

## **6.0 LOWER NIOBRARA RIVER BASIN**

### **6.1 Summary**

Based on the analysis of the sufficiency of the long-term surface water supply in the Lower Niobrara River Basin, the Department has reached a preliminary conclusion that the basin is not fully appropriated. The analysis of lag effects of current development for the Lower Niobrara Basin indicates a reduction in streamflows of 32 cfs in 25 years. The analysis of the impacts of future development on the Lower Niobrara Basin based on current development trends indicates an additional reduction in streamflows of 47 cfs in 25 years. The future number of days available to junior irrigators was not estimated because only minimal surface water administration has occurred on the Niobrara River in the past 20 years. Even though the future number of days available to junior irrigators was not estimated, the current number of days in which surface water was available for diversion far exceeds the number of days necessary to meet the net corn crop irrigation requirement (NCCIR).

### **6.2 Basin Description**

The Lower Niobrara River Basin in Nebraska is defined in this report as the surface areas in Nebraska that drain into the Niobrara River Basin and that have not previously been determined to be fully appropriated. This general basin area extends from the Spencer Hydropower facility in the west downstream to the confluence of the Niobrara River and the Missouri River and includes all aquifers that impact surface water flows in the basin (Figure 6-1). The total area of the Lower Niobrara River Basin evaluated in this year's report is approximately 1,200 square miles. The Lower Niobrara and the Upper Elkhorn NRDs are the only NRDs with significant area in the Lower Niobrara River Basin.

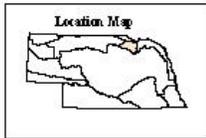


Hanning and Assistance Division

## General Basin Map LOWER NIOBRARA RIVER SURFACE WATER BASIN

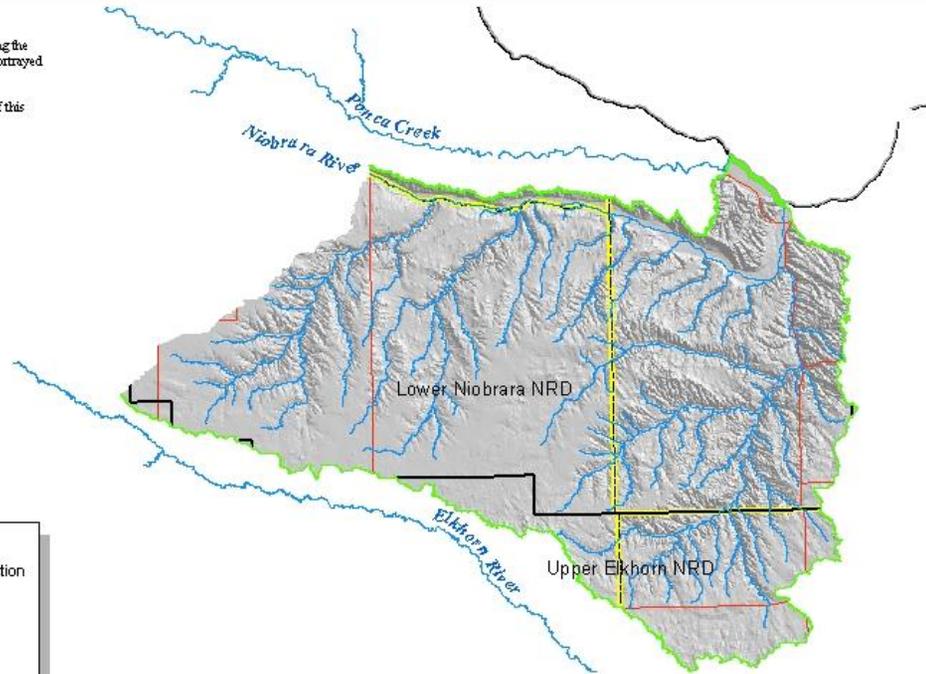


This map is intended to supply only general information concerning the matter stated in its title. Boundaries and the location of features portrayed on this map are not to be construed as legal boundaries or actual locations, and may change as additional or better data become available. User assumes all risks associated with interpretations of this map beyond its intended purpose.



### Explanation

- gjsbasedata.GISWRITER\_NE\_Streams selection
- Lower\_Niobrara\_Data\_Mask
- Downstream\_streams
- NRD Boundary
- Cultural Features**
- County Boundary
- State Boundary
- Highways



