

1

Study Researchers

Tonight's Presenters

Mark Borchardt, PhD (USDA-ARS)

Study background and scientists' role

Maureen Muldoon, PhD (WGNHS)

Hydrogeology of southwest Wisconsin

Joel Stokdyk, (USGS)

Groundwater quality and risk factors for contamination

Ken Bradbury, PhD (WGNHS)

Information for private well owners

Burney Kieke (Marshfield Clinic Research Institute)

Statistical models

2

Study Background and scientists' roles

Mark Borchardt, Ph.D.
Emeritus, Research Microbiologist
USDA-Agricultural Research Service



3

Study Team

County Conservationists

- Lynda Schweikert, Chippewa County
- Katie Abbott, Iowa County
- Terry Loeffelholz, Iowa County
- Erik Heagle, Grant County
- Erica Sauer, Lafayette County

Laboratory and Field Sampling

- Aaron Firnstahl, U.S. Geological Survey
- Susan Spencer, USDA Agricultural Research Service

Support

- Scott Laeser, Clean Wisconsin



4

Acknowledgements

Well Geo-Locating

- Steve Mael (WGNHS)
- Matt Rehwald (WGNHS)
- Chris Headlee (WGNHS)

Geographic Information Systems Data Layers

- Lauree Aulik (Lafayette County)
- Jaclyn Essandoh (Southwest WI Regional Planning)
- Terry Loeffelholz (Iowa County)

Septage and Sludge Records

- Steve Warrner (WI DNR)

Precipitation Data

- Dustin Goering (U.S. National Weather Service)

5

Study Funding

- Grant, Iowa, and Lafayette counties
- Lafayette Ag Stewardship Alliance
- Residents of Lafayette County
- Iowa County Uplands Watershed Group
- WI Department of Natural Resources
- US Geological Survey
- USDA-Agricultural Research Service
- WI Geological & Natural History Survey

6

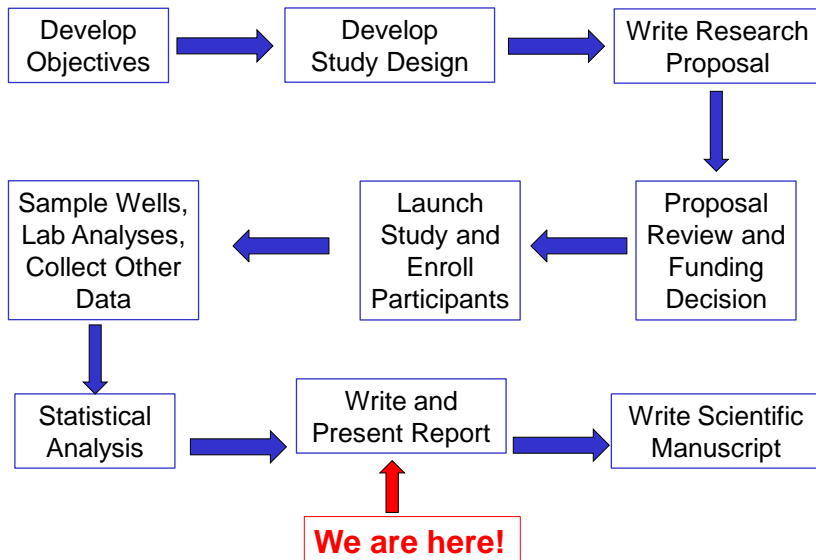
Background

- Jan. 2018, Grant County, Moratorium & Manure Spreading Restriction requests
- Drs. Mark Borchardt & Madeline Gotkowitz presented
- Invited Iowa & Lafayette Counties
- Grant County approved groundwater study
- Iowa & Lafayette counties participation



7

SWIGG Research Process



8

Kewaunee County Published Scientific Papers

Research

A Section 508-conformant HTML version of this article is available at <https://doi.org/10.1289/ehp.97815>.

