5.0 BLUE RIVER BASINS

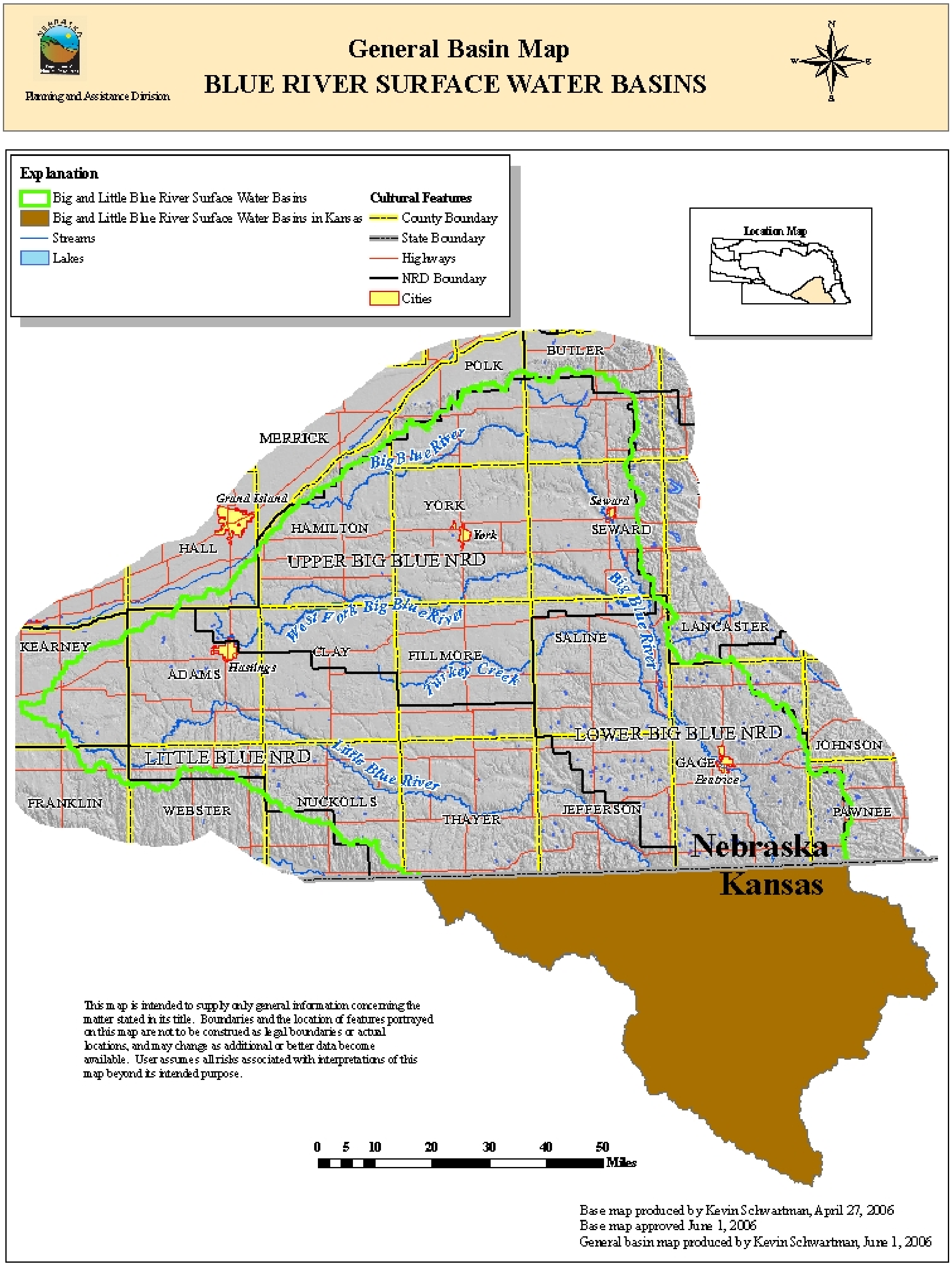
5.1 Summary

Based on the analysis of the sufficiency of the long-term surface water supply in the Blue River basins, the Department has reached a preliminary conclusion that the basins are not fully appropriated. Even though the effects of future ground water depletions on future water supplies were not estimated in the basins, 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. The best available data do not allow for analysis of whether this determination would change if no additional legal constraints are imposed on future development.

5.2 Basin Descriptions

The Blue River basins in Nebraska include all surface areas that drain into the Big Blue River and the Little Blue River and all aquifers that impact surface water flows of the basins (Figure 5-1). The total area of the Blue River surface water basins in Nebraska is approximately 7,100 square miles, of which 4,600 square miles are in the Big Blue River Basin and 2,500 square miles are in the Little Blue River Basin. Natural resources districts with significant area in the basins are the Little Blue Natural Resources District, the Lower Big Blue Natural Resources District, the Upper Big Blue Natural Resources District, and the Tri-Basin Natural Resources District. The basins are the subject of an interstate compact between Kansas and Nebraska that sets state-line target flows.

Figure 5-1 General basin map, Blue River basins



5.3 Nature and Extent of Water Use

5.3.1 Ground Water

Ground water in the basins is used for a variety of purposes: domestic, industrial, livestock, irrigation, and other uses. A total of 24,765 ground water wells had been registered within the basins as of December 31, 2006 (Department registered ground water wells database), with an estimated 640 ground water wells to be developed during 2007 (Figure 5-2). The locations of all active ground water wells are shown in Figure 5-3.