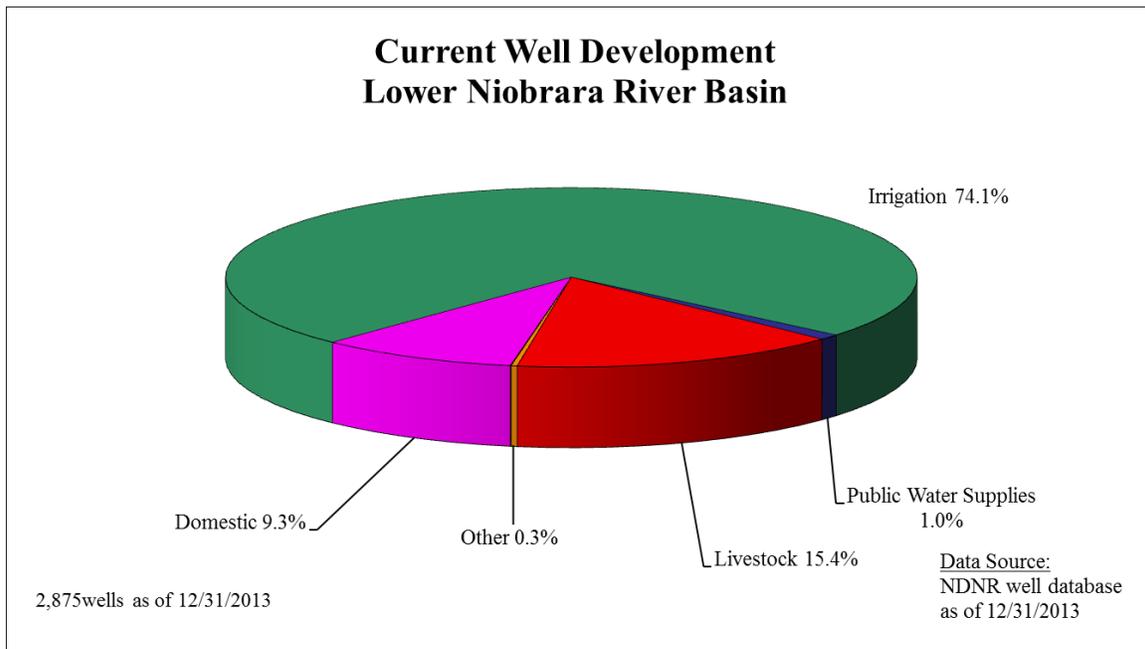
Base map produced by Kevin Schwartzman, April 27, 2006  
Base map to be approved June 1, 2006  
General basin map produced by Kevin Schwartzman, June 24, 2008

Figure 6-1. General basin map, Lower Niobrara River Basin.

## 6.3 Nature and Extent of Water Use

### 6.3.1 Groundwater

Groundwater in the Lower Niobrara River Basin is used for a variety of purposes: domestic, industrial, livestock, irrigation, and other uses. A total of 2,875 groundwater wells had been registered within the basin as of December 31, 2013 (Department registered groundwater wells database) (Figure 6-2). The locations of all active groundwater wells can be seen in Figure 6-3.



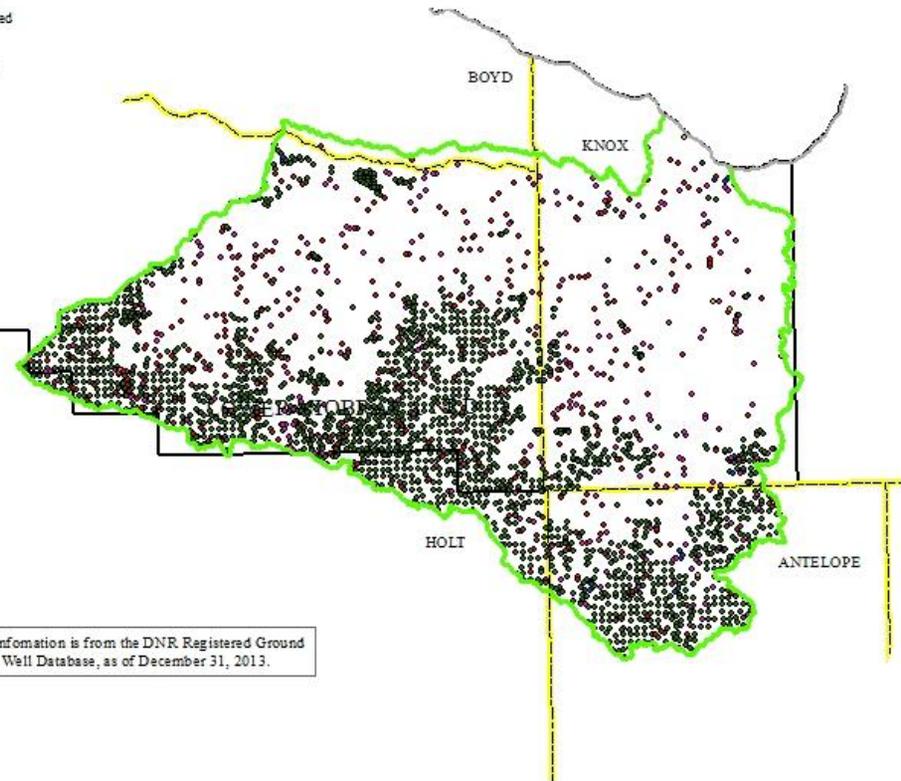
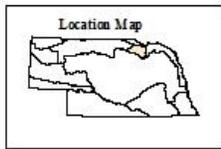
**Figure 6-2.** Current well development by number of registered wells, Lower Niobrara River Basin.



