Purpose and Overview

This report was written to comply with Nebraska Revised Statutes § 46-713(1)(a)(Reissue 2004) which states:

> By January 1 of each year beginning in 2006 and except as otherwise provided in this section and section 46-720, the Department of Natural Resources shall complete an evaluation of the expected long-term availability of hydrologically connected water supplies for both existing and new surface water uses and existing and new ground water uses in each of the state's river basins and shall issue a report that describes the results of the evaluation. For purposes of the evaluation and the report, a river basin may be divided into two or more subbasins or reaches. A river basin, subbasin, or reach for which an integrated management plan has been or is being developed pursuant to sections 46-715 to 46-717 or pursuant to section 46-719 shall not be evaluated unless it is being reevaluated as provided in subsection (2) of this section. For each river basin, subbasin, or reach evaluated, the report shall describe (i) the nature and extent of use of both surface water and ground water in each river basin, subbasin, or reach, (ii) the geographic area within which the department preliminarily considers surface water and ground water to be hydrologically connected and the criteria used for that determination, and (iii) the extent to which the then-current uses affect available near-term and long-term water supplies. River basins, subbasins, and reaches designated as overappropriated in accordance with subsection (4) of this section shall not be evaluated by the department.

Following the evaluation, the Department of Natural Resources (Department) is then required to determine which basins, subbasins or reaches are fully appropriated. Specifically, Nebraska Revised Statutes § 46-713(1)(b)(Reissue 2004) states:

> Based on the information reviewed in the evaluation process, the department shall arrive at a preliminary conclusion for each river basin, subbasin, and reach evaluated as to whether such river basin, subbasin, or reach presently is fully appropriated without the initiation of additional uses. The department shall also determine if and how such preliminary conclusion would change if no additional legal constraints were imposed on future development of hydrologically connected surface water and ground water and reasonable projections are made about the extent and location of future development in such river basin, subbasin, or reach.

The statutory criteria for determining a basin, subbasins or reaches to be fully appropriated are set forth in Nebraska Revised Statutes § 46-713(3) (Reissue 2004) which states:

> A river basin, sub-basin, or reach shall be deemed fully appropriated

> if the department determines that then-current uses of hydrologically connected surface water and ground water in the river basin, subbasin, or reach cause or will in the reasonably foreseeable future cause (a) the surface water supply to be insufficient to sustain over the long term the beneficial or useful purposes for which existing natural flow or storage appropriations were granted and the beneficial or useful purposes for which, at the time of approval, any existing instream appropriation was granted, (b) the streamflow to be insufficient to sustain over the long term the beneficial uses from wells constructed in aquifers dependent on recharge from the river or stream involved, or (c) reduction in the flow of a river or stream sufficient to cause noncompliance by Nebraska with an interstate compact or decree, other formal state contract or agreement, or applicable state or federal laws.

The specific criteria to be used to reach a determination of whether a basin, subbasin or reach is fully appropriated are set forth in Department rule 457 NAC 24.001 (Appendix A) of the Nebraska Administrative Code. These criteria focus on the requirements of Nebraska Revised Statutes, Section 46-713(3)(a) (Reissue 2004) regarding the availability of surface water to meet the demands of junior surface water appropriators. As the documentation in Appendix B explains more fully, if sufficient water supplies are available for the junior surface water appropriators, there also will be sufficient water available to meet the long term beneficial uses of wells dependent on recharge from streamflow. Thus the analysis to determine whether part (a) of the statutory criteria, whether surface water supplies are sufficient to sustain the uses of surface water appropriations, also addresses the requirements of part (b) of the statutory criteria i.e. that streamflow be sufficient to sustain uses from wells dependent on recharge from the river or stream.

The basins in Nebraska that have not already been determined to be fully appropriated or designated as overappropriated and, therefore, are the subjects of this report include: (1) the Big Blue River Basin, (2) the Little Blue River Basin, (3) the Elkhorn River Basin, (4) the Loup River Basin, (5) the Missouri Tributaries Basin, (6) the Nemaha Basin, (7) the Lower Niobrara River Basin, and (8) the Lower Platte River Basin. In addition, this report includes an evaluation of the extent of areas where ground water is considered to be hydrologically connected to that portion of the Platte River that was previously determined to be fully appropriated.

Based on the requirements of the statutes mentioned above, the report must describe for each basin evaluated:

1. the existing uses of water;
2. the geographic area within which surface water and ground water are considered by the Department to be hydrologically connected;
3. the criteria used to make the determination in number two above; and
4. the extent to which the current water uses will affect future water supplies, near term and long term.

