

Memorandum

To: Programs, Projects, and Operations Subcommittee

Subject: US Geological Survey (USGS) Water Quality Monitoring

Date: January 30, 2008

From: Gerry Bowen

In December, 2007, the District considered a proposal from the USGS to conduct an analysis of the water quality data collected in the District since 1992. The proposal was not approved at that time, however USGS and Management were asked to revise the proposal and re-submit to the Subcommittee for consideration at a later date.

USGS has submitted the attached revised proposal. The following description of the District's monitoring effort is included here for clarity.

USGS Irrigation Well Monitoring:

In 1992 and with guidance from USGS, the District identified ninety-four (94) irrigation (primarily) wells in five different groundwater areas for monitoring water quality. The groundwater areas are Missouri River, Platte River, Elkhorn River, Upland, and Dakota. Each well is sampled at least every four years. The wells are tested for a wide variety of parameters (nitrates, pesticides, major ions, and trace metals). The data is maintained for each well, used for comparison with other wells, and to determine if a water quality problem exists. If a problem is identified, we follow the procedures outlined in the GWMP. The network was established in 1992 and sampling has proceeded annually thereafter.

USGS Well Nest Monitoring:

Again to build a data base of water quality and quantity in the District, we established 9 well nests in the groundwater areas listed above (one nest in the Dakota, and two each in the other areas). Each well nest contains two or three wells screened at different levels (shallow, medium, or deep) so that a complete picture of the aquifer can be drawn. Shallow wells sample the upper five feet, medium measures the middle five feet, and deep wells sample the lowest five of the aquifer. This sampling has been occurring for the past six years. Each sample is analyzed for a wide array of parameters on a semi-monthly pattern between April and November. Water level measurements are also recorded at each nest.

NRD Water Level Monitoring:

Each spring and summer, the District records water level measurements on 30 irrigation wells throughout the District. This information is submitted to the UN-L Conservation and Survey Division where it is compiled into a statewide database for groundwater levels.

The sampling and analysis is done by USGS personnel and the costs are shared via a cooperative agreement. The NRD share of the costs comes partially from the Natural Resources Water Quality Fund (NRWQF). The District has been budgeting approximately \$95,000 each year for this program, offset by approximately \$32,000 in NRWQF funds as a revenue source.

The revised USGS proposal covers federal fiscal years (FFY) 2008-2010 and includes the following:

1. Continue to gather water quality data in the manner described above for the next three fiscal years. In addition to the parameters mentioned above, the following will also be done:
 - a. Test for explosives and volatile organic compounds at the Venice well nest site on an annual basis.
 - b. Assist the NRD in identifying 3 or 4 more USGS irrigation wells to be included in the District's water level monitoring program.
2. An analysis of the groundwater data collected since 1992 to determine the groundwater conditions in the District.
3. Suggest possible changes to the monitoring program in response to this analysis.
4. Suggested possible changes to the District's Groundwater Management Plan in response to this analysis.
5. Create a web page for each county in the District on the USGS Nebraska Water Center website detailing the water quality data collected to date. These sites will be updated annually.

The total cost of the sampling, analyzing, and investigative report is estimated at \$373,600 (\$2,700 less than the previous proposal). USGS will provide 20% funding for the project, or \$74,740. The total District cost will be the remaining 80%, or \$298,860 over the next three federal fiscal years (NRD fiscal years 2008-11) as shown below.

Agency	FFY 2008	FFY2009	FFY2010	Totals
USGS	\$32,900	\$32,040	\$9,800	\$74,740
P-MRNRD	\$131,600	\$128,160	\$39,100	\$298,860
Total	\$164,500	\$160,200	\$48,900	\$373,600

The District's previous agreement with USGS expired on September 30, 2007 (end of the federal FY 2007). The proposal summarized above would involve a new agreement with USGS to accomplish.

To date, the District has paid \$40,700 under Account #05-00-4485 to satisfy the previous agreement, leaving a balance in that account of \$53,975. If adopted, the new agreement would require an additional \$21,825 or a total of \$75,800. This would make this account increase more than 10%, requiring Board approval.

Management recommends that the Subcommittee recommend to the Board that the General Manager be authorized to execute an agreement with the U.S. Geological Survey to conduct an Analysis and Assessment of Groundwater Quality and Groundwater Quantity Monitoring as proposed, in addition to the routine sampling of groundwater wells in the District, up to a maximum District expenditure of \$298,860 in Fiscal Years 2008-2011, and that Account #05-00-4485 be allowed to go over 110% of the budgeted amount on the FY 2008 Budget.