## Current Well Development LOWER NIOBRARA RIVER SURFACE WATER BASIN



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- Explanation**
- Lower Niobrara Surface Water Basin
- Cultural Features**
- County Boundary
  - State Boundary
  - NRD Boundary
- Wells**
- Public Water Supplies
  - Domestic
  - Livestock
  - Irrigation
  - Other

Well information is from the DNR Registered Ground Water Well Database, as of December 31, 2013.

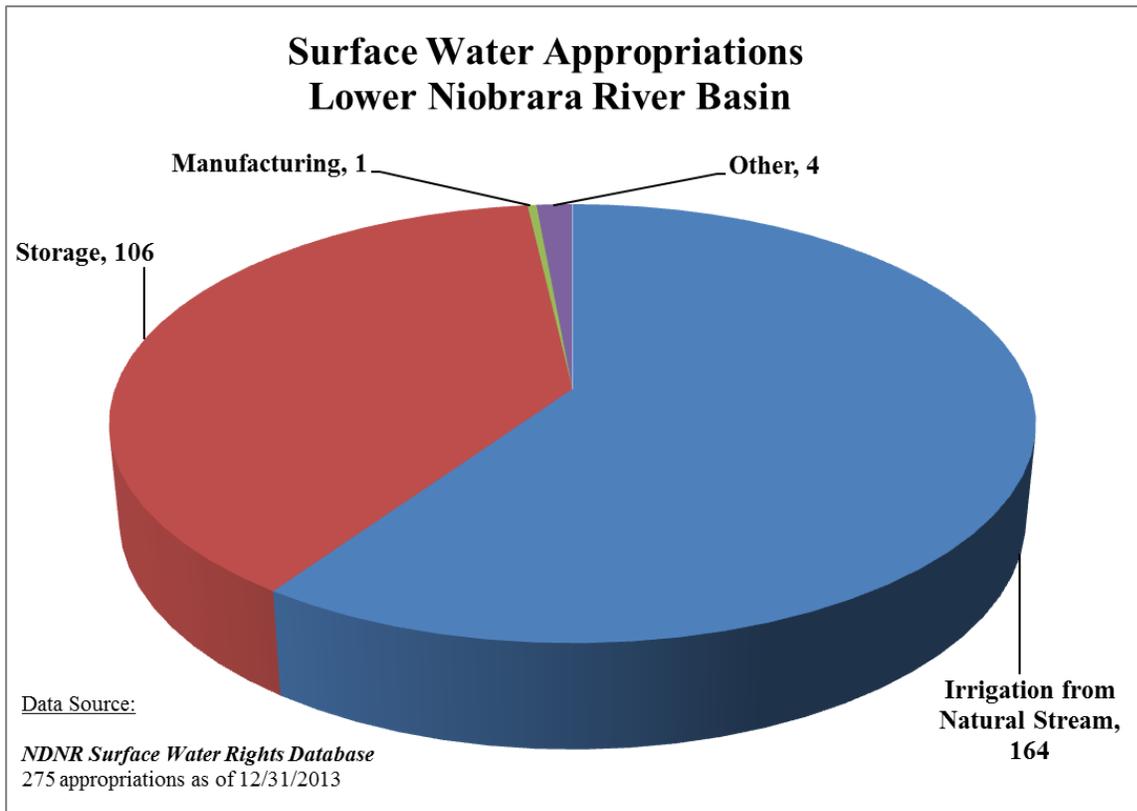


Base map produced by Kevin Schwartman, April 27, 2006  
 Base map to be approved June 1, 2006  
 General basin map produced by Kevin Schwartman, October 7, 2014

Figure 6-3. Current well locations, Lower Niobrara River Basin.

### 6.3.2 Surface Water

As of December 31, 2013, 275 active surface water appropriations were held in the Lower Niobrara River Basin, issued for a variety of uses (Figure 6-4). Most of the surface water appropriations are for irrigation use and storage and tend to be located on the major streams. The first surface water appropriations in the basin were permitted in 1894 and development has continued through the present day. The approximate locations of the surface water diversion points are shown in Figure 6-5.



