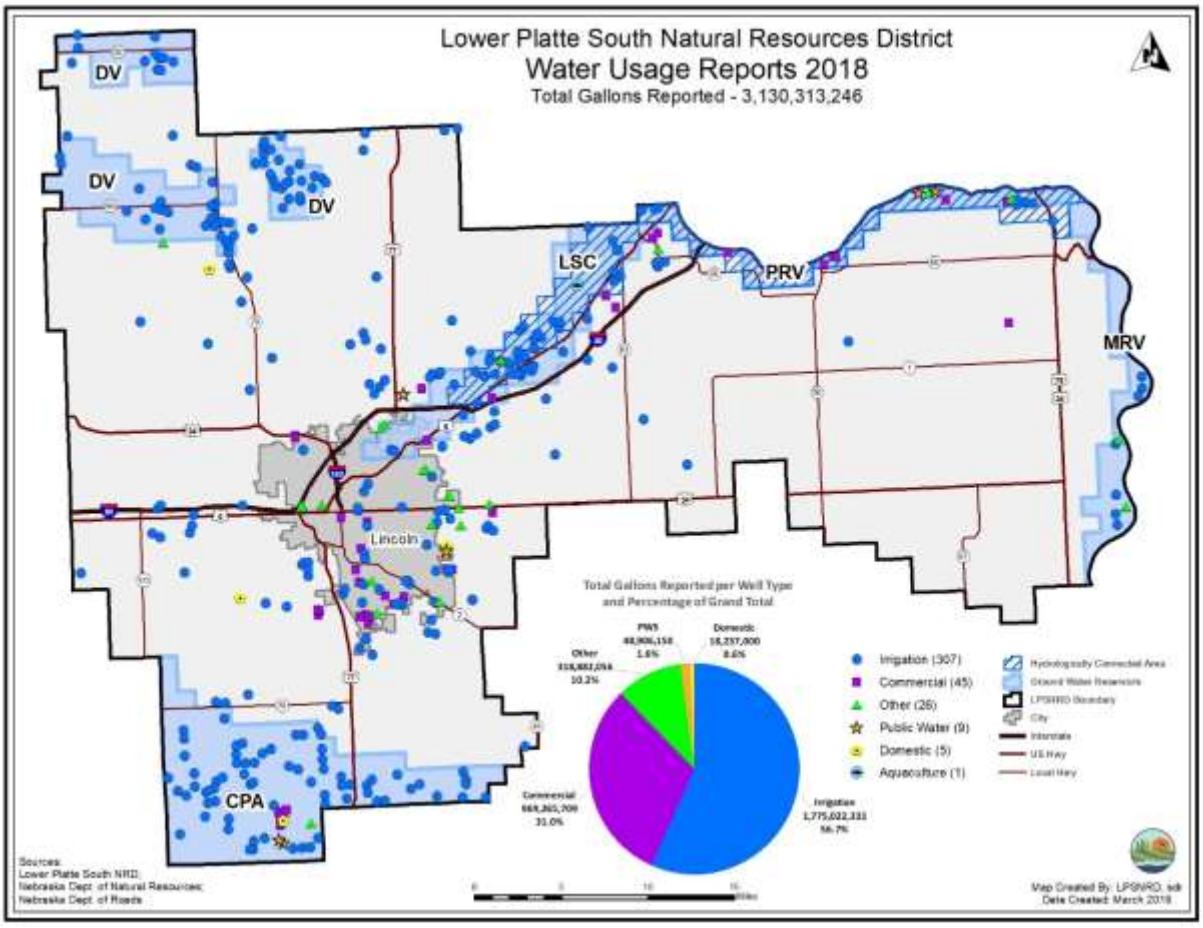
Water meters for accurately measuring the flow from a well are among the most important tools used to document and manage the use of ground water. In Nebraska, NRDs are given the authority to require the installation of water meters, and several Districts throughout Nebraska have implemented that requirement.

The LPSNRD Ground Water Rules and Regulations require that all new wells constructed to pump over 50 gallons per minute (gpm) be fitted with a water meter that can accurately measure the flow, and that the volume of water pumped from those wells be reported by the well owner/operator to the District annually. In addition, those regulations require that all wells capable of pumping more than 50 gpm be fitted with a water flow meter prior to use. There is no specific requirement of a given type of meter; LPSNRD only requires that the meter installed be accurate, and have the capability of showing the total volume of water pumped. In addition, owners of any wells that are retrofitted with water meters must also begin reporting total annual pumpage to LPSNRD.

2018 was the eighth year of the requirement that any well owner/operator who has a well equipped with a water flow meter provide annual water usage information to the District on the volume of water pumped. As of December 31, 2018, the District had received all but 20 water usage reports back (since that time, the District has received those reports). Out of the readings received this year and at the end of 2018, we were able to calculate overall gallons used in 2018 from the 412 metered wells across the District (Figure 48). These wells pumped a total of 3,430,039,926 gallons in 2018. (Figure 50). Of those 412 wells, 312 are irrigation wells and are responsible for 59.37% of that total, or 2,036,551,446 (approximately 74,989 acre-inches or 6,249 acre-feet; see Figure 46 for acre-inches pumped by individual irrigation wells.