**Analysis and Assessment of Ground-Water-Quality
and Ground-Water-Quantity Monitoring in Accordance with the
Ground-Water Management Plan,
Papio-Missouri River Natural Resources District**

By

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U.S. Geological Survey
Lincoln, Nebraska

February 7, 2008

**Analysis and Assessment of Ground-Water-Quality
and Ground-Water-Quantity Monitoring in Accordance with the
Ground-Water Management Plan,
Papio-Missouri River Natural Resources District**

Background: From 1992 to the present (2008), the U.S. Geological Survey (USGS) Nebraska Water Science Center (NEWSC), in cooperation with the Papio-Missouri River Natural Resources District (PMRNRD), has collected and analyzed samples from the PMRNRD's network of water-quality wells. The water-quality network consist of about 170 domestic, industrial, irrigation, municipal, and stock (DIIMS) wells (fig. 1) as well as 26 monitoring wells in 9 well nests (fig. 2). The DIIMS wells in the water-quality network were initially identified and sampled in a 1992 USGS synoptic study (Verstraeten and Ellis, 1995); the well nests were installed in 1999. PMRNRD's network of water-quantity wells consists of about 58 wells (fig. 3). The USGS measures water-levels in the 26 monitoring wells in the 9 well nests; the PMRNRD measure water levels in about 32 irrigation wells (fig. 3).

Verstraeten and Ellis identified five primary aquifers within the PMRNRD—the Elkhorn River aquifer, Missouri River aquifer, Platte River aquifer, Upland alluvial aquifer and the Dakota aquifer. All the aquifers, except the Dakota, are the surficial aquifer in the respective area.

The primary purpose of the sampling is to access water quality in the area's five primary aquifers. The areas of interest for the PMRNRD generally are areas where the concentration of one or more Title 118 analytes exceeds half the maximum contaminant level (MCL) for that analyte (Papio-Missouri River Natural Resources District Board of Directors and others, 1994). When a sample's concentrations exceed half the MCL for one or more Title 118 analyte, the PMRNRD will initiate further investigations in the area to determine if the elevated concentration(s) are a local or regional problem and, based on the results of this investigation, will determine whether to recommend further actions. The current areas of interest for the PMRNRD are areas where the nitrate concentration is greater than 5 mg/L; the Title 118's MCL for nitrate is 10 mg/L (Papio-Missouri River Natural Resources District Board of Directors and others, 1994). The current areas of interest are generally in the Upland aquifer and around the Springfield, Tekamah, and Venice well nests (fig. 2).

Currently, the DIIMS wells are generally sampled once every 3 years during irrigation season; however, some wells, which are in areas of interest for the PMRNRD, have been sampled annually. Samples are collected from the DIIMS wells for nitrate plus nitrite as nitrogen (hereafter referred to as the nitrate concentration) or nutrient (ammonia, nitrate, nitrite only, and phosphate) analysis, triazine screening, and, for the six wells with the highest screening results, pesticide analysis. Each time a well is sampled, field parameters are measured, including pH, water temperature, specific conductance, and dissolved oxygen. The static water level is not measured in the DIIMS wells because the pumps typically are in operation when the well site is visited.

In 2007, the monitoring wells in the well nests were sampled on two schedules: bimonthly and biannually. Three nests are in areas of interest for the PMRNRD and sampled bimonthly. The remaining six nests are sampled biannually. Samples are collected from the monitoring wells for major ions, nitrate or nutrient analysis, triazine screening, and, for the six wells with the highest screening results, pesticide analysis. Each time a well is sampled, field parameters are measured. Prior to sampling, the static water level is measured in each monitoring well of the well nest.

The PMRNRD measures static water levels in about 30 irrigation wells each spring and fall (fig. 3). The PMRNRD sends their water level data to the USGS and the University of Nebraska—Lincoln, Conservation and Survey Division. The USGS loads the water-level data into their National Water Information System (NWIS) to enable public access to the data through NWISWeb (<http://waterdata.usgs.gov/ne/nwis/gw/>).

