7.0 MISSOURI TRIBUTARY BASINS

7.1 Summary

Based on the analysis of the sufficiency of the long-term surface water supply in the Missouri River Tributary Basins, the Department has reached a preliminary conclusion that the basins are not fully appropriated. The use of the SDF methodology to determine lag effects of current development requires sufficient data and appropriate hydrogeologic conditions. Those data and conditions exist only in the Bazile Creek subbasin at this time. Therefore, lag effects of current development and potential future development were estimated only for in the Bazile Creek subbasin.

The analysis of lag effects of current development for the Bazile Creek subbasin indicates a reduction in streamflows by 14 cfs in twenty-five years. The analysis of the impacts of future development on the Bazile Creek subbasin based on current development trends indicates an additional reduction in streamflows of 19 cfs in twenty-five years. The future number of days available to junior irrigators was not estimated because no surface water administration has occurred in the Bazile Creek subbasin in the past twenty 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).

7.2 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 7-1). 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. NRDs with significant

area in the basins are the Lower Niobrara, the Lewis and Clark, the Papio-Missouri River, and the Nemaha NRDs.

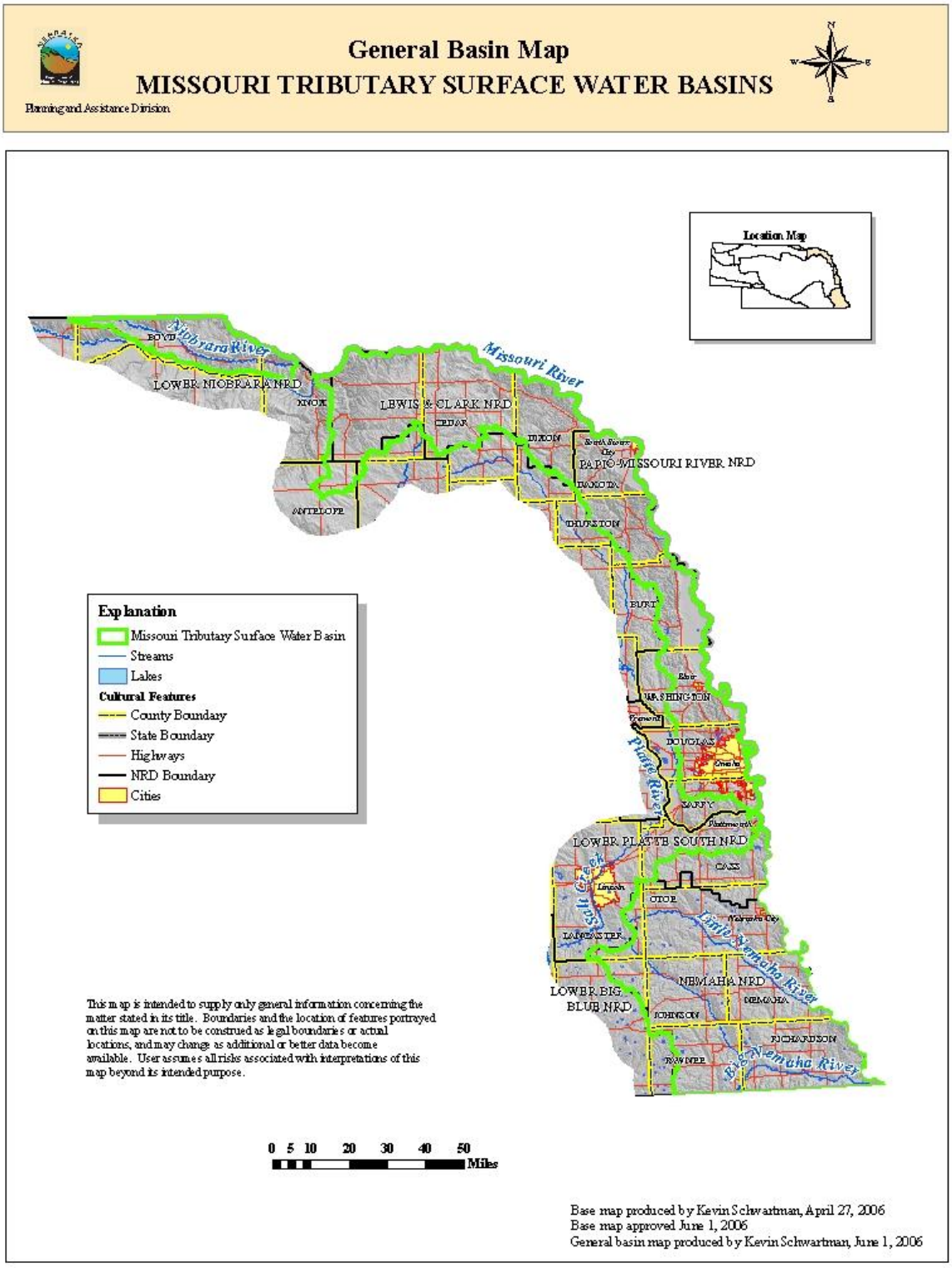

Figure 7-1. General basin map, Missouri Tributary Basins.

