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 Department has also determined that, based on current information, if no additional legal constraints are imposed on future development of hydrologically connected surface water and groundwater, and reasonable projections are made about the extent and location of future development, this preliminary conclusion would not change to a conclusion that the basin is fully appropriated.

The analysis of lag effects of current development for areas in the Lower Niobrara River Basin indicates a reduction in streamflows by 29 cfs in 25 years. The analysis of the impacts of potential future development in the Lower Niobrara River Basin, based on current development trends, indicates an additional reduction in streamflows of 84 cfs in 25 years.

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 downstream of those portions of the basin which were designated as fully appropriated in 2004. This general basin area extends from the Mirage Flats diversion dam 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 12,100 square miles. NRDs with significant area in the basin are the Upper Niobrara-White, the Middle Niobrara, and the Lower Niobrara NRDs.

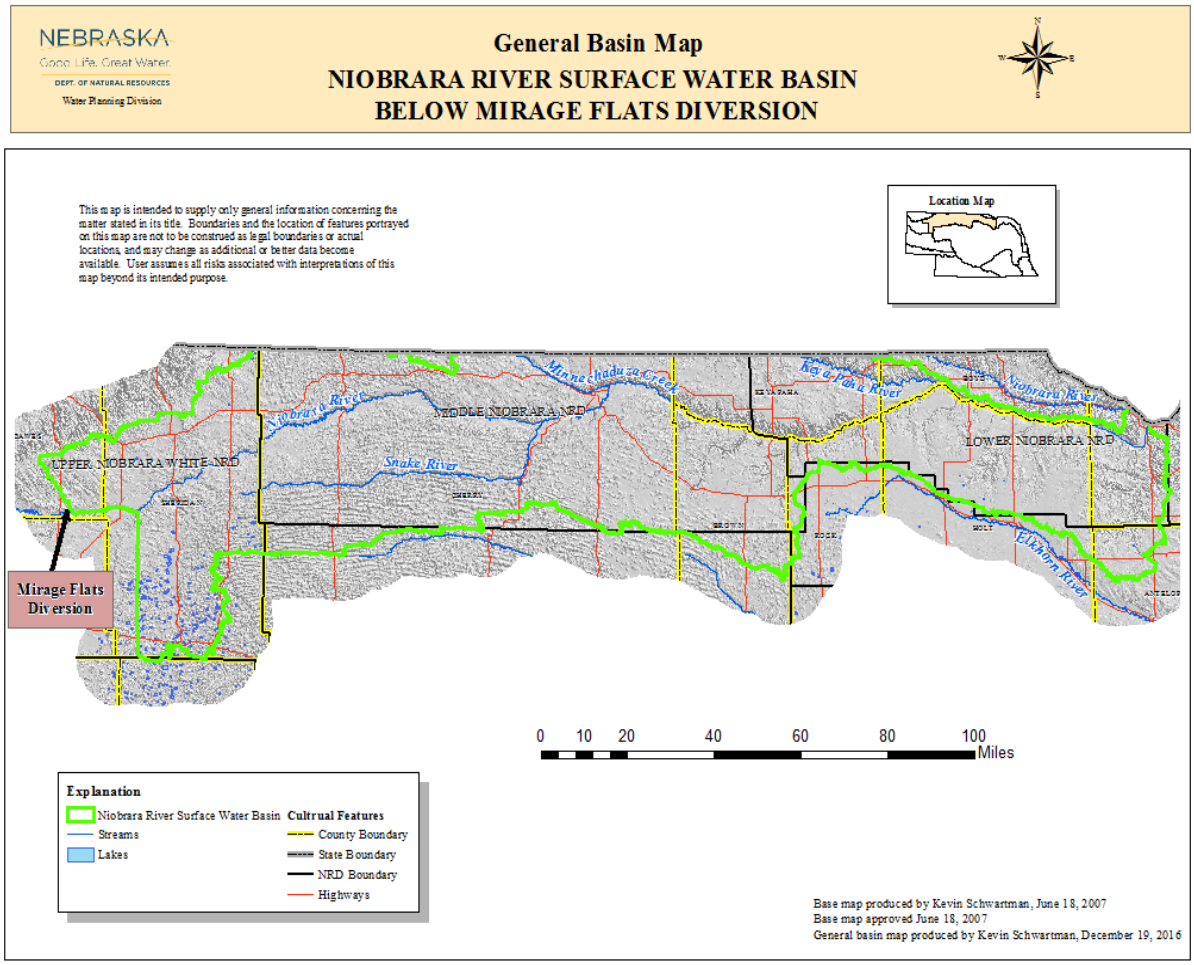

Figure 6-1. General basin map, Lower Niobrara River Basin.

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 9,390 groundwater wells had been registered within the basin as of December 31, 2015 (Department registered groundwater wells database) (Figure 6-2). The locations of all active groundwater wells can be seen in Figure 6-3.

