March 2010 No. 3

Water Matters

Published by the Nebraska Department of Natural Resources

A guide to integrated water management in Nebraska

Integrated Water Management and the Basin Water Supply

By Jesse Bradley

> While the information presented in this article is technical in nature, it has been generalized to appeal to a broader audience. This article provides an overview of a very complex topic.

Introduction

Since the passage of LB962 in 2004, integrated water management has been the focus of much of Nebraska's water planning and management activity. Integrated water management entails planning for the current and future needs of surface water and groundwater uses. It focuses on fully developing the water supplies in a given river basin while minimizing the negative impacts on current users. In Nebraska, this is accomplished through the implementation of management strategies and/or controls, when needed, to maintain a balance between uses and supplies. This management is required to provide for the economic viability, social and environmental health, safety, and welfare of the state's river basins in both the short and long term. Developing effective plans to meet these purposes requires a broad understanding of basin water supplies and their spatial and temporal availability. This guide examines factors that go into determining that supply.

Basin Water Supply

A key component of the planning process is to develop an understanding of both the water supply available within the river basin and the uses of that supply. For purposes of the current process used by the Department, this water supply is termed the Basin Water Supply (BWS). The BWS is essentially the amount of streamflow that would occur in a basin in the absence of the development of water uses. Therefore, in a basin with the development of water uses, the BWS is defined as the sum of three main elements: streamflow, surface water uses, and depletions to streamflow due to groundwater uses. Groundwater and surface water uses are commonly referred to as consumptive uses. Water use may exceed the BWS through the removal of water from storage (e.g., reservoirs, aquifers). Generally, removal of water from storage reduces the available streamflow in the short term (e.g., as reservoirs are refilled) and/or the long term (e.g., as aquifer storage is replenished). In many cases, the total use in a river basin is further restricted by obligations to provide some portion of the streamflow supply for downstream needs or to preserve a portion to meet future needs.

Streamflow

The total streamflow of a river basin, as measured at or near the basin outlet, is generally comprised of baseflow and runoff. Baseflow is the flow of groundwater into a stream through the streambed. Runoff is the overland flow (or rapid interflow through the shallow subsurface) of precipitation into a river or tributary. Baseflow typically provides a relatively steady level of streamflow during all conditions, while runoff produces peak flows following heavy rainfall events. Figure 1 illustrates the baseflow and runoff components of a hypothetical streamflow hydrograph.

Surface Water Uses

Surface water uses include all direct diversions of streamflow minus the portion of the diversion that returns to the stream (return flow). Return flow can occur as direct runoff (e.g., overland flow or canal spillways), or through recharge to the aquifer, eventually returning to the stream as baseflow. Surface water uses can be estimated through the use of measured diversion data combined with assumptions regarding return flow, or through crop irrigation requirement calculations using climatic and crop acreage data while accounting for the availability of streamflow (e.g., stream gage data, water administration records).

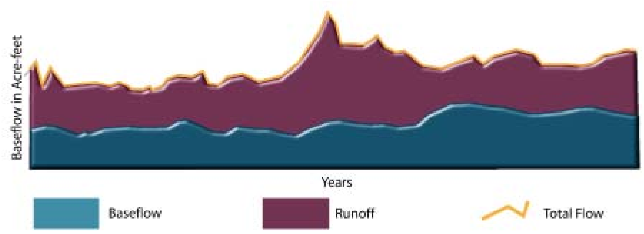

Figure 1: Hydrograph separated into baseflow and runoff components.

Groundwater Uses

Groundwater is largely derived from precipitation recharge, which, in the absence of groundwater pumping, discharges from the aquifer as baseflow to a river or direct evapotranspiration from the water table (typically in riparian zones). Generally, over the long term, the discharge from the aquifer (baseflow) is equal to the aquifer recharge. Groundwater use can change this equation and reduce the amount of net recharge (recharge minus pumping) that ultimately discharges to the stream. This difference in stream baseflow is termed "stream depletion" and can be estimated with a groundwater model by comparing the simulated stream baseflow with inclusion of the groundwater pumping (baseline) to the simulated stream baseflow without groundwater pumping (figure 2).

Supply Versus Use

As mentioned above, BWS is determined by adding the groundwater and surface water uses to the streamflow. In some cases, a basin may be subject to agreements that require certain portions of the BWS to flow downstream (e.g., the Republican River Compact among Nebraska, Kansas, and Colorado) or remain in the stream (e.g., the Platte River Recovery and Implementation Program). By subtracting the water needed for these requirements from the BWS, the remaining BWS (see Available Water Supply section) can be compared to the water use to determine whether the use has exceeded the available water supply. The balance between certain areas, types of use (e.g., agricultural, municipal, industrial, environmental), groups of water users (e.g., groundwater and surface water users), and the lag depletions of groundwater use (depletions from past pumping that increase over time) may also need to be addressed.

