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July 17, 2014

Appendix to the Lewis and Clark Groundwater Management Rules and Regulations addressing groundwater quality and quantity.

Abstract:

The Lewis and Clark NRD is adding an appendix to its existing Groundwater Management Rules and Regulations to address Groundwater "quality" and "quantity" issues. .

Quality

The NRD has additional reference data relating to groundwater "quality" issues. Annual nitrate sampling has shown two primary areas of concern, east of Hartington, referred to as "East Hwy 84," and west of Bloomfield, referred to as "Dolphin Township". Increased monitoring and education efforts will be implemented in those areas. If necessary, Phase II Rules and Regulations will be implemented to address the issue. The areas of concern are identified on Figure 1. which represents nitrate concentrations in irrigation wells sampled across the District. Table 1. reflects recent nitrate sampling results in the areas identified.

Focus on groundwater nitrate contamination in the Bazile Creek area of Knox, Antelope, and Pierce Counties has led to a coordinated effort with the other NRDs in the area (Upper Elkhorn NRD, Lower Elkhorn NRD, and Lower Niobrara NRD) to educate residents and improve fertilizer and groundwater management. The NRDs have worked with DEQ to develop the Bazile Groundwater Management Plan (BGMP). Excerpts of the plan which define the area, review the groundwater quality concerns, and list the goals, objectives, and action tasks of the plan are included as Attachment A. A technical report by UNL Water Center on Evaluation and Assessment of Agrichemical Contaminants in the Creighton Area (7/2000) provides additional insight to the source of contamination in the region, and indicates contamination is most likely due to non-point source agronomic sources. To review the conclusion section of this report, see Attachment B.

Groundwater Management Area Rules and Regulations will be revised to allow the NRD to manage groundwater quality needs of the identified areas of Dolphin Township and East Hwy 84, and other areas if necessary. Revision of the rules and regulations is also necessary to implement the action tasks of the BGMP.

Quantity

Groundwater quantity has held relatively stable across the District through the years, until the spring of 2013 when the largest, single year decline was observed in many of the wells measured compared to the spring of 2012. Groundwater level changes from 2012 to 2013 are represented in Figure 2. The NRD also received several reports of groundwater use conflicts during the summer of 2012, the approximate location of those instances are shown on Figure 3. Drought and/or in season pumping could further impact those conflicts.

Outside factors, including economic considerations, farm programs, and conservation plan compliance, have a bearing on groundwater usage. During the last 5 years, groundwater development for irrigation has increased dramatically in the LCNRD. Groundwater quantity has been generally stable as monitored by static water level readings however recent drought and irrigation development has prompted the LCNRD to draft rules and regulations to better manage groundwater resources.

The drafted rules and regulations include identified sub-areas within the NRD to determine and isolate problems with aquifers, an expanded well permit procedure that includes the entire District (Figure 4.), "triggers" for elevated response methods to deal with water quantity issues, and associated action tools for management. Those features will provide for certification of irrigated acres and expansion of those acres, flow meter requirements, variance or transfer requests to deal with exceptions and enforcement methods to insure compliance.

The subareas defined by the District are based on the first aquifer encountered and/or the expected potential to access a high yielding groundwater source. The subareas defined as "Limited Potential" are based on well logs of wells completed in the District and do not indicate the absence of high yielding wells, it indicates the potential to locate a high yielding well in the area is less likely than in the "Remaining Area". Subareas are outlined in Figure 4.

The LCNRD has initiated development of a Voluntary Integrated Management Plan (IMP) for water resources with DNR. Work on the IMP will begin in 2014. It is the intent of the District to utilize the IMP as the guiding document for ground and surface water planning.

With these thoughts in mind the LCNRD hereby adopts the attached rules and regulations addressing Groundwater Quantity.

Table 1. Areas of groundwater quality concern.