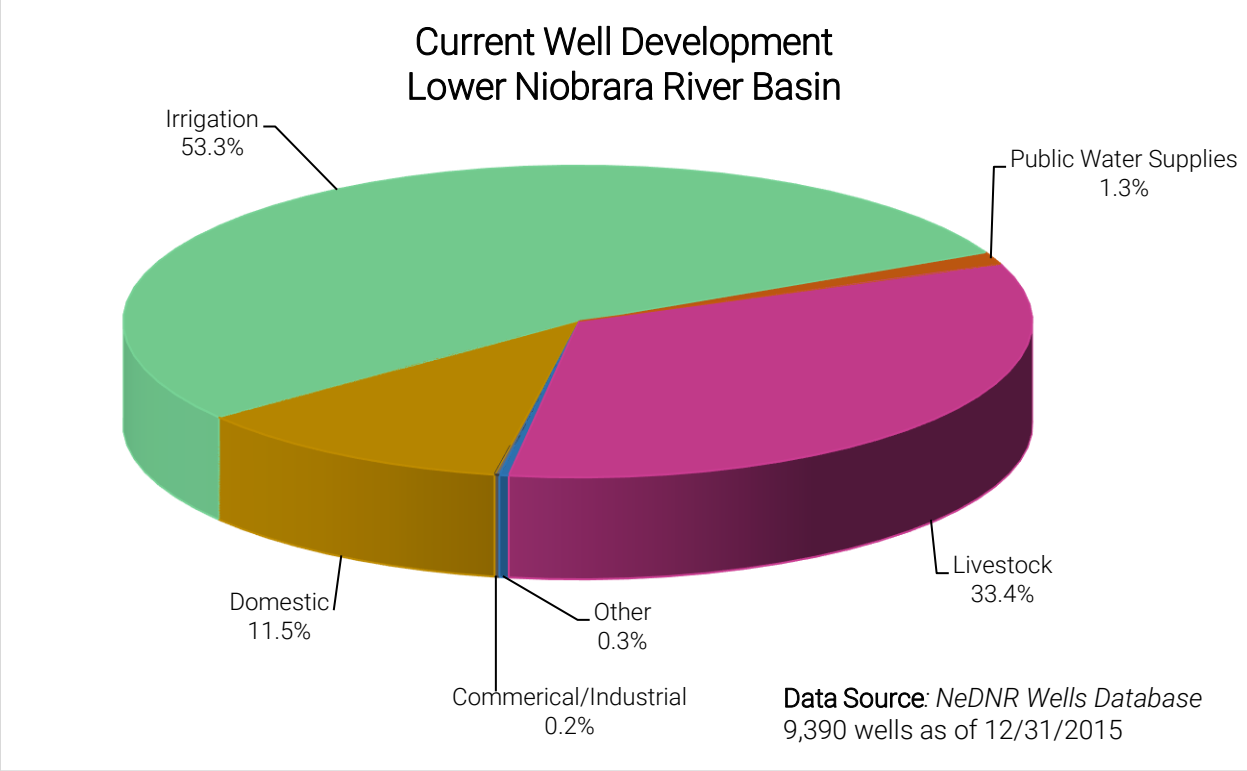

Figure 6-2. Current well development by number of registered wells, Lower Niobrara River Basin.

