

6.0 LOWER NIOBRARA RIVER BASIN

6.1 Summary

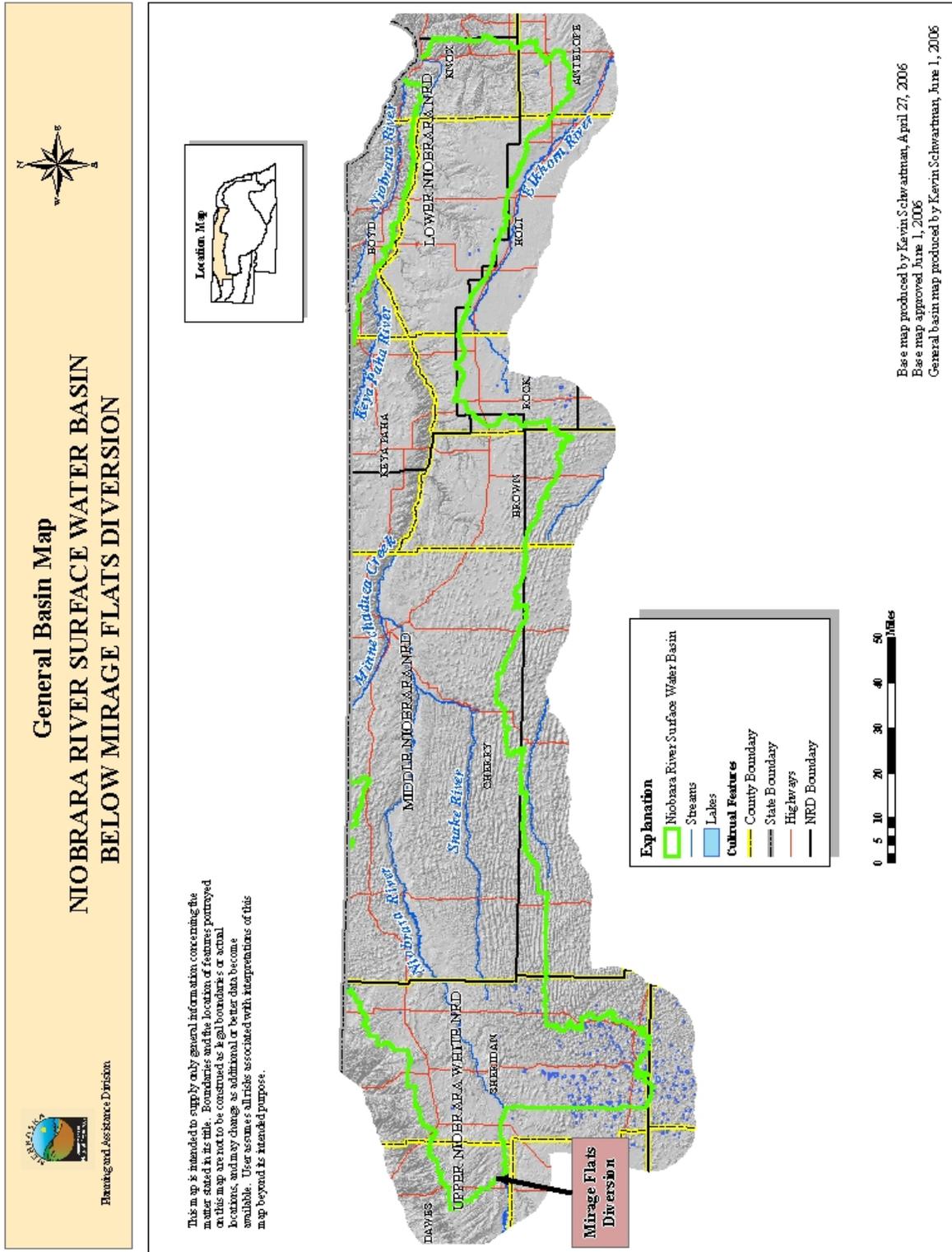
Based on the analysis of the sufficiency of the long-term surface water supply in the Lower Niobrara River Basin, the Department has reached a preliminary conclusion that the basin is fully appropriated upstream of the Spencer Hydropower facility. The designation as fully appropriated is the result of two factors. The first factor is that the current number of days available for diversion is less than the necessary crop irrigation requirements for junior irrigators within the basin. The second factor is that those irrigation rights which are junior to the calling senior right are currently receiving less water than was available for the twenty-year period prior to the granting of the appropriations. This preliminary conclusion differs from the preliminary conclusion found in last year's report in part because, prior to 2007, no call had been made to administer for the rights of the Spencer Hydropower facility. On March 5, 2007, the Department received a written request from Nebraska Public Power District (NPPD) to administer the water rights on the Niobrara River when flows fall below those to which NPPD's permits are entitled in order to generate electricity. Therefore, irrigators junior to the Spencer Hydropower rights were closed while administration was occurring on the river upstream of Spencer Hydropower. Some irrigators chose to pay NPPD to subordinate its water rights, in accordance with Nebraska law. Those irrigators were not closed, and the amount of water for which NPPD could call was lowered accordingly.

The basin downstream of the Spencer Hydropower facility is not currently included in the fully appropriated designation for the Lower Niobrara River Basin. The effects of future ground water depletions on future water supplies were estimated for the basin downstream of the Spencer Hydropower facility, but, due to a lack of administration, the number of days available for diversion in the future was could not be estimated.

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 have not previously been determined to be fully appropriated. 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 Niobrara River surface water basin is approximately 8,900 square miles. Natural resources districts with significant area in the basin are the Upper Niobrara White Natural Resources District, the Middle Niobrara Natural Resources District, and the Lower Niobrara Natural Resources District.

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



6.3 Nature and Extent of Water Use

6.3.1 Ground Water

Ground water in the basin is used for a variety of purposes: domestic, industrial, livestock, irrigation, and other uses. A total of 7,023 ground water wells had been registered within the basin as of December 31, 2006 (Department registered ground water wells database), with an estimated 310 ground water wells to be developed during 2007 (Figure 6-2). The locations of all active ground water wells can be seen in Figure 6-3.

