Nebraska Statewide Groundwater-Level Monitoring Report

2024

Aaron R. Young, Mark E. Burbach, Susan Olafsen Lackey, R.M. Joeckel, and Jeffrey P. Westrop

Conservation and Survey Division
School of Natural Resources

Nebraska Water Survey Paper Number 93

Institute of Agriculture and Natural Resources
University of Nebraska–Lincoln

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Nebraska Water Issues of Interest in 2024

R.M. Joeckel, Nebraska State Geologist and Director of the Conservation and Survey Division; Senior Associate Director, School of Natural Resources

Surface water

Heavy rains in mid-June in parts of Minnesota, Iowa, South Dakota, and northcentral Nebraska resulted in minor to moderate flooding along the Missouri River in Nebraska during the last week in June and into early July 2024. The Decatur and Blair gauging stations on that river recorded their third highest crests on record, exceeded only by crests in 1952 and 2011. The Omaha station experienced its fifth highest crest, and the Plattsmouth, Nebraska City, Brownville, and Rulo stations experienced significant but lower-ranking crests (Meyer et al., 2024). Damage to major infrastructure from this flooding was minimal (Nystrom, 2024).

The State of Nebraska began buying land in Colorado for the proposed Perkins County Canal in late December 2023 (Knapp, 2024a) and the Nebraska Department of Natural Resources posted an overview of the planned Perkins County Canal project on its website in February 2024 (https://dnr.nebraska.gov/perkins-county-canal). Nevertheless, Governor Pillen stated at the end of May that he would abandon the project if legal costs became excessive (Knapp, 2024b), yet project planning continued through 2024 (Knapp, 2024c). LB17, which proposed to repeal the Perkins County Canal Project Act and terminate the associated fund, was introduced into the Nebraska Legislature in July and referred to the Natural Resources Committee but then indefinitely postponed in August (Nebraska Legislature, 2024a).

Groundwater irrigation

In late January, the Lower Elkhorn NRD approved more than 5,700 acres of new groundwater irrigation in the district (Anonymous, 2024c).

Groundwater quality

Governor Pillen signed Legislative Bill 1368, which proposed the adoption of the Nitrogen Reduction Incentive Act, in April; a program for fertilizer-reduction incentive payments to farmers from a special fund became effective as Nebraska Revised Statute 2-414 in July and it will remain in effect until the end of December 2029 (Nebraska Legislature, 2024b).

Proposed updates to the Central Platte NRD's groundwater management plan were scheduled to go into effect November 1; these changes include expansions of acres classified as Phase I and Phase III, those being areas of lower (≤7.5 ppm) and high (>10.1 ppm) groundwater nitrate levels (Anonymous, 2024a). The Nebraska Association of Natural Resource Districts announced the release of "Producer Connect," a web and mobile app that facilitates reporting annual levels of fertilizer application by farmers and should discourage overapplication (Hamel, 2024). In June, the Little Blue NRD elevated four high-groundwater-nitrate areas under their jurisdiction to Level III (Anonymous, 2024b).

The Nebraska Department of Environment and Energy released its 2024 Nebraska Groundwater Quality Monitoring Report (https://dee.nebraska.gov/forms/publications-grants-forms/24-026) in November.

At the Federal level, the first national drinking water standard regarding polyfluoroalkyl substances (PFAS) was promulgated in April as part of a larger action plan to deal with these widespread contaminants (U.S. EPA, 2024a). The U.S. EPA issued the results of the agency's fourth review of drinking water standards, which reviewed the national primary drinking water regulations regarding many other contaminants (U.S. EPA, 2024b).

SELECT RECENT PUBLICATIONS INVOLVING CSD PERSONNEL

Burbach, M.E., Kennedy, S., Rudnick, R.R., Stockton, M., Burr, C.A., and Rhoades, K., 2024. The influence of a real-life farm management competition on how non-agricultural producers relate to producers with implications for collaborative natural resource management. Socio-Ecological Practice Research, 6(2), 455-467 [https://doi.org/10.1007/s42532-024-00196-8].

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Kawo, N., **Korus, J.T.,** Kishawi, Y., Haacker, E., Mittelstet, A., 2024. Three-dimensional probabilistic hydrofacies modeling using machine learning. Water Resources Research 60. E2023WR035910 [https://doi.org/10.1029/2023WR035910].

Kolarik, N.E., **Shrestha, N.,** Caughlin, T. and Brandt, J.S., 2024. Leveraging high resolution classifications and random forests for hindcasting decades of mesic ecosystem dynamics in the Landsat time series. Ecological Indicators 158, 111445 [https://doi.org/10.1016/j.ecolind.2023.111445].

Korus, J.T., Joeckel, R.M., Mittelstet, A.R., **Shrestha, N.,** 2024, Multiscale characterization of splays produced by a historic, snow-detonated flood on a large braided stream (Platte River, Central USA). Earth Surface Processes and Landforms 49(14): 4788-4807 [https://doi.org/10.1002/esp.5997 30].

Shrestha, N., Kolarik, N. and Brandt, J., 2024. Mesic vegetation persistence: A new approach for monitoring spatial and temporal changes in water availability in dryland regions using cloud computing and the sentinel and Landsat constellationt. Science of the Total Environment Mar 20:917:170491, doi: 10.1016/j.scitotenv.2024.170491.

Solomon, D.K., and **Gilmore, T.E.,** 2024. Age dating young groundwater: How to determine groundwater age from environmental tracer data. The Groundwater Project [https://doi.org/10.21083/LIIU2727].

INTRODUCTION

Groundwater-level information is valuable to citizens and stakeholders.
It quantifies the availability of groundwater and informs management decisions.

This report is a synthesis of groundwater-level monitoring programs in Nebraska. It is a continuation of the series of annual reports and maps produced by the Conservation and Survey Division (CSD) of the University of Nebraska in cooperation with the U.S. Geological Survey (USGS) since the 1950s. Groundwater-level monitoring began in Nebraska in 1930 to survey the state's groundwater resources and observe changes in its availability on a regular basis. The CSD and USGS cooperatively developed, maintained, and operated an observation-well network throughout the state. These two agencies were responsible for collecting and archiving this information, and for making it available to the citizens.

Although CSD and USGS still occupy the central roles in the statewide groundwater-level monitoring program, other agencies have assumed the responsibilities of building and maintaining observation networks and measuring groundwater-levels. The CSD and USGS continue to operate some of the original observation wells, but today most measurements are made by agencies such as Natural Resources Districts (NRDs) (Fig.1), U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, and Public Power and Irrigation Districts. Because these agencies are located throughout the state, they can implement groundwater-level monitoring programs using local field staff, landowner contacts, taxing and regulatory authority, and first-hand knowledge of local conditions. Collectively, these agencies have developed an extensive network of observation wells throughout the state.

The CSD provides vital technical expertise to these agencies as they develop and implement groundwater-level monitoring plans. The CSD evaluates the adequacy and accuracy of the groundwater-level data and provides the statewide assessment of groundwater-level changes across many of the state's aquifers (Figs. 2–3).

The CSD has long provided technical services to stakeholders by integrating groundwater-level change data with multiple data sets in order to:

1) Determine the amount of groundwater in storage and its availability for use.
2) Assess the water-supply outlook by identifying changes in the volume of groundwater in storage.
3) Identify areas in which changes in groundwater levels may have an economic impact.
4) Assist state and local agencies in the formulation and administration of resource-management programs.
5) Determine or estimate the rate and direction of groundwater movement, specific yield of aquifers, base flow of streams, sources and amounts of groundwater recharge, and locations and amounts of groundwater discharge.
6) Assess the validity of hydrogeologic interpretations and the assumptions used in developing models of groundwater systems.

The need for this essential information only escalates as water-use pressures steadily increase. The CSD strives to meet this challenge by focusing on fundamental data, building collaborative relationships with the agencies that depend on the information, and providing scientifically accurate information in a timely manner.