7.3 Nature and Extent of Water Use

7.3.1 Groundwater

Groundwater in the basins is used for a variety of purposes including domestic, industrial, livestock, irrigation, and other uses. A total of 6,677 groundwater wells had been registered within the basins as of December 31, 2010 (Department registered groundwater wells database) (figure 7-2). The locations of all active groundwater wells can be seen in figure 7-3.

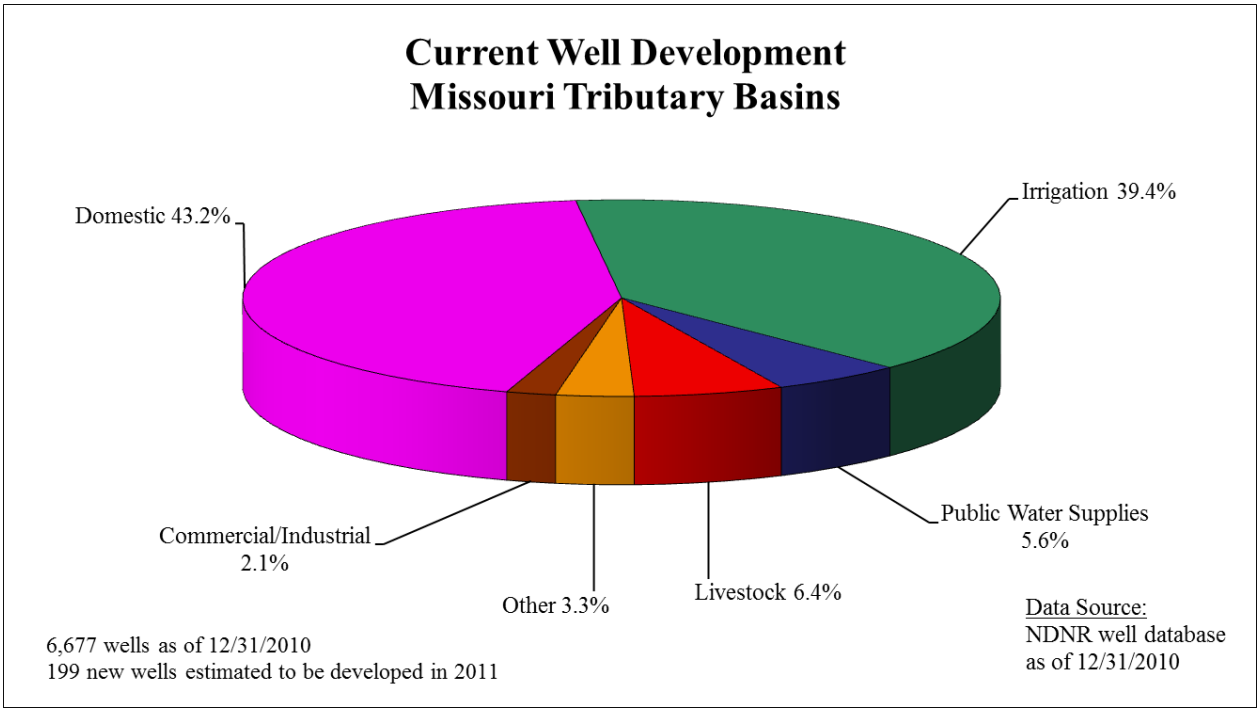

Figure 7-2. Current well development by number of registered wells, Missouri Tributary Basins.