Figure 5-2 Current well development by number of registered wells, Blue River basins

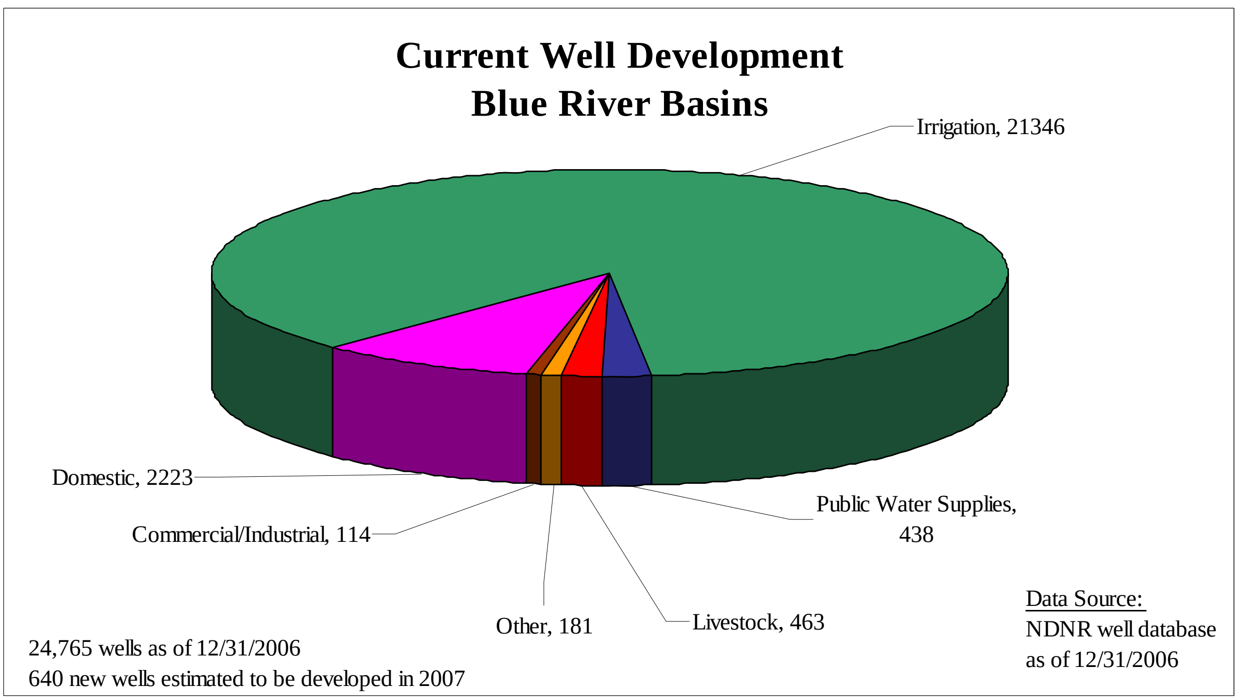
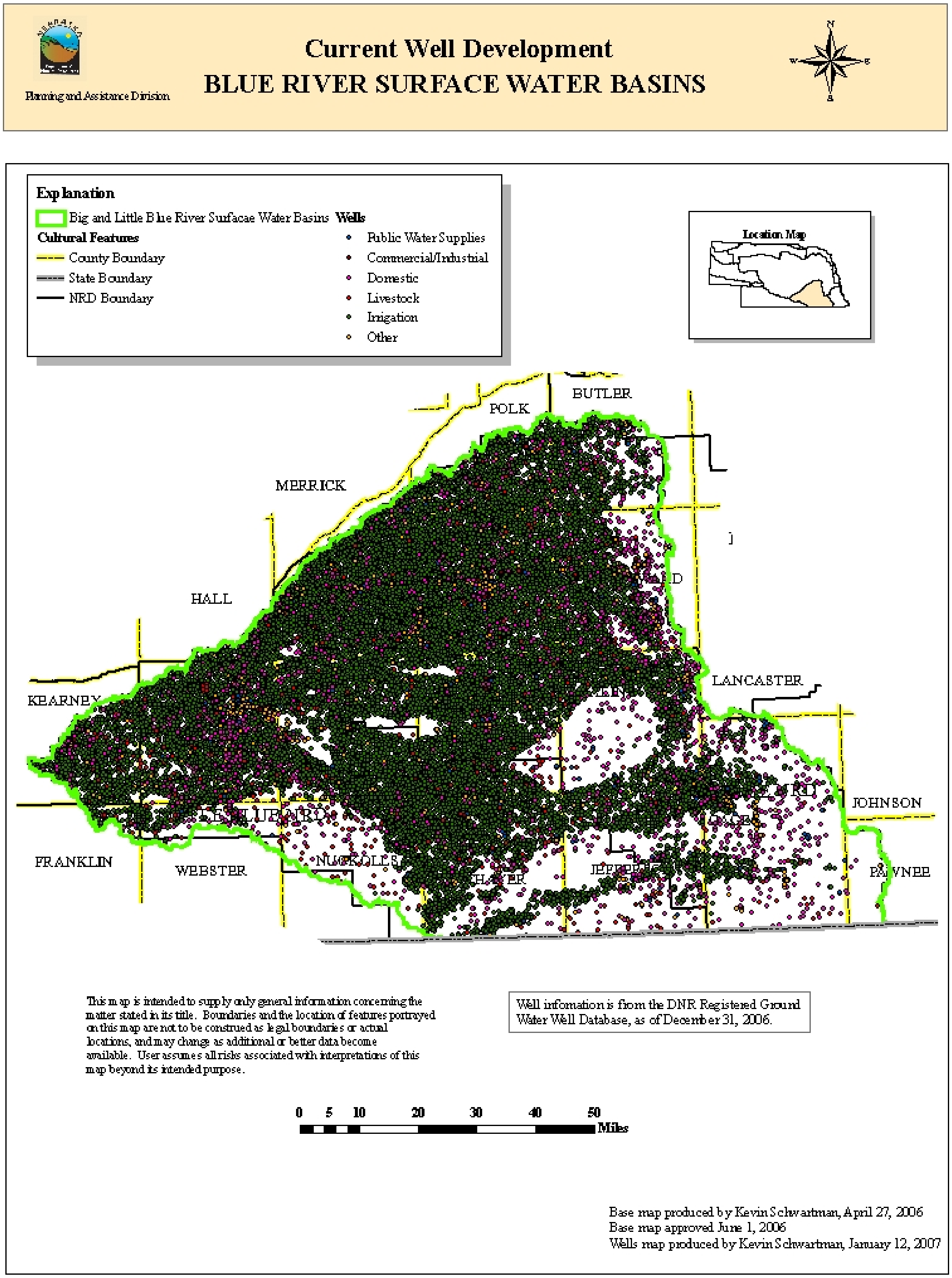