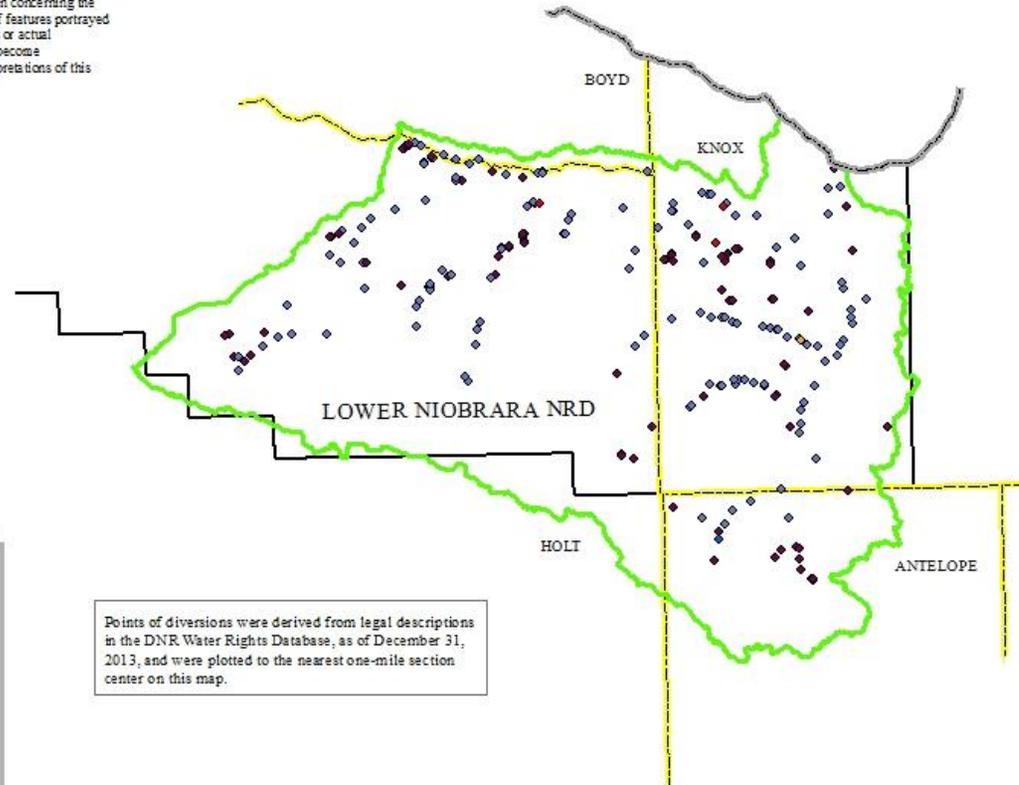
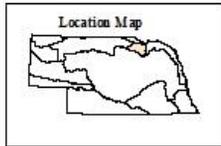
**Figure 6-4.** Surface water appropriations by number of diversion points, Lower Niobrara River Basin.



## Surface Water Diversions LOWER NIOBRARA RIVER SURFACE WATER BASIN



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- Explanation**
- █ Lower Niobrara Surface Water Basin
  - Cultural Features**
  - County Boundary
  - State Boundary
  - NRD Boundary
  - Surface Water Diversions**
  - ◆ Irrigation
  - ◆ Storage
  - ◆ Manufacturing
  - ◆ Domestic
  - ◆ Other

Points of diversions were derived from legal descriptions in the DNR Water Rights Database, as of December 31, 2013, and were plotted to the nearest one-mile section center on this map.



Base map produced by Kevin Schwartman, April 27, 2006  
 Base map to be approved June 1, 2006  
 General basin map produced by Kevin Schwartman, October 7, 2014

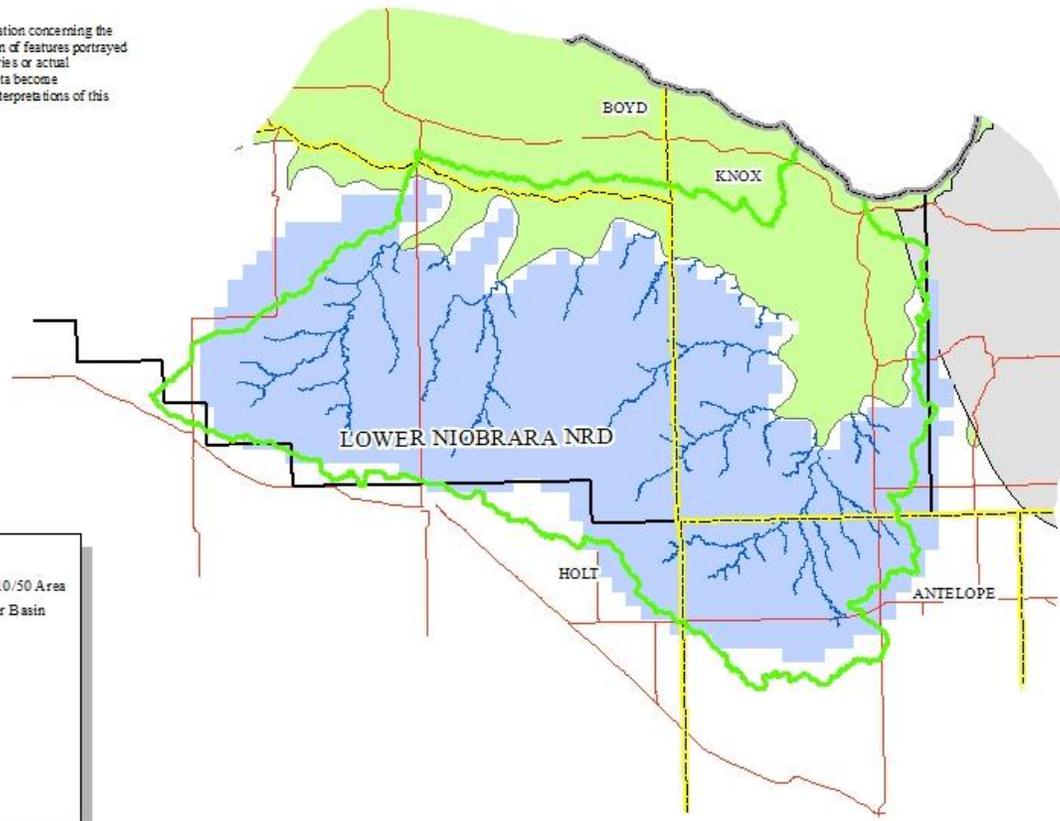
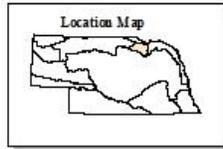
**Figure 6-5.** Surface water appropriation diversion locations, Lower Niobrara River Basin.

