8.0 MISSOURI TRIBUTARY BASINS

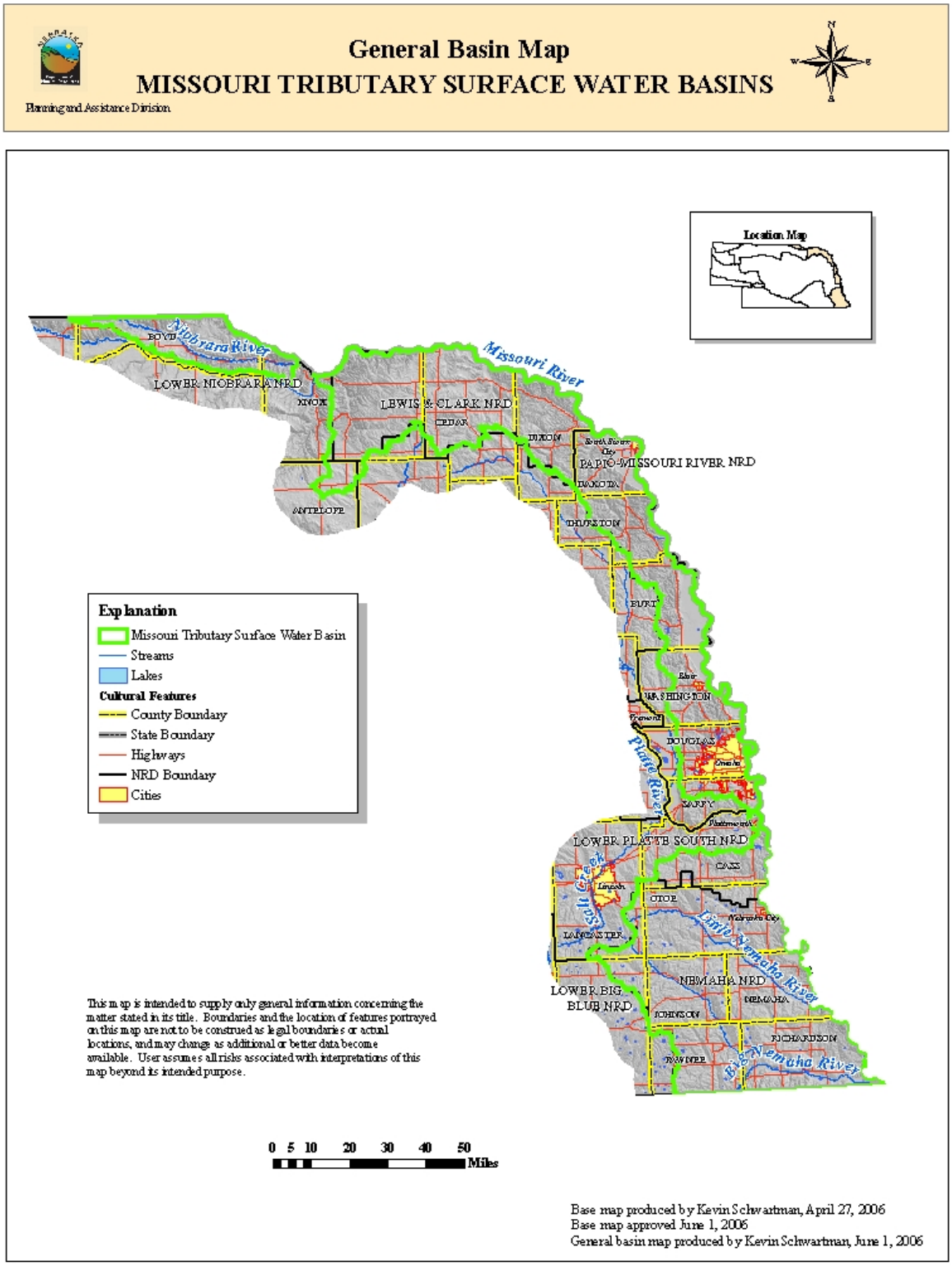
8.1 Summary

Based on the analysis of the sufficiency of the long-term surface water supply in the Missouri Tributary basins, the Department has reached a 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.

8.2 Basin Descriptions

The Missouri Tributary basins include all surface areas that drain directly into the Missouri River, with the exception of the Niobrara River and Platte River basins, and all aquifers that impact surface water flows in the basins (Figure 8-1). Major streams in these basins include Ponca Creek, Bazile Creek, Weeping Water Creek, the Little Nemaha River, and the Big Nemaha River. The total area of the Missouri Tributary surface water basins is approximately 6,200 square miles, of which approximately 450 square miles drain into the Missouri River above the Niobrara River confluence, approximately 3,000 square miles drain into the Missouri River between the Niobrara River confluence and the Platte River confluence, and 2,800 square miles drain into the Missouri River below the Platte River confluence. Natural resources districts with significant area in the basins are the Lower Niobrara Natural Resources District, the Lewis and Clark Natural Resources District, the Papio-Missouri River Natural Resources District, and the Nemaha Natural Resources District.