Purpose and Methods

Most of the groundwater used in Nebraska is pumped from the High Plains aquifer system (HPA), although there are multiple aquifers in the state (Fig. 2, 3). The HPA underlies parts of eight states, including South Dakota, Wyoming, Nebraska, Colorado, Kansas, Oklahoma, Texas, and New Mexico. In total, Nebraska overlies approximately 64,600 mi^2 of the HPA, or 36%

Figure 1. Nebraska Natural Resources Districts

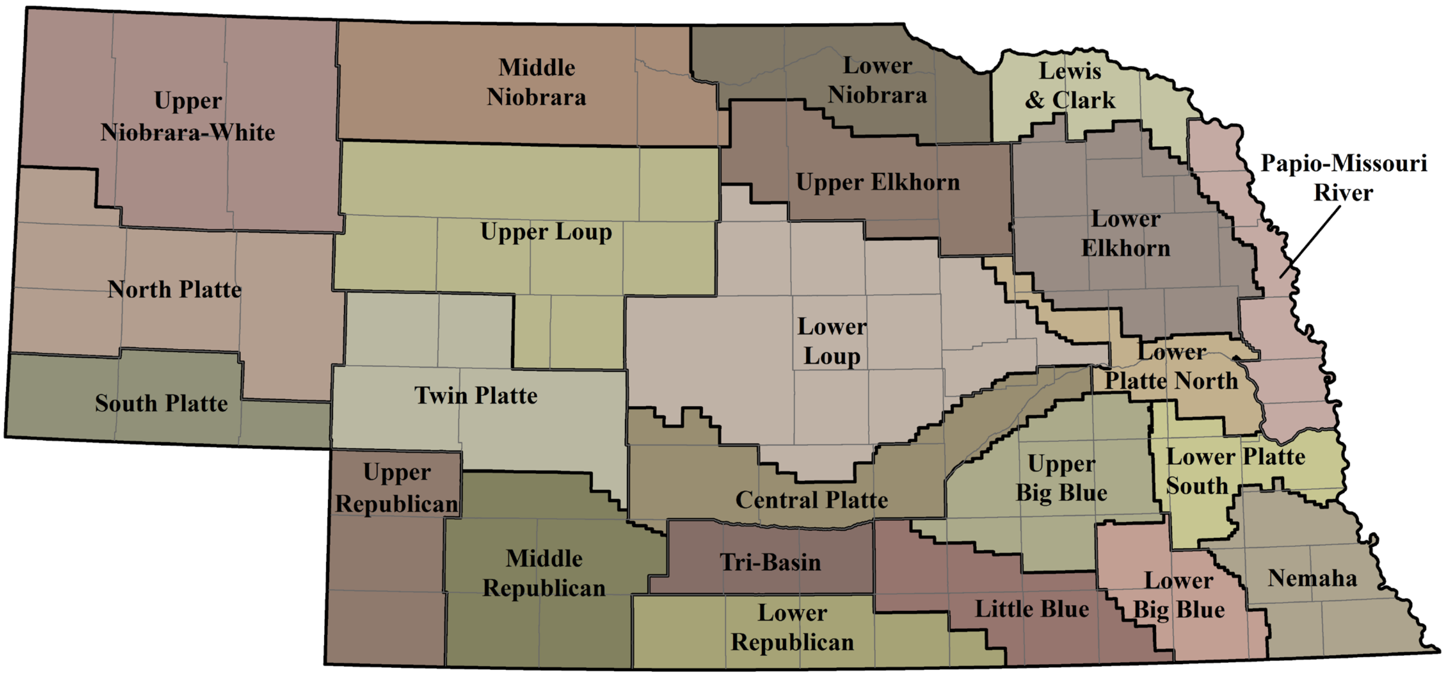
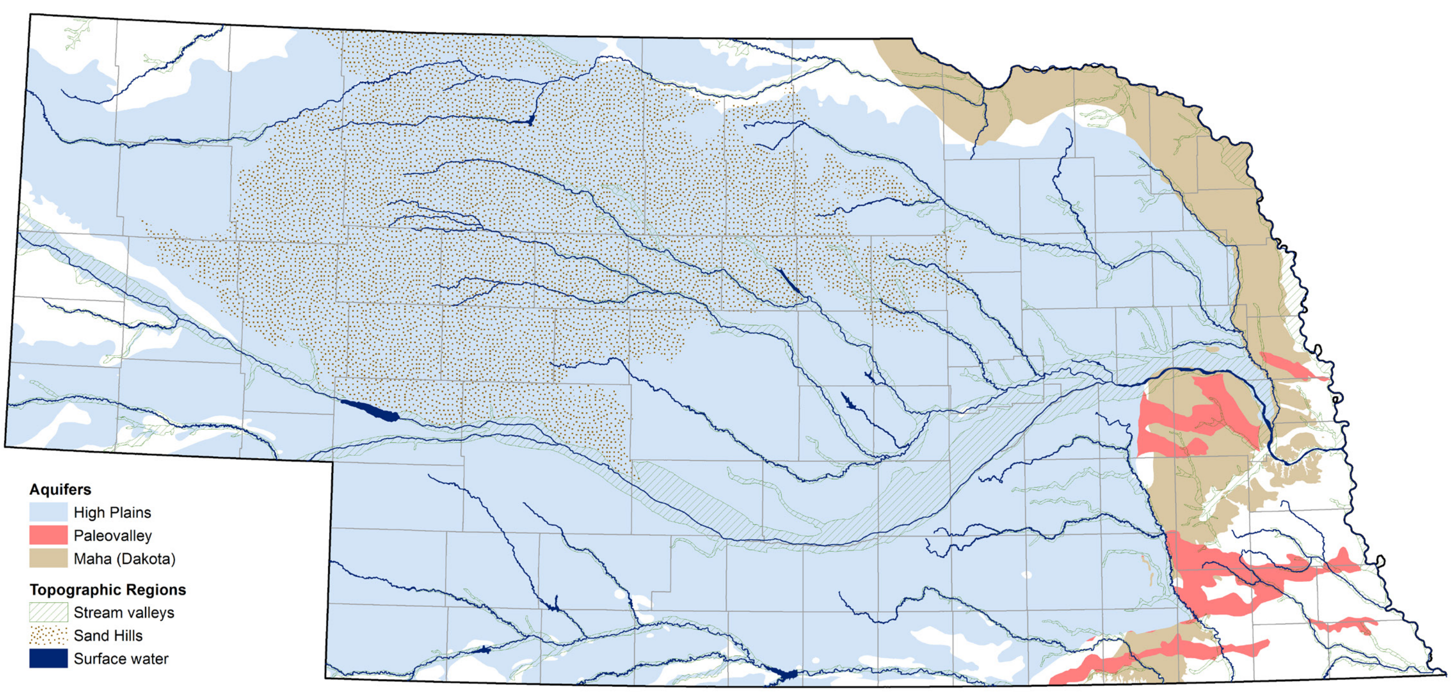


Figure 2. Important Aquifers and Topographic Regions of Nebraska



Note: The aquifer units shown here may contain little or no saturated thickness in some areas.

