ILLINOIS INTEGRATED WATER QUALITY REPORT AND SECTION 303(d) LIST - 2014

Clean Water Act Sections 303(d), 305(b) and 314

Water Resource Assessment Information and Listing of Impaired Waters

Volume II: Groundwater

March 24, 2014

Illinois Environmental Protection Agency
Bureau of Water

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EXECUTIVE SUMMARY

This 2014 Integrated Report continues the reporting format first adopted in the 2006 reporting cycle. However, beginning with the 2010 cycle the Integrated Report was divided into two volumes: Volume I covering surface water quality and Volume II assessing groundwater quality. Prior to 2006, assessment information was reported separately in the Illinois Water Quality [Section 305(b)] Report and Illinois Section 303(d) List. The Integrated Report format is based on federal guidance for meeting the requirements of Sections 305(b), 303(d) and 314 of the Clean Water Act (CWA).

The purpose of this report (Volume II) is to provide information to the federal government and the citizens of Illinois on the condition of groundwater in the state. This information is provided in detail in Section C and in Appendix A.

The results of the 2014 Use Assessment show that of the 357 Community Water Supply (CWS) probabilistic network wells this cycle:

39 (11 percent) were determined to be Not Supporting ("poor") due to the elevated levels of nitrate and chloride (Cl-) over the Groundwater Quality Standard (GWQS) of10 mg/L and 200 mg/L, respectively, or bacterial contaminantion of the source water;
44 (12 percent) were determined to be Not Supporting ("fair") due to statistically significant increases chloride (Cl-) above background, detections of VOCs, nitrate (total nitrogen) greater than 3 mg/l, but have not exceeded the health-based GWQS; and
274 (77 percent) were determined to be Fully Supporting ("good"), which show no detections over background levels of any of the above analytes.

Additionally, trend analyses for VOCs also show that there is a statistically significant increase in the number of CWS wells with VOC detections, despite the fact that the number of CWS analyzed for VOCs over the same time period declined, and the detection limit remained constant.

Illinois groundwater resources are being degraded. Degradation occurs based on the potential or actual diminishment of the beneficial use of the resource. When contaminant levels are detected (caused or allowed) or predicted (threat) to be above concentrations that cannot be removed via ordinary treatment techniques, applied by the owner of a private drinking water system well, potential or actual diminishment occurs. At a minimum, private well treatment techniques consist of chlorination of the raw source water prior to drinking.

PART A: INTRODUCTION

A-1. Reporting Requirements

The 2014 Integrated Report is based on guidance from the United States Environmental Protection Agency (USEPA) which is intended to satisfy the requirements of Sections 305(b), 303(d) and 314 of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500) and subsequent amendments (hereafter, collectively called the "Clean Water Act" or "CWA") in a single combined report. For this reporting cycle the Integrated Report is being divided into two volumes: Volume I covering surface water quality and Volume II assessing groundwater quality.

Accordingly, Section 102 of the CWA requires:

SEC. 102 [33 U.S.C. 1252] Comprehensive Programs for Water Pollution Control:

(a) The Administrator shall, after careful investigation, and in cooperation with other Federal agencies, State water pollution control agencies, interstate agencies, and the municipalities and industries involved, prepare or develop comprehensive programs for preventing, reducing, or eliminating the pollution of the navigable waters **and ground waters** and improving the sanitary condition of surface and **underground waters**. In the development of such comprehensive programs due regard shall be given to the improvements which are necessary to conserve such waters for the protection and propagation of fish and aquatic life and wildlife, recreational purposes, and the **withdrawal of such waters for public water supply**, agricultural, industrial, and other purposes. For the purpose of this section, the Administrator is authorized to make joint investigations with any such agencies of the condition of any waters in any State or States, and of the discharges of any sewage, industrial wastes, or substance which may adversely affect such waters. (Emphasis added)

Further, Section 104(a)(5) of the CWA [33 U.S.C. 1254]) requires:

5) in cooperation with the States, and their political subdivisions, and other Federal agencies establish, equip, and maintain a water quality surveillance system for the purpose of monitoring the quality of the navigable waters **and ground waters** and the contiguous zone and the oceans and the Administrator shall, to the extent practicable, conduct such surveillance by utilizing the resources of the National Aeronautics and Space Administration, the National Oceanic and Atmospheric Administration, the United States Geological Survey, and the Coast Guard, **and shall report on such quality in the report required under subsection (a) of section 516; and [104(a)(5) amended by PL 102-285] (Emphasis added)**

Section 516 of the CWA requires U.S. EPA to provide a report to Congress on the quality of water, including groundwater. States are required to report biennially on the quality of water with an emphasis on navigable waters pursuant to Section 305(b) of the CWA, and compared to the objectives established in Section 304(a)(1) of the CWA. Section 304(a)(1)(A) of the CWA requires that water quality criteria developed must also consider pollutants that originate from groundwater:

> "The Administrator, after consultation with appropriate Federal and State agencies and other interested persons, shall develop and publish, within one year after the date of enactment of this title (and from time to time thereafter revise) criteria for water quality accurately reflecting the latest scientific knowledge (A) on the kind and extent of all identifiable effects on health and welfare including, but not limited to, plankton, fish, shellfish, wildlife, plant life, shore lines, beaches, esthetics, and recreation which may be expected from the presence of pollutants in any body of water, **including ground water**…"

Thus, for these reasons, and the hydrologic connection between groundwater and surface water, that the Illinois EPA has established an integrated monitoring strategy, and includes a volume in our Section 305(b) Report on ambient groundwater monitoring results.

Illinois reports the resource quality of its waters in terms of the degree to which the beneficial uses[1] of those waters are attained and the reasons (causes and sources) beneficial uses may not be attained. In addition, states are required to provide an assessment of the water quality of all publicly owned lakes, including the status and trends of such water quality as specified in Section 314(a)(1) of the CWA.

Section 303(d) of the CWA and corresponding regulations in Title 40 of the Code of Federal Regulations, require states to:

- Identify water quality-limited waters where effluent limitations and other pollution control requirements are not sufficient to implement any water quality standard;
- Identify pollutants causing or expected to cause water quality standards violations in those waters;
- Establish a priority ranking for the development of Total Maximum Daily Load[2] (TMDL) calculations including waters targeted for TMDL development within the next two years; and,
- Establish TMDLs for all pollutants preventing or expected to prevent the attainment of water quality standards.

This list of water quality limited waters is often called the 303(d) List.

To the extent possible, this 2014 Illinois Integrated Report is based on USEPA's *Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act* issued July 29, 2005 and additional guidance contained in USEPA memorandums from the Office of Wetlands, Oceans and Watersheds regarding Clean Water Act Sections 303(d), 305(b), and 314 Integrated Reporting and Listing Decisions.

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[1] Beneficial uses, also called designated uses, are discussed in more detail in Section B-2 Groundwater Protection Programs, Illinois Groundwater Quality Standards.

[2] Total Maximum Daily Load calculations determine the amount of a pollutant a water body can assimilate without exceeding the state's water quality standards or impairing the water body's designated uses.

A-2. Changes from the 2012 Report Methodology and Format

As stated above, the 2012 Integrated Report was divided into two volumes: Volume I covering surface water quality and Volume II assessing groundwater quality. This was done to accommodate the increased size of the Integrated Report, which has been greatly expanded to include more water quality information. This two volume format also improves the organizational structure of the report and makes it easier for the reader to find the specific information that may be of concern.

In all other aspects, the Illinois EPA is using the same methodology and format in 2014 as was completed in 2012 with no significant changes.

PART B: BACKGROUND INFORMATION

B-1. Total Waters

There are approximately 5,200 groundwater-dependent public water supplies in the state, of which 1,171 are community water supplies (including direct users and purchase systems), see Table B-1. In addition, the Illinois Department of Public Health (IDPH) estimates approximately 400,000 residences of the state are served by private wells. This equates to approximately 30 percent of the population in the state that utilize groundwater as their primary source of drinking water. To assess the groundwater resources of the state, the Illinois EPA utilizes three primary aquifer classes that were developed by O'Hearn and Schock (1984). These three principal aquifers are sand and gravel, shallow bedrock and deep bedrock aquifers. O'Hearn and Schock defined a principal aquifer as having a potential yield of 100,000 gallons per day per square mile and having an area of at least 50 miles. Approximately 58 percent (32,000 square miles) of the state is underlain by principal aquifers. Of these, about 33 percent (18,500 square miles) are major shallow groundwater sources. The following are numbers of CWS wells that withdraw from these aquifers: Out of 3,393 active CWS wells, 46 percent (1,557) utilize sand and gravel aquifers; 21 percent (723) utilize a shallow bedrock aquifer; 24 percent (804) utilize a deep bedrock aquifer, 5 percent (171) utilize a combination of two or more aquifers (mixed) and 4 percent (138) are undetermined.

Table B-1. Illinois Atlas.

Topic	Value	Scale	Source
State Population in year 2012 (estimate)	12,875,255		US Census Bureau
State Surface Area (sq. mi.)	57,918		US Census Bureau
Active CWS Facilities	1,747	N/A	SDWIS
Surface Facilities	85	N/A	SDWIS
Groundwater Facilities	984	N/A	SDWIS
Mixed Facilities	8	N/A	SDWIS
Surface Purchase Facilities	475	N/A	SDWIS
Groundwater Purchase Facilities	187	N/A	SDWIS
Active CWS Wells	3,393	N/A	SDWIS
Confined Wells	2,209	N/A	SDWIS
Unconfined Wells	1,184	N/A	SDWIS

SDWIS = Safe Drinking Water Information System

B-2. Groundwater Protection Programs

Illinois Groundwater Quality Standards

Since the inception of the Illinois Environmental Protection Act (Act) (415 ILCS 5) in 1970, it has been the policy of the State of Illinois to restore, protect, and enhance the groundwater of the State as a natural and public resource. Establishment of comprehensive groundwater quality standards is a critical component of Illinois' groundwater protection program. To this end, the Illinois EPA established the Groundwater Quality Standards (35.Ill.Adm.Code 620). For a detailed explanation and listing of Illinois' Groundwater Quality Standards (GWQS), see the Illinois Pollution Control Board's (Board) webpage at: http://www.ipcb.state.il.us. Further, Section 12(a) of the Act [415 ILCS 5/12(a)] also applies to groundwater.

Groundwater Management Zone

Within any class of groundwater, a groundwater management zone may be established as a three dimensional region containing groundwater being managed to mitigate impairment caused by the release of contaminants from a site: that is subject to a corrective action process approved by the Illinois EPA; or for which the owner or operator undertakes an adequate corrective action in a timely and appropriate manner.

Groundwater Protection

For a full description of Illinois' groundwater protection programs see the Illinois Groundwater Protection Act Biennial Report at: http://www.epa.state.il.us/water/groundwater/groundwater-protection/index.html or contact the Groundwater Section at 217/785-4787 for more information.

B-3. Cost/Benefit Assessment

Section 305(b) requires the state to report on the economic and social costs and benefits necessary to achieve Clean Water Act objectives. Information on costs associated with water quality improvements is complex, and not readily available for developing a complete cost/benefit assessment. The individual program costs of pollution control activities in Illinois, the general surface water quality improvements made, and the average groundwater protection program costs follow.

Cost of Pollution Control and Groundwater/Source Water Protection Activities

The Illinois EPA Bureau of Water distributed a total of $239.3 million in loans during 2010 for construction of municipal wastewater treatment facilities. Other Water Pollution Control program and Groundwater/Source Water Protection costs for Bureau of Water activities conducted in 2010 are summarized in Table B-2.

Table B-2. Water Pollution Control Program Costs for the Illinois Environmental

Activity	**Total**
Monitoring	$5,414,600
Planning	$1,537,200
Point Source Control Programs	$14,346,900
Nonpoint Source Control Programs	$9,705,300
Groundwater/Source-Water Protection	$2,096,300
Total	$33,100,300

Groundwater Improvements

Protecting and managing groundwater is critical. Groundwater is an important natural resource that not only provides Illinois' citizens water for drinking and household uses, but also supports industrial, agricultural, and commercial activities throughout the state.

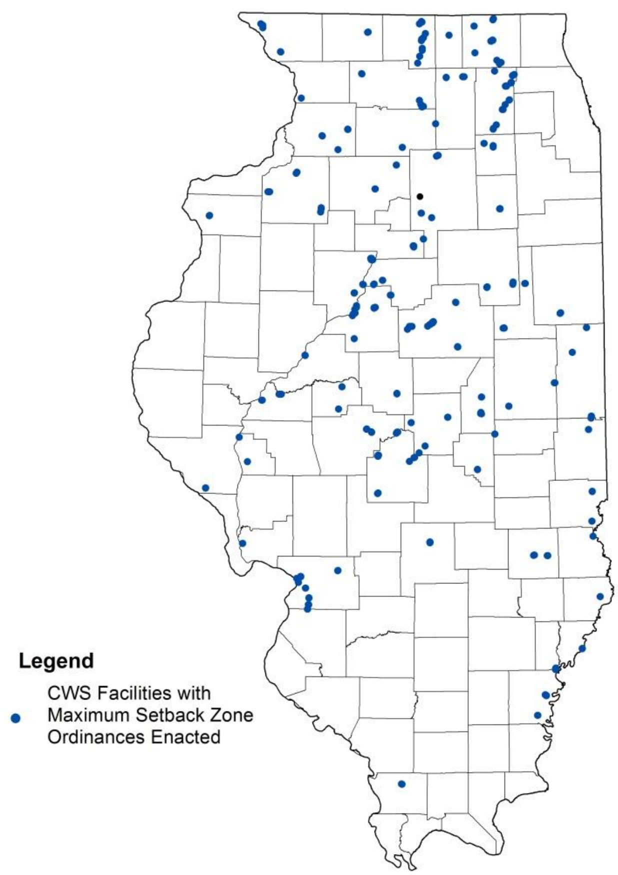
Unfortunately, industrial, agricultural and commercial activities can often produce VOCs. They are usually produced in large volumes and are associated with products such as plastics, adhesives, paints, gasoline, fumigants, refrigerants, and dry-cleaning fluids. They can reach groundwater through many sources and routes, including leaking storage tanks, landfills, infiltration of urban runoff and wastewater, septic systems, and injection through wells. Volatile organic compounds are an important group of environmental contaminants to monitor and manage in groundwater because of their widespread and long-term use, as well as their ability to persist and migrate in groundwater. Further analysis of VOC detections in CWS wells are provided in Section C-6 of this Integrated Report.