The District has also implemented a cost-share program to promote adoption of this important management tool. The program provides 50% cost-share for the purchase of a water meter, to a maximum of $650. In 2018, no applications for this cost-share were received.

Figure 51 – Water Usage Reports

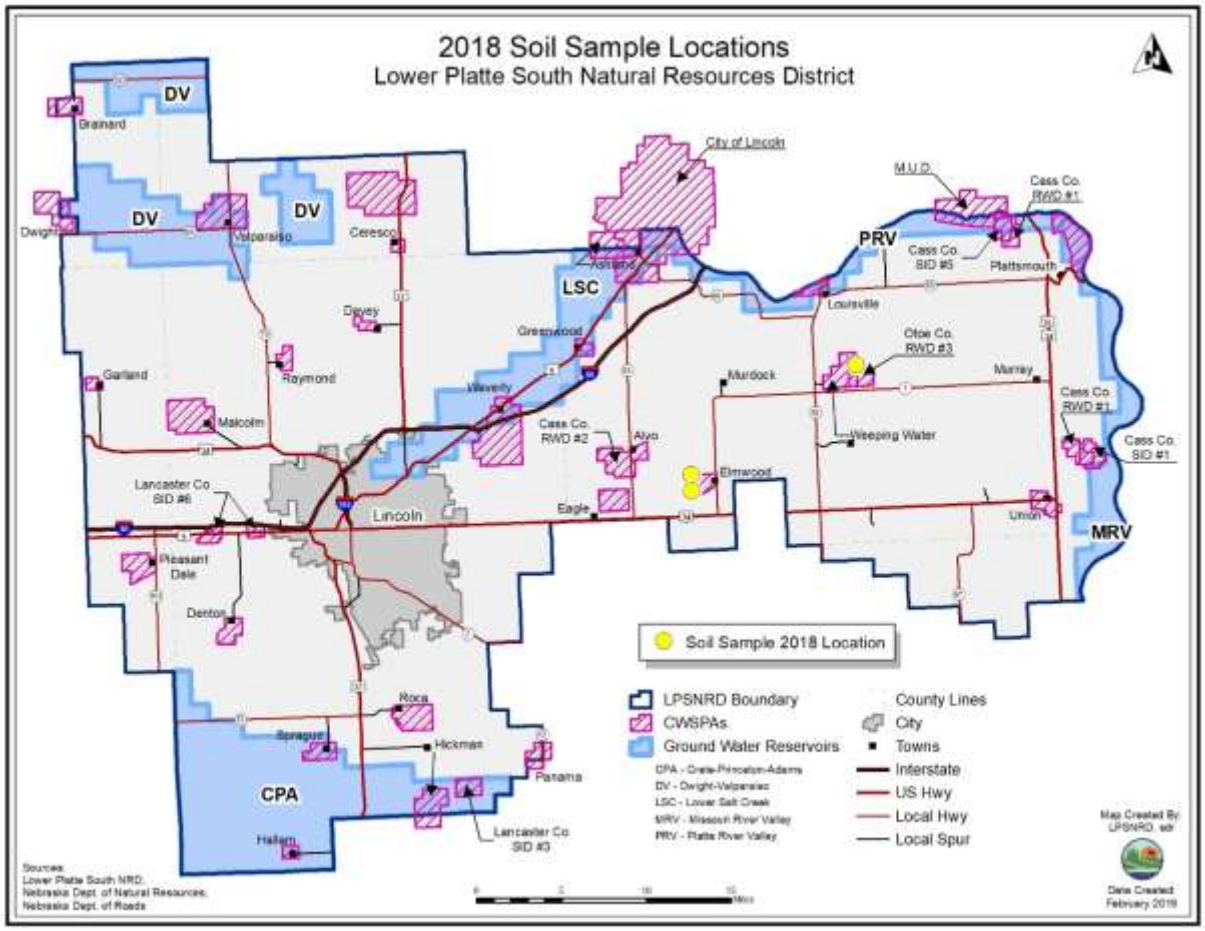


9. SOIL SAMPLING

Sampling soil content and analyzing for nutrients assists in determining the application rate of additional nutrients needed for a field while reducing the potential for water and soil pollution. LPSNRD cost-shares on the sampling of soil as a way to more accurately determine the amount of additional nitrogen needed for crops.

In 2018, the District received and approved three applications for the Soil Sampling Program (Figure 51).