Figure 3. Generalized Geologic and Hydrostratigraphic Framework of Nebraska

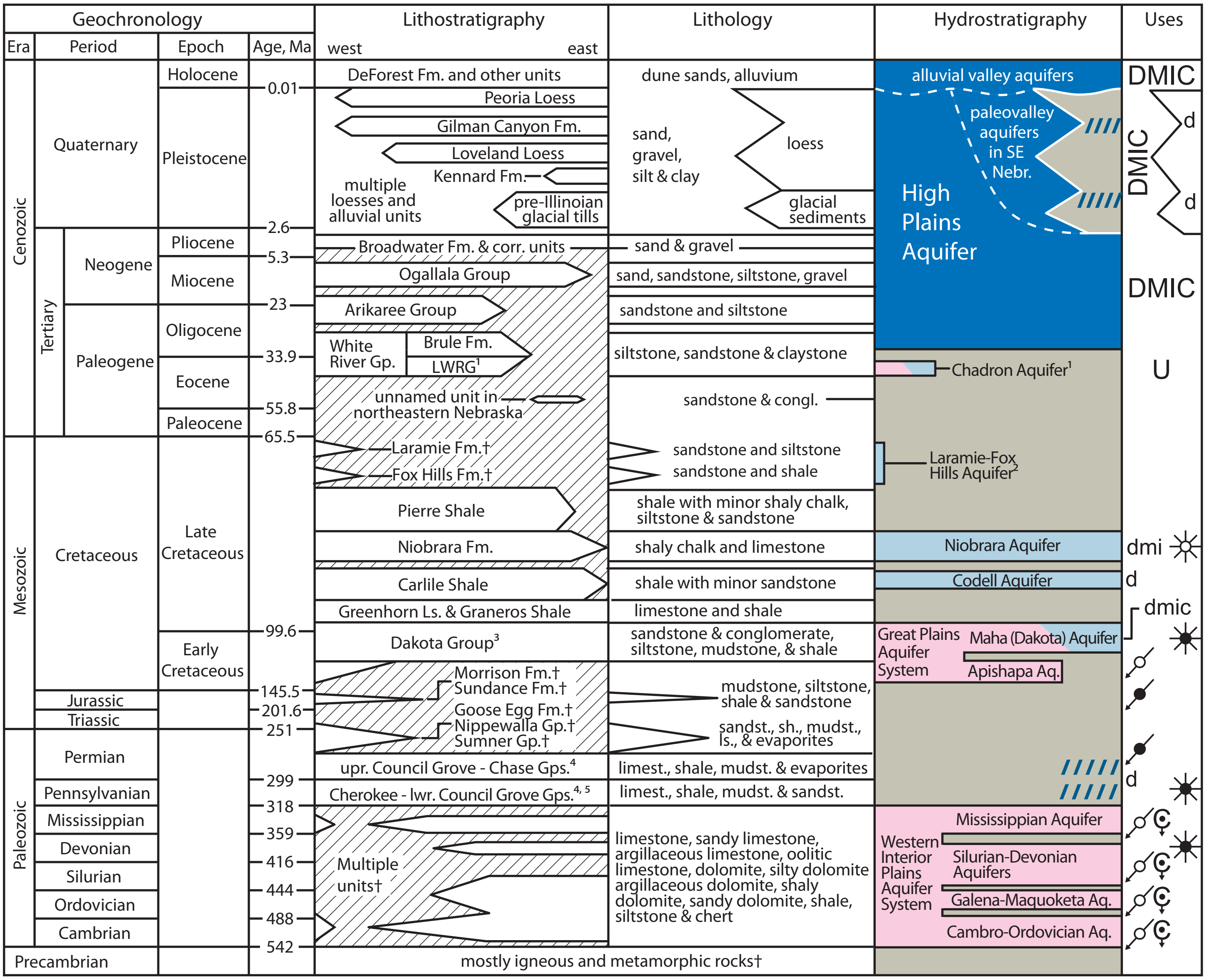


Diagram is not to scale relative to geologic time and stratigraphic thicknesses.

Hydrostratigraphic characteristics and water quality

- primary aquifers with good quality water
- secondary aquifers with good quality water
- secondary aquifers with generally poor quality water
- //// aquitards with local low-yield aquifers
- aquitards

[1] lower White River Group - includes Chamberlain Pass and Chadron Formations according to some authors; "Chadron Aquifer" historically refers to aquifer in lower White River Group

[2] important aquifer in Colorado, but present in Nebraska only in extreme southwestern Panhandle

[3] Dakota Formation in adjacent states

[4] includes correlative units with different names in northwest Nebraska

[5] Cherokee, Marmaton & Pleasanton Groups are not exposed in Nebraska

†present only in subsurface

Groundwater uses and related aspects

D	major domestic use	I	major irrigation use
d	minor domestic use	i	minor irrigation use
M	major municipal use	C	major commercial/industrial use
m	minor municipal use	c	minor commercial/industrial use

- units used for wastewater injection
- units with potential use for wastewater injection
- U unit mined for uranium by in-situ leaching (Dawes Co.)
- unit with potential use for carbon sequestration
- unit producing petroleum or natural gas
- unit with natural gas potential

From: Korus and Joeckel (2011)

of the total aquifer by area. By volume as of 2009, Nebraska has approximately 2.040 billion acre-feet of saturated sediments, or 69% of the total volume of the HPA (McGuire et. al., 2012). The greatest area of saturated thickness in the HPA, nearly 1,000 feet, is located under the western portion of the Nebraska Sand Hills (c.f. Korus et. al. 2013, pp. 44).

Although Nebraska is fortunate to have such vast supplies of groundwater, any groundwater supply is vulnerable to depletion through overpumping. According to the 2017 U.S. Census of Agriculture, Nebraska leads the nation in irrigated acres with more than 8.6 million acres. Without proper oversight, irrigation pumping on this scale can rapidly deplete aquifers and lead to large-scale economic hardship. The present report illustrates the changes in groundwater levels in Nebraska at different time scales, resulting from both natural and anthropogenic influenced changes. This information is important to both state and local lawmakers in assessing the current state of Nebraska's groundwater resources, and to local producers in making land management decisions.

This report summarizes changes in Nebraska's groundwater levels over periods of one and ten years prior to 2024, as well as from predevelopment times (generally pre-1960) to 2024. These changes are depicted in maps that delineate regional trends on a statewide basis. **We stress that the maps presented in this report provide overviews of the general locations, magnitudes, and extents of rises and declines. Local conditions, which may vary considerably, are not depicted in the maps in this report and, indeed, they cannot be represented with accuracy at the scale of the maps.** The reader is referred to Figures 1 through 4 for the boundaries of NRDs and the locations of rivers, aquifers, and counties mentioned in the text.

The one- and ten-year changes are presented in the spring 2023 to spring 2024 and spring 2014 to spring 2024 maps, respectively. Groundwater levels measured from thousands of wells throughout the state during the spring of 2024 (Fig. 5) were compared to levels measured in the same wells in the spring of the preceding target year. For the one- and ten-year change maps, contours were generated using computer interpolation. These contours were incorporated into the final maps in areas where the principal aquifer is geographically continuous and in relatively good hydraulic connection, and where data density is comparatively high. In areas not meeting these criteria, the computer-generated contours were manually edited at various scales in order to conform to hydrogeologic boundaries that prevent the flow of groundwater. Such boundaries include: (1) areas where relatively impermeable bedrock units outcrop or exist in the shallow subsurface, such as southeastern Nebraska and in areas of Scotts Bluff County, (2) valley boundaries in eastern Nebraska where alluvial aquifers are a major source of groundwater but upland areas between them lack a primary aquifer, and (3) areas where the HPA is dissected by deeply entrenched parts of the Niobrara, Republican, and Platte River valleys.