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

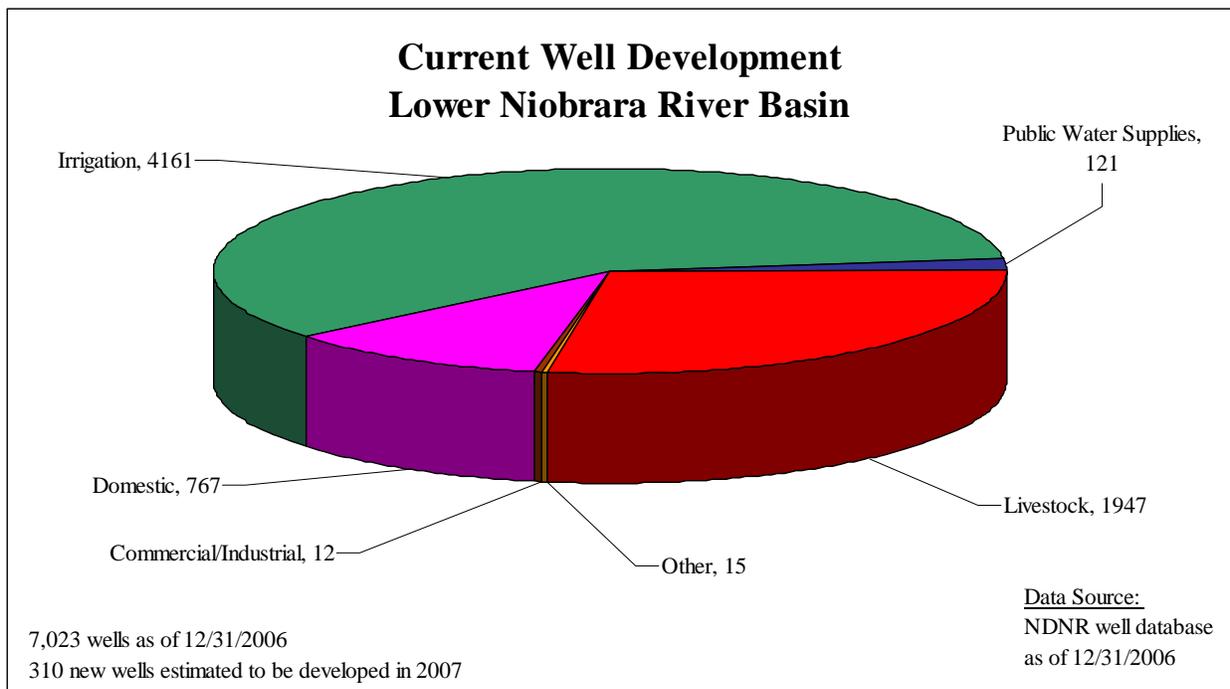
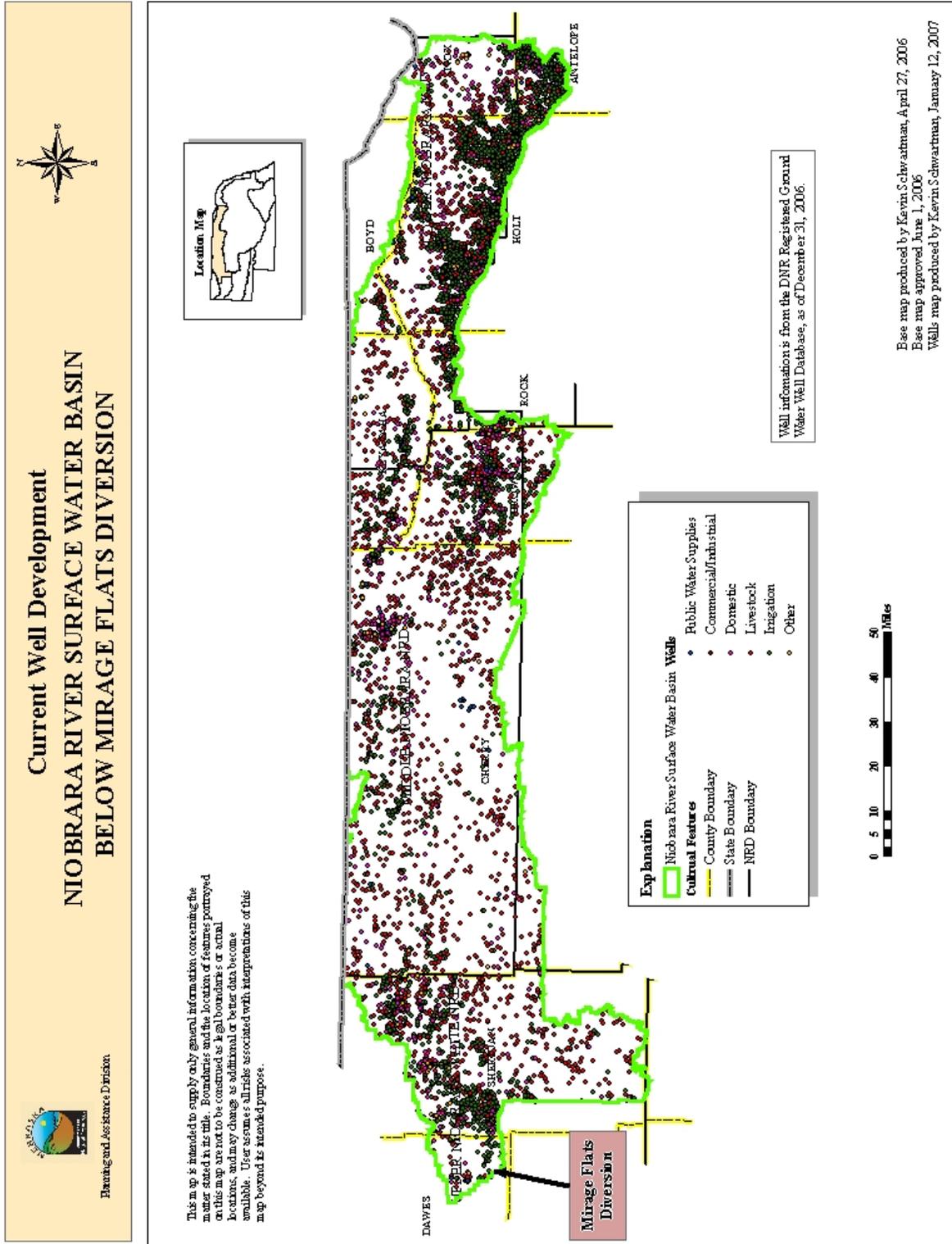


Figure 6-3 Current well locations, Lower Niobrara River Basin



6.3.2 Surface Water

As of December 31, 2006, there were 845 surface water appropriations in the 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. There is an instream flow appropriation in the basin located on Long Pine Creek and a hydropower appropriation on the Niobrara River near Spencer. 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