Figure 8-1 General basin map, Missouri Tributary basins.



8.3 Nature and Extent of Water Use

8.3.1 Ground Water

Ground water in the basins is used for a variety of purposes: domestic, industrial, livestock, irrigation, and other uses. A total of 6,082 ground water wells had been registered within the basins as of December 31, 2007 (Department registered ground water wells database) (Figure 8-2). The locations of all active ground water wells can be seen in Figure 8-3.

Figure 8-2 Current well development by number of registered wells, Missouri Tributary basins.

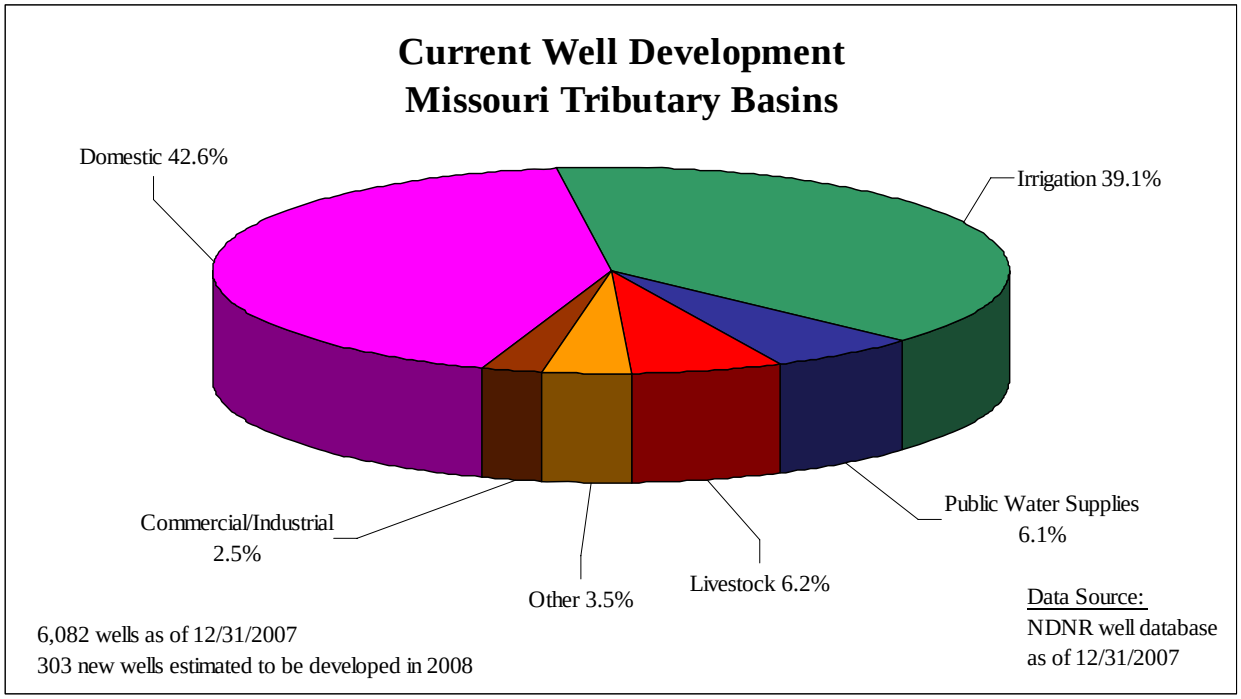
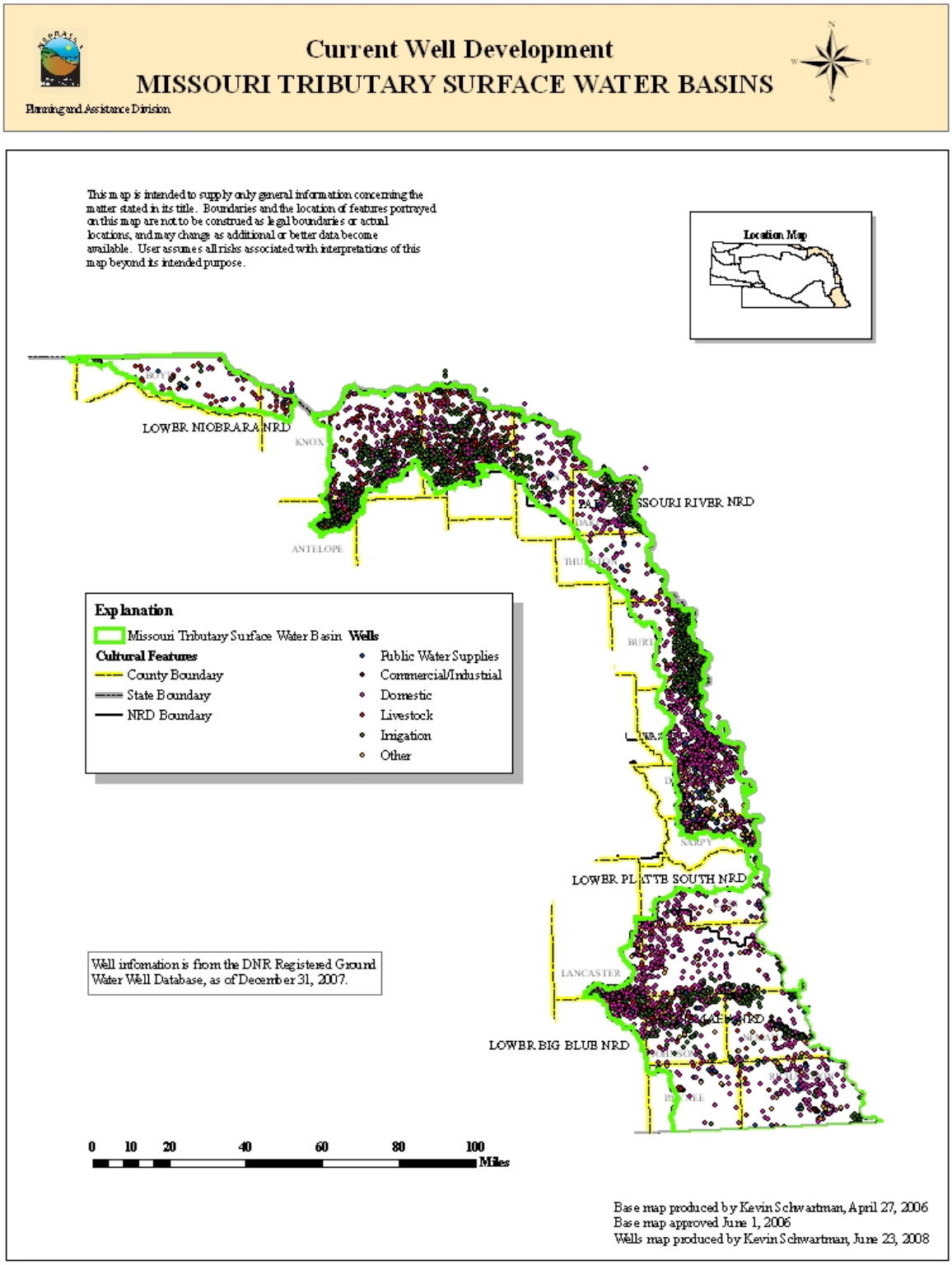