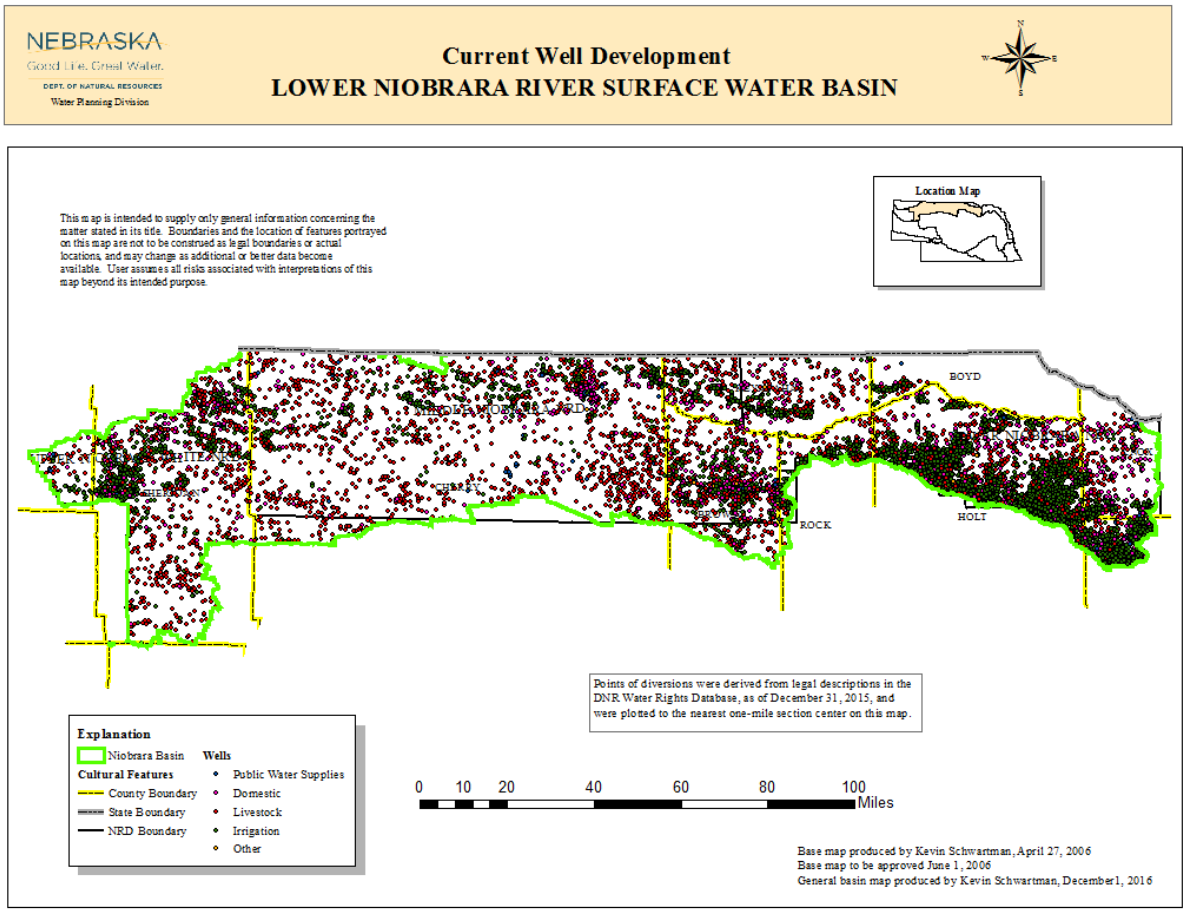

Figure 6-3. Current well locations, Lower Niobrara River Basin.

6.3.2 Surface Water

As of December 31, 2015, 757 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.

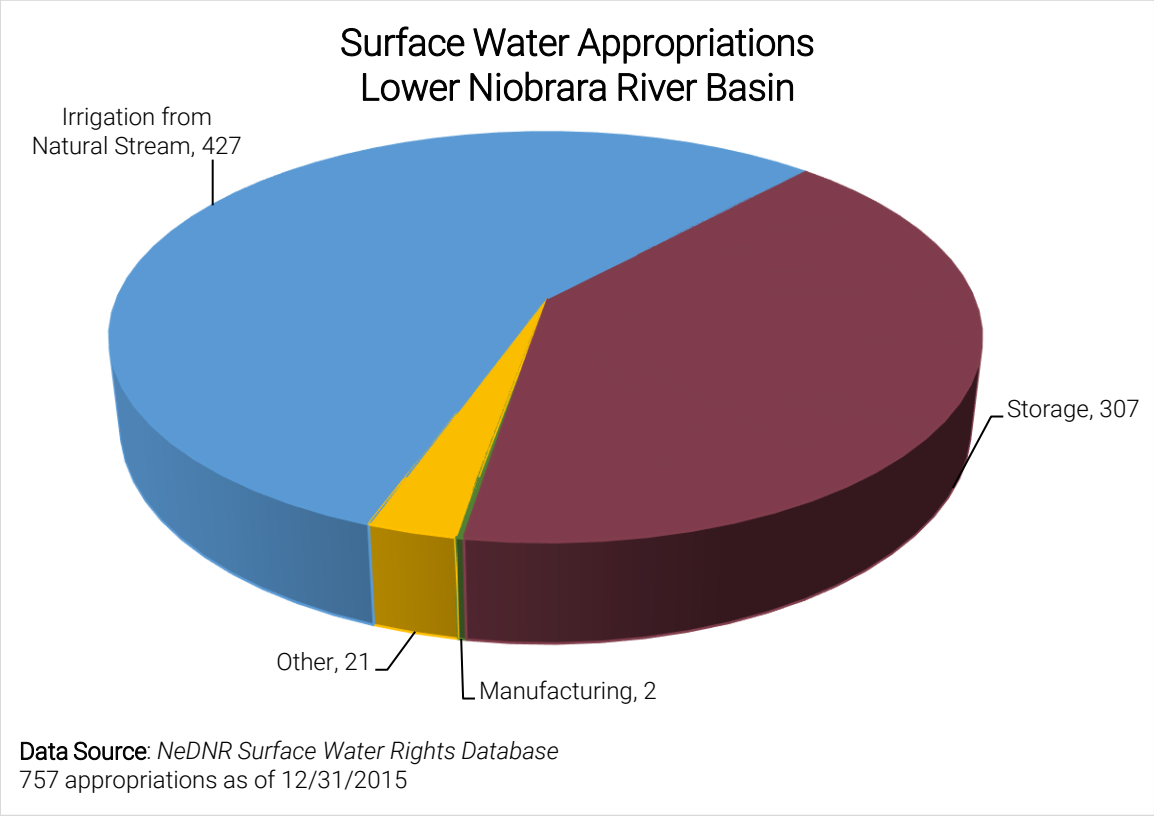

Figure 6-4. Surface water appropriations by number of diversion points, Lower Niobrara River Basin.