The Illinois EPA and IDPH continue to promote the "Safe Well Water Initiative" to increase awareness of private well owners in Illinois of the need to have regular testing for VOCs that potentially may have historically contaminated groundwater sources. The primary purpose of this effort is to ensure that citizens across our state who obtain drinking water from an estimated 400,000 private wells do not have a potential health risk from contamination. As part of this initiative, the Illinois EPA has posted several helpful documents on our Website, http://www.epa.state.il.us/community-relations/fact-sheets/safe-water-wells/index.html, including instructions on private well testing, laboratories accredited to analyze water samples for VOCs, links to fact sheets regarding potential health effects from exposure to specific VOCs, and information on Illinois' Right To Know (RTK) Laws that keep the public informed about their public and private drinking water sources

Maximum setback zones are used to expand protection to a CWS well and lower potential for groundwater contamination. Maximum setback zone protection is becoming increasingly important because of RTK legislation. Due to the increasing trend of VOC contamination, the voluntary wellhead protection approach pays off, and costly, unneeded expenses may be avoided with additional protection. The Illinois EPA and Illinois Rural Water Association have provided maximum setback zone educational information during CWS site visits and at professional conventions.

The locations of the CWSs that have adopted maximum setback zones are shown in Figure B-1. A total of 119 CWS with a total of 380 active wells have maximum setback zone protection. During this two-year reporting period the communities of Assumption, Earlville, Hoopeston, La Salle, Toluca, Tonica, and Wenona have pursued adopting maximum setback zones for 22 CWS wells. Furthermore, the communities of Albion, Collinsville, Lake in the Hills, Newton, and Virginia added 16 new wells to existing Maximum Setback Zone Ordinances. It should also be noted that the Fayette Water Company adopted maximum setback zones through the Illinois Pollution Control Board for six CWS wells.

Figure B-1. Maximum Setback Zones Adopted



For a detailed discussion of groundwater protection improvements, please refer to the recently published Interagency Coordinating Committee on Groundwater Biennial Comprehensive Status and Self-Assessment Report on Illinois Groundwater Protection Program at: http://www.epa.state.il.us/water/groundwater/groundwater-protection/index.html.

PART C: GROUNDWATER MONITORING AND ASSESSMENT

C-1.   Resource-Quality Monitoring Program

Hydrologic Background

To assess the groundwater resources of the state, the Illinois EPA utilizes three primary aquifer classes (O'Hearn and Schock, 1984). These three "principal aquifers" are sand and gravel, shallow bedrock and deep bedrock aquifers, as illustrated in figures C-1 thru C-3. A principal aquifer is defined as having a potential yield of 100,000 gallons per day per square mile and having an area of at least 50 miles.

Figure C-1. Principal Sand and Gravel Aquifers in Illinois

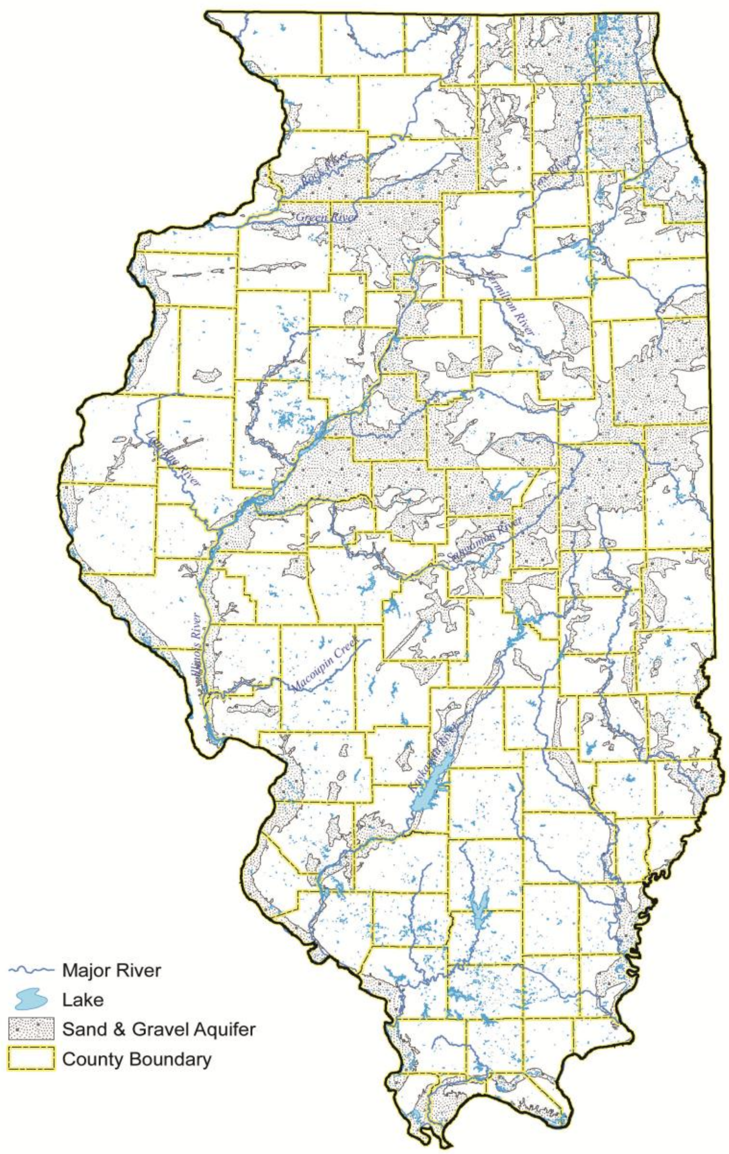


Figure C-2. Principal Shallow Bedrock Aquifers in Illinois

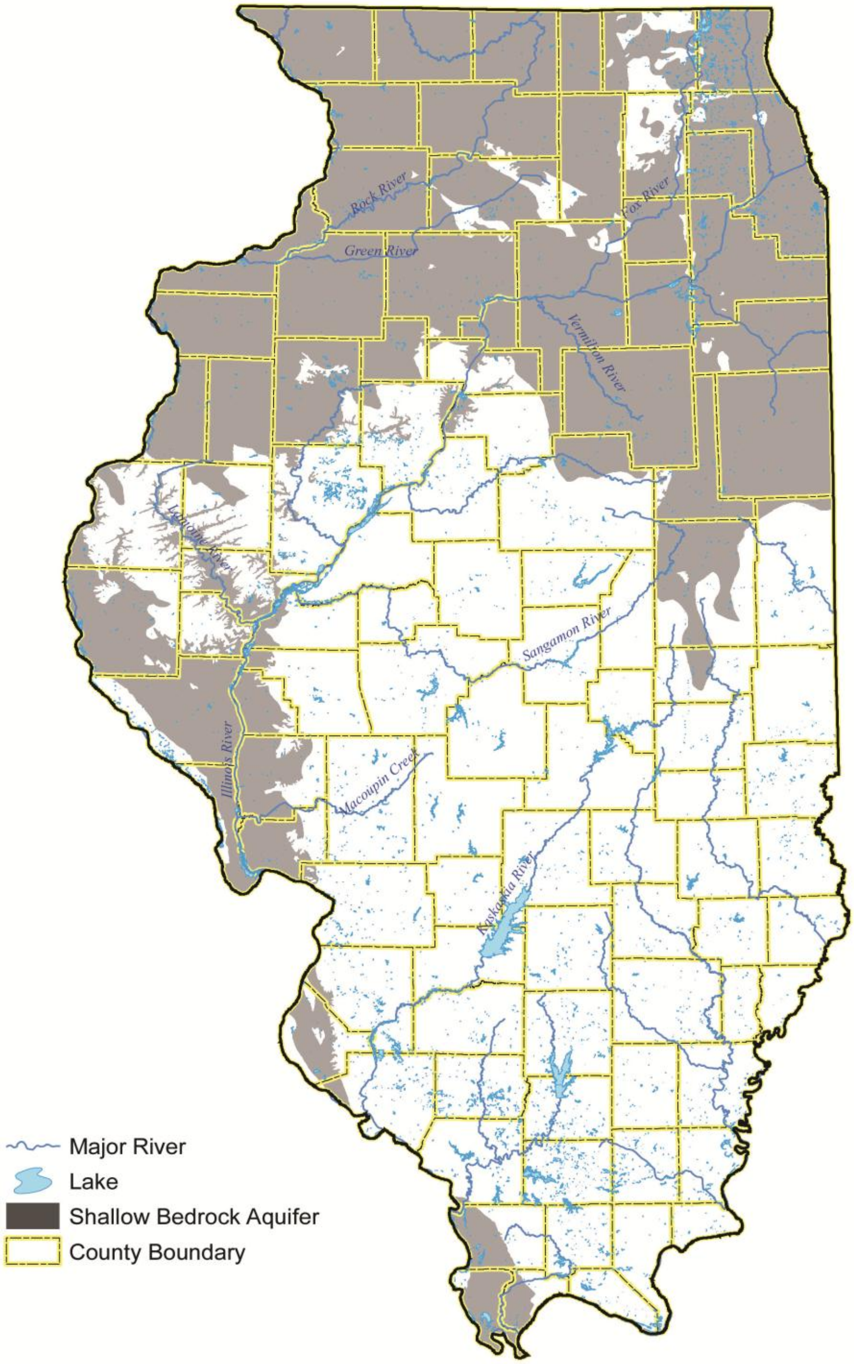
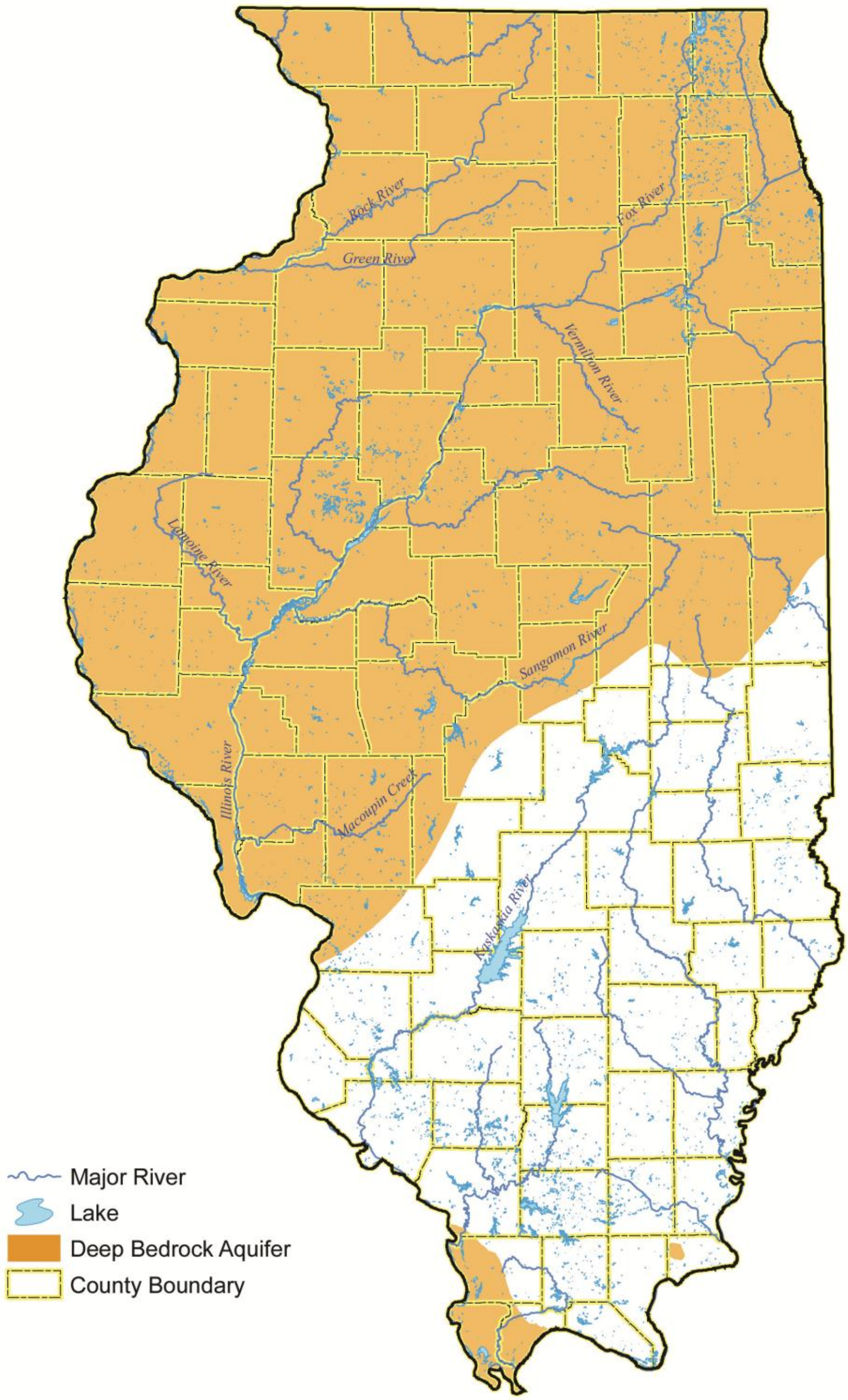


Figure C-3. Principal Deep Bedrock Aquifers in Illinois



Water resource availability can be expressed in a number of ways. In the groundwater field, the term "potential yield" or "safe yield" is often used. Potential aquifer yield is the maximum amount of groundwater that can be continuously withdrawn from a reasonable number of wells and well fields without creating critically low water levels or exceeding recharge (Wehrmann, et. al., 2003). Statewide estimates of groundwater availability, based on aquifer potential yield estimates, were developed in the late 1960s (Illinois Technical Advisory Committee on Water Resources, ITACWR, 1967). The ITACWR report presented maps of the estimated potential yields, expressed as recharge rates in gallons per day per square mile (gpd/mi^2), of the principal sand and gravel and shallow bedrock aquifers of Illinois. For reference, a recharge rate of 100,000 gpd/mi^2 is equal to 2.1 inches/year (Wehrmann, et. al., 2003).