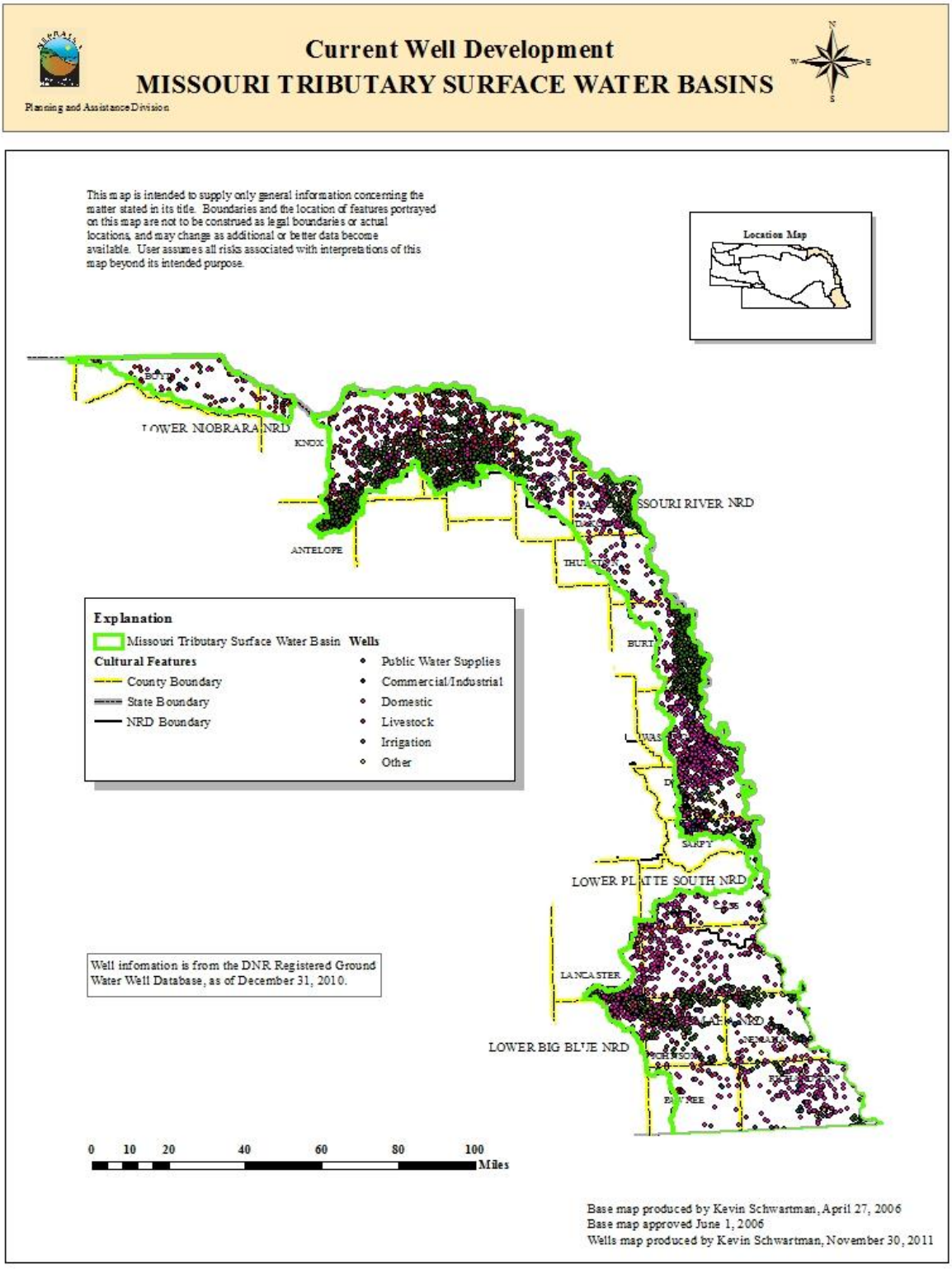

Figure 7-3. Current well locations, Missouri Tributary Basins.

7.3.2 Surface Water

As of December 31, 2010, 1,269 active surface water appropriations were held in the basins, issued for a variety of uses (figure 7-4). 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 7-5.