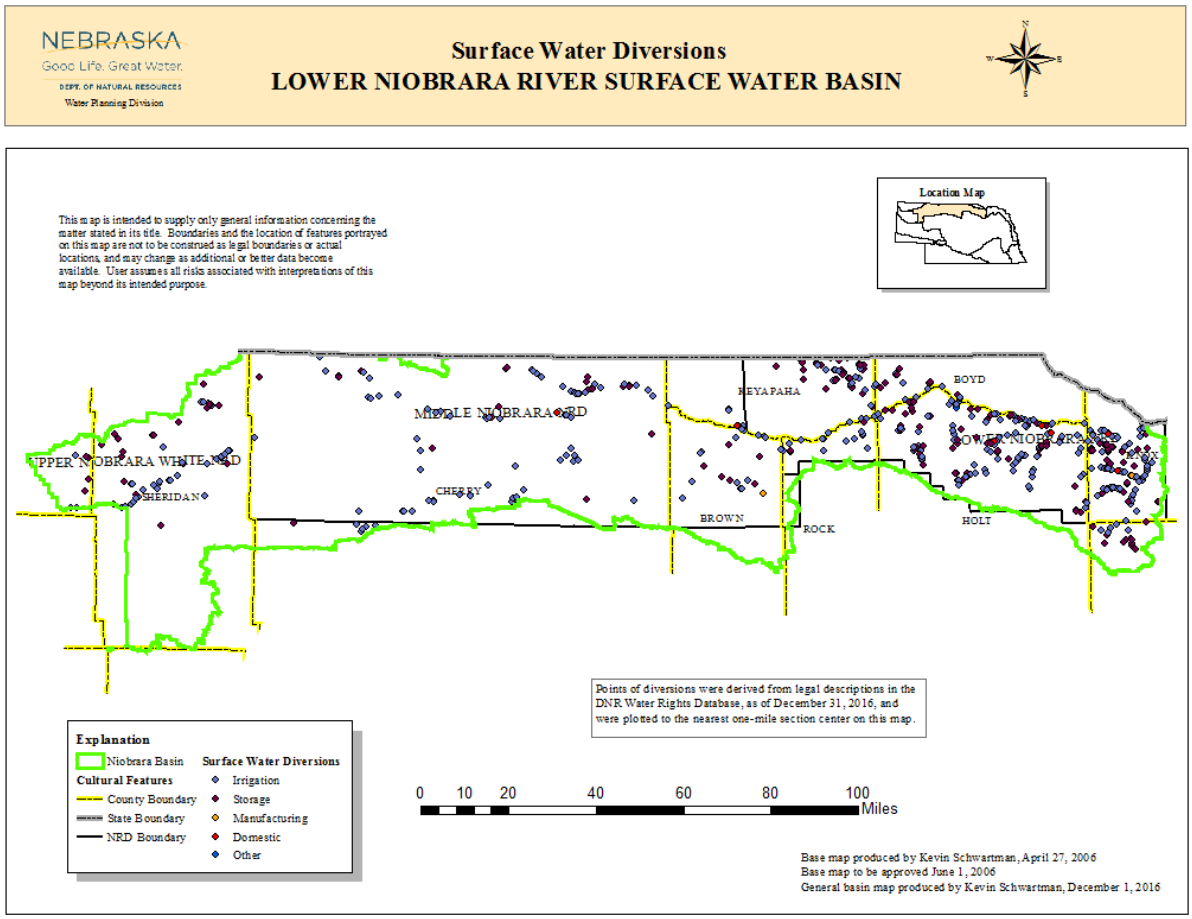

Figure 6-5. Surface water appropriation diversion locations, Lower Niobrara River Basin.

6.4 Hydrologically Connected Area

The CENEB model and Upper Niobrara-White model were 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.