Figure 5-3 Current well locations, Blue River basins



5.3.2 Surface Water

As of December 31, 2006, there were 2,464 surface water appropriations in the basins, issued for a variety of uses (Figure 5-4). Most of the surface water appropriations are for irrigation and storage use and tend to be located on the major streams. The first surface water appropriations in the basins were permitted in 1868, and development has continued through the present day. The approximate locations of the surface water diversion points are shown in Figure 5-5.

Figure 5-4 Surface water appropriations by number of diversion points, Blue River basins

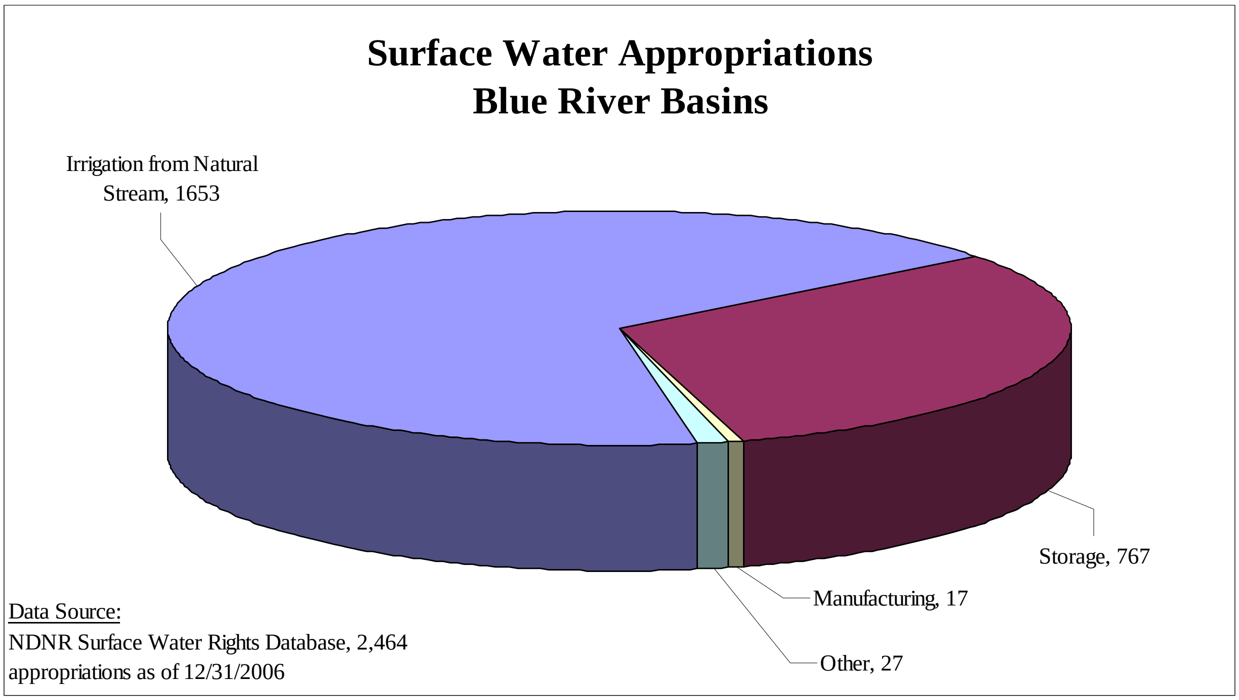
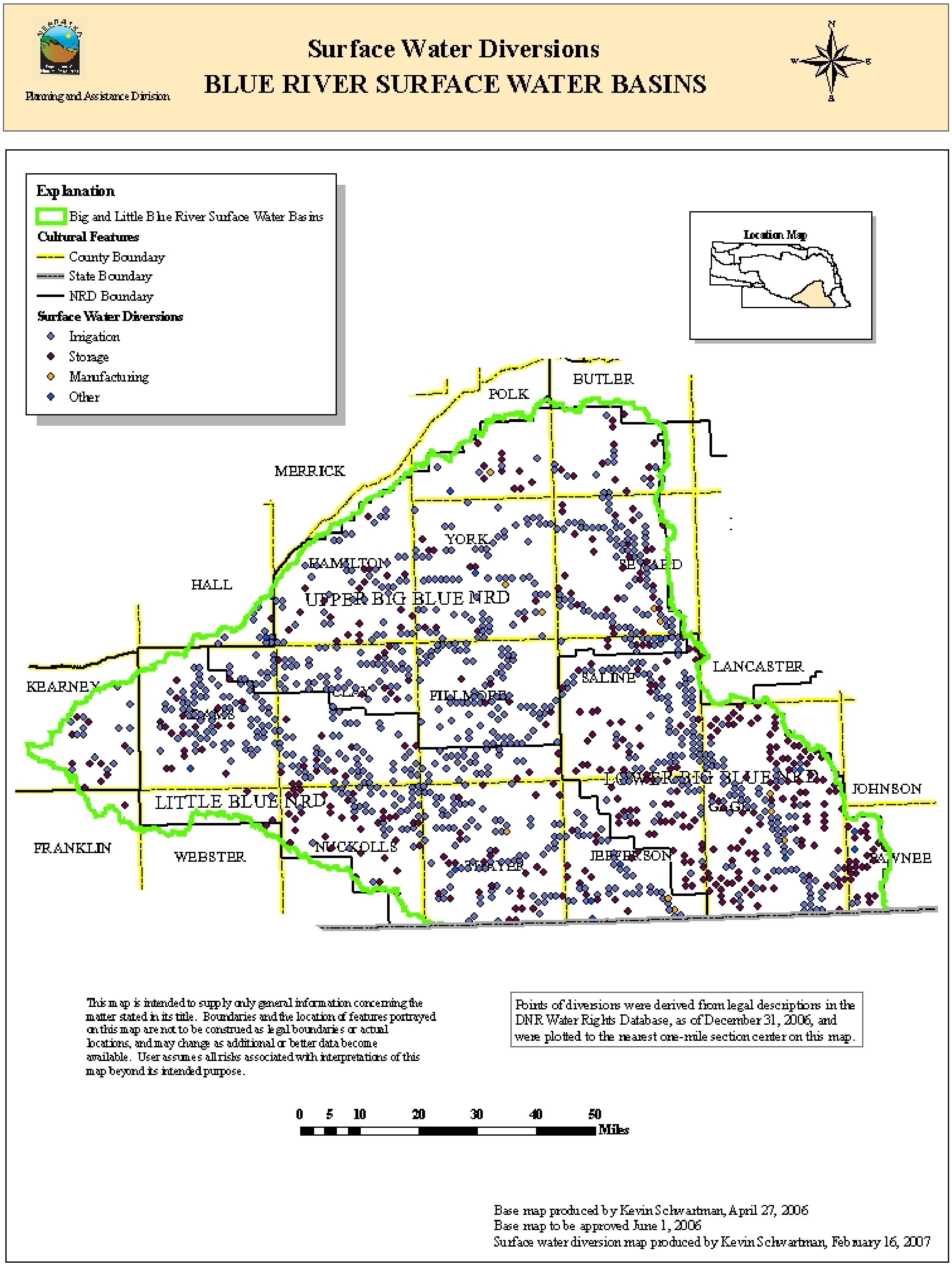


