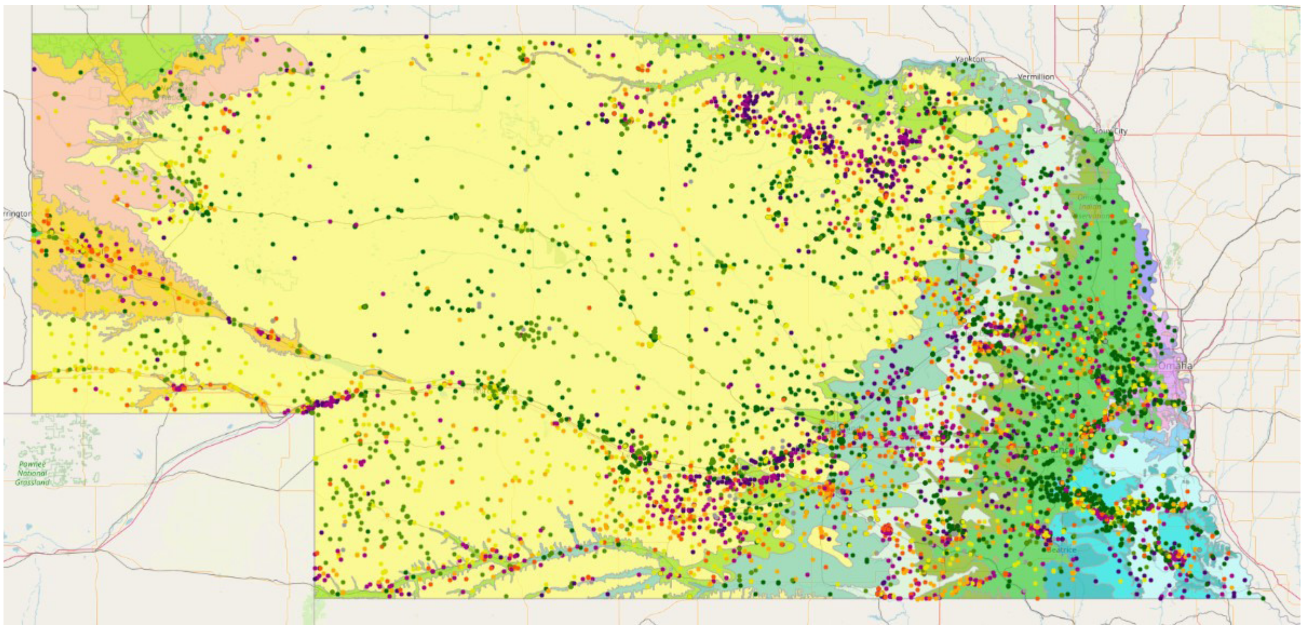
2021 Nebraska Groundwater Quality Monitoring Report and Clearinghouse Users Guide



NEBRASKA

Good Life. Great Resources.

DEPT. OF ENVIRONMENT AND ENERGY

Groundwater Section

November 2021

Prepared Pursuant
to Neb. Rev. Stat. §46-1304
(LB329 – 2001)

Image on front cover:

A map generated using the Clearinghouse application showing the Nitrate concentration at each location sampled for Atrazine. This data overlays the Bedrock Geology of Nebraska.

Acknowledgements:

This report would not be possible without the cooperation of the agencies and organizations contributing groundwater data to the "Clearinghouse" (formerly Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater), most notably the State's 23 Natural Resources Districts. The University of Nebraska must be thanked for their ongoing work on the Database and attention to detail in assessing the quality of data presented for inclusion. Thanks to Emily Case for compiling the report, and Sue Dempsey for editing (both with NDEE). Direct any questions regarding this report to David Miesbach, Groundwater Section, NDEE, at (402) 471-4982.

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2021 Nebraska Groundwater Quality Monitoring Report

Introduction

The 2001 Nebraska Legislature passed LB329 (Neb. Rev. Stat. §46-1304) which, in part, directed the Nebraska Department of Environment and Energy (NDEE) to report on groundwater quality monitoring in Nebraska. Reports have been issued annually since December 2001. The text of the statute applicable to this report follows:

"The Department of Environment and Energy shall prepare a report outlining the extent of ground water quality monitoring conducted by natural resources districts during the preceding calendar year. The department shall analyze the data collected for the purpose of determining whether or not ground water quality is degrading or improving and shall present the results to the Natural Resources Committee of the Legislature beginning December 1, 2001, and each year thereafter. The districts shall submit in a timely manner all ground water quality monitoring data collected to the department or its designee. The department shall use the data submitted by the districts in conjunction with all other readily available and compatible data for the purpose of the annual ground water quality trend analysis."

The section following the statute quoted above (§ 46-1305), requires the State's Natural Resources Districts (NRDs) to submit an annual report to the legislature with information on their water quality programs, including financial data. That report has been prepared by the Nebraska Association of Resources Districts and is being issued concurrently with this groundwater quality report.

Groundwater monitoring was being conducted years before LB329 was passed. Many entities performed monitoring of groundwater besides the 23 NRDs for a variety of purposes.

Dismal River, Thomas County (Lexi Spurlin, Upper Loup NRD)

Those entities include:

- Nebraska Department of Agriculture
- Nebraska Department of Environment and Energy
- Nebraska Department of Health and Human Services
- Public Water Suppliers
- University of Nebraska-Lincoln
- United States Geological Survey

The Nebraska Departments of Agriculture (NDA), Environment and Energy and the University of Nebraska - Lincoln (UNL) began a project in 1996 to develop a centralized data repository for groundwater quality information that would allow comparison of data obtained at different times and for different purposes. The result of this project was the Quality-Assessed Agrichemical Contaminant Database for Nebraska Groundwater (referred to as the Database in this publication). The Database brought together groundwater data from different sources and provided public access to this data.

The Database served two primary functions. First, it provided the public the results of groundwater monitoring for agricultural compounds in Nebraska as performed by a variety of entities. Second, the Database provided an indicator of the methodologies that were used in sampling and analysis for each of the results. UNL staff examined the methods used for sampling and analysis to assign a quality "flag" consisting of a number from 1 to 5 to each of the sample results. The flag depends upon the amount and type of quality assurance/quality control (QA/QC) that was identified in obtaining each of the results. The higher the "flag" number, the better the QA/QC, and the higher the confidence in that particular result.

During the past several years, NDEE and UNL staff worked with a contractor sponsored by the Ground Water Protection Council (GWPC) to develop a new application to present the Database to the public. The Nebraska Groundwater Quality Clearinghouse (referred to as the Clearinghouse in this publication) was developed using the Database as an interactive interface that features data, maps, well construction details and statistics.

This year's publication will serve as an instruction manual for the Clearinghouse. There are over 1,688,000 samples tested for 271 potential contaminants from over 34,000 public and private wells. Below is information on the groundwater in Nebraska to help the user better understand the data presented in the Clearinghouse and what it means to our State.

Groundwater in Nebraska

Groundwater can be defined as water that occurs in the open spaces below the surface of the earth (Figure 1). In Nebraska (as in many places worldwide), useable groundwater occurs in voids or pore spaces in various layers of geologic material such as sand, gravel, silt, sandstone, and limestone. These layers are referred to as aquifers where such geologic units yield sufficient water for human use. In parts of the state, groundwater may be encountered just a few feet below the surface, while in other areas, it may be a few hundred feet underground. This underground water "surface" is usually referred to as the water table, while water which soaks downward through overlying rocks and sediment to the water table is called recharge as shown in Figure 2. The amount of water that can be obtained from a given aquifer may range from a few gallons per minute (which is just enough to supply a typical household) to many hundreds or even thousands of gallons per minute (which is the yield of large irrigation, industrial, or public water supply wells).

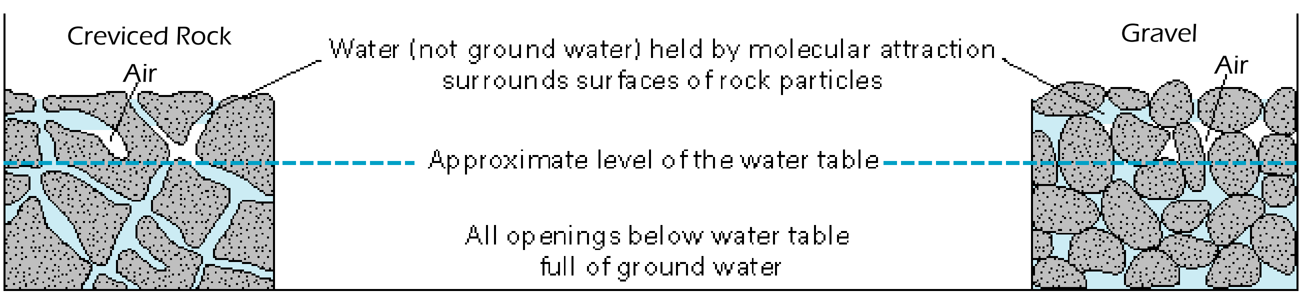


Figure 1. Basic aquifer concepts (U.S. Geological Survey).