## **6.4 Hydrologically Connected Area**

The CENEB model was used to determine the extent of the 10/50 area for the Lower Niobrara River Basin. Figure 6-6 specifies the extent of the 10/50 area.



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**Explanation**

- Lower Niobrara River Basin 10/50 Area
- Lower Niobrara Surface Water Basin
- Glaciated Areas
- Aquifer Absent
- Streams

**Cultural Features**

- County Boundary
- State Boundary
- NRD Boundary
- Highways



Base map produced by Kevin Schwartzman, April 27, 2006  
 Base map to be approved June 1, 2006  
 General basin map produced by Kevin Schwartzman, October 8, 2014

Figure 6-6. 10/50 area, Lower Niobrara River Basin.

## **6.5 Net Corn Crop Irrigation Requirement**

Figure 6-7 is a map of the net corn crop irrigation requirement (NCCIR) for the Lower Niobrara River Basin (DNR 2005). The NCCIR in the basin ranges from 8.9 to 9.6 inches. To assess the number of days required to be available for diversion, a surface water diversion rate equal to 1 cfs per 70 acres, a downtime of 10 percent, and an irrigation efficiency of 80 percent were assumed. Based on these assumptions, a junior surface water appropriation in the Lower Niobrara River Basin will require between 23.6 and 25.5 days annually to divert 65 percent of the NCCIR and between 30.9 and 33.3 days to divert 85 percent of the NCCIR.

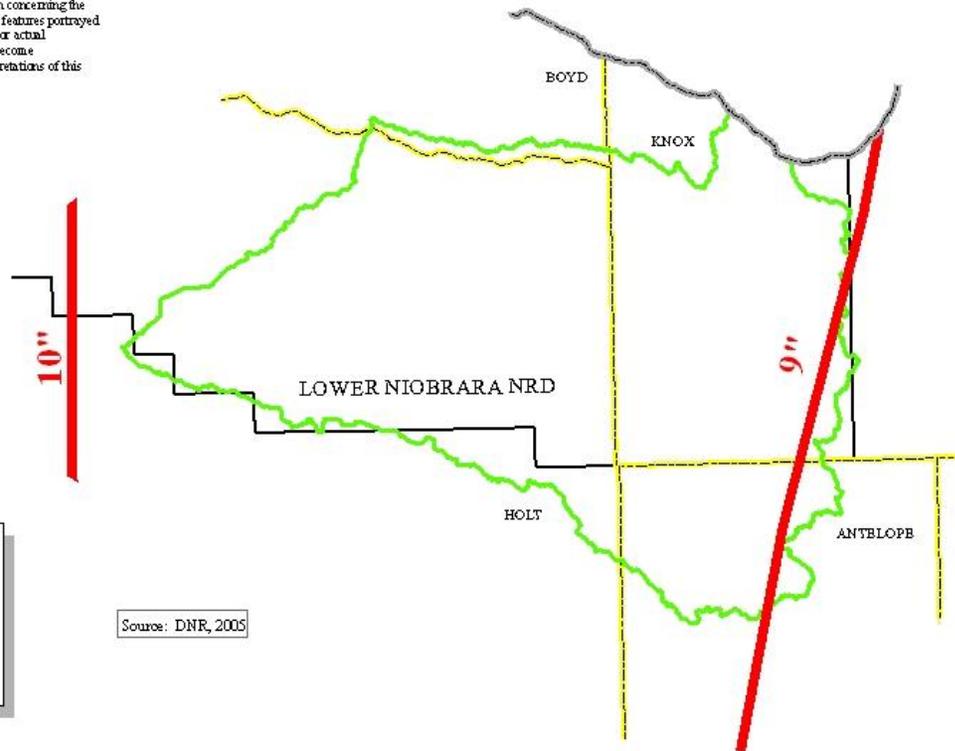
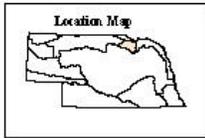