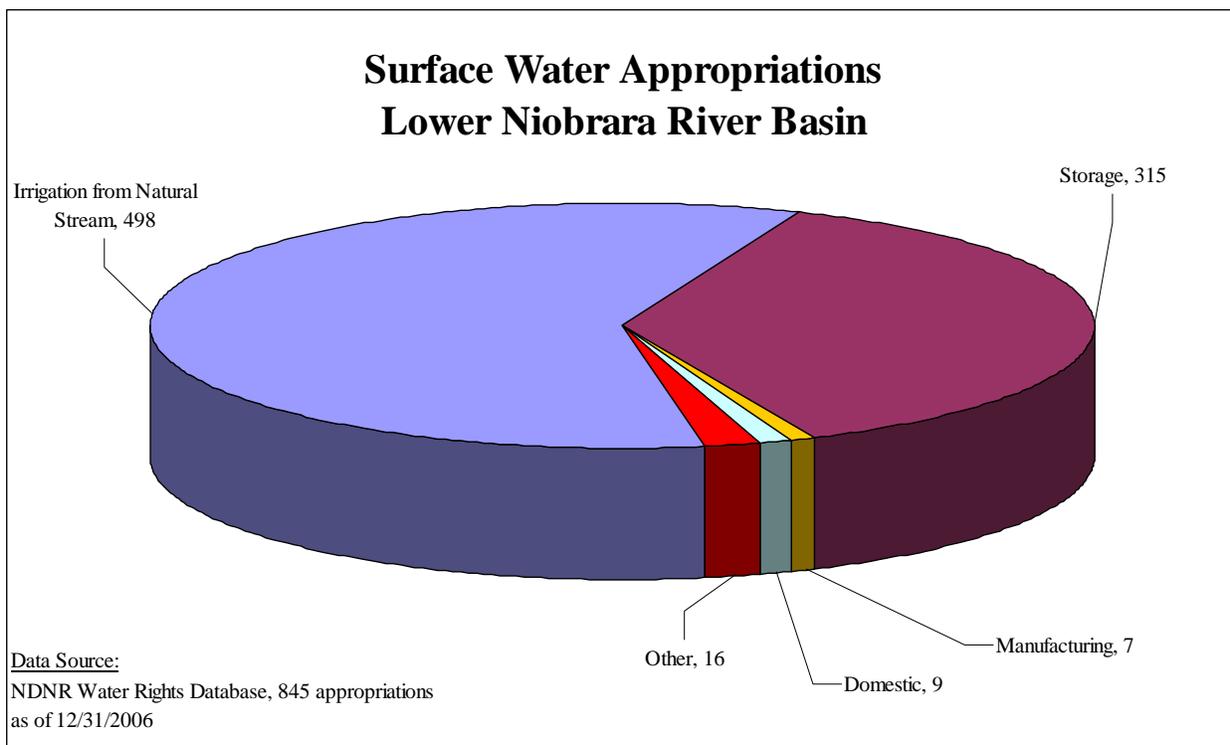
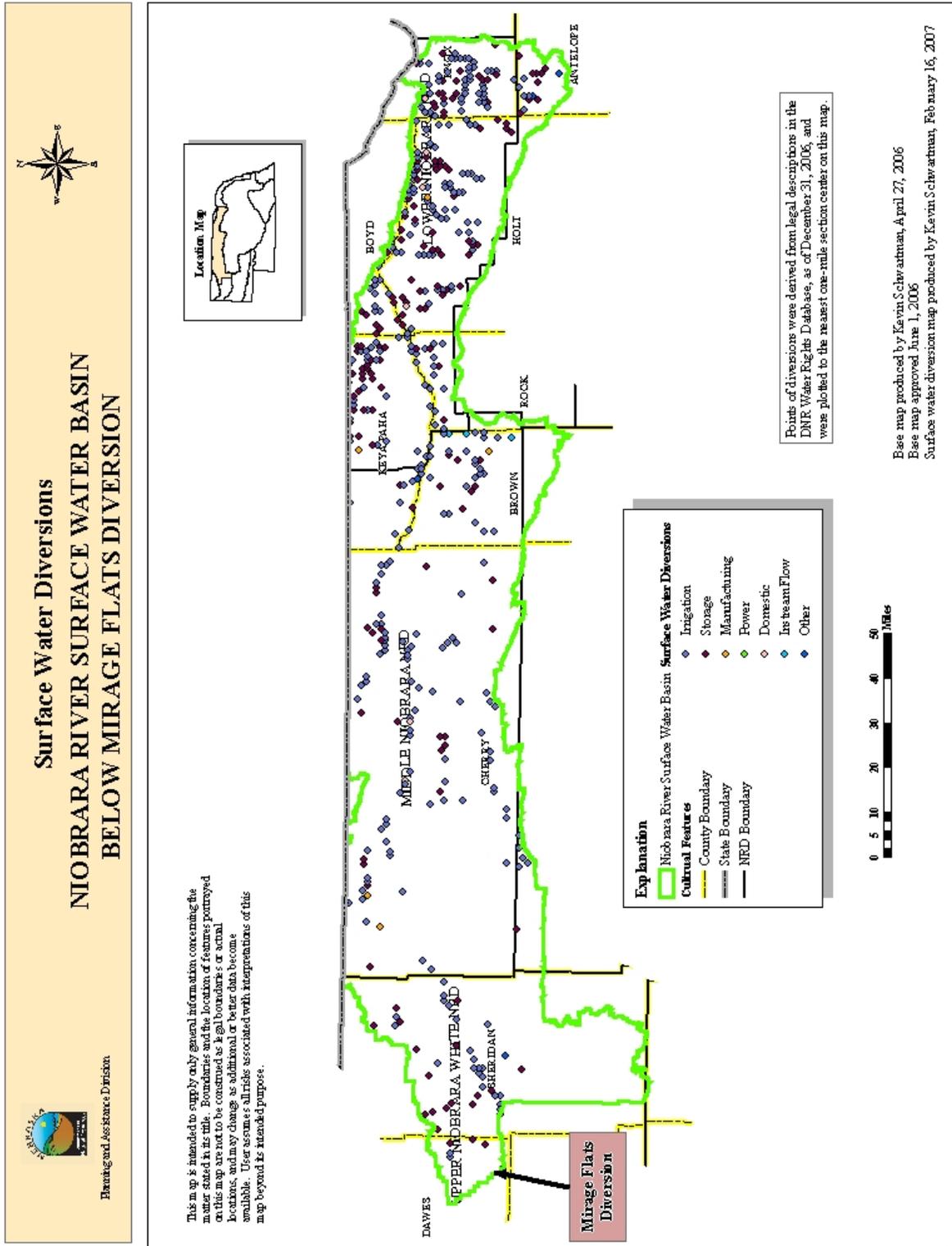