Objectives: The objectives of this study are:

- Water-quality monitoring To continue to sample and analyze ground-water samples from selected PMRNRD network wells (fig. 1) and well nests (fig. 2) to determine the concentration of nutrients and pesticides in water samples from all the wells. To sample selected wells and analyze the water samples for other analytes (trace metals, uranium, radon, volatile organic compounds, and explosives).
- Water-level monitoring To assist PMRNRD staff with identifying additional wells to be added to the PMRNRD water-level-monitoring program; Figure 3 shows the wells in the current PMRNRD water-level-monitoring program.
- Reporting To develop and maintain a publically available Web site that will provide the PMRNRD and public with easy access to the historical and current water-quality and water-level-monitoring results.
- Reporting To publish an on-line report that will present an overview and analysis of water-quality and water-level results collected by the PMRNRD or USGS from 1992 through September 2009. The report will assess PMRNRD water-quality and water-level networks and, if indicated by the analysis, suggest modifications to the PMRNRD ground-water plan (Papio-Missouri River Natural Resources District Board of Directors and others, 1994).
- Reporting To present the year's water-quality and water-level results to the PMRNRD when the results become available.

Approach: The approach for this study is:

- Water-quality monitoring To continue sampling the PMRNRD wells nests (6 nests annually and 3 nests quarterly) and network wells (30 selected wells annually) for the analytes included in 2007 sampling and for several additional analytes. The analytes included are:

Analytes included in 2007

- Nutrients;
- Triazine screening;
- Pesticide and pesticide degradates (only 12 samples with highest pesticide screening results are sent in for a pesticide analysis); and
- Major ions (well nests only).

Additional analytes in 2008 and 2009 in selected wells

- Trace metals, including arsenic;
 - Radon and uranium in selected wells; and
 - Explosives and volatile organic compounds in the three wells in the Venice well nest. Some explosive and volatile organic compounds that have been detected in ground water in the vicinity of the former Ordnance Plant near Mead, Nebraska; the purpose of this sampling is to verify these analytes are not present at this location.
- Water-level monitoring In cooperation with the PMRNRD, continue to monitor ground-water levels in the PMRNRD and add a set of new wells to the water-level monitoring network.
 - Reporting—Web site In 2008, to develop and maintain a USGS Web site that will provide the PMRNRD and the public with easy access to the historical and current water-quality- and water-level-monitoring results. The wells will be displayed on a clickable map.

The water-quality results will be displayed on a Web site similar to http://ca.water.usgs.gov/sanbern/wq_list.html

The water levels will be displayed on the USGS Active Water Level network site:

- Dakota County http://ogw01.er.usgs.gov/countymaps/NE_043.html
- Thurston County http://ogw01.er.usgs.gov/countymaps/NE_173.html
- Burt County http://ogw01.er.usgs.gov/countymaps/NE_021.html
- Washington County http://ogw01.er.usgs.gov/countymaps/NE_177.html
- Douglas County http://ogw01.er.usgs.gov/countymaps/NE_055.html
- Sarpy County http://ogw01.er.usgs.gov/countymaps/NE_153.html

In 2009, the Web site will be revised to include the latest data. In 2010, the Web site will be revised to include maps and figures from the published report (discussed below).

- Reporting—Report To publish an on-line USGS Scientific Investigations Report (SIR) that will present an overview and analysis of water-quality and water-level results collected by the PMRNRD or USGS through September 2009 and an assessment of the water-quality- and water-quantity-monitoring networks. The report will address two questions posed by PMRNRD:
 - 1) What does the water-quality and water-level data collected through 2009 tell us about ground-water conditions in the district?
 - 2) How should the PMRNRD adjust their ground-water plan (Papio-Missouri River Natural Resources District Board of Directors and others, 1994) in response to this analysis?

The water-quality results include concentrations of nutrients, pesticides, dissolved gases, chlorofluorocarbons, nitrogen (N^{15})- and oxygen (O^{18})-stable isotopes in dissolved nitrate, and N^{15} in dissolved nitrogen gas. Historical data, including ground-water-quality, rainfall, and streamflow data maintained by the USGS and others, and data collected during this study will be compiled and interpreted with respect to water-quality characteristics and general geochemistry, water levels, and ground-water-flow directions.

Topics to be discussed in the report will include areas where the nitrate concentration exceeds half the MCL, which are areas of interest to the PMRNRD in accordance with their Groundwater Management Plan (Papio-Missouri River Natural Resources District Board of Directors and others, 1994) and areas indicating of evidence of denitrification. If possible, nitrate concentrations will be related to explanatory factors such as depth to water, proximity to agricultural activities and surface water, ground-water-flow direction, and other factors.

