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EC79-722 Rainbarrels and Reservoirs...Water Storage in Nebraska

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Rainbarrels and Reservoirs . . .

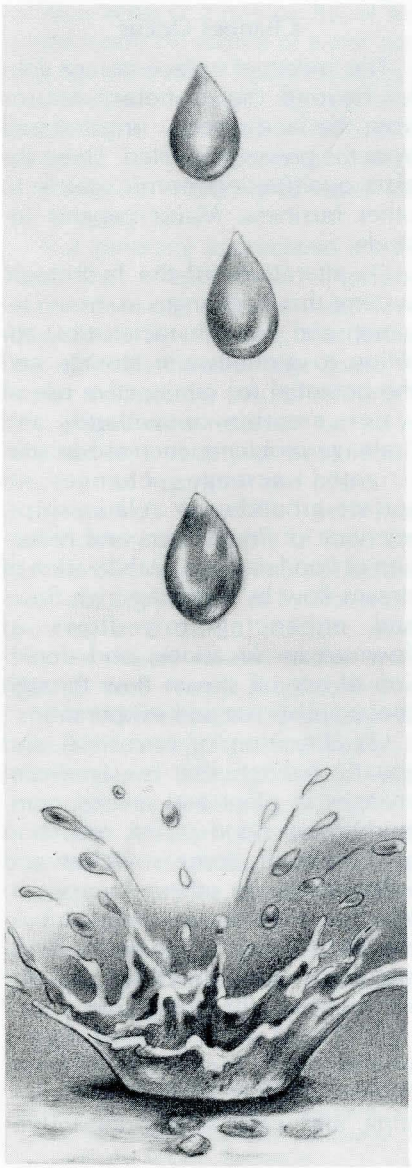
Water Storage in Nebraska

WATER . . .

What would we do without it? It's as important today as it was to the pioneers who crossed Nebraska years ago.

We use it to drink, to bathe in, to water our lawns and irrigate our crops. We also use it for recreation. Mother Nature has her own uses for water.

The article about water storage on this page is one of four stories in this issue on this very important Nebraska resource. Following are articles about irrigation costs, the destinations of the weed seeds which often float on and in the water, and one about the water table in Nebraska.



By Vincent H. Dreeszen and Deon D. Axthelm

The rainbarrel, the cistern, the cookstove reservoir and the dug well were important to the water supply in the settlement of Nebraska. Water from the rains and melting snow were stored in the rainbarrel and the cistern for later household use. The cookstove reservoir provided an indoor supply of warm water.

Because of their large diameter, dug wells provided not only a source but also storage for drinking water. That chapter of water supply and storage is now history, but the lesson is timeless: storage is the key to our water supply.

Reservoirs that store water vary greatly in type and characteristics, and can be natural or man-made. Many of us view water impoundments—such as lakes and ponds and city storage tanks—as the major water-storage facilities in Nebraska. Although important, these facilities—in terms of total quantity of water stored—are minor compared with the huge supplies of water stored in a soil-moisture reservoir, in a groundwater reservoir, in natural lakes and marshes, and in stream channels. The challenge of water management is to combine the use of these water supplies for all purposes.

Although crop choice and soil-moisture management are important to agriculture, Nebraska's relatively strong and stable agriculture-economic base has been achieved by diverting water from stream channels, by constructing dams to store runoff for later use, and by pumping from wells. Drought in 1859 and the early 1860s spawned the first irrigation in the state. That irrigation was from direct flow of streams.

However, the drought of the 1890s demonstrated the limited capability of streams—that is, the limited storage of stream channels—to supply sufficient water for increasing needs. In addition to state legislation to allocate our precious surface-water resource, meetings were held at local, state and national levels to discuss storing water in surface reservoirs in wet years and during periods of high runoff, for releasing water during the irrigation season, and for drawdowns of reservoir storage to meet irrigation needs during the dry years. Congress recognized these needs by passing the Reclamation Act of 1902, which created the agency that later became the U.S. Bureau of Reclamation.