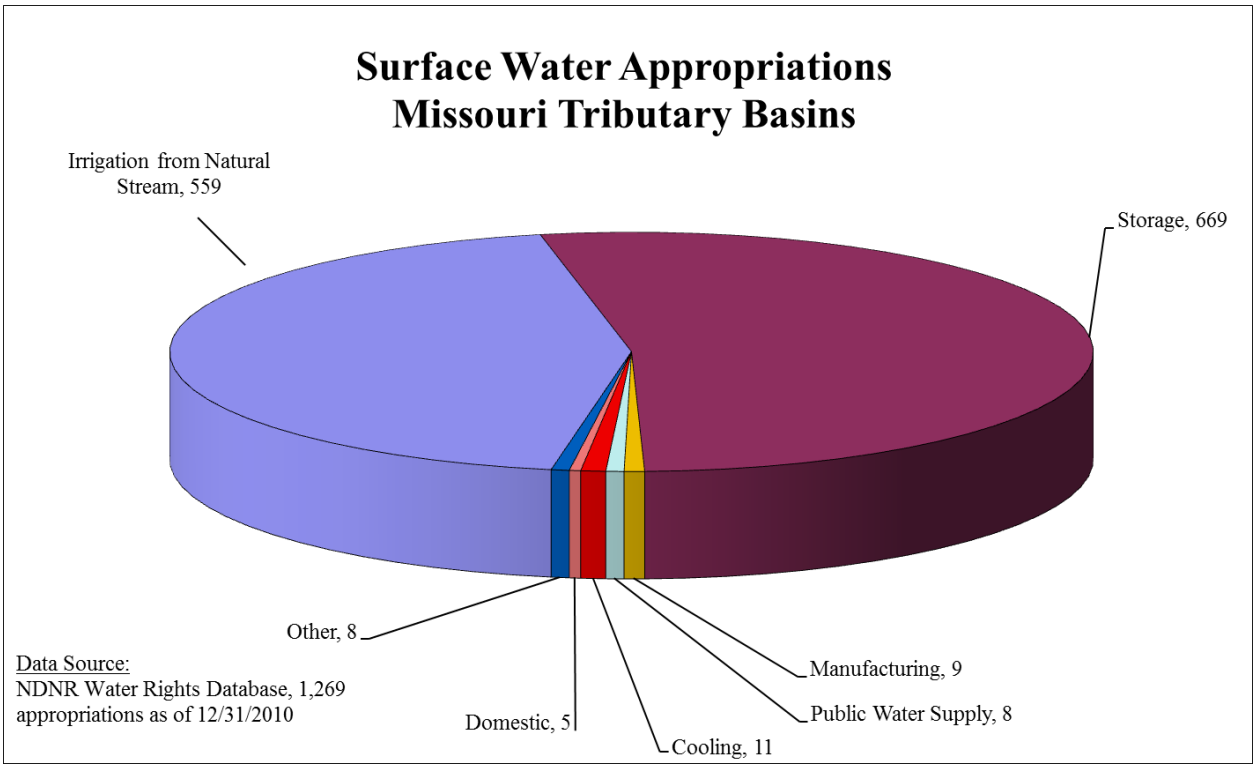

Figure 7-4. Surface water appropriations by number of diversion points, Missouri Tributary Basins.

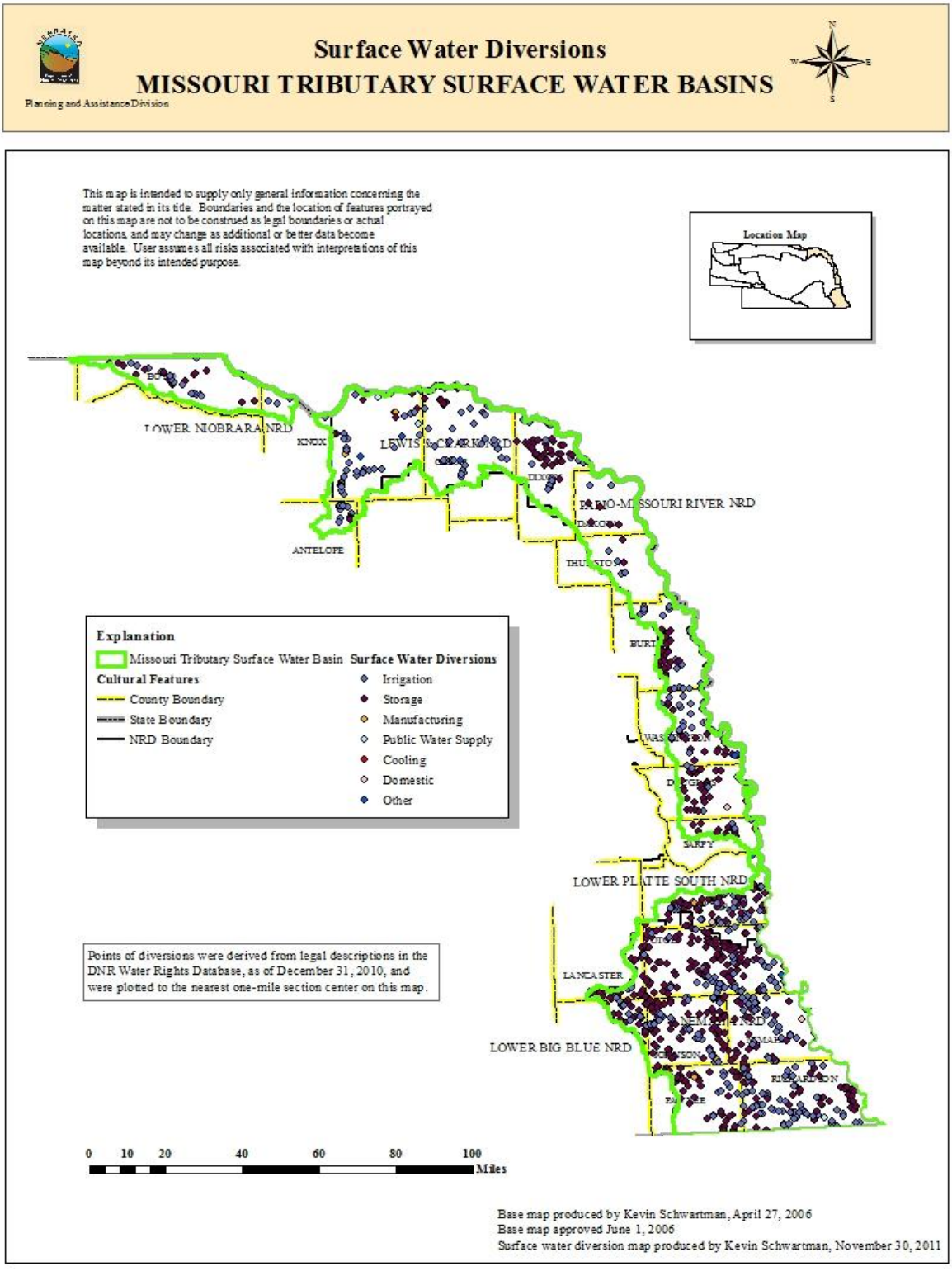

Figure 7-5. Surface water appropriation diversion locations, Missouri Tributary Basins.