EAST HWY 84 - Cedar County

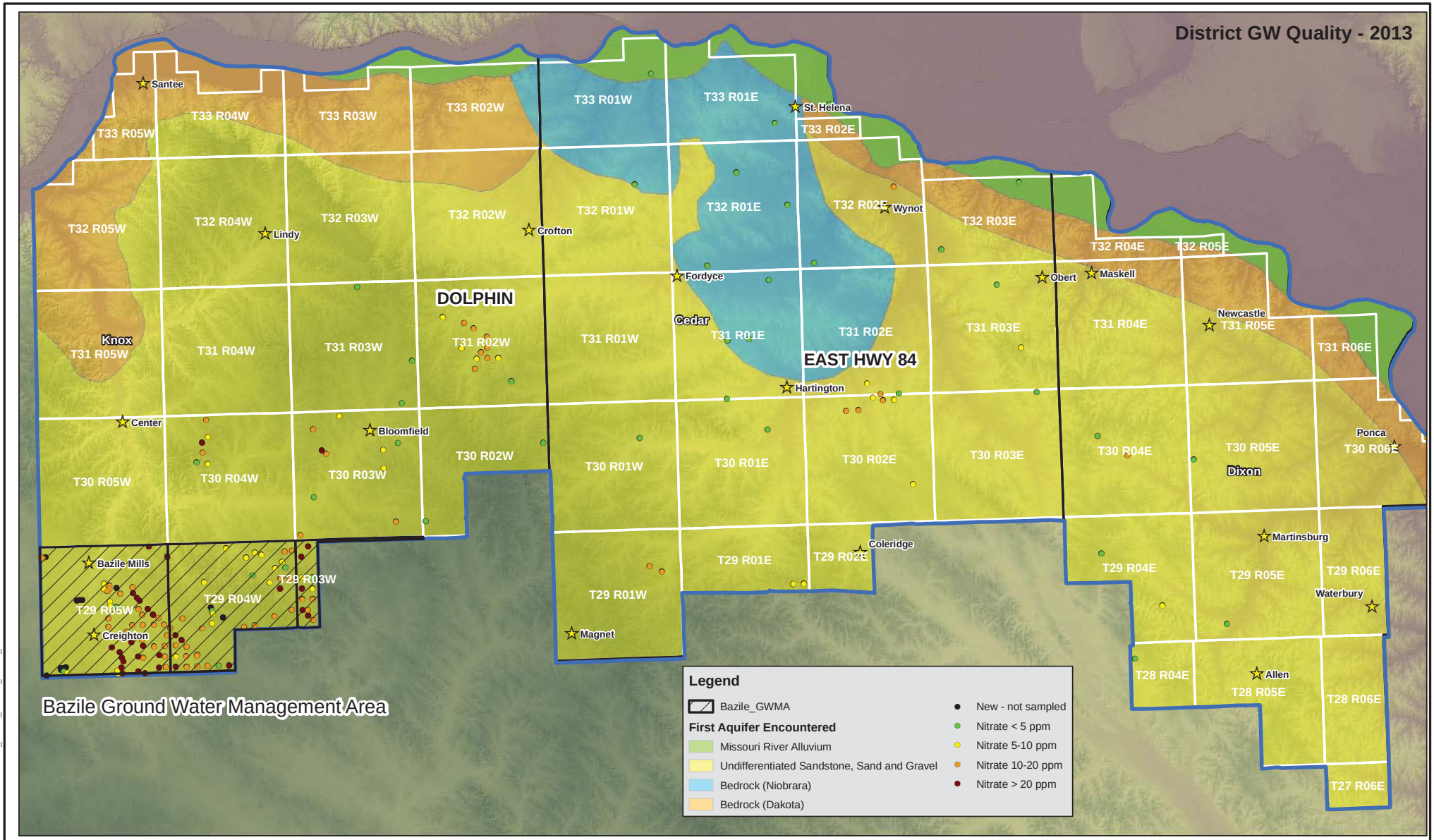
T30N & T31N, R2E — November 18, 2013

1/4,1/4	Sec	TWP	RNG	Register #	NRD #	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
NW	3	30	2E	G-057535	C3	8.0	10.2	10.2	11.5	12.3	11.2	12.0	11.8	10.9	11.6	9.5
NE	3	30	2E	G-062440	C4	12.8	14.2	13.2	14.1	15.3	14.4	12.8	12.8	12.2	13.7	13.8
NWNW	2	30	2E	G-089386	C5	7.8	8.1	7.7	8.2	8.6	7.0	7.7	7.7	8.2	9.4	9.4
SESW	35	31	2E	G-095282	C6	8.7	8.7	9.4	9.7	10.9	11.2	9.9	9.9	8.5	12.2	2.1
NW	34	31	2E	G-099174	C7	3.8	3.9	4.4	3.8	4.2	9.2	4.5	4.5	5.1	5.3	6.5
SWSE	34	31	2E	G-056746	C18	9.4	11.0	10.2	11.9	13.7	12.8	12.8	13.2	11.4	12.2	11.8
SW	4	30	2E	G-097437	C26			10.8	12.6	9.4	11.4	11.3	11.3	10.3	11.2	11.0
SE	4	30	2E	NONE	C34R						3.5	3.0	3.0	4.8	3.1	14.4
Values in orange have been carried over.				**Average Nitrate Level**		**8.4**	**9.4**	**9.4**	**10.3**	**10.6**	**10.1**	**9.3**	**9.3**	**8.9**	**9.8**	**9.8**
				Maximum Nitrate Level		**12.8**	**14.2**	**13.2**	**14.1**	**15.3**	**14.4**	**12.8**	**13.2**	**12.2**	**13.7**	**14.4**

DOLPHIN TWP - Knox County

T31N, R2W — November 18, 2013

1/4,1/4	Sec	TWP	RNG	Register #	NRD #	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
SESE	21	31	2W	G-041985	K2	21.7	21.9	22.4	21.5	20.8	15.7	8.4	8.4	8.4	6.3	6.3
SENE	21	31	2W	G-056155	K3	19.2	18.2	18.2	18.8	24.4	20.4	23.4	20.7	20.7	17.9	14.0
NWNW	22	31	2W	G-042322	K4	14.8	13.7	13.7	13.8	13.8	12.7	18.0	16.5	16.3	17.0	18.6
SWSW	15	31	2W	G-057492	K5	11.0	11.1	11.4	11.8	11.5	11.1	11.2	11.2	7.4	13.2	12.2
SWSW	8	31	2W	G-050196	K6	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	6.2	6.2
NE	16	31	2W	NONE	K49	10.4	10.4	10.4	10.4	9.3	7.3	9.1	7.8	9.1	15.5	19.4
NW	16	31	2W	NONE	K52	15.3	15.9	16.3	16.1	17.2	14.1	13.2	14.7	16.1	15.3	14.2
SESW	26	31	2W	G-093192	K53	0.5	0.7	0.3	0.3	0.7	0.5	0.5	0.5	1.0	0.6	0.6
NWNE	28	31	2W	G-052944	K55	18.6	20.2	19.5	20.4	22.7	18.5	17.1	16.0	13.8	14.4	18.1
SE	22	31	2W	G-051970	K56	8.2	7.7	7.8	8.2	10.0	7.5	6.5	8.1	7.5	10.6	6.6
NW	21	31	2W	NONE	K57	2.2	1.7	1.7	1.8	2.6	2.6	2.6	2.6	4.8	5.9	5.9
SW	22	31	2W	G-058943	K63	12.2	12.6	12.6	12.5	11.5	12.8	13.5	14.9	15.9	9.5	16.2
Values in orange have been carried over.				**Average Nitrate Level**		**11.9**	**9.9**	**9.8**	**10.0**	**10.6**	**9.0**	**8.9**	**9.2**	**9.7**	**10.3**	**11.6**
				Maximum Nitrate Level		**21.7**	**21.9**	**22.4**	**21.5**	**24.4**	**20.4**	**23.4**	**20.7**	**20.7**	**17.9**	**19.4**



M:\arcgis\2013 Nitrate Results - District\2013_Nitrate_Results_District_for GWMP.mxd User: asudbeck