Sources and Risk Factors for Nitrate and Microbial Contamination of Private Household Wells in the Fractured Dolomite Aquifer of Northeastern Wisconsin

Mark A. Borchardt,¹ Joel P. Stokdyk,² Burney A. Kieke Jr.,³ Maureen A. Muldoon,⁴ Susan K. Spencer,¹ Aaron D. Firnstahl,² Davina E. Bonness,⁵ Randall J. Hunt,⁶ and Tucker R. Burch¹

¹Environmentally Integrated Dairy Management Research Unit, U.S. Dairy Forage Research Center, U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS), Marshfield, Wisconsin, USA

²Upper Midwest Water Science Center, U.S. Geological Survey, Marshfield, Wisconsin, USA

³Center for Clinical Epidemiology and Population Health, Marshfield Clinic Research Institute, Marshfield, Wisconsin, USA

⁴Wisconsin Geological and Natural History Survey, Madison, Wisconsin, USA

⁵Kewaunee County Department of Land and Water Conservation, Luxemburg, Wisconsin, USA

⁶Upper Midwest Water Science Center, U.S. Geological Survey, Middleton, Wisconsin, USA



Research

A Section 508-conformant HTML version of this article is available at <https://doi.org/10.1289/ehp.97815>.

Quantitative Microbial Risk Assessment for Contaminated Private Wells in the Fractured Dolomite Aquifer of Kewaunee County, Wisconsin

Tucker R. Burch,¹ Joel P. Stokdyk,² Susan K. Spencer,¹ Burney A. Kieke Jr.,³ Aaron D. Firnstahl,² Maureen A. Muldoon,⁴ and Mark A. Borchardt¹

¹Environmentally Integrated Dairy Management Research Unit, U.S. Dairy Forage Research Center, U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS), Marshfield, Wisconsin, USA

²Upper Midwest Water Science Center, U.S. Geological Survey, Marshfield, Wisconsin, USA

³Center for Clinical Epidemiology and Population Health, Marshfield Clinic Research Institute, Marshfield, Wisconsin, USA

⁴Wisconsin Geological and Natural History Survey, University of Wisconsin-Madison Division of Extension, Madison, Wisconsin, USA

9

SWIGG and Kewaunee Studies were Designed to Achieve Two Goals...

- A state-of-the-art assessment of private well contamination
- Findings that help identify ways to address contamination

10

Scientists' Role

We do...

- Design study to meet specific questions and objectives
- Apply appropriate technologies to address objectives
- Strive for objectivity and transparency
- Provide and interpret scientific results

We do NOT...

- Make policy or management recommendations
- Advocate for certain viewpoints or actions

11

Scientists' Motivation

Research locally, publish globally

- Local research provides information that is beneficial to the residents of southwest Wisconsin
- Global publishing advances groundwater science and allows others around the world to use the findings

Uniqueness

- SWIGG is only the second study to relate microbial contamination of private wells to risk factors, like land use

12

Gratitude for Study Participants



**816 households
with private wells
participated in the
SWIGG study**

13

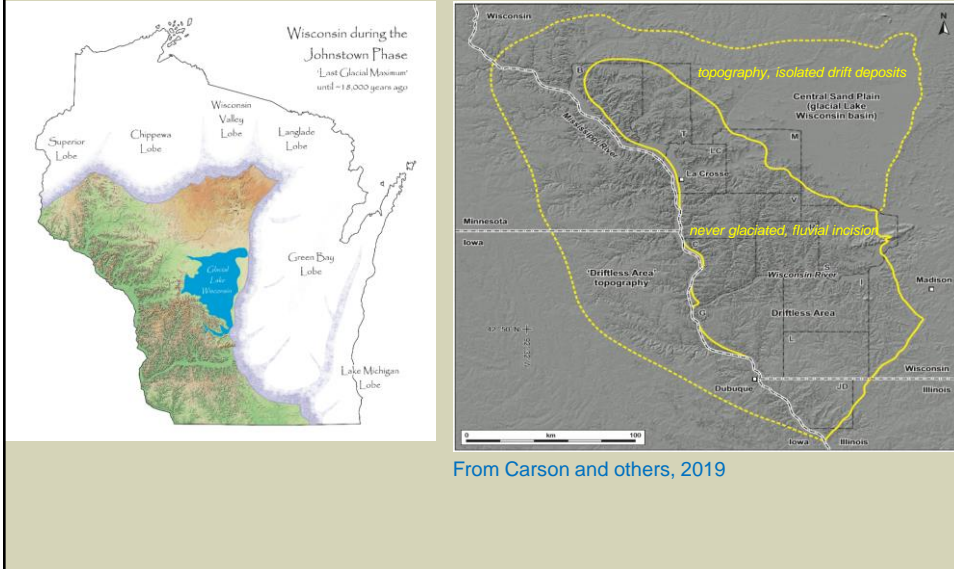
Hydrogeology of SW Wisconsin

Maureen Muldoon, Ph.D.
Hydrogeologist
Wisconsin Geological & Natural History Survey