Figure 8-3 Current well locations, Missouri Tributary basins.



8.3.2 Surface Water

As of December 31, 2007, 1,413 surface water appropriations were held in the basins, issued for a variety of uses (Figure 8-4). Most of the surface water appropriations are for storage and irrigation use and tend to be located on the major streams. The first surface water appropriations in the basins were permitted in 1881, and development has continued through the present day. The approximate locations of the surface water diversion points are shown in Figure 8-5.

Figure 8-4 Surface water appropriations by number of diversion points, Missouri Tributary basins.

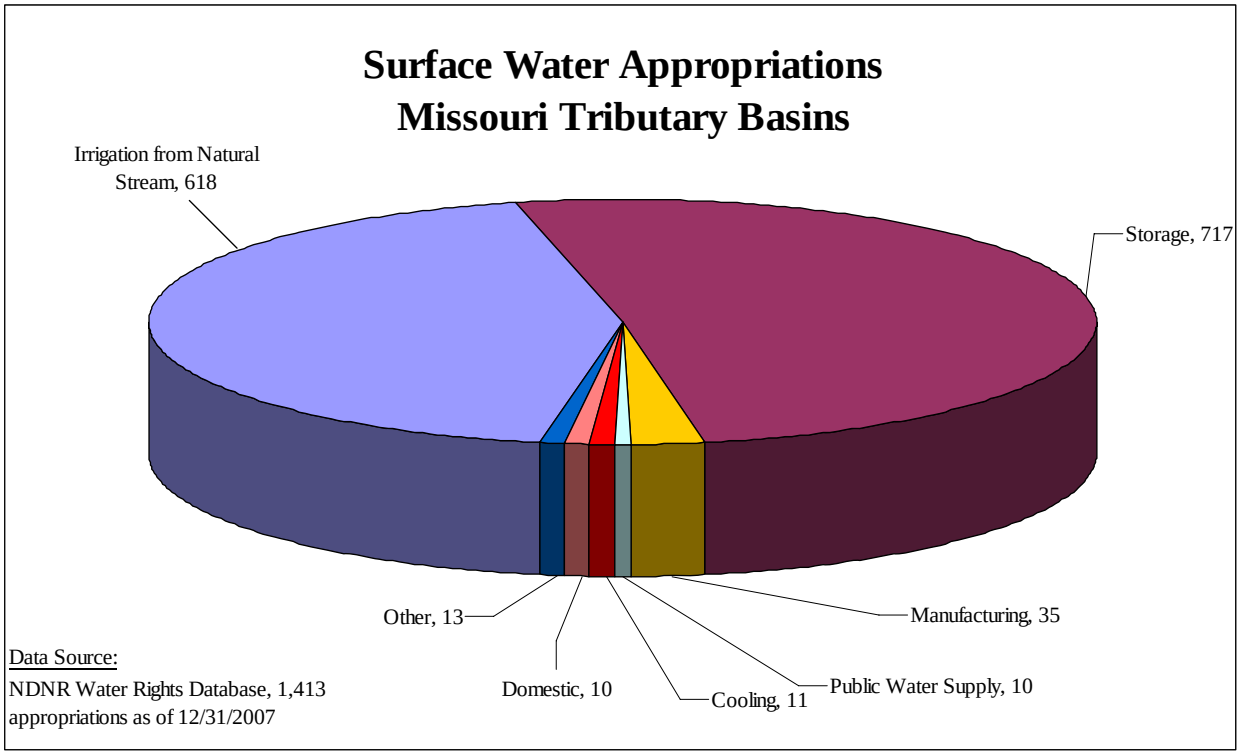
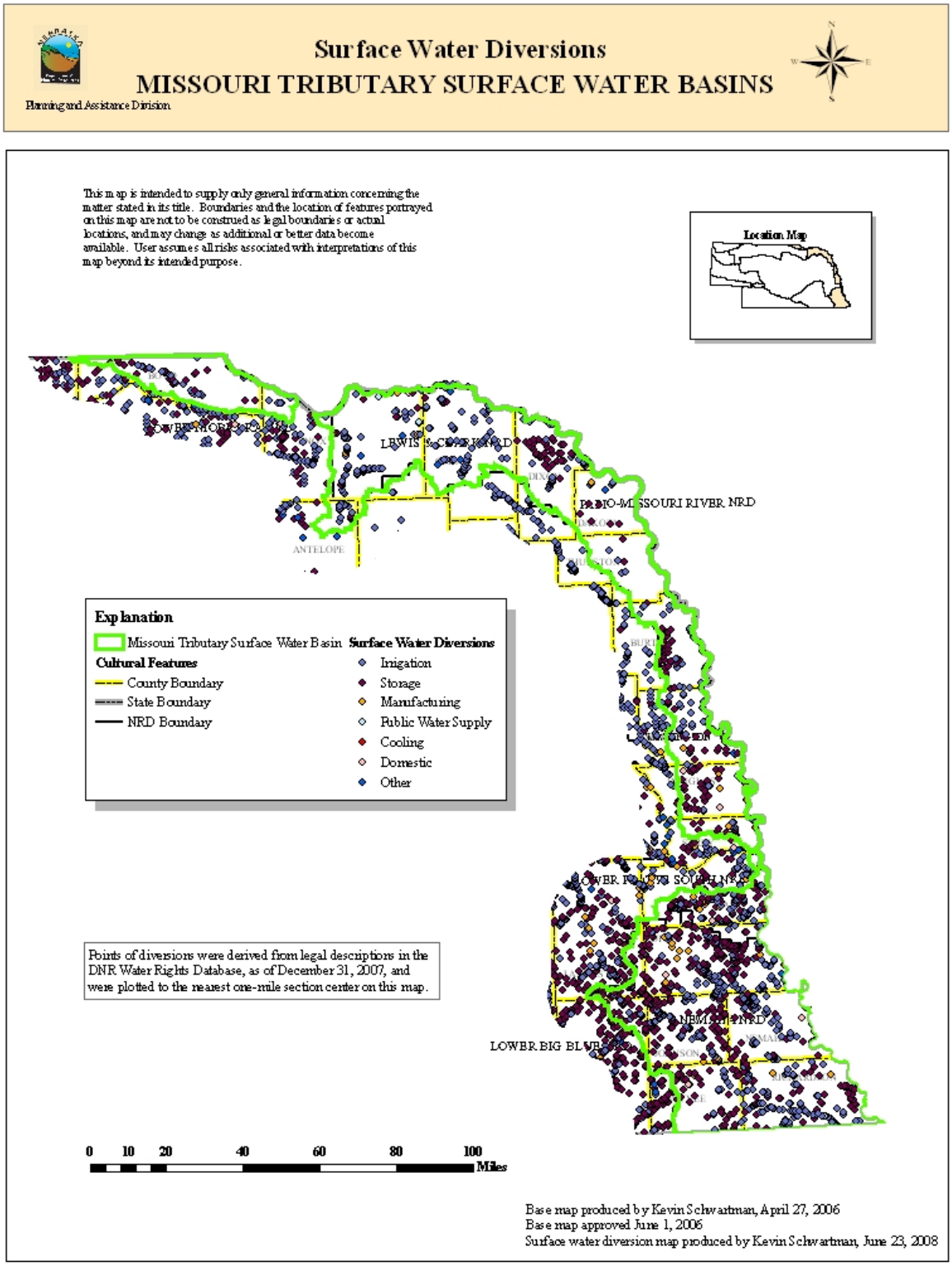