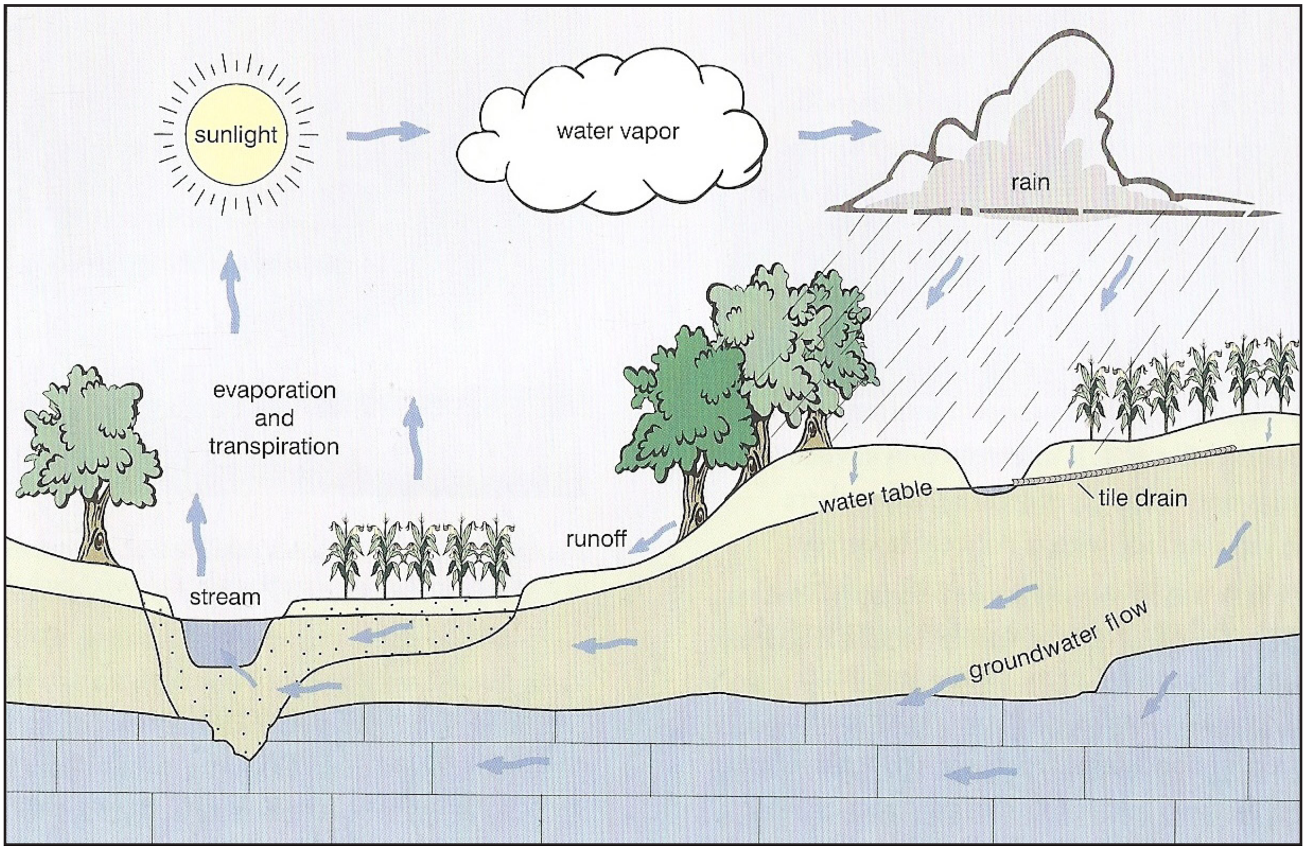


Figure 2. Generalized hydrologic cycle. (Prior, 2003).

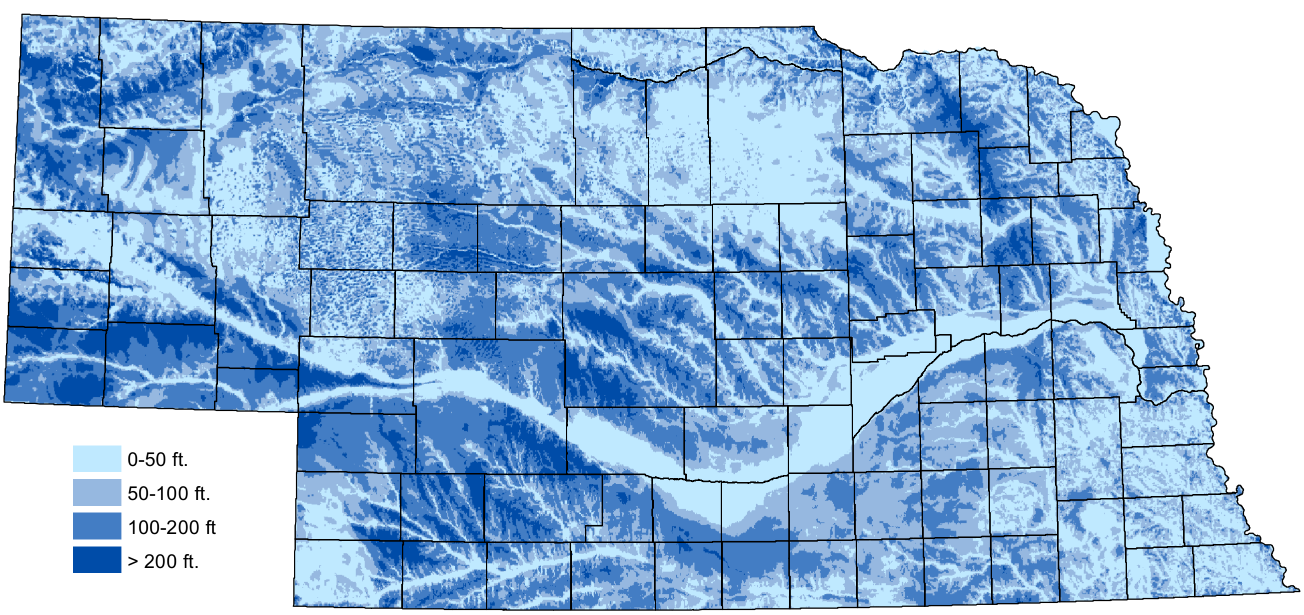


Figure 3. Generalized depth to groundwater.
(Source: University of Nebraska, Conservation and Survey Division, 1998)

Depth & Velocity of Groundwater

The depth to groundwater plays a very important role in Nebraska's valuable water resource. A shallow well is cheaper to drill, construct, and pump. However, shallow groundwater is more at-risk from impacts from human activities. Surface spills, application of agricultural chemicals, effluent from septic tank leach fields, and other sources of contamination will impact shallow groundwater more quickly than groundwater found at depth. The map in Figure 3 shows the great variation of depth to water across the State.

In general, groundwater flows very slowly, especially when compared to the flow of water in streams and rivers. Many factors determine the speed of groundwater and most of these factors cannot be

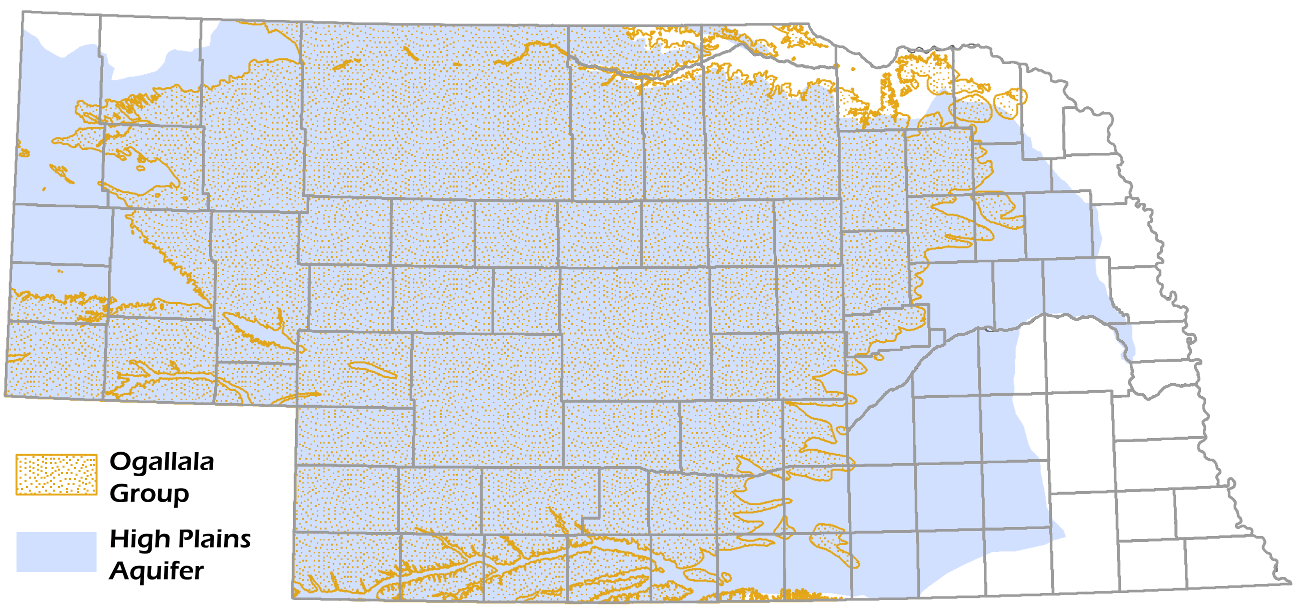


Figure 4. Map of the High Plains aquifer identifying the Ogallala Group. (Source: University of NE, Conservation and Survey Division, 2013)

measured or observed directly. Basic groundwater features are shown in Figures 1 and 2. The most important geologic characteristics that impact groundwater movement are as follows:

- The sediment in the saturated zone of the aquifer. Groundwater generally flows faster through gravel sediments than clay sediments.
- The 'sorting' of the sediment. Groundwater in aquifers with a mix of clay, sand, and gravel (poor sorting) generally does not flow as fast as in aquifers that are composed of just one sediment, such as gravel (good sorting).
- The 'gradient' of the water table. Groundwater flows from higher elevations toward lower elevations under the force of gravity. In areas of high relief, groundwater flows faster. A typical groundwater gradient in Nebraska is 10 feet of drop over a mile (0.002 ft/ft).
- Well pumping influences. In areas of the State with numerous high capacity wells (mainly irrigation wells), groundwater velocity and direction can be changed seasonally as water is pumped.