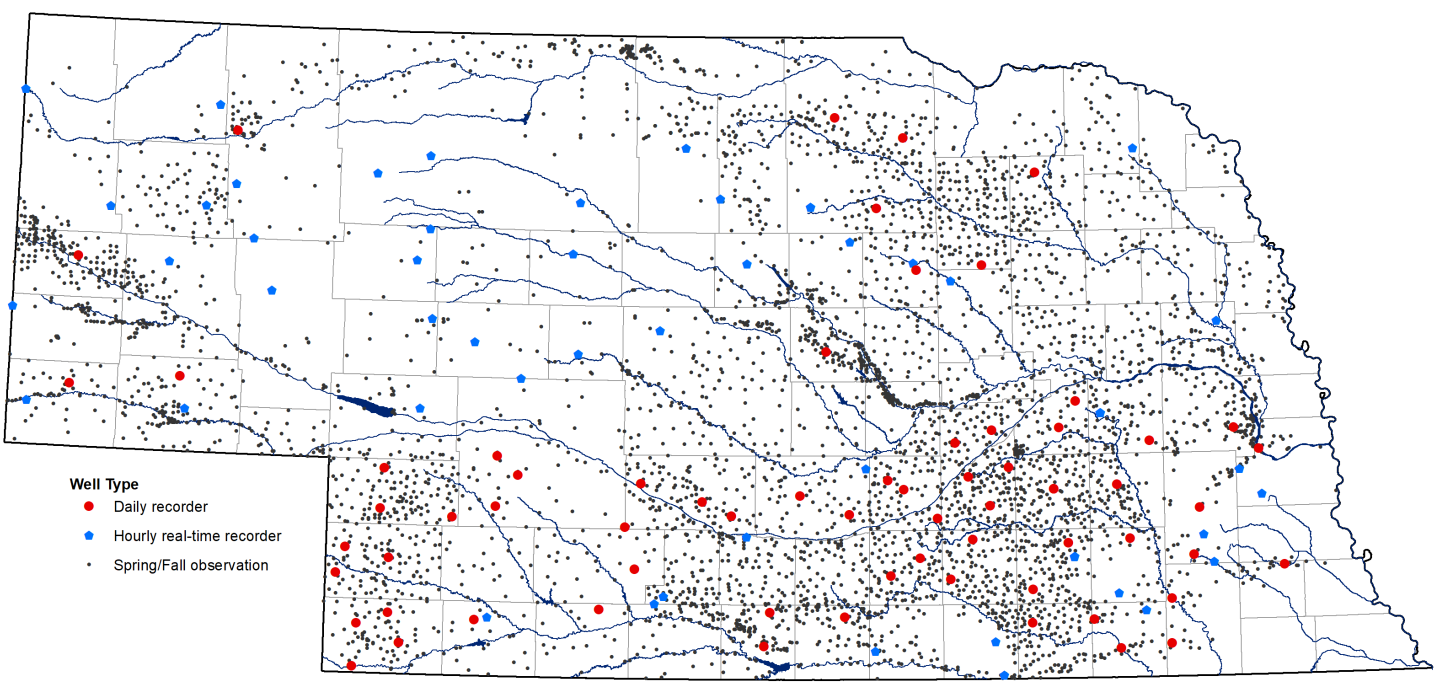
For the predevelopment to spring 2024 map, groundwater levels from wells measured in 2024 were compared to estimated predevelopment groundwater levels in the same wells. An estimated predevelopment groundwater level is the approximate average groundwater level at a well site prior to any development that significantly affects groundwater levels. Predevelopment groundwater levels are generally presumed to be those that predate intensive groundwater irrigation. Such intensive use of groundwater began during the approximate period 1930 to 1960, although not synchronously across the state. Predevelopment map contours were drawn manually with the aid of previously existing maps for similar time periods and with knowledge of major hydrogeologic boundaries.

Areas of sparse data are shown with a hatched pattern on all maps (e.g., Fig. 7). A point-density interpolation was used to determine the number of observation points within a 6-mile (approximately 10-kilometer) search radius. Areas of sparse data were defined as areas with zero observation points within the search radius.

Precipitation maps were prepared by comparing total precipitation over the time period of interest to the 30-year normal provided by the National Climate Data Center (www.ncdc.noaa.gov). The 30-year normal currently in use is calculated on the basis of average annual precipitation during 1991-2020. A precipitation surface is generated using the inverse distance weighted interpolation method in ArcGIS with a 1,640 ft (500 m) cell size. The resulting surface is classified with a defined interval of ten percent and contoured. The resulting contours are smoothed and then converted to polygons.

Figure 4. Counties, Major Cities, and Streams of Nebraska

Figure 5. Location of Observation Wells by Type



Sources: U.S. Geological Survey, Nebraska Water Science Center; U.S. Bureau of Reclamation, Kansas-Nebraska Area Office; Nebraska Natural Resources Districts; Central Nebraska Public Power and Irrigation District; Conservation and Survey Division, School of Natural Resources, University of Nebraska-Lincoln

Factors Causing Groundwater-Level Changes

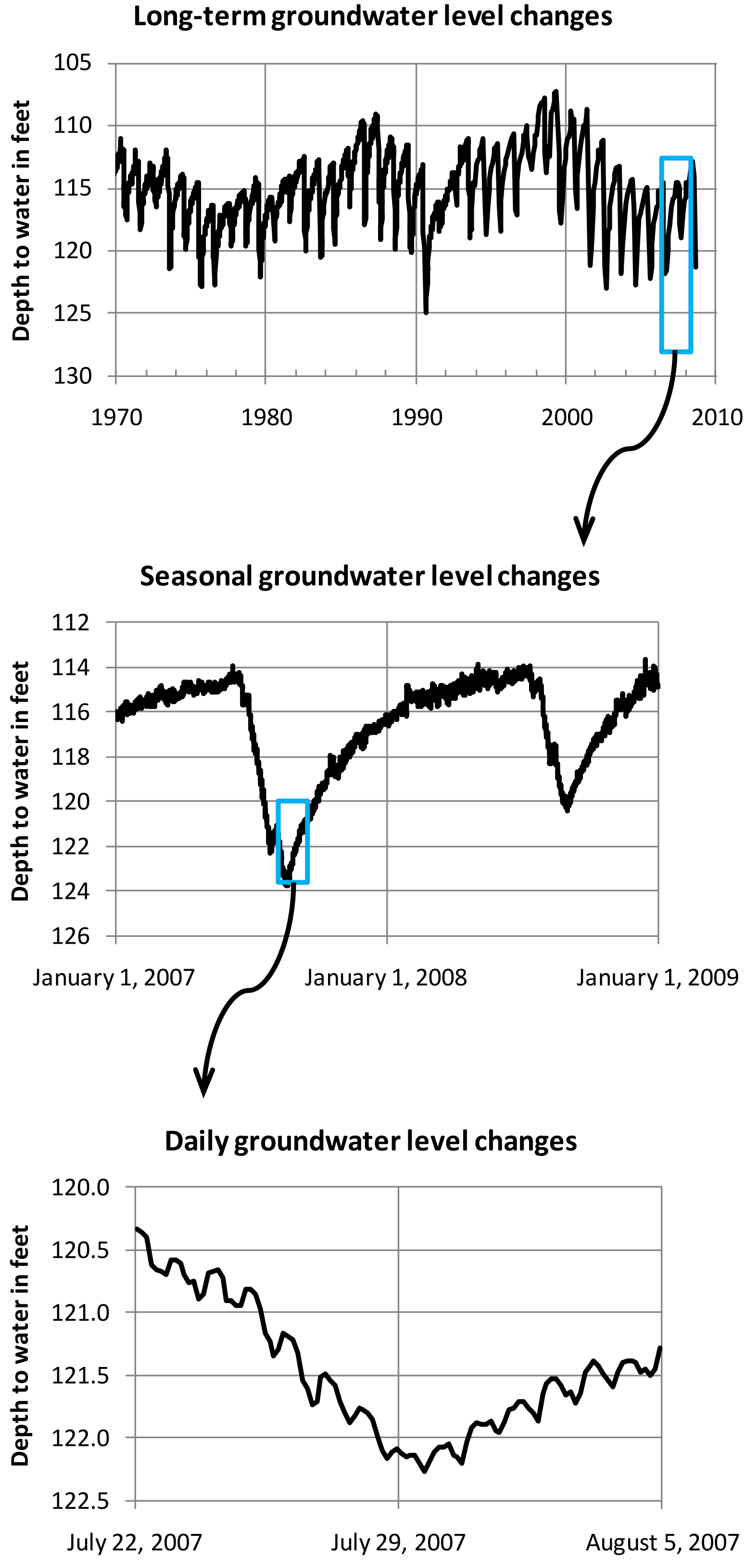
Long-term groundwater-level changes result from the changing balance between recharge to, discharge from, and storage in an aquifer. If recharge and discharge are in balance, such as they were before widespread irrigation development, groundwater levels are generally steady because the amount of water stored in the aquifer does not change. Minor changes in groundwater levels may occur due to natural variations in precipitation and streamflow, but generally the system is in equilibrium. If, however, the rate of recharge exceeds the rate of discharge over a long period, the amount of water stored in the aquifer increases and groundwater levels rise. Conversely, if the rate of discharge exceeds the rate of recharge for a long period, the amount of water in storage is depleted and groundwater levels decline. The magnitudes, locations, and rates of groundwater-level changes are controlled by many factors, including: the aquifer's storage properties, permeability, and saturated thickness; the locations, rates, and pumping schedules of wells; the locations and rates of artificial recharge areas; and the degree of hydraulic connection between the aquifer and surface water bodies.