Thus, for each basin, the report will provide information on: 1) precipitation in the basin, a major source of both surface and ground water, 2) the basin's hydrogeologic characteristics that determine the available ground water supply, 3) current and expected well development and ground water use in the basin including changes in ground water table elevations, 4) streamflow, which is an expression of the basin's surface water supply, 5) current surface water appropriation development in the basin, and where relevant 6) discussion of interstate compacts, decrees, or other formal interstate agreements or applicable state or federal laws. The discussion in this report is limited to interstate compacts and state laws because in the basins evaluated there are no interstate decrees, agreements or federal laws that are or could be impacted at this time. The Department is aware that species of wildlife listed as endangered or threatened pursuant to the federal Endangered Species Act of 1973 (ESA) exist in Nebraska and that there is a possibility that flow reductions could cause a federal project or program to be in noncompliance with the ESA in the future: however, no agency of the federal government has informed the Department of any such project or program at this time. Following this information each chapter contains a summary of the analyses for the fully appropriated determination.

Nebraska Revised Statutes § 46-713(1)(c) (Reissue 2004) states that each annual report must also include, for informational purposes only, a summary of relevant data provided by any interested party concerning the social, economic, and environmental impacts of additional hydrologically connected surface water and ground water uses on resources that are dependent on streamflow or ground water levels but are not protected by appropriations or regulations. The Department published a notice inviting the public to submit relevant data

for this purpose by November 30, 2005 (Appendix I). No information was received by the Department; however, additional information provided by some Natural Resources Districts was considered and is listed in the bibliographies following each chapter.

In preparing this report, the Department has relied "on the best scientific data and information readily available" as required by Nebraska Revised Statutes § 46-713(1)(d) (Reissue 2004). The types of scientific data and other information that may be considered for making the conclusions are specified in Department rule 457 NAC 24.002, which states as follows:

> 002 INFORMATION CONSIDERED. For making preliminary determinations required by Neb. Rev. Stat. Section 46-713 (Reissue 2004, as amended) the Department will use the best scientific data and information readily available to the Department at the time of the determination. Information to be considered will include:
>
> Surface water administrative records
> Department Hydrographic Reports
> Department and United States Geological Survey stream gage records
> Department's registered well data base
> Water level records and maps from Natural Resources Districts, the Department, the University of Nebraska, the United States Geological Survey or other publications subject to peer review
> Technical hydrogeological reports from the University of Nebraska, the United States Geological Survey or other publications subject to peer review
> Ground water models
> Current rules and regulations of the Natural Resources Districts
>
> The Department shall review this list periodically, and will propose amendments to this rule as necessary to incorporate scientific data and information that qualifies for inclusion in this rule, but was not available at the time this rule was adopted.

Methodology for Determining Whether a Basin is Fully Appropriated

Step One – Determination of Net Corn Crop Irrigation Requirement and Number of Days in Which Surface Water is Available for Diversion.

Department rule 457 NAC 24.001.01, states the criteria under which the Department shall determine a basin to be fully appropriated, as follows:

> 001.01 For purposes of Section 46-713(3)(a), the surface water supply for a river basin, subbasin, or reach shall be deemed insufficient, if, after considering the impact of the lag effect from existing groundwater pumping in the hydrologically connected area that will deplete the water supply within the next 25 years, it is projected that during the period of May 1 through September 30, inclusive, any irrigation right will be unable to divert sufficient surface water to meet on average eighty-five percent of the annual crop irrigation requirement, or, during the period of July 1 through August 31, inclusive, will be unable to divert sufficient surface water to meet at least sixty-five percent of the annual crop irrigation requirement.
>
> For purposes of this rule, the "annual crop irrigation requirement" will be determined by the annual irrigation requirement for corn. This requirement is based on the average evapotranspiration of corn that is fully watered to achieve the maximum yield and average amount of precipitation that is effective in meeting the crop water requirements for the area.
>
> The availability of stream flow will be based on the percentage of time junior rights were able to divert water during the previous 20 year period and the projected impacts of depletions on stream flow from existing wells over the next 25 years.
>
> In the event that the junior water rights are not irrigation rights, the Department will utilize a standard of interference appropriate for the use, taking into account the purpose for which the appropriation was granted.
>
> Use of the method described in this rule is not intended to express or imply any mandate or requirement that the method used herein must be included in the goals and objectives of any integrated management plan adopted for a river basin, subbasin or reach determined to be fully appropriated under this rule. Further, nothing in this section is intended to express or imply a priority of use between surface water uses and ground water uses.

The net corn crop irrigation requirements for each basin are set out in each chapter, Figure 1. The requirements are based on the average evapotranspiration of corn that is fully watered to achieve the full yield and the average amount of precipitation that is effective in meeting the net corn crop irrigation requirements for the area. The development of net corn crop irrigation requirements is described in Appendix C.