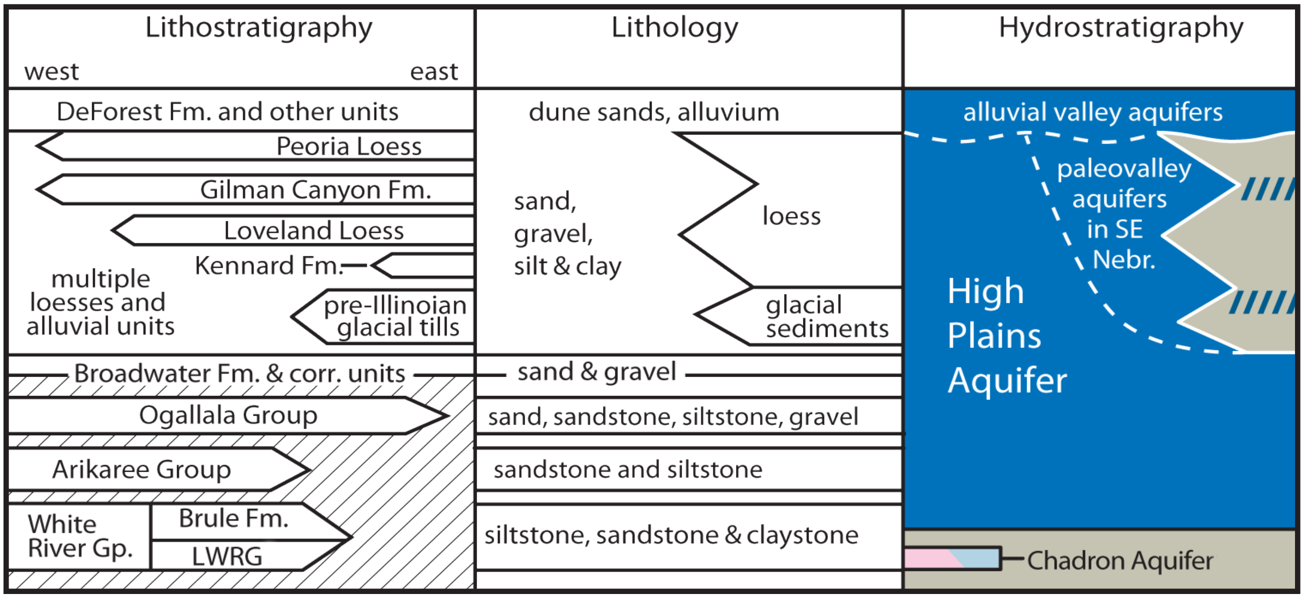


Figure 5. Excerpts from the generalized geologic and hydrostratigraphic framework of Nebraska. (Source: University of Nebraska, Conservation and Survey Division, 2013)

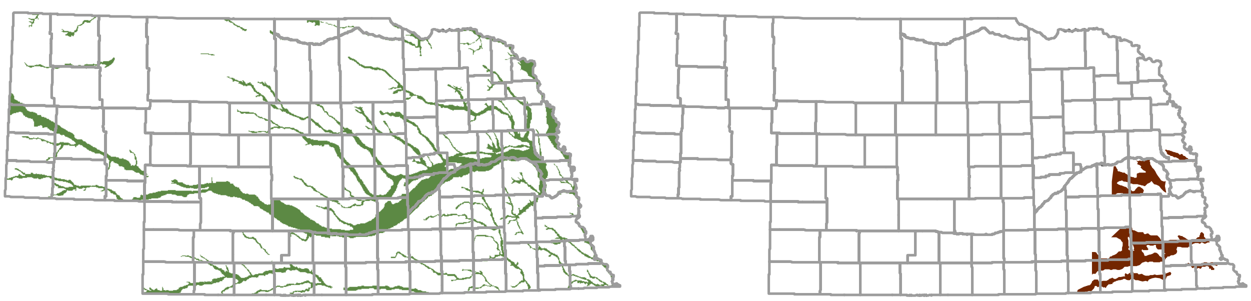
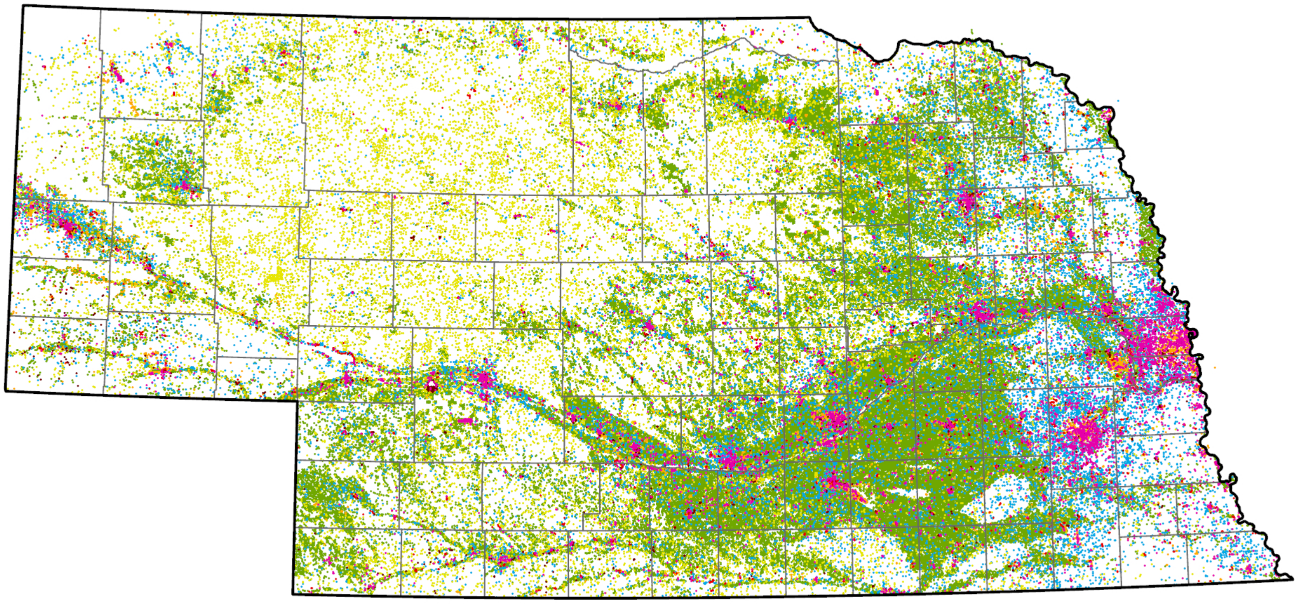


Figure 6. Map of the valleys topographic region (left) and paleovalley aquifers (right). (Source: University of Nebraska, Conservation and Survey Division, 2013)

Ultimately, groundwater scientists have determined that groundwater in Nebraska can flow as fast as one to two feet per day in areas like the Platte River valley and as slow as one to two inches per year in areas like the Pine Ridge in northwest Nebraska or the glacially deposited sediments in southeast Nebraska.

Geology and Groundwater

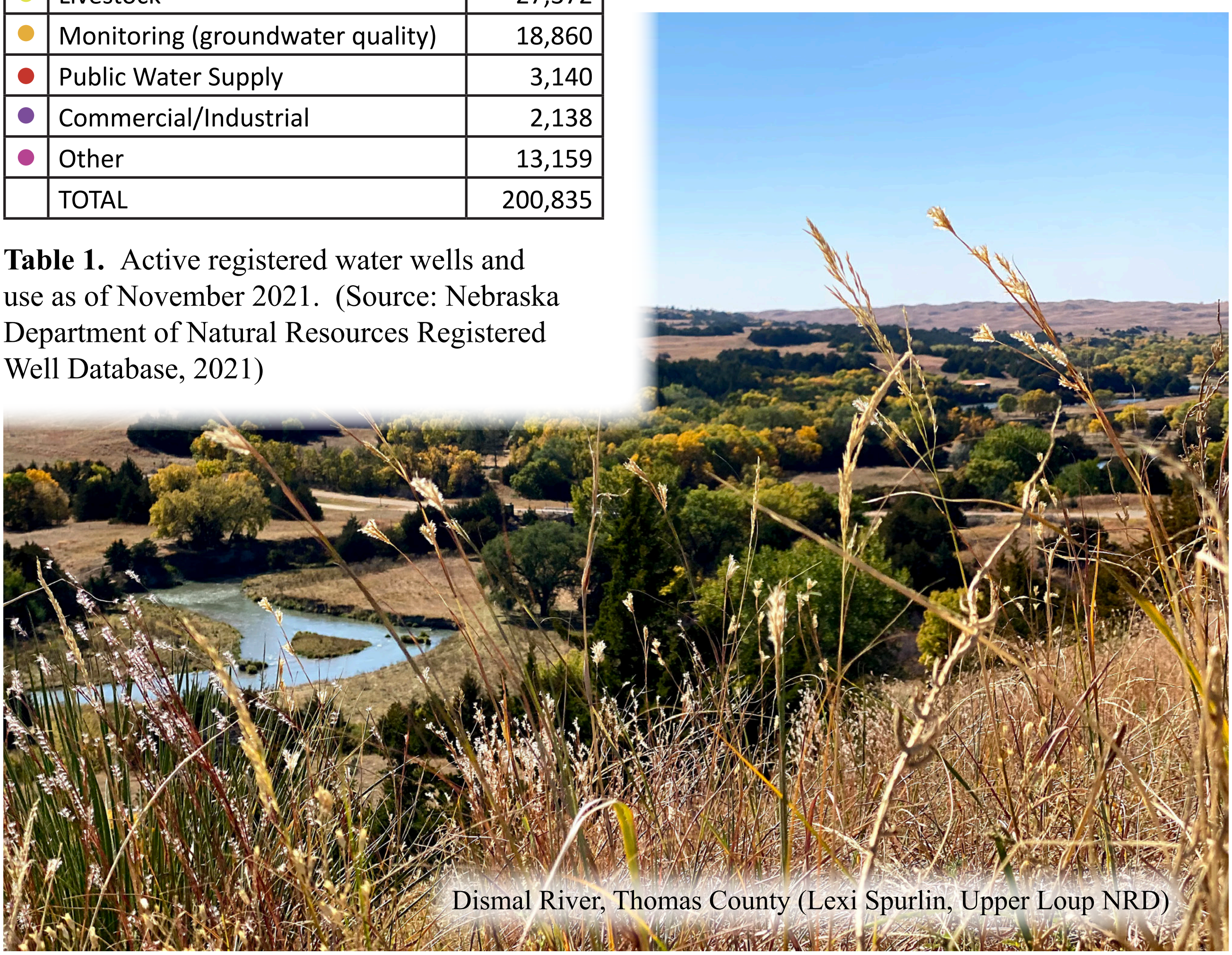
Nebraska has been "underwater" most of its history. Ancient seas deposited multiple layers of marine sediments that eventually formed sandstone, shale, and limestone. These geologic units are now considered "bedrock" and underlie the entire State. Limited fresh water supplies can be found in this bedrock mainly in the eastern portion of the State. After the seas retreated, huge river systems deposited sand and gravel eroded from mountain building to the west to form groundwater bearing formations such as the lower Chadron, Ogallala (Figures 4 and 5) and Broadwater. Next, the combination of erosion (statewide) and glaciation in the east introduced new material that was deposited by wind, water, and ice to form the remainder of the High Plains Aquifer (Figure 4 and 5).