14

Wisconsin's Driftless Area



15

Wisconsin's Karst

- Karst -- a landscape created when water dissolves rocks such as dolomite and limestone

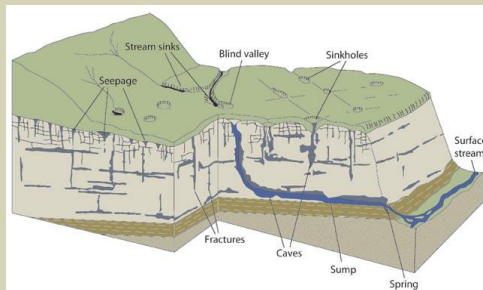
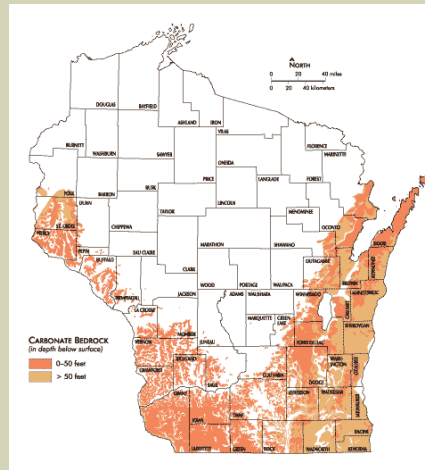


Image courtesy of Tony Runkel, MN Geological Survey



<https://wgnhs.wisc.edu/catalog/publication/000905/resource/fs02>

16

Karst & Surficial Geology

- Karst features
 - Sinkholes, conduits, caves
- Surficial Geology
 - Residuum – reddish clay from weathered carbonate bedrock, locally known as the ‘Rountree Formation’
 - Loess (wind-blown sediment) that is silt-sized and is the parent material for many soils in the region



Sinkhole near Blue Mounds, WGNHS photo



Photo by Eric Carson, WGNHS

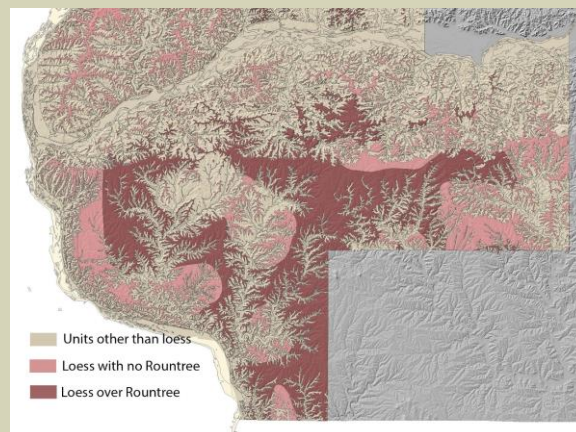


Conduit in 151 roadcut, WIDOT photo

17

Southwest Wisconsin Surficial Geology

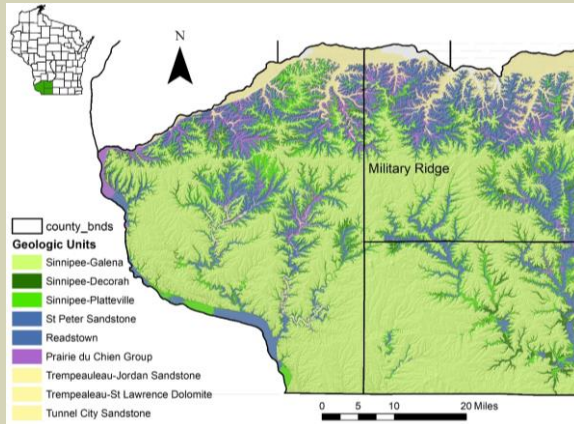
- Rountree Formation
 - Not present everywhere
 - Ranges from clayey to sandy
 - Generally less than 5 feet in thickness
 - If present, it is overlain by loess