Figure 52– Soil Sampling Cost–Share Locations

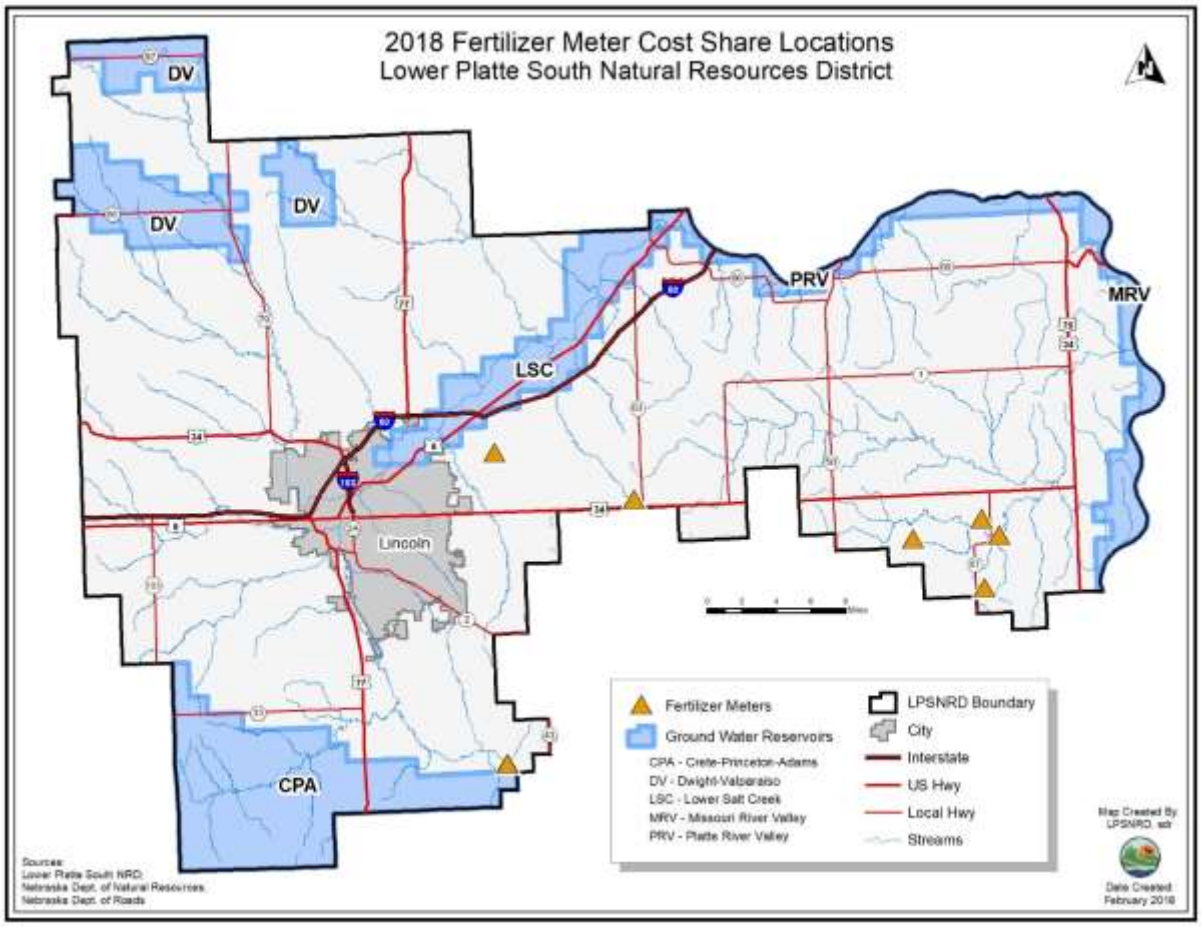


10. FERTILIZER METERS

Accurate application of nitrogen fertilizer to crop ground is an important part of protecting ground water from leaching of nitrates. If producers can accurately control the amount of fertilizer applied, it is less likely that excess nitrates will leach below the crop root zone and infiltrate to ground water. LPSNRD cost-shares on the purchase of these meters as a way of promoting proper nitrogen management.

In 2018 the District received and approved seven applications for the Fertilizer Flow Meter Cost-Share Program (Figure 52).