DATE: March 18, 2014

Sources:
Hillshade - Developed from DNR DEM

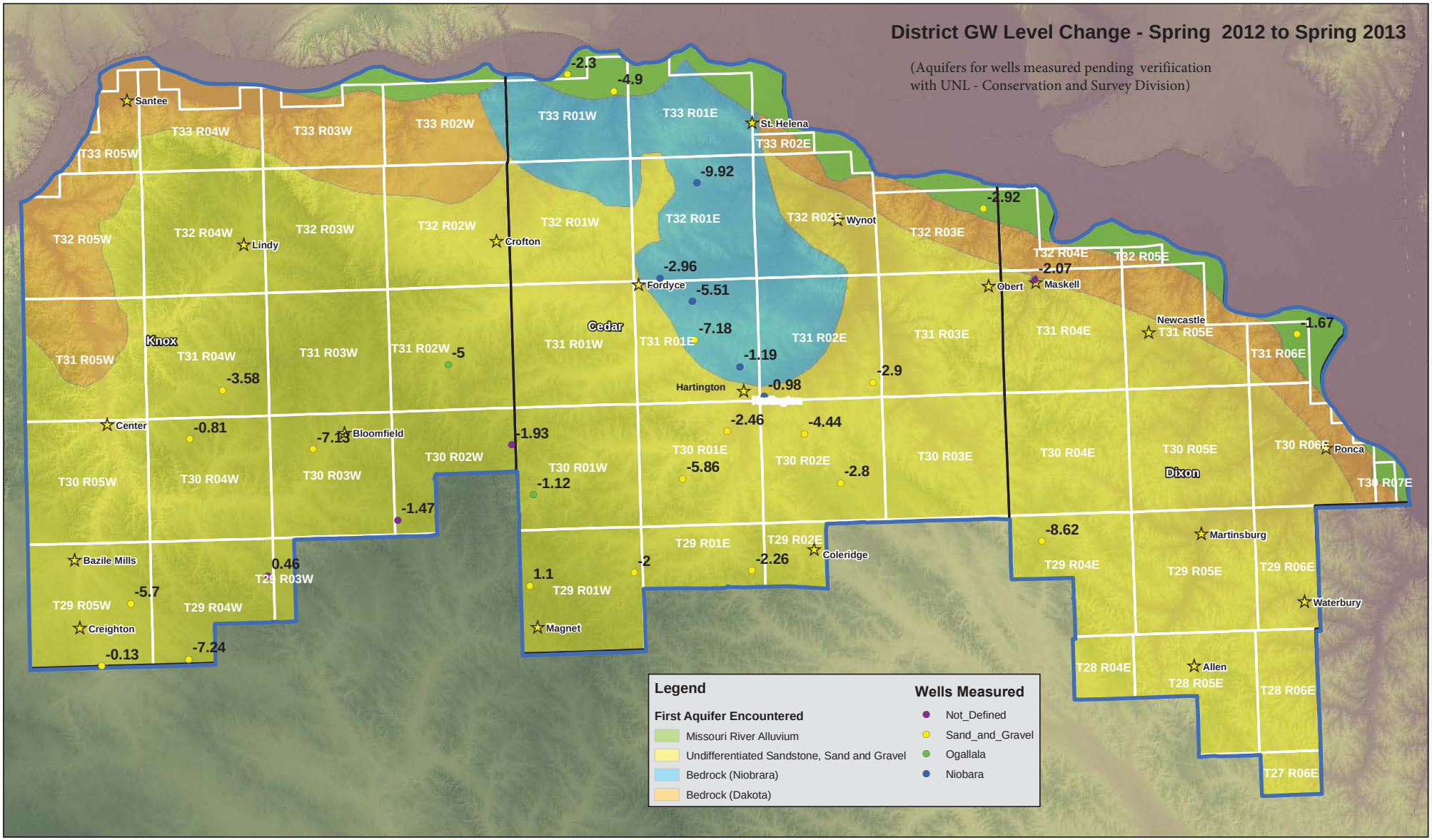
2.5 0 2.5 5 7.5 Miles

1:260,000

N

2013 Nitrate Results plotted on
Fist Aquifer Encountered Map
Lewis and Clark Natural Resources District

FIGURE 1



M:\arcgis\2013 Water Level Changes\2013_Groundwater_level_change_2102_2013_for_GWMP.mxd User: asudbeck

DATE: March 18, 2014

Sources:
Hillshade - Developed from DNR DEM

2.5 0 2.5 5 7.5 Miles

1:274,558

N

Difference in Water Level, Spring 2012 to Spring 2013
Plotted on Fist Aquifer Encountered Map
Lewis and Clark Natural Resources District