To determine the amount of water available to meet the net corn crop irrigation requirement, the Department calculated the average number of days that a junior surface water appropriation was able to divert surface water during two time periods, May 1 through

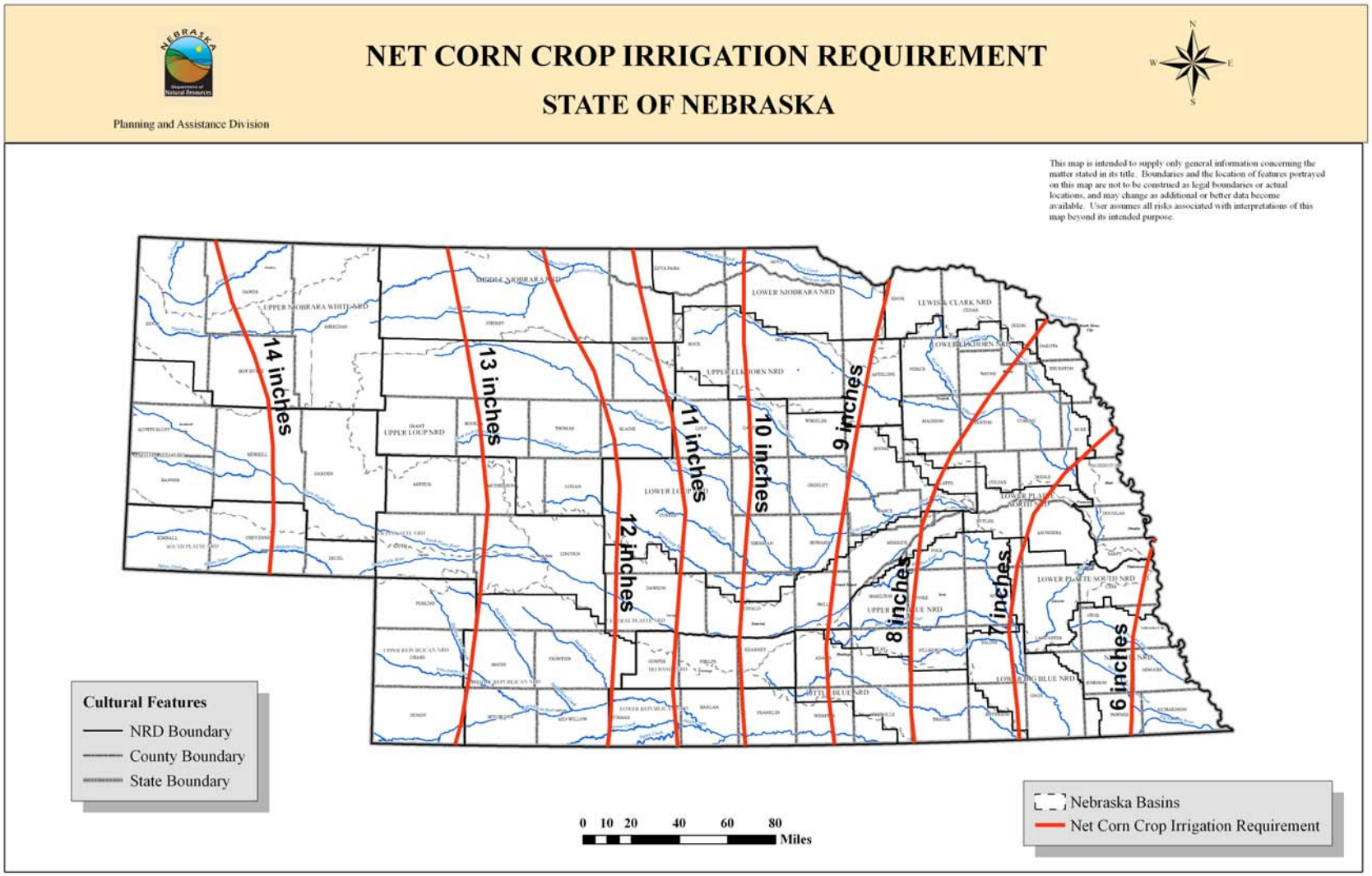
September 30 and July 1 through August 31, over the previous 20 year period. If a surface water appropriation was able to divert any water, it was assumed the surface water appropriation could divert at the rate of diversion specified in the permit. The Department's water administration records for the years 1985-2004 were used to determine the average number of days for the two time periods that junior surface water appropriations were able to divert surface water.

If administration records between 1985 and 2004 showed times when the senior surface water appropriation making a call on junior surface water appropriations had a priority date later than 1985, the Department completed a second analysis and reconstructed the administrative record as if all the surface water appropriations that existed as of 2004 existed in 1985 (Appendix D).