	Water Use	Active
●	Irrigation	99,222
●	Domestic	36,944
●	Livestock	27,372
●	Monitoring (groundwater quality)	18,860
●	Public Water Supply	3,140
●	Commercial/Industrial	2,138
●	Other	13,159
	TOTAL	200,835

Table 1. Active registered water wells and use as of November 2021. (Source: Nebraska Department of Natural Resources Registered Well Database, 2021)

Figure 7. Active registered water wells as of November 2021. (Source: Nebraska Department of Natural Resources Registered Well Database, 2021)



Dismal River, Thomas County (Lexi Spurlin, Upper Loup NRD)

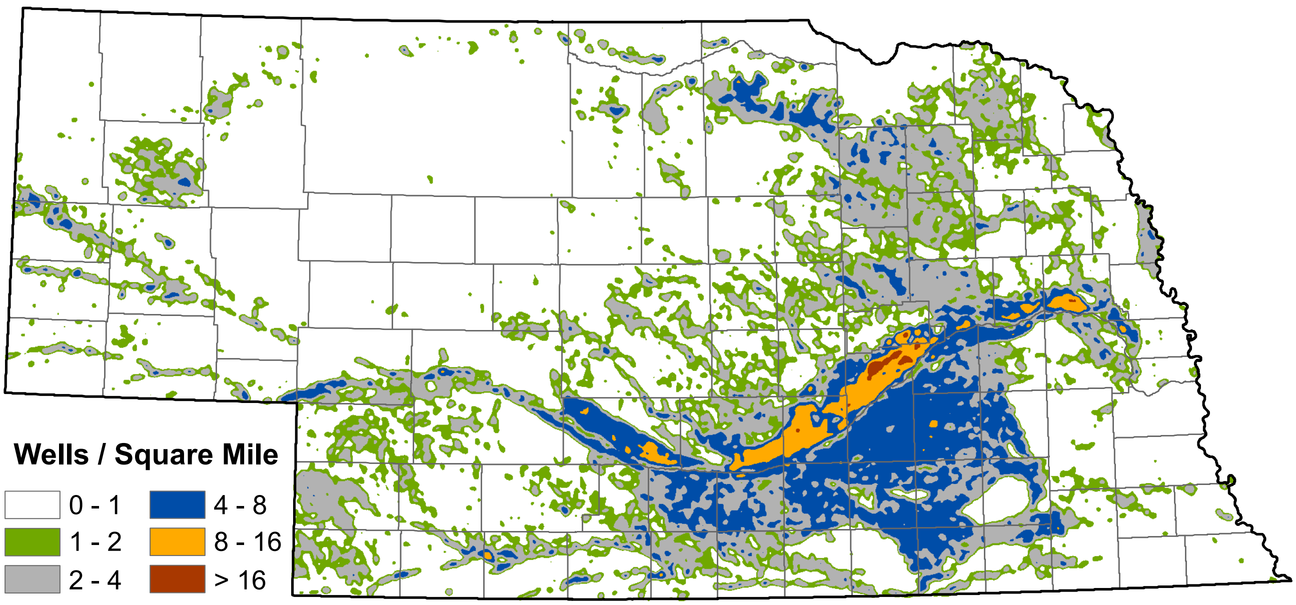


Figure 8. Density of active registered irrigation wells as of November 2013. (Source: Nebraska Department of Natural Resources Registered Well Database, 2013)

The High Plains Aquifer is a conglomeration of many separate groundwater bearing formations such as the Brule, Arikaree, Ogallala, Broadwater, and many more recent unnamed deposits (including the Sand Hills). Many of the unnamed deposits are found mainly within the stream valleys (recent or ancient) and are a common source of groundwater (Figure 6, left pane). No single formation completely covers the entire state. However, when these numerous formations and deposits are combined, they form the High Plains Aquifer, covering almost 90% of Nebraska.

There are parts of eastern Nebraska where the High Plains Aquifer is not present. These areas rely heavily on groundwater from buried ancient river channels (paleovalleys) or recent alluvial valleys (Missouri, Platte, and Nemaha Rivers) (Figure 6, right pane).

Importance of Groundwater

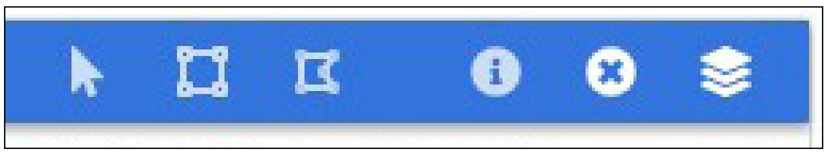
Nebraska is one of the most groundwater-rich states in the United States. Approximately 88% of the state's residents rely on groundwater as their source of drinking water. If the public water supply for the Omaha metropolitan area (which gets about a third of its water supply from the Missouri River) isn't counted, this rises to nearly 99%. Essentially all of the rural residents of the state use groundwater for their domestic supply. Not only does Nebraska depend on groundwater for its drinking water supply, the state's agricultural industry utilizes vast amounts of groundwater to irrigate crops and water livestock. Nebraska experiences variable amounts of precipitation throughout the year, so irrigation is used, where possible, to ensure adequate amounts of moisture for raising such crops as corn, soybeans, alfalfa, and edible beans. As of November 2021, the Nebraska Department of Natural Resources (NeDNR) listed 99,222 active irrigation wells and 36,944 active domestic wells registered in the state. Domestic wells were not required to be registered with the state prior to September 1993, therefore thousands of domestic wells exist that are not registered with the NeDNR. Figures 7 and 8 and information shown in Table 1 help illustrate this.

Using the Clearinghouse

The Clearinghouse can be found at clearinghouse.nebraska.gov. Once the application is loaded, the user will see that it is divided into three functions; Map (top right), Sample Results Explorer (left), and Well Explorer (bottom right), and a viewing pane titled Aggregate Nitrate Chart (lower left) (Figure 9). Also, there is a tool bar at the very top right that has three static buttons: Alert, Help, and Information along with three active buttons: Reset All Filters, Export Filter Results, and Download Database. The three active buttons will be discussed in the following text.

Map Function

When the application is loaded, the map shows all the wells that have been sampled as gray dots. There is a tool bar in the upper right corner of the Map (within the blue bar — see below).



Hovering over each icon they are identified from left to right as:

- Select Wells by Click (arrow)
- Select Wells by Rectangle (square)
- Select Wells by Polygon (polygon)
- Display/Hide tooltip (i within a circle or information icon)
- Clear Selection (x within a circle or clear icon)
- Display/Hide Layers (layer icon)

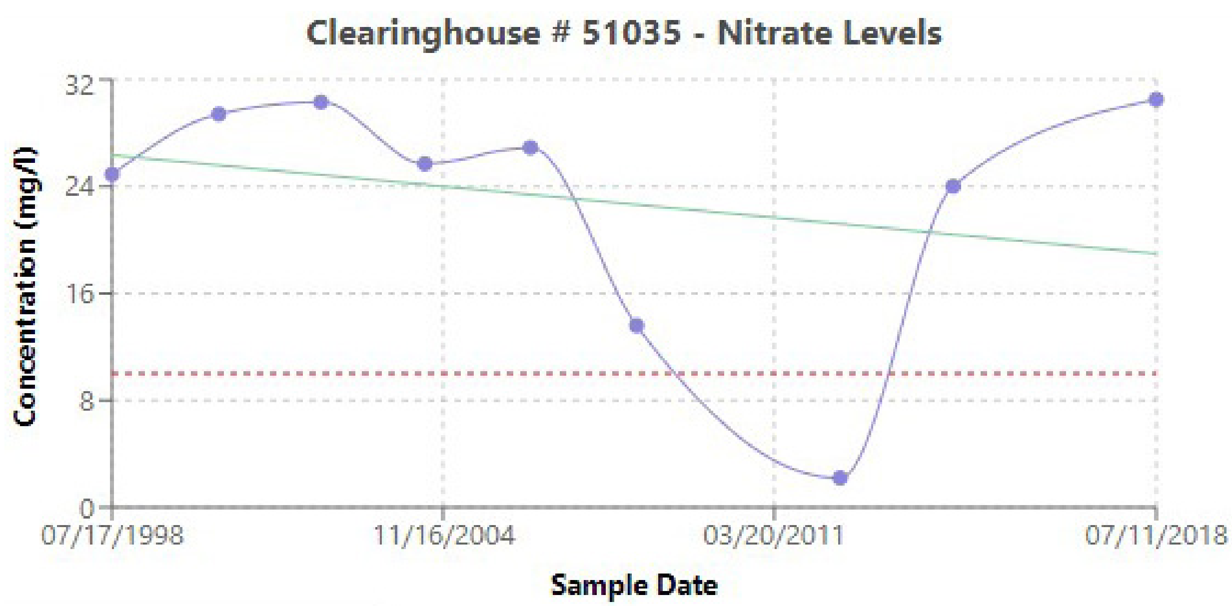


Figure 9. This screenshot shows a chart after choosing a Clearinghouse number. (Source: Clearinghouse 2021)

ARROW: Clicking on the arrow in the tool bar the user can drag the arrow onto the map and either hover or select a well to see data about that well. If the well is selected, the user will see a table showing the:

- Clearinghouse number (and link)
- DNR Registration number (and link)
- Well Type
- Well Depth
- Sample Count
- Last Sample Date
- Nitrate overview (with limited statistics)

Choosing the Clearinghouse number link from the table will bring up another table showing all available data in the Clearinghouse for that location including:

- Locational Data
- Well Data (using Well Details or Well Screens tabs)
- Sample Results (using the Sample results tab)
- Most Recent Pesticide Sample Date
- A chart showing data, trend line, and MCL for All Time or Last 20 Years (Figure 9)

If the DNR link is selected either from table, the user will be directed to the all the construction data available for that well on the DNR website.