It is a common misconception that the rate of recharge from precipitation can be used as a "safe yield" or "sustainable limit" on the rate of groundwater extraction from an aquifer (Bredehoeft, 1997). This concept is a gross oversimplification of hydrogeologic processes. The aquifer properties and all sources of recharge and discharge must be taken into consideration. Recharge is provided primarily by precipitation, but also by irrigation return flow and seepage from canals, reservoirs, and streams. Discharge occurs as baseflow to streams and lakes, evapotranspiration, and groundwater pumping. Groundwater levels, therefore, respond to a variety of natural and anthropogenic factors affecting recharge and discharge and are controlled largely by the physical properties of the aquifer. Limiting groundwater extraction to a rate equal to or less than the rate of recharge from precipitation will not prevent depletion of the aquifer. In fact, groundwater "mining" is prone to occur to one degree or another in any heavily pumped aquifer. A holistic, adaptive approach to groundwater management based on hydrologic mass balance is more appropriate. These strategies are discussed by several authors (e.g., Sophocleous, 1997, 1998, 2000; Alley and Leake, 2004; Maimone, 2004; Korus and Burbach, 2009a).

Groundwater-level changes can be observed at many different temporal scales (Fig. 6). Changes may occur over several minutes or hours in response to pumping, floods, or earthquakes. Long-term changes may occur due to the cumulative effects of pumping over many irrigation seasons, prolonged droughts or periods of high rainfall, or seepage from man-made water bodies. Similarly, groundwater levels can be observed at multiple spatial scales. For example, groundwater levels decline around the immediate vicinity of an individual well during pumping, but also from the cumulative effects of many irrigation wells pumped over many irrigation seasons at the scale of an entire regional aquifer. Groundwater levels rise along the banks of a stream during a flood, but they may also rise significantly over an entire drainage basin during a prolonged wet period. The temporal and spatial scales of observation must be taken into account when using the maps presented in this report.

The maps presented in this report were generally created at a scale of 1:557,000 or 1:500,000. **They are intended solely to identify regional conditions and trends at varying time scales throughout the entire state of Nebraska, and not at the local scale**. As such, these changes chiefly reflect the interplay between precipitation, groundwater pumping, and artificial recharge from reservoirs and canals.

Figure 6. Example of Groundwater-Level Changes at Different Temporal Scales



Data from Plymouth Recorder well, Jefferson County

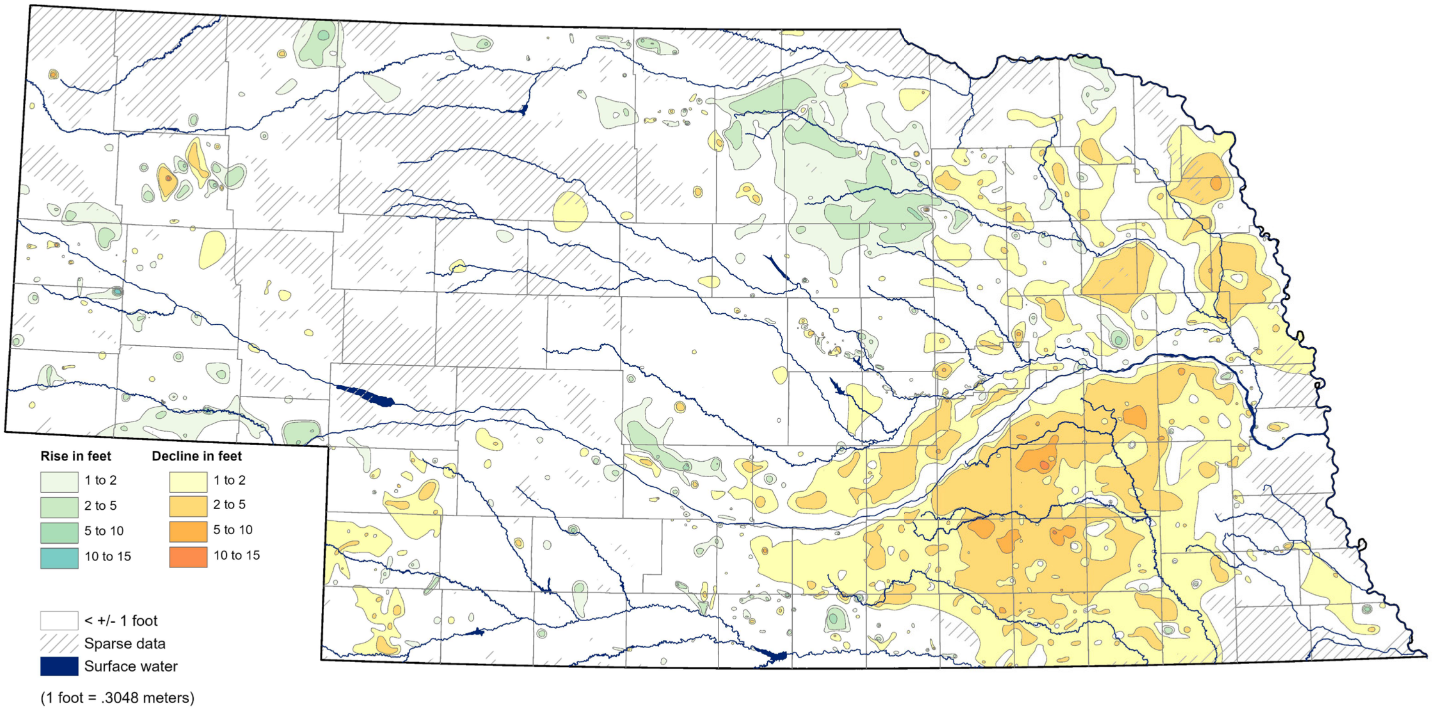
CHANGES IN GROUNDWATER LEVELS, SPRING 2023 TO SPRING 2024

From the spring of 2023 to the spring of 2024, groundwater levels in Nebraska recorded an average decline of 0.52 feet.

Groundwater levels in Nebraska generally decreased from the spring of 2023 to the spring of 2024. In total, 4,879 wells were measured consecutively in the spring of 2023 and spring 2024. Groundwater-level declines were recorded in 61% of these measured wells, and 36% of all measured wells experienced a decline of greater than one foot (Fig. 7). Groundwater-level rises were recorded in 38% of measured wells, and only 14% of all measured wells recorded a rise greater than one foot. Approximately 1% of wells experienced no change from spring of 2023 to spring of 2024. The average groundwater-level change for all measured wells in Nebraska in the spring of 2024 was a decline of 0.52 feet. From January 2023 to January 2024, precipitation values were above the 30-year average at 54 reporting stations in Nebraska, and below the 30-year average at 46 sites (Fig. 8).