Also, the PMRNRD's water-quality- and water-quantity-monitoring networks will be assessed in the report. The water-quality-monitoring network will be assessed using the 1992 through September 2009 results to determine if wells, analytes sampled, and frequency of sampling should be modified. Also, considered will be the current patterns of ground-water use, that is, areas where the residents obtain their drinking water from private wells, areas predominantly serviced by rural water systems, and areas predominantly serviced by municipal water systems.

The water-level and river-stage data, where there is sufficient data, will be used to map the water-table or potentiometric-surface elevation. Areas with insufficient data will be delineated.

Data review and report compilation will continue through the third quarter of 2009. The last quarter of 2009 and the first half of 2010 will be used to complete and publish the USGS SIR.

- Reporting--Status To present the year's water-quality results to the PMRNRD annually.

Quality Assurance: To assure the quality of the USGS sampling data in 2008 and 2009, all samples will be analyzed by the USGS National Water Quality Laboratory, Denver, Colorado or by the USGS Organic Geochemistry Research Laboratory, Lawrence, Kansas. During each sample collection period, wells designated for quality assurance samples will be selected randomly. The quality assurance samples will consist of a field blank and field replicate set for ten percent of the wells sampled.

To assure the quality of the water-level and water-quality data and the overview and analysis report, the USGS has an extensive protocol for review of data and the resulting publications or Web sites.

Products: A set of Web pages will be added to the USGS Nebraska Water Science Center Web site by September 2008 to enable the PMRNRD and the public to easily access the historical and current PMRNRD water-level and water-quality data. The report detailing an overview and analysis of water-level and water-quality data will be published as a USGS SIR (on-line only). A summary of the report will be presented, if requested, to the PMRNRD.

Relevance and Benefits: A USGS SIR, a product of this proposal, will present an overview and analysis of water-quality and water-quantity results and an assessment of the water-quality and water-quantity network. The SIR will be published on-line, which will make the analysis results easily available to the public and to the PMRNRD decision makers. The USGS Web site for this study will provide easy access to the water-level and water-quality data to the PMRNRD and the public. Access to the report and to the water-quality and water-level data will increase understanding of the water-quality and water-quantity conditions in the PMRNRD and help improve the monitoring network in the PMRNRD.

This proposed work is consistent with part of the USGS's Strategic Directions to develop a Water Census. The overall objective of the Water Census is to "inform the public and decisionmakers about (1) the status of its freshwater resources and how they are changing; (2) a more precise determination of water use for meeting future human, environmental, and wildlife needs; (3) how freshwater availability is related to natural storage and movement of water, as well as engineered systems, water use, and related transfers; (4) how to identify water sources, not commonly thought to be a resource, that might provide freshwater for human and environmental needs; and (5) forecasts of likely outcomes for water availability, water quality, and aquatic ecosystem health caused by changes in land use and land cover, natural and engineered infrastructure, water use, and climate " (U.S. Geological Survey, 2007). In this proposal, the proposed report and web site comply with the Water Census' strategic action to expand the time-series data-collection capabilities for status and trends of water quantity and quality and make the information available to the public and to decisionmakers in a useful format.

Personnel:

USGS Personnel	Days		
	FY08	FY09	FY10
Sampling			
Hydrologic Technician	66	64	
Hydrologist	25	24	
Reporting			
Hydrologist	87	68	23
Webmaster	5	3	3

Timeline: The schedule for publication of the USGS SIR by June 30, 2010 assumes the USGS and PMRNRD cooperative water agreement is signed by February 29, 2008.

Activity	2008				2009				2010	
	PMRNRD Fiscal Calendar									
	FY08		FY09				FY10			
	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
	USGS Fiscal Calendar									
	FY08			FY09				FY10		
	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
Ground-water sampling	X	X	X	X	X	X	X	2010 agreement		
Collection of historical data for report		X	X							
Data analysis			X	X	X	X				
Web site		X	X			X	X		X	X
Report preparation					X	X	X	X		
Report completed									X	X

Cost: The estimated cost of sampling in 2008 and 2009, the Web site, and the report in the form of a USGS SIR is \$373,600.