The 1967 ITACWR report stated the following:

- The potential yield of the [sic] principal sand and gravel and bedrock aquifers in Illinois are estimated to be 4.8 and 2.5 billion gallons per day (bgd), respectively;
- The total groundwater potential in Illinois based on full development of either sand and gravel or bedrock aquifers, whichever has the higher recharge rate, is estimated to be 7.0 bgd;
- Principal sand and gravel aquifers underlie only about 25 percent of the total land area in Illinois;
- About 3.1 bgd, or about 65 percent of the total potential yield of the principal sand and gravel aquifers in the state, is concentrated in less than 6 percent of the total land area in Illinois and is located in alluvial deposits that lie directly adjacent to major rivers such as the Mississippi, Illinois, Ohio, and Wabash;
- About 0.5 bgd, or about 10 percent of the total potential sand and gravel yield is from the principal sand and gravel aquifers in the major bedrock valleys of the buried Mahomet Valley in east-central Illinois and in the river valleys of the Kaskaskia, Little Wabash, and Embarras Rivers in southern Illinois;
- Of the total estimated yield of bedrock aquifers in the State, 1.7 bgd, or 68 percent, is available from the shallow bedrock aquifers, mainly dolomites in the Northern third of the State;
- The potential yield of the shallow dolomite varies. In areas where the more permeable shallow dolomites lie directly beneath the glacial drift, the potential yield ranges from 100,000 to 200,000 gpd/mi^2;
- In areas where less permeable dolomites lie directly beneath the drift or are overlain by thin beds of less permeable rocks of Pennsylvanian age, the potential yield ranges from 50,000 to 100, 000 gpd/mi^2; and
- Where the overlying Pennsylvanian rocks are thick, the potential yield is less than 50,000 gpd/mi^2.

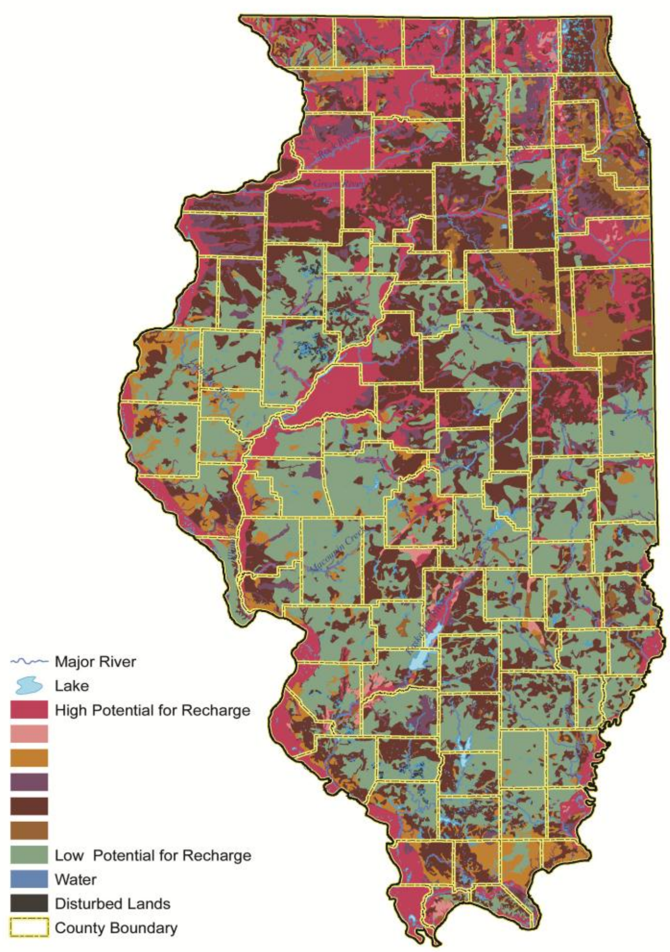
Future groundwater shortages are predicted in Northeastern Illinois (Meyer, Roadcap, et. al., 2009). In addition, although shortages are not predicted, the Mahomet Aquifer in Champaign/ Urbana shows significant drawn down trends (Roadcap, and Wehrmann, 2009 and MAC, 2009). Approximately 58 percent (32,000 square miles) of the state is underlain by principal aquifers; of these, about 33 percent (18,500 square miles) are shallow groundwater sources. The following are numbers of community water supply wells that withdraw from these aquifers:

Out of 3,393 active CWS wells:

- 46 percent (1,557) utilize a sand and gravel aquifer;
- 21 percent (723) utilize a shallow bedrock aquifer;
- 24 percent (804) utilize a deep bedrock aquifer;
- 5 percent (171) utilize a combination of two or more aquifers (mixed)
- 4 percent (138) are undetermined.

There are approximately 5,200 groundwater-dependent public water supplies in the state, of which 1,171 utilize CWS (including direct users and purchase systems). In addition, the Illinois Department of Public Health estimates approximately 400,000 residences of the state are served by private wells[3].

Figure C-4. Potential for Aquifer Recharge in Illinois



Water that moves into the saturated zone and flows downward, away from the water table is recharge. Generally, only a portion of recharge will reach an aquifer. The overall recharge rate is affected by several factors, including intensity and amount of precipitation, surface evaporation, vegetative cover, plant water demand, land use, soil moisture content, depth and shape of the water table, distance and direction to a stream or river, and hydraulic conductivity of soil and geologic materials (Walton, 1965).

Figure C-4 illustrates the potential for aquifer recharge, defined as the probability of precipitation reaching the uppermost aquifer. The map is based on a simplified function of depth to the aquifer, occurrence of major aquifers, and the potential infiltration rate of the soil. This simplification assumes that recharge rates are primarily a function of leakage from an overlying aquitard (fine

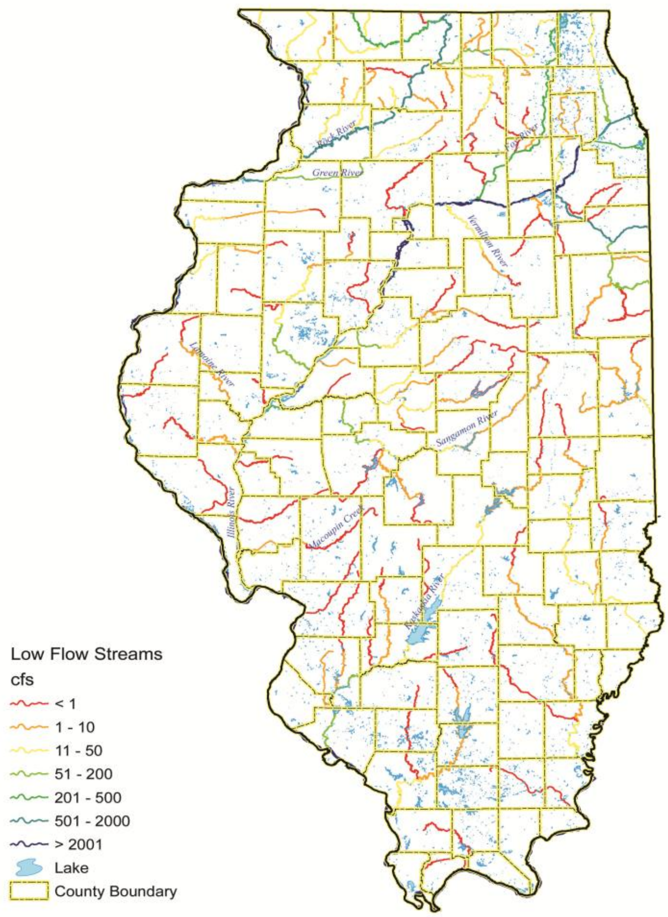
[3] "Private Water System" means any supply which provides water for drinking, culinary, and sanitary purposes and serves an owner-occupied single family dwelling. (Section 9(a)(5) of the Illinois Groundwater Protection Act [415 ILCS 55/9(a)(5)])

grained non-aquifer materials). Moreover, recharge may also be occurring from outside of a watershed boundary. Additionally, pumping stresses from potable water supply wells located adjacent to watershed boundaries may change the natural groundwater flow directions. Therefore, aquifer boundaries may not be consistent with surface watershed boundaries. Additional and more detailed information is available via Illinois EPA's Environmental Facts Online (ENFO): http://www.epa.state.il.us/enfo/.

Groundwater contribution to stream flow in the form of base flow was analyzed for 78 drainage basins in Illinois (O'Hearn and Gibb, 1980). This study determined that median base flow per square mile of drainage area generally increases from the Southwest to the Northeast at all three flow durations. Figure C-5 shows the three-year low flow streams. This provides a good indictor of groundwater base flow in surface water.

Increased withdrawal of groundwater is having a direct impact on surface water quantity. Groundwater modeling studies conducted in Kane County show that as of 2003 stream flow capture by groundwater pumping had reduced natural groundwater discharge to streams in and near Kane County by about 17 percent (Meyer, Roadcap, et. al., 2009).

Figure C-5. Three-Year Low Flow Streams in Illinois



Illinois Groundwater Monitoring Network

Section 13.1 of the Act (415 ILCS 5/13.1) requires the Illinois EPA to implement a groundwater monitoring network to assess current levels of contamination in groundwater and to detect future degradation of groundwater resources. Further, Section 7 of the IGPA (415 ILCS 55/7) requires the establishment of a statewide ambient groundwater monitoring network comprised of CWS wells, non-community water supply wells, private wells, and dedicated monitoring wells. The Interagency Coordinating Committee on Groundwater (ICCG) serves as a groundwater monitoring coordinating council. The following provides a summary of the Illinois EPA's network of CWS wells.

Prototype Ambient Groundwater Monitoring

The collection of high quality chemical data is essential in assessing groundwater protection efforts. In 1984, the Illinois State Water Task Force published a groundwater protection strategy. This strategy lead to the addition of Section 13.1 to the Act (415 ILCS 5/13.1) which required the Illinois EPA to develop and implement a Groundwater Protection Plan and to initiate a statewide groundwater-monitoring network. In response to these requirements, the Illinois EPA and the United States Geological Survey (USGS) Illinois District Office, located in Urbana, IL. began a cooperative effort to implement a pilot groundwater monitoring network (i.e., ambient monitoring network) in 1984 (Voelker, 1986). The CWS well ambient network design started with pilot efforts in 1984, moved to implementation of the Illinois State Water Survey (ISWS) network design (O'Hearn, M. and S. Schock. 1984) for several years, and was followed by sampling all of Illinois' CWS wells (3,000+) (Voelker, 1988 and 1989).

The prototype monitoring efforts included development of quality assurance and field sampling methods. Illinois EPA's quality assurance and field sampling methods, originally developed in 1984 in cooperation with the USGS, were compiled into a field manual in 1985 (Cobb and Sinnott, 1987, and Barcelona, 1985). This manual has since been revised many times to include quality improvements. Monitoring at all stations sampled by Illinois EPA is completed by using Hydrolab® samplers to insure that in-situ groundwater conditions are reached prior to sampling. Water quality parameters include: field temperature, field specific conductance, field pH, field pumping rate, inorganic chemical (IOC) analysis, synthetic organic compound (SOC), and VOC analysis. All laboratory analytical procedures are documented in the Illinois EPA Laboratories Manual.

In the year 2000, the Illinois EPA tasked the USGS to conduct a yearlong independent evaluation of our groundwater quality sampling methodology. The USGS concluded that Illinois EPA sampling program (sampling methodology guidelines, water quality meter calibration, and sampling performance) is considered to provide samples representative of aquifer water quality. Only minor revisions to the sampling program were suggested (Mills and Terrio, 2003). In addition, Illinois EPA also participates in the annual USGS National Field Quality-Assurance Program.

Coordinated Ambient Monitoring

From the experience gained from these prototype networks, implemented pursuant to Section 13.1 of the Act, Illinois EPA designed a probabilistic monitoring network of CWS wells (Gibbons 1995). The design of this network was completed in coordination with the USGS, the Illinois State Geological Survey (ISGS), and the ISWS, with USGS performing the detailed design. The goal of the network is to represent contamination levels in the population of all active CWS wells. The network wells were selected by a random stratified probability-based approach using a 95 percent confidence level (CWS Probabilistic Monitoring Network). This results in an associated plus or minus 5 percent precision and accuracy level. Further, the random selection of the CWS wells was stratified by depth, aquifer type and the presence of aquifer material within 50 feet of land surface to improve precision and accuracy. Illinois EPA used geological well log records and construction log detail to perform this process.

The random stratified selection process included nearly 3,000 CWS wells resulting in 354 fixed monitoring locations, see Figure C-6. Additionally, in order to prevent spatial or temporal bias 17 random groups of 21 wells, with alternates, were selected from all the 354 fixed station wells. To further assure maximum temporal randomization within practical constraints, the samples from each sample period are collected within a three-week timeframe.

This probabilistic network is designed to provide an overview of the groundwater conditions in the CWS wells; provide an overview of the groundwater conditions in the principal aquifers (e.g., sand and gravel, Silurian, Cambrian-Ordovician, etc.,); establish baselines of water quality within the principle aquifers; identify trends in groundwater quality in the principal aquifers; and evaluate the long-term effectiveness of the IGPA, CWA and Safe Drinking Water Act (SDWA) program activities in protecting groundwater in Illinois. Illinois EPA has also developed an integrated surface and groundwater monitoring strategy. This "Water Monitoring Strategy, 2007-2012" document identifies the data collection programs, and their associated goals and objectives, that will be carried out by Illinois EPA, see: http://www.epa.state.il.us/water/water-quality/monitoring-strategy/2007-2012/index.html. Figure C-7 shows the Probabilistic Groundwater Monitoring Network wells integrated with the surface water monitoring stations.