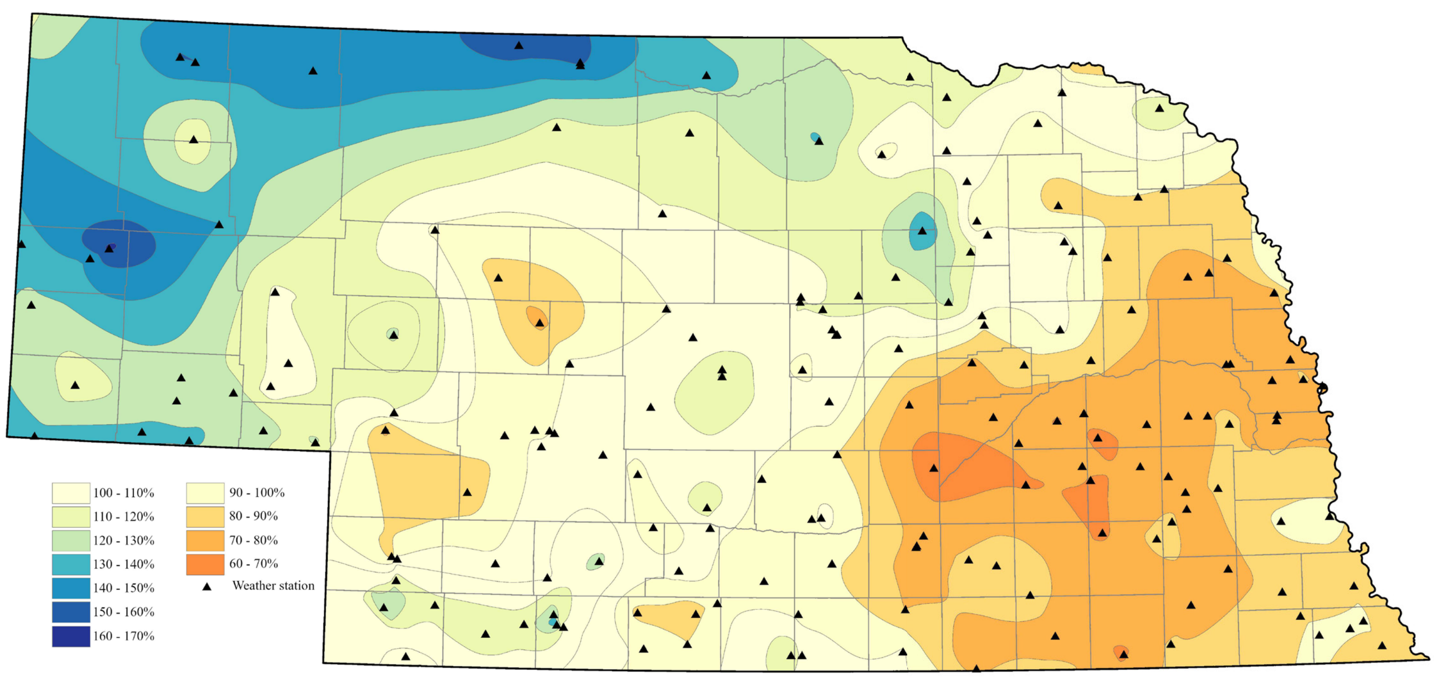
From the spring of 2023 to the spring of 2024, trends in groundwater level changes in Nebraska generally followed patterns in precipitation and drought persistence statewide. In early 2023, all of Nebraska was classified in some level of drought, with persistent areas of extreme and exceptional drought over much of northeast, north-central and southwest Nebraska. Beginning in early spring 2023, increased precipitation, particularly in the western half of the state, allowed drought conditions to ease going into the growing season. However, with below-average precipitation in eastern Nebraska during 2023, drought conditions persisted into 2024. Regions of the state where drought conditions have eased, particularly in the north and west, saw groundwater levels remain at current levels or slightly rise. In regions of the state that remained under persistent drought conditions through the 2023 growing season, groundwater levels declined in response to increased irrigation withdrawals and decreased recharge.

Figure 7. Groundwater-Level Changes in Nebraska - Spring 2023 to Spring 2024



Sources: U.S. Geological Survey, Nebraska Water Science Center; U.S. Bureau of Reclamation, Kansas-Nebraska Area Office; Nebraska Natural Resources Districts; Central Nebraska Public Power and Irrigation District; Conservation and Survey Division, School of Natural Resources, University of Nebraska–Lincoln

Figure 8. Percent of Normal Precipitation - January 2023 to January 2024



Source: High Plains Regional Climate Center, University of Nebraska-Lincoln

CHANGES IN GROUNDWATER LEVELS, SPRING 2014 TO SPRING 2024

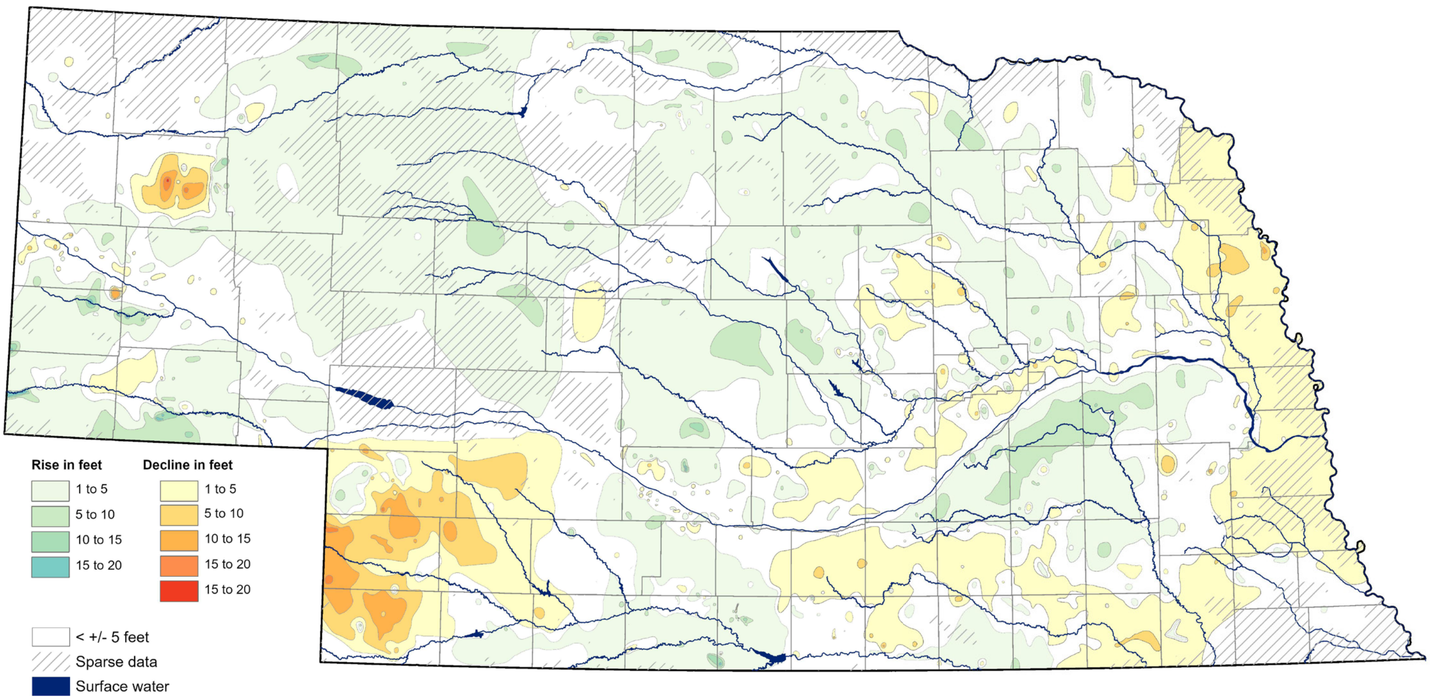
Following major shifts in weather and climate conditions from record-setting drought to record-setting rainfall, modest groundwater-level rises were generally recorded throughout Nebraska over the last 10 years.

Of 4,180 wells measured in both the spring of 2014 and the spring of 2024, 58% of those wells recorded groundwater-level rises, with 42% of wells rising more than one foot (Fig. 9). Groundwater-level declines were recorded in 42% of wells measured in Nebraska from the spring of 2014 to spring 2024, and 26% of measured wells experienced declines of greater than one foot. Groundwater levels in wells have increased by an average of 0.55 feet statewide over the last 10 years.

Weather conditions from the spring of 2014 to the spring of 2024 were highly variable. This ten-year period began with the emergence from a record-setting drought beginning in the spring of 2012 and persisting through the spring of 2013. Precipitation values over most of Nebraska were near the long-term average from late 2013 through 2014. Between 2014 and 2019, precipitation values generally remained near or slightly above the 30-year average. Precipitation values in early 2019 were well above the 30-year average for much of central and northern Nebraska, with some stations recording nearly double average annual precipitation amounts. Beginning in early 2020, weather stations in Nebraska began recording below-average precipitation for most of the state, with drought conditions persisting throughout most of Nebraska into early 2023. Drought conditions eased for Northern and western Nebraska in 2023. However, drought conditions persisted through the spring of 2023 in most of eastern and southern Nebraska. When compared with the 30-year average, precipitation values statewide from the spring of 2014 to the spring of 2024 were generally close to the long-term average despite large swings in weather (Fig. 10).