USGS Fiscal Year (October to September)	Total	USGS	PMNRD
FY2008	\$164,500	\$32,900	\$131,600
FY2009	160,200	32,040	128,160
FY2010	48,900	9,800	39,100
Total	373,600	74,740	298,860

References

- Papio-Missouri River Natural Resources District Board of Directors, Staff, HRD Engineering, Inc., 1994, Papio-Missouri River Natural Resources Groundwater Management Plan: Papio-Missouri River Natural Resources document, 105 pages not including appendices.
- Verstraeten, I. V. and Ellis, M.J., 1995, Reconnaissance of ground-water quality in the Papio-Missouri River Natural Resources District, eastern Nebraska, July through September 1992: U.S. Geological Survey Water-Resources Investigations 94-4, 90 p.
- U.S. Geological Survey, 2007, Facing tomorrow's challenges—U.S. Geological Survey science in the decade 2007–2017: U.S. Geological Survey Circular 1309, 70 p.

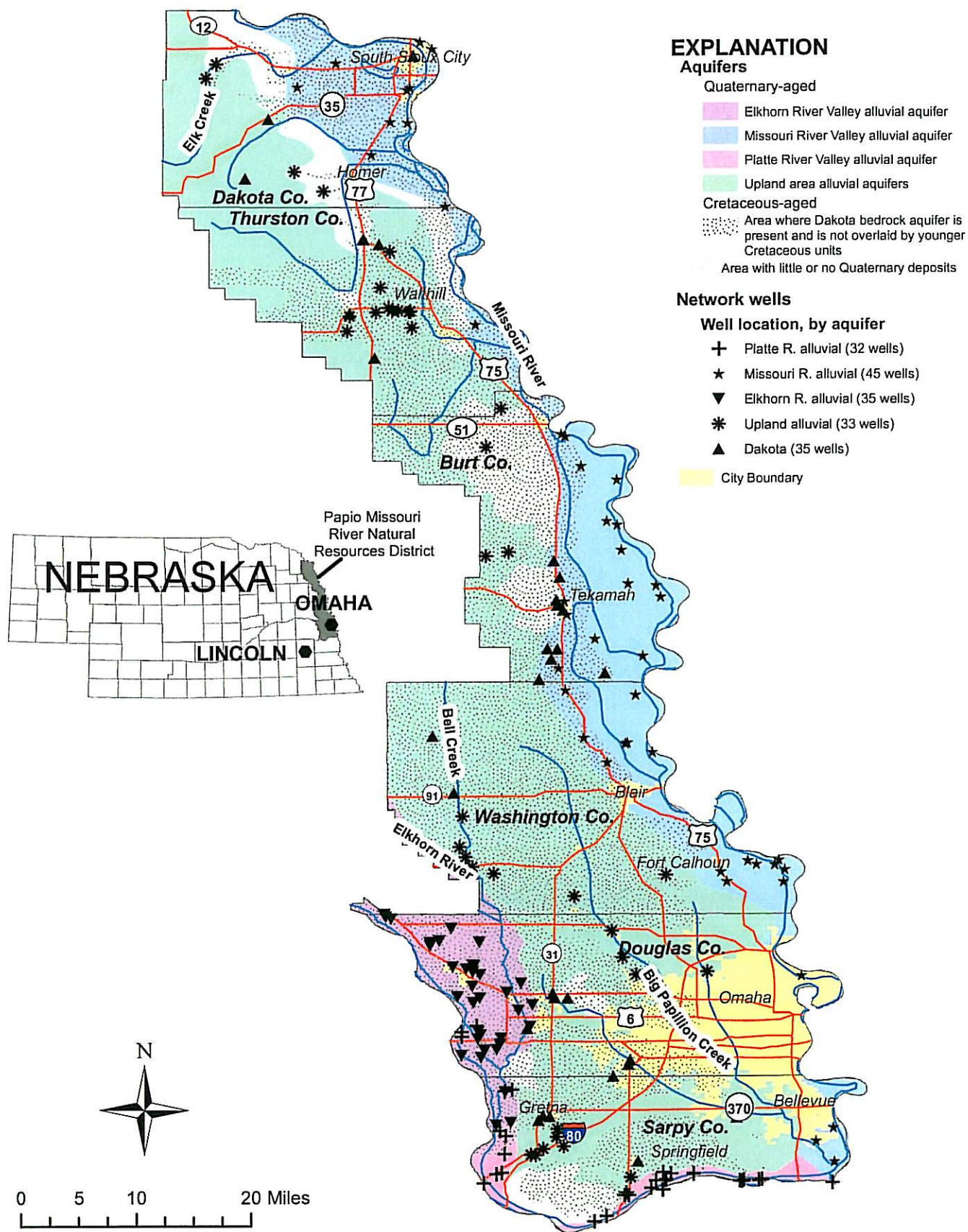


Figure 1. Network wells in the Papio Missouri River Natural Resources District's Water Quality Monitoring Program, as of January 2008