7.4 Hydrologically Connected Area

No sufficient numeric groundwater model is available in the Missouri Tributary Basins to determine the 10/50 area. Much of the basins were glaciated and in those areas, the lack of sufficient data and appropriate hydrogeologic conditions does not allow for the use of the existing methodologies. 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 groundwater 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 was calculated (figure 7-6).

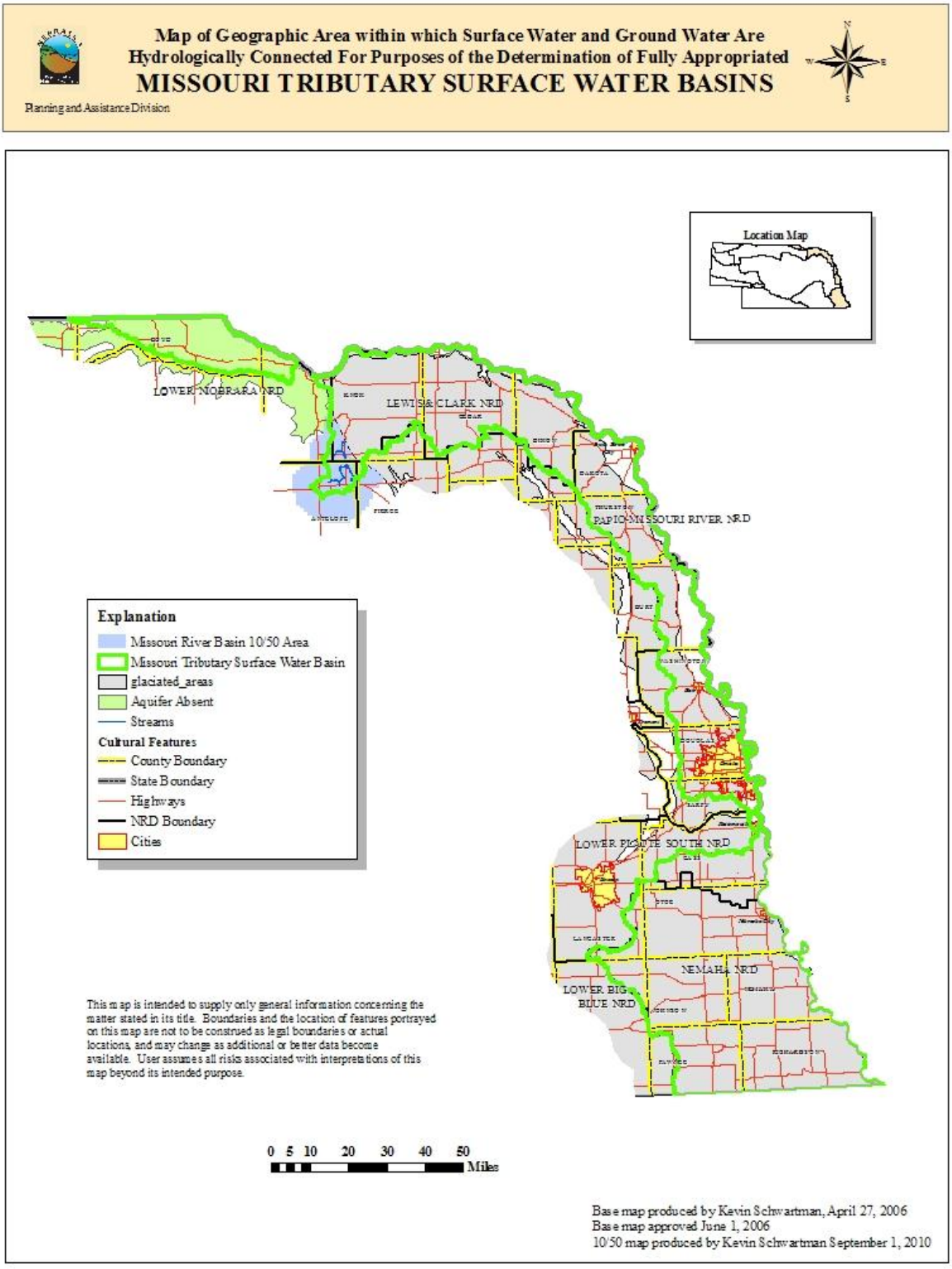

Figure 7-6. 10/50 area, Missouri Tributary Basins.

7.5 Net Corn Crop Irrigation Requirement

Figure 7-7 is a map of the net corn crop irrigation requirement (NCCIR) 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 ten percent, 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.