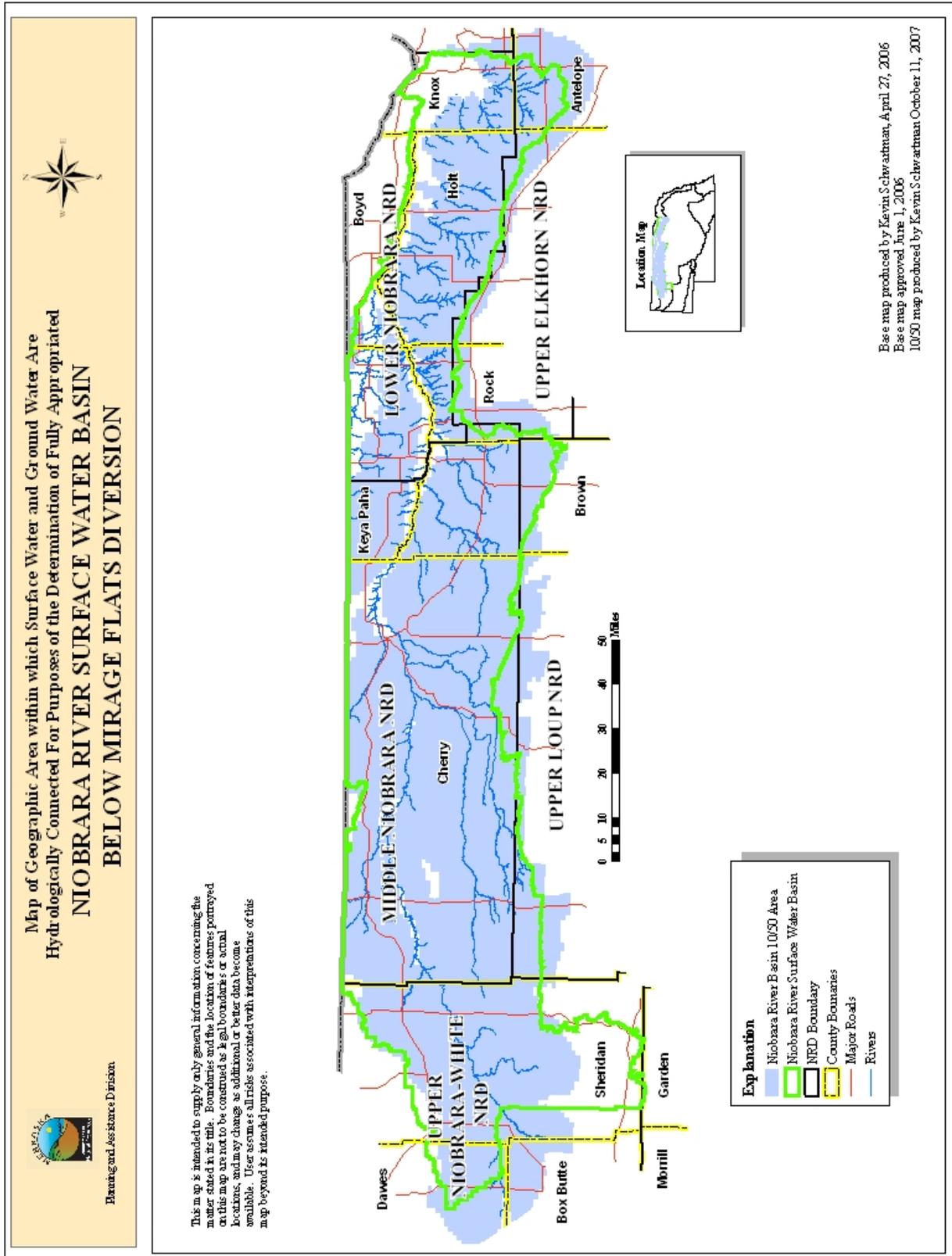
Figure 6-5 Surface water appropriation diversion locations, Lower Niobrara River Basin



6.4 Hydrologically Connected Area

No sufficient numeric ground water model is available in the Lower Niobrara River Basin to determine the 10/50 area. Therefore, the 10/50 area was determined using stream depletion factor (SDF) methodology. Figure 6-6 specifies the extent of the 10/50 area. A description of the SDF methodology used appears in the “Methodology” section of this report.