FIGURE
1

2012 Reports of Well Interference in the Lewis and Clark NRD

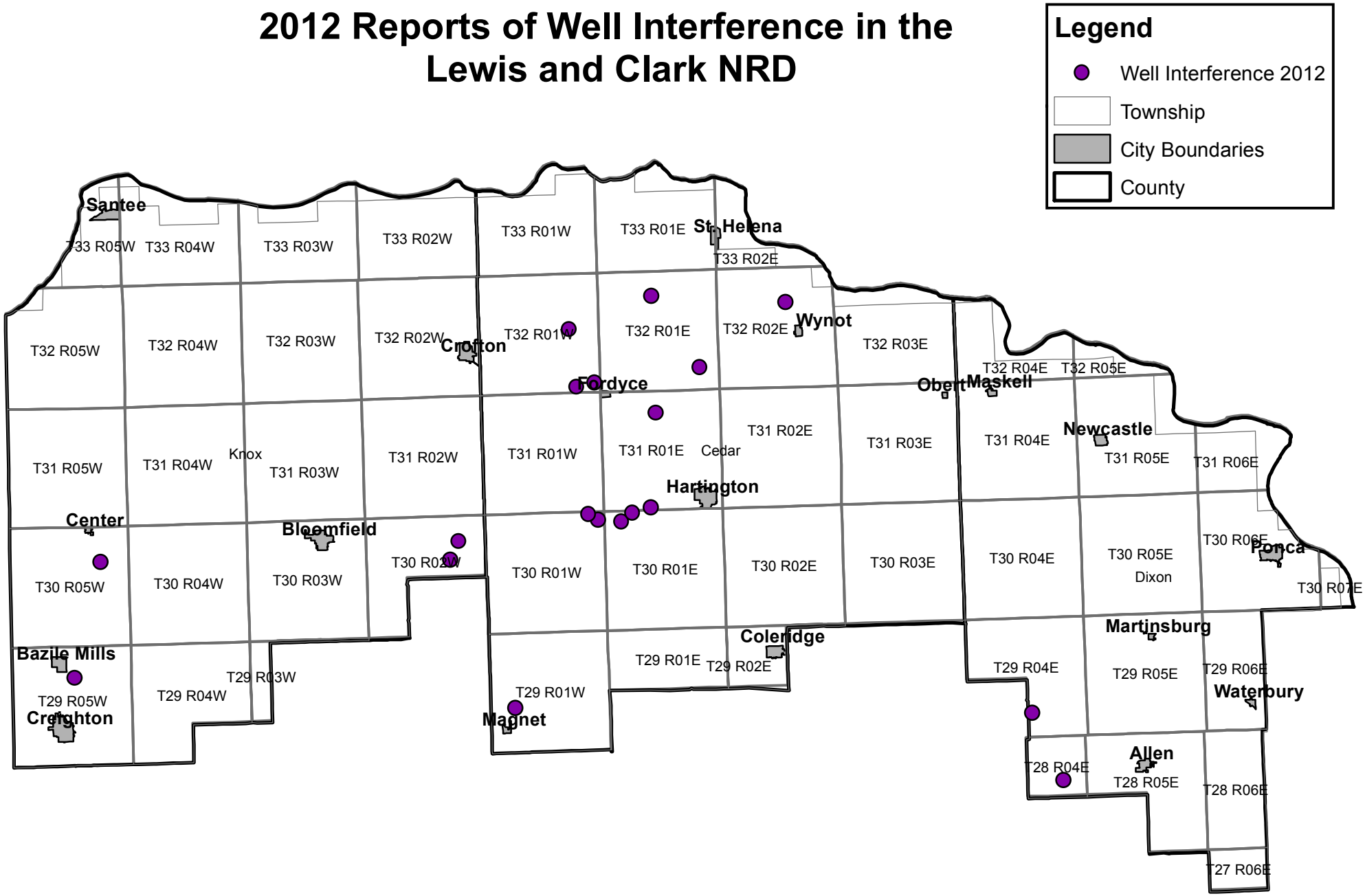
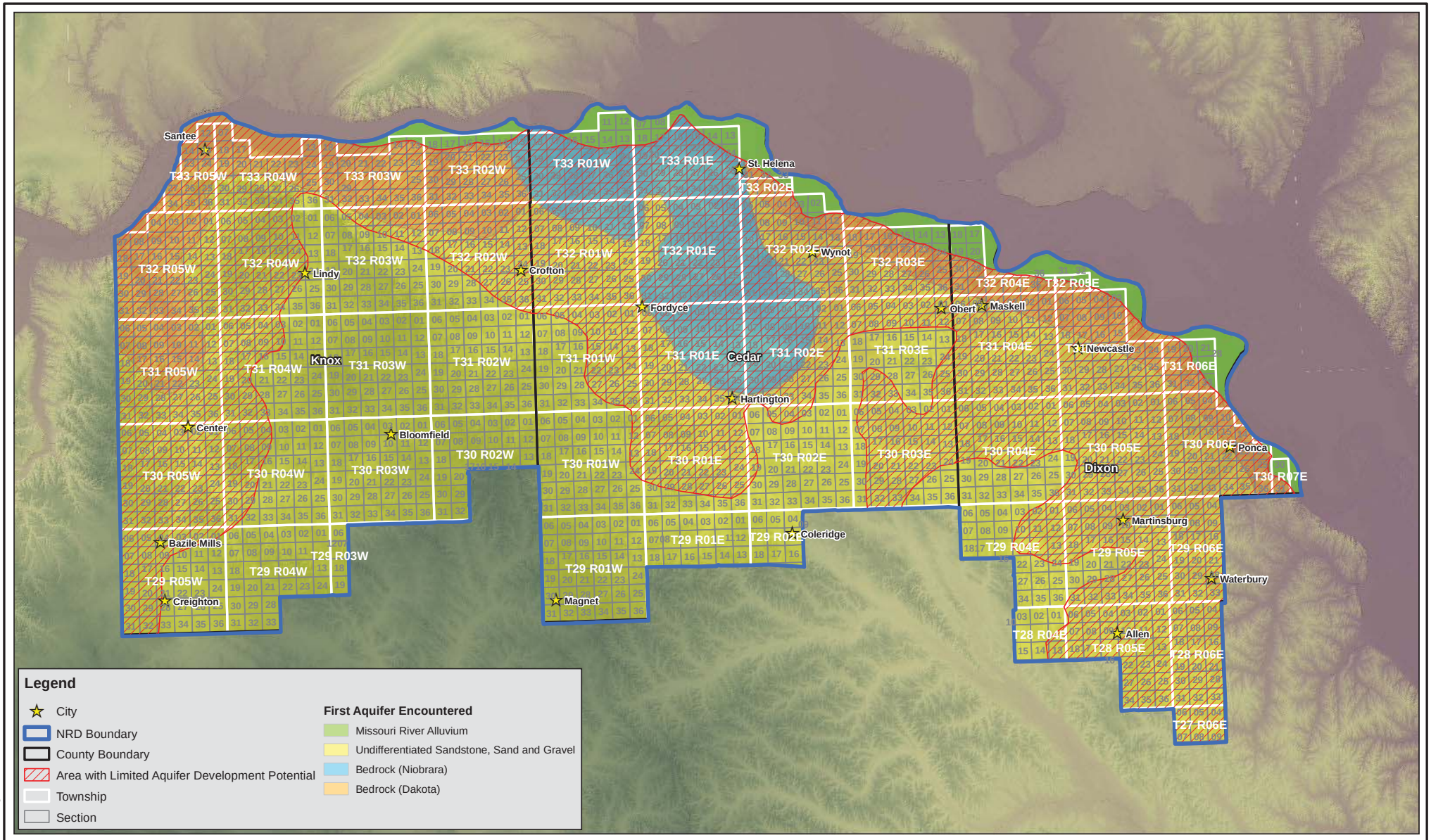


Figure 2.



Legend

- City
- NRD Boundary
- County Boundary
- Area with Limited Aquifer Development Potential
- Township
- Section

First Aquifer Encountered

- Missouri River Alluvium
- Undifferentiated Sandstone, Sand and Gravel
- Bedrock (Niobrara)
- Bedrock (Dakota)

PROJECT: 013-0132
DRAWN BY: RD
DATE: August 14, 2013

Sources:
Hillshade - Developed from DNR DEM

2.5 0 2.5 5 7.5 Miles
1:316,800

N

PRELIMINARY SUBAREA DELINEATION MAP
Lewis and Clark Natural Resources District
Northeast, Nebraska

OLSSON ASSOCIATES

FIGURE 4

M:\arcgis\Olsson GIS Files\Fig 1 - Prelim Subarea Delineation v10.mxd User: asudbeck

Attachment – A
Excerpts from:

Bazile Groundwater Management Area Plan

Developed for the:
Lewis and Clark Natural Resources District
Lower Niobrara Natural Resources District
Lower Elkhorn Natural Resources District
Upper Elkhorn Natural Resources District

May 2013

Groundwater Quality Concerns

An area of concern was identified in the late 1980s as a result of affected municipal wells in the vicinity of the Villages of Brunswick, Creighton, Orchard, Osmond, Plainview, Royal, and Wausa in northeast Nebraska (Figures 1 and 2) The area lies in three counties: Antelope, Knox, and Pierce and parts of four NRDs: Lewis and Clark (LCNRD), Lower Elkhorn (LENRD), Lower Niobrara (LNNRD), and Upper Elkhorn (UENRD). The area was deemed the Bazile Triangle due to the Bazile Creek drainage in the center. It should be noted surface water drainage in the area also includes the North Fork Elkhorn River and Verdigre Creek.

In 1990 the Conservation and Survey Division, University of Nebraska published results from a study of the Bazile Triangle area of concern. The conclusions of the report indicated the aquifers appeared to be contaminated to varying degrees and the source was likely related to fertilizer application and irrigation practices. The report also concluded there was insufficient data to implement a specific groundwater management strategy (UNL 1990).

In the years since the study was completed, the NRDs continued to collect data and information on the groundwater nitrate concentrations. Average nitrate concentrations remain a concern with the recent readings being illustrated in Table 1.

Figure 1. Bazile Groundwater Management Area Location in Nebraska.