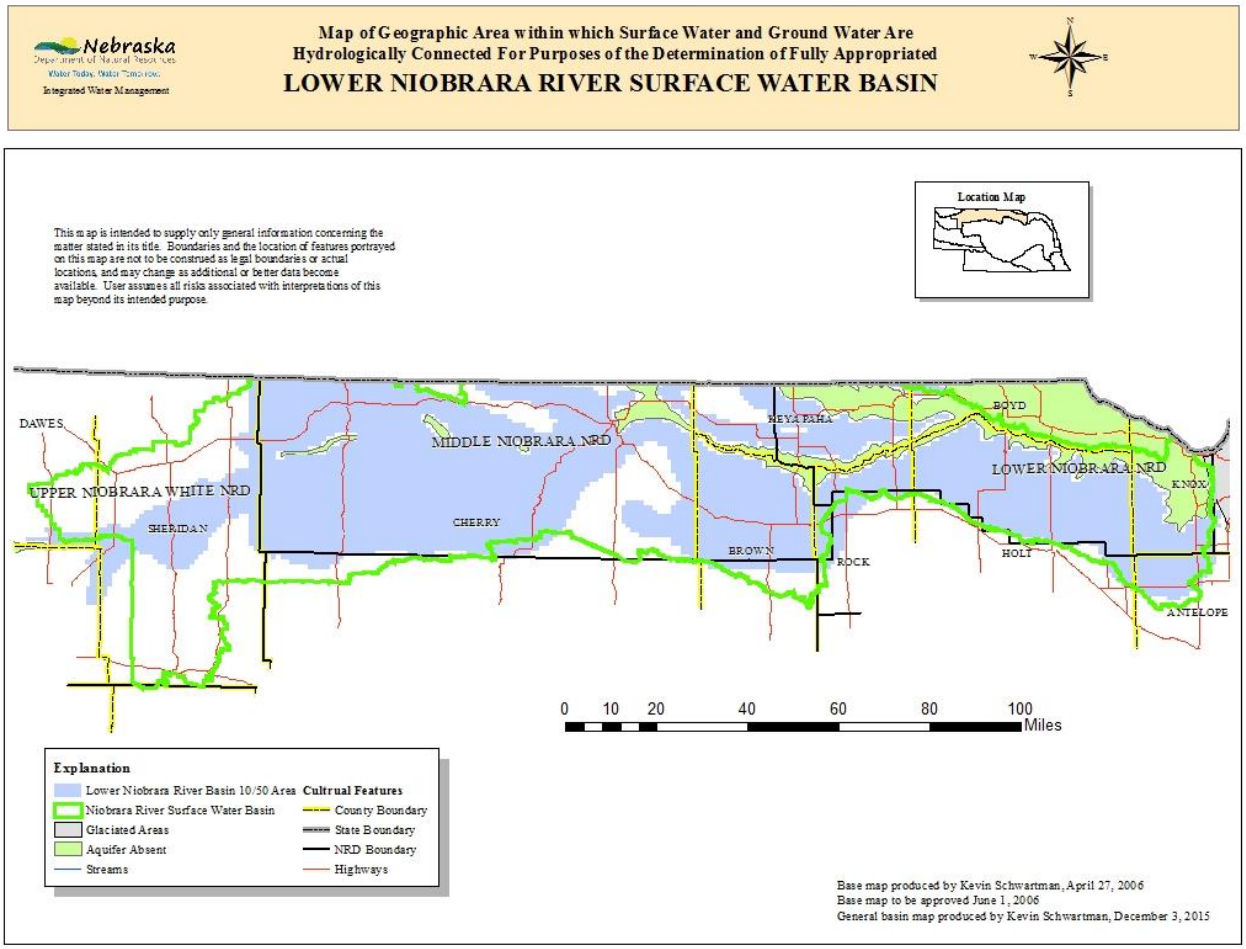

Figure 6-6. 10/50 area, Lower Niobrara River Basin.

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 13.9 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 36.9 days annually to divert 65 percent of the NCCIR and between 30.9 and 48.3 days to divert 85 percent of the NCCIR.

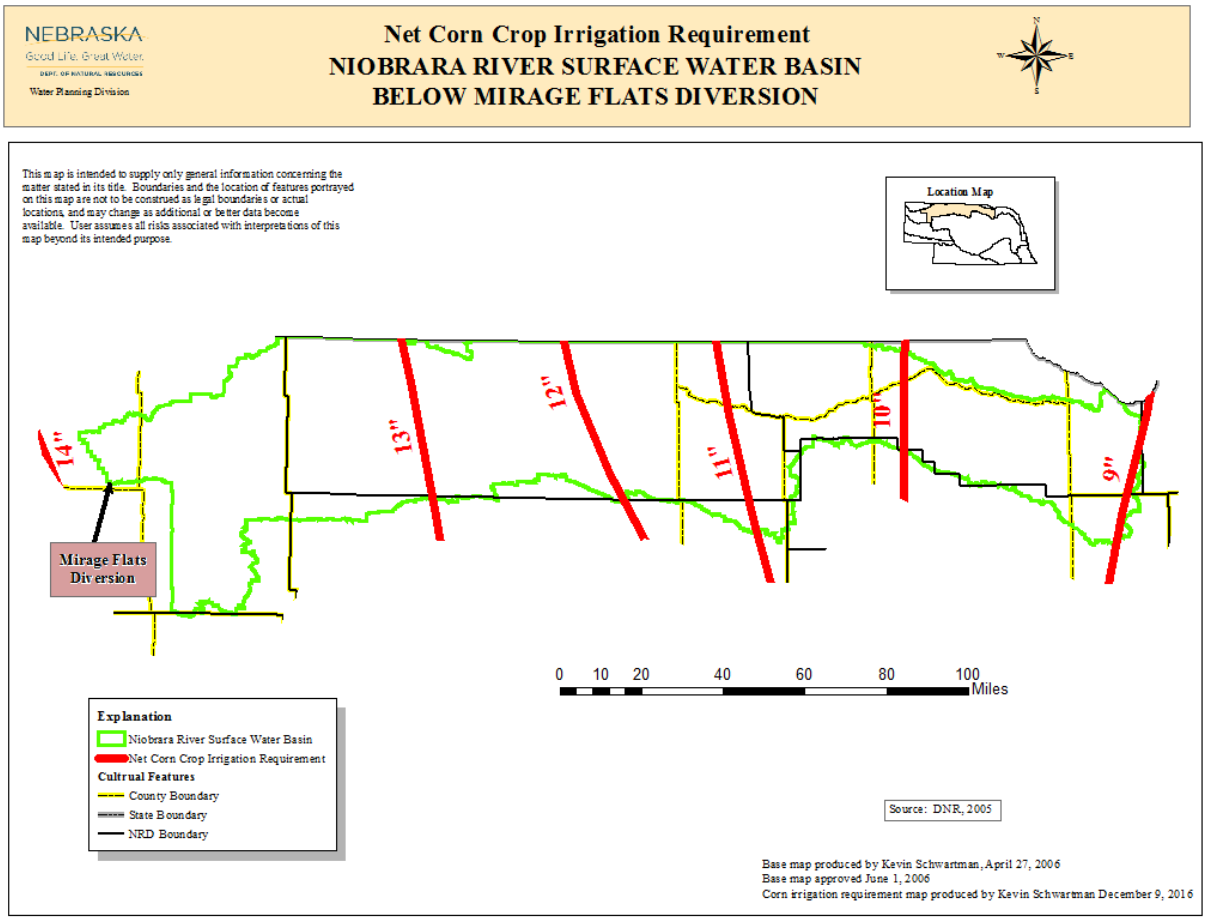

Figure 6-7. Net corn crop irrigation requirement (NCCIR), Lower Niobrara River Basin.

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 1996 and 2015.

Table 6-1. Surface water administration in the Lower Niobrara River Basin, 1996-2015.