Figure 53 – Fertilizer Meter Cost–Share Locations

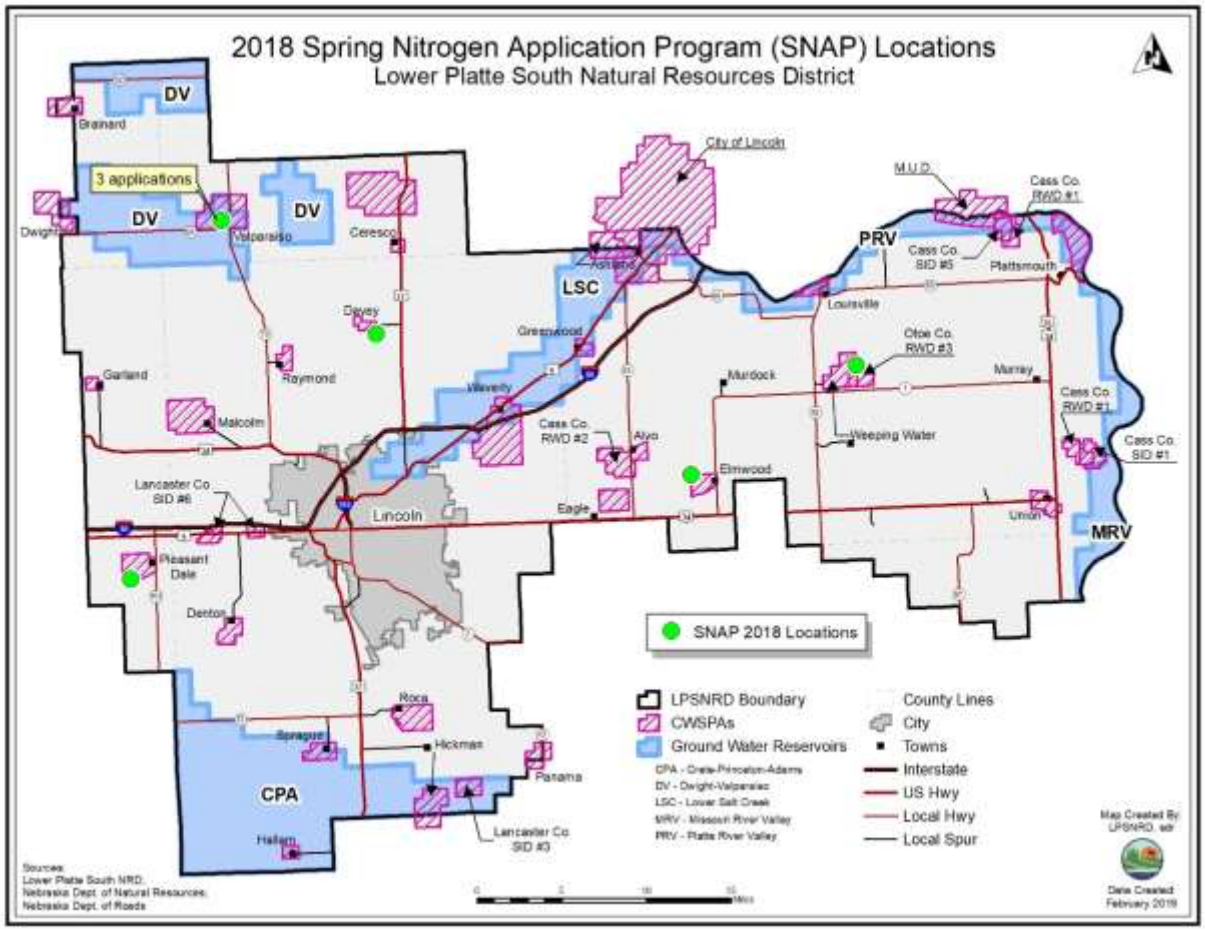


11. SPRING NITROGEN APPLICATION PROGRAM (SNAP)

Application of nitrogen fertilizer in the spring instead of the fall can reduce pollution of ground water through the accurate and uniform application of the fertilizer, as well as allowing less time for the fertilizer to leach into the ground water. The precise and uniform application of nutrients in the spring is a known best management practice. LPSNRD cost-shares on the application of spring (after March 1) versus fall fertilizer in all of the CWSPA areas throughout the District.

In 2018, the District received and approved seven applications for the Spring Nitrogen Application Program (SNAP; Figure 53).

Figure 54 – Spring Nitrogen Application Program (SNAP) Locations



12. IRRIGATION MANAGEMENT

Proper irrigation management goes hand-in-hand with fertilizer management to prevent the leaching of nitrate to ground water. If only the amount of water used by the crop is applied, less deep infiltration is available to carry excess nitrate to ground water. The District cost-shares on a variety of best management practices associated with irrigation water management. In 2018, LPSNRD did not approve any cost-share applications for these practices.

13. SALT WATER INTRUSION

Applicable Regulations: Section H

In some parts of LPSNRD, the intrusion of salt water into fresh ground water is a concern. This is especially so in areas where the Dakota Formation bedrock is fairly close to the surface, as some units within the Dakota contain saline water. Excess pumping of shallow, fresh ground water can induce intrusion of saline water from deeper geologic units, and therefore the District continues to monitor for indicators of salt water

intrusion, as well as work with well owners to address such concerns. In 2017, the District had no inquiries or reports of salt water intrusion. However, the District is cooperating with the Saline Wetlands Conservation Partnership to install two wells producing saline water for restoration of wetlands at the Marsh Wren Saline Wetlands north of Lincoln, and in 2018continued applying salt water to various portions of the wetlands complex to initiate restoration.

14. IMPROPER IRRIGATION RUNOFF

Applicable Regulations: Section M

Nebraska's NRDs are granted authority to deal with the improper runoff of ground water applied as irrigation water. Such runoff is a waste of ground water, can contribute to both ground and surface water quality problems, and can cause a variety of erosion problems. As noted below, in 2018 the District continued to work with parties involved in one 2009 complaint.