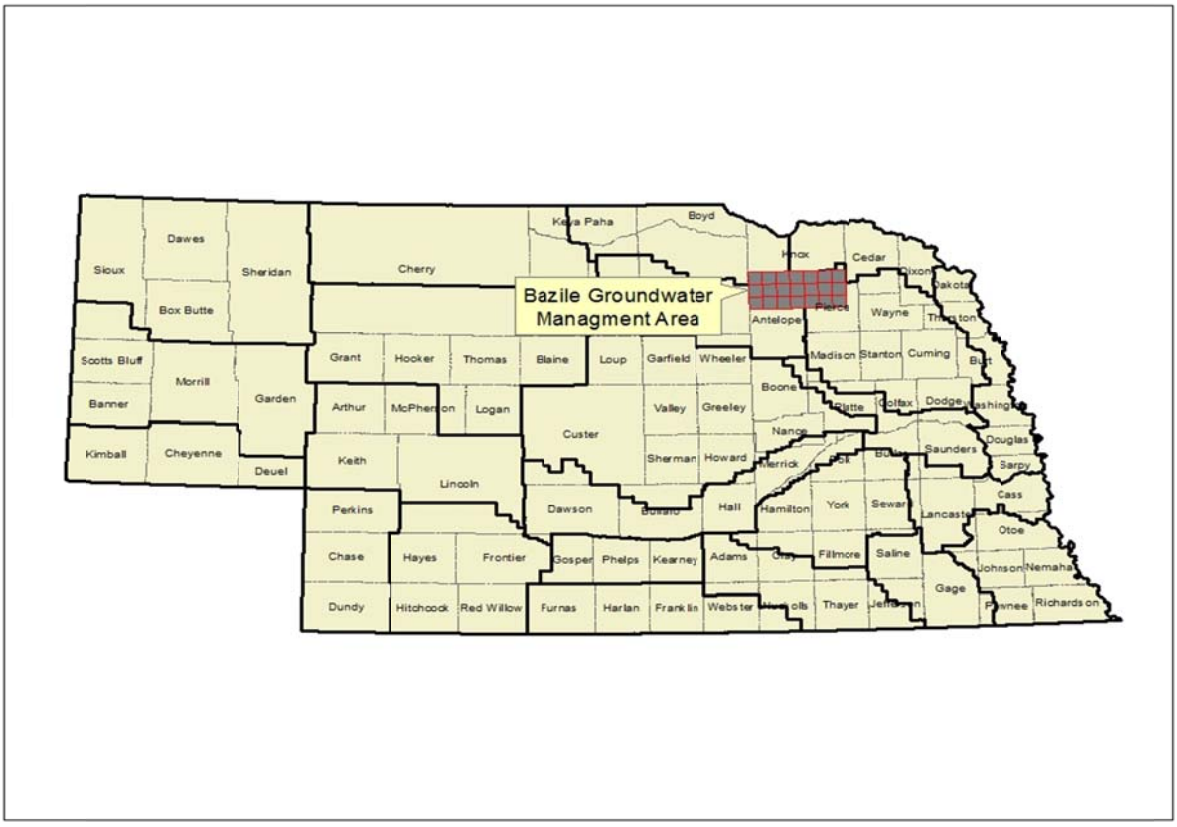
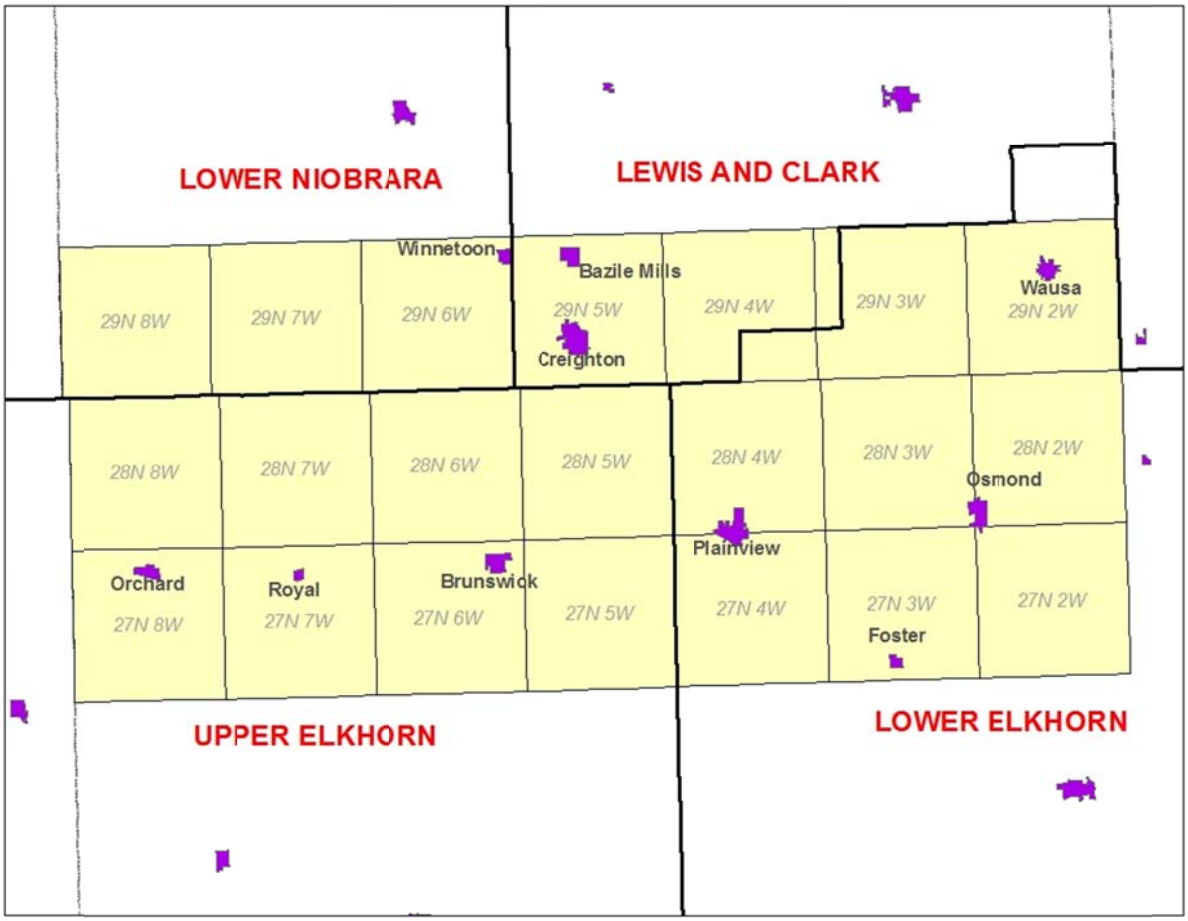


Table 1. Average Nitrate Concentration by NRD in Bazile Groundwater Management Area

NRD	Year	Average Nitrate Concentration
Lewis and Clark	2010	18.25 mg/l
Lower Elkhorn	2005	11.84 mg/l
Lower Niobrara	2009	8.24 mg/l
Upper Elkhorn	2010	13.6 mg/l

Table 1 is a simple reporting of the latest information. Another illustration of the average nitrate concentration changes is provided in Figure 3. Trend lines have been included with the charts and show an increase in the average nitrate concentrations for the period of record. A direct comparison of the data from NRD to NRD is not appropriate as the quantity of wells sampled, data points, and period of record differ.