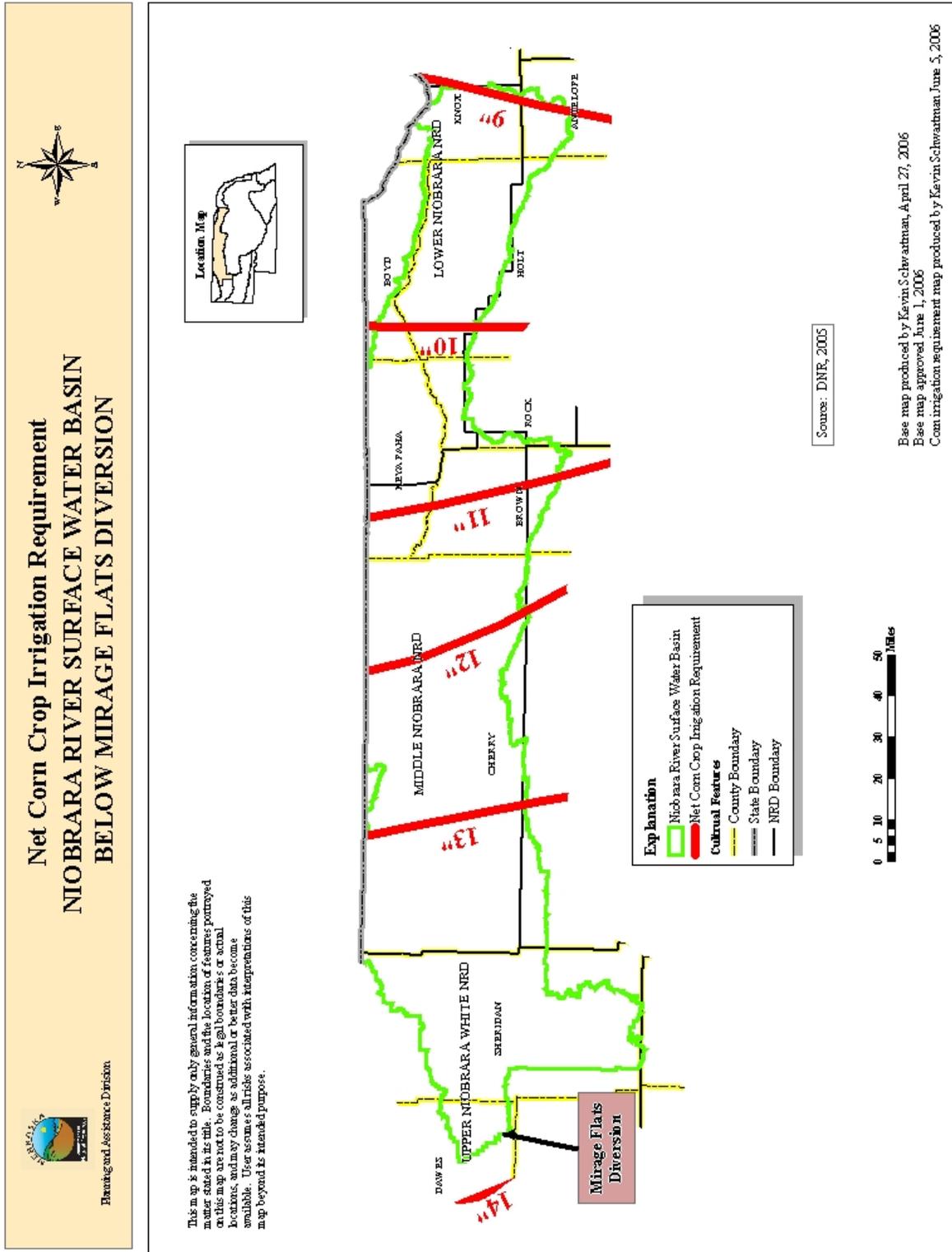
Figure 6-6 10/50 area, Lower Niobrara River Basin



6.5 Net Corn Crop Irrigation Requirement

Figure 6-7 is a map of the net corn crop irrigation requirement for the 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%, and an irrigation efficiency of 80% were assumed. Based on these assumptions, it will take the junior surface water appropriation in the Niobrara River Basin upstream of Spencer Hydropower 36.9 days annually to divert 65% of the NCCIR and 68.1 days to divert 85% of the NCCIR. Junior surface water appropriations in the Niobrara River Basin downstream of Spencer Hydropower will require between 23.6 and 25.6 days annually to divert 65% of the NCCIR and between 30.9 and 33.4 days to divert 85% of the NCCIR.

Figure 6-7 Net corn crop irrigation requirement, Lower Niobrara River Basin



6.6 Surface Water Closing Records

Table 6-1 records all surface water administration that has occurred in the basin between 1987 and 2006.

Table 6-1 Surface water administration in the Lower Niobrara River Basin, 1987-2006

Year	Water Body	Days	Closing Date	Opening Date
1991	North Branch Verdigre Creek	3	Jul 26	Jul 29

In May 2007, the entire Niobrara River Basin upstream of the Spencer Hydropower facility was closed to appropriations junior to NPPD's permits due to NPPD's call for administration. The closing orders were lifted soon after that, when NPPD took the hydropower plant offline for regularly scheduled maintenance. NPPD then withdrew its call until August 1, in order to allow those irrigators who chose to do so time to enter into subordination agreements with NPPD.

6.7 Evaluation of Current Development

6.7.1 Current Water Supply

The previous twenty-year period was used as an estimate of the expected future twenty-year flows. In 2007, NPPD, the owner of the Spencer Hydropower facility and holder of surface water permits for power production, notified the Department that, beginning in 2007 and continuing into the future, it will request administration for its water rights. Thus, to analyze the availability of water for irrigation rights above the Spencer Hydropower facility, the Department analyzed the last twenty years of flows to predict the expected number of days that irrigation rights junior to the Spencer Hydropower facility would be turned off for the senior Spencer Hydropower right. When the senior appropriation (Spencer Hydropower) is satisfied, it is assumed that all junior irrigation rights are able to divert.

The results of the analysis conducted for the Lower Niobrara River Basin upstream of Spencer Hydropower and downstream of Spencer Hydropower are shown in Tables 6-2 and 6-3.

Table 6-2 Estimated number of days surface water is available for diversion upstream of Spencer Hydropower with current development

Year	July 1 though 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
1987	4	16
1988	2	34
1989	0	0
1990	0	13
1991	0	34
1992	5	6
1993	16	37
1994	2	17
1995	0	62
1996	0	64
1997	6	43
1998	8	41
1999	8	45
2000	0	13
2001	3	19
2002	0	5
2003	0	15
2004	0	0
2005	0	27
2006	0	0
Average	2.7	24.6

Table 6-3 Estimated number of days surface water is available for diversion downstream of Spencer Hydropower with current development

Year	July 1 though 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
1987	62	153
1988	62	153
1989	62	153
1990	62	153
1991	59	150
1992	62	153
1993	62	153
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
Average	61.9	152.9

The comparison of the near-term water supply days available for diversion to the number of days surface water is required to be available to divert 65% and 85% of the NCCIR is detailed tables 6-4 and 6-5. The results indicate that the Lower Niobrara River Basin upstream of Spencer Hydropower provides to the most junior water right an average of 2.7 days available for diversion between July 1 and August 31 and 24.6 days available for diversion between May 1 and September 30. The Lower Niobrara River Basin downstream of Spencer Hydropower provides 61.9 days available for diversion between July 1 and August 31 and 152.9 days available for diversion between May 1 and September 30. The results indicate that the current water supply is unable to satisfy all the surface water

appropriations upstream of Spencer Hydropower but is able to satisfy all surface water appropriations downstream of Spencer Hydropower.