During the 1997 monitoring cycle, Illinois EPA initiated a rotating monitoring network of CWS wells. Illinois EPA rotates every two years from the probabilistic (fixed station) network to special intensive or regional studies. For this reporting period, the Groundwater Section has evaluated monitoring results from the 2010 and 2012 probabilistic monitoring network of CWS wells.

Beginning in 2007, Illinois EPA began requiring sampling at all wells on a monthly basis for total coliform bacteria in preparation of the Groundwater Rule. By December 1, 2009, all groundwater-dependent CWSs were required to comply with this regulation. The benefit of this monitoring is two-fold: (1) this data have identified wells at risk which, in most cases, has led to mitigation efforts; and (2) this approach has allowed Illinois EPA to compare source water monitoring for bacterial contaminants as an additional criteria for predicting the likelihood of attaining full use support in the major aquifers in Illinois.

Figure C-6. Active Community Water Supply Wells and Community Water Supply Probabilistic Network Wells

All CWS Wells in Illinois | **CWS Probabilistic Network Wells in Illinois**

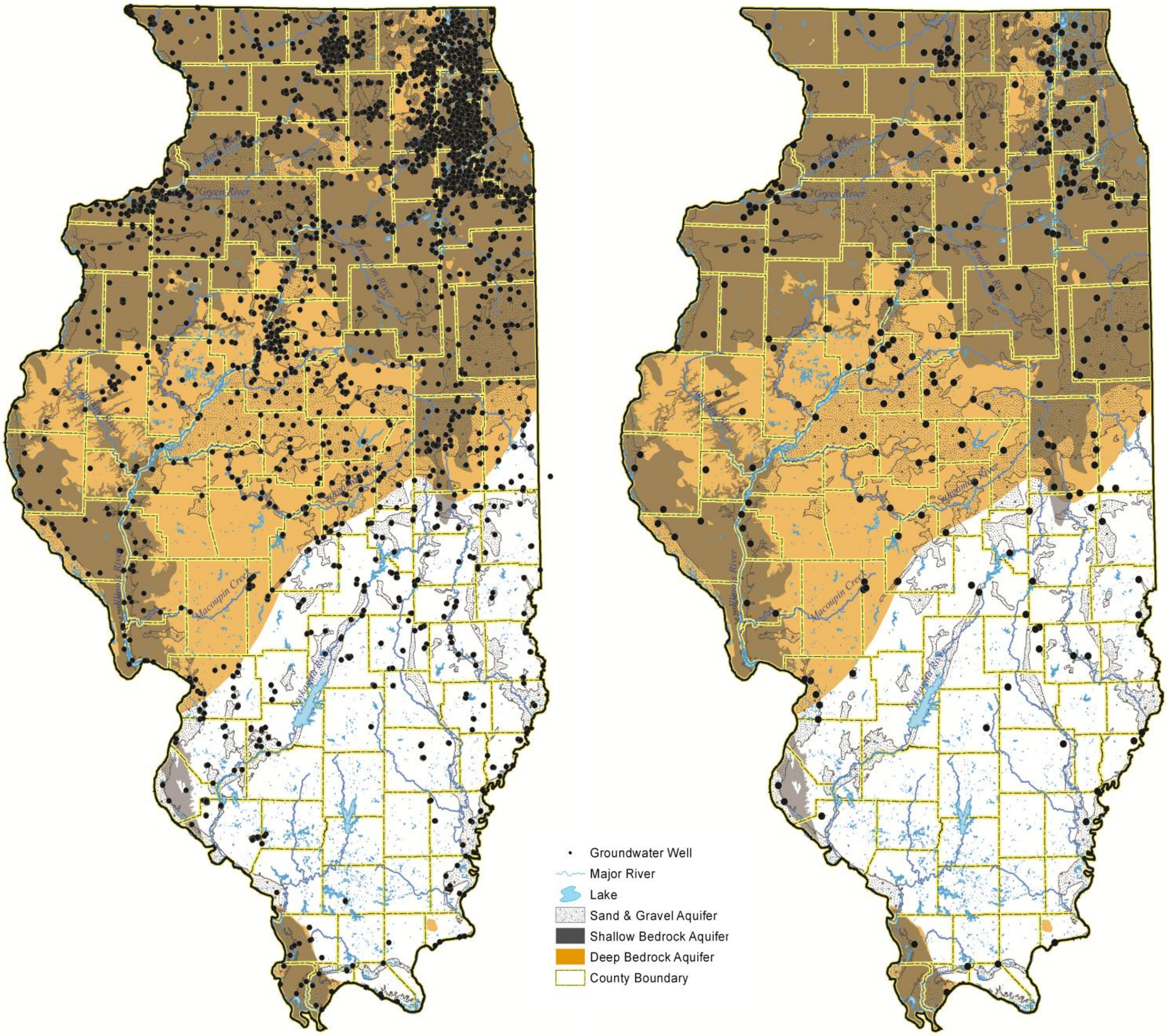
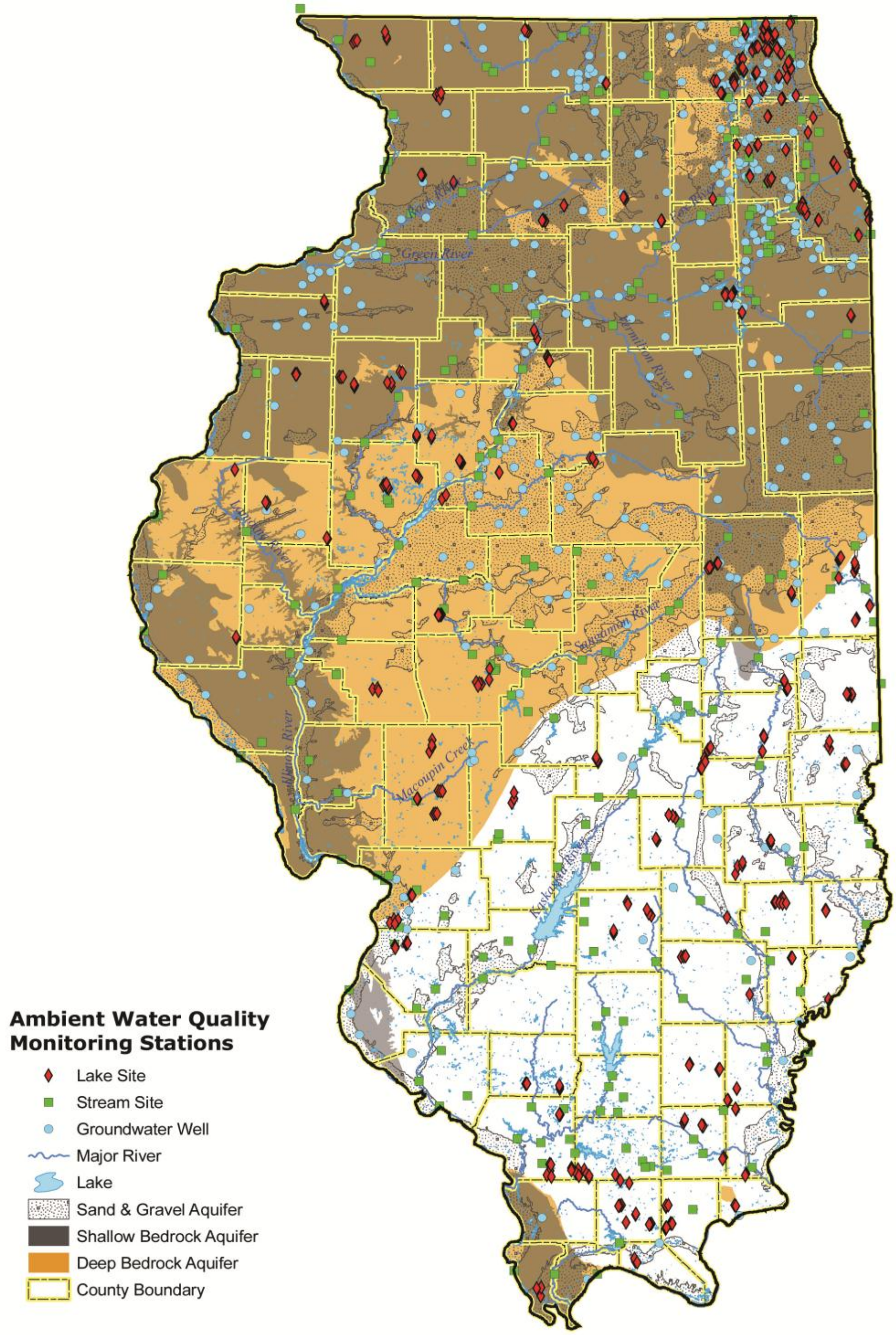


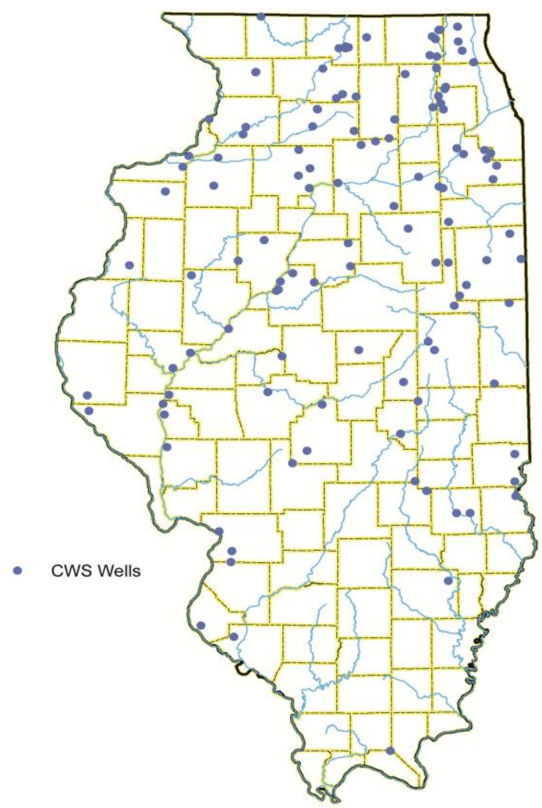
Figure C-7. Illinois EPA's integrated surface and groundwater monitoring network sites



In a cooperative study with the USGS, the Illinois EPA has developed a statistically designed network to sample for chromium-6 and total chromium at:

- 119 wells at CWSs using groundwater (Figure C-8);
- 32 intakes at community water systems (CWSs) using surface water;
- At the entry point to the distribution system for the CWSs using surface water; and
- Locations within the distribution system for the CWSs using surface water.

Figure C-8. CWS Wells in the 2013 Chromium-6 Network



For the study, the USGS has initiated a subcontract with Underwriters Laboratories (UL) to analyze samples for chromium-6 and total chromium. UL is one of only a few laboratories in the country that is able to achieve a detection limit of 0.02 parts per billion (ppb) for chromium-6 and 0.1 ppb for total chromium. All chromium-6 samples will be analyzed within twenty four hours of collection by Illinois EPA staff. The Illinois EPA staff, in cooperation with the USGS and UL labs, have planned the logistics and trained on proper quality assurance/control for sample collection and transportation. Sample collection is currently beginning (January 2013). In the initial assessment, contaminant concentration by source-water type and location will be summarized and evaluated with respect to various quality assurance considerations. Results will be presented in a short web based USGS Fact Sheet or other USGS interpretative report, depending on the nature of the data, in the fall of 2014.

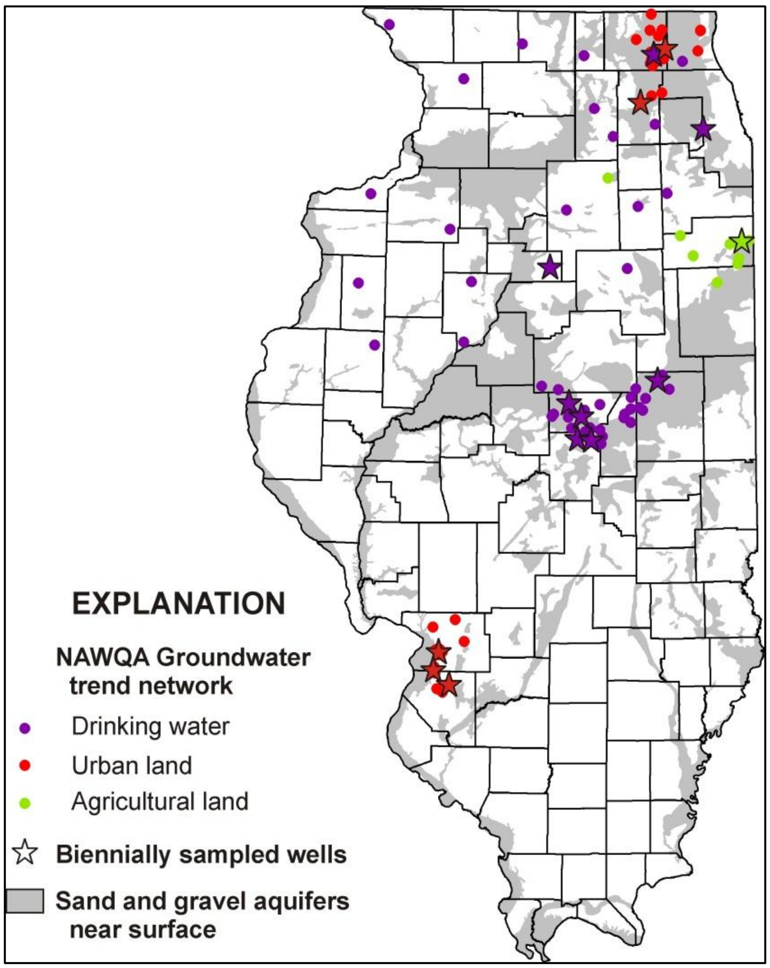
As previously stated, the IGPA required the establishment of a statewide ambient groundwater monitoring network coordinated by the ICCG, and comprised of CWS wells; non-CWS[4] wells; private wells; and dedicated monitoring wells. Illinois also used a statistically-based approach for designing: a pilot rural private well monitoring network (Schock and Mehnert, 1992, and Goetsch et.al., 1992) and the Illinois Department of Agriculture (IDA) dedicated pesticide monitoring well network (Mehnert et al. 2005). The ICCG continues to coordinate with the USGS on groundwater monitoring studies occurring within Illinois, as described in: http://www.epa.state.il.us/water/tmdl/303-appendix/2008/2008-final-draft-303d.pdf.