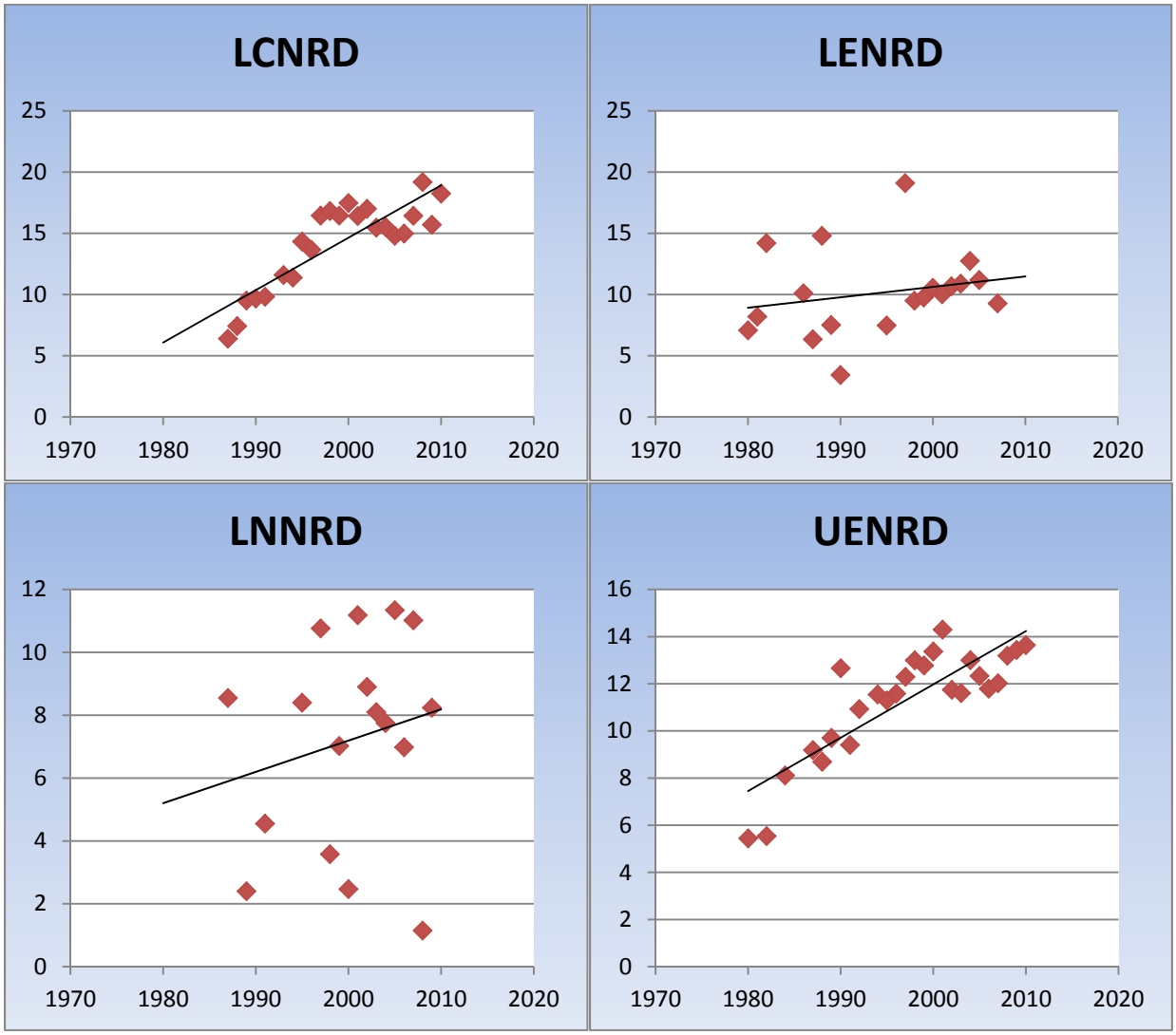
Figure 2. Bazile Groundwater Management Area



Groundwater management plans in each NRD have been implemented; unfortunately, improvements are not being achieved as quickly as desired. It should be noted that even aggressive actions taken to reduce nitrates in the water supply require multiple years to realize the results. Recharge rates from the surface to the aquifer vary greatly due to soil types, topography, and the depth to groundwater. Nitrate contamination currently observed in the water supply may be the result of nitrogen applied several years or even decades ago.

As indicated previously, each NRD has a groundwater management plan. Each plan was developed, subjected to public review and comment, adopted by the NRD board, and reviewed and approved by the State, according to the NGM&PA. Each plan addresses both groundwater quantity and quality concerns and meets the minimum statutory requirements however each district were allowed to tailor the plans to address the local needs and situations. There are differences in the plans that will be discussed later.

Figure 3. Average Annual Nitrate Concentrations in the Area of Concern by NRD



Each NRD has expressed interest in developing a master plan for the Bazile area on which future projects or other actions will be based. Municipalities in the area also are interested stakeholders in the process as drinking water providers for the perspective entity. In order to develop a master plan, a community based planning process was utilized whereby all stakeholders had an opportunity to identify concerns and work collaboratively with technical advisory agencies to make decisions that will protect and restore groundwater quality of the area. For the purposes of this master plan, the area will now be known as the Bazile Groundwater Management Area. The expanded area encompasses 756 square miles as shown in the subsequent figure 2.

Goals and Objectives

Project goals and objectives were developed by the advisory council with assistance from the technical advisors. The water quality objectives listed in the goals are based on being able to reduce the nitrate concentration in the groundwater to below10 mg/l and achieve reductions that will allow the NRDs to step back into lower groundwater management phase triggers. It is realized that nitrate contamination of groundwater does not occur as rapidly as surface water and a reduction in pollutant concentrations may not be realized rapidly as well. Because of this both short and long term goals and objectives were developed. In developing the plan, the interaction between surface water and groundwater was recognized and considered. The goals and objectives primarily focus on groundwater however, the advisors included goals for groundwater quantity and surface water and if necessary the plan will be modified during one of the evaluations.

Short Term Goals – 5 years

Goal 1: Educate landowners, agricultural producers, commercial properties and residents on the importance of environmental stewardship and good ground water quality.

Objective 1: Inform 100% of landowners and producers in the BGMA about available opportunities to improve their operation and water quality through one on one contact.

Objective 2: Inform 100 % of communities on efforts available to protect their public water supplies

Objective 3: Inform 100% of the crop consultants, fertilizer dealers and others about water quality of the area and the potential impacts to agriculture production.

Objective 4: Provide information to commercial operations about water quality of the area and the opportunities to improve operations.

