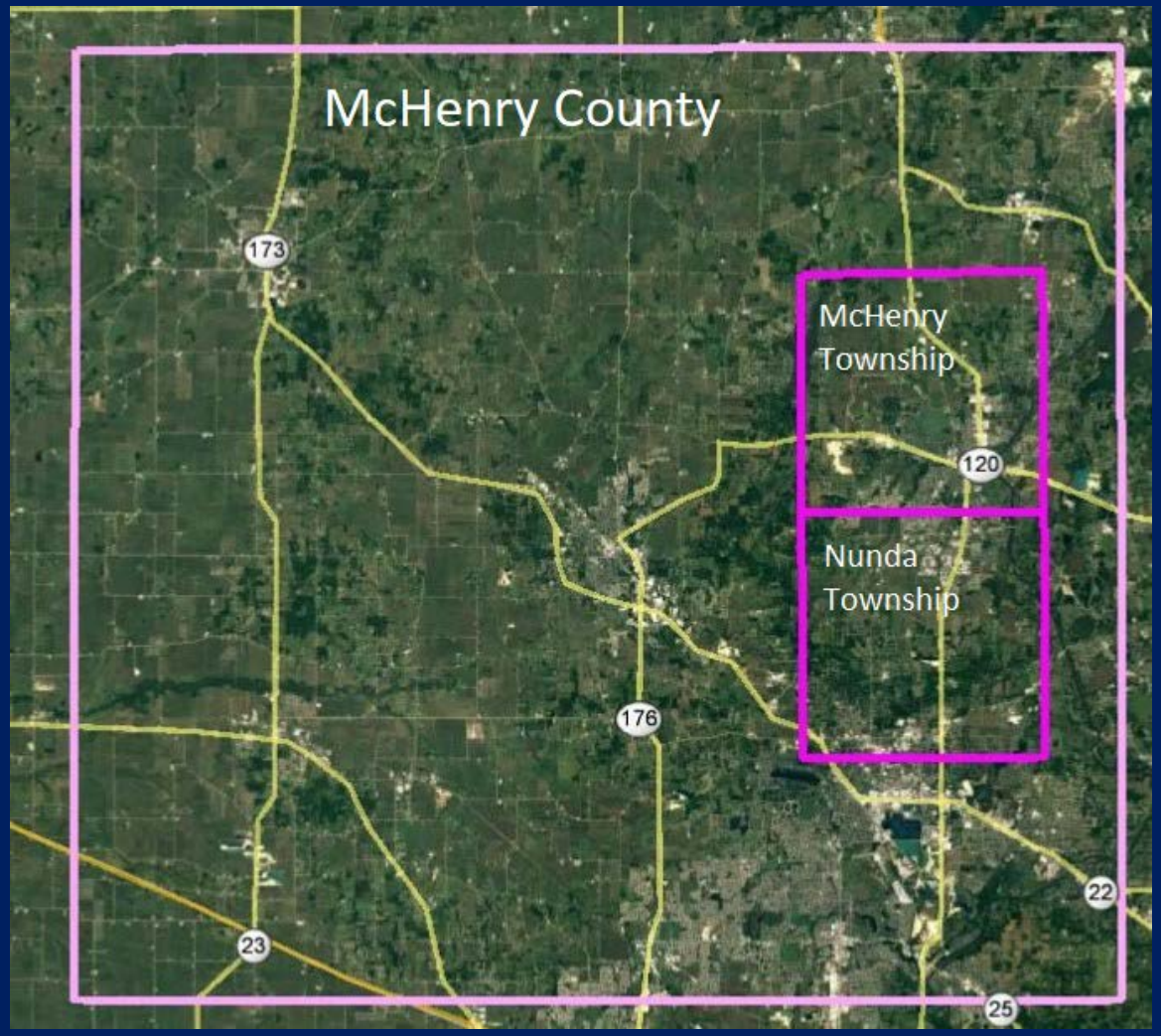
Assessment of Water Use in McHenry and Nunda Townships, McHenry County, Illinois

Robert Kay
U.S. Geological Survey
Central Midwest Water Science Center
DeKalb, Illinois
rtkay@usgs.gov
815-752-2041

USGS
science for a changing world

Study Area



Two Townships:

- McHenry T45N R8E
- Nunda T44N R8E

Types of major water use

- Public
- Commercial
- Industrial
- Irrigation
- Self-supplied residential

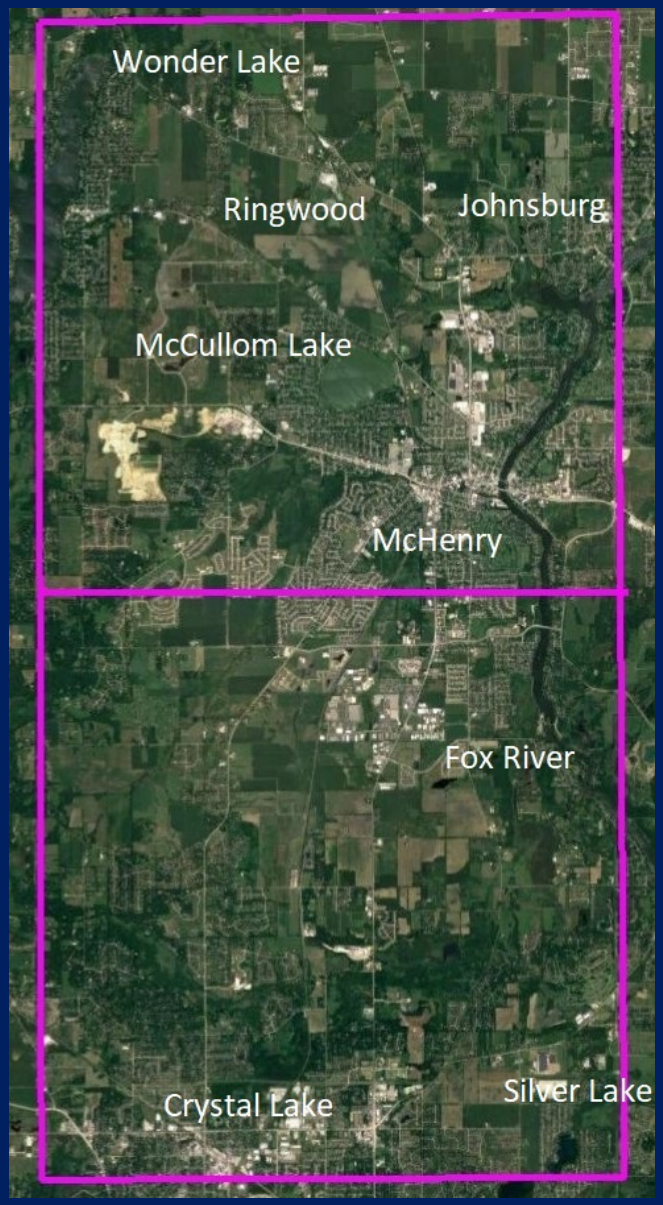
EXPLANATION

County

Township

USGS science for a changing world

Study Area, cont.



Includes:

- Wonder Lake
- Ringwood
- Johnsburg
- McCullom Lake
- City of McHenry
- Fox River
- Northern part of City of Crystal Lake
- Silver Lake

EXPLANATION

Township

USGS
science for a changing world

Hydrogeology of McHenry County

SYSTEM	GROUP	FORMATION	Hydrogeologic Unit	DESCRIPTION
Quaternary			Glacial Drift	Glacial-till, silt, gravel: windblown silt; alluvial silt, sand, gravel
Silurian		Kankakee Edgewood	Shallow Bedrock	Dolomite, silty at base
Ordovician	Maquoketa		Shallow bedrock in western part of county, minimal use in eastern part	Shale, locally argillaceous dolomite or limestone
	Galena			Dolomite and limestone
	Platteville			
	Ancell	Glenwood	Cambrian-Ordovician Aquifer System	Sandstone, shale at top.
		St. Peter		Sandstone. Basal shale
	Prairie du Chein	Shakopee New Richmond Oneota		Dolomite Sandstone Dolomite
		Gunter		Sandstone
Cambrian		Eminence and Potosi		Dolomite and sandstone
		Franconia		Dolomite, sandstone, and shale
		Ironton		Sandstone, fine-to-medium grained,
		Galesville		
		Eau Claire	Confining unit	Shale siltstone, dolomite, sandstone
			Mt. Simon aquifer	Sandstone
		Mt. Simon		Sandstone