Figure 5-5 Surface water appropriation diversion locations, Blue River basins

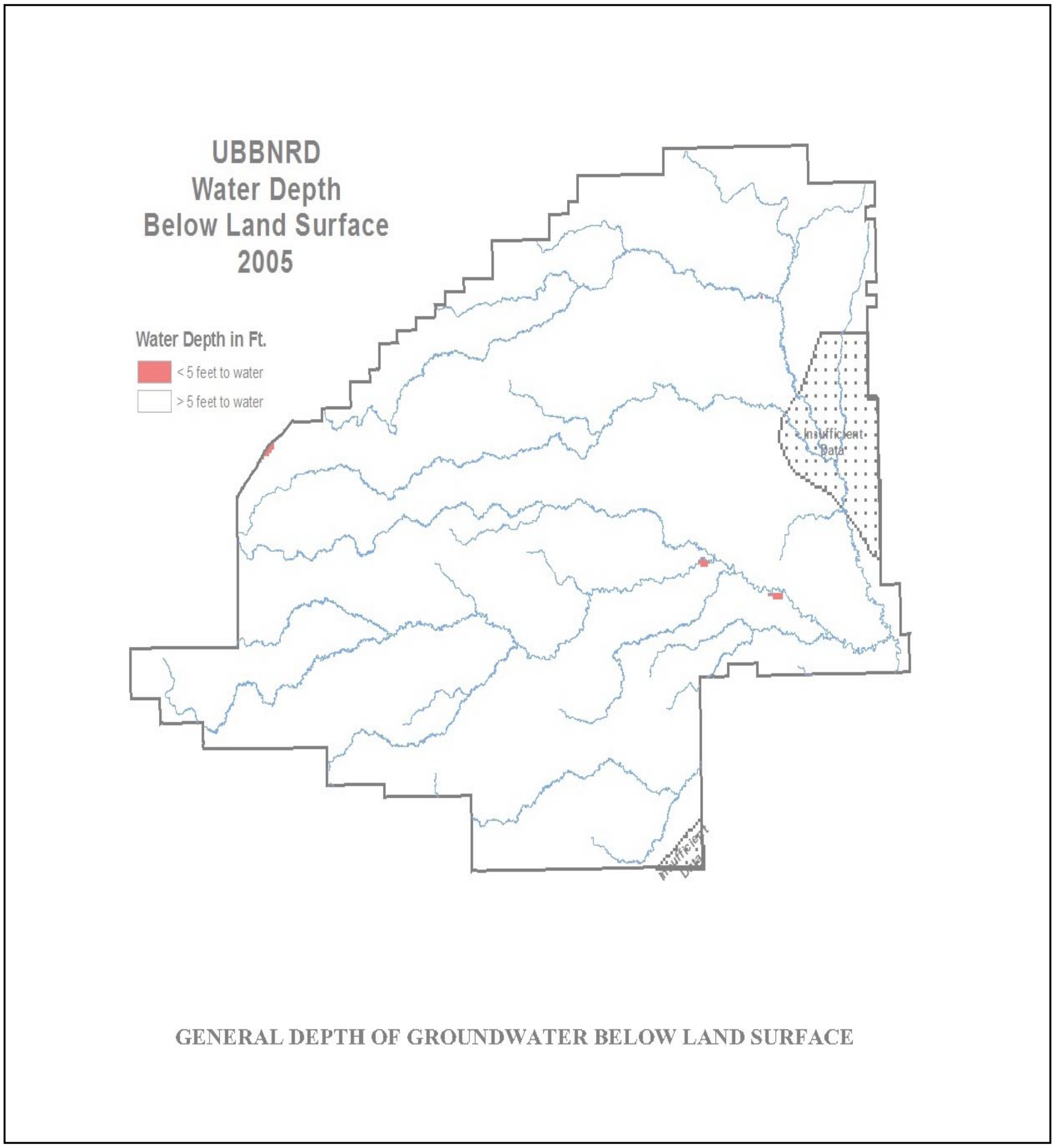


5.4 Hydrologically Connected Area

5.4.1 Big Blue River Basin

The Big Blue River Basin can be divided into two distinct areas based on the presence or absence of glacial deposits. At the present time, the Department cannot determine the 10/50 area for the Big Blue River and its tributaries in these areas. The stream depletion factor (SDF) methodology cannot be used to delineate the 10/50 area because of the restrictive and complex nature of the hydrogeology in the glaciated portions of the basin (CSD, 2005). The geology of the non-glaciated western area of the basin is less complex; however, in all but two small areas, the principal aquifer is not in hydrologic connection with the streams, because the water table is lower than the streambed elevation (Figure 5-6) (Bitner, 2005).