SQUARE: Clicking on the square in the tool bar, the user can drag the pointer to the map and click and drag to select entire areas on the map. The data will be summarized in the Aggregate Nitrate Chart in the lower viewing pane of the application (if there are less than 2100 wells selected). Basic statistics including minimum, maximum, median and trends will be shown. Dragging the pointer across the chart will show statistics throughout the sampling life of the well. The user can also toggle between 20 years of data and All Time by selecting the “Layers” menu (far right button on the blue Map bar) and selecting the “Most Recent Nitrate Concentrations” option. (Figures 10 and 11)

POLYGON: Clicking on the polygon in the tool bar, the user can click on each corner of the polygon and then double click to select entire areas on the map. The data will be summarized in the Aggregate Nitrate Chart in the lower viewing pane of the application (if there are less than 2100 wells selected). Basic statistics including minimum, maximum, median and trends will be shown. Dragging the pointer across the chart will show statistics throughout the sampling life of the well. Also, using the carrot in the upper right of the chart, the user can toggle between 20 years of data and All Time. (Figures 10 and 11)

INFORMATION ICON: Clicking on the information icon in the tool bar, the icon will be highlighted. When the icon is highlighted, the user can drag the pointer to the map and hover over a well. The same table will appear as if using the arrow.

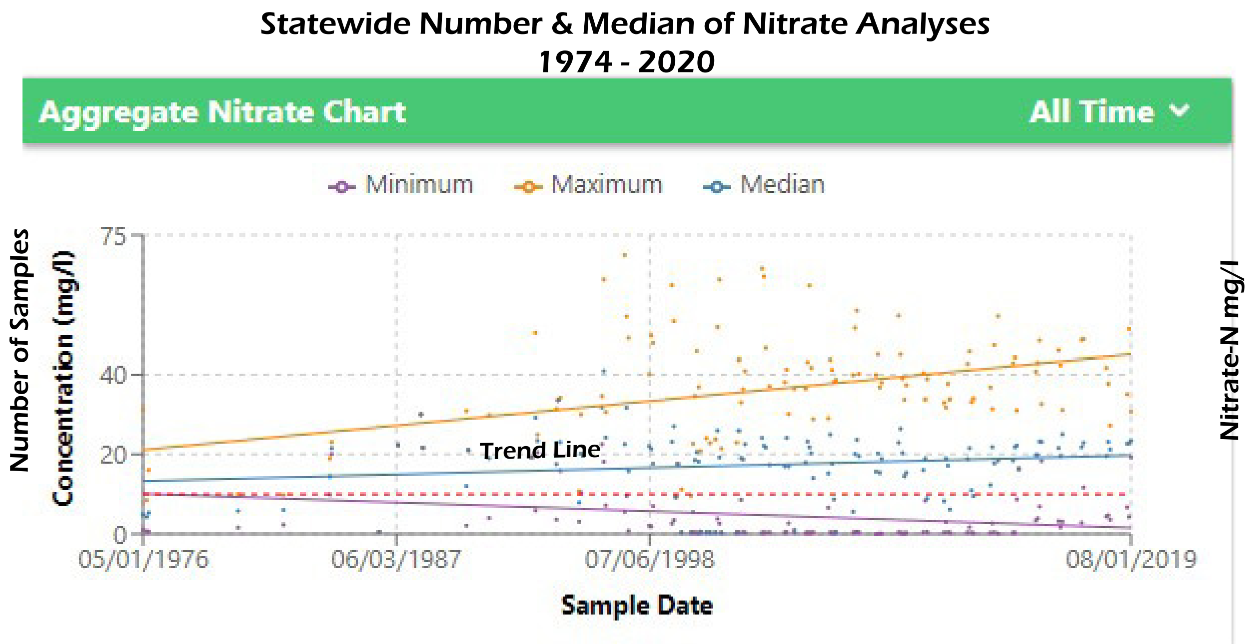


Figure 10. Chart showing "All Time" data after selecting an area. (Source: Clearinghouse 2021)

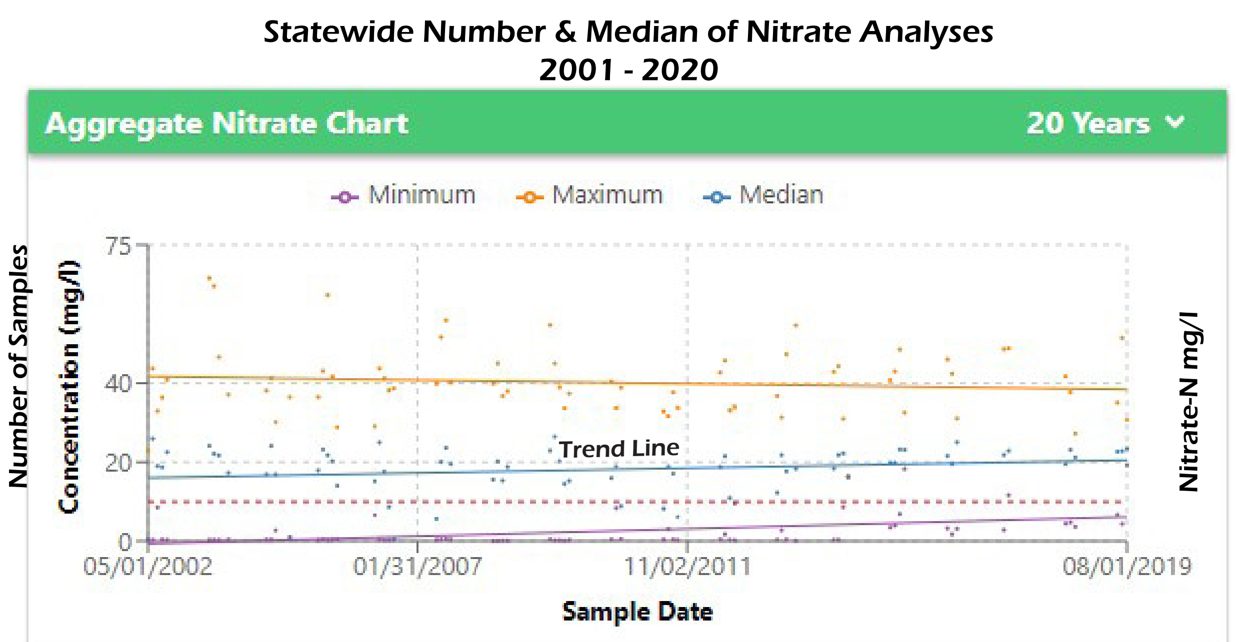


Figure 11. Chart showing "20 Years" data after selecting an area. (Source: Clearinghouse 2021)

CLEAR ICON: Clicking on clear icon in the tool bar simply clears all previous selections.

LAYER ICON: Clicking on the layer icon will bring up the layers table. The layers table consists of two categories, Clearinghouse Wells and Basemap Layers. Checking the box to the left of each layer will turn the layer on to view on the map. If there is a carrot to the right of the layer, a legend is available. If there is a magnifying glass, zooming is required to see the layer, and if there is an information icon there is additional information. The layers are:

- Sampled Point (default)
- Most Recent Nitrate Concentration during the last 20 years
- 2018 Aerial Photo
- 2014 Aerial Photo
- Township/Range
- Section
- County
- NRD Boundary
- DNR Registered Wells
- Topographic Regions
- High Plains Aquifer
- Ogallala Group
- Bedrock Geology
- UNL/CSD Test Holes
- Soils Ksat NRCS*
- Aquifer Vulnerability**
- Depth to Groundwater
- TR Median NO3 Concentration (statistics for each township)
- TR Median NO3 Sample Count (statistics for each township)

*Ksat=Hydraulic conductivity of the saturated sediements

**Based off of the DRASTIC model

Sample Results Explorer Function

There is a filter icon (3 horizontal bars) in the upper right corner of the Sample Result Explorer (within the red bar). Clicking on the filter icon will produce the query table. Samples can be queried by:

- Analyte
  - Analyte/CAS# (information icon available)
  - USGS Grouping
  - Pesticide Sub-Grouping
- Sample Detail
  - Filter for Most Recent Sample Results? (on/off)

  - Sample Date
  - Concentration
  - Submitting NRD or Agency
  - Quality Flag (information icon available)
  - Exclude Special Studies
- Analytical Method
  - Analytical Method ID-System
- Maximum Contaminant Level (MCL)
  - Analyte/CAS# (information icon available)
  - % of MCL

The user selects by entering a value and/or using the drop-down carrot. Once the selections are made, clicking the "Apply Filter" at the bottom of the window will run the query. After the query has been run, Sample Result Explorer will list the results in tabular form and show a count of results (bottom of table), the Map will be updated to show the sample locations on the map (shown as gray dots), and the Well Explorer will list the wells associated with the samples and a count of results (bottom of table). Data may be exported in an Excel format using the Export Filter Results at the top right if there are less than 2,100 results. If there are greater than 2,100 results, the user is instructed to us the Download Database button. The user may also turn on the Most Recent Nitrate Concentrations in the Layers Table which will physically show the nitrate concentration at each sample location identified on the map for that query. To run another query, the user must click on the filter icon on the top right of the Sample Results Explorer and then click "Clear All Filters" at the bottom of the table or use the Reset All Filters button located at the top right of the application.