15. TRANSFER OF GROUND WATER

Applicable Regulations: Section N

The District has the responsibility of reviewing and approving or denying applications to transfer ground water from one area to another. In 2018, no requests were received for such a transfer.

16. VARIANCES

Applicable Regulations: Section P

LPSNRD also has provisions in its regulations for granting variances from those regulations upon petition if a landowner, well owner, or other individual can demonstrate such a need. In 2018, the District received no requests for variance.

17. COMPLAINTS/ENFORCEMENT/INVESTIGATIONS

Applicable Regulations: Sections D, J, K, L, M, N, O

As described above, 2018 was the eighth year that the District required any well owner and/or operator who has a well equipped with a water flow meter to annually provide water usage information on the volume of water pumped to the District. LPSNRD staff requested usage information from all metered wells and will continue to work with owners of irrigation, commercial, and other wells so that they are in compliance with the water well flow meter rules and regulations.

Also, in 2018, District staff inspected 119 wells for required water flow meters. The inspection included taking photos of the meter, GPS locations, verifying the serial number on the meters, checking for proper installation, and verifying the water meter

readings and units. The inspector would attempt these activities while the well was running, so it could be verified that the meter was working properly. All wells checked during these inspections had a meter installed properly and no violations were found at the time of the inspection. Wells that were listed as inactive irrigation wells were also checked to make sure they were not being used. Staff will continue inspecting at least 25% of the metered wells each year, so that all wells will be inspected at least every four years.

Beginning in 2014, the District revised the Ground Water Rules and Regulations to add the Dwight-Valparaiso-Brainard (DVB) Special Management Area. With this addition, one of the new rules for this area was that there shall be no new ground water irrigated acres from any water well location in the special management area beyond those acres certified by the District on March 1, 2014. The District also established an initial 3-year allocation of 21 acre-inches per irrigated acre not to exceed nine acre-inch annual maximum for sprinkler irrigation and thirty acre-inches per irrigated acre not to exceed a twelve acre-inch maximum for gravity irrigation, beginning in calendar year 2014. . 2016 was the final year of the three year allocation. As of January 1, 2017, the District removed the allocation for the portion of the Special Management Area located in Township 13 N, Range 6 E, Saunders County due to reduced concern over in-season water level declines. However, the Board of Directors voted to apply the same initial allocation in the rest of the Special Management Area for the next three years (2017-2019). 2018 was the second year of this allocation.

From time to time, the District receives a variety of complaints or inquiries regarding various water resources concerns. These issues are investigated on a case-by-case basis, and the District will then determine if any violations of its rules and regulations have occurred. An ongoing issue has involved an irrigation complaint filed in September of 2009 due to ground water irrigation runoff from a property located in Saunders County. The party involved worked with NRCS to prepare a plan to control irrigation runoff, which was approved in early 2010 and the party implemented the plan. Since that time, the downstream neighbor has reported that irrigation runoff has occurred again in years following the initial investigation and has showed staff and the Board of Directors video evidence of irrigation runoff. Each year, the operator submitted their irrigation management plan and it was determined that they were following their irrigation management plan. In early 2015, the operator informed the LPSNRD that they are working with NRCS to design a water control structure to control any runoff from leaving their property. A hearing was held in April 2015 to enter into an Order to Cease and Desist for Irrigation Runoff Complaint #002 with regard to violator. In early 2016, a water/sediment control basin was constructed to control irrigation runoff. On July 25, 2018, the LPSNRD received a call that ground water runoff was occurring below the water/sediment control basin. The compliance specialist conducted an inspection and took photos above and below the basin. On July 31, 2018, the compliance specialist received another call stating that irrigation runoff was occurring. The compliance specialist conducted an inspection and took photos above and below the basin. Staff reviewed all available information and presented it to the Water Resources Subcommittee along with the inspection reports. The Water Resources Subcommittee recommended the

Board of Directors determine there was no irrigation runoff and no violation of the NRD's April 22, 2015 Cease and Desist Order against Benes Service Company, Inc. The Board of Directors approved the motion and both parties were notified of the action.

18. INFORMATION/EDUCATION

One of the most important activities that the LPSNRD undertakes is education of its citizens about ground water quality and quantity issues. The District is involved in a wide variety of such activities. Highlights of the District's 2018 activities are described below.