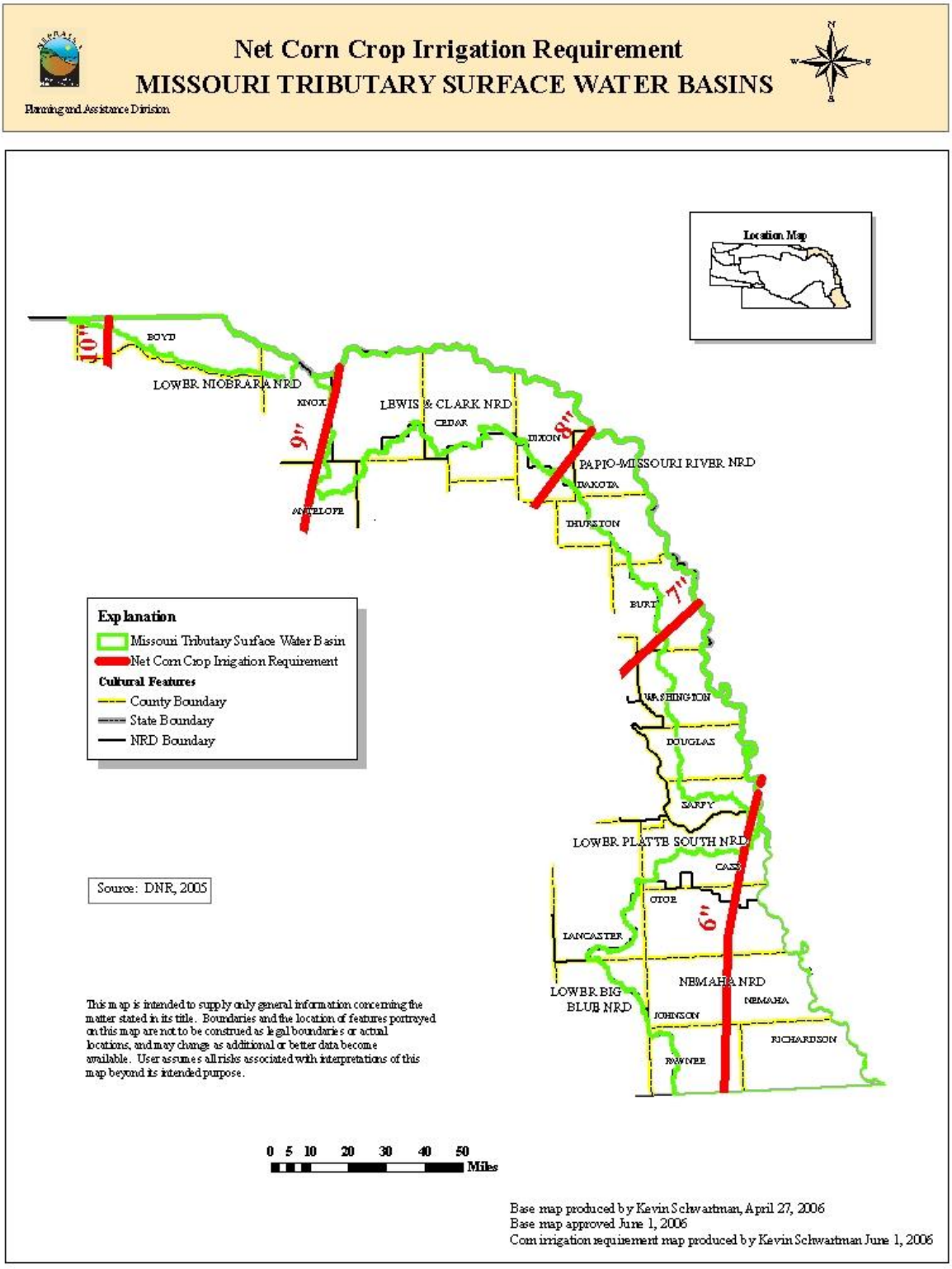

Figure 7-7. Net corn crop irrigation requirement, Missouri Tributary Basins.

7.6 Surface Water Closing Records

Table 7-1 records all surface water administration that has occurred in the basins between 1991 and 2010.

Table 7-1. Surface water administration in the Missouri Tributary Basins, 1991-2010.

Year	Water Body	Days	Closing Date	Opening Date
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

7.7 Evaluation of Current Development

7.7.1 Current Water Supply

The current water supply is estimated by using the previous twenty years (1991-2010) of surface water administration. The results of the analyses conducted for the Missouri Tributary Basins are shown in table 7-2. The results indicate that the current surface water supply in the Missouri Tributary Basins provides an average of at least 60.7 days available for diversion between July 1 and August 31 and 151.7 days available for diversion between May 1 and September 30 (table 7-3).

Table 7-2. Estimate of the current number of days surface water is available for diversion in the Missouri Tributary Basins.

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
1991	62	153
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	41	132
2003	62	153
2004	59	150
2005	59	150
2006	62	153
2007	62	153
2008	62	153
2009	62	153
2010	62	153
Average	60.7	151.7

Table 7-3. Comparison between the number of days required to meet the net corn crop irrigation requirement and number of days surface water is currently available for diversion in the Missouri Tributary Basins.

	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)	14.1 to 26.6	60.7 or greater (at least 34.1 days above the requirement)
May 1 – September 30 (85% Requirement)	18.4 to 34.7	151.7 or greater (at least 117.0 days above the requirement)

7.7.2 Long-Term 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 groundwater 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 sixty years (figure 7-8). Data do not exist to test whether trends in groundwater 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 groundwater wells.