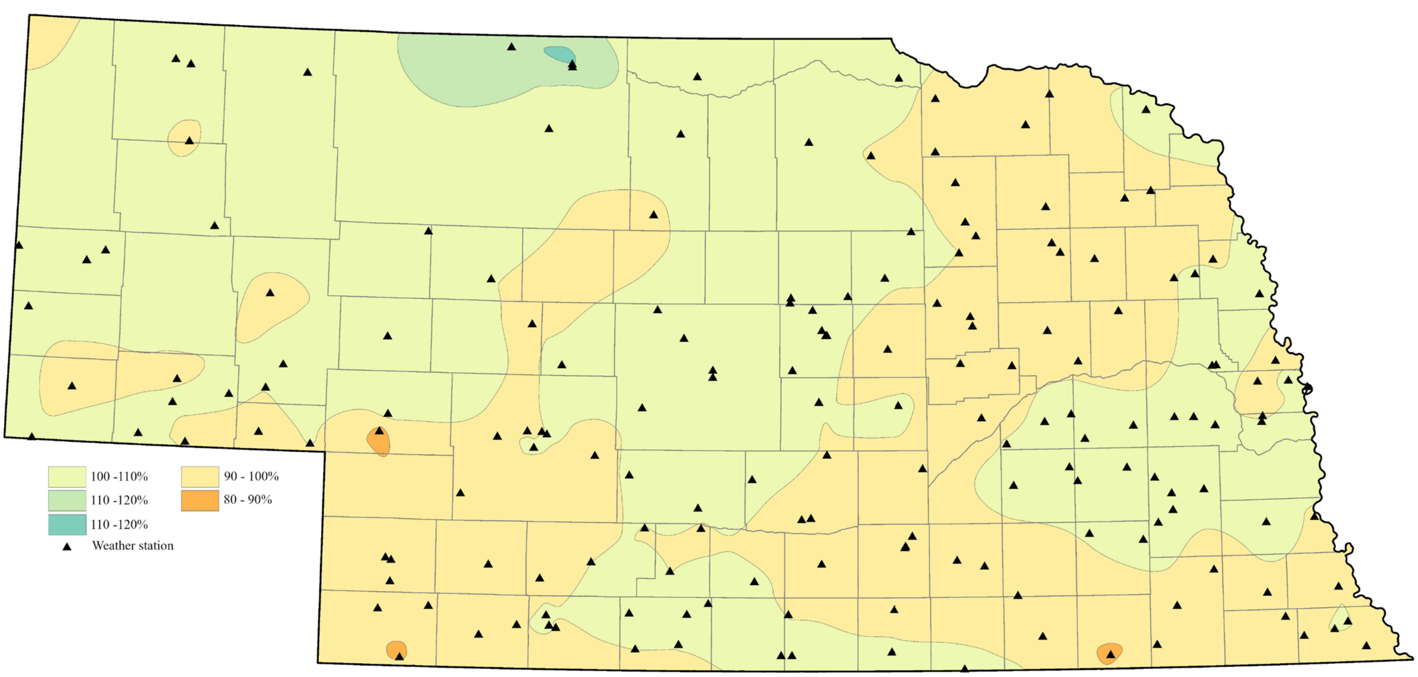
From the spring of 2014 to the spring of 2024, groundwater levels fluctuated in some areas, despite near-average precipitation statewide. The regional patterns of groundwater-level changes may have resulted from: (1) extreme regional variability in year-to-year precipitation and associated irrigation pumping rates, (2) the delayed reaction times of aquifers to shifts in weather and climate, (3) increased runoff during brief, high-intensity rainfall events, and (4) continued pumping of irrigation wells in areas of the state that receive minimal recharge to aquifers. Although some long-term trends can be observed at this scale, such as steadily increasing levels in the central Sand Hills, steadily rising levels in Butler, Polk, Hamilton, and York counties, and steadily decreasing levels in areas such as Box Bute County, and southwestern Nebraska, groundwater levels have fluctuated from year to year due to extreme variations in yearly rainfall, recharge, and evapotranspiration over the past 10 years. Groundwater-level changes mapped in Figure 12, therefore, may exhibit the effects of short-term extremes rather than long-term trends.

Figure 9. Groundwater-Level Changes in Nebraska - Spring 2014 to Spring 2024



Sources: U.S. Geological Survey, Nebraska Water Science Center; U.S. Bureau of Reclamation, Kansas-Nebraska Area Office; Nebraska Natural Resources Districts; Central Nebraska Public Power and Irrigation District; Conservation and Survey Division, School of Natural Resources, University of Nebraska–Lincoln

Figure 10. Percent of Normal Precipitation - January 2014 to January 2024



Sources: National Climate Data Center, Asheville, North Carolina; High Plains Regional Climate Center, University of Nebraska-Lincoln

CHANGES IN GROUNDWATER LEVELS, PREDEVELOPMENT TO SPRING 2024

Long-term groundwater-level changes in Nebraska primarily reflect aquifer depletion in areas of dense irrigation development and increases in storage due to seepage from canals and reservoirs.

Spring 2024 groundwater levels indicate both long-term declines and long-term rises from predevelopment in certain areas of Nebraska (Fig. 11). Almost all the areas of significant groundwater-level declines correspond to high irrigation-well densities in deep aquifers having little direct connection to surface water (Fig. 12). The greatest decline from predevelopment to 2024 is approximately 131 feet, in Box Butte County just north of the city of Alliance. Notable groundwater-level declines from predevelopment to spring 2024 have occurred in Box Butte County, and in Chase, Perkins, and Dundy counties. A large area of smaller declines in southeast to south-central Nebraska probably reflects a slight depletion of the High Plains aquifer. The largest groundwater-level rises occurred in Gosper, Phelps, and Kearney counties, where there are extensive canals and surface-water irrigation systems.

The predevelopment groundwater levels used in Chase, Perkins, and Dundy counties are representative of the approximate average groundwater levels prior to 1953. A general trend of declining groundwater levels that began around 1966 correlates temporally with the intensive use of groundwater for irrigation. The approximate average groundwater levels prior to 1938 were utilized as predevelopment values for the groundwater-level change map in Box Butte County. Intensive groundwater development for irrigation since 1950 has caused groundwater levels to decline by 5 feet to more than 130 feet from predevelopment levels (Fig. 11). Records from wells in southwestern Nebraska indicate that rates of decline have been essentially steady, despite subsequent changes in groundwater management practices, water use allocations, and fluctuations in the amount of annual precipitation (Korus and Burbach, 2009b). Records from wells in Box Butte County indicate that rates of decline have slowed somewhat.