North Platte Basin

Authorized in 1903, the North Platte Project in Wyoming and Nebraska was the second project to be built under the Federal Reclamation Act. Pathfinder Dam was constructed in Wyoming on the North Platte River in 1909. It stores mountain snowmelt which formerly flowed rapidly across Nebraska each spring and occasionally had contributed to flooding on the Platte River.

Lake Alice (1913) and Lake Minatare (1915) in Nebraska and the

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Leo E. Lucas, Director

Guernsey Reservoir (1927) in Wyoming were the next storage features constructed as part of the project. Later additions to reservoir storage on the North Platte in Wyoming are Alcova (1938), Seminoe (1939) and Glendo (1957). A number of private irrigation ditches in Nebraska receive water from storage in Pathfinder and Glendo reservoirs.

The significance of water storage (about 3 million acre-feet or 3.7 billion cubic meters) in the North Platte River basin in Wyoming is fully appreciated in Nebraska only in the western part of the state, where it provides water for irrigation and power production. However, it is highly important to Platte River valley residents in central and eastern Nebraska also, because the river's flow now is much more dependable than it used to be.

Several early private irrigation developments incorporated storage features. Oliver Reservoir (1911) and Bennett Reservoir (late 1920s) were built on Lodgepole Creek, but neither now functions for irrigation storage. In 1923, Whitney Reservoir was constructed on a tributary of White River.

Tri-County Project

The Nebraska Legislature in 1933 provided for the formation of Public Power and Irrigation Districts. Federal grants and loans from the Public Works Administration were used under this act to finance construction of Lake Maloney and the Sutherland Reservoir in 1935 and Lake McConaughy and Jeffrey and Johnson Reservoirs in 1941. Construction of Elwood Reservoir on Plum Creek was completed in 1978 as part of the "Tri-County Project." Lake McConaughy, the largest of these reservoirs, was conceived in the 1890s but required more than 25 years of intensive effort and extensive controversy before it could be completed. It provides water not only for hydroelectric power and new irrigation, but also a firm supply for those holding senior rights to divert water for irrigation.

Groundwater recharge was an unplanned but equally important aspect of the reservoirs in the Nebraska part of the Platte River drainage basin.

Storage in the groundwater reservoir has supported intensive withdrawal from irrigation wells in Dawson County without declines; has provided huge reserves in the form of groundwater mounds and recharge to irrigation wells in southwestern Lincoln County and Gosper, Phelps, and western Kearney Counties; and has increased groundwater seepage to the Platte River.

Together with the canals and irrigation laterals these reservoirs have contributed to groundwater storage several times their combined surface storage capacity of nearly 2 million acre-feet (2.5 billion m^3).

The stabilized flow in the Platte River to the east contributes significantly to groundwater recharge in the valley portion of Buffalo, Hall, and Merrick Counties and to the upper part of the Blue River Basin, thus helping to maintain groundwater supplies in those areas. A new lesson was learned: water from surface-water sources can be integrated with water from the groundwater reservoir for use and storage.

Major storage reservoirs constructed as a part of irrigation projects in Nebraska are located on the map and the capacities, dates operational, and projects served are listed on the accompanying tabular material.

Others Planned

Several other federal projects have been proposed and planned. A few have been found feasible and two are authorized. The North Loup project with storage on the Calamus River and the O'Neill project with storage on the Niobrara River have received construction funds, and when completed will total 130,000 acres (52,600 ha). A recent Supreme Court decision relative to the North Loup project required voters of the Twin Loups Reclamation District to approve the repayment and water-service contracts. A court decision in regard to the adequacy of certain aspects of the environmental impact statement on the O'Neill project is pending.

Land irrigated from surface-water reservoirs and by direct diversion from streams amounts to about 1 million acres (400,000 ha). The storage capability of existing large reservoirs within the state is about 3 million acre-feet (3.7 billion m^3). However, this potential is seldom reached. For example, according to the Nebraska Department of Water Resources, the total storage in these reservoirs on April 1, 1979, was about 1,860,000 acre-feet (2.3 billion m^3). Nebraska's potential for a significant increase in direct irrigation from new surface reservoirs is limited by available sites, suitable land, funding constraints, environemental concerns, and legal and institutional constraints. Even so, the potential for integrating new surface reservoirs with groundwater storage is great.