Year	Water Body	Days	Closing Date	Opening Date
200	Niobrara River above Spencer Hydro	6	May 1	May 7
200	Niobrara River above Spencer Hydro	61	Aug 1	Oct 1
200	Niobrara River above Spencer Hydro	124	May 1	Oct 6
200	Niobrara River above Spencer Hydro	8	May 19	May 27
200	Niobrara River above Spencer Hydro	14	Jun 2	Jun 16
200	Niobrara River above Spencer Hydro	15	Jul 2	Jul 17
200	Niobrara River above Spencer Hydro	75	Jul 22	Oct 5
201	Niobrara River above Spencer Hydro	35	Aug 20	Sep 24
201	Niobrara River above Spencer Hydro	7	May 10	May 17
201	Niobrara River above Spencer Hydro	34	Jul 21	Aug 24
201	Niobrara River above Spencer Hydro	37	Sep 2	Oct 8
201	Niobrara River above Spencer Hydro	114	May 15	Sep 6
201	North Branch Verdigre Creek	38	Jul 13	Aug 20
201	Niobrara River above Spencer Hydro	7	Jul 31	Aug 7
201	Niobrara River above Spencer Hydro	61	Aug 14	Oct 14
201	Niobrara River above Spencer Hydro	90	Jul 9	Oct 7
201	Niobrara River above Spencer Hydro	67	Jul 16	Sep 21

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 (1996-2015) 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 at least 43.0 days available for diversion between July 1 and August 31 and 115.5 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.

Year	July 1 through August 31 Number of Days Surface Water is Available for Diversion	May 1 through September 30 Number of Days Surface Water is Available for Diversion
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	31	86
2008	0	0
2009	7	46
2010	51	118
2011	28	84
2012	0	39
2013	37	98
2014	9	70
2015	15	86
Average	43.0	115.5

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.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	Average Number of Days Available for Diversion with Current Development
July 1 – August 31 (65% Requirement)	23.6 to 36.9	43.0 (at least 6.1 days above the requirement)
May 1 – September 30 (85% Requirement)	30.9 to 48.3	115.5 (at least 67.2 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 upper 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.

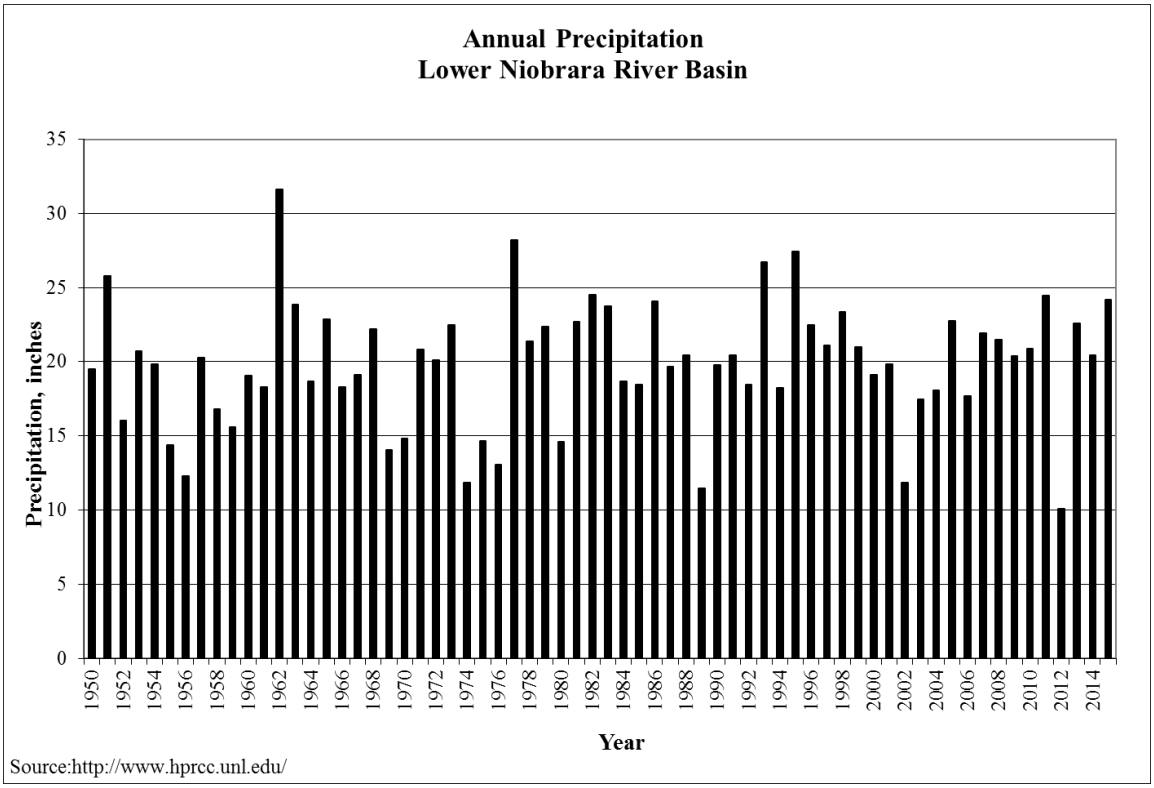

Figure 6-8. Annual precipitation, Lower Niobrara River Basin.