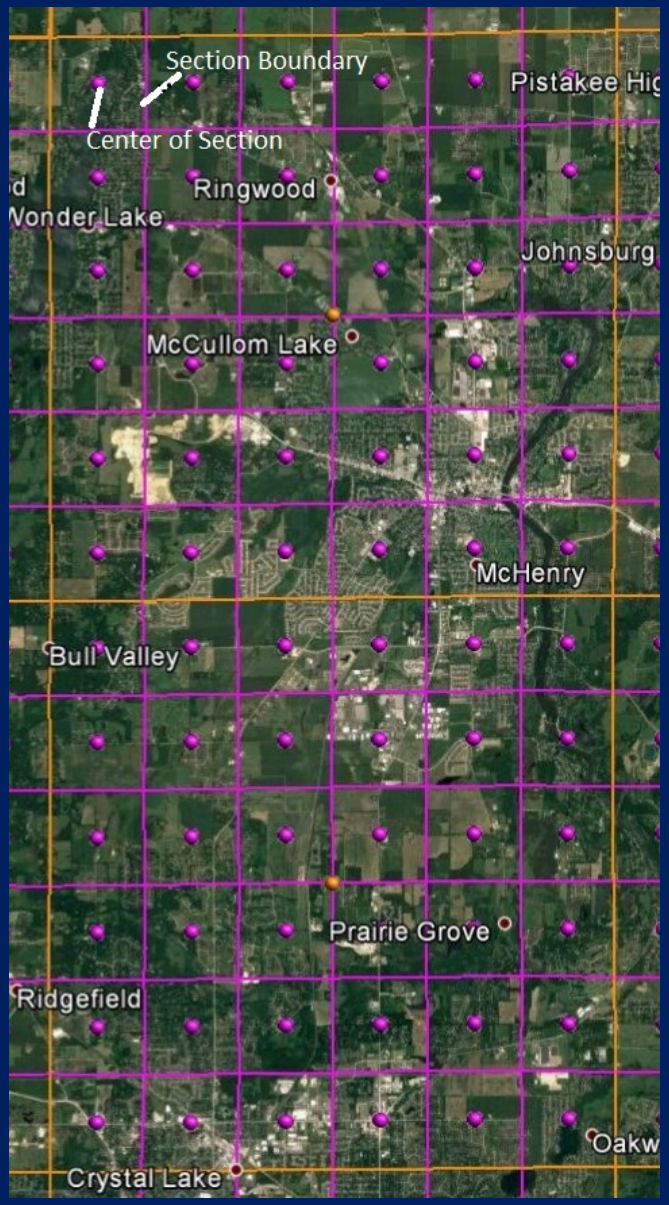
All of the potable water used in McHenry County is derived from groundwater, which is pumped from 1 of 3 units:

- Glacial Drift (sand and gravel)
- Shallow Bedrock (mostly Silurian dolomite)
- Cambrian-Ordovician Aquifer system (St. Peter and Ironton-Galesville Sandstones)

Modified from Visocky, A. P., M. G. Sherrill, and K. Cartwright, 1985, Geology, Hydrogeology, and Water Quality of the Cambrian and Ordovician Systems in Northern Illinois: Illinois State Geological Survey, and Illinois State Water Survey, Cooperative Groundwater Report 10, 136 p.

USGS science for a changing world

Objective



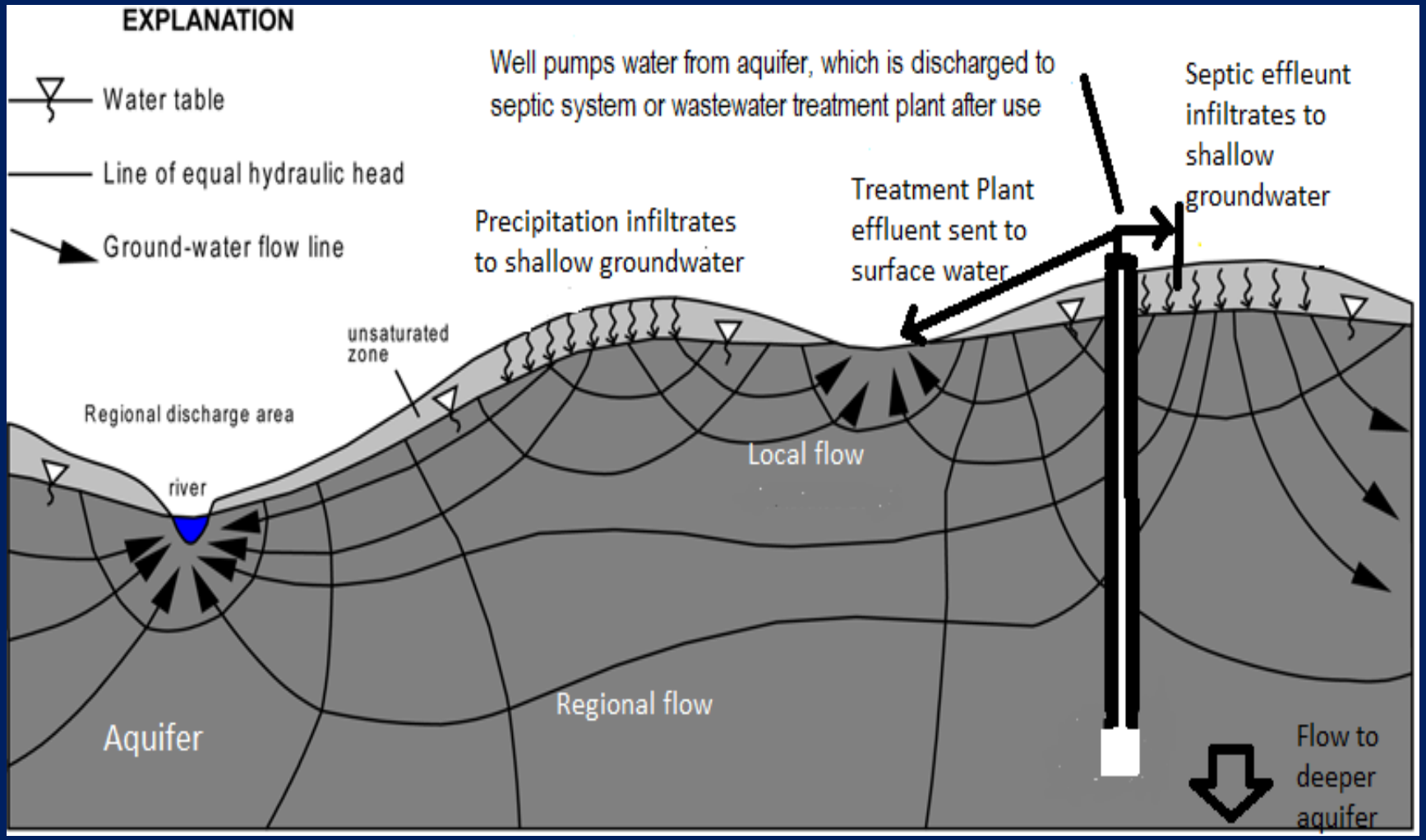
To estimate total water withdrawals by type of use for each aquifer in each Section (36 Sections per Township = 72 Sections).

EXPLANATION

Section

USGS
science for a changing world

Groundwater Cycle



Modified from: Fleming, A. H., 1994, The hydrogeology of Allen County, Indiana–a geologic and ground-water atlas: Indiana Geological Survey Special Report 57, 111 p.

USGS
science for a changing world

Natural Flow of Groundwater

Can be altered by PUMPING, which may:

- **Lower water levels in the aquifer**
  - increase cost of pumping (electricity, wear and tear on pump)
  - wells can "go dry" and need to be re-drilled
- **Reduce flow to surface water**
  - groundwater removed from aquifer is not available to flow to its natural discharge point (rivers, wetlands)
  - in extreme circumstances, low water levels can reverse flow and cause surface-water bodies to dry up
- **Divert flow from deeper groundwater**
  - reduces water availability in deeper aquifers