18.1 Programs for Students and Teachers

- Ground water related classroom presentations were given at area schools to 2,500 elementary, junior, and senior high school students. The students utilized hands-on models, kits, and activities such as the District's ground water flow model, Hach nitrate test kit, Incredible Water Journey, Sum of the Parts, and H2O Olympics.
- The District led 50 field trips with elementary, junior, and senior high school biology students focusing on different water quality parameters and the influence of land practices on surface and ground water.
- The District participated in two different summer camps with other agencies/NRDs focusing on water quality, including the Nebraska Association of Resources Districts' ACE Camp in Halsey.
- The LPSNRD sponsored the Earth Wellness Festival, which was attended by 3,600 fifth graders from Lancaster County. The District also participated in Spring Conservation Sensation, Waterworks, and other ground water festivals.
- Ground water material and information was made available from the Resource Lending Library and was emphasized in the Resources Corner newsletter to teachers throughout the District.
- Social Media-the NRD reported through NRD Facebook the following updates on the NRD ground water programs: ground water spring and fall levels; number of wells sampled annually; ground water meters; Test Your Well Night information.
- In 2018, the NRD hosted 2 Test Your Well Nights in partnership with local FFA chapters for the following areas: Raymond / Valparaiso and Waverly. These nights invite landowners with private wells to bring in water samples to be tested for nitrates. FFA students ran the nitrate tests using Hach equipment. If there were any samples at 6 ppm (parts per million) or greater, the NRD kept the sample and sent it to Midwest Labs for an additional nitrate test. In Raymond / Valparaiso, 82 water samples were tested for nitrates (8 were sent to Midwest Labs), and for the Waverly event there were 25 samples tested (with 12 being sent on to Midwest Labs). For samples that were sent onto Midwest Labs, NRD staff followed up with a mailing to the landowners sharing those additional results.

18.2 Public Information

- LPSNRD launched a new website in August 2018, featuring accordion-like menus, which allow access to a lot of information at one time for ground water elements of the website. Other overall improvements include better security and compatibility with a variety of devices. The ground water staff worked closely with IT and I&E staff to re-organize ground water information during development of the new site. The result is that much of the information from the former site is included on the new one, but is better organized and more easily accessible. The ground water staff continues to provide input for improvements.
- The new website gives landowners new tools for electronically submitting well flow meter reports and it allows interactivity with constituents on information concerning certified acres, chemigation, water quality and water levels.
- LPSNRD continued implementation of its voluntary Integrated Management Plan (IMP) in 2018. The 2017 annual report summarizing IMP progress was posted on the websites of both the NRD and NDNR.
- A webpage dedicated exclusively to the IMP, with links offered to the entire plan, the Water Balance and Stakeholder Perspectives studies that preceded the plan, and the Annual Report, was maintained throughout 2018 on both the former and revised websites. The IMP webpage is accessible through the new website's Programs menu and the IMP and IMP Annual Report are also accessible through the Publications menu.
- For several weeks during the summer, parts of Lancaster, Seward, Saunders and Butler counties were sites of electromagnetic surveys by a low-flying helicopter to collect geological information. A news release was distributed to District media and updates were posted on the website and on social media. Information was also published, prior to the flights, in the District's newsletter.
- The District began planning for its voluntary Water Quality Management Plan (WQMP) in 2017, and by the end of 2018 the plan was in the final stages of development. Public Open Houses were held in March, April and August and news releases on all three were distributed to District media and posted on the website and on social media. The WQMP was also featured in the District's Fall 2018 newsletter.
- While no television ads were aired by LPSNRD on any topic in 2018, the District is producing new television ads promoting water conservation, environmental education and flood management. The new ads will begin airing in 2019.
- Ground water quality and quantity radio spots are aired year-round on Lincoln radio stations owned by NRG Media and Alpha Media.
- The District's "Look Out Below" logo remained on a Cass County Rural Water District #2 water tower near Eagle.
- The District continued advertising on several baseball park placards throughout the District to remind citizens about the importance of ground water protection. After many years, promotional signs at ballparks in Hickman, Valparaiso and Weeping Water were updated in 2017 with the District's newest logo.
- Articles and advertising on various other ground water programs and activities appeared in District media, as well as in the NRD newsletter and website. Themes and hands-on activities relating to ground water and its importance were prominent in

various District activities, including Earth Wellness Festival, middle school nature nights, Earth Day booth. Husker Harvest Days, and others.

- Ground water programs and water quality best management practices (BMPs) are featured in brochures being produced and printed in-house on an as-needed basis. Brochures are also updated as needed. In 2018 there was a total update of the District's basic brochure template, giving all District brochures, including ground water-related brochures, a fresh look.
- The District distributed many water education aids featuring the "Look Out Below" and "Wellhead Willy" logos, including: magnets, t-shirts, golf balls, and informational brochures.

19. EASTERN NEBRASKA WATER RESOURCES ASSESSMENT (ENWRA)

The Eastern Nebraska Water Resources Assessment (ENWRA) was formed in 2006 by a joint agreement between the six NRDs which cover the easternmost portion of Nebraska. The Lewis and Clark, Lower Elkhorn, Lower Platte North, Lower Platte South, Nemaha, and Papio-Missouri River NRDs formed a coalition aimed at developing a three-dimensional geologic framework and water budget for all of eastern Nebraska (Divine *et al.*, 2009). In the years since its inception, ENWRA has hired a project coordinator, and has completed a variety of projects and investigations aimed at gaining a better understanding of the complex water system in the glaciated portion of eastern Nebraska. An excellent description of these activities is presented in Divine *et al*., 2009. Additional updated information can be found on the website, www.enwra.org.