Well Explorer Function

There is a filter icon (3 horizontal bars) in the upper right corner of the Well Explorer (within the teal bar). Clicking on the filter icon will produce the query table. Samples can be queried by:

- Well Detail
  - Clearinghouse Number
  - DNR Registration Number
  - DNR Well ID
  - Well Type
  - Included in NGWMN?*
  - Sample Count
- Location
  - Township
  - Range
  - Range Direction
  - Section (information icon available)
  - County
  - NRD
- Lat/Long
  - Latitude (information icon available)
  - Longitude (information icon available)
  - Radius

*NGWMN=National Groundwater Monitoring Network

The user selects by entering a value and/or using the drop-down carrot. Once the selections are made, clicking the "Apply Filter" at the bottom of the window will run the query. After the query has been run, Well Explorer will list the wells in tabular form and show a count of wells (bottom of table), the Map will be updated to show the well locations on the map (shown as gray dots), and the Sample Result Explorer will list the samples associated with the wells and a count of results (bottom of table). Data may be exported in an Excel format using the Export Filter Results at the top right if there are less than 2,100 results. If there are greater than 2,100 results, the user is instructed to use the Download Database button. The user may also turn on the Most Recent Nitrate Concentrations in the Layers Table which will physically show the nitrate concentration at each well location identified on the map for that query. To run another query, the user must click on the filter icon on the top right of the Well Explorer and then click "Clear All Filters" at the bottom of the table or use the Reset All Filters button located at the top right of the application.

Understanding the data

Groundwater monitoring performed by these organizations meets a variety of needs, and therefore is not always directly comparable. For instance, the state's 23 NRDs perform groundwater monitoring primarily to address contaminants over which they have some authority; mainly nitrates and agricultural chemicals. In contrast, the state's approximately 1,300 public water systems monitor groundwater for a large number of possible contaminants which could impact human health. These include basic water quality parameters such as pH, conductivity, and temperature, as well as testing for agricultural, industrial, and naturally-occurring chemicals that may be present at levels that are not safe for consumption.

Much of the groundwater monitoring has been for area-specific or regional-specific purposes (ex. NRD districts), and it has been difficult to assess data on a statewide basis. Creation of the Clearinghouse has provided an important tool for such analysis.

The table in Appendix A shows a wide variety of contaminants for which groundwater samples have been analyzed, most of which are used in agricultural. The Clearinghouse contains an additional 34 non-agricultural contaminants than were reported in last year's report.

Discussion and Analysis

The database highlights the presence of elevated levels of nitrate and herbicides in groundwater and the occurrence is associated with the practice of irrigated agriculture, especially corn production (Exner and Spalding 1990). In response, the Natural Resources Districts have instituted Groundwater Management Areas (GWMAs) in nearly all of the 23 districts based on the results of this data. The implementation of Groundwater Management Areas indicates a concern and recognition of nonpoint source groundwater contamination and a need to protect this State's most valuable natural resource. Additionally, NDEQ's Groundwater Management Area Program has completed 20 studies across the state since 1988, identifying areas of nonpoint source contamination mainly from the widespread application of commercial fertilizer and animal waste.

The State of Nebraska has a geographic area of over 77,000 square miles. Accurately characterizing the quality of Nebraska's groundwater in a complex aquifer system has always been challenging. Collaboration and taking a statewide view of all the groundwater data collected provides for robust trend analysis. The goal is to ascertain areas in Nebraska where groundwater contaminant levels are decreasing through better management and farming practices so that these positive trends can continue across the state.

Though we have groundwater data, there are over 200,000 active registered wells in Nebraska and only enough resources to collect samples from less than 4% of them annually (since 2000). Samples are also not collected evenly throughout the State. Additional resources and logistics are needed to obtain a more complete picture of Nebraska's groundwater quality.

Nitrate Trends Utilizing the Database

Nitrate monitoring data have been collected from wells for many years, and the purpose of collection has varied by the agency or organization performing the work. For instance, public water system operators sample their drinking water wells to ensure they are in compliance with the Safe Drinking Water Act while the NRDs have been collecting data to make groundwater management decisions. The Clearinghouse now makes accessing and reviewing groundwater data relatively straightforward, but users need to be aware that differences in wells may result in incorrect assumptions.

Data may be collected from:

- Deep wells (bottom of the aquifer) vs. shallow wells (top of the aquifer)
- Irrigation wells (potentially screened across multiple aquifers) vs. dedicated monitoring wells (with perhaps only 10 feet of screen)
- Wells located near potential sources of contamination such as septic tanks or past chemical spills vs. wells located in pristine rangeland
- Wells used for measuring water levels (observation) vs. wells used for water quality.

Several different methods have been used to present and interpret the nitrate data collected since the early 1970's. Reviewing the entire Clearinghouse shows that consistent sampling events and locations have occurred over the last 20 years. Figures 12 and 13 present the median (center of the data) nitrate concentration and simple trends during that time period. Figure 12 is specifically all the data collected minus any public water supply data. Figure 13 is all of the data including public water supplies. The public water supply data is collected pretreatment (if there is treatment).

Maps are used to help "see" the data and were generated using the Clearinghouse in an attempt to show "current" statewide groundwater quality from the most recent time the well had been sampled (aiming to show the most current water quality at that location). A township (36 square miles) map was also developed using the same data set from Figure 14. The most recent sample for each well analyzed since 2001 was used to calculate the median value of nitrate for each township (Figure 15). The Clearinghouse can be used visualize trends on a single well, county, NRD or any portion thereof by using the simple steps outlined in this report.

This is the first year Nebraska has participated in the USGS National Groundwater Monitoring Network. This network has over 500 wells that have known aquifer parameters and consistent sampling. The USGS network takes the place of the Statewide Monitoring Network.

Statewide Number & Median of Nitrate Analyses, 2001-2020

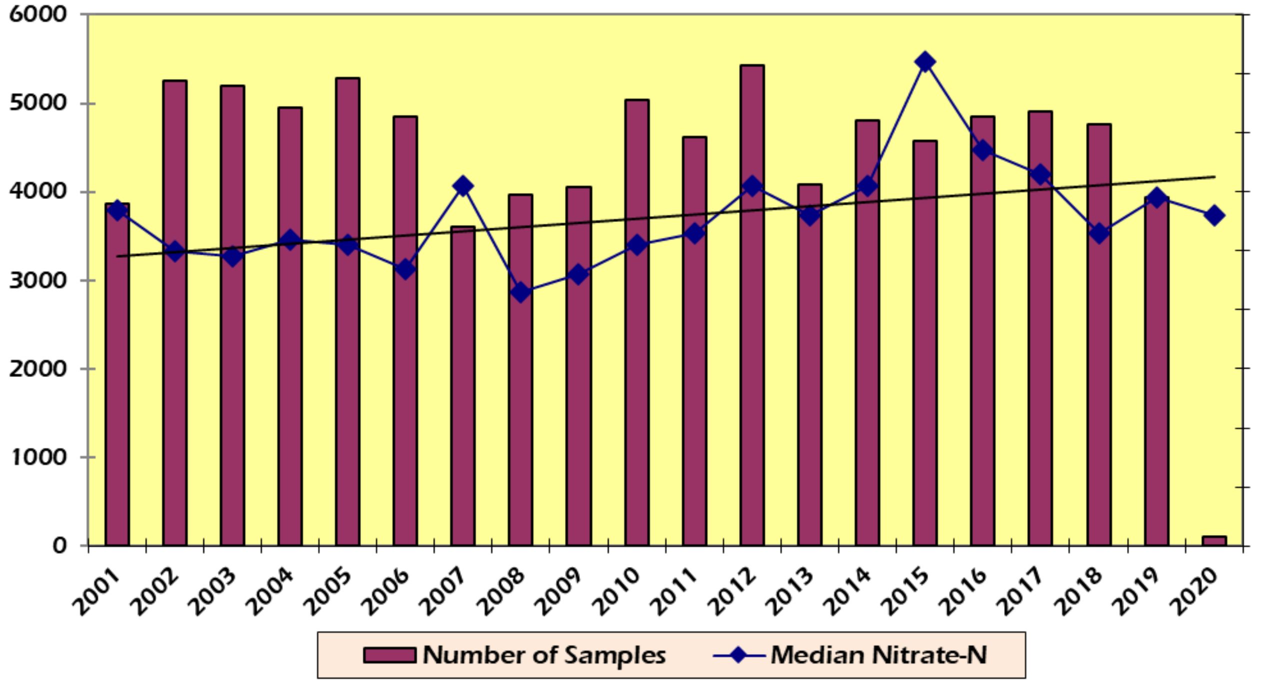


Figure 12. All 86,405 analyses and median Nitrate-N levels for Nebraska, 2001-2020 without public water samples. (Source: Clearinghouse 2021)