Figure 5-6 Areas of ground water and surface water connection, Upper Big Blue NRD (from Bitner, 2005)



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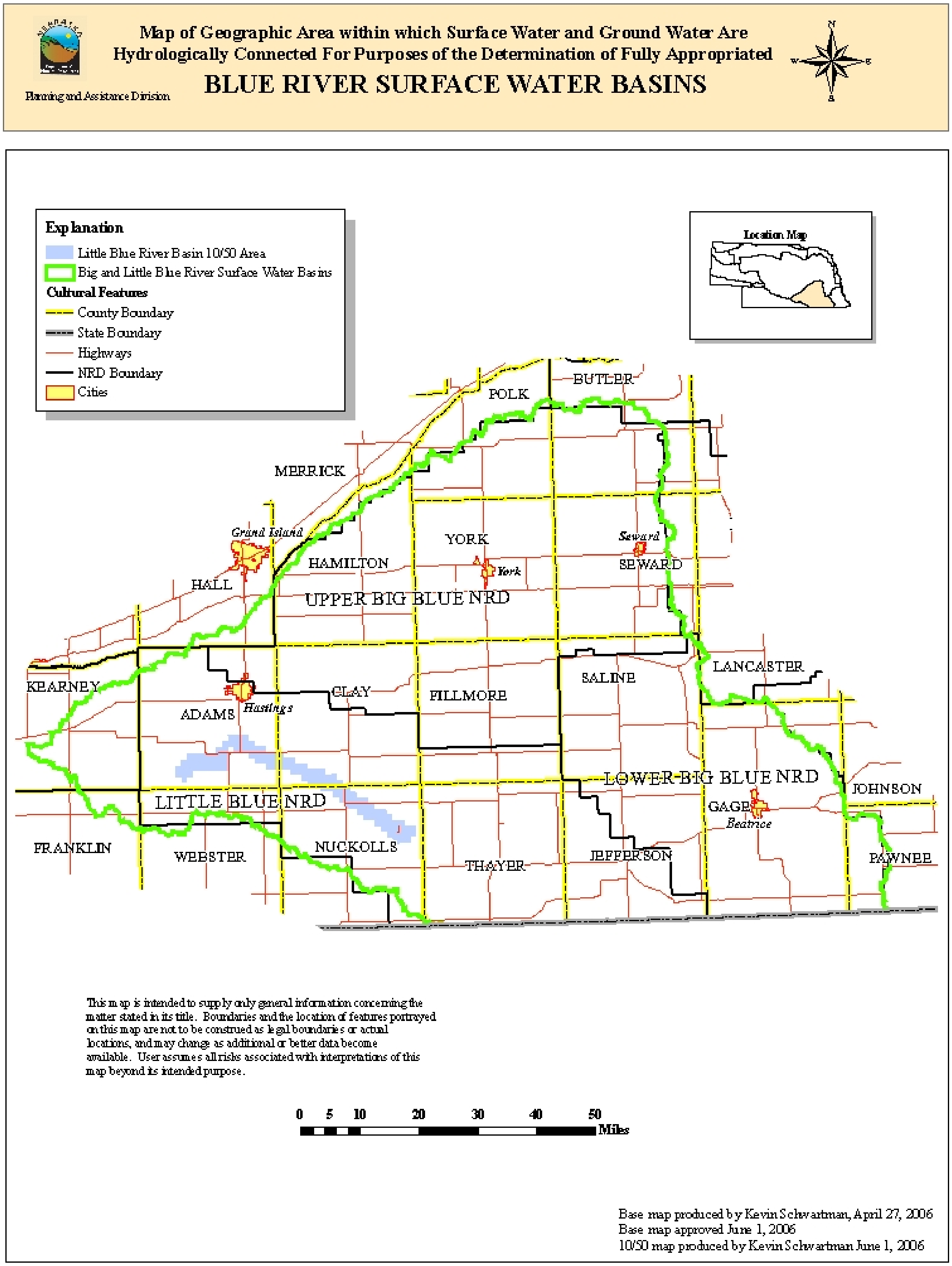
5.4.2 Little Blue River Basin

The Little Blue River Basin can also be divided into two distinct areas based on the presence or absence of glacial deposits. As with the Big Blue River Basin, the stream depletion factor (SDF) methodology cannot be used to delineate the 10/50 area because of the restrictive and complex nature of the hydrogeology in the glaciated portions of the basin (CSD, 2005). The 10/50 area for the other portions of the basin were determined from the results of the MODFLOW ground water model developed by the Upper Big Blue Natural Resources District (DNR, 2005) (Figure 5-7).