The ENWRA Coordinator has 60% duties as the coordinator and 40% duties as a UNL-CSD survey hydrogeologist to help NRDs and other entities with ground water quantity and quality related issues in eastern Nebraska. A Long Range Plan (LRP) document was adopted for ENWRA in 2009 which outlines the background, goals and objectives, and organizational structure of ENWRA. Updates to the LRP (including lists of priority mapping areas specific to each ENWRA NRD) are conducted biennially with input from ENWRA technical advisory agencies and the project partners. Between 2007 and 2018, ENWRA NRDs conducted almost 16,000 miles of airborne electromagnetic (AEM) flights across the ENWRA area resulting in significant regional and local scale assessment coverage. Much of the AEM was co-funded with the Nebraska Department of Natural Resources (NDNR) and/or reimbursed with state Water Sustainability Fund (WSF) Dollars. Over 4,300 miles of the ENWRA AEM flight total has been conducted for the LPSNRD to date. The *Nebraska GeoCloud and AEM Data Integration Project* (GeoCloud), a WSF funded ENWRA project currently in Year 3 of 4 (completion scheduled for June 30, 2020), will house all the AEM data collected in Nebraska statewide in a cloud-based platform. Just over half of the GeoCloud project budget is spent ($412,396 total project budget not including $50,500 in USGS Coop funds). ENWRA pays 45% of the local match and the 10 NRD interlocal (which includes ENWRA NRDs) pays 55% of the local match for the project. WSF pays 60% with ~$132,000 reimbursed so far out of the $247,437.60 award. More information on the AEM related projects can be found in Section 19 below.

Additional 2018 ENWRA activities included: several ENWRA meetings, public presentations; updates to the ENWRA website (including new AEM data postings); coordinating public inquiries for AEM flight data; coordinating and logging test holes advanced along flight lines; administering agreements and grants; collecting, analyzing and compiling annual water levels and water quality samples; and maintaining pilot site installations, instrumentation and data.

20. RESEARCH

In addition to the research activities undertaken by the ENWRA project, the District engages in a variety of other research related actions. As already mentioned in Section 4.1.2, LPSNRD has begun a program to collect data on the occurrence of nitrate in the vadose zone at several CWSPA locations throughout the District. Over the next several years, LPSNRD expects to include locations which represent a wide variety of land use, soil, and hydrogeologic settings to help determine loading amounts and general rates of movement, which will help to guide future nitrogen management activities. In 2016, District staff began discussion of a project with UNL-WSL to develop SOPs for vadose zone sample collection which will be able to be utilized by all 23 NRDs in Nebraska. As already described, this project will include everything from basic sample collection and analysis to high-grade, research techniques. The cooperative agreement for this project was signed in early 2017, and vadose zone sampling at several sites was initiated in the fall of 2017. These are sites for which LPSNRD has historical data, and this ongoing sampling will allow for at least qualitative analysis of infiltration rates and movement of contaminants through the vadose zone. In addition, UNL-WSL is evaluating a variety of analytical techniques involving additional parameters (e.g. ammonia, arsenic, etc.) as well as advanced isotopic and age-dating techniques which will provide additional information on contaminant movement rates. The final report for this project is anticipated in 2019.