Step Two - Determination of the Area Considered To Be Hydrologically Connected to a Fully Appropriated Basin

For all evaluated basins, the geographic areas of hydrologically connected surface water and ground water, if any, are shown in Figure 2 and a basin wide map is included with each basin chapter. In those maps, the surface watershed basin is shown by a dashed line and the ground water portion is depicted by a shaded area. Surface water supplies are considered to be hydrologically connected to a stream or stream reach if the surface water is draining to the streams. In accordance with Department Rule 457 NAC 24.001.02, the Department considers the area within which ground water is hydrologically connected to a stream to be that area within which "pumping of a well for 50 years will deplete the river or a base flow tributary thereof by at least 10% of the amount pumped in that time." For purposes of the report, the Department determined estimated pumping in accordance with the methodology described in Appendix D. In this report this area is referred to as either the "hydrologically connected area" or the '10/50' area. In this report, the use of the term "hydrologically connected" means the area in which ground water lies within the 10/50 area.

Figure 1. Net Corn Crop Irrigation Requirement.



The methodologies used for determining the hydrologically connected area (10/50 area) of a basin are described in detail in Appendix D. When making the decision of which methodology is appropriate to use for this purpose in each basin, an evaluation of the existing information and the ability to utilize that information in an acceptable manner directed the selection. Each of the methodologies used in our evaluation has a documented history of being used extensively for this type of analysis for water management purposes.

In those areas of the state that were the subject of the numeric ground water (MODFLOW) models from the Cooperative Hydrology Study (COHYST) effort, the COHYST models were used. These models were peer reviewed by outside parties for completeness and compliance with national modeling standards such as those developed by the American Society for Testing and Materials (ASTM). Documentation on these models is in Appendix E. A numerical MODFLOW model developed by the Upper Big Blue Natural Resources District using COHYST data was reviewed by the Department and deemed suitable for delineating the extent of the area hydrologically connected (10/50 area) to the Platte River within the Upper Big Blue and the Little Blue Natural Resources Districts. This model was also used to delineate the extent of the area hydrologically connected (10/50 area) to the Little Blue River (Appendix E).

Unfortunately, in many areas of the state there are no sufficient numerical models available, nor are the data required to develop such a model available. Until such time as these data and models can be developed, the Department must rely on less data-intensive analytical models such as the Glover-Balmer or Jenkins methods, Appendix F. The use of the Jenkins method for this report was also peer reviewed by the United States Geological Survey, Appendix G. The Jenkins method was used in the Lower Niobrara, Loup, Elkhorn, Lower Platte, and Missouri Tributaries Basins.

There are areas of the state, such as in the Big Blue Basin, where it is not possible to use any method currently available to determine the 10/50 area or the lag impact of ground water pumping.

The data used in the above methodologies and throughout the report comes from published reports from the University of Nebraska-Conservation and Survey Division, and represents the most current publication available. These data include information on transmissivity, specific yield, saturated thickness, depth to water, surficial geology, bedrock geology, water table elevation change, water table elevation, characteristics of aquifers and test-hole information. These data are available on the UNL-Conservation and Survey Division web site: http://csd.unl.edu/. Additional data used in the report comes from the U.S. Geological Survey through their web site which is located at http://waterdata.usgs.gov/ne/nwis/gw and represents the most current publication available.

Step Three – Determining Lag Impacts

For purposes of this report, lag impacts are defined as the delayed effect that the consumptive use of water associated with well pumping will have on hydrologically connected streamflow and the associated impact on surface water appropriations. In accordance with Department rule 457 NAC 24.001.01, when making these determinations the Department must also take into account the lag impacts of ground water uses on water supplies over the next 25 years. The calculation of the lag impacts for the next 25 years from current development was evaluated by analyzing the impact from high capacity wells, wells pumping greater than 50 gallons per minute that were part of the registered well data base as of October 1, 2005. Expected future ground water uses, including their lag impacts, were also calculated to determine their impact on the water supply over the next 25 years. In some basins, the lag impact was not calculated due to a lack of data or models. In those cases, because the number of days in which surface water is available for diversion so far exceeded the number of days necessary to meet the net corn crop irrigation requirement the final conclusion would not change even with the addition of lag impacts.

Results

Figure 2 shows the hydrologically connected areas for the basins evaluated in this report. Tables 1 and 2 summarize the results of the analysis for sufficiency of water availability for irrigation in each basin. A description of the methodology for this analysis is available in Appendix D. When viewing the results from the above analysis, the time period of July 1 through August 31 is the critical period for supplemental water. It is during these months that the trigger for meeting the fully appropriated status is most likely to be met. The basins closest to meeting the trigger are the Loup River Basin, Elkhorn River Basin, and Lower Platte River Basin.

Table 1. Summary of Comparison between Net Corn Crop Irrigation Requirement and Number of Days in Which Surface Water is Available for Diversion (July 1 –August 31).