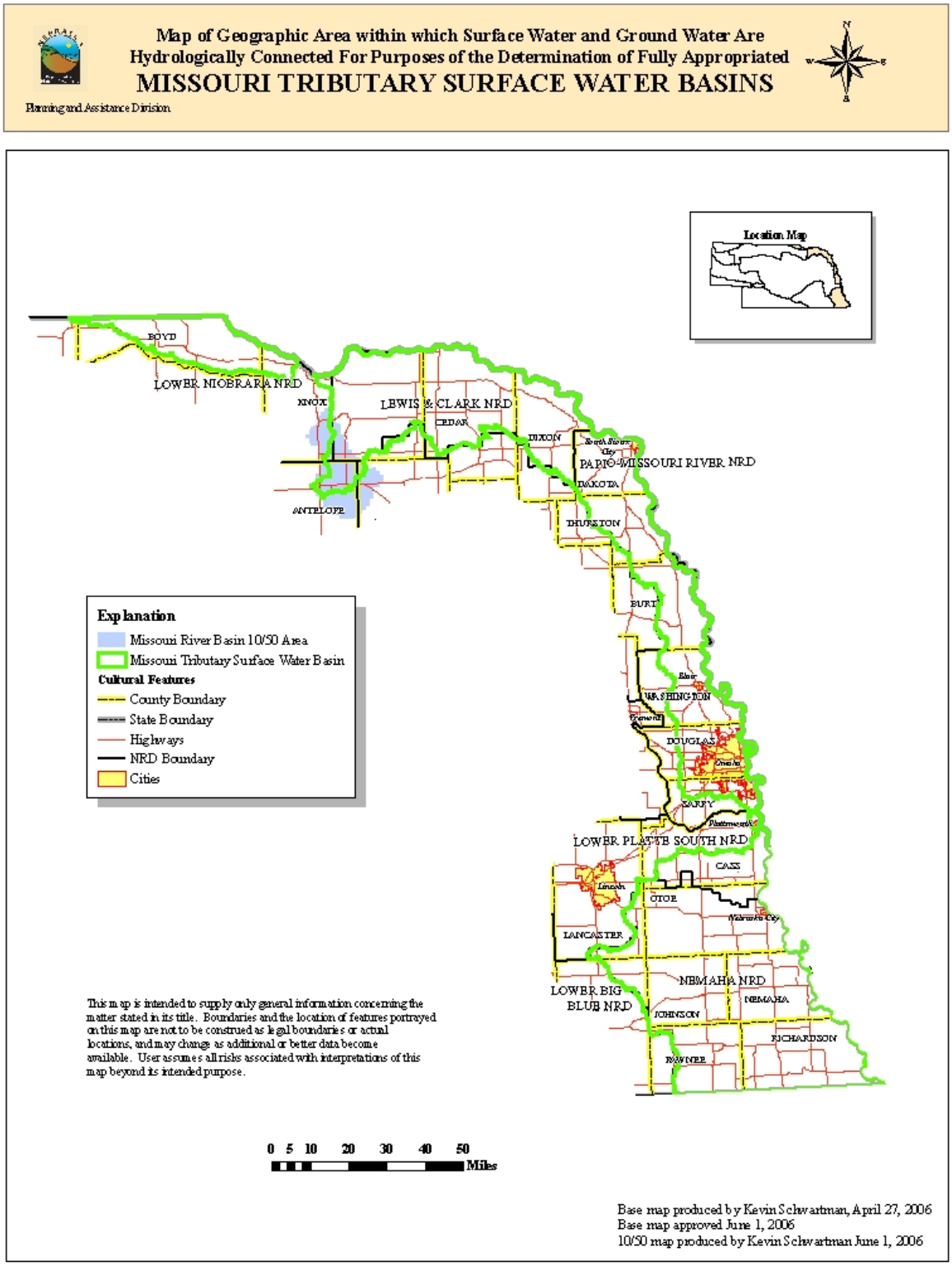
Figure 8-5 Surface water appropriation diversion locations, Missouri Tributary basins.



8.4 Hydrologically Connected Area

No sufficient numeric ground water model is available in the Missouri Tributary basins to determine the 10/50 area. The stream depletion factor (SDF) methodology can be applied only where sufficient data and appropriate hydrogeologic conditions exist. In most of the basins, the principal aquifer is absent or very thin due to the glaciated nature of the area (CSD, 2005). Additionally, where a principal aquifer is present, the complex hydrogeologic nature of the area makes the degree of connection between the ground water system and the surface water system either poor or uncertain (CSD, 2005). The area surrounding the headwaters of Bazile Creek is the only portion of the basins where the principal aquifer is both present and known to be in hydrologic connection with the streams. Consequently, this is the only portion of the study area in which the 10/50 area can be calculated (CSD, 2005) (Figure 8-6).