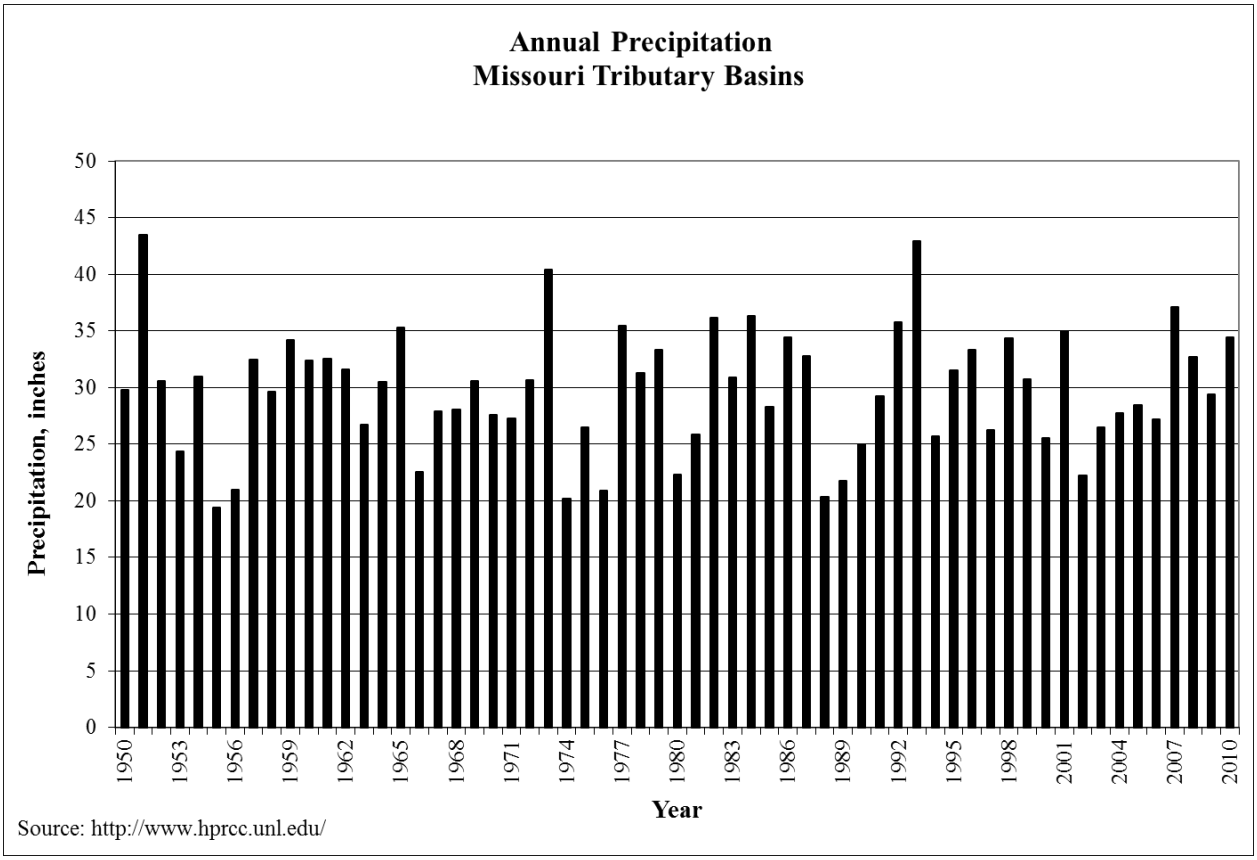

Figure 7-8. Annual precipitation, Missouri Tributary Basins.

7.7.3 Depletions Analysis

The future depletions due to current well development that could be expected to affect streamflow in the basin were estimated using the SDF methodology. The results estimate the future streamflows in the Bazile Creek subbasin to be depleted by 14 cfs in twenty-five years. For all other Missouri Tributary Basins, a lack of sufficient data and appropriate hydrogeologic conditions prohibited the use of the SDF methodology at this time.

7.7.4 Evaluation of Current Levels of Development against Future Water Supplies

The estimates of the twenty-year average number of days available for diversion were not estimated for any of the Missouri Tributary Basins including the Bazile Creek subbasin 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.

7.8 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 7-9). 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 estimated to be 35 wells per year in the basin.