Planning and Assistance Division

## Net Corn Crop Irrigation Requirement LOWER NIOBRARA RIVER SURFACE WATER BASIN



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### Explanation

- Net Corn Crop Irrigation Requirement
- Lower Niobrara Surface Water Basin
- Cultural Features
  - County Boundary
  - State Boundary
  - NRD Boundary

0 3.5 7 14 21 28 35 Miles

Base map produced by Kevin Schwartzman, April 27, 2006  
Base map to be approved June 1, 2006  
General basin map produced by Kevin Schwartzman, June 26, 2008

Figure 6-7. Net corn crop irrigation requirement (NCCIR), Lower Niobrara River Basin.

## 6.6 Surface Water Closing Records

Table 6-1 contains records of all surface water administration that has occurred in the Lower Niobrara River Basin between 1994 and 2013.

**Table 6-1.** Surface water administration in the Lower Niobrara River Basin, 1994-2013.

<b>Year</b>	<b>Water Body</b>	<b>Days</b>	<b>Closing Date</b>	<b>Opening Date</b>
2012	North Branch Verdigre Creek*	38	Jul 13	Aug 20

\*Closing information was not included in the previous year's report but water administration did occur

## 6.7 Evaluation of Current Development

### 6.7.1 Current Water Supply

The current water supply is estimated by using the most recent 20-year period (1994-2013) of flows available for junior irrigation rights. The results of the analysis conducted for the Lower Niobrara River Basin are shown in Table 6-2. The results indicate that the current surface water supply in the basin provides an average of 60.1 days available for diversion between July 1 and August 31 and 151.1 days available for diversion between May 1 and September 30 (Table 6-3).

**Table 6-2.** Estimate of the current number of days surface water is available for diversion in the Lower Niobrara River Basin.

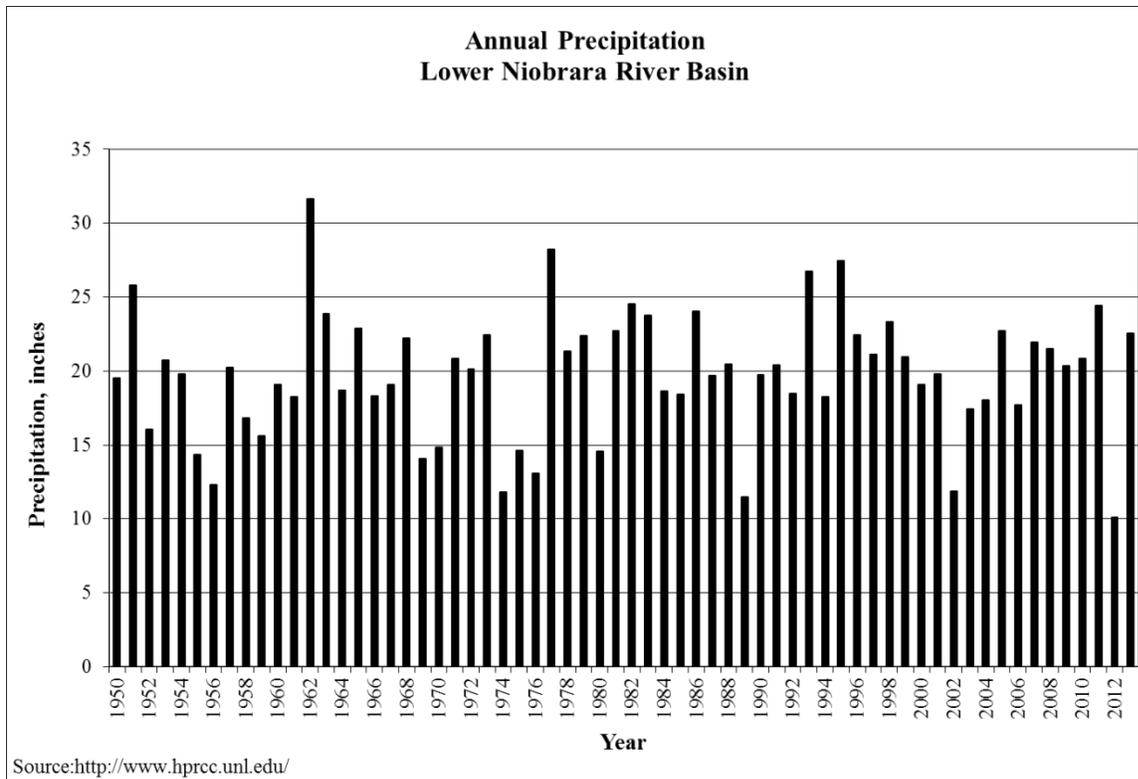
<b>Year</b>	<b>July 1 through August 31 Number of Days Surface Water is Available for Diversion</b>	<b>May 1 through September 30 Number of Days Surface Water is Available for Diversion</b>
1994	62	153
1995	62	153
1996	62	153
1997	62	153
1998	62	153
1999	62	153
2000	62	153
2001	62	153
2002	62	153
2003	62	153
2004	62	153
2005	62	153
2006	62	153
2007	62	153
2008	62	153
2009	62	153
2010	62	153
2011	62	153
2012	62	153
2013	24	115
<b>Average</b>	<b>60.1</b>	<b>151.1</b>