Table 6-4 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, Lower Niobrara River Basin upstream of Spencer Hydropower

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	Near-Term Supply Average Number of Days Available for Diversion (1987-2006)
July 1 – August 31 (65% Requirement)	36.9	2.7 days (34.2 days below the requirement)
May 1 – September 30 (85% Requirement)	48.3	24.6 days (23.7 days below the requirement)

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, Lower Niobrara River Basin downstream of Spencer Hydropower

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	Near-Term Supply Average Number of Days Available for Diversion (1987-2006)
July 1 – August 31 (65% Requirement)	23.6 to 25.6	61.9 days (at least 36.3 days above the requirement)
May 1 – September 30 (85% Requirement)	30.9 to 33.4	152.9 days (at least 119.5 days above the requirement)

6.7.2 Erosion of Irrigation Rights Upstream of Spencer Hydropower

The erosion rule was applied to evaluate whether, at the time that junior surface water irrigation appropriations upstream of Spencer Hydropower were granted, flows could have satisfied the 65/85 rule and, therefore, whether the junior rights have been eroded. The results of the analysis are shown in Table 6-6 below. The results indicate that a junior surface water irrigation appropriation granted in 2001 would have been able to divert on average 4.0 days between July 1 and August 31 and 31.0 days between May 1 and September 30 for the twenty-year period prior to 2001. This is greater than the average number of days that are currently available for diversion (2.7 days between July 1 and August 31 and 24.6 days between May 1 and September 30) by 1.3 days and 6.5 days, respectively. Thus, the junior irrigation rights have been eroded. As a result of the analysis, the Niobrara River upstream of Spencer Hydropower is designated fully appropriated.

Table 6-6 Comparison between the number of days available to junior appropriators for diversion at the time appropriations were obtained and the number of days currently available for diversion, in the Lower Niobrara River Basin upstream of Spencer Hydropower

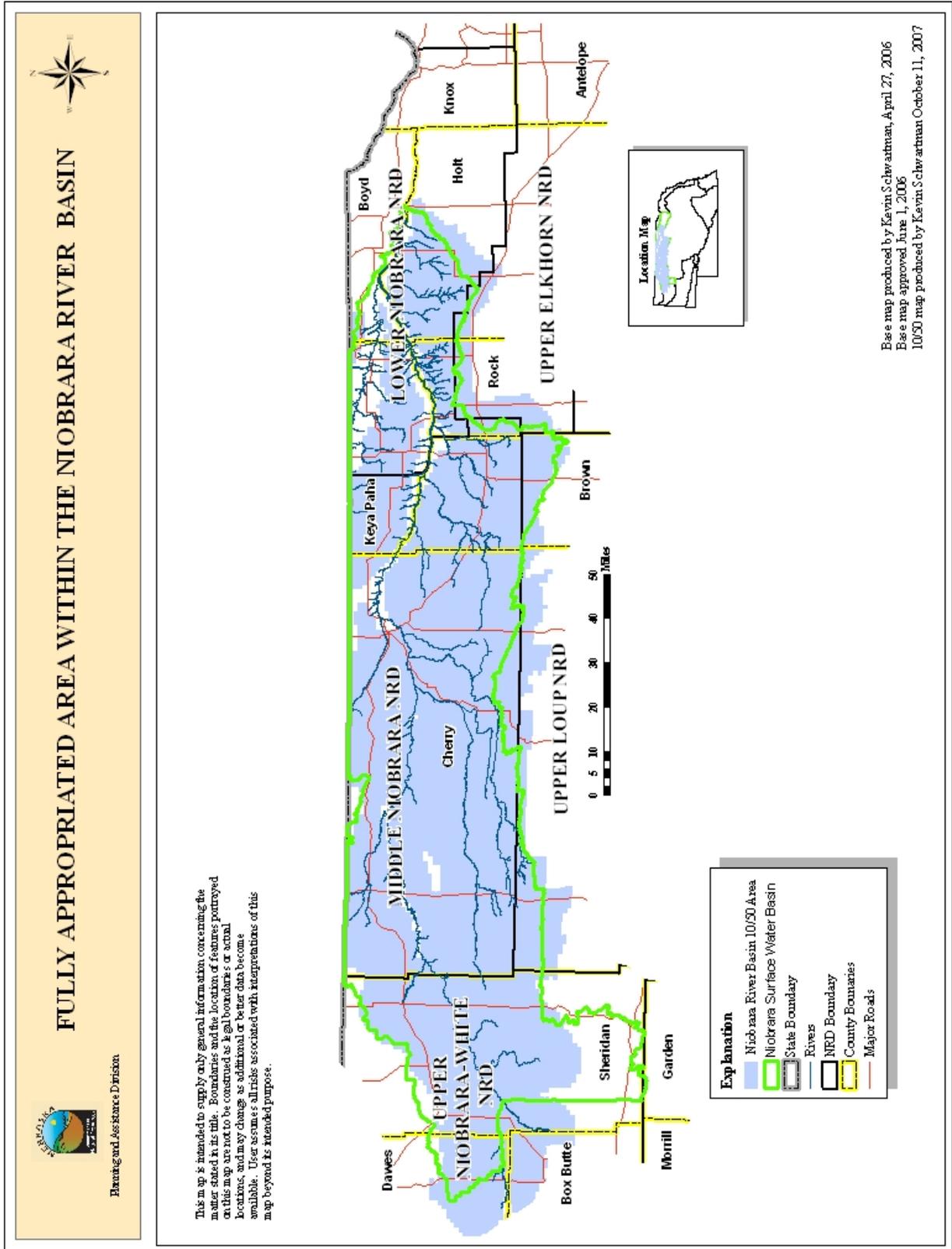
	Number of Days Required to Meet the Net Corn Crop Irrigation Requirement	Number of Days Available to a Junior Irrigator between 1982-2001	Number of Days Currently Available for Diversion (1987-2006)
July 1 – August 31 (65% Requirement)	36.9	4.0	2.7
May 1 – September 30 (85% Requirement)	48.3	31.0	24.6

6.7.3 Fully Appropriated Area

Based on the analysis of current water supplies, the hydrologically connected subbasin upstream of the Spencer Hydropower facility is considered to be fully appropriated (Figure 6-8). The calculation of lag

impacts from existing wells was not completed for the subbasin upstream of the Spencer Hydropower facility, because the addition of impacts from wells would only further decrease future water supplies.