[4] "Non-Community Water System" means a public water system which is not a community water system, and has at least 15 service connections used by nonresidents, or regularly serves 25 or more nonresident individuals daily for at least 60 days per year. (Section 9(a)(4) of the Illinois Groundwater Protection Act [415 ILCS 55/9(a)(4)]).

Dedicated Monitoring Well Network for Illinois Generic Management Plan for Pesticides in Groundwater – The IDA is the state lead agency for the regulation of pesticide use in Illinois. The IDA is responsible for managing pesticide use to prevent adverse effects to human health and the environment. Illinois, like many states, is voluntarily implementing the U.S. EPA-recommended provisions of pesticide management plans to protect groundwater. In June 2000, under the leadership of the IDA, the Pesticide Subcommittee of the ICCG approved the *Illinois Generic Management Plan for Pesticides in Groundwater* (IDA, 2000). The management plan, which was revised in 2006, describes the framework to be used by the State of Illinois for addressing the risks of groundwater contamination by pesticides. Background information on the history of the management plan, including the development and design of a dedicated groundwater monitoring well network can be found at:
http://www.epa.state.il.us/water/groundwater/groundwater-protection/index.html

USGS Illinois River Basin National Water Quality Studies – As part of the National Water Quality Assessment (NAWQA) program, the USGS is assessing both the Lower and Upper Illinois River Basins (LIRB and UIRB, respectively), see Figure C-9. A summary report of the LIRB activities through 1998 is available, see USGS Circular 1209; a similar summary of the UIRB activities through 2001 is also available, see USGS Circular 1230. Water quality and water-level data continues to be collected.

Figure C-9. U.S. Geological Survey NAWQA Water-Quality Network Wells



In 2010, the 30-well network in an urban land-use study area near Chicago was sampled for a large suite of pesticides, trace elements, and VOCs. In 2012, a 30-well network in the agricultural land-use study area near Kankakee was sampled for a similar suite of constituents. The wells are mostly monitoring wells in the shallow aquifer system. In years when the full network of wells (approximately 30 wells) are not sampled, then a subset of five wells are re-sampled for assessing changes and trends (biennial samples).

Every year since 2005, water levels have been collected at all 111 wells that are part of the NAWQA trends network (table below). The Cambrian-Ordovician network was initiated in 2007 and water levels have been collected every year since it was initiated. The sampling plans for the NAWQA networks in Illinois are summarized in Table C-1, below.

Table C-1. NAWQA Networks Sampling Plans

Area of Illinois	Principal aquifer	Network type	Number Of Active Wells	Initial Network Sample	Decadal Network Sample	Biennial Sampling (5-well subset of full network)
Lower Illinois River Basin	glacial aquifer system	urban land use	26	2005	2015	2013, 2011, 2009, 2007
Lower Illinois River Basin	glacial aquifer system	drinking water resource	30	1996	2007	2013, 2011, 2009, 2005, 2002
Upper Illinois River Basin	Cambrian-Ordovician	drinking water resource	31	2007	2017	2013, 2011, 2009
Upper Illinois River Basin	glacial aquifer system	urban land use	26	2000	2010	2013, 2011, 2009, 2007, 2005, 2003
Upper Illinois River Basin	glacial aquifer system	agricultural land use	29	1999	2012	2013, 2011, 2009, 2007, 2005, 2003

The data are available in the NAWQA data warehouse Web site that provides for data delivery and mapping http://infotrek.er.usgs.gov/traverse/f?p=NAWQA:HOME:0. Additionally, the data is being summarized by principal aquifer, such as the glacial aquifer system, and water-quality data from over 150 wells in the UIRB and LIRB are included in this regional synthesis. Reports and interactive maps of the regional data, including Illinois data, can be found at: http://water.usgs.gov/nawqa/studies/praq/.

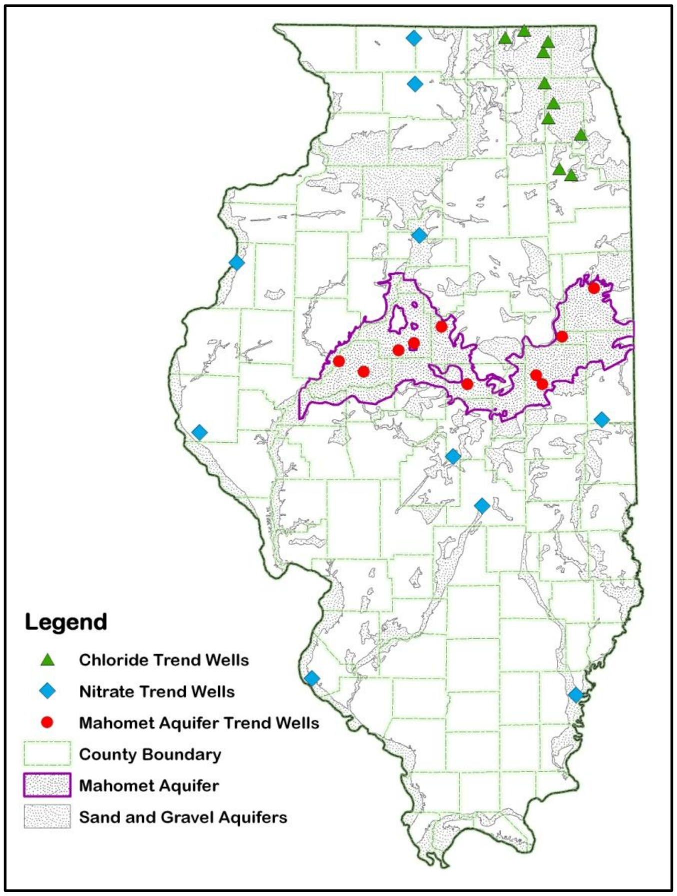
Illinois EPA Trend Monitoring Network

For the calendar year 2011, the Illinois EPA developed an inorganic chemical (IOC) Trend Monitoring Network consisting of three trend subsets with ten wells within each group **(**see Figure C-10**)**. The 30 CWS wells were selected from the Probabilistic Sampling Network which provided wells with a history of IOC results. The subsets include Nitrate Trend wells, Chloride Trend wells, and Mahomet Aquifer Trend wells. Each well was sampled once every two months at approximately the same time of the month to maintain an even temporal interval between sampling events. When available, the static and pumping water levels were obtained. The groundwater monitoring data was analyzed to determine if there were any fluctuations in the water chemistry during the next reporting period.

The *Nitrate Trend* wells are distributed throughout the state and are largely situated within sand and gravel aquifers that are more susceptible to nonpoint source contamination. These wells were selected based upon their history of nitrate detections which ranged from an average concentration of 4-11 mg/L (milligrams per liter). A majority of the wells selected for the Nitrate Trend network are located within or directly adjacent to agricultural fields and are less than 100 feet in depth.

The *Chloride Trend* wells are all concentrated in Northeastern Illinois, including, Cook, DuPage, Kane, McHenry, and Will Counties. This part of the state has been experiencing increasing levels of chloride concentrations in the past 50 years possibly related to runoff from increased use of road salt. The shallow aquifers of the region are vulnerable to surface-derived contaminants, and the increase in developed land may be increasing the rate at which groundwater quality is being degraded. According to research completed by the ISWS, approximately 16 percent of the samples collected from municipal wells in northeastern Illinois in the 1990s had chloride concentrations greater than 100 mg/L; median values were less than 10 mg/L prior to 1960, before extensive road salting (Kelly and Wilson, 2004). Wells indicating both a history of relative stable chloride levels and apparent increasing levels were selected. The sand and gravel and the shallow (Silurian) bedrock aquifers are represented.

Figure C-10. Illinois EPA 2011 Trend Monitoring Network



The *Mahomet Aquifer Trend* wells are a subset of wells selected as part of a pilot study for the National Groundwater Monitoring Network (NGWMN) of the Mahomet-Teays Aquifer. The NGWMN was proposed by the Subcommittee on Ground Water of the Federal Advisory Committee on Water Information with the goal to collect and to analyze data for present and long-term water quality management and implementation needs. The Mahomet Aquifer stretches across central Illinois and into western Indiana. These trend wells were initially chosen in conjunction with the ISWS as part of the NGWMN pilot study, and were added to the Illinois EPA 2011 Trend Network as continued support in cooperation with the Mahomet-Teays Aquifer study (Statement of Interest, NGWMN, 2009).

C-2. Assessment Methodology

Overall Use Support

Though there are many uses of groundwater in Illinois, the groundwater use assessments are based primarily upon CWS chemical monitoring analyses. The assessment of chemical monitoring data essentially relies on the Board's Class I: GWQS.

The fixed station Probabilistic Monitoring Network of CWS wells is utilized to predict the likelihood of attaining full use support in the major aquifers in Illinois. As previously described, the overall use support is based on compliance with Illinois' Class I GWQS. Class I standards include the nondegradation standards. The Probabilistic Network wells were also evaluated for total coliform bacteria monitoring as required by the Groundwater Rule. The attainment of use support is described as Full and Nonsupport, as described below:

Full Support
Good - indicates that no detections occurred in organic chemical monitoring data and inorganic constituents assessed were at or below background levels for the groundwater source being utilized.

Nonsupport
Fair - indicates that organic chemicals were detected and therefore exceed the nondegradation standard, but measured levels are less than the numerical Class I GWQS, and inorganic constituents assessed were above background level (nondegradation standard) but less than the numerical Class I GWQS.

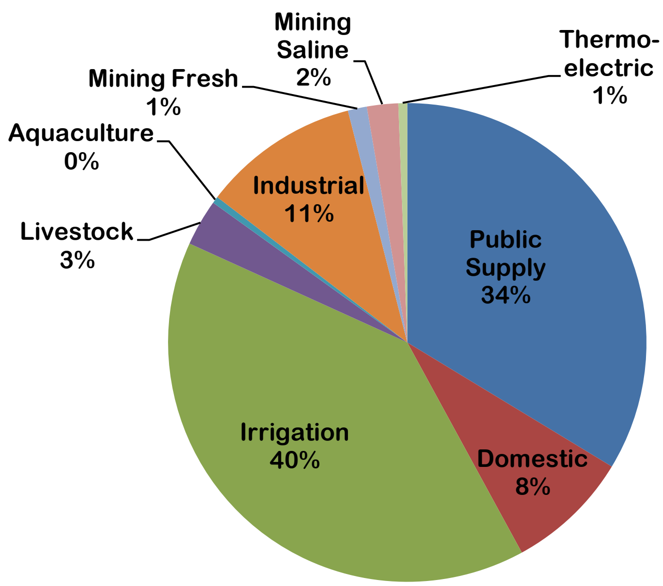
Poor - indicates that organic chemical monitoring data detections were greater than the Class I GWQS and inorganic chemicals assessed were greater than both the background concentration and Class I GWQS, or compliance issues related to bacterial contamination in the source water.

Organic results in the probabilistic network of CWS wells, which are commonly known to be anthropogenic in nature, were analyzed by well and year. It was determined that a detection of an organic contaminant would be recorded and not averaged. In this manor, the Illinois EPA is able to track the contamination and determine if a trend in that CWS well exists.

Individual Use Support

Groundwater in Illinois supports many uses. For over 50 years, the USGS has been collecting data on estimated water withdrawals by state, source of water, and category. (Note: data compilation for the report *Estimated Use of Water in the United States in 2010* had a delayed start in Fall 2011. Report completion and data availability is not expected until 2014). According to the USGS[5], the major uses of groundwater in Illinois are domestic, public water supply, agricultural, livestock, industrial, and thermoelectric.

Figure C-11. Groundwater Withdrawals in Illinois (USGS 2005)



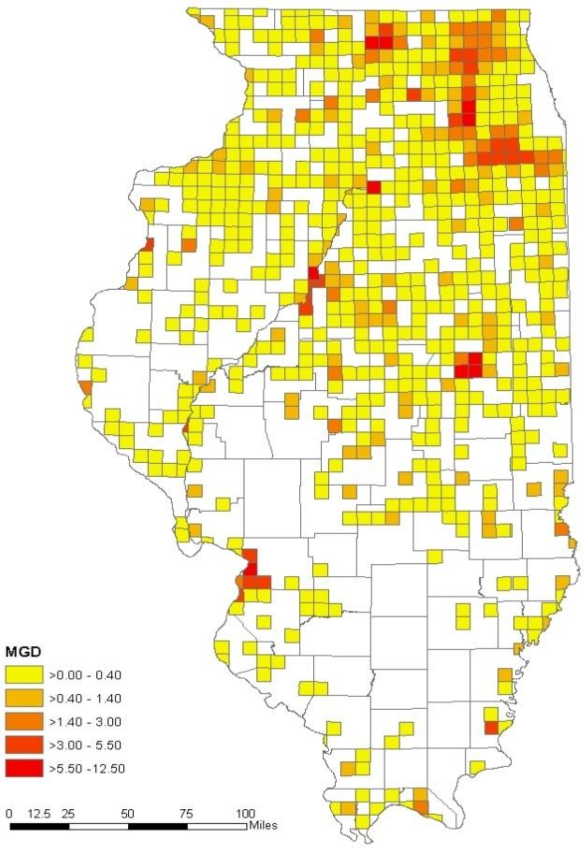
According to the USGS, Illinois uses approximately 15.2 billion gallons of fresh water per day. Only a small percentage – 1,210 million gallons per day (MGD), is from groundwater sources, as illustrated in Figure C-11. Irrigation uses most of the groundwater with over 479 MGD (40 percent), followed by Public Water Supplies use - 406 MGD (34 percent). Industrial (self-supplied) withdraws slightly more than 128 MGD (11 percent), followed by Domestic, which includes private well usage, 101 MGD (8 percent), and Livestock/ Aquaculture at 44 MGD (3 percent). Mining (both fresh and saline) accounts for 41 MGD (3 percent) and Thermoelectric sources withdraw the least amount with approximately 7 MGD (1 percent) of groundwater usage in the State.