	Days Necessary to Meet 65% of Net Corn Crop Irrigation Requirement.	Average Annual Days Available to the Most Junior Water Appropriations (1985-2004)	Days Above Fully Appropriated in 2030 with Additional Well Development
Big Blue River Basin	23.9	57	Not Calculated*
Elkhorn River Basin	29.2	39.2	6.0
Little Blue River Basin	26.6	57	Not Calculated*
Loup River Basin	31.9	37.2	1.2
Lower Niobrara River Basin	37.2	62	Not Calculated*
Lower Platte River Basin	23.9	37.2	9.2
Missouri Tributaries Basin	23.9	62	Not Calculated*
Nemaha Basin	18.6	59	Not Calculated*

* This number was not calculated. Because the number of days in which surface water is available for diversion so far exceeds the number of days necessary to meet the net corn crop irrigation requirement the final conclusion would not change even with the addition of lag impacts from additional wells.

Figure 2. Hydrologically Connected Areas

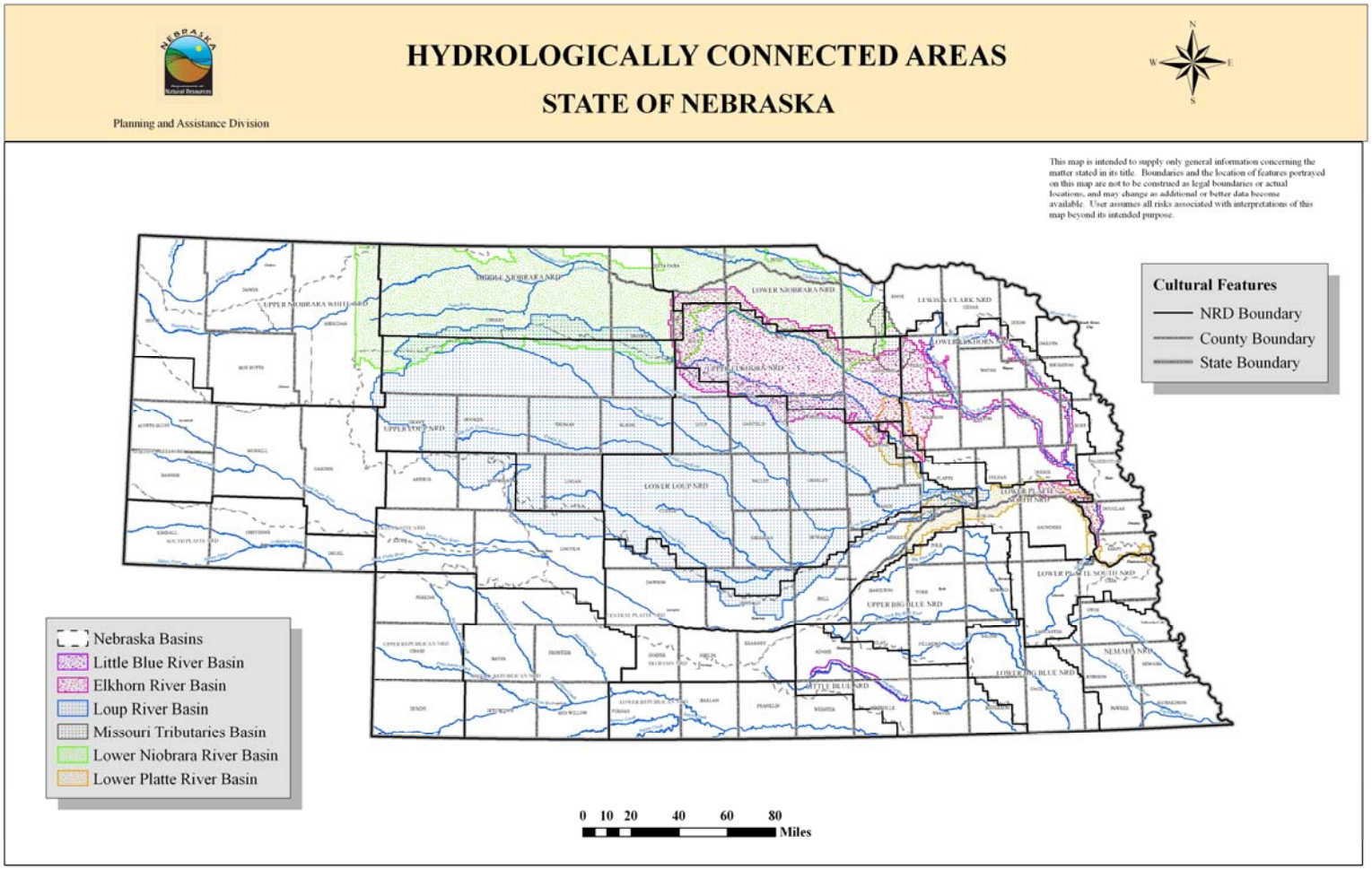


Table 2. Summary of Comparison between Net Corn Crop Irrigation Requirement and Number of Days in Which Surface Water is Available for Diversion (May 1 – September 30).