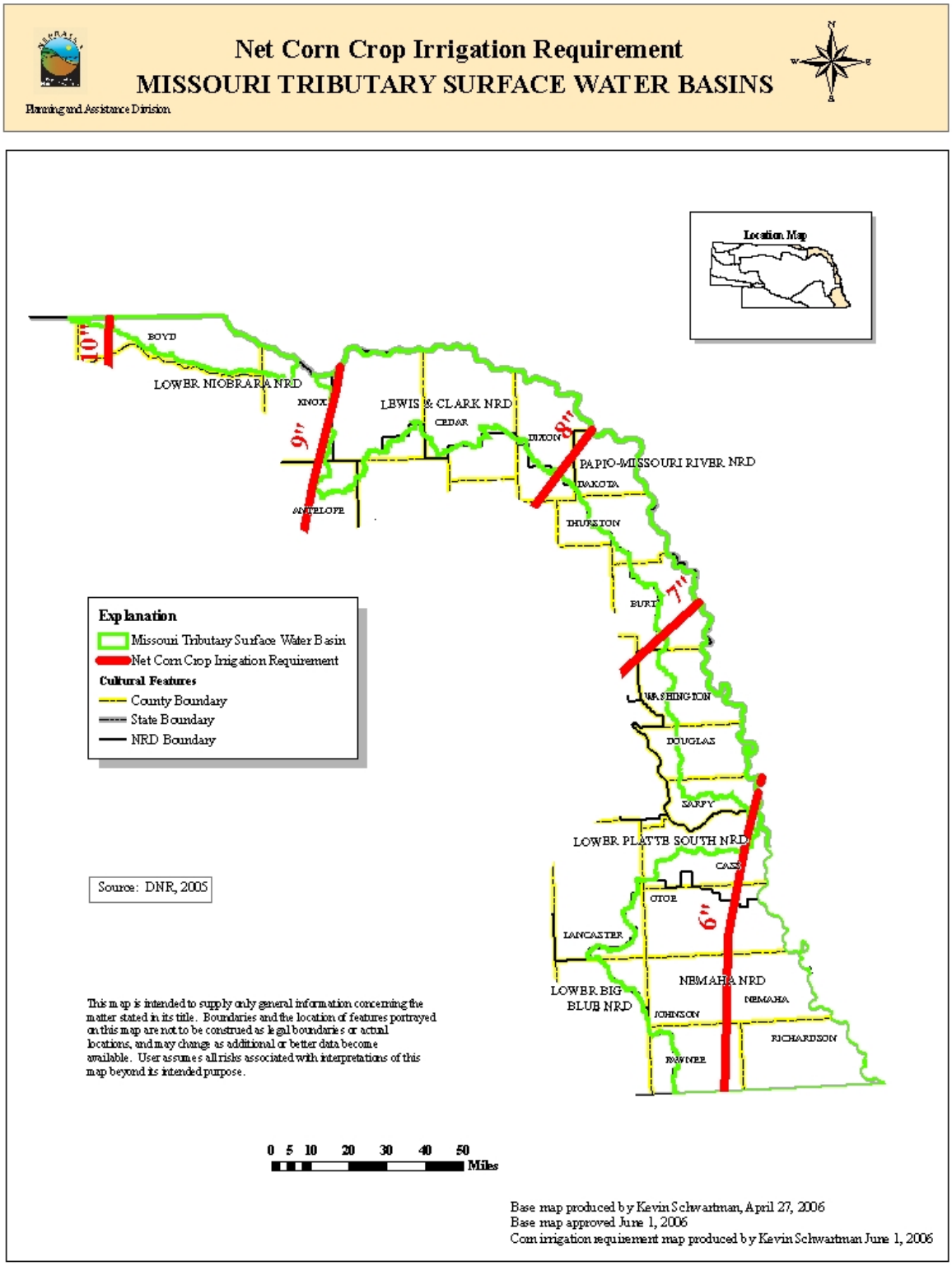
Figure 8-6 10/50 area, Missouri Tributary basins.



8.5 Net Corn Crop Irrigation Requirement

Figure 8-7 is a map of the net corn crop irrigation requirement for the basins (DNR, 2005). The NCCIR in the basins ranges from 5.3 to 10.0 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 a junior surface water appropriation between 14.1 and 26.6 days annually to divert 65% of the NCCIR and between 18.4 and 34.7 days to divert 85% of the NCCIR.

Figure 8-7 Net corn crop irrigation requirement, Missouri Tributary basins.



8.6 Surface Water Closing Records

Table 8-1 records all surface water administration that has occurred in the basins between 1988 and 2007.

Table 8-1 Surface water administration in the Missouri Tributary basins, 1988-2007.

Year	Water Body	Days	Closing Date	Opening Date
1988	Menominee Creek	???*	Jun 27	
1989	Little Nemaha River	25		
1989	North Fork Big Nemaha River	14		
1989	Long Branch	5		
1990	North Fork Little Nemaha River	14	July	July
1991	Little Nemaha River	7	Jul 2	Jul 9
1991	Little Nemaha River	19	Jul 18	Aug 6
1991	North Fork Little Nemaha River	1	Jul 8	Jul 9
2002	Weeping Water Creek	21	Jul 30	Aug 20
2004	Weeping Water Creek	3	Aug 23	Aug 26
2005	Weeping Water Creek	3	Jul 15	Jul 18

* Ending date could not be determined from administration records.