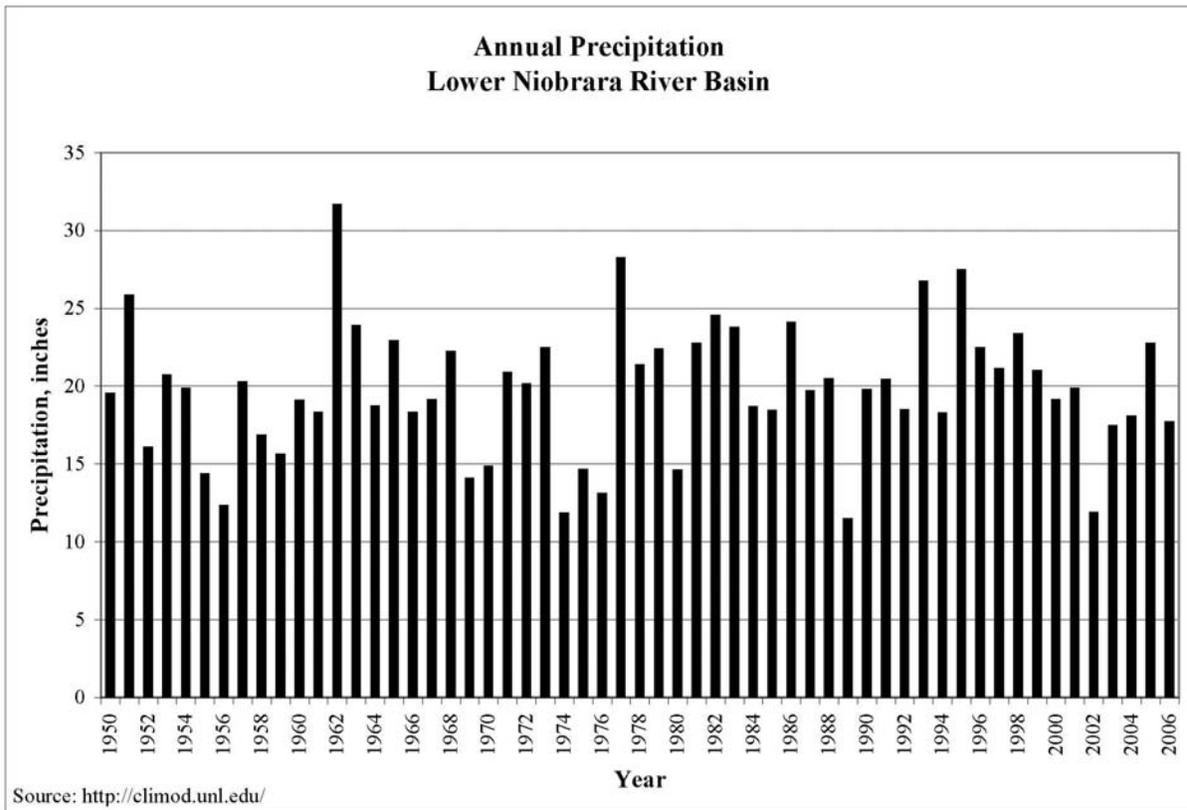
Figure 6-8 Area designated as fully appropriated within the Niobrara River Basin



6.7.4 Future Water Supply for Niobrara Subbasin Downstream of Spencer Hydropower Facility

In order to complete the long-term evaluation of surface water supplies for the Lower Niobrara River Basin downstream of Spencer Hydropower, a future twenty-year water supply for this portion of the basin must be estimated. The basin's water sources are precipitation, which runs off as direct streamflow and infiltrates into the ground to discharge as baseflow, ground water 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 fifty years (Figure 6-9). No statistical analyses of ground water movement into the basin or streamflow from the upper Niobrara River were made due to the lack of data. Therefore, using the previous twenty years of streamflow data as the best estimate of the future surface water supply is a reasonable starting point for applying the lag depletions from ground water wells.

Figure 6-9 Annual precipitation, Lower Niobrara River Basin



6.7.5 Depletions Analysis for Niobrara Subbasin Downstream of Spencer Hydropower Facility

The future depletions analysis was not conducted for the Niobrara River upstream of Spencer Hydropower, since current levels of development are already unable to satisfy the 65/85 rule and the erosion rule. The depletion analysis was performed on the basin downstream of Spencer Hydropower to estimate expected depletions to streamflow. The SDF methodology, as documented in the “Methodology” section, was used to conduct this analysis. The results estimate the future streamflow at the mouth of the Niobrara River would be depleted by 48 cfs in twenty-five years due to lag impacts from current well development.

6.7.6 Evaluation of Current Levels of Development against Future Water Supplies

The comparison of the near-term water supply days available for diversion to the number of days surface water is required to be available to divert 65% and 85% of the NCCIR for the Niobrara River Basin downstream of Spencer Hydropower is detailed in Table 6-7. No estimate of the twenty-year average number of days available for diversion was made, because no surface water administration has historically occurred on the Niobrara River itself downstream of the Spencer Hydropower facility. 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 NCCIR. Thus, it is unlikely that this portion of the basin would be fully appropriated.

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, Lower Niobrara River Basin downstream of Spencer Hydropower

	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	Near-Term Supply Average Number of Days Available for Diversion (1987-2006)
July 1 – August 31 (65% Requirement)	23.6 to 25.6	61.9 days (at least 36.3 days above the requirement)
May 1 – September 30 (85% Requirement)	30.9 to 33.4	152.9 days (at least 119.5 days above the requirement)