Statewide Number & Median of Nitrate Analyses, 2001-2020 *(All data)*

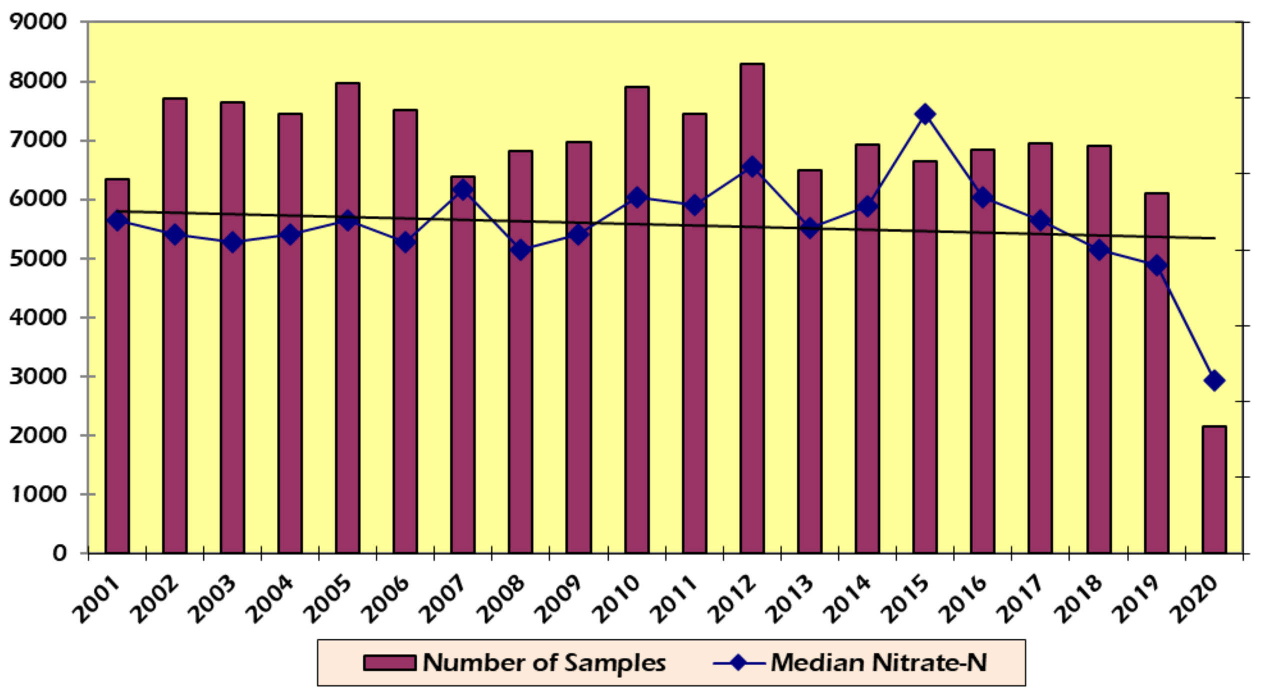


Figure 13. All 137,508 analyses and median Nitrate-N levels for Nebraska, 2001-2020. (Source: Clearinghouse 2021)

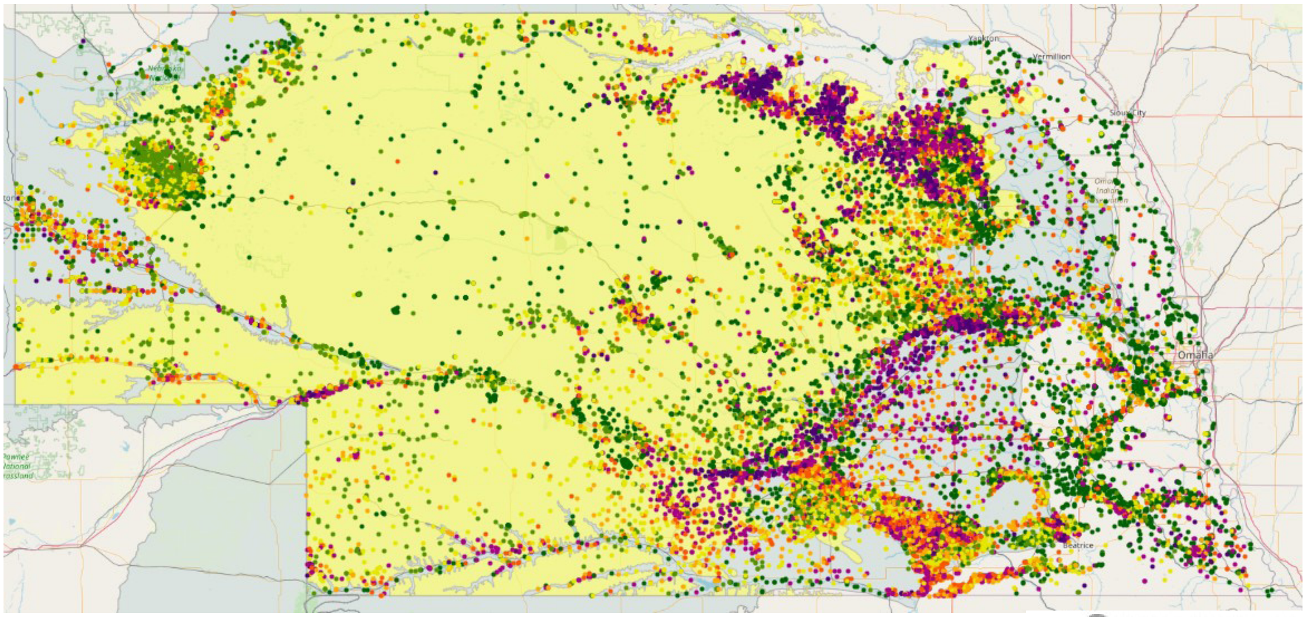


Figure 14. Most recent recorded Nitrate-N concentrations of 18,483 wells from 2001-2020. (Source: Clearinghouse 2021)

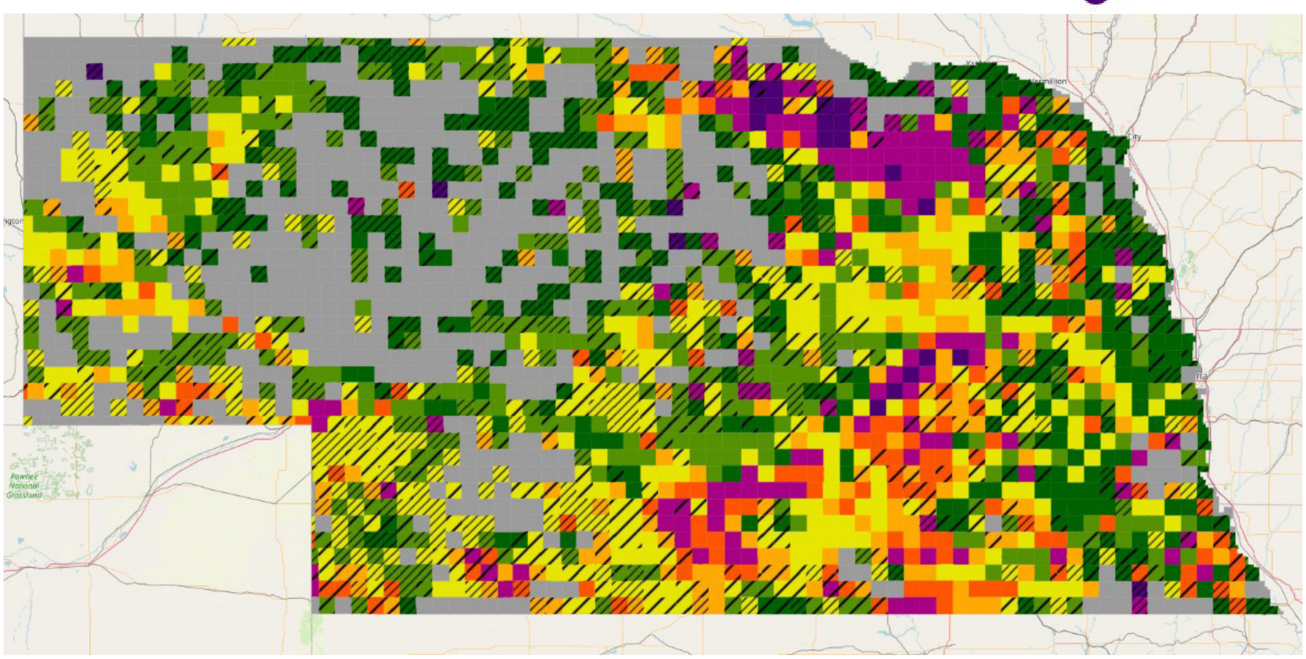


Figure 15. Median of the most recent Nitrate-N concentration by township of 18,483 wells from 2001-2020. (Source: Clearinghouse, 2021) *Note: Gray areas indicate no data reported, not the absence of nitrate in groundwater.*

HERBICIDES

Atrazine, alachlor, and metolachlor are herbicides used for weed control in crops such as corn and sorghum. In addition, the Nebraska Department of Agriculture identified alachlor and simazine as priority compounds for development of pesticide State Management Plans, following guidance produced by the U.S. Environmental Protection Agency.

Atrazine

Atrazine is used as an herbicide to eradicate broad leaf weeds. There have been 17,661 groundwater samples collected and analyzed for atrazine in the last 20 years. The mean atrazine concentration is 0.08 micrograms per liter or µg/L, compared to the USEPA's Maximum Contaminant Level of 3 µg/L, as established in the Safe Drinking Water Act.

Alachlor

Alachlor is used as an herbicide to eradicate broad leaf weeds and grasses. There have been 14,889 groundwater samples collected and analyzed for alachlor in the last 20 years. The mean alachlor concentration is 0.0.08 µg/L, compared to the USEPA's MCL of 6 µg/L.

Metolachlor

Metolachlor is used as an herbicide to eradicate broad leaf weeds. There have been 15,521 groundwater samples collected and for metolachlor in the last 20 years. The mean metolachlor concentration is 0.0.12 µg/L. There is not USEPA MCL for metolachlor, however Minnesota developed a guidance value of 300 µg/L for metolachlor in drinking water.

Simazine

Simazine is used as an herbicide to eradicate broad leaf weeds. There have been 14,790 groundwater samples collected and analyzed for simazine in the last 20 years. The mean simazine concentration is 0.07 µg/L. The USEPA's MCL for simazine is 4 µg/L.