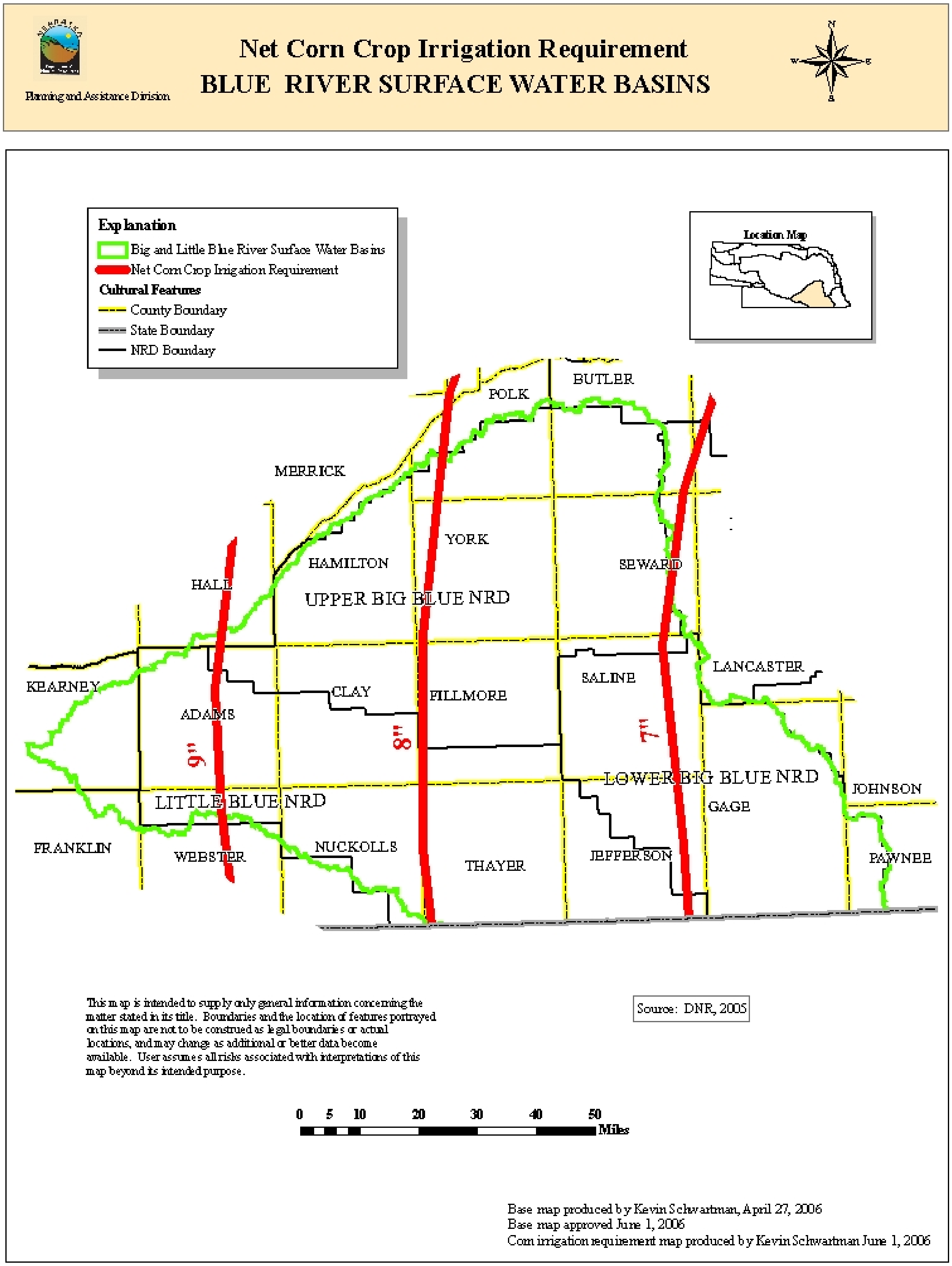
Figure 5-7 10/50 area, Little Blue River Basin



5.5 Net Corn Crop Irrigation Requirement

Figure 5-8 is a map of the net corn crop irrigation requirement for the Blue River basins (DNR, 2005). The greatest NCCIR of a junior surface water appropriation in the Big Blue River Basin is 9.0 inches, and the greatest NCCIR in the Little Blue River Basin is 9.7 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 Big Blue River Basin 23.9 days annually to divert 65% of the NCCIR and 31.3 days to divert 85% of the NCCIR. The junior surface water appropriation in the Little Blue River Basin will need 25.8 days annually to divert 65% of the NCCIR and 33.7 days to divert 85% of the NCCIR.

Figure 5-8 Net corn crop irrigation requirement, Blue River basins



5.6 Surface Water Closing Records

Tables 5-1 and 5-2 record all surface water administration that has occurred in the basins between 1987 and 2006.

Table 5-1 Surface water administration in the Big Blue River Basin, 1987-2006

Year	Water Body	Days	Closing Date	Opening Date
2000	Turkey Creek	3	Jun 9	Jun 12
2000	Big Blue River above Lincoln Creek	2	Aug 15	Aug 17
2001	Big Blue River above Lincoln Creek	1	Aug 14	Aug 15
2002	Big Blue River above Lincoln Creek	11	Jul 11	Jul 22
2002	Big Blue River above Lincoln Creek	14	Jul 30	Aug 13
2002	Big Blue River Basin	8	Aug 5	Aug 13
2002	North Fork Big Blue River	1	Aug 14	Aug 15
2003	Big Blue River above Lincoln Creek	49	Jul 16	Sep 3
2003	Big Blue River Basin	11	Jul 17	Jul 28
2003	Big Blue River Basin	8	Aug 11	Aug 19
2004	Big Blue River above Lincoln Creek	16	Aug 3	Aug 19
2005	Big Blue River above Lincoln Creek	14	Jul 12	Jul 26
2005	Big Blue River Basin	13	Jul 13	Jul 26
2005	Big Blue River above West Fork	8	Jul 18	Jul 26
2005	Big Blue River above Lincoln Creek	11	Aug 4	Aug 15
2005	Big Blue River Basin	6	Aug 9	Aug 15
2005	Big Blue River above West Fork	5	Aug 10	Aug 15
2006	Big Blue River above West Fork	13	Jul 1	Jul 14
2006	Big Blue River above West Fork	22	Jul 17	Aug 8
2006	Big Blue River Basin	11	Jul 3	Jul 14
2006	Big Blue River Basin	5	Jul 19	Jul 24
2006	Big Blue River Basin	9	Jul 29	Aug 7