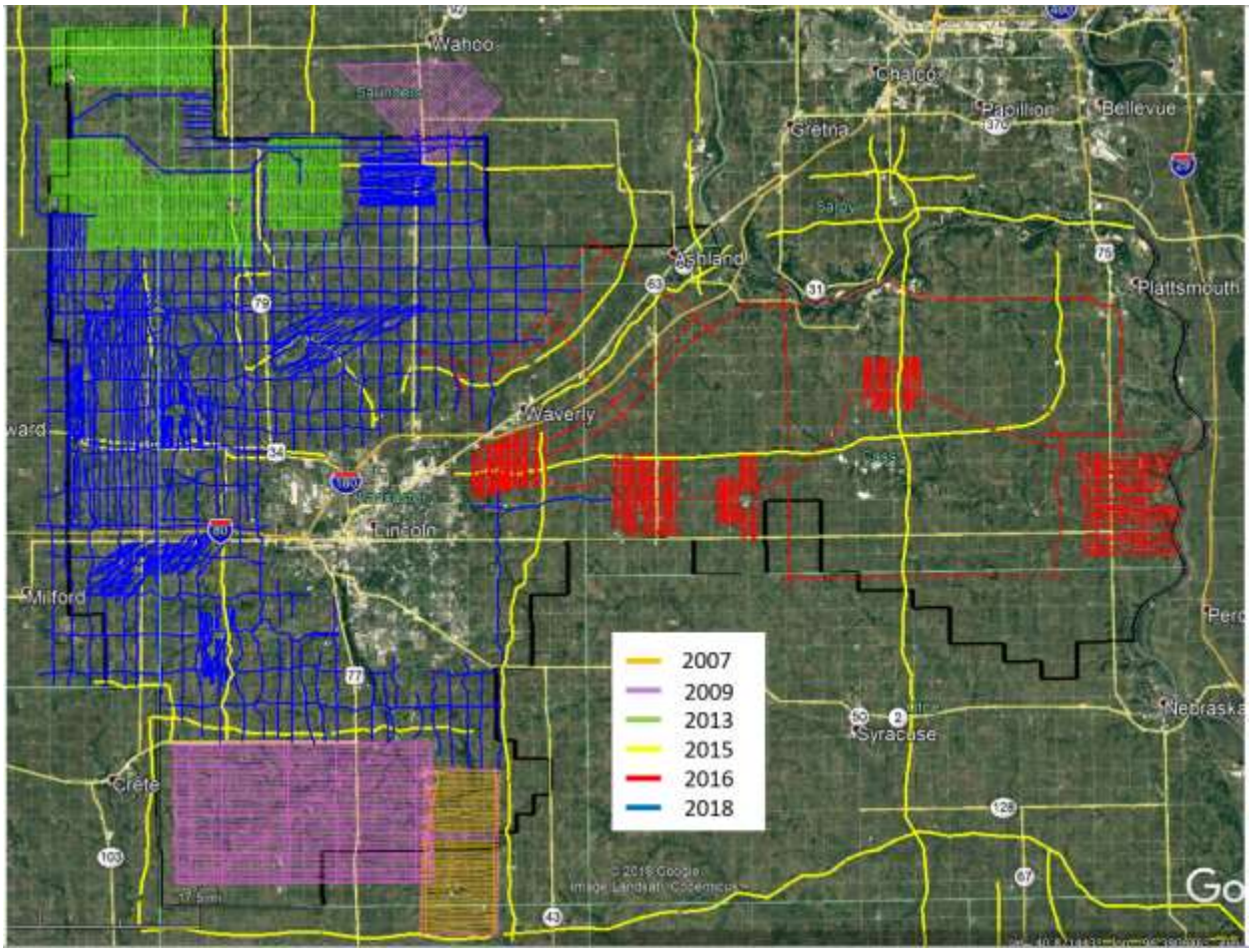
Regarding 2018 AEM developments, the AEM reports and associated data sets for the LPSNRD 2016 AEM flights were received at the end of calendar year 2017, and were presented to the LPSNRD in April 2018. The GeoCloud project is well underway and is being designed to promote the sharing and usage of the AEM data between partners as showcased in a two-day workshop in August 2018 (another workshop is planned for 2019). The conservation and Survey Division, School of Natural Resources, University of Nebraska-Lincoln (UNL-CSD) and U.S. Geological Survey (USGS) will generate hydrogeologic products for two eastern Nebraska pilot areas and provide guidance on future AEM planning relative to groundwater quality and quantity management.

As mentioned above, in 2018 LPSNRD continued its acquisition and analysis of AEM data in conjunction with ENWRA bringing the total miles of collected lines to over 4,300 for LPSNRD since 2007 (see Figure 55—lines collected in 2018 are in blue). In late 2017, LPSNRD (as part of a larger $3,280,000 ENWRA project application) applied for $510,000 of funding from the Water Sustainability Fund (WSF). The LPSNRD, on behalf of ENWRA, retained a private contractor Aqua-GeoFrameworks, LLC (the same

core team members providing AEM work in Nebraska since 2007) to gather additional AEM data focused on the western portion of the NRD. The LPSNRD collected over 1,900 miles in the summer of 2018 in a grid style (one to two mile spacing) to cover the west portions of LPSNRD and then flew closer-spaced blocks in the CWSPAs located in those parts of LPSNRD. With this 2018 focus on the western part of LPSNRD in conjunction with the previous 2016 AEM focus on the eastern CWSPAs and 2007 to 2015 groundwater reservoir focused surveys, the LPSNRD is hoping to provide more detailed information for the public water suppliers and residents Districtwide. The recent flights took place in June 2018 and the draft image files for each flight line were provided by AGF to LPSNRD in July 2018. The chapter report deliverable including: report text, interpreted profiles, 2D maps, and 3D images in pdf format and Google Earth and other digital datasets, will be provided in November 2019. A presentation of the deliverable from AGF to LPSNRD is anticipated for late 2019 to early 2020. The AEM flight lines as collected in 2018 and previous years are shown in Figure 55 and, as mentioned, the final report for the project is scheduled for late 2019.

It's important to note that, once this project is finished, LPSNRD will have completed the large-scale collection of AEM data within its jurisdiction. It is possible that additional airborne or other geophysical data collection will be undertaken in the future, but it is anticipated this would be on a more local and focused scale than what has been accomplished to date.

Figure 55 –AEM Flight Lines in LPSNRD Completed Since 2007



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