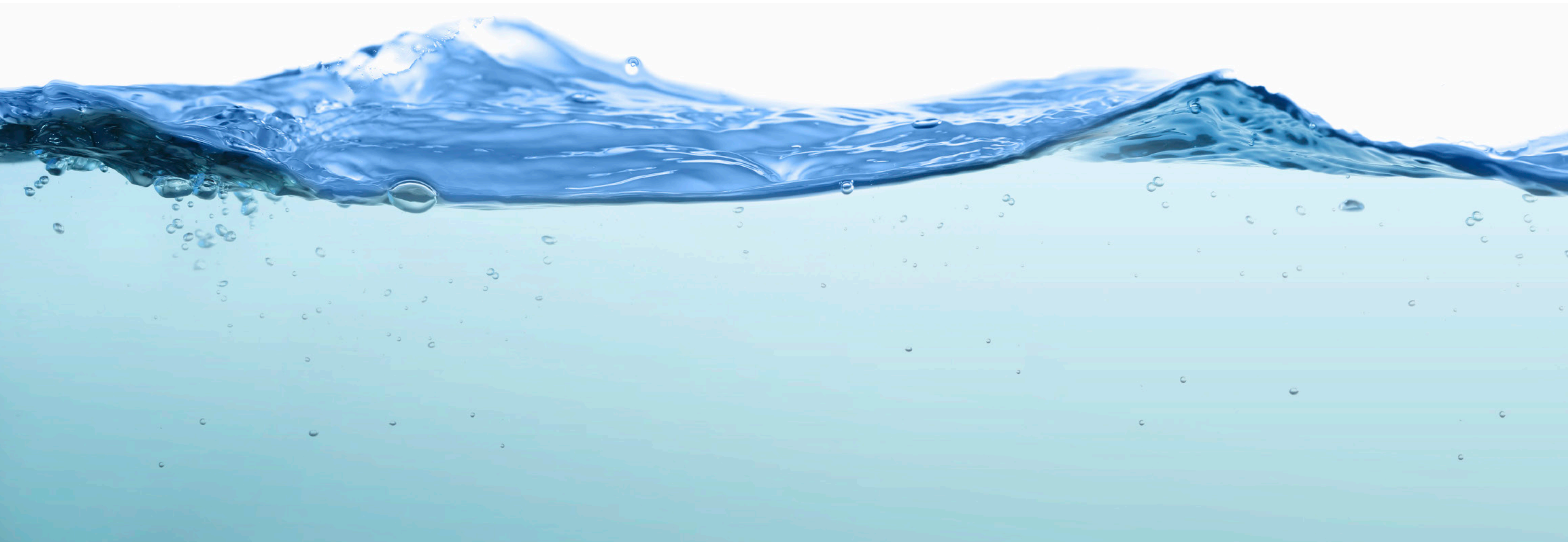
CONCLUSIONS

Groundwater is Nebraska's most valuable natural resource. 93% of Nebraska's ~1,300 public water systems serve populations under 3,300 and 95% of those systems rely solely on groundwater. Agriculture and industry in Nebraska rely on heavily on groundwater for production. Most public water supplies that utilize groundwater in Nebraska, do not require any form of treatment. The State's reliance on groundwater highlights the important of maintaining the quantity and quality of this resource Monitoring groundwater contaminant trends statewide helps to ensure this.

The Clearinghouse is available to aid in managing Nebraska's valuable groundwater resource. The report authorized by Neb. Rev. Stat. § 46-1304 (LB 329, 2001) lead the way to the development of the Clearinghouse. Now both recent and historic groundwater quality data can be easily viewed in one location for analysis, mapping or other uses.

Concentrations and trends of contaminants. Figures 12 and 13 present the median nitrate concentration in groundwater for each year and this data was utilized in a simple trend analysis, which indicated that there was no clear trend after year 2000. These figures also show that there are still areas in Nebraska where the median nitrate concentration in groundwater is approaching the drinking water MCL of 10 mg/L. Once the USGS network can be utilized along with the Clearinghouse, more detailed trend analyses for nitrates will be conducted. There is not enough recent data statewide for atrazine, alachlor, metolachlor, or simazine to conduct any trend analyses.

The Future. Continued attention and resources directed toward groundwater monitoring data for the Clearinghouse and implementation of the USGS National Groundwater Monitoring Network will be crucial for the successful management of Nebraska's groundwater. Best-Management practices, such as adjusting fertilizer application rates and timing must continue to see improvements in Nebraska's groundwater quality.



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Compound			
1,1,1-Trichloroethane	Acetochlor sulfynilacetic acid	Cadmium	Dechloroalachlor
1,1,2-Trichloroethane	Acifluorfen	Carbaryl	Dechlorodimethenamid
1,1-Dichloroethene	Acrylonitrile	Carbofuran	Dechlorometolachlor
1,2,4-Trichlorobenzene	Alachlor	Carbon disulfide	Deethylatrazine
1,2-Dibromo-3-chloropropane	Alachlor ethane sulfonic acid	Carbon tetrachloride	Deethylcyanazine
1,2-Dibromoethane (Ethylene dibromide)	Alachlor oxanilic acid	Carboxin	Deethylcyanazine acid
1,2-Dichlorobenzene	Alachlor sulfynilacetic acid	Chloramben methyl ester	Deethylcyanazine amide
1,2-Dichloroethane	Aldicarb	Chlordane	Deethylhydroxyatrazine
1,2-Dichloropropane	Aldicarb sulfone	Chlorimuron-ethyl	Deisopropylatrazine
1,3-Dichloropropane	Aldicarb sulfoxide	Chlorobenzene	Deisopropylhydroxyatrazine
1,4-Dichlorobenzene	Aldrin	Chloroform	Delta-HCH
1-Naphthol	Alpha-HCH	Chlorothalonil	Demethylfluometuron
2,3,7,8-TCDD	Ametryn	Chlorpyrifos	Desulfinylfipronil
2,4,5-T	Antimony	Chlorpyrifos Oxon	Desulfinylfipronil amide
2,4,6-Trichlorophenol	Arsenic	Chromium	Di(2-ethylhexyl)adipate
2,4-D	Asbestos	Cis-1,2-dichloroethene	Di(2-ethylhexyl)phthalate
2,4-D Methyl ester	Atrazine	Cis-1,3-dichloropropene	Diazinon
2,4-DB	Azinphos-methyl	Cis-permethrin	Diazoxon
2,4-Dinitrophenol	Azinphos-methyl oxon	Clopyralid	Dicamba
2,6-Diethylaniline	Barium	Copper	Dichlobenil
226 Radium	Bendiocarb	Cyanazine	Dichlorprop
228 Radium	Benfluralin	Cyanazine acid	Dichlorvos
2-Ethyl-6-methylaniline	Benomyl	Cyanazine amide	Dicrotophos
3,4-Dichloroaniline	Bensulfuron-methyl	Cyanide	Didealkylatrazine
3,5-Dichloroaniline	Bentazon	Cycloate	Dieldrin
3-Hydroxycarbofuran	Benzene	Cyfluthrin	Dimethenamid
4,6-Dinitro-o-cresol	Benzo(A)pyrene	Cypermethrin	Dimethenamid ethane sulfonic acid
4-Chloro-2-methylphenol	Beryllium	Cyprazine	Dimethenamid oxalic acid
4-Chloro-3-methylphenol	Beta-HCH	Dalapon	Dimethoate
4-Nitrophenol	Bromacil	DCPA	Dinoseb
Acenaphthene	Bromomethane	DCPA Monoacid	Diphenamid
Acetochlor	Bromoxynil	DDD	Diquat
Acetochlor ethane sulfonic acid	Butachlor	DDT	Disulfoton
Acetochlor oxanilic acid	Butylate	Dechloroacetochlor	Disulfoton sulfone

Compound			
Diuron	Hexachlorocyclopentadiene	Metribuzin	Propyzamide
Endosulfan I	Hexazinone	Metsulfuron-methyl	Combined Radium (-226 & -228)
Endosulfan Ii	Hydroxyacetochlor	Molinate	Selenium
Endosulfan sulfate	Hydroxyalachlor	Myclobutanil	Siduron
Endothal	Hydroxyatrazine	Naphthalene	Silvex
Endrin	Hydroxydimethenamid	Napropamide	Simazine
Endrin aldehyde	Hydroxymetolachlor	Neburon	Simetryn
Eptc	Hydroxysimazine	Nicosulfuron	Styrene
Esfenvalerate	Imazaquin	Nitrate-N	Sulfometuron-methyl
Ethalfluralin	Imazethapyr	Nitrite as NO2	Tebuthiuron
Ethion	Imidacloprid	Norflurazon	Terbacil
Ethion monoxon	Iodomethane	Oryzalin	Terbufos
Ethoprop	Iprodione	Oxadiazon	Terbufos oxon sulfone
Ethyl parathion	Isofenphos	Oxamyl	Terbuthylazine
Ethylbenzene	Isoxaflutole	Oxyfluorfen	Terbutryn
Fenamiphos	Isoxaflutole diketonitrile	Pebulate	Tetrachloroethene
Fenamiphos sulfone	Lead	Pendimethalin	Thallium
Fenamiphos sulfoxide	Lindane	Pentachlorophenol	Thiobencarb
Fenuron	Linuron	Permethrin	Toluene
Fipronil	Malathion	Phorate	Total Xylenes
Fipronil sulfide	Malathion oxon	Phorate oxon	Toxaphene
Fipronil sulfone	MCPA	Phosmet	Trans-1,2-dichloroeth-ene
Flufenacet	MCPB	Phosmet oxon	Trans-1,3-dichloropro-pene
Flufenacet ethane sulfonic acid	Mercury	Picloram	Triallate
Flufenacet oxanilic acid	Metalaxyl	Prometon	Trichloroethene
Flumetsulam	Methidathion	Prometryn	Triclopyr
Fluometuron	Methiocarb	Propachlor	Trifluralin
Fluoride	Methomyl	Propachlor ethane sulfonic acid	Uranium
Fonofos	Methoxychlor	Propachlor oxanilic acid	Vernolate
Fonofos oxon	Methyl paraoxon	Propanil	Vinyl chloride
Glyphosate	Methyl parathion	Propargite	
Gross beta	Methylene chloride	Propazine	
Heptachlor	Metolachlor	Propham	
Heptachlor epoxide	Metolachlor ethane sulfonic acid	Propiconazole	
Hexachlorobenzene	Metolachlor oxanilic acid	Propoxur	