Table 5-2 Surface water administration in the Little Blue River Basin, 1987-2006

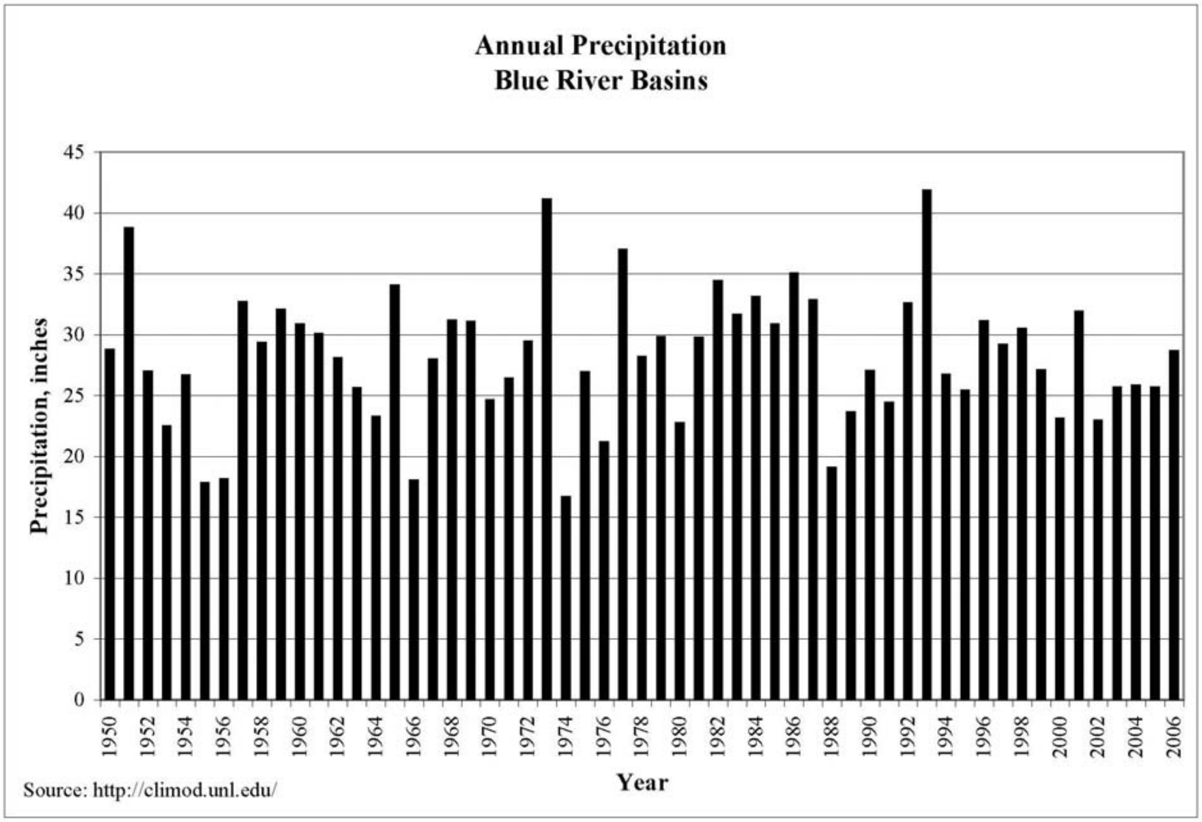
Year	Water Body	Days	Closing Date	Opening Date
1988	Little Blue River Basin	50	Aug 11	Sep 30
1989	Rose Creek	4		
1991	Little Blue River Basin	45	Aug 16	Sep 30
1991	Rose Creek	94	Jun 28	Sep 30
2002	Little Blue River Basin	11	Jul 18	Jul 29
2002	Little Blue River Basin	13	Aug 6	Aug 19
2002	Little Blue River Basin	7	Sep 9	Sep 16
2004	Little Blue River Basin	10	Sep 13	Sep 23
2005	Little Blue River Basin	15	Jul 11	Jul 26
2005	Little Blue River Basin	7	Aug 8	Aug 15
2006	Little Blue River Basin	9	Jul 5	Jul 14
2006	Little Blue River Basin	1	Jul 20	Jul 21
2006	Little Blue River Basin	7	Jul 31	Aug 7
2006	Little Blue River Basin	8	Aug 9	Aug 17

5.7 Evaluation of Current Development

5.7.1 Future Water Supply

In order to complete the long-term evaluation of surface water supplies, a future twenty-year water supply for the basins must be estimated. The basins' water sources are precipitation, which runs off as direct streamflow and infiltrates into the ground to discharge as baseflow, and ground water movement into the basins, which discharges as baseflow. 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 basins was completed. The analysis showed no statistically significant trend in precipitation ($P > 0.95$) over the past fifty years (Figure 5-9). Data do not exist to test whether there is a changing trend in ground water movement into the basin. 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 5-9 Annual precipitation, Blue River basins



5.7.2 Depletions Analysis

The future depletions due to current well development that could be expected to affect streamflow in the Big Blue River Basin and the glaciated portion of the Little Blue River Basin were not estimated for the same reasons as those described in Section 5.4. Even though a MODFLOW ground water model, developed by the Upper Big Blue Natural Resources District, exists for the other portions of the Little Blue River Basin, it is not sufficient to estimate future depletions at the current time.

5.7.3 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 is detailed in Tables 5-3 and 5-4. There is no estimate at this time of the long-term number of days available for diversion in the basins, due to limited understanding of the extent of hydrologic connection and an inadequacy of current data and models in predicting future stream depletions. Even though the future impacts on current water supplies were not estimated, it is unlikely that the basins will become fully appropriated in the future, since 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.