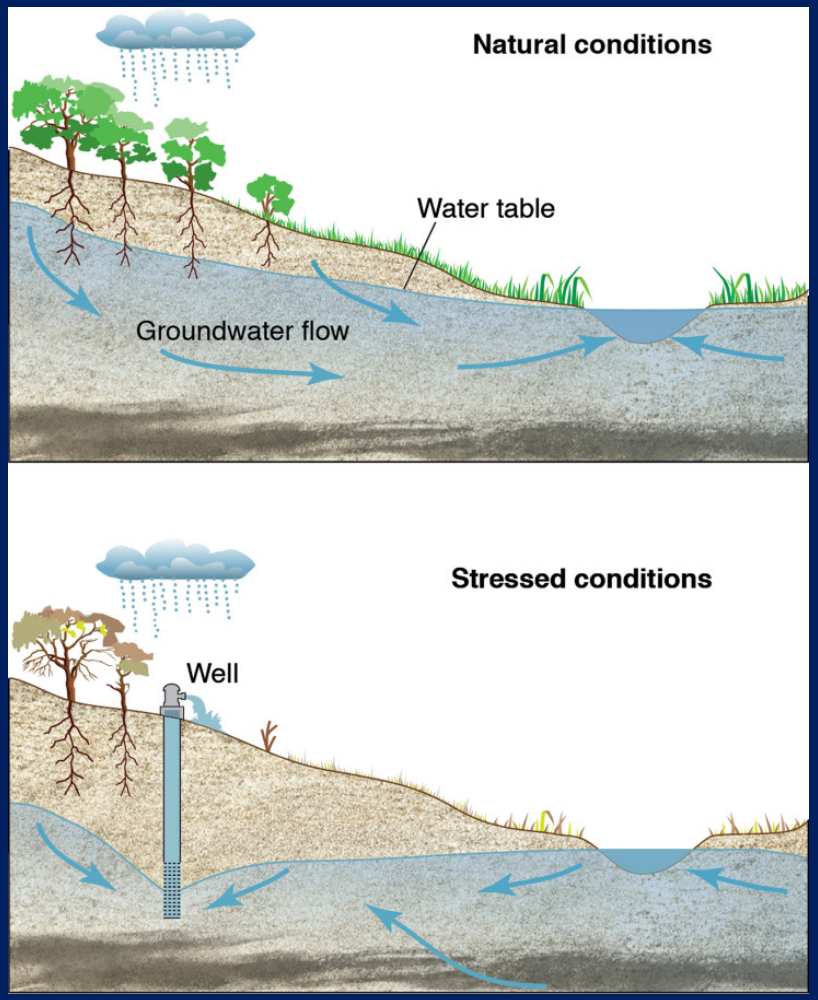


Figure from: Steven M. Gorelick and Chunmiao Zheng, "Global Change and the Groundwater Management Challenge," Water Resources Research, vol. 51, March 28, 2015

USGS
science for a changing world

Natural Flow of Groundwater, cont.

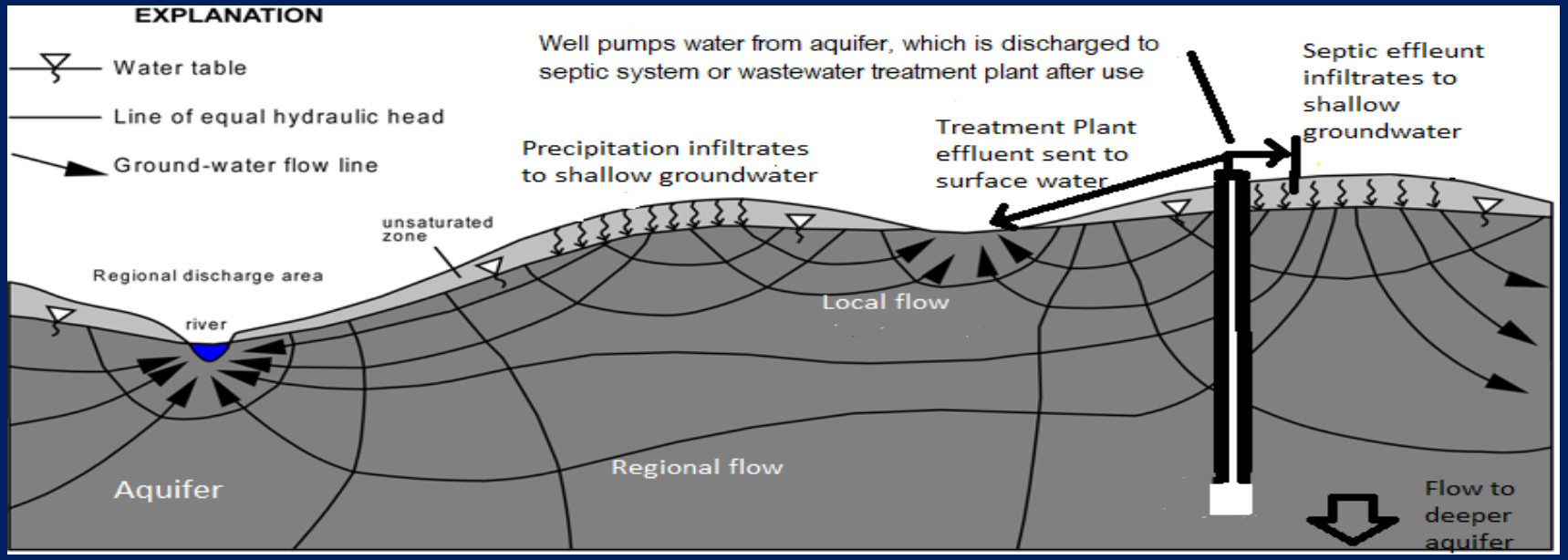
Can be altered by DISPOSAL OF USED GROUNDWATER (wastewater), which may:

- **Affect discharge to surface water**

  - septic effluent or irrigation water added to water table, with more groundwater flow to local surface water, with potentially less flow to regional surface water

- **Alter location and volume of flow of surface water**

  - municipal effluent typically discharges to surface water at a single point in space



Modified from: Fleming, A. H., 1994, The hydrogeology of Allen County, Indiana–a geologic and ground-water atlas: Indiana Geological Survey Special Report 57, 111 p.

USGS science for a changing world

Natural Flow of Groundwater, cont.

Can be altered by DISPOSAL OF USED GROUNDWATER (wastewater), which may:

- **Alter water quality**
  - discharge of septic and industrial wastes can affect:
    - groundwater quality (N, P, bacteria, etc.)
    - surface-water quality by discharge of affected groundwater (Fox River, Wonder Lake, McCullom Lake)
    - surface-water quality by direct wastewater discharge (Fox River)

- **Alter location and volume of flow of surface water**
  - municipal effluent typically a point discharge to surface water

USGS
science for a changing world

Reasons for Assessment

1. Focus monitoring efforts to identify location of potential threats to:

- Human Health
  - Nitrate
  - Chloride
  - Emerging contaminants

- Groundwater Availability

- Ecology of surface-water systems
  - Lakes
  - Rivers
  - Wetlands

USGS
science for a changing world

Reasons for Assessment, cont.

2. To help guide planning for:
   - Housing Density
   - Water Supply

     -Private or municipal system
   - Wastewater

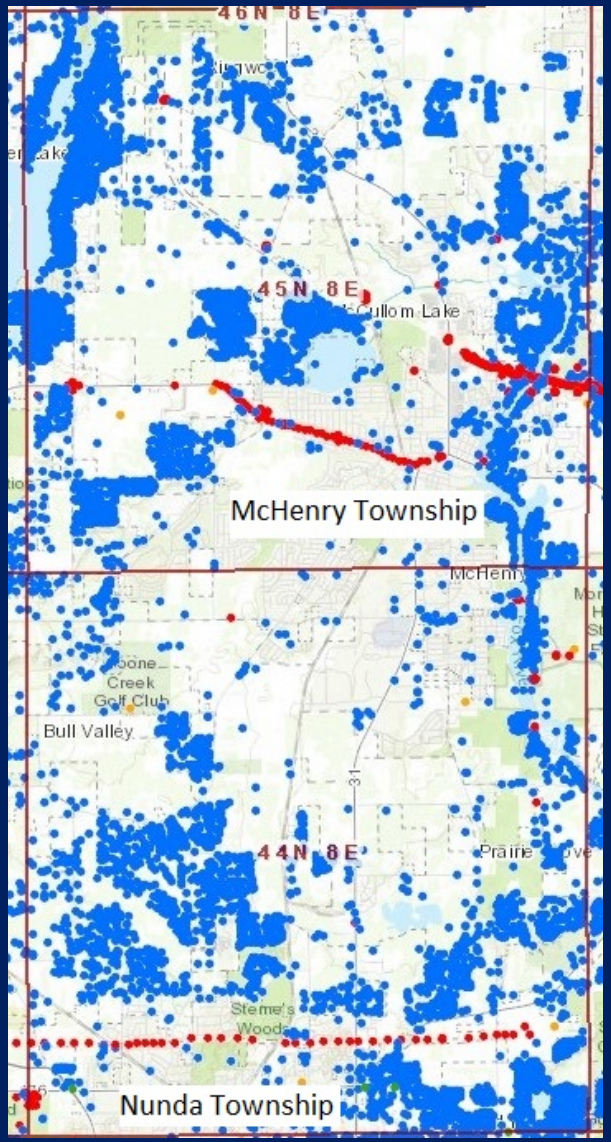
     - Septic system or municipal wastewater treatment
   - Location

     - Avoid areas with water dependent habitats

     - Don’t dispose of chemicals near large water users or critical aquifers

USGS
science for a changing world

Approach



1. Search Illinois State Geological Survey Well Database (ILWATER) for well location and other information

EXPLANATION

- Water supply well
- Engineering well

From https://isgs.Illinois.edu/ilwater

USGS
science for a changing world

Approach, cont.