	Days Necessary to Meet 85% of Net Corn Crop Irrigation Requirement.	Average Annual Days Available to the Most Junior Water Appropriations (1985-2004)	Days Above Fully Appropriated in 2030 with Additional Well Development
Big Blue River Basin	31.3	148	Not Calculated*
Elkhorn River Basin	38.2	115.4	70.3
Little Blue River Basin	34.7	144	Not Calculated*
Loup River Basin	41.7	112.6	63.8
Lower Niobrara River Basin	48.6	153	Not Calculated*
Lower Platte River Basin	31.3	112.6	74.2
Missouri Tributaries Basin	31.3	153	Not Calculated*
Nemaha Basin	24.3	150	Not Calculated*

* This number was not calculated. Because the number of days in which surface water is available for diversion so far exceeds the number of days necessary to meet the net corn crop irrigation requirement the final conclusion would not change even with the addition of lag impacts from additional wells.

Basin Summaries

Big Blue River Basin

Big Blue River Basin

The Big Blue River in Nebraska is located in south-central Nebraska and flows into Kansas where it becomes a tributary of the Kansas River. Major tributaries of the Big Blue River in Nebraska include Lincoln Creek, West Fork of the Big Blue River, Turkey Creek, Swan Creek, and Big Indian Creek. The total area of the Big Blue River Basin in Nebraska is approximately 4,600 square miles.

The principal aquifer includes all saturated unconsolidated sediments of Quaternary age above the bedrock (exclusive of the glacial sediments) as well as the bedrock Tertiary age Ogallala Group. Though it is not part of the principal aquifer, in local areas wells drilled into the Dakota Sandstone are known to produce 500 to 800 gallons per minute. In the northwestern area of the Big Blue River Basin, most stream reaches have streambed elevations five feet or more above the surrounding water table elevation. In the glaciated areas of the Big Blue River Basin the hydrogeology is complex and the degree of hydrologic connection between the ground water system and the surface water system is poor and uncertain.

Although a numeric ground water model is available to determine the 10/50 area and to estimate lag impacts from ground water wells it does not sufficiently represent the complexities relating to the hydrologic connection between the principal aquifer and the streams of the Big Blue River Basin; therefore a determination regarding the 10/50 area or the lag impacts could not be made by that model at this time. The same complexities also prevented the use of the Jenkins method to determine the 10/50 area or lag impacts from pumping ground water wells at this time. There is no map of geographic areas of hydrologically connected surface water and ground water (10/50) for the Big Blue River Basin.

The northern part of the Big Blue River Basin has hydrologic connection with the Platte River, which is fully appropriated at that location. A discussion of that area is in the Platte River Chapter.

No portions of the Big Blue River Basin have been determined to be fully appropriated with respect to the Big Blue River and its tributaries. The number of days in which surface water is available for diversion to the junior surface water appropriations far exceeds the number of days necessary to meet the net corn crop irrigation requirement as specified in Department rule 457 NAC 24.001.01. Although reductions in flows may require water administration more often in the future, under the Kansas-Nebraska Big Blue River Compact compliance provisions, low flows do not cause noncompliance.

Little Blue River Basin

The Little Blue River in Nebraska is located in south-central Nebraska and flows into Kansas where it becomes a tributary of the Big Blue River. The major tributary to the Little Blue River in Nebraska is Big Sandy Creek. The total area of the Little Blue River Basin in Nebraska is approximately 2,500 square miles.

The principal aquifer includes all saturated unconsolidated sediments of Quaternary age above bedrock as well as the bedrock Tertiary age Ogallala Group. Other bedrock aquifers in the Little Blue River Basin are known to yield water at a moderate rate, but are not included in the principal aquifer. In the eastern and south-central areas of the Little Blue River Basin the principal aquifer is very thin or absent.
A MODFLOW ground water model was available to determine the 10/50 area; however it did not provide data on the lag impacts from ground water wells. In the western half of the Little Blue River Basin no sufficient transmissivity or specific yield data are available on a regional basis. Because of the lack of sufficient data, lag impacts from pumping ground water wells could not be determined using the Jenkins method at this time.

No portions of the Little Blue River Basin have been determined to be fully appropriated. The number of days in which surface water is available for diversion to the junior surface water appropriations far exceeds the number of days necessary to meet the net corn crop irrigation requirement as specified in Department rule 457 NAC 24.001.01. Although reductions in flows may require water administration more often in the future, under the Kansas-Nebraska Big Blue River Compact compliance provisions, low flows do not cause noncompliance.

Elkhorn River Basin

The Elkhorn River is located in northeast and north-central Nebraska and flows in a southeasterly direction until its confluence with the Platte River near Gretna. Major tributaries to the Elkhorn River include the South and North Forks of the Elkhorn River, Logan Creek, and Maple Creek. The total area of the Elkhorn River Basin is approximately 7,000 square miles.