Changes Occur

The impact of surface storage goes far beyond the monetary returns from the land directly irrigated and from the power generated. There are also positive economic gains to other business. Major impacts include:

(1) alterations of the hydrologic system; that is, changes in stream regimen and flow characteristics, addition to groundwater storage and the potential for conjunctive use of water, creation of wetlands and drainage problems, increase in subirrigated acreage, changes in surface-groundwater relationships, retention of floodwaters and reduction of flood damage, stabilization of stream flow by reducing high flows and enhancing low flows at downstream locations, and depletion of annual stream flow through consumptive use and evaporation;

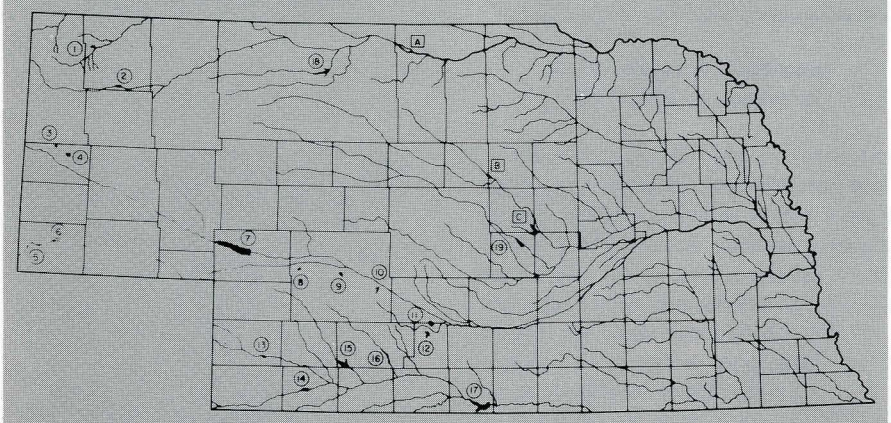
(2) alteration of terrestrial and aquatic habitat; that is, significant changes in plant and animal communities on flood plains, reduction of fisheries in some stretches and enhancement in others, increase in lake-type fisheries, and reduction in riverine habitat for some kinds of migratory water fowl and habitat enhancement for others; and

(3) change in recreational opportunities; that is, increase in flat water recreation such as boating, swimming, and water skiing, and reduc-

WYOMING WATER STORAGE RESERVOIRS ON THE NORTH PLATTE RIVER

	Year	Capacity in 1000 acre feet	(million m³)
Pathfinder Reservoir	1909	1,000	(1230)
Guernsey Reservoir	1927	49	(60)
Alcova Reservoir	1938	191	(240)
Seminoe Reservoir	1939	1,011	(1250)
Glendo Reservoir	1957	798	(980)

EXISTING AND AUTHORIZED MAJOR IRRIGATION RESERVOIRS IN NEBRASKA



	Year Operational	Capacity 1000 acre feet	(million m³)
1 Whitney Lake	1923	11	(13.5)
2 Box Butte Reservoir	1945	31	(38)
3 Lake Alice	1913	11	(13.5)
4 Lake Minatare	1915	62	(76.5)
5 Oliver Reservoir	1911	inoperative	
6 Bennett Reservoir	late 1920s	inoperative	
7 Lake McConaughy	1941	1,948	(2,400)
8 Sutherland Reservoir	1935	80	(99)
9 Lake Maloney	1935	6	(7.5)
10 Jeffrey Reservoir	1941	11	(13.5)
11 Johnson Reservoir	1941	54	(66.5)
12 Elmwood Reservoir	1978	41	(50.5)
13 Enders Reservoir	1950	44	(54)
14 Swanson Lake	1953	120	(148)
15 Hugh Butler Lake	1961	38	(47)
16 Harry Strunk Lake	1949	37	(45.5)
17 Harlan County Reservoir	1952	343	(423)
18 Merritt Reservoir	1965	74	(91)
19 Sherman Reservoir	1960	69	(85)

AUTHORIZED BUT UNBUILT IRRIGATION STORAGE RESERVOIRS

	Capacity 1000 acre feet	(million m³)
A. Norden Dam Reservoir	411	(507)
B. Calamus Dam Reservoir	128	(158)
C. Davis Creek Dam Reservoir	32	(39.5)

tion in canoeing and floating in some stream stretches and an increase in others.