Page 1 ILLINOIS STATE GEOLOGICAL SURVEY

Private Water Well	Top	Bottom
sandy brown clay	0	4
gravel	4	26
red clay	26	167
sand & gravel	167	169
Total Depth		**169**

Casing: 5" PVC SCH 40 from 0' to 169'

Grout: CLAY BENTONITE from 0 to 169.

Water from gravel at 58' to 169'.

Static level 58' below casing top which is 1' above GL

Pumping level 65' when pumping at 10 gpm for 3 hours

Permanent pump installed at 100'
on May 19, 1995, with a capacity of 15 gpm

Owner Address: NNNN 8888 St McHenry, IL
Address of well: same as above
Add'l loc. info: Lot: 5 & 6 Subdivision: Lake Est.

Location source: Aerial Photograph verified Verified by: VJA on July 6, 2011.

Permit Date: April 26, 1995 **Permit #:** 111-G08

COMPANY Snelten, Greg
FARM Doe, John and Jane
DATE DRILLED May 17, 1995 NO.
ELEVATION COUNTY NO. AAAAA
LOCATION SW NW NW
LATITUDE 42.ddddd LONGITUDE -88.ddddd
COUNTY **McHenry** API 121113383200 22 - 45N - 8E

2. Collect well log information filled out by driller from ILWATER; compile information by Section:

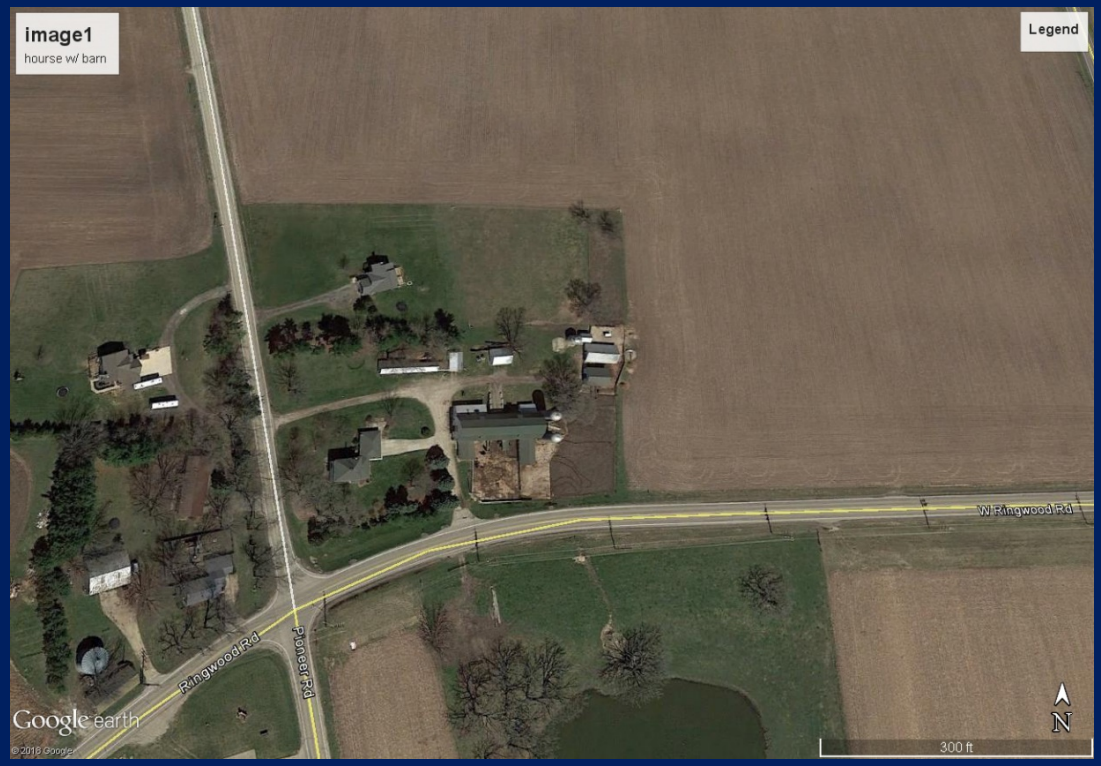
- Type of Well (private, commercial, industrial, irrigation)
- Aquifer used
- Pumping capacity
- Location (latitude/longitude, address, Township, Range, Section)

From https://isgs.Illinois.edu/ilwater

USGS science for a changing world

Approach, cont.

3. Look up selected locations on Google Earth™*



- Verify location—is there a structure? Sprinkler?
- Historical land use—is well current?
- Indicate type of water use (residence, irrigation, commercial facility)
- Provide some estimate of other water users (livestock, horses)
- Estimate size of field or building

*Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government

USGS science for a changing world

Approach, cont.

4. Estimate residential water use

- Residential well pumps 190 gallons per day (gpd)
  - 73.2 gpd per person (Chicago Metropolitan Agency for Planning data for McHenry County 1998-2007)
  - 2.6 persons/household (2017 U.S. Census for County, https://www.census.gov/quickfacts/mchenrycountyillinois)

- Pro-rate to number of residences in section
  - County provided data on number of units per Section
    - Assume percentage of aquifers used by wells in database is representative of percentage of aquifers used by wells in section

EXAMPLE: 20 residences in a Section, 10 well logs in ISGS database for Section, of which 5 are in Glacial Drift, means 10 wells pump from Glacial Drift at 190 gpd, total of 1,900 gpd in that section

USGS science for a changing world

Approach, cont.

5. Obtain public supply water withdrawal information

This information was collected from:

- System operator reports to Illinois State Water Survey
- IEPA Source Water Assessment Fact Sheets
- Directly from water system operators

USGS
science for a changing world

Approach, cont.

6. Estimate industrial water use

This information was collected from:

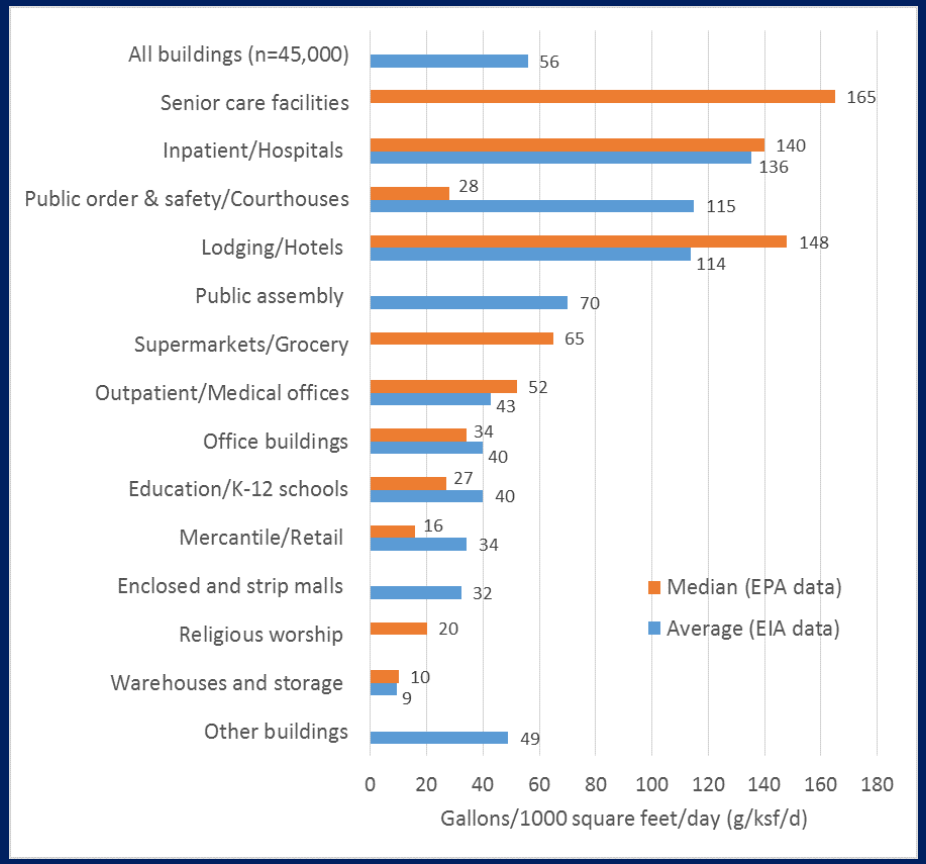
- facility contacts (some unresponsive)
- National Pollutant Discharge Elimination System Data (NPDES, https://echo.epa.gov/trends/loading-tool/water-pollution-search)
  - equal amounts from each well on facility

USGS
science for a changing world

Approach, cont.