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 29 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 are calculated by comparing the depleted future streamflows with the flows necessary to satisfy the Spencer Hydropower right during the period that water administration has historically occurred (2007-2015). The results of the analyses are shown in Table 6-4 and are compared to the numbers of days surface water is required to be available to divert

65 percent and 85 percent of the NCCIR in Table 6-5. The estimated long-term surface water supply, given current levels of development, is sufficient to satisfy the 65/85 rule.

Table 6-4. Estimate of days surface water is available for diversion in the Lower Niobrara River Basin with current development and 25-year lag impacts.

Year	July 1 through August 31 Number of Days Surface Water is Available for Diversion	May 1 through September 30 Number of Days Surface Water is Available for Diversion
1	62	153
2	62	152
3	62	153
4	62	153
5	62	153
6	62	153
7	62	152
8	62	153
9	62	153
10	62	153
11	62	153
12	31	86
13	0	0
14	7	45
15	50	117
16	28	84
17	0	39
18	37	95
19	9	68
20	14	85
Average	42.9	115.0

Table 6-5. Comparison between the number of days required to meet the net corn crop irrigation requirement and number of days surface water is available for diversion in the Lower Niobrara River Basin with current development and lag impacts.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	Average Number of Days Available for Diversion with Future Development and 25 Years of Lag Impacts
July 1 – August 31 (65% Requirement)	23.6 to 36.9	42.9 (6.0 days above the requirement)
May 1 – September 30 (85% Requirement)	30.9 to 48.3	115.0 (66.7 days above the requirement)

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 (Figures 6-9). The present-day rate of development is based on the linear trend of the previous 10 years of development in the basins. Based on the analysis of the past 10 years of development, the rate of increase in high-capacity wells is estimated to be 135 wells per year in the Lower Niobrara River Basin. This rate does not reflect all of the current limits on new wells that are currently in place within the basin.

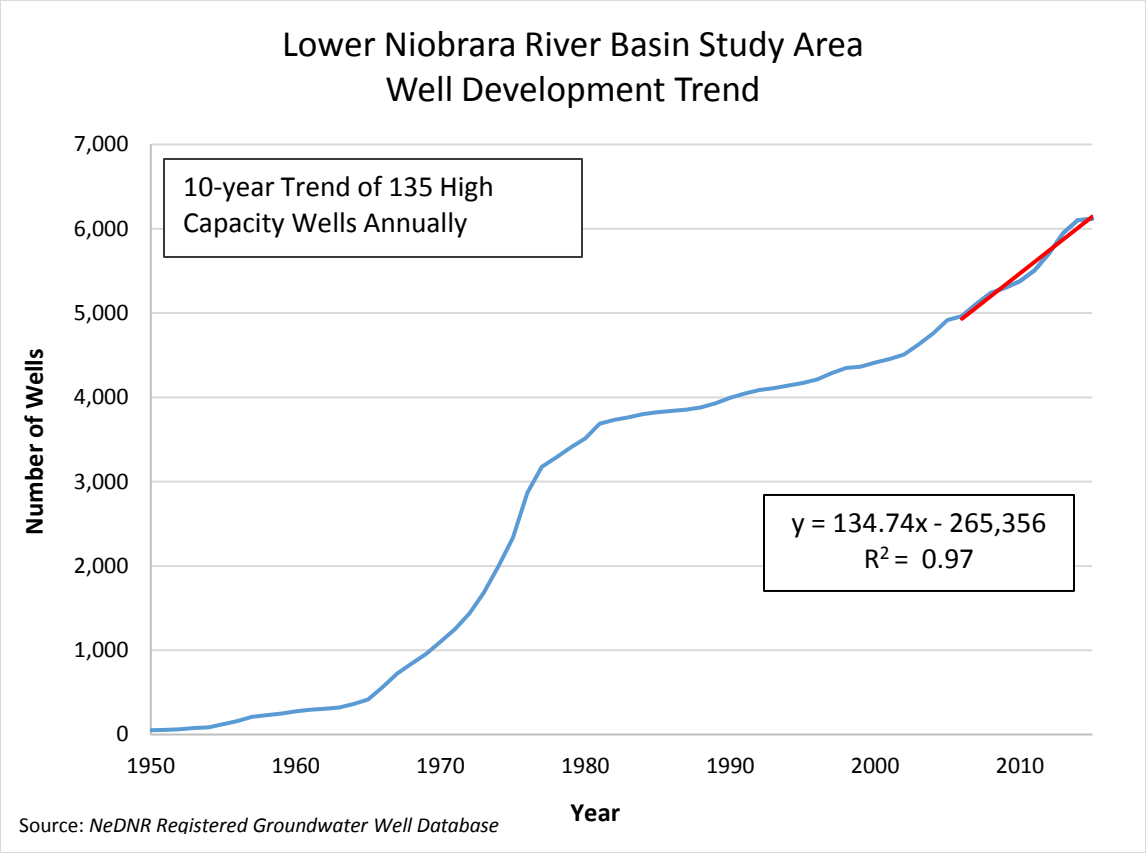

Figure 6-9. High capacity well development in the Lower Niobrara River Basin.

The future depletions due to current and future well development that could be expected to affect streamflow in the basin were estimated using the CENEB model. The results estimate the streamflow in the Lower Niobrara River Basin will be depleted by an additional 84 cfs in 25 years due to this estimate of future development.