**Table 6-3.** Comparison between the number of days required to meet the net corn crop irrigation requirement and the current number of days surface water is available for diversion in the Lower Niobrara River Basin.

	<b>Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement</b>	<b>Average Number of Days Available for Diversion with Current Development</b>
July 1 – August 31 (65% Requirement)	23.6 to 25.5	60.1 (at least 34.6 days above the requirement)
May 1 – September 30 (85% Requirement)	30.9 to 33.4	151.1 (at least 117.7 days above the requirement)

### 6.7.2 Long-Term Water Supply

In order to complete the long-term evaluation of surface water supplies, a future 20-year water supply for each basin must be estimated. The Lower Niobrara River Basin’s major water sources are precipitation, which runs off as direct streamflow and infiltrates into the ground to discharge as baseflow; groundwater movement into the basin, which discharges as baseflow; and streamflow from the Middle Niobrara River. Using methodology published in the *Journal of Hydrology* (Wen and Chen 2005), a nonparametric Mann-Kendall trend test of the weighted average precipitation in the basin was completed. The analysis showed no statistically significant trend in precipitation ( $P > 0.95$ ) over the past 60 years (Figure 6-8). Therefore, using the previous 20 years of precipitation and streamflow data as the best estimate of the future surface water supply is a reasonable starting point for applying the lag depletions from groundwater wells.



**Figure 6-8.** Annual precipitation, Lower Niobrara River Basin.

### 6.7.3 Depletions Analysis

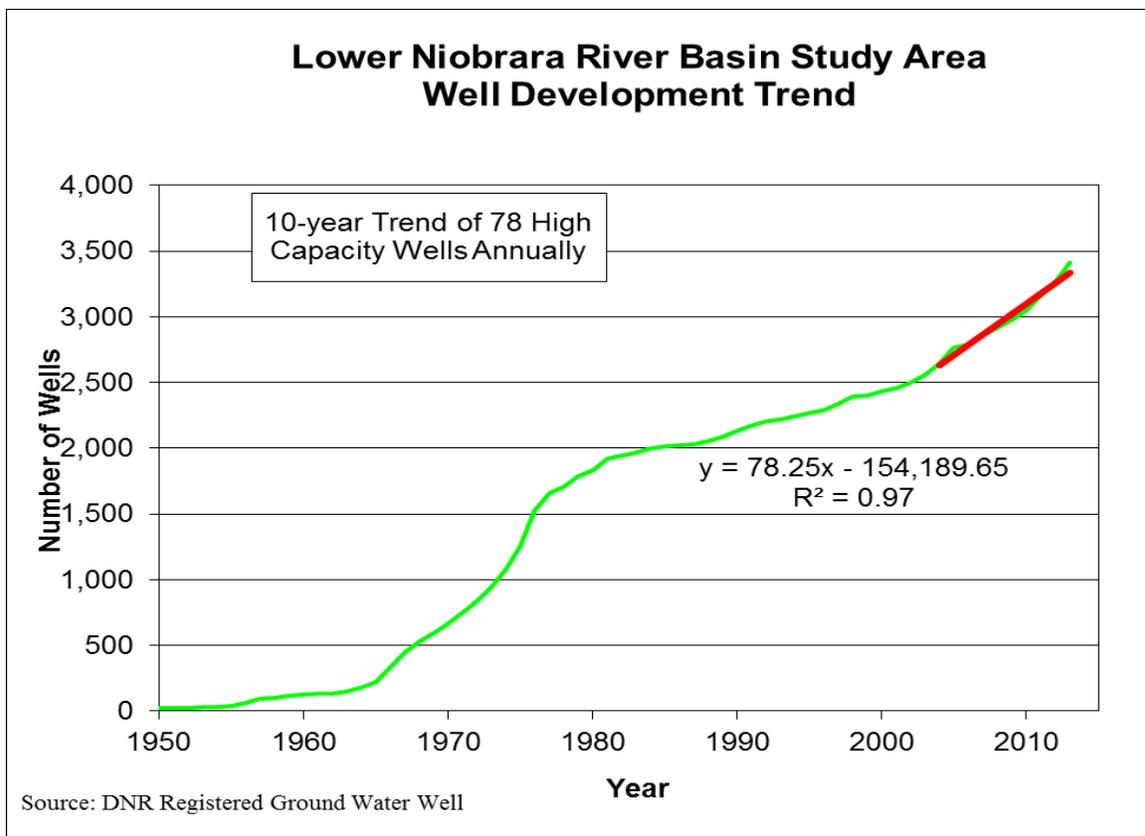
The future depletions due to current well development that could be expected to affect streamflow in the basin were estimated using the CENEB Model. The results estimate the future streamflows in the Lower Niobrara River Basin to be depleted by an additional 32 cfs in 25 years.