The principal aquifer includes all saturated unconsolidated sediments of Quaternary age above the bedrock (exclusive of the glacial sediments) as well as the bedrock Tertiary age Ogallala Group. In the western and central parts of the Elkhorn River Basin the principal aquifer is unconfined in nature and generally in hydrologic connection with the streams. In the eastern part of the Elkhorn River Basin the hydrogeologic system is complex due to glaciations, therefore the degree of hydrologic connection between the ground water system and the surface water system is poor and uncertain, except where alluvial aquifer systems have been identified.

No sufficient numeric ground water model is available in the Elkhorn River Basin to determine the 10/50 area or the lag impact of ground water wells. In the areas where a hydrologic connection has been identified it is possible to use the Jenkins method to determine the 10/50 area and to calculate lag impacts from ground water wells.

No portions of the Elkhorn River Basin have been determined to be fully appropriated. The number of days in which surface water is available for diversion to the junior surface water appropriations exceeds the number of days necessary to meet the net corn crop irrigation requirement as specified in Department rule 457 NAC 24.001.01.

Loup River Basin

The Loup River Basin is defined as the area of central Nebraska that drains into the Loup River above its confluence with the Platte River. Major tributaries of the Loup River include Beaver and Mud Creeks and the Calamus, Cedar, Dismal, Middle Loup, North Loup, and South Loup Rivers. The total area of the Loup River Basin is approximately 15,200 square miles.

The Sand Hills cover a large portion of the Loup River Basin. The principal aquifer includes all saturated unconsolidated sediments of Quaternary age above the bedrock as well as the bedrock Tertiary age Ogallala Group. Throughout the Loup River Basin the aquifer is unconfined in nature and in hydrologic connection with the alluvial aquifers and/or the streams.

No sufficient numeric ground water model is available in the Loup River Basin to determine the 10/50 area or the lag impact of ground water wells. Because the aquifers in the entire Loup River Basin are in hydrologic connection with the streams it is possible to use the Jenkins method to determine the 10/50 area and to calculate lag impacts from ground water wells.

No portions of the Loup River Basin have been determined to be fully appropriated. The number of days in which surface water is available for diversion to the junior surface water appropriations exceeds the number of days necessary to meet the net corn crop irrigation requirement as specified in Department rule 457 NAC 24.001.01.

Missouri Tributaries Basin

The Missouri Tributaries Basin is defined as the area along the northeast and eastern border of Nebraska that drains into the Missouri River below its confluence with the Niobrara River and above its confluence with the Platte River. Major streams and rivers in the Missouri Tributaries Basin include Ponca, Bazile, Aowa, Elk, Omaha, Blackbird, and Papillion Creeks and the Missouri River. The total area of the Missouri Tributaries Basin is approximately 3,000 square miles.

Glacial sediments cover a large portion of the Missouri Tributaries Basin except for the western part of Knox County and the northeastern part of Antelope County. The principal aquifer includes all saturated unconsolidated sediments of Quaternary age above the bedrock (exclusive of the glacial sediments) as well as the bedrock Tertiary age Ogallala Group. Throughout most of the Missouri Tributaries Basin the occurrence of a principal aquifer as well as the hydrologic connection between the principal and the streams is limited by the nature of glacial sediments and bedrock. Only in the upper reaches of Bazile Creek and in the Missouri River alluvium is the principal aquifer present and known to be in hydrologic connection with the streams.

No sufficient numeric ground water model is available in the Missouri Tributaries Basin to determine the 10/50 area or the lag impact of ground water wells. The Jenkins method can be used in the headwaters of Bazile Creek to determine the 10/50 area and to calculate lag impacts from ground water wells. However, the remainder of the Basin cannot be analyzed with the Jenkins method because of the limited occurrence of the principal aquifer and the poor or uncertain hydrologic connection between the principal aquifer and the streams.

No portions of the Missouri Tributaries Basin have been determined to be fully appropriated. The number of days in which surface water is available for diversion to the junior surface water appropriations exceeds the number of days necessary to meet the net corn crop irrigation requirement as specified in Department rule 457 NAC 24.001.01.

Nemaha Basin

The Nemaha Basin in Nebraska is defined as the area of Nebraska south of the Platte River Basin that drains directly into the Missouri River including the Missouri River below its confluence with the Platte River. Major tributaries of the Nemaha Basin include Weeping Water Creek, the Little Nemaha River, the Big Nemaha River, and the Missouri River. The total area of the Nemaha Basin is approximately 2,800 square miles.

Glacial sediments cover most of the Nemaha Basin. The principal aquifer includes all saturated unconsolidated sediments of Quaternary age above the bedrock (exclusive of the glacial sediments). Throughout the Nemaha Basin the occurrence of the principal aquifer is limited by the nature of glacial sediments and bedrock; and in this area the hydrologic connection between the surface water and ground water is poor and uncertain. In the areas where the Missouri River alluvium is present the aquifer is unconfined and in hydrologic connection with the streams.