7. Estimate commercial water use

- Identify type of commercial facility from well log, Web search
- Get area of building from Google Earth™*
- Multiply area of facility by median water use for that type of facility (some exceptions)
- Pro-rate to number of commercial facilities in section provided by county for total commercial use.
- Pro-rate to withdrawal by aquifer based on percentage of wells from various aquifers in well database for that section



From: DziegielewskiBA, CC BY-SA 4.0, https://creativecommons.org/licenses/by-sa/4.0),from Wikimedia Commons; https://commons.wikimedia.org/wiki/File:WUI_metrics-benchmarks.png

*Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government

USGS science for a changing world

Approach, cont.

9. Other estimates of water use

This information was collected from City of McHenry:

- school (3,040 gpd geomean, n=5)
- church (143 gpd geomean, n=3)
- restaurant
  - sit down (geomean 3,320 gpd, n=5)
  - fast food (geomean 1,450 pgd, n=5)

USGS
science for a changing world

Approach, cont.

8. Estimate irrigation water use

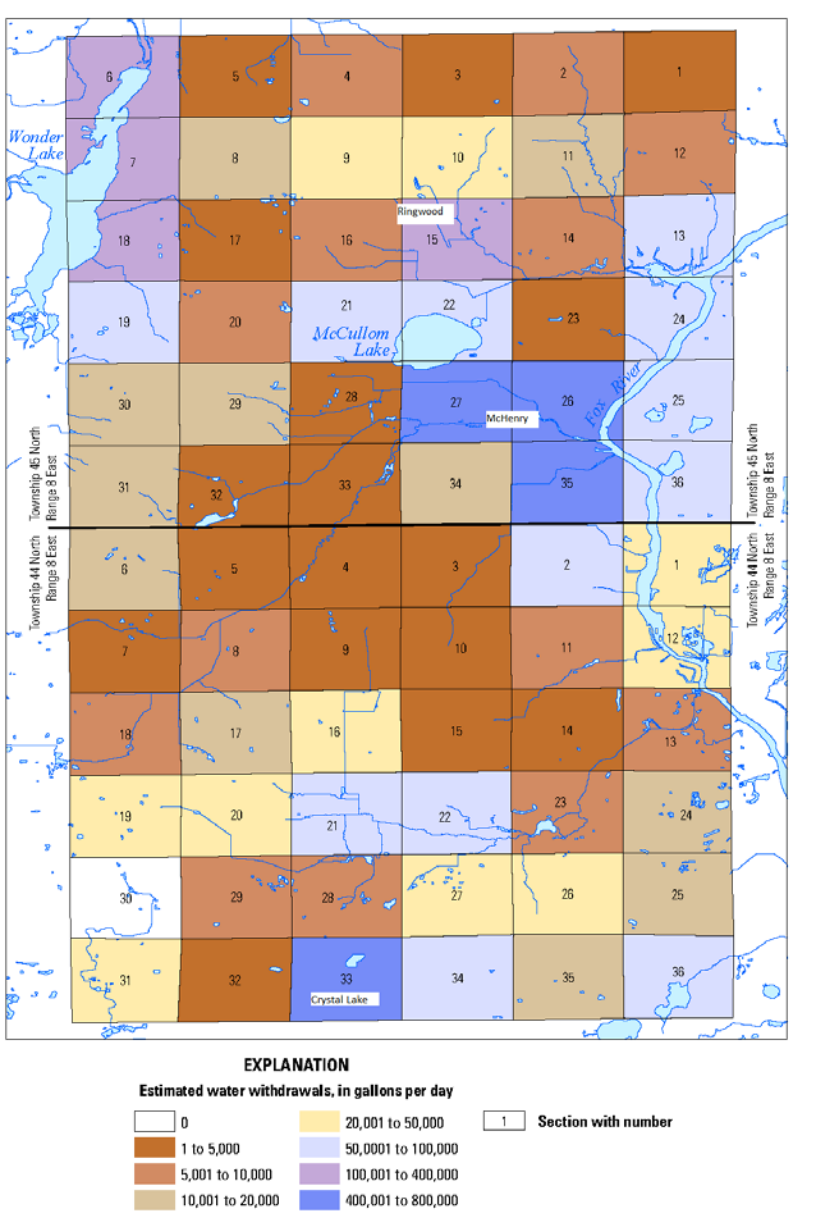
This information was collected from:

- Illinois State Water Survey measured pumping data from a sod farm in McHenry County: 5 gallons per acre per day
  - acreage from Google Earth™*
  - pro-rated over entire year
  - low in comparison to other methods of estimation
  - highly variable with climatic conditions

*Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government

USGS science for a changing world

Results – Glacial Drift



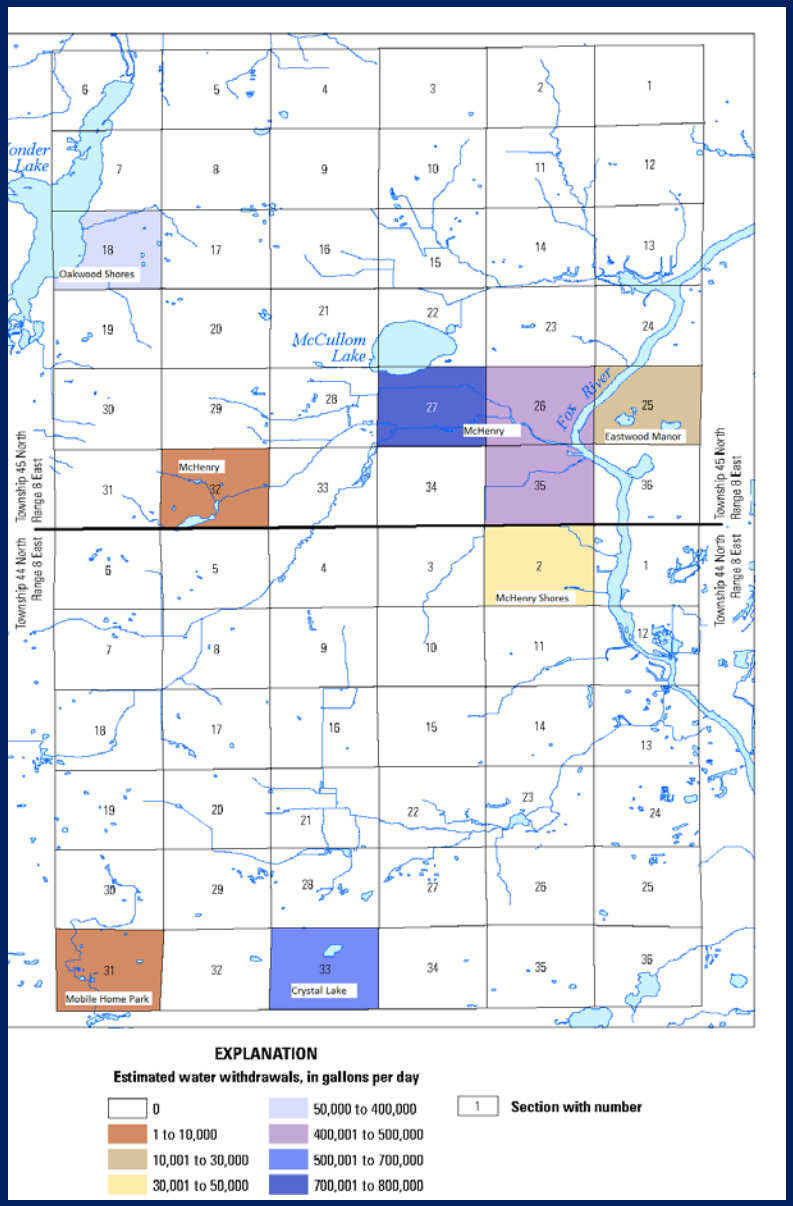
1. Estimated water withdrawals from Glacial Drift for public-supply, residential, commercial/industrial combined; primary aquifer for water supply in the area

- Range 0-715,000 gallons per day (gpd)

- Greater than 100,000 gpd
  - Wonder Lake (residential)
  - Ringwood (industrial/remediation)
  - McHenry (public)
  - Crystal Lake (public)

USGS science for a changing world

Results – Glacial Drift, cont.