Objective 5: Educate domestic groundwater users on the current status of the local aquifer.

Goal 2: Reduce the trend of increasing nitrate concentrations within the BGMA.

Objective 6: Reduce average nitrate concentrations in the BGMA by 3.2 mg/l.

Objective 7: Reduce and maintain nitrate concentrations below 10 mg/l in all wellhead protection areas for public water supplies

Objective 8: Increase vadose zone monitoring and utilize information for management decisions

Long Term Goals– 20 years

Goal 3: Reduce and maintain groundwater nitrate concentrations to below the maximum contaminant level of 10 mg/l.

Objective 9: Reduce average nitrate concentrations in the BGMA to below 10 mg/l.

Objective 10: Reduce and maintain all areas of the BGMA to 9.0 mg/l or below (Figure 13).

Objective 11 Reduce and maintain all areas of the BGMA to the respective NRD's Phase II and/or I nitrate concentrations

Goal 4: Maintain an adequate and sustainable supply of groundwater to provide sufficient quantities for domestic, municipal, agricultural and industrial uses.

Objective 12: Manage groundwater usage to avoid over use and excessive aquifer depletions

Goal 5: Ensure groundwater contamination and other activities do not impair surface water beneficial uses.

Objective 13: Introduce and implement practices that protect surface water quality.

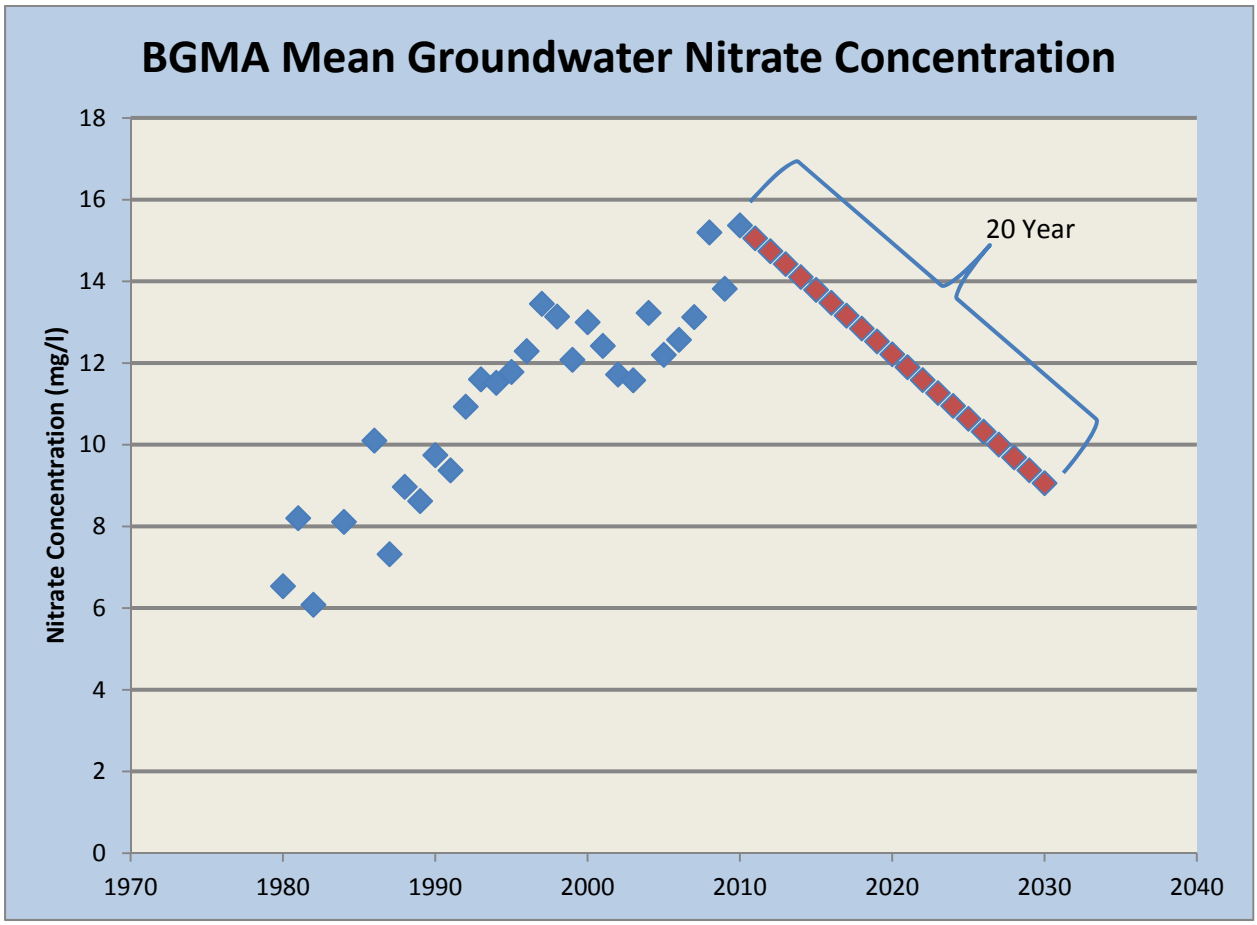
Actions and Tasks

The advisory council identified several Action Items that will facilitate meeting the project goals. The Action Items listed below will be periodically reviewed and revised as the implementation of the plan progresses. It should be noted all of the activities are specific to the BGMA.

1. User Education – to be completed within five years of plan approval
    a. Prepare bi-annual mailings explaining the groundwater concerns, best management practices (BMPs), cost share programs, etc.
    b. Issue periodic news releases
    c. Hold a minimum of three meetings, workshops or seminars to further educate producers
    d. Initiate one-to-one contact with producers to facilitate the implementation or further implementation of BMPs.
    e. Educate communities in the area on the benefits of wellhead protection management planning
2. Soil Sampling
    a. Require annual soil sampling for any crop (including turf grass) where >50 lbs per acre per year of organic or inorganic nitrogen will be applied.
        i. Each sample will only be representative of 40 acres.
        ii. Sampling depths will be 0-8" and 8"- 24"
        iii. Producers are encouraged to sample 24"- 48"
    b. Each soil sample must include a cation exchange capacity and organic matter analysis
    c. It is recommended NRDs provide cost share
3. Irrigation Water Sampling
    a. Irrigation water will be sampled every other year
        i. Irrigation water users are encouraged to sample water annually
    b. It is recommended NRDs provide cost share

4. Water Well Flow Meters
    a. Each operator is required to have at least one irrigation system flow meter installed
    b. Larger operations (>10 systems) will be required to have at least one meter installed per 10 existing systems (i.e. 11 systems will require two flow meters)
    c. All new and replacement wells will be required to install a flow meter
    d. Meters must be installed within five years of plan approval
    e. NRDs should develop a meter inspection program
5. Soil Moisture Sensors and Irrigation Scheduling
    a. Each operator is required to install and utilize at least one soil moisture sensor for irrigation scheduling
    b. Larger operations (>10 irrigation systems) will be required to have installed and use at least one soil moisture sensor per 10 wells (i.e. eleven systems will require two sensors)
    c. Implementation should be completed within five years of plan approval
6. Fall Fertilizer Application
    a. No nitrogen fertilizer (organic or inorganic) shall be applied post harvest to November 1.
    b. Surface applied organic nutrients will be exempted from this if the application is in compliance with future cropping needs and a nutrient management plan.