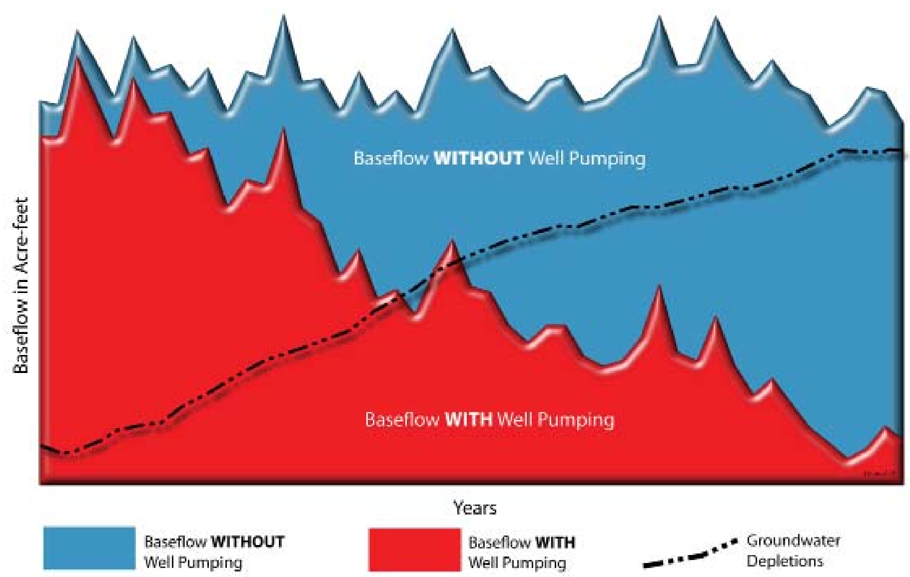

Figure 2: Graph of baseflow with and without groundwater pumping and the related depletions.

Available Water Supply

The Available Water Supply (AWS) is the BWS that is available for use within a basin. Calculation of AWS requires an adjustment to the BWS to account for outside obligations limiting water use (reducing AWS) and additional sources for water use, such as imported water (increasing AWS). For example, in the Republican River Basin in Nebraska, the AWS is approximately 50% of the BWS (Nebraska's allocation under the Republican River Compact), plus an imported water supply credit (due to Platte River BWS that is recharged by surface water uses and enhances stream baseflow in the Republican River Basin). Figures 3 and 4 provide an example of how the AWS may be determined for a hypothetical basin.

The annual AWS can also be further subdivided to take timing into account. For example, agricultural uses occur primarily in the growing season (or irrigation season), and streamflow supply that occurs in the non-irrigation season (that cannot be otherwise stored for later use) may not be part of the AWS for agricultural uses. Therefore, in some cases, the AWS might be developed independently for two or more time periods during the year. Obviously, this is a motive for the retiming of water supplies, which is the reason many reservoirs have been constructed. Storage reservoirs provide a controllable source of water supplies and enhanced aquifer storage. Enhanced aquifer storage and intentional groundwater recharge may also provide benefits, such as retiming water supplies, though the timing and location of benefits are more difficult to control.

Basin Water Supply Calculation Example

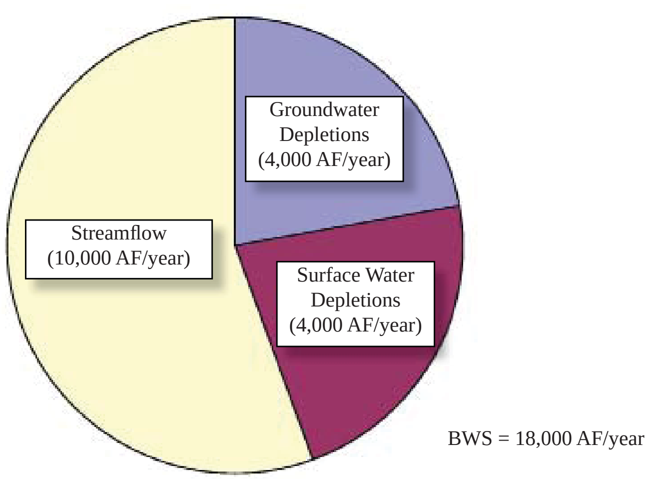

Figure 3: BWS is determined by summing the streamflow, depletions due to groundwater use, and surface water depletions. In this example, groundwater and surface water depletions are both 4,000 AF/year and streamflow is 10,000 AF/year. Therefore, BWS is 18,000 AF/year.