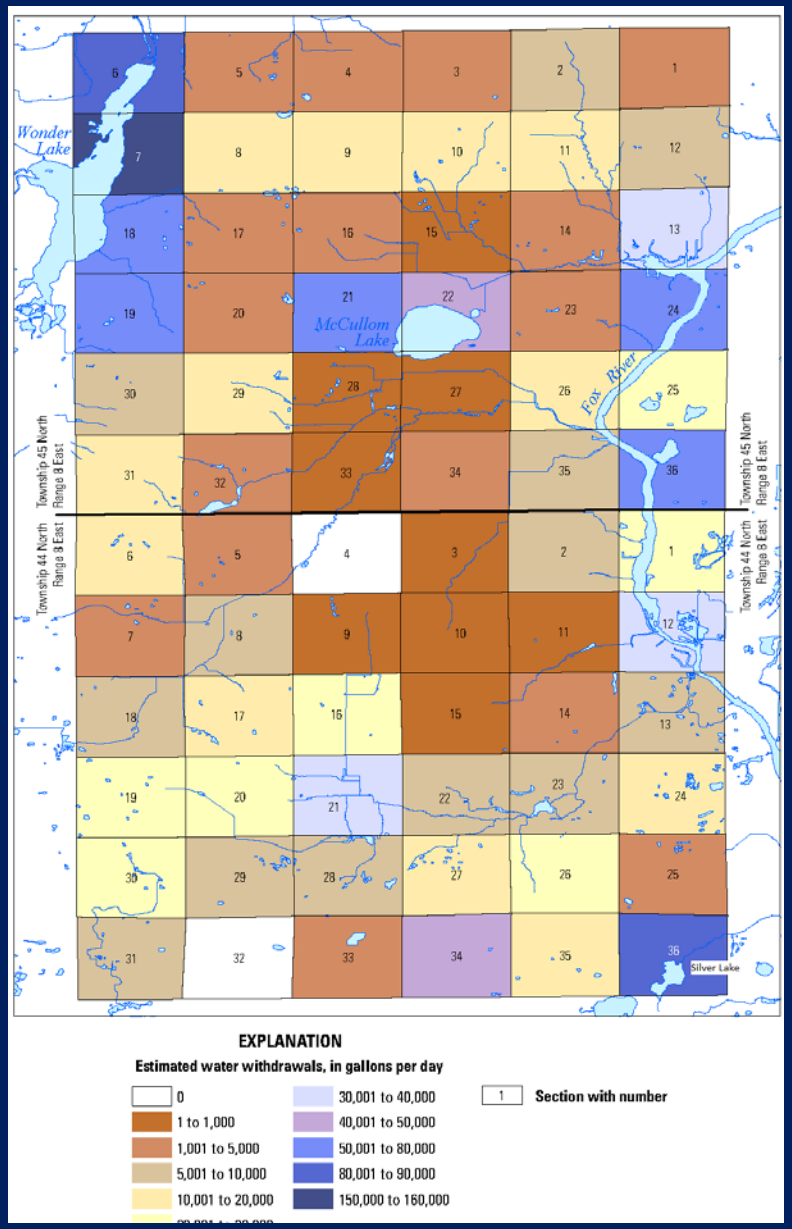


1a. Estimated water withdrawals from Glacial Drift: PUBLIC-SUPPLY WELLS

- Range 0-715,000 gallons per day (gpd)
- Mainly City of McHenry
- City of Crystal Lake
- Smaller utilities
- Mobile Home Park

USGS science for a changing world

Results – Glacial Drift, cont.

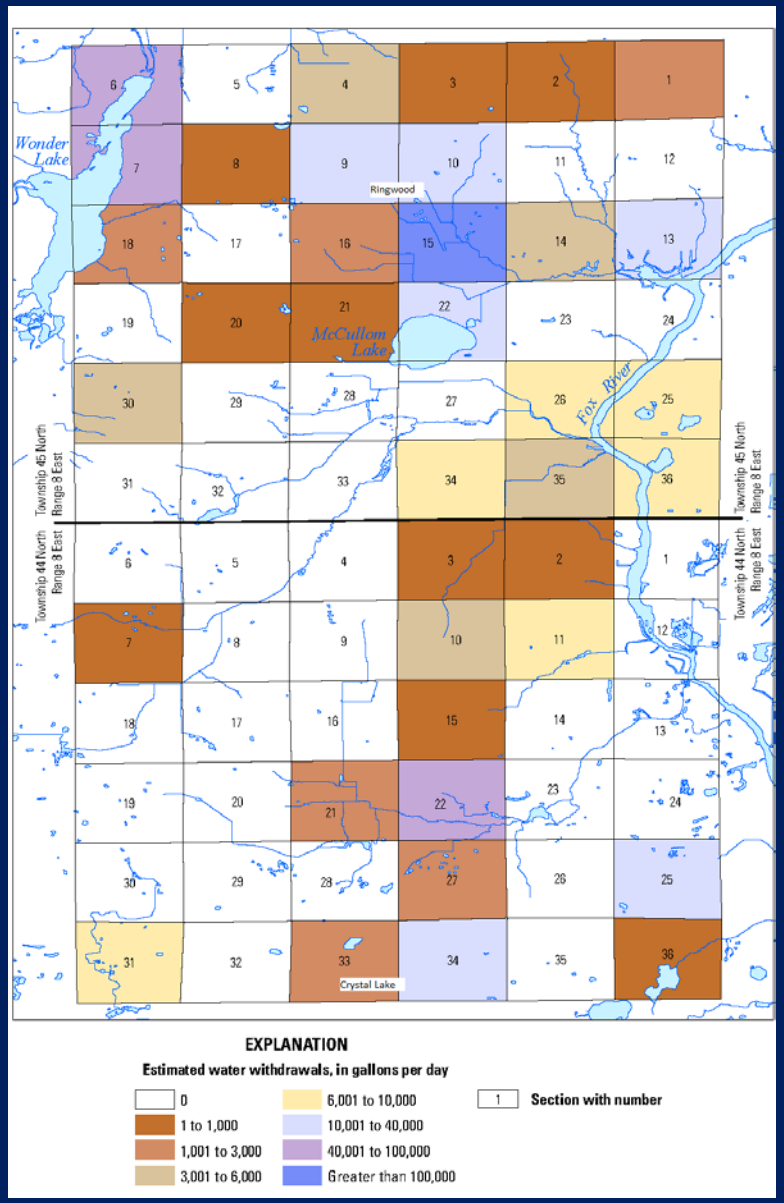


1b. Estimated water withdrawals from Glacial Drift: RESIDENTIAL WELLS

- Range 0-155,000 gallons per day
- Low in municipal areas and low rural population
- Highest near surface-water bodies
  - Wonder Lake
  - Silver Lake
  - Fox River
  - McCullom Lake (north)

USGS science for a changing world

Results – Glacial Drift, cont.