Figure 13. Historic Data and Short and Long Term Nitrate Reduction Goals



7. Winter Application
    a. Nitrogen fertilizer applications to frozen or snow covered ground will not be allowed without district permission
8. Manure Applications
    a. All manure applied will be based on a nutrient analysis
    b. Require applicator to uniformly apply organic nutrients.
    c. Application equipment should be maintained and calibrated
9. Crop Tissue Analysis
    a. Each producer will be required to complete one growing season tissue analysis and one late season stalk nitrate test within five years of the plan approval
10. Split Fertilizer Applications
    a. Split application of nitrogen fertilizer will be required where the soil cation exchange capacity is <10.
    b. In soil types where the cation exchange capacity is >10, one-to-one contact with producers should be undertaken to increase split applications on 50% of the BGMA
11. Fertilizer application through irrigation system (fertigation)
    a. Work with producers to achieve 90% of corn producers utilizing fertigation
    b. NRD are encouraged to provide cost share
12. Nitrification Inhibitors
    a. Encourage the use of nitrification inhibitors through education
13. Variable application and precision farming
    a. Create a partnership with local fertilizer distributors and crop consultants to create demonstration field(s)
    b. Demonstrations will include nitrification inhibitors; growing season tissue analysis and late season stalk nitrate test
    c. Demonstration fields should incorporate multiple BMPs including no-till, cover crops, etc.
14. Nitrogen Budgeting/Accounting
    a. Require producers to document nitrogen requirements and usage for all fields where >50lbs per acre of nitrogen is applied.
    b. NRDs are encouraged to utilize a common reporting form or other form that contains the required information
15. Sub-surface Irrigation
    a. Work with a sub-surface irrigation system distributor to establish one demonstration field that includes the usage of a fertigation system
16. Irrigation Well Rehabilitation
    a. Implement water well construction standards that protect confined layers
    b. Work with the Nebraska Water Well Standards Board to conduct a well rehabilitation demonstration.
17. Vadose Zone Sampling
    a. The NRDs will establish baseline vadose zone nitrate conditions and conduct periodic re-assessments including the 10 and 20 year time frame
18. Areas of Significant Concerns
    a. The NRDs will monitor the progress of the actions and tasks undertaken and where necessary increased management will be undertaken which may include regulatory actions.

Monitoring and Evaluation

Groundwater quality data and information is needed to determine whether or not the management plan is effective at reducing groundwater nitrate concentrations. Each NRD annually collects groundwater quality data from multiple wells within the BGMA. During the

initial phases of the plan implementation, a representative well network will be developed and utilized to determine the changes in groundwater nitrate concentrations. Groundwater quality data and information will be collected annually.

Additionally, vadose zone nitrate concentrations will be collected and utilized to assess the potential threat to groundwater and the impacts of the implementation of best management practices.

As resources allow, the NRDs will be encouraged to make use of analytical methods to identify sources (organic and inorganic) of nitrogen. Such data and information will be invaluable when determining the appropriate BMP to implement.

Changes in groundwater quality are often not realized as quickly as surface water and therefore the short and long term goals are based on ten and twenty year time frames, respectively. Evaluation of the plan will include the following:

- Annually meet to assess the progress of the implementation of the action items and adjust plan where necessary
- 2018 – determine if BMPs and other activities identified in action items have been completed
- 2022 – determine if short term goal are being met
- 2032 – determine if long term goals are being met

Information and Education

Educating producers is one step in protecting and improving groundwater quality. One of the primary goals of this project will be to increase the usage of best management practices for irrigation and nitrogen management through one-on-one contact with producers in the NRD.

- Publish the information (charts, graphs, etc) in the NRD's newsletters.
- Present the information annually to the NRD's Board of Directors at a public meeting.
- Continue to integrate the information into the current nitrogen and irrigation management workshops.
- Utilize the NRD web sites to distribute information
- Prepare and distribute news releases to media within the NRDs and surrounding areas.
- Cooperate with UNL Extension Educators to distribute information about the project.

Utilize multi-media outlets to advertise the BGMA activities and follow-up with success stories.

Attachment – B
Excerpts from:

Evaluation and Assessment of Agrichemical Contaminants in the Creighton, NE Area

Final Report for the Lewis and Clark Natural Resources District
July 20, 2000

Mark E. Burbach, Dr. Roy F. Spalding

University of Nebraska Lincoln, Water Sciences Laboratory

CONCLUSIONS

A large plume of non-point source nitrogen from agronomic sources (commercial-N and fertilizer-N) lies immediately east-southeast of Creighton, NE. A golf course, abandoned gravel pit, and fertilizer plant do not appear to be significant contributors to the N03-N in the ground water upgradient of the Creighton municipal wells. The N03-N in this plume exceeds the MCL for drinking water and is impacting the city of Creighton municipal wells as well as numerous private drinking water wells. A portion of the plume is also migrating to the northwest towards the village of Bazile Mills. A zone underlying approximately 830 ac has a N03-N concentration exceeding 30 mg/L. The leading edge of this area is approximately 1.25 miles downgradient of the city of Creighton municipal wells and is well within the estimated 20-year travel period to the municipal wells. However, a discharge area between the leading edge and the municipal wells

may in part intercept this part of the plume.

Nitrate analyses of vadose zone cores indicate a significant amount of NO_3-N continues to leach through the sediments beneath irrigated com fields in the study area. This will cause NO_3-N concentrations in the ground water to remain the same or continue to increase in the near
future.

The city of Creighton reverse-osmosis treatment system can currently reduce 13 mg/L NO_3-N in well water by 80%. To meet demand, treated water is blended with untreated water for a final N03-N concentration in the municipal water supply system of 5-7 mg/L. If the N03-N concentration in the municipal wells increases in the future more water will need to be treated before entering the final water supply. This may cause the city to fail to meet demand.

With the exception of extremely low concentrations of deethylatrazine, no other pesticides were detected in ground water from monitoring well clusters. Nitrogen isotope values confirm that the source of nitrogen in the majority of wells in the study area is derived predominately from commercial fertilizer sources. Deuterium values confirm that the source of recharge to the ground water in the study area is derived from precipitation and not impacted by surface water bodies. Chloride and sulfate values are slightly elevated in some portions of the study area.