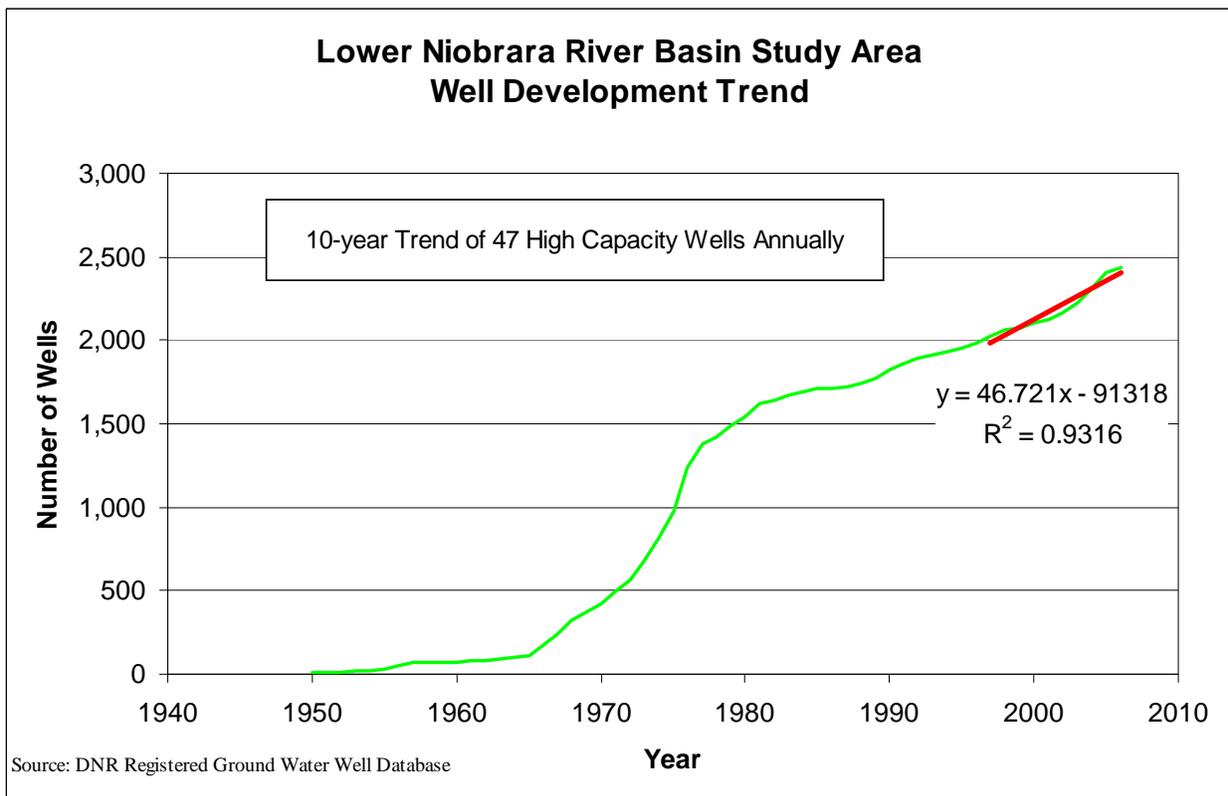
6.8 Evaluation of Predicted Future Development for Niobrara Subbasin Downstream of Spencer Hydropower Facility

As a result of designating the basin above Spencer Hydropower as fully appropriated, estimates of the number of high capacity wells (wells pumping greater than 50 gpm) that would be completed over the

next twenty-five years, if no new legal constraints on the construction of such wells were imposed, were calculated only for the Niobrara River Basin downstream of Spencer Hydropower. The estimated number of high capacity wells was calculated based on extrapolating the present-day rate of increase in well development into the future (Figure 6-10). The present-day rate of development is based on the linear trend of the previous ten years of development. Based on the analysis of the past ten years of development, the rate of increase in high capacity wells is estimated to be 47 wells per year in the basin.

For the depletion analysis, it is assumed that further ground water development will most likely be in the form of high capacity wells for irrigation purposes. Each future well was placed in an area where the soil is classified as irrigable by the U.S. Department of Agriculture and at least 1,400 feet away from existing high capacity wells, which is slightly larger than the radius of an average center pivot.

Figure 6-10 High capacity well development, Lower Niobrara River Basin downstream of Spencer Hydropower



The future depletions due to current and future well development that could be expected to affect streamflow in the basin were estimated using SDF methodology. The results estimate the future streamflow at the mouth of the Niobrara to be depleted by 125 cfs in ten years, 166 cfs in fifteen years, 232 cfs in twenty years, and 299 cfs in twenty-five years.

For the same reasons stated in Section 6.7.5 above, no estimates of future water supplies were computed. Even though the effects on 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 NCCIR in the Niobrara River Basin downstream of Spencer Hydropower. Therefore, it is unlikely that the lag effect will cause this portion of the basin to be fully appropriated.

6.9 Analysis of Long Pine Instream Flow Surface Water Appropriation

The future surface water supply for the instream flow appropriation in the basin was evaluated by applying the erosion rule on a monthly basis. The twenty-year estimate of the future average number of days when the instream flow appropriation would be met at the time of the appropriation application was compared to the twenty-year average estimate of the number days when the instream flow appropriations would be met using the future depleted surface water supply. The results are shown in Table 6-8. Results show no erosion in any month. The long-term surface water supply in the basin is sufficient for the instream flow appropriation in the basin.

Table 6-8 Long Pine Creek instream flow appropriation evaluation

Month	Estimate of Future Days When Flows Met at Time of Application	Estimate of Future Days Flows Met Using Long-Term Water Supply
October	31.0	31.0
November	30.0	30.0
December	31.0	31.0
January	31.0	31.0
February	28.0	28.0
March	31.0	31.0
April	30.0	30.0
May	31.0	31.0
June	30.0	30.0
July	31.0	31.0
August	31.0	31.0
September	30.0	30.0

6.10 Sufficiency to Avoid Noncompliance

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

6.11 Ground Water 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, for reasons explained in Appendix H.

6.12 Current Studies being Conducted to Assist with Future Analysis

A substantial portion of the Niobrara River Basin on the south side of the river is included in the Elkhorn-Loup ground water model (ELM), which is currently being developed to evaluate the ground water-surface water relationship and the water supply of the Elkhorn and Loup River Basins. Although not

developed specifically to evaluate the water supply in the Niobrara River Basin, this model may eventually be adapted to analyze water resources in the basin. Efforts will be made to incorporate results from this model into future reports.

6.13 Relevant Data Provided by Interested Parties

The Department received letters from two interested parties, the National Park Service and the U.S. Fish and Wildlife Service, concerning the social, economic, and environmental impacts of additional hydrologically connected surface water and ground water uses on the Fort Niobrara National Wildlife Refuge, the Niobrara Wilderness Area, and the Niobrara National Scenic River. The letters can be found in Appendix A and are included in this report for informational purposes, as required by Section 46-713(1)(c). The two federal agencies urged the Department to consider their potential, unquantified, federally reserved water rights in its evaluation of the Lower Niobrara River Basin; however, current methodology requires an interest to be represented by a quantifiable amount to be considered in the evaluation.

6.14 Conclusions

Based upon the evaluation of available information, the Department has reached a preliminary conclusion that the Lower Niobrara River Basin upstream of Spencer Hydropower is fully appropriated. The designation as fully appropriated is a result of two factors: 1) the current number of days available for diversion is less than the necessary to satisfy all water user including irrigators and the Spencer Hydropower facility and 2) irrigation rights that are junior to the calling senior right have been eroded. The Niobrara River Basin downstream of Spencer Hydropower is not currently included in the fully appropriated designation.

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.

Wen, F.J., and X.H. Chen. 2005. Streamflow trends and depletion study in Nebraska with a focus on the Republican River Basin. *Water Resources Research* (In Review).