### 6.7.4 Evaluation of Current Levels of Development against Future Water Supplies

The estimates of the 20-year average number of days available for diversion were not estimated for the Lower Niobrara Basin because only minimal surface water administration has previously occurred in the basin, and the threshold flows necessary to satisfy senior appropriations could not be estimated. Even though the future water supplies were not estimated, the current number of days in which surface water was available for diversion far exceeds the number of days necessary to meet the 65/85 rule.

## 6.8 Evaluation of Predicted Future Development

Estimates of the number of high-capacity wells (wells pumping greater than 50 gpm) that would be completed over the next 25 years, if no new legal constraints on the construction of such wells were imposed, were calculated based on extrapolating the present-day rate of increase in well development into the future (Figure 6-9). The present-day rate of development is based on the linear trend of the previous 10 years of development. Based on the analysis of the past 10 years of development, the rate of increase in high capacity wells is estimated to be 78 wells per year in the Lower Niobrara River Basin.



**Figure 6-9.** High capacity well development, Lower Niobrara River Basin.

The additional depletions due to future well development that could be expected to affect streamflow in the basin were estimated using the CENEBC Model. The results estimate the future streamflow to be depleted by an additional 47 cfs in 25 years.

The estimate of the 20-year average number of days surface water is available for diversion was not calculated because minimal surface water administration has previously occurred and the threshold flows necessary to satisfy senior appropriations could not be estimated. Even though the future water supplies were not estimated, the current number of days in which surface water was available for diversion far exceeds the number of days necessary to meet the 65/85 rule.

### **6.9 Sufficiency to Avoid Noncompliance**

There are no compacts on any portions of the Lower Niobrara River Basin in Nebraska.

### **6.10 Groundwater Recharge Sufficiency**

The streamflow is sufficient to sustain over the long-term the beneficial uses from wells constructed in aquifers dependent on recharge from the stream, as explained in Appendix F.

### **6.11 Current Studies Being Conducted to Assist with Future Analysis**

The Department applied for and received funding from the Bureau of Reclamation to develop modeling tools that may assist in completing future evaluations. The project began in April 2011 with an anticipated completion date of January 2015.

### **6.12 Relevant Data Provided by Interested Parties**

The Department published a request for relevant data for this year's evaluation from interested parties on September 17, 2014, (see Appendix B for affidavit). In response to the published affidavit, the Department received a letter from the National Park Service. This letter is included in Appendix B.

### **6.13 Conclusions**

Based on the analysis of the sufficiency of the long-term surface water supply in the Lower Niobrara River Basin, the Department has reached a preliminary conclusion that the basin is not fully appropriated. The analysis of lag effects of current development for the Lower Niobrara

Basin indicates a reduction in streamflows of 32 cfs in 25 years. The analysis of the impacts of future development on the Lower Niobrara Basin based on current development trends indicates an additional reduction in streamflows of 47 cfs in 25 years. The future number of days available to junior irrigators was not estimated because only minimal surface water administration has occurred on the Niobrara River in the past 20 years. Even though the future number of days available to junior irrigators was not estimated, the current number of days in which surface water was available for diversion far exceeds the number of days necessary to meet the net corn crop irrigation requirement (NCCIR).

## **Bibliography of Hydrogeologic References for Lower Niobrara River Basin**

Conservation and Survey Division. 2005. *Mapping of Aquifer Properties-Transmissivity and Specific Yield-for Selected River Basins in Central and Eastern Nebraska*. Lincoln.

Nebraska Department of Natural Resources. 2005. *2006 Annual Evaluation of Availability of Hydrologically Connected Water Supplies*. Lincoln.

Nebraska Department of Natural Resources. 2013. *Central Nebraska Groundwater Flow Model*. Lincoln.

Wen, F.J. and X.H. Chen, 2006. Evaluation of the Impact of Groundwater Irrigation on Streamflow Depletion in Nebraska. *Journal of Hydrology*, 327: 603-617.