The impact of surface storage also has resulted in a shift in economic opportunities and population in Nebraska.

It is interesting to look at these past reservoir developments and to reflect on how things would be today without those developments.

Other Reservoirs

In addition to the large reservoirs for storing irrigation water, several other reservoirs have been built for flood control and as regulating reservoirs for power production. The more important of the flood control reservoirs are the 10 constructed by the U.S. Corps of Engineers in the 1960s in the Salt Creek drainage basin. The largest of these is Branched Oak Lake, which has a capacity of 26,000 acre-feet (32 million m³), and the smallest is Holmes Lake, which has a capacity of 1,200 acre-feet (122,000 m³) have been built in this state. Even though so numerous, their combined storage capacity is small compared with that of the large reservoirs.

Although the primary purpose of these smaller reservoirs is to retard runoff and thus help reduce flooding and erosion from flooding, many are used for livestock watering, fishing, recreation, and irrigation. Like large reservoirs, the small ones help reduce or prevent floods, but they also deplete streamflow because they lose water by both seepage and evaporation. Most of the losses by seepage become recharge to groundwater. Irrigation reuse pits and small pools above grade-stabilization structures are other types of small reservoirs. The former collect irrigation runoff for reuse and both types provide habitat for wildlife and also result in small amounts of recharge to ground water.

Lewis and Clark Lake stores 540,000 acre-feet (670 million m³) of water and is used for power generation, flood control, and recreation. This federal reservoir on the Missouri River north of Crofton, Nebraska, is shared with South Dakota. Water stored in the lake has been

Reservoir names and completion dates, excluding the Platte River	*Project served*
NIOBRARA RIVER BASIN	
Box Butte on Niobrara River (1945)	Mirage Flats
Merritt on Snake River (1964)	Ainsworth
LOUP RIVER BASIN	
Sherman on Oak Creek (1960) (Filled with water diverted from Middle Loup River)	Farwell
REPUBLICAN RIVER BASIN	
Enders on Frenchman River (1950)	Frenchman
Swanson on Republican River (1953)	Meeker-Driftwood; Cambridge; Red Willow
Hugh Butler on Red Willow Creek (1961)	Red Willow
Harry Strunk on Medicine Creek (1949)	Cambridge
Harlan County on Republican River (1952)	Bostwick

OTHER RESERVOIR AND SMALL IMPOUNDMENT STORAGE
(not shown on map)

	Number	*Capacity 100 acre feet*	*(million m³)*
Lewis and Clark Lake		540	(666)
Impoundments over 100 A surface area	23	111	(137)
Impoundments under 100 A surface area (1975 estimate)	590	42	(52)
Farm Ponds (1970 estimate)	29,280		unknown

considered a potential source of supply for irrigation.

Natural Lakes

Nebraska's Sandhills Lakes, a 1977 Nebraska Game and Parks Commission publication, lists more than 1,300 natural lakes in the Sand Hills Region. Their total surface area is about 78,500 acres (31,770 ha). The quantity of water stored in these lakes and in marshes varies seasonally and never is large compared with the amount stored in man-made reservoirs. Many of the lakes are hydraulically continuous with adjacent and underlying ground water. Some are highly mineralized but most are important for the fish and wildlife habitat and recreation they provide.

The Soil Reservoir

Soil provides the first opportunity for water storage and management, and from the viewpoint of an agriculturalist, the most important water-storage facility is right under his feet. The top few feet of soil are the second largest water reservoir in the state.

The soil is the interface between precipitation and other reservoirs. Its slope and its capacity to absorb and hold water determine the proportion of precipitation that runs off, that enters the soil and is held there, that becomes available for uptake by plants, and that infiltrates to groundwater storage. High rates of runoff increase streamflow and movement of water out of an area. High intake rates result in more water available for storage in the soil-moisture and groundwater reservoirs and for the maintenance of the base-flow of streams.