Available Water Supply Calculation Example

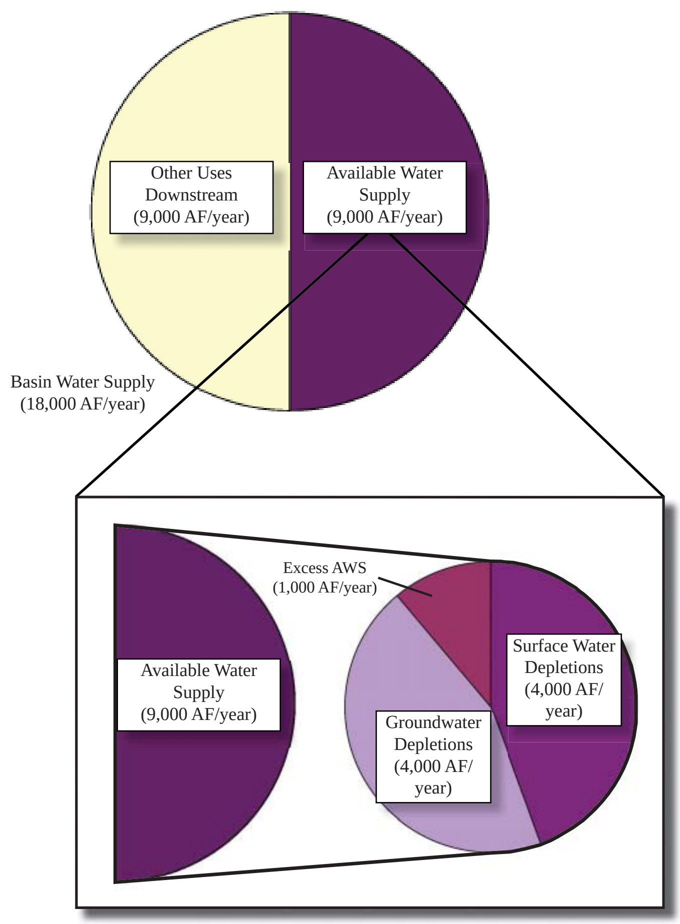

Figure 4: BWS may be limited by various obligations, such as compacts limiting the use or other requirements to keep a portion of the water in the river for downstream uses. In this example, 50% of the BWS is reserved for other uses downstream, so the remaining 50% is the Available Water Supply. If groundwater and surface water depletions both total 4,000 AF/year, that leaves 1,000 AF/year of excess AWS.

The cyclical nature of the streamflow supply (e.g., wet years and dry years) is another motive for balancing the AWS through reservoir storage and intentional groundwater recharge. In this manner, the AWS in wet years may be utilized to enhance water supplies in drier years.

Managing the Available Water Supply

In Nebraska, surface water use is regulated by the prior appropriations doctrine, and groundwater is managed through modified correlative rights. Also, an established preference system places domestic uses as most important, followed by agricultural uses, and finally, industrial uses. When the depletions from groundwater use and surface water use (each from one or more levels of preference) have begun to compete, or are projected to compete for the AWS in the future, it becomes necessary to divide the water among surface water and groundwater uses. Often, these divisions are based on the current and/or projected levels of development for each type of use and/or geographic area. When such competition for water supplies occurs, an integrated management planning process is typically initiated to reconcile the differences between various water uses and the AWS.

Integrated Management Plans

The role of the integrated management planning process is to develop the broad goals and objectives for management of the AWS and the specific controls necessary to carry them out. The goals and objectives are intended to be tailored to each natural resources district (NRD) and the needs of stakeholders in the area. These goals and objectives must seek to balance the water uses and available water supplies so that the economic viability, social and environmental health, safety, and welfare of the area subject to the IMP are maintained for both the near and long term.

Integrated management plans (IMPs) provide the framework for outlining the constraints and opportunities for the use and development of groundwater and surface water given the cyclical nature of the supply. The IMPs' constraints serve to protect all existing users while allowing the management options to be flexible in meeting the goals of the local NRD and stakeholders in the area. This framework serves as the foundation on which the monitoring portion of the IMP is developed.

An article titled "Baseflow vs. Runoff: Two Sources of Water For Nebraska's Streams," by Jim Schneider and Jesse Bradley, appeared in the October 2007 edition of the DNR's newsletter. This article included information about the various factors that affect streamflow. The newsletter is available at http://www.dnr.ne.gov/dnrnews/newsarchive2.html.

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