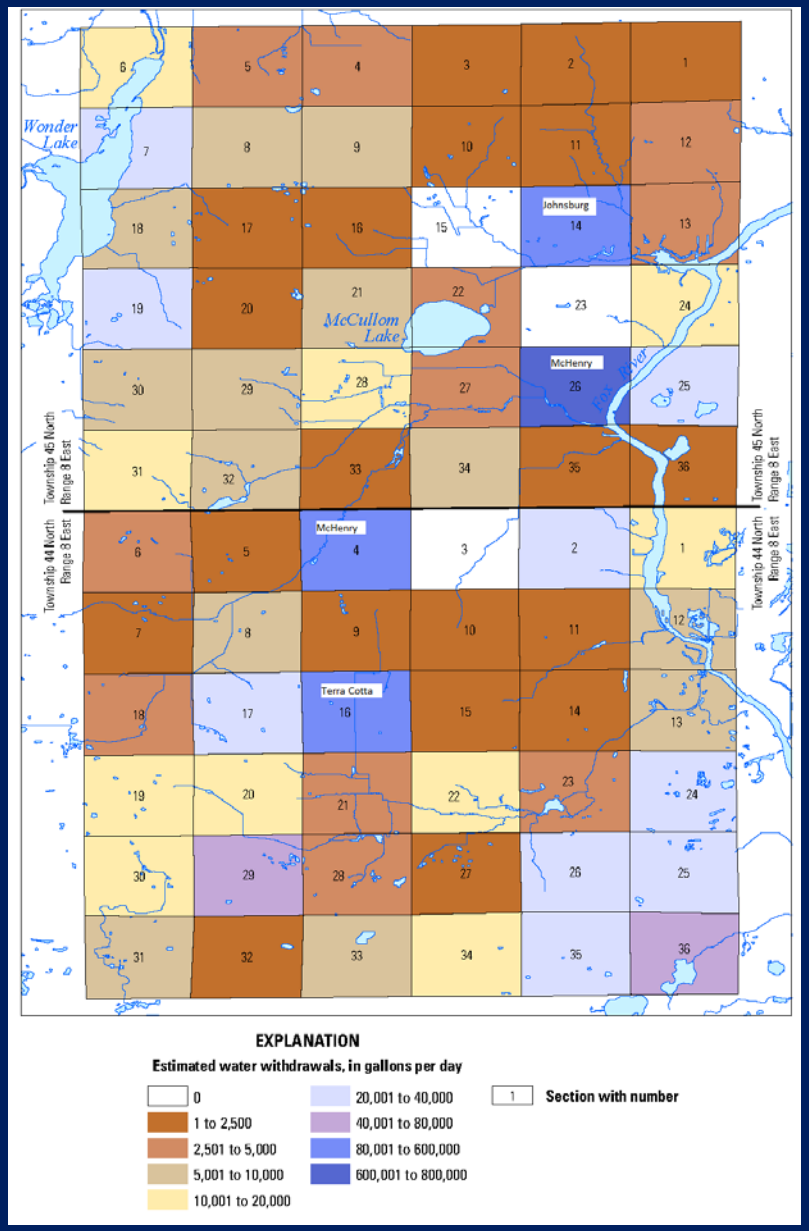


1c. Estimated water withdrawals from Glacial Drift: COMMERCIAL and INDUSTRIAL WELLS

- Range 0-157,000 gallons per day (gpd)
- Above 100,000 gpd at Ringwood (industrial remediation)
- Above 40,000 gpd in
  - Wonder Lake (commercial)
  - North of Crystal Lake (industrial)

USGS science for a changing world

Results – Shallow Bedrock



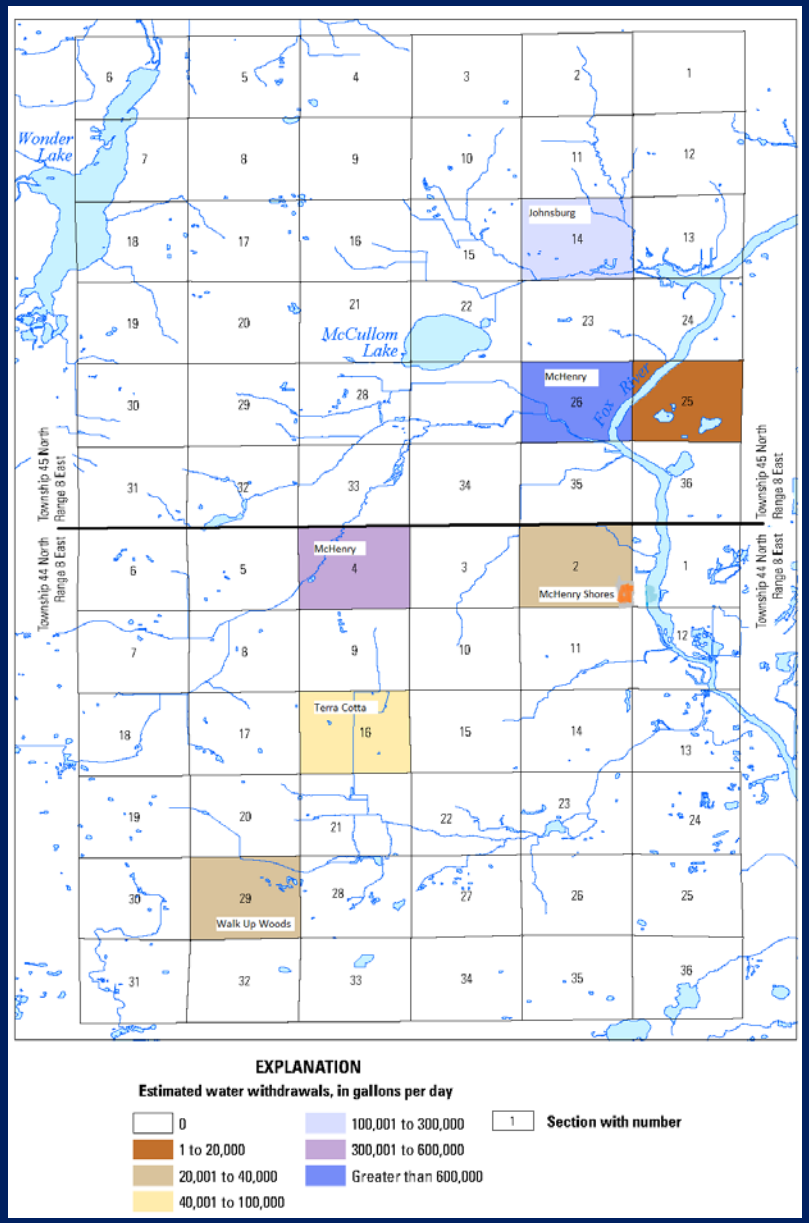
2. Estimated water withdrawals from Shallow Bedrock for public-supply, residential, commercial/industrial combined; almost always less than from Glacial Drift

- Range 0-668,000 gallons per day

- Above 80,000 gallons per day
  - Johnsburg (public)
  - McHenry (pubic)
  - Terra Cotta (public)

USGS science for a changing world

Results – Shallow Bedrock, cont.

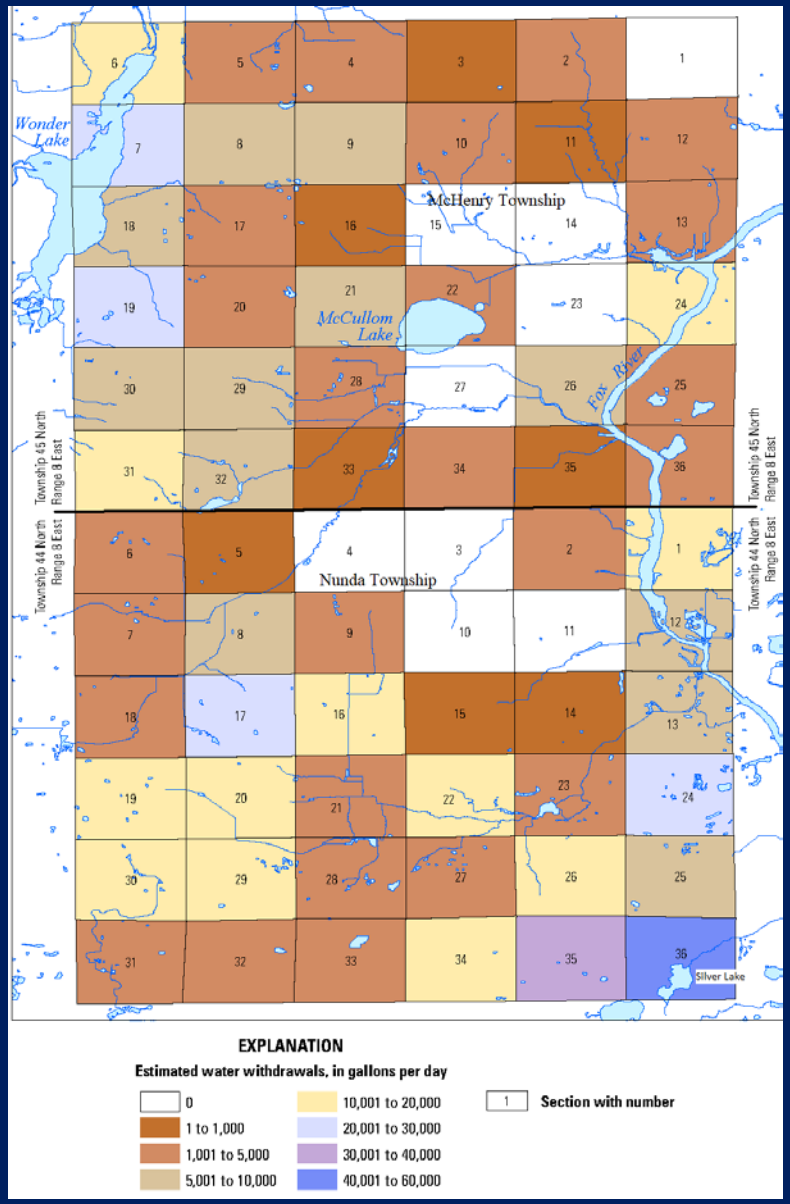


2a. Estimated water withdrawals from Shallow Bedrock: PUBLIC-SUPPLY WELLS

- Range 0-660,000 gallons per day
- Cities of McHenry and Johnsburg
- Smaller Utilities

USGS science for a changing world

Results – Shallow Bedrock, cont.