In addition, since 1979 the ISWS has been conducting an annual survey of water useage in Illinois through their Illinois Water Inventory Program (IWIP). The survey is comprised of both surface and groundwater data, and is collected from both CWSs and self-supplied industrial-commercial facilities in Illinois. For purposes of this report, only the CWS groundwater data are used and are presented by township in MGD (Figure C-12). For additional information and a description of the IWIP Program view the ISWS website at http://www.isws.illinois.edu/gws/iwip/.

[5] Based on **USGS Circular 1344,** 2005, which can be found at http://pubs.usgs.gov/circ/1344/

As shown in Figure C-12, and described by Wehrmann (2003), the major withdrawals from sand and gravel aquifers can be seen in the Metro-East area of St. Louis and in Quincy along the Mississippi River; in the Peoria-Pekin area along the Illinois River, in the Fox River corridor in Northeastern Illinois, and in the Champaign area of east-central Illinois. Major withdrawals from the shallow bedrock aquifers can be clearly seen almost solely in Northeastern Illinois in southern Cook, Kankakee and Will Counties for communities such as Crest Hill, Lockport, Manteno, New Lenox, Park Forest, and Romeoville (Wehrmann, 2003). Major withdrawals from the deep bedrock aquifers are found spread across northern Illinois, particularly in the Rockford area of north-central Illinois, the Fox River corridor, and farther south in the area of Joliet and the I-55 industrial corridor near Channahon (Wehrmann, 2003).

Figure C-12. Groundwater withdrawals by public water systems in Illinois, by township (ISWS, 2010)



Groundwater contributes to stream flow in the form of base flow in many of these river corridors. Thus, stream flows may also be impacted in areas where the ratio of use-to-yield is greater than 0.9. This is especially true in Northeastern Illinois due to the following factors: Supreme Court limitations on Lake Michigan water withdrawals; continued population growth; and a deep aquifer condition beyond sustainable recharge. It is predicted that these factors will force an increased reliance on the use of the sand and gravel and shallow bedrock aquifer resources. These shallow aquifers are in direct hydraulic connection to surface waters. This can result in decreased base flow in area streams that may have an impact on surface water quality and stream habitat.

Some groundwater in Illinois has been designated as Class III "special resource." Special Resource Groundwater is described as the groundwater contributing to highly sensitive areas including dedicated nature preserves that supports ecologically sensitive areas such as the Parker Fen in McHenry County and the Southwest Sinkhole Karst Plain located in Monroe, St. Clair and Randolph Counties. For a complete list of currently adopted and proposed Class III Special Resource Groundwater designated areas of the state, see:
http://www.epa.state.il.us/water/groundwater/groundwater-protection/index.html

C-3. Potential Causes and Potential Sources of Impairment

Potential Causes of Impairment

As previously stated, when possible, assessments of overall groundwater use support is based upon application of Illinois' GWQS (including non-degradation standards) to water quality sample measurements from the probabilistic network of CWS wells. Generally, a detection of an organic contaminant above the laboratory practical quantification limit or the detection of an inorganic constituent above the naturally occurring background level, or bacterial contamination in a CWS well is considered a cause of less than full use support.

Potential Sources of Impairment

Illinois EPA utilized a database of potential sources that have been inventoried as part of well site surveys, hazard reviews, groundwater protection needs assessments, source water assessments, and other special field investigations to evaluate potential sources of contamination relative to CWS Wellhead Protection Areas (WHPAs). Further, the Illinois EPA relied on a Geographic Information System (GIS) to calculate land use activities proximate to the probabilistic network of CWS wells[6]. Table C-2 describes the most prevalent (common) potential sources of groundwater contamination in Illinois relative to CWS WHPAs.

[6] County by county land cover grid data for Illinois derived from Thematic Mapper (TM) Satellite data from the Landsat 4 sensor. Dates of the imagery used range from 1995 to 2002.

Table C-2. Most Prevalent Potential Sources of Ground Water Contamination[7]

Contaminant Sources	Occurrence of Potential Source[8]	Contaminants[9]
AGRICULTURAL ACTIVITIES		
Agricultural chemical facilities	587	A, B, E
Animal feedlots	66	E, J, K, L
Drainage wells	3	A, B, C, D
Fertilizer applications	323	A, B, E
Irrigation practices	63	A, B, E
Pesticide applications	174	A, B, E
STORAGE AND TREATMENT ACTIVITIES		
Land application	14	A, B, D, E, G, H, J
Material stockpiles	683	G, H
Storage tanks (above ground)	2,249	C, D
Storage tanks (underground)	2,878	C, D
Surface impoundments	236	E, G, H, J, K, L
Waste piles	231	E, G, H
Waste tailings	9	G, H, I, J
DISPOSAL ACTIVITIES		
Deep injection wells	9	A, B, C, D, E, F, G, H, I, M
Landfills	40	C, D, G, H, J
Septic systems	6,290	E, G, H, J, K, L
Shallow injection wells	9	A, B, C, D, E, F, G, H, J, K, L
OTHER		
Hazardous waste generators	-	A, B, C, D, G, H
Hazardous waste sites	97	A, B, C, D, G, H
Industrial facilities	1,565	A, B, C, D, G, H
Material transfer operations	232	A, B, C, D, E, F, G, H
Mining and mine drainage	19	G, H, M
Pipelines and sewer lines	111	C, D, E, G, H, J, K, L
Salt storage and road salting	76	G
Salt water intrusion	-	G
Spills	9	A, B, C, D, E, G, J
Transportation of materials	164	A, B, C, D, E
Manufacturing/repair shops	1,554	C, D, G, H
Urban runoff	1,184	A, B, D, E, G, H, J, K, L
Other sources (potential routes of contamination such as drainage wells, improperly abandoned potable water wells, or sand & gravel quarries)	249	A, B, D, E, J, K, L
FACILITY TREATMENT AND RECREATION		
Former storage facility	113	A, B, C, D, E, G, H
Commercial waste or chemical handling facility	1,078	C, D, E, G, J
Public utilities facility	203	E, F, G, H, J, K, L
Waste treatment facility	202	E, G, H, J, K, L
Recreational facility	581	J, L
Agriculture materials storage and sales	-	A, B, E, G, M

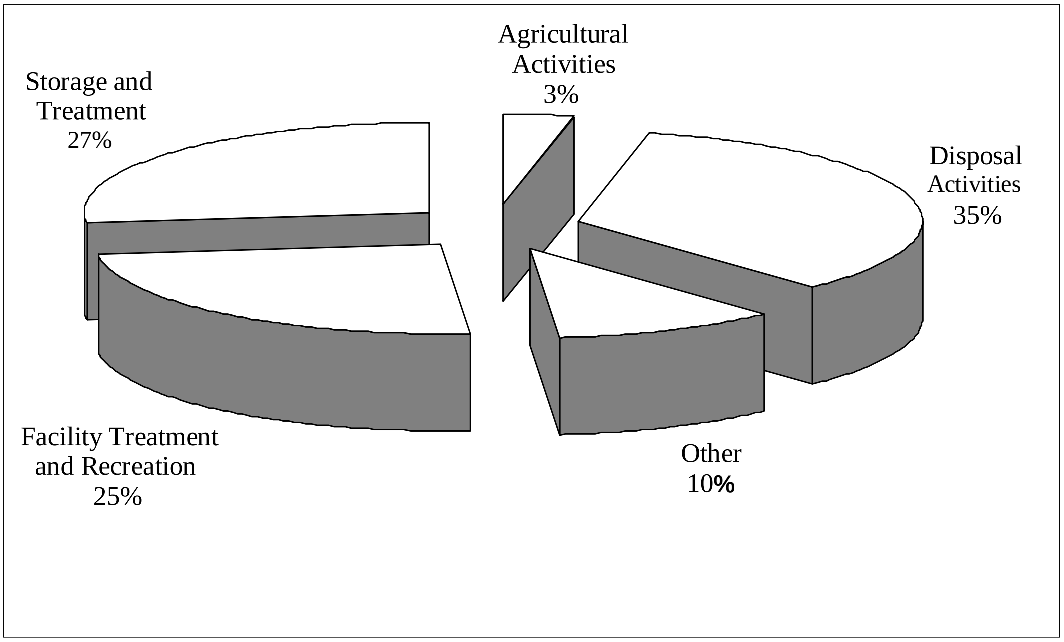
[7] The basis for the analysis provided in this table is a combination of existing monitoring data and potential source of groundwater contamination data from the completed CWS well site survey reports which Illinois EPA has conducted over the past 20 years.

[8] Occurrences are based solely on the Illinois EPA Groundwater Section's existing databases. This is only an estimate and should not be used as anything more than an approximation of potential sources of contamination to CWS wells in Illinois.

[9] Contaminants: A. Inorganic pesticides; B. Organic pesticides; C. Halogenated solvents; D. Petroleum compounds; E. Nitrate; F. Fluoride; G. Salinity/brine; H. Metals; I. Radio-nuclides; J. Bacteria; K. Protozoa; L. Viruses; and M. Other.

The Illinois EPA identified 16,354 potential sources of groundwater contamination of which 1,163 are considered threatening. Figure C-13 shows the most threatening potential contamination sources associated with CWS wells with VOC detects. The most prevalent potential source category was land disposal activities (2,953 sites) and the most threatening potential source category was chemical/petroleum processing/storage facilities (255 sites).

Figure C-13. Most Threatening Potential Contamination Sources in Community Water Supply Wells with VOC detections



In addition, ISWS research on CWS wells in Northeastern Illinois has determined that road salting is the most threatening potential source causing and contributing to chloride contamination above background levels in this part of the state. Approximately 16 percent of the samples collected from CWS wells in Northeastern Illinois during the 1990s had chloride concentrations greater than 100 mg/L. However, prior to 1960 – before extensive road salting practices, the median values of groundwater samples collected from Northeastern Illinois were less than 10 mg/L (Kelly and Wilson, 2004). The 75^{th} quartile value of the sand and gravel CWS probabilistic network wells in Northeastern Illinois show a 35 percent increase in chloride concentration compared to the state wide ambient value of CWS wells in the network.

C-4. Monitoring Results

Illinois Department of Agriculture Dedicated Pesticide Monitoring Well Network Results

Results of the most recent sampling period (132 samples collected from October 2008 through September 2010) indicate that parent pesticides were detected in ten of the samples (7.9 percent). Atrazine was detected in five samples, metolachlor was detected in three samples, and acetochlor and simazine were each detected in one sample. Three of those samples had concentrations above levels of concern. One or more of the atrazine degradation products was present above the minimum reporting level in 19.0 percent of the samples. One or more of the metabolites of the chloroacetanlide herbicides was detected in 53.8 percent of the samples. None of those samples had concentrations above levels of concern. For a detailed discussion of the IDA's dedicated pesticide monitoring well network results see: http://www.epa.state.il.us/water/tmdl/303-appendix/2008/2008-final-draft-303d.pdf.

CWS Probabilistic Monitoring Network Results

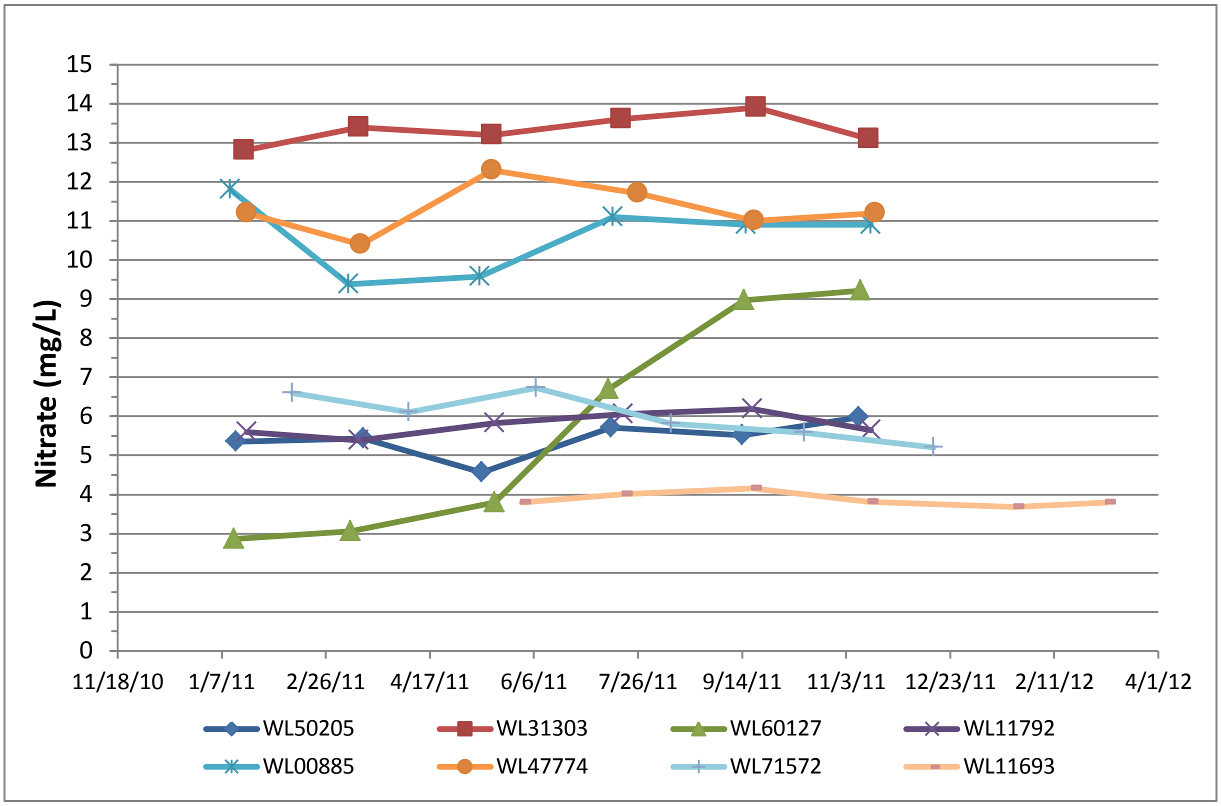
Statistics have a critical role in determining environmental impacts to groundwater quality, especially with respect to IOCs. The problem is technically interesting: given a new measurement for a well in the network, drilled in a particular aquifer, and analyzed for a particular substance, what is the probability that the measurement represents an effect of an unnatural source (Gibbons, 1995). Thus, this becomes a problem of statistical prediction. Given a collection of historical or background measurements for a substance, what limit or interval will contain the new measurement with a desired level of confidence? The wells in the CWS probabilistic network are not necessarily located in areas geographically removed from potential sources of contamination, as described above (Gibbons, 1995).