The estimate of the 20-year average number of days surface water is available for diversion with additional future development is calculated by comparing the depleted future streamflows with the flows necessary to satisfy the Spencer Hydropower right during the period that water administration has historically occurred (2007-2015). The results of the analyses are shown in Table 6-6 and are compared to the numbers of days surface water is required to be available to divert 65 percent and 85 percent of the NCCIR in Table 6-7. The estimated long-term surface water supply, given this projected level of development, is sufficient to satisfy the 65/85 rule. The results indicate that, based on current

information, the Department's conclusion that the basin is not fully appropriated would not change if no additional constraints are placed on future development of surface water and groundwater in the basin.

Table 6-6. Estimated number of days surface water is available for diversion in the Lower Niobrara River Basin with current and predicted future development.

Year	July 1 through August 31 Number of Days Surface Water is Available for Diversion	May 1 through September 30 Number of Days Surface Water is Available for Diversion
1	62	145
2	62	147
3	62	148
4	61	149
5	62	152
6	62	149
7	62	151
8	62	153
9	62	153
10	62	151
11	62	153
12	31	83
13	0	0
14	6	37
15	49	110
16	28	79
17	0	37
18	37	94
19	9	64
20	13	82
Average	42.7	111.9

Table 6-7. Comparison between the number of days required to meet the net corn crop irrigation requirement and number of days surface water is available for diversion in the Lower Niobrara River Basin with current and predicted future development.

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	Average Number of Days Available for Diversion with Future Development and 25 Years of Lag Impacts
July 1 – August 31 (65% Requirement)	23.6 to 36.9	42.7 (5.8 days above the requirement)
May 1 – September 30 (85% Requirement)	30.9 to 48.3	111.9 (63.6 days above the requirement)

6.9 Instream Flow Surface Water Appropriation Analysis

The Nebraska Game and Parks Commission's holds two instream flow rights within the Lower Niobrara River Basin. These two rights are located on Long Pine Creek. The purpose of these rights is to maintain habitat for the fish community. Therefore, the Department determined that an appropriate standard of interference would be to determine whether the instream flow requirements that could be met at the time the water rights were granted can still be met today.

To calculate the average monthly flow that the instream flow permits could have expected at the time they were granted, the 20-year period prior to the permits being granted (1969-1988) was used. In conducting this analysis, the lag impacts were calculated for development through 1988 and subtracted from the daily flows (see Section 4.2.4 for more detail). The average number of days that flows were available for each month at the time the appropriations were obtained and compared against the current average number of days that flows are available for each month. The results are shown in Table 6-8.

The results in Table 6-8 indicate that the instream flow appropriation is not expected to experience erosion of the water right for any month. Thus, the long-term surface water supply estimate in the basin is sufficient for the instream flow appropriations in the basin, based on the current level of development and the calculated 25 year lag impacts.

Table 6-8. Number of days Long Pine Creek instream flow appropriation is expected to be met.

Month	Number of Days Flows Met at Time of Application [1]	Number of Days Flows Met With Current Development [2]	Difference in the Number of Days Instream Flow Appropriation is Currently Met
October	31.0	31.0	0
November	30.0	30.0	0
December	31.0	31.0	0
January	31.0	31.0	0
February	28.3	28.3	0
March	31.0	31.0	0
April	30.0	30.0	0
May	31.0	31.0	0
June	30.0	30.0	0
July	31.0	31.0	0
August	31.0	31.0	0
September	30.0	30.0	0

[1] The number of days instream flows would be expected to be met at the time of application (1969-1988) with lag effects of well development at the time of the appropriation.
[2] The number of days instream flows would be expected to be met at current time (1996-2015) with lag effects of current well development.

6.10 Sufficiency to Avoid Noncompliance

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

6.11 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.

6.12 Current Studies Being Conducted to Assist with Future Analysis

The Department and NRDs with areas hydrologically connected to streams within the basin are currently working to develop a basin-wide plan for integrated management of the water resources within the basin. Additionally, the Lower Niobrara NRD has completed a voluntary integrated management plan and the Middle Niobrara NRD is currently working with the Department to develop an integrated management plan. The Upper Niobrara-White NRD completed an integrated management plan for the fully appropriated portions of the District in 2009.

To assess water resources in the Upper Niobrara White NRD, the Department and NRD are working together on various types of analysis to better determine the future long term condition of groundwater and baseflow in the area utilizing the Department's Conjunctive Use Model.

6.13 Relevant Data Provided by Interested Parties

The Department published a request for relevant data from interested parties for this year's evaluation on November 23, 2016 (see Appendix B for affidavit). The Department did not receive any such information.

6.14 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 under the current rule. The Department has also determined that, based on current information, if no additional legal constraints are imposed on future development of hydrologically connected surface water and groundwater, and reasonable projections are made about the extent and location of future development, this preliminary conclusion would not change to a conclusion that the basin is fully appropriated.

The analysis of lag effects of current development for areas in the Lower Niobrara River Basin indicates a reduction in streamflows of 29 cfs in 25 years. The analysis of the impacts of potential future development in the Lower Niobrara River Basin based on current development trends indicates an additional reduction in streamflows of 84 cfs in 25 years.

Although the basin has not been be determined to be fully appropriated using the methodology of the current rule, there may be times when supplies within the basin or a particular subbasin are not sufficient to meet all demands in that basin or subbasin, as is shown by the Department's INSIGHT analysis. This is important for water managers to consider when developing a basin-wide plan or voluntary integrated management plan.

Bibliography of Hydrogeologic References for Lower Niobrara River Basin

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