No sufficient numeric ground water model is available in the Nemaha Basin to determine the 10/50 area or the lag impact of ground water wells. Due to the hydrogeologic complexities of the Nemaha Basin and lack of sufficient data, the Jenkins method cannot be used to determine the 10/50 area or lag impacts from pumping ground water wells.

No portions of the Nemaha Basin have been determined to be fully appropriated. The number of days in which surface water is available for diversion to the junior surface water appropriations exceeds the number of days necessary to meet the net corn crop irrigation requirement as specified in Department rule 457 NAC 24.001.01. There is no map of geographic areas of hydrologically connected surface water and ground water (10/50 area) for the Nemaha Basin.

Lower Niobrara River Basin

The Lower Niobrara River Basin is defined as the area of north-central Nebraska that drains into the Niobrara River Basin from the Mirage Flats Diversion Dam to the confluence of the Niobrara River and the Missouri River. Major tributaries of the Lower Niobrara River include Minnechaduza Creek, the Snake River, the Keya Paha River, Plum Creek, Eagle Creek, Redbird Creek, Long Pine Creek, and Verdigre Creek. The total area of the Lower Niobrara River Basin is approximately 12,100 square miles.

The Sand Hills cover a large portion of the Lower Niobrara River Basin. The principal aquifer includes all saturated unconsolidated sediments of Quaternary age above the bedrock as well as the bedrock Tertiary age Ogallala Group. Throughout the Lower Niobrara River Basin the aquifer is unconfined in nature and in hydrologic connection with the alluvial aquifers and/or the streams.

No sufficient numeric ground water model is available in the Lower Niobrara River Basin to determine the 10/50 area or the lag impact of ground water wells. Because the aquifers in the entire Lower Niobrara River Basin are in hydrologic connection with the streams, it is possible to use the Jenkins method to determine the 10/50 area and to calculate lag impacts from ground water wells.

No portions of the Lower Niobrara River Basin have been determined to be fully appropriated. The number of days in which surface water is available for diversion to the junior surface water appropriations exceeds the number of days necessary to meet the net corn crop irrigation requirement as specified in Department rule 457 NAC 24.001.01.

Platte River Basin

Lower Platte River Basin

The Lower Platte River is defined as the portion of the Platte River from its confluence with the Loup River to its confluence with the Missouri River. For purposes of this report, the Lower Platte River Basin does not include the Loup and Elkhorn River Basins. Major tributaries in the Lower Platte River Basin include Shell Creek, Salt Creek, and Wahoo Creek. The total area of the Lower Platte River Basin is approximately 3,200 square miles.

The principal aquifer includes all saturated unconsolidated sediments of Quaternary age above the bedrock (exclusive of the glacial sediments) as well as the bedrock Tertiary age Ogallala Group which lies in the western end of the Lower Platte River Basin. In the western and central parts of the Lower Platte River Basin the principal aquifer is unconfined in nature and generally in hydrologic connection with the streams. In the remaining areas of the Lower Platte River Basin the hydrogeologic system is complex due to glaciations and the degree of hydrologic connection between the ground water system and the surface water system is poor and uncertain.

No sufficient numeric ground water model is available in the Lower Platte River Basin to determine the 10/50 area or the lag impact of ground water wells. In the areas where a hydrologic connection has been identified it is possible to use the Jenkins method to determine the 10/50 area and to calculate lag impacts from ground water wells.

No portions of the Lower Platte River Basin have been determined to be fully appropriated. The number of days in which surface water is available for diversion to the junior surface water appropriations exceeds the number of days necessary to meet the net corn crop irrigation requirement as specified in Department rule 457 NAC 24.001.01.

Upper Platte River Basin

The Upper Platte River is defined as the portion of the Platte River from the Wyoming state line to the Platte River's confluence with the Loup River. By operation of law and an order dated September 30, 2004 the portions of the Platte River Basin lying in the North Platte, South Platte, Twin Platte, and Central Platte Natural Resources Districts were determined to be fully appropriated. No further evaluation of those areas was done for this report. However, the Department's earlier evaluation of water supplies and uses in the Upper Platte River Basin was applied, for the first time to those portions of the Upper Platte River Basin that lie within the Upper Big Blue, Little Blue and Tri- Basin Natural Resources Districts. Those areas were determined to be fully appropriated. A combination of the Jenkins Stream Depletion Factor method, Cooperative Hydrology Study (COHYST) models and numeric groundwater models derived from the COHYST model would be the best scientific method readily available to the department to locate the 10% in 50 year line. Maps showing the 10/50 areas can be found in the Upper Platte River Basin chapter.

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