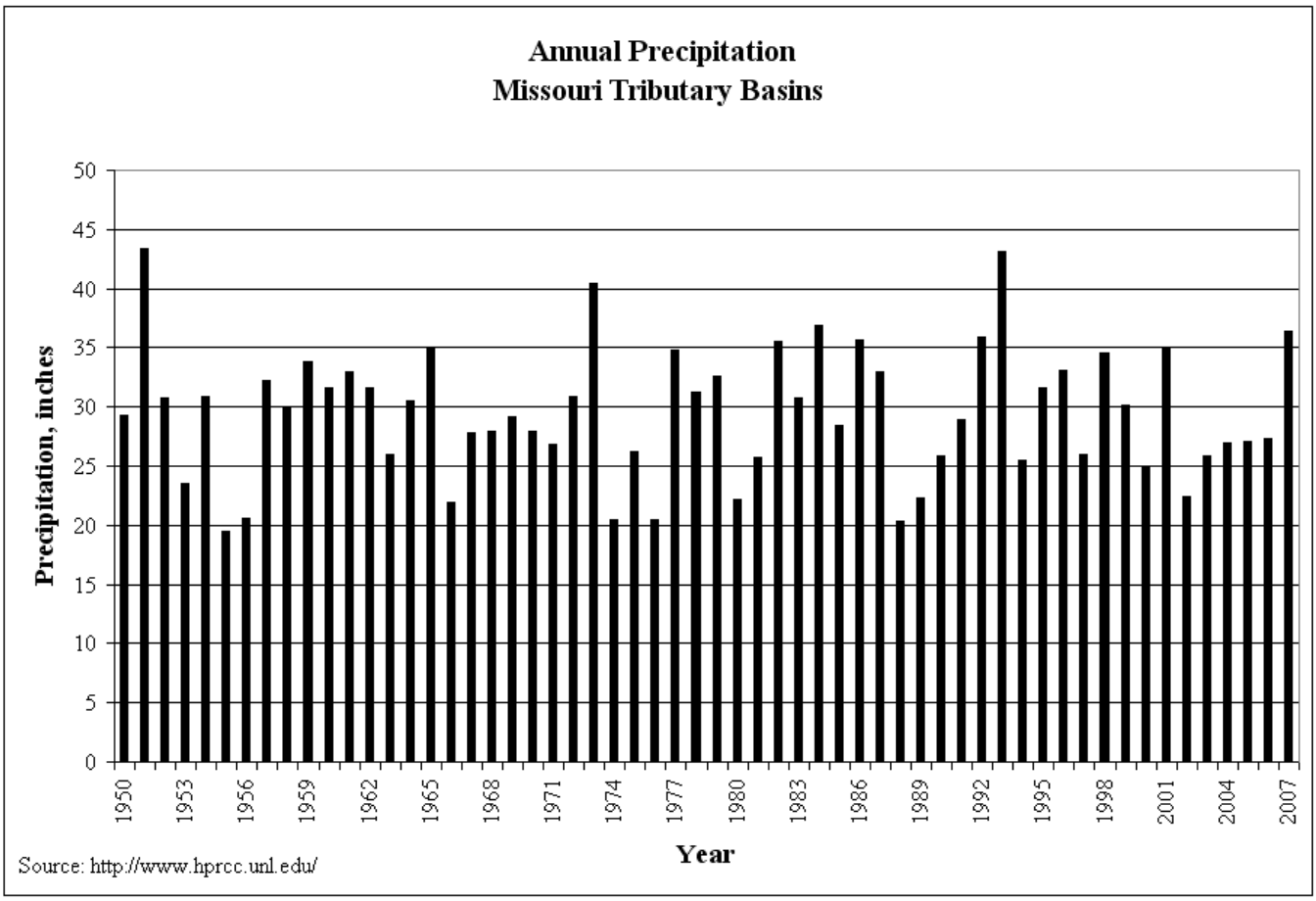
8.7 Evaluation of Current Development

8.7.1 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 8-8). Data do not exist to test whether trends in ground water movement into the basin have changed. 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 8-8 Annual precipitation, Missouri Tributary basins.



8.7.2 Depletions Analysis

The future depletions due to current well development that could be expected to affect streamflow in the basins were not estimated, for the same reasons as those described in Section 8.4.

8.7.3 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 Table 8-2. No estimate of the twenty-year average days available for diversion in the basins has been made, given the inadequacy of current data and models in predicting future stream depletions. 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.

Table 8-2 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 Missouri Tributary basins.