As stated earlier in this report, the *Nitrate Trend* wells are distributed throughout the state and are largely situated within sand and gravel aquifers that are more susceptible to nonpoint source contamination. These wells were selected based upon their history of nitrate detections which ranged from an average concentration of 4-11 mg/L (milligrams-per-liter).

As Figure C-14 indicates, most of the sampling of the nitrate network spanned from January thru November of 2011. Some sampling of network wells were started later, one in February and one as late as June of that year. An important objective of the network was to collect six samples over the course of a year, one every two months, so all sampling events were considered valid for this network.

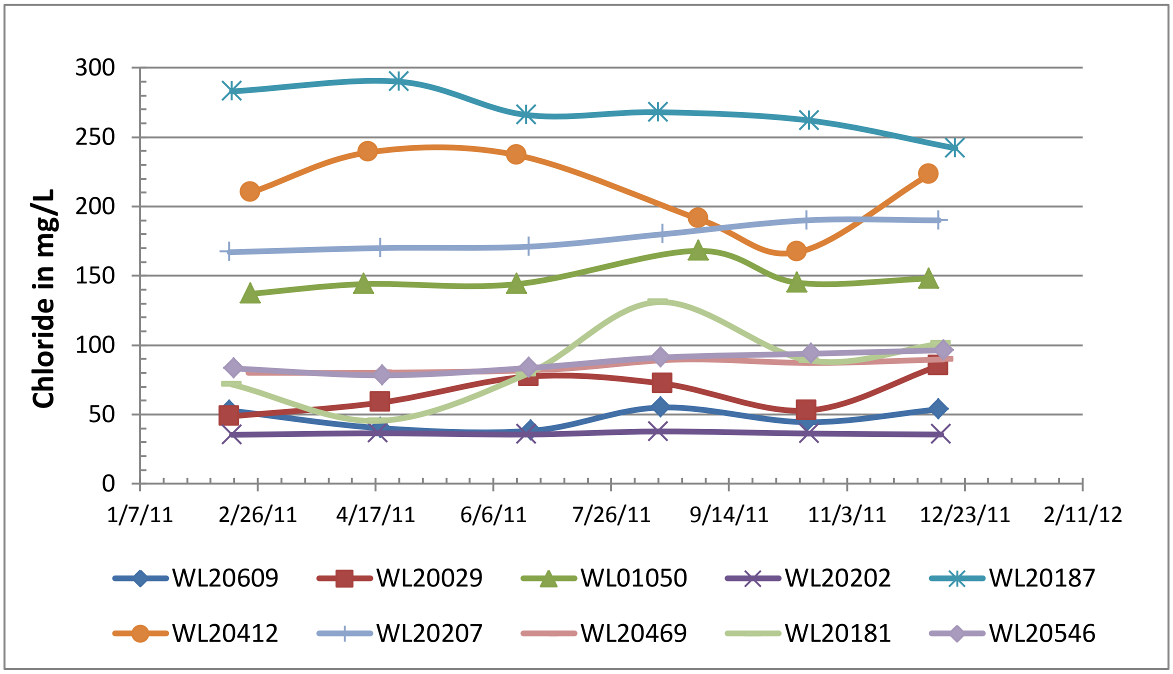
The concentrations of nitrate found in a majority of trend wells remained the same for the calendar year of 2011, in general fluctuating one or two milligrams-per-liter throughout the overall sampling cycle. The exception to these overall trends was well WL60127 which is displayed in Figure C-14 as a green line. The data show a slight increase of nitrate in the first two sample periods which jump a full five milligrams-per-liter in the subsequent two sample periods with it leveling out at approximately nine milligrams-per-liter. This data set seems to show an increasing trend of nitrate that may due to a point source within the immediate capture zone of this well.

Figure C-14. Results from Illinois EPA 2011 Nitrate Trend Monitoring



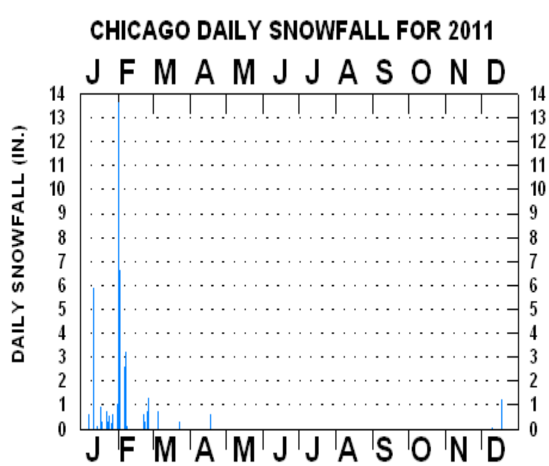
The *Chloride Trend* wells are all concentrated in Northeastern Illinois, including, Cook, DuPage, Kane, McHenry, and Will Counties. Wells indicating both a history of relative stable chloride levels and apparent increasing levels were selected. The sand and gravel and the shallow (Silurian) bedrock aquifers are represented. Figure C-15 show the results in the Chloride Trend wells, like the Nitrate Trend wells, show little variability over all. Most of the concentrations of chloride in the wells fluctuate only 50 milligrams-per-liter throughout the full cycle of the network and several of these fluctuations are both increasing and decreasing.

Figure C-15. Results from Illinois EPA 2011 Chloride Trend Monitoring Network



One possible explaination for the lack of an observable chloride trend is that the winter of 2011 was mild in the Midwest, with only one big storm across the region in early February of that year as shown in Figure C-16 (ClimateStations.com, 2013). The graph reflects this storm as a spike on the first or second day of February which is when a large snowstorm hit the Chicagoland Area dropping 16-18 inches. Approximately half of the wells display a slight increase of chloride concentration after this weather event with the other half of wells showing no trend at all (Figure C-15). The study does show that the existing chlorides in the aquifer remain consistent with two wells above the groundwater standard of 200 milligrams-per-liter.

Figure C-16. Graph depicting the daily snowfall for Chicago during 2011

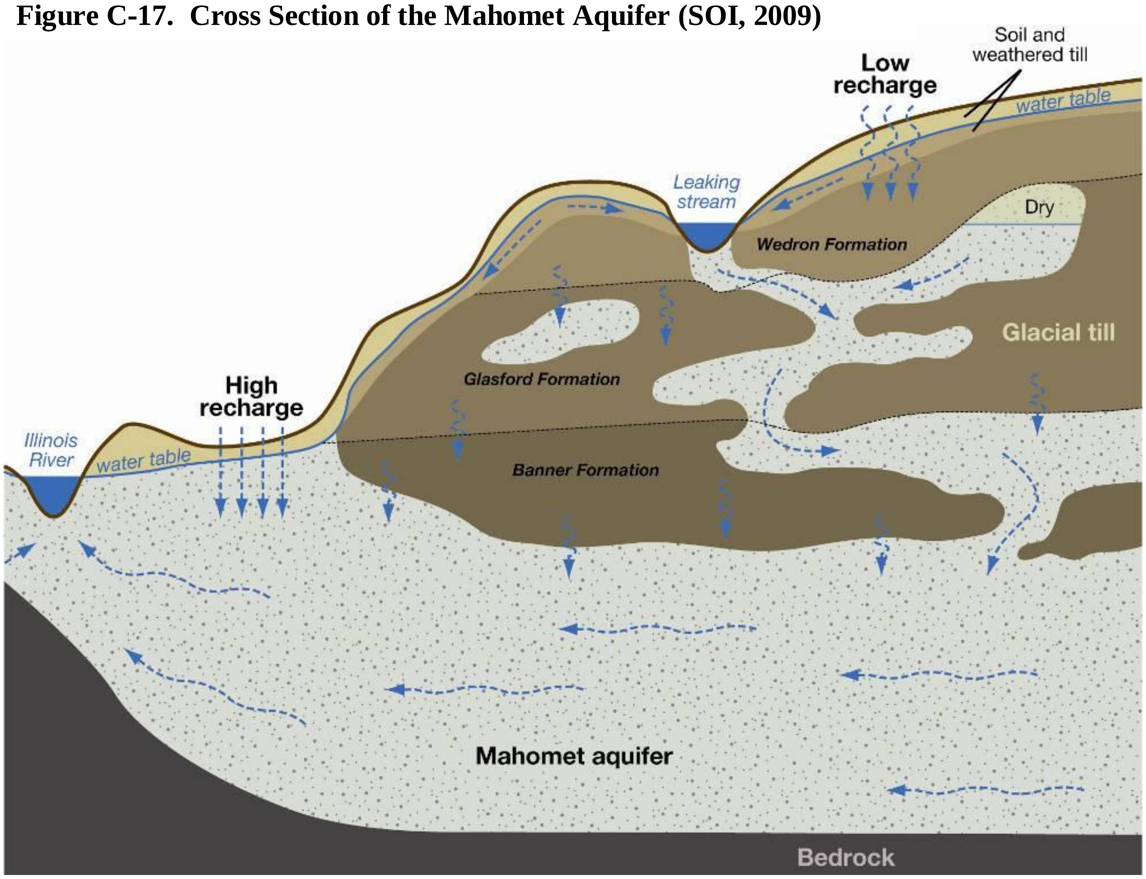


Both the Nitrate and the Chloride Networks could have been extended to the following year to get a full 12 months of data, but it is believed that the results of both networks would have not drastically changed with the addition of the extra months' worth of data.

The Mahomet Aquifer

Illinois EPA completed a focused evaluation the CWS probabilistic network wells screened in the Mahomet Aquifer. The aquifer occupies a portion of the Teays Bedrock Valley extending across east-central Illinois from the Indiana border near Hoopeston to the Illinois River. The Mahomet Aquifer is comprised of various unconsolidated geologic materials as illustrated in the following conceptual model of the hydrogeology (Figure C-17)

Figure C-17. Cross Section of the Mahomet Aquifer (SOI, 2009)

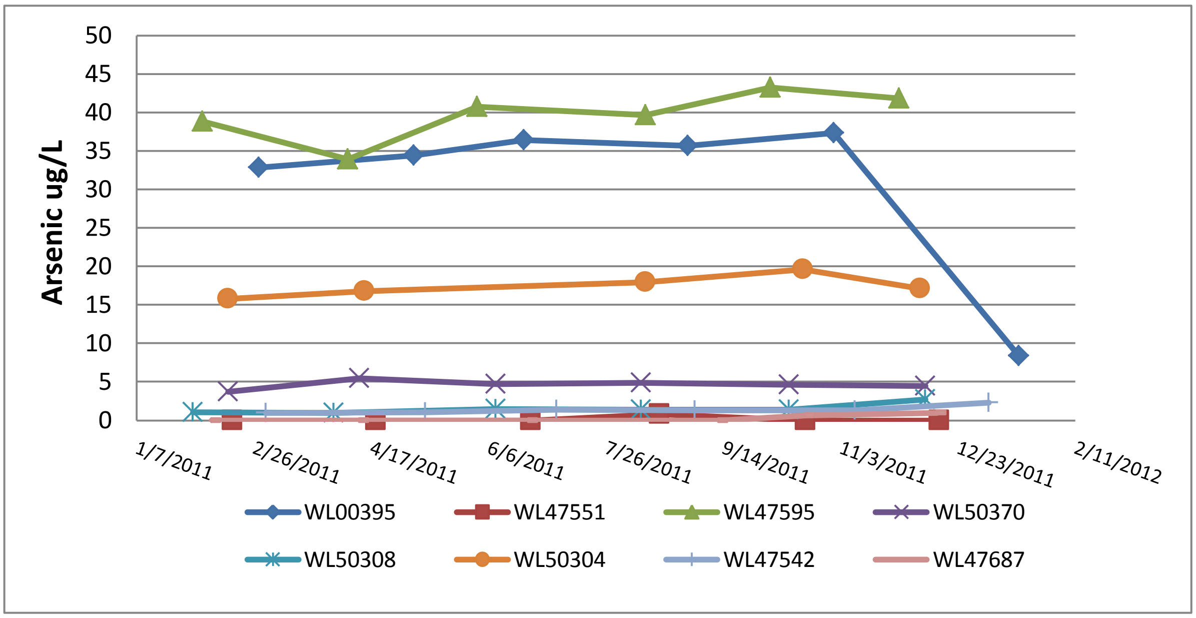


Arsenic is a naturally occurring inorganic compound that has been the subject of numerous research projects and investigations in the Mahomet Aquifer. The concentration of arsenic and several other inorganic compounds present in the CWS probabilistic network wells screened in different hydrogeologic units in the Mahomet-Teays Bedrock Valley were evaluated in Vollume II of the 2012 Integrated Report, see http://www.epa.state.il.us/water/tmdl/303-appendix/2012/iwq-report-ground-water.pdf

For puposes of the 2014 report, the *Mahomet Aquifer Trend* wells, which were originally selected as part of the aforementioned pilot study, and consist of a subset of the Ambient Network wells, were sampled as continued support in cooperation with the Mahomet-Teays Aquifer study.

Arsenic, as stated above, has been the subject of numerous studies in this aquifer and will be the focus of our Trend Network evaluation. As illustrated in Figure C-18, the overall trend for arsenic in the network wells show little variation over the year. The levels stay witin 10 milligrams-per-liter over the six sample periods of 2011 as Figure C-18 shows.