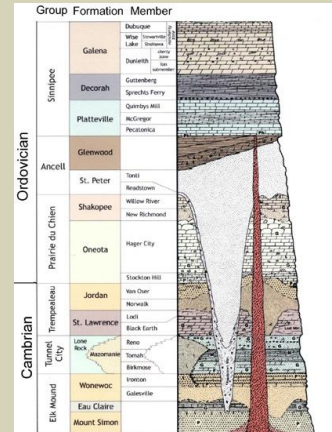
Preliminary map of the distribution of the Rountree Fm in Grant and Iowa Counties
From Eric Carson, WGNHS

18

Southwest Wisconsin Bedrock Geology



Geology from WGNHS bedrock mapping projects currently underway in SW WI. Eric Stewart and others



"Bedrock Stratigraphic Units of Wisconsin"
<https://wgnhs.wisc.edu/catalog/publication/000200/resource/es051>

19

Water Cycle

- Processes
 - Evaporation
 - Transpiration
 - Precipitation
 - Infiltration
 - Groundwater flow
 - Overland flow
 - Stream runoff

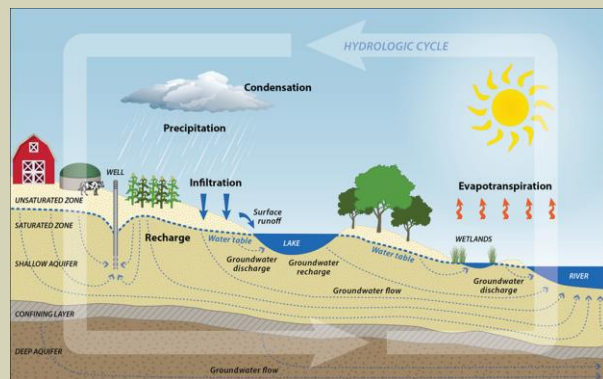
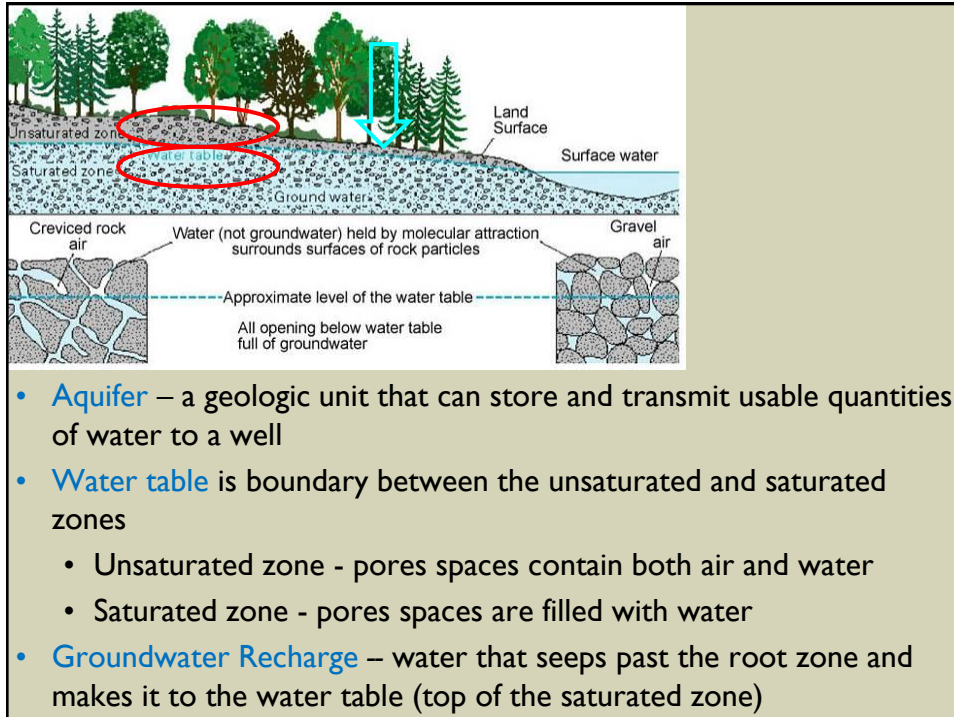