Soil-moisture reservoirs have specific water-storage capacity determined by soil texture. Clays and loams may store as much as 3 to 4 inches per foot (25-32.5 cm/m) whereas sandy soils may store only one-third as much. Total soil-moisture storage can be large. For example, the top 4 feet (1.2 m) of soils across the state held an average of 6 inches (15 cm) of water, or about 24.7 million acre-feet (30.5 billion m³), in the spring of 1958 and again in the fall of 1965 (both wet periods). During drought and after the growing season the soil-moisture reservoir may be nearly depleted, as the dry falls of 1953 and 1956 when the average amount of water in the soil-moisture reservoir was estimated to be only 1.9 inches (4.8 cm), or about 8.9 million acre-feet (11 billion m³).

Moisture

The amount of moisture in the soil-reservoir determines yields of crops and may even determine the life or death of crops, trees, grasses and ornamental plants. The drought of the 1930s dramatically emphasized the hazards of poor soil-moisture management.

Subsurface and conservation tillage methods, mulch and fallow systems, grass and tree plantings, and contour and terrace farming were all developed during the drought and became generally accepted as practices to increase available soil moisture for crop production. Drought-tolerant crops were developed and their use was widely accepted.

The end of the drought and the extensive development of water for irrigation from ground and surface reservoirs tended to reverse the trend of those on-the-farm management practices. Viewed initially as drought insurance or supplemental water to rainfall, irrigation generally became a practice of water application with little regard to water available in the soil-moisture reservoir.

Today we are rediscovering the opportunity to use the available moisture annually stored in soils. Depletion of the supply of water in the groundwater reservoir, increasing costs of the energy needed to pump water from wells, and the difficulty of developing additional storage in surface-water reservoirs have increased sensitivity to the value of protecting and utilizing soil-moisture reservoir.

Total Supply Large

Amounts of annual precipitation range between 80 and 100 million acre-feet (100 and 125 billion m³). Storage in the soil-moisture reservoir ranges between 8 and 25 million acre-feet (10 and 30 billion m³). Average inflow of water to the state amounts to about 2 million acre-feet (2.5 billion m³), and annual outflow from the state, although highly variable, averages about 8 million acre-feet (10 billion m³). The difference of 6 million acre-feet (7.5 billion m³) between inflow and outflow consists of runoff from precipitation, which increases about 1 inch (2.5 cm) for each 24 miles (38 km) from west to east, and water seeping out of groundwater reservoirs into stream channels. Storage in surface reservoirs within the state ranges from 2 million to nearly 4 million acre-feet (2.5 to 5 billion m³). Although the total of these amounts of water annually available for use is large, it pales in significance when compared with the nearly 2 billion

acre-feet (2.5 trillion m^3) of good quality groundwater stored in the groundwater reservoir.

Groundwater Reservoir

Awareness of Nebraska's large store of available groundwater developed slowly. Awareness of the opportunity to use the storage capacity of the groundwater reservoir began to develop much later and still is not generally recognized.

Several features of the groundwater reservoir make it essential to water-resource management in Nebraska. Among these are: (1) broad extent of area; (2) tremendous volume of water stored; (3) importance to agriculture (more than 62,000 irrigation wells and approximately 5.5 million acres (2.2 million ha) of irrigated land); (4) source of water supply for domestic, stock, municipal and industrial needs; (5) source of base flow of many Nebraska streams; (6) resistance to drought and relative immunity to water loss by evaporation.

Not generally appreciated are the facts that effective use of groundwater reservoirs requires water-level drawdown by pumping; that lowering of levels creates more space for water storage; the natural refilling of the groundwater reservoir can be increased in a variety of ways requiring human ingenuity and effort.

Nebraska's "good life"—our jobs, our homes, our supply of food and drink, our recreational opportunities, our production of hydroelectric power, and our abundant wildlife—is closely related to the abundance and ready availability of water. Maintenance of that good life requires learning from the lessons of the past and making sound water-management decisions today.

It also requires determination to continually evaluate water availability; to increase water storage in surface reservoirs, in the soil, and in the groundwater reservoir; and to promote greater efficiency and curb waste in water use.□

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