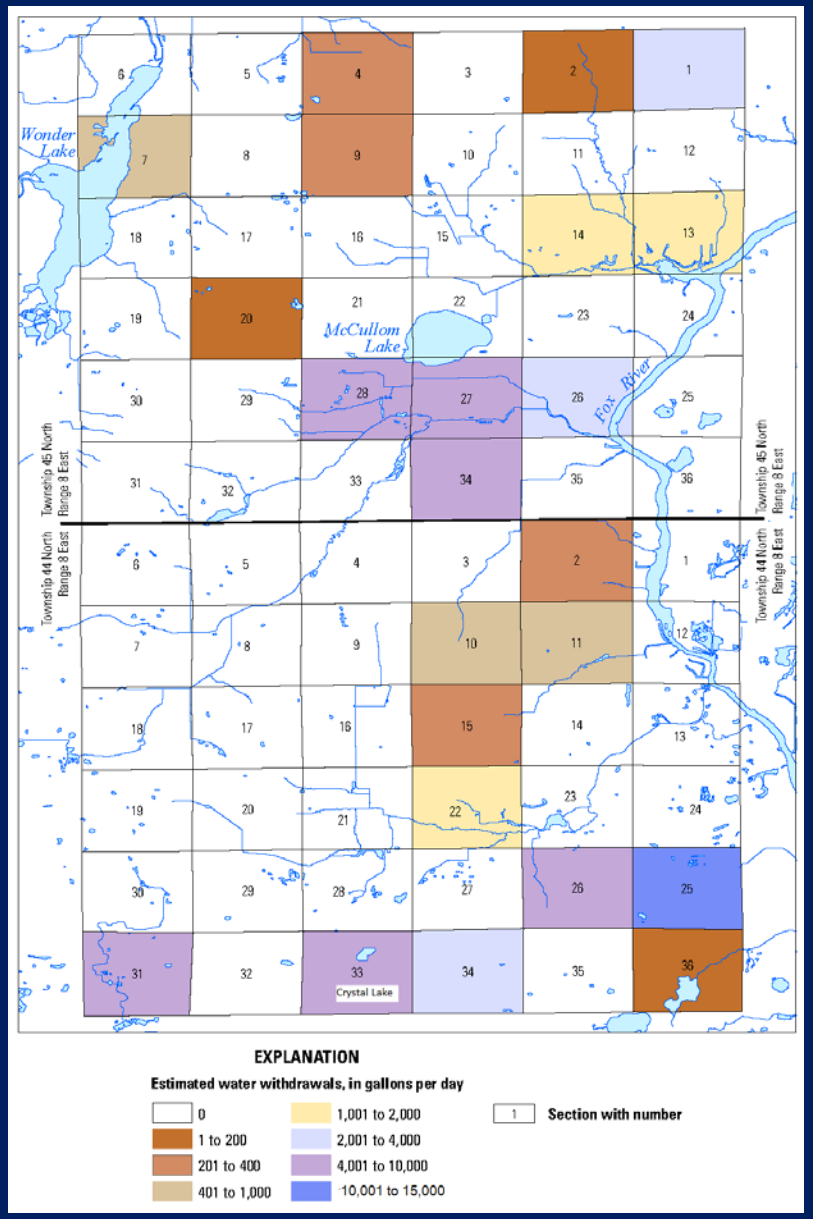


2b. Estimated water withdrawals from Shallow Bedrock: RESIDENTIAL WELLS

- Range 0-56,000 gallons per day
- Typically less than half the amount withdrawn from the Glacial Drift
- Less difference in southern part of Nunda Township
- Tends to be highest near surface-water bodies
  - Wonder Lake
  - Silver Lake

USGS science for a changing world

Results – Shallow Bedrock, cont.

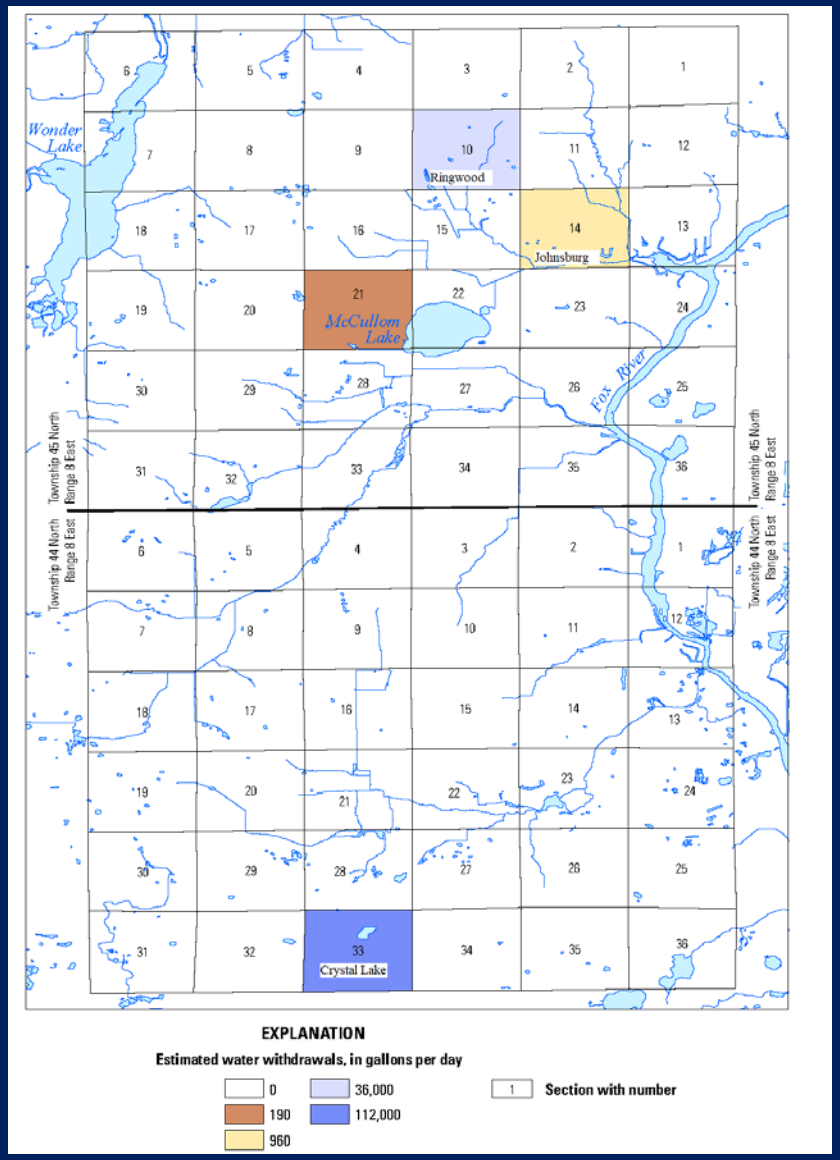


2c. Estimated water withdrawals from Shallow Bedrock: COMMERCIAL AND INDUSTRIAL WELLS

- Range 0-20,000 gallons per day
- Maximum withdrawals from area northeast of Crystal Lake

USGS science for a changing world

Results – Cambrian-Ordovician



3. Estimated water withdrawals from Cambrian-Ordovician for public-supply, residential, commercial/industrial combined; major source of water-supply in Northern Illinois and Southern Wisconsin, including southern McHenry County

- Range 0-112,000 gallons per day (gpd)
- Above 100,000 gpd
  - Crystal Lake (public)
- Emergency public supply at Johnsburg
- One residential well at McCullom Lake
- Above 36,000 gpd
  - Ringwood (industrial)

USGS science for a changing world

Summary

- About 4.3 million gallons per day pumped from Glacial Drift aquifer in area for public, residential, commercial, and industrial use in study area
- Over 1.9 million gallons per day pumped from Shallow Bedrock aquifer in area for public, residential, commercial, and industrial use in study area
- About 150,000 gallons per day pumped from Cambrian-Ordovician aquifer system in area for industrial and public use in study area
- Withdrawals typically highest where population is highest—cities or subdivisions with high housing density (often near water bodies); also in some areas of heavy industry

USGS
science for a changing world

Summary, cont.

- Effect of pumping on water levels

  - Could divert flow from streams and wetlands in areas of high water use, especially in Glacial Drift

    - Most areas of high-water use are near surface-water bodies

  - Wells going dry not known to be an issue, but could occur in sections with high water use

USGS
science for a changing world

Summary, cont.

- Effects on water quality

  - Groundwater quality could be affected in areas with large numbers of wells served by septic systems (Wonder Lake and McCullom Lake areas)

  - Surface-water quality could be affected at points of municipal wastewater discharge and in lakes and wetlands near areas with large number of wells served by septic systems—especially Wonder, Silver, and McCullom Lakes and the Fox River

USGS
science for a changing world

QUESTIONS?

USGS
science for a changing world