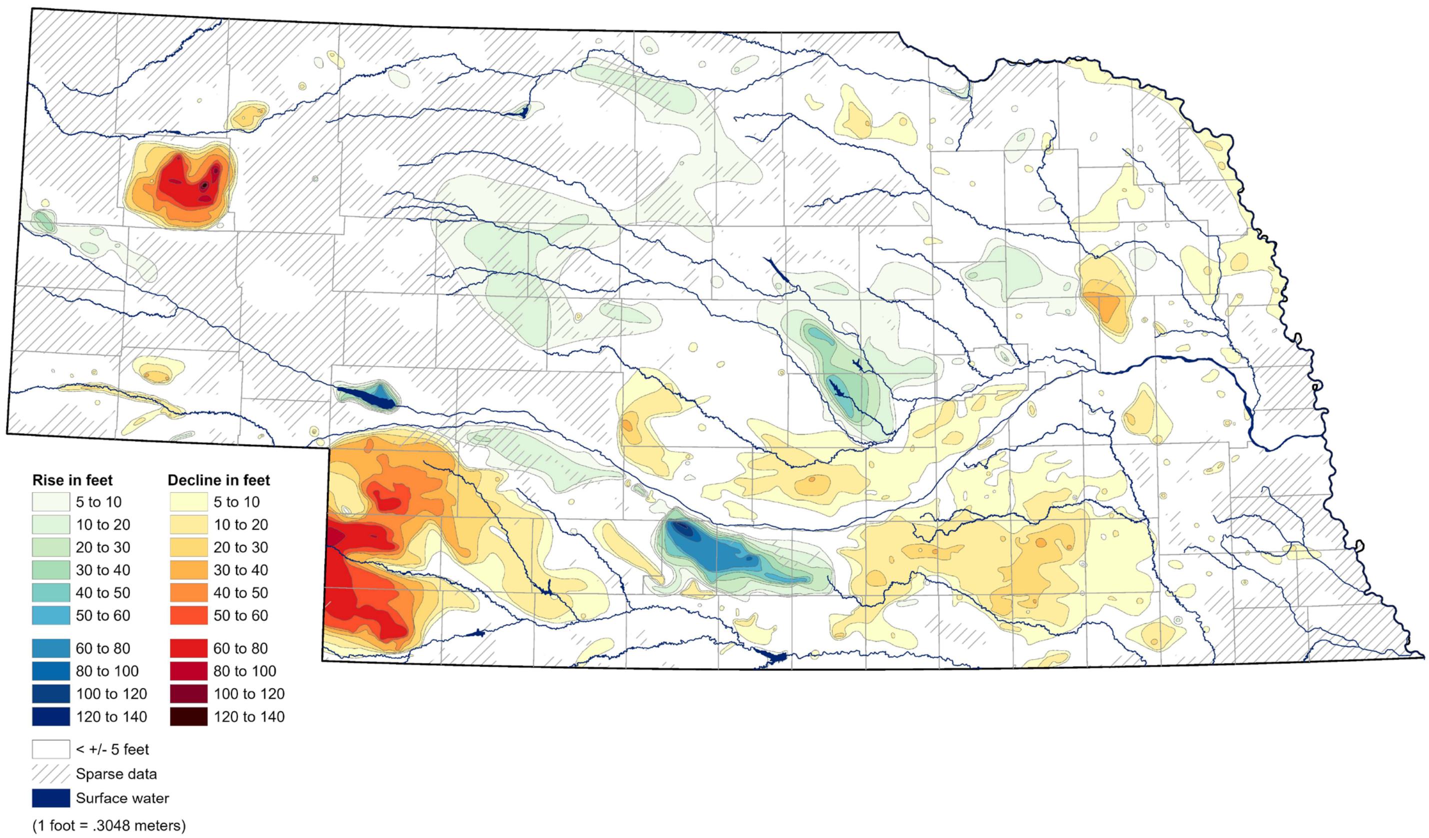
Much of southeastern to south-central Nebraska has experienced long-term groundwater-level declines since predevelopment times (Fig. 11). Predevelopment water levels in this area are generally representative of the approximate average water levels prior to 1950. Groundwater levels in large parts of this region have declined more than 10 feet, and in some areas by more than 30 feet, since predevelopment.

Groundwater-level declines also occurred in large areas between the Platte and Loup or South Loup rivers and in the Republican River Valley and the Panhandle. Irrigation-well densities are high in some, but not all, of the aforementioned areas. Aquifer characteristics, rates of recharge, and irrigation scheduling may have contributed to these declines as well. Recently, groundwater fluctuations in this region have been closely tied to fluctuations in the regional climate; however, levels seem to be stabilizing over the long term.

Groundwater-level rises from predevelopment generally occurred in areas of surface-water irrigation systems. Storage of water in Lake C. W. McConaughy began in 1941, and seepage losses caused groundwater-level rises of as much as 60 feet in nearby observation wells (Ellis and Dreeszen, 1987). Groundwater levels around the lake generally stabilized by about 1950 and since then have fluctuated in response to changes in reservoir levels and precipitation (Johnson and Pederson, 1984). Water released from storage in Lake C. W. McConaughy is subsequently diverted from the Platte River near Sutherland west of North Platte, and then flows through the Tri-County Canal and a series of reservoirs toward Dawson, Gosper, Phelps, and Kearney counties, where it has been used for irrigation since 1941. The deep percolation of water from these irrigation-distribution systems and from excess water applied to crops has gradually increased groundwater levels by more than 120 feet (Fig. 11). Groundwater levels have also risen in response to seepage from Sutherland Reservoir, Lake Maloney, and associated canals in eastern Keith and central Lincoln counties. Similarly, there are groundwater-level rises of as much as 60 feet associated with irrigation canals in southern Sioux, Scotts Bluff, and western Morrill counties.

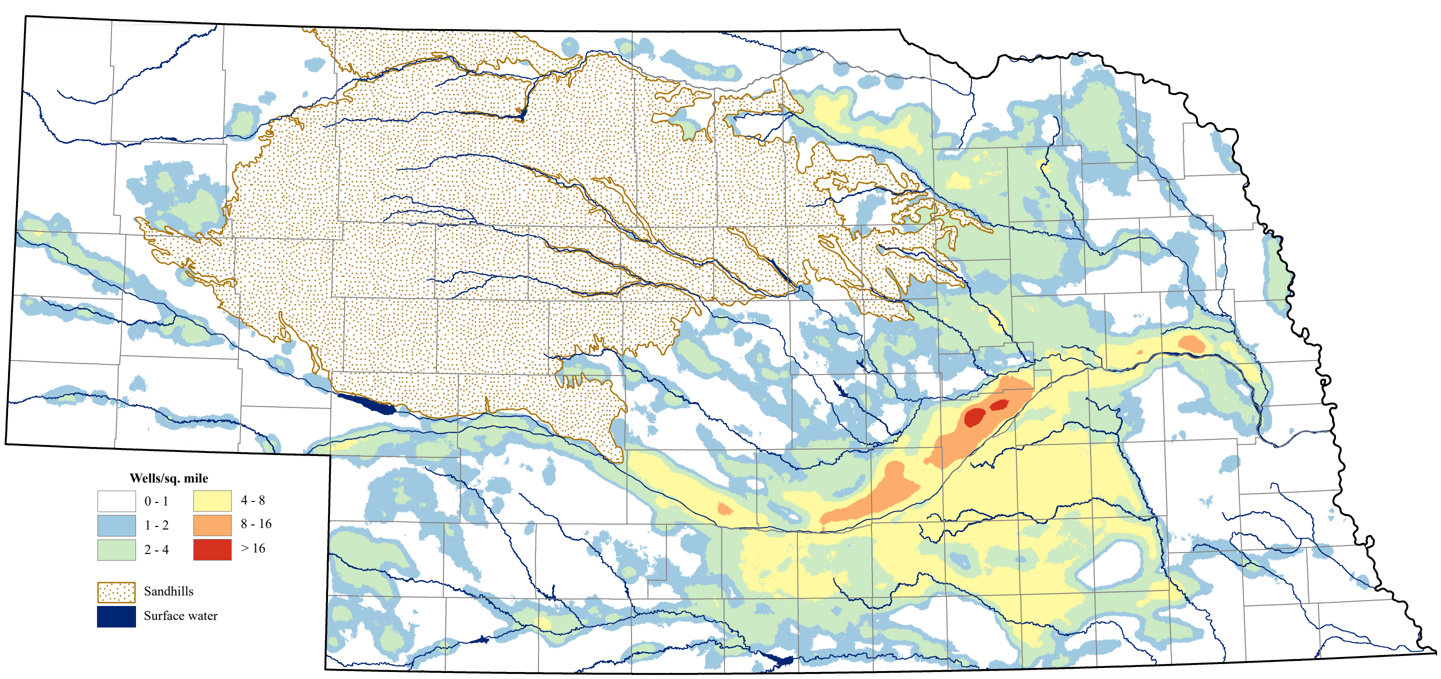
Groundwater-level rises of 10 to more than 50 feet occurred in portions of central Nebraska (Fig. 11). The highest groundwater-level rises occurred in Valley, Sherman, and Howard counties in response to sustained seepage from irrigation canals, Sherman and Davis Creek reservoirs, and the deep percolation of irrigation water applied to crops.

Figure 11. Groundwater-Level Changes in Nebraska - Predevelopment to Spring 2024



Sources: U.S. Geological Survey, Nebraska Water Science Center; U.S. Bureau of Reclamation, Kansas-Nebraska Area Office; Nebraska Natural Resources Districts; Central Nebraska Public Power and Irrigation District

Figure 12. Density of Active Registered Irrigation Wells - December 2024



Source: Nebraska Department of Natural Resources

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