	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 (1988-2007)**
July 1 – August 31 (65% Requirement)	14.1 to 26.6	58.8 or greater (at least 32.2 days above the requirement)
May 1 – September 30 (85% Requirement)	18.4 to 34.7	149.8 or greater (at least 115.1 days above the requirement)

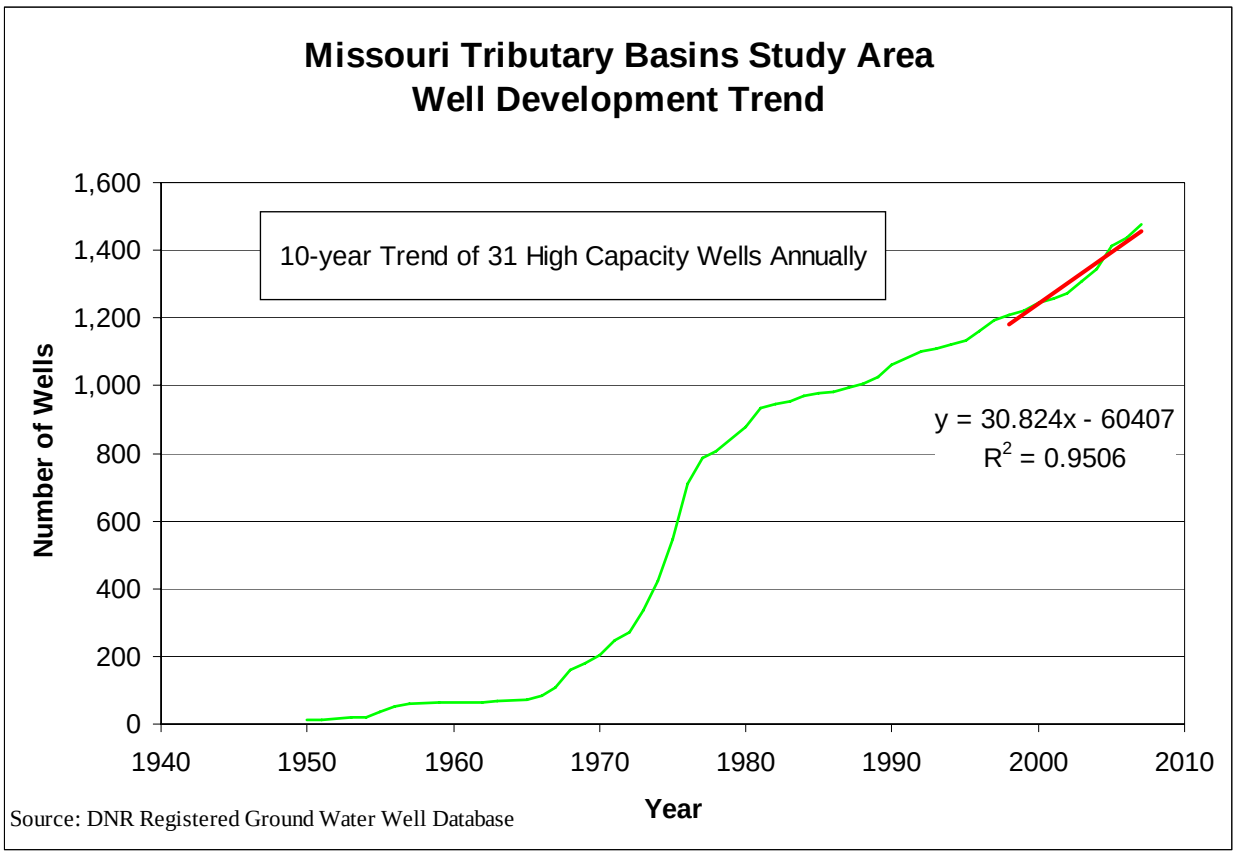
8.8 Evaluation of Predicted Future Development

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 8-9). 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 calculated to be 31 wells per year in the basins.

For the same reasons as those stated above in Section 8.7.2, 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 65/85 rule.

Figure 8-9 High capacity well development, Missouri Tributary basins.



8.9 Sufficiency to Avoid Noncompliance

There are no compacts on any portions of the Missouri Tributary basins in Nebraska.

8.10 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 form the stream (Appendix H).

8.11 Current Studies Being Conducted to Assist with Future Analysis

An effort to categorize the aquifer characteristics and the water supply of the glaciated portion of eastern Nebraska, which includes large areas of the Missouri Tributary basins, is underway. This extensive body of work will provide future reports with critical data on the hydrologically connected areas and impacts of future development.

8.12 Relevant Data Provided by Interested Parties

The Department published a request for relevant data for this year's evaluation from interested parties on May 12, 2008 (see Appendix A for Affidavit). The Department did not receive any such information.

8.13 Conclusions

Based on the evaluation of available information, the Department has reached a conclusion that the Missouri Tributary 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. 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.

Bibliography of Hydrogeologic References for Missouri Tributaries 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, 2006. Evaluation of the impact of groundwater irrigation on streamflow depletion in Nebraska. *Journal of Hydrology* 327: 603-617.