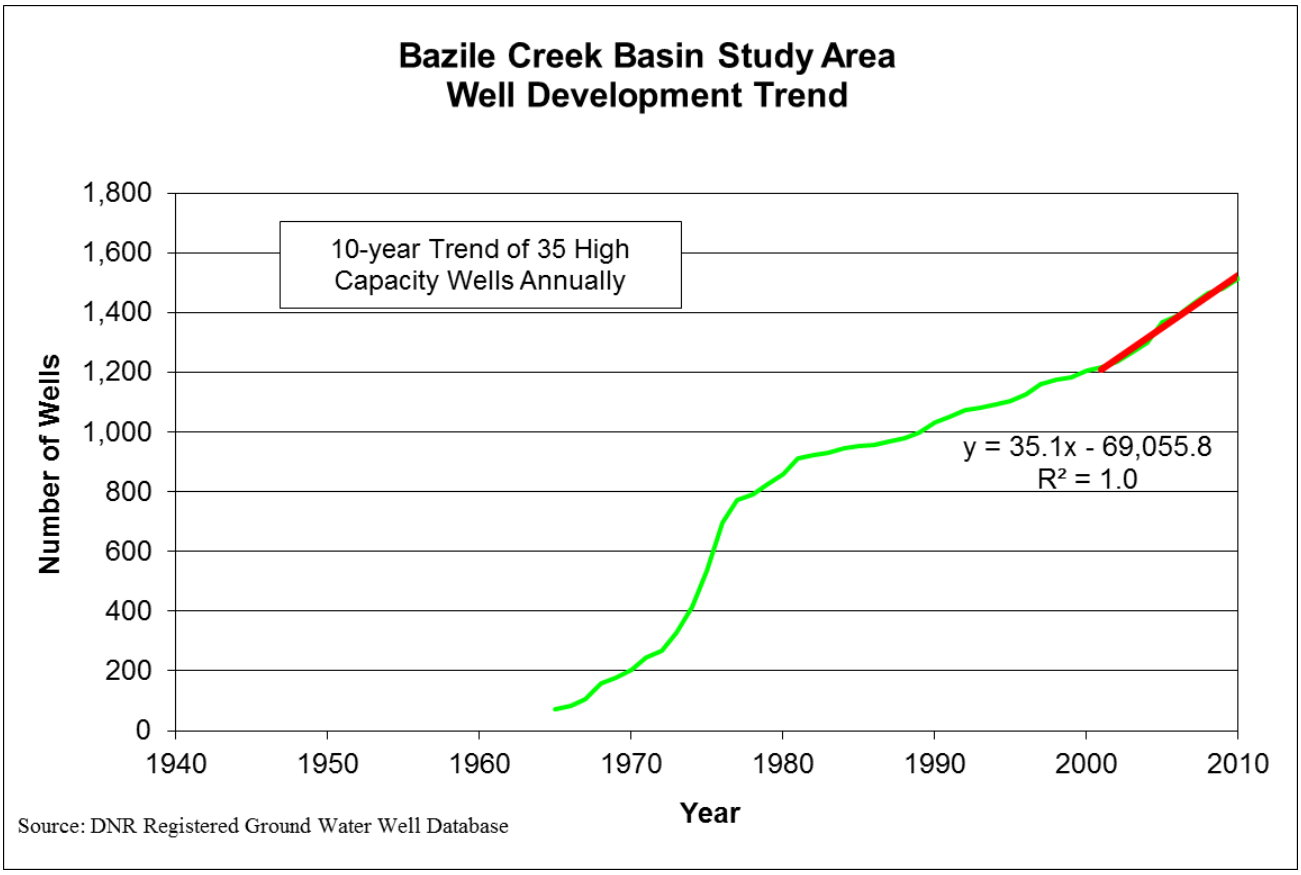

Figure 7-9. High capacity well development, Missouri Tributary Basins.

The future depletions due to potential future well development that could be expected to affect streamflow in the Bazile Creek subbasin were estimated using the SDF methodology. The results estimate the future streamflow to be depleted by an additional 5 cfs in ten years, 9 cfs in fifteen years, 14 cfs in twenty years, and 19 cfs in twenty-five years. Future depletions due to potential future well development were not estimated for all other Missouri Tributary Basins at this time due to a lack sufficient data and appropriate hydrogeologic conditions

The estimate of the twenty-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.

7.9 Sufficiency to Avoid Noncompliance

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

7.10 Groundwater Recharge Sufficiency

The streamflow is sufficient to sustain over the long term the beneficial uses from wells constructed in aquifers dependent on recharge form the stream (Appendix F).

7.11 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 continuing. This body of work will be reviewed by the Department to evaluate potential methods that may be developed to assess hydrologically connected areas and potential impacts of current and future development. The Department will continue to coordinate with the natural resources districts in the basin as this review is being conducted.

7.12 Relevant Data Provided by Interested Parties

The Department published a request for relevant data for this year's evaluation from interested parties on August 19, 2011 (see Appendix B for affidavit). The Department did not receive any such information.

7.13 Conclusions

Based on the analysis of the sufficiency of the long-term surface water supply in the Missouri Tributary Basins, the Department has reached a preliminary conclusion that the basins are not fully appropriated. The use of the SDF methodology to determine lag effects of current development requires sufficient data and appropriate hydrogeologic conditions. Those data and those conditions exist only in the Bazile Creek subbasin at this time. Therefore, lag effects of current development and potential future development were estimated only in the Bazile Creek subbasin.

The analysis of lag effects of current development for the Bazile Creek subbasin indicates a reduction in streamflow of 14 cfs in twenty-five years. The analysis of the impacts of future development on the Bazile Creek subbasin based on current development trends indicates an additional reduction in streamflow of 19 cfs in twenty-five years. The future number of days available to junior irrigators was not estimated because no surface water administration has occurred on the Bazile Creek subbasin in the past twenty 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 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.

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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.