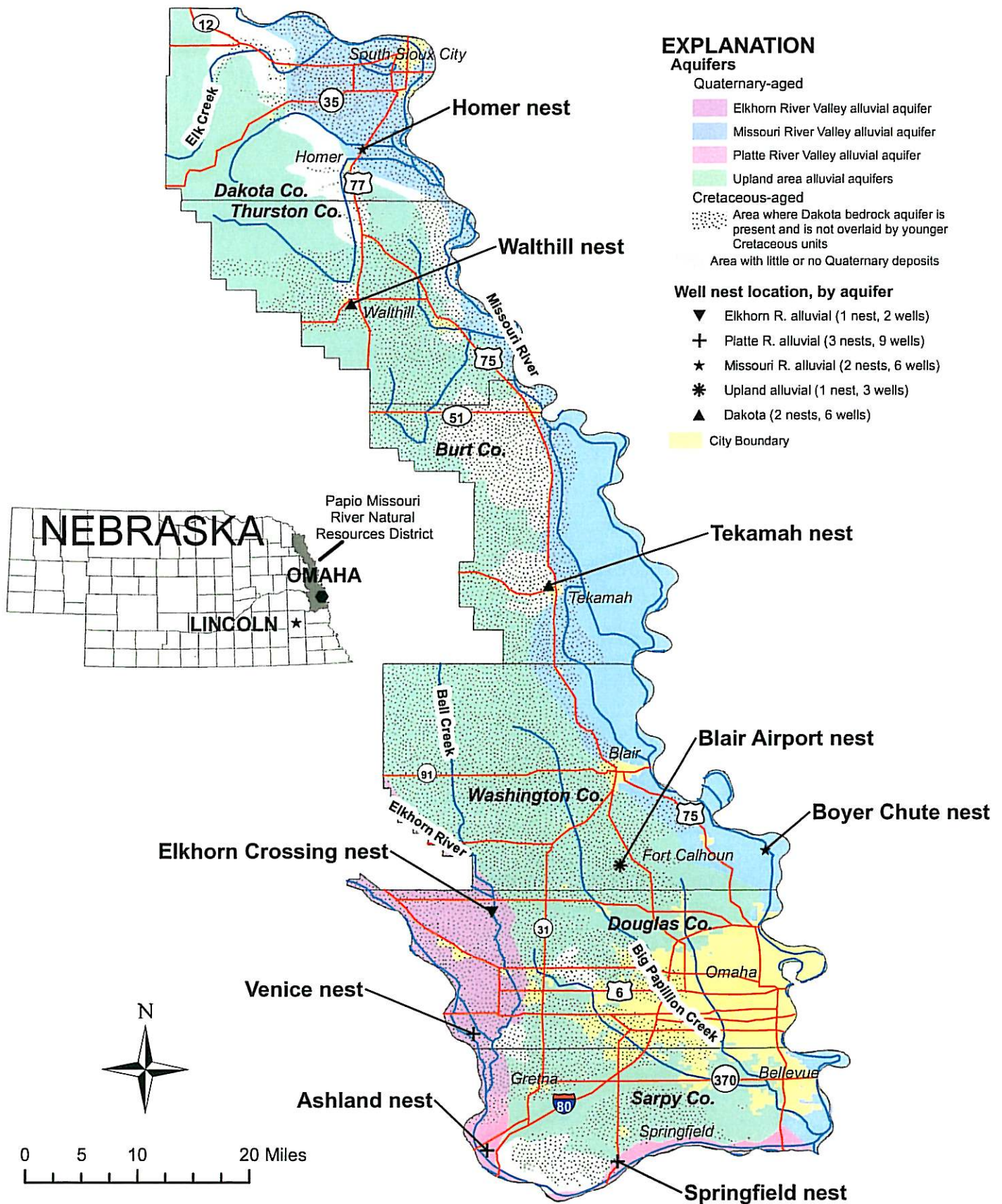


Figure 2. Well nests in the Papio Missouri River Natural Resources District's Water Quality Monitoring Program, January 2008