Figure C-18. Results from Illinois EPA 2011 Mahomet Aquifer Trend Monitoring Network



While the majority of the arsenic data show little variation WL00395 does show an interesting drop of arsenic concentration within the winter of 2011. Further evaluation of the arsenic levels in this well (12 sampling events from 1999 to present) show that this drop in arsenic levels has happened twice. These anomilies are not well understood as is the overall occurance and mobility of arsenic in groundwater. For more information on the Mahomet Aquifer and arsenic levels in the aquifer visit the *Mahomet Aquifer Consortium* at http://www.mahometaquiferconsortium.org/ or the *Illinois State Water Survey* at http://www.isws.illinois.edu/gws/archive/arsenic/ilsources.asp

C-5. Use Support Evaluation

Figure C-19 and C-20 summarize use support in the State of Illinois as determined by measurements in the probabilistic network of CWS wells. The results show that of the 357 CWS probabilistic network wells this cycle:

39 (11 percent) were determined to be Not Supporting ("poor") due to the elevated levels of nitrate and chloride (Cl-) over the Groundwater Quality Standard (GWQS) of 10 mg/L and 200 mg/L, respectively, or bacterial contaminantion of the source water;
44 (12 percent) were determined to be Not Supporting ("fair") due to statistically significant increases chloride (Cl-) above background, detections of VOCs, nitrate (total nitrogen) greater than 3 mg/L, but have not exceeded the health-based GWQS; and
274 (77 percent) were determined to be Fully Supporting ("good"), which show no detections over background levels of any of the above analytes.

Figure C-19. 2014 Use Support in CWS Network

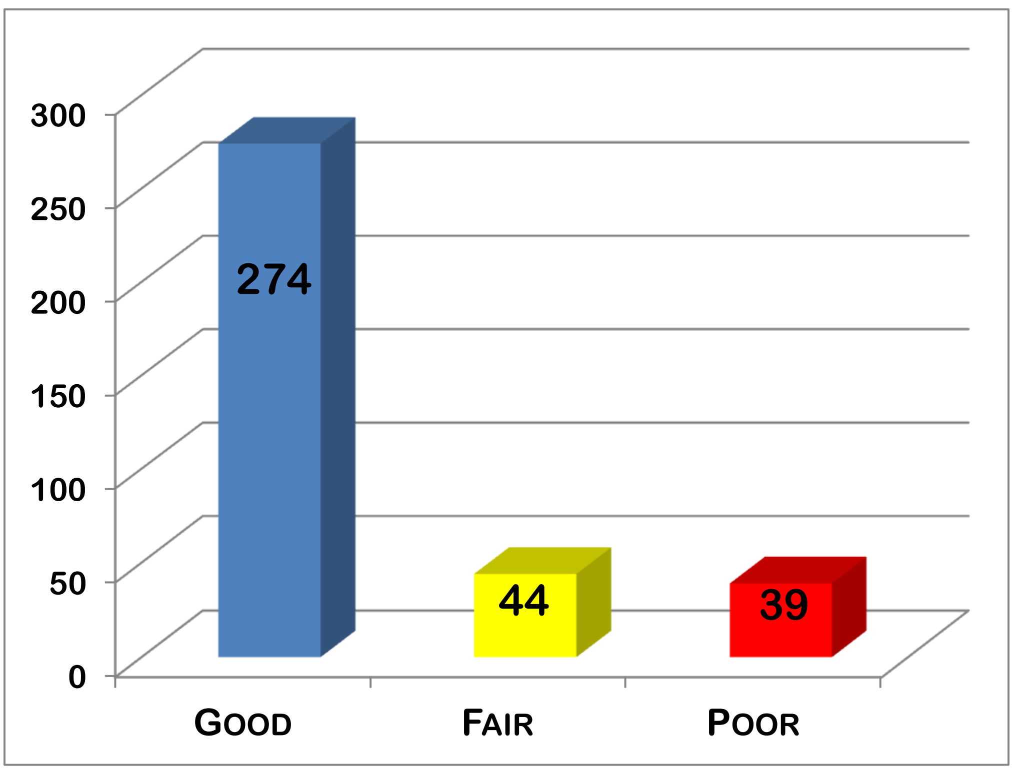
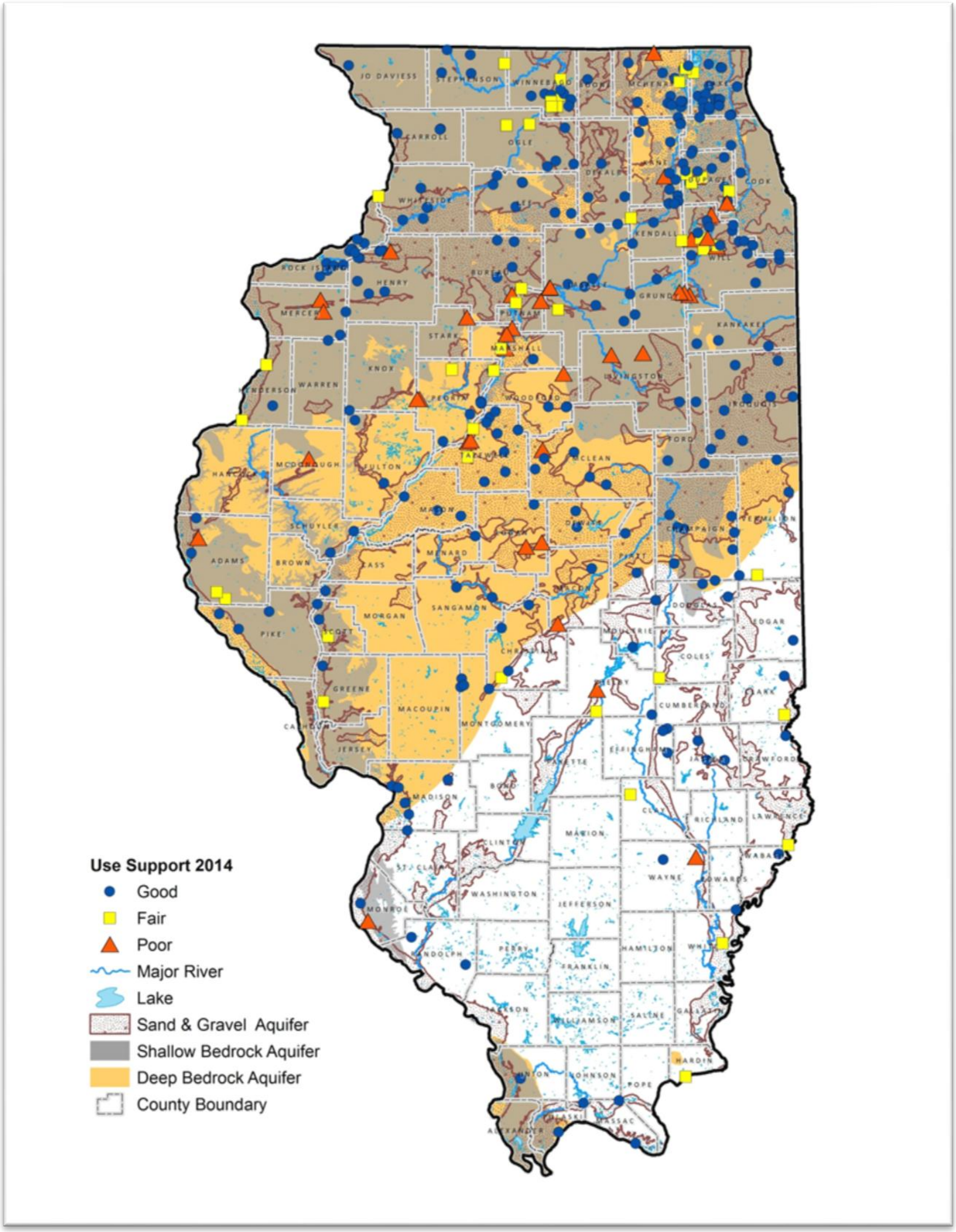


Figure C-20. Use Support for the CWS Ambient Network Wells within Illinois' Principal Aquifers

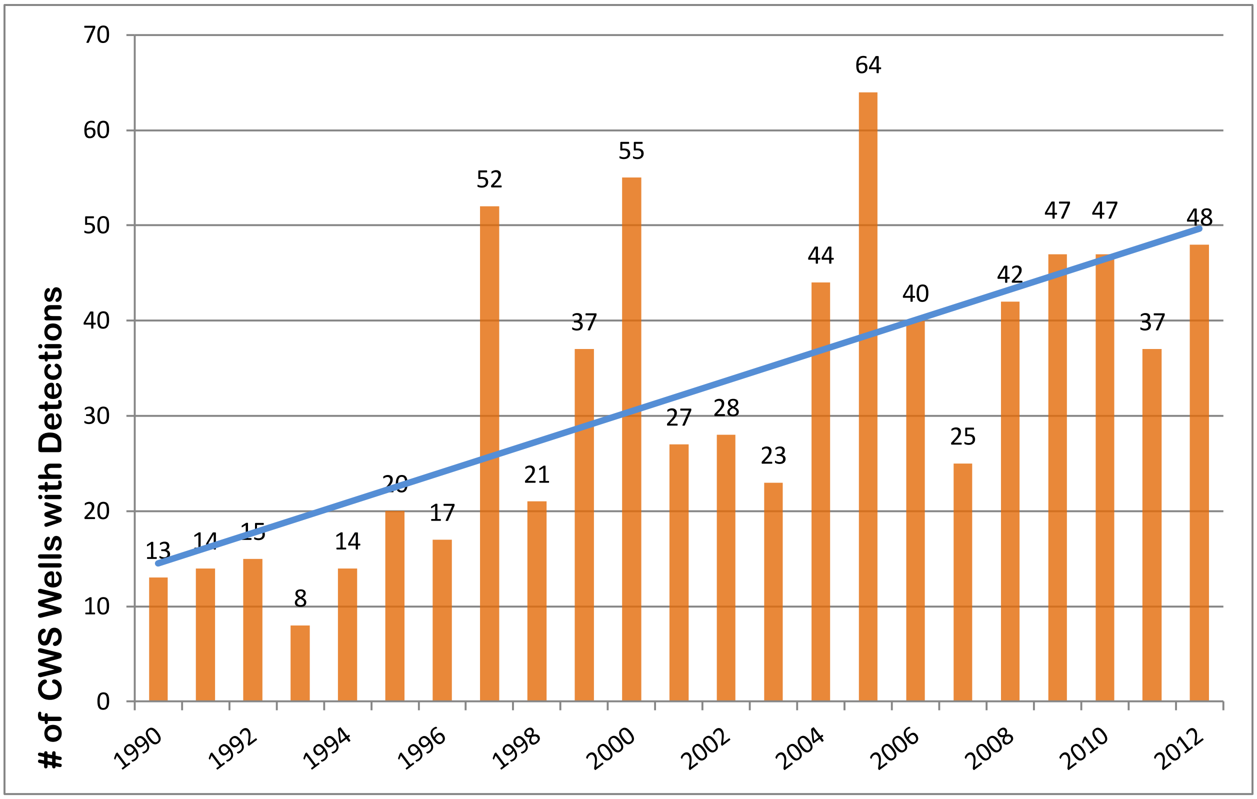


C-6. Potential Causes of Impairment

Volatile Organic Compounds in CWS Wells

As previously stated, when possible, assessments of groundwater overall use support is based upon Illinois' GWQS within the probabilistic network of CWS wells. Generally, a detection of an organic contaminant above the laboratory practical quantification limit or the detection of an inorganic constituent above the naturally occurring background level in a CWS well is considered a cause of less than full use support. To assess the potential impairment that VOCs are having on Illinois' groundwater resources, the Illinois EPA compiled groundwater monitoring data from CWS wells (1990 to the present) to complete a VOC trend analysis. The Illinois EPA included the monitoring data collected through 2012 for all of the CWS wells (not just the fixed station network wells) for this Integrated Report. While year-to-year assessment of groundwater monitoring data from CWS wells has shown fluctuations of VOCs, analyses of this data indicate a statistically increasing trend of VOC contamination in CWS wells. Unfortunately, this overall trend (i.e. blue line) has continued to increase over time as illustrated in Figure C-21.

Figure C-21. Long-term VOC Trend from all CWS Wells



As illustrated above, analyses of groundwater monitoring data collected from 1990 to the present indicates a statistically significant increasing trend of CWS wells with VOC detections per year, despite the fact that the number of CWS analyzed for VOCs over the same time period declined, and the detection limit remained constant. Evaluation of the causal data indicates that trichloroethylene, tetrachloroethylene and 1,1,1- trichloroethane are the most frequently detected VOCs in CWS wells.

A long-term investigation by the U.S. Geological Survey continues to provide the most comprehensive national analysis, to date, of the occurrence of VOCs in groundwater. One of the major findings is that these compounds were detected in most aquifers throughout the nation, and were not limited to a few specific aquifers or regions (Morrow, 1999). For additional information on this investigation, see: http://toxics.usgs.gov/highlights/monitoring_vocs.html.

Groundwater Degradation

Illinois groundwater resources are being degraded. Degradation occurs based on the potential or actual diminishment of the beneficial use of the resource. When contaminant levels are detected (caused or allowed) or predicted (threat) to be above concentrations that cannot be removed via ordinary treatment techniques, applied by the owner of a private drinking water system well, potential or actual diminishment occurs. At a minimum, private well treatment techniques consist of chlorination of the raw source water prior to drinking. This groundwater degradation is exacerbated due to the predicted shortages of drinking water sources in the Northeastern Illinois.

It should be noted that groundwater that is consumed via a CWS has to be treated before it is delivered to the users. This treatment often includes methods for removing various contaminants, including the ones previously mentioned in this section. For more information on waters that are being consumed from CWS, the public can contact their local CWS or the applicable *Consumer Confidence Report* at http://epadata.epa.state.il.us/water/bowccr/ccrselect.aspx

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