Table 5-3 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 Big Blue River Basin

	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)	23.9	55.0 (31.1 days above the requirement)
May 1 – September 30 (85% Requirement)	31.3	145.8 (114.5 days above the requirement)

Table 5-4 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 in the Little Blue River Basin

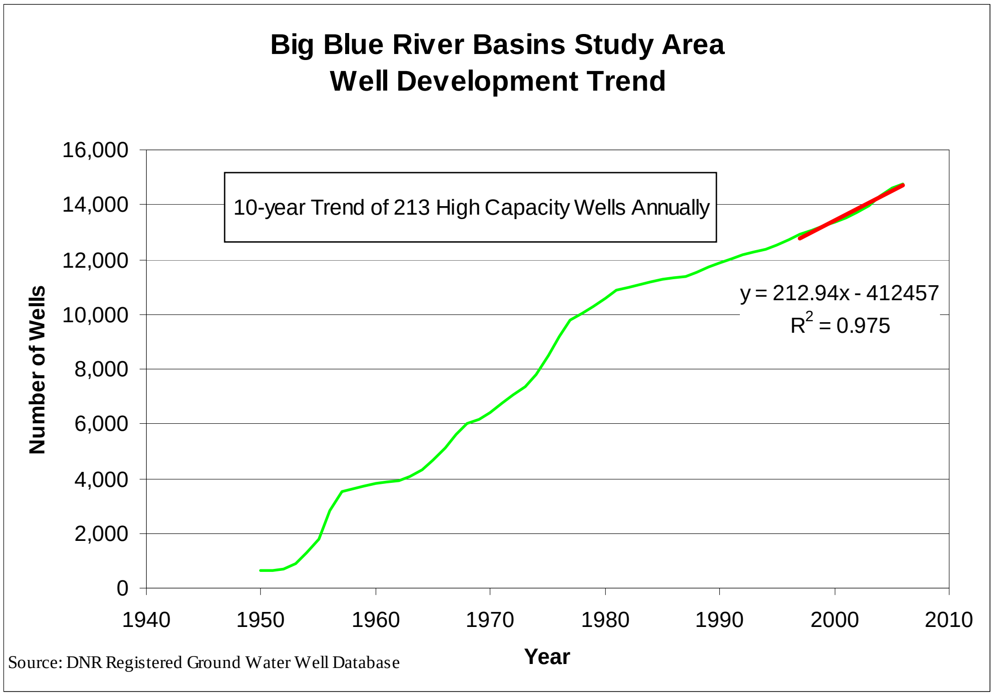
	Number of Days Necessary to Meet the 65% and 85% of Net Corn Crop Irrigation Requirement	**Near-Term Supply Average Number of Days Available for Diversion (1987-2006)**
July 1 – August 31 (65% Requirement)	25.7	56.7 (31.0 days above the requirement)
May 1 – September 30 (85% Requirement)	33.6	143.7 (110.1 days above the requirement)

5.8 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 twenty-five 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 5-10). 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 was calculated to be 213 wells per year in the basins.

For the same reasons as those stated above in Section 5.7.2, no estimates of depletions due to current and future ground water development 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. Therefore, it is unlikely that the basins will become fully appropriated.

Figure 5-10 High capacity well development, Blue River basins



The future water supply in the basins may actually improve in the future if water can be made available to augment state-line flows to meet Big Blue River Compact targets. A cooperative study by the Department, the U.S. Bureau of Reclamation, and the basin NRDs is examining the value of augmentation water and identifying potential projects to supply augmentation water.

5.9 Sufficiency to Avoid Noncompliance

The State of Nebraska is a signatory member of the Kansas – Nebraska Big Blue River Compact (Compact). The purposes of the Compact are to promote interstate comity; to achieve an equitable apportionment of the waters of the Big Blue River Basin; to encourage continuation of the active pollution-abatement programs in each of the two states; and to seek further reduction in pollution of the waters of the Big Blue River Basin.

The Compact sets state-line flow targets from May 1 through September 30. The state-line targets, measured in cubic feet of water per second, are shown in Table 5-5. If the flow targets are not met, the State of Nebraska is required to take the following actions:

1. Limit surface water diversions by natural flow appropriators to their decreed appropriations;
2. Close natural flow appropriators with priority dates junior to November 1, 1968, in accordance with the doctrine of priority;
3. Ensure that no illegal surface water diversions are taking place; and
4. Regulate wells installed after November 1, 1968, within the alluvium and valley side terrace deposits downstream of Turkey Creek in the Big Blue River Basin and downstream of Walnut Creek in the Little Blue River Basin, unless it is determined by the Compact Administration that such regulation would not yield any measurable increase in flows at the state line gage.

For the present time, the Compact Administration has found that the regulation of those wells will not yield measurable increases in flow at the state line.

Table 5-5 State-line flow targets for the Big Blue River

Month	Big Blue River Target Flow	Little Blue River Target Flow
May	45 cfs	45 cfs
June	45 cfs	45 cfs
July	80 cfs	75 cfs
August	90 cfs	80 cfs
September	65 cfs	60 cfs

As long as Nebraska administers surface and ground water in compliance with the Compact, decreased streamflow, in and of itself, will not cause Nebraska to be in noncompliance; therefore, any depletion would not cause Nebraska to be in noncompliance. However, decreased streamflows could increase the number of times the state would have to administer water to remain in compliance, thereby reducing the number of days available for junior irrigators to divert.

5.10 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.

5.11 Current Studies being Conducted to Assist with Future Analysis

The geologic complexity of the basins requires more sophisticated efforts in investigating the extent of hydrologic connection between ground water and surface water supplies. Development of a ground water model for the Big Blue and Little Blue River basins was begun in 2005 by the NRDs within those basins. This work is an expansion of the ground water model developed by the Upper Big Blue NRD for the 2006 report. It will utilize new hydrogeologic mapping and related information being collected for this effort.

5.12 Conclusions

Based upon the evaluation of available information, the Department has reached a preliminary conclusion that the surface water and ground water supplies in hydrologic connection in the Blue River basins are not fully appropriated. The best available data do not allow for analysis of whether this determination would change if no additional legal constraints are imposed on future development of hydrologically connected surface water and ground water.

Bibliography of Hydrogeologic References for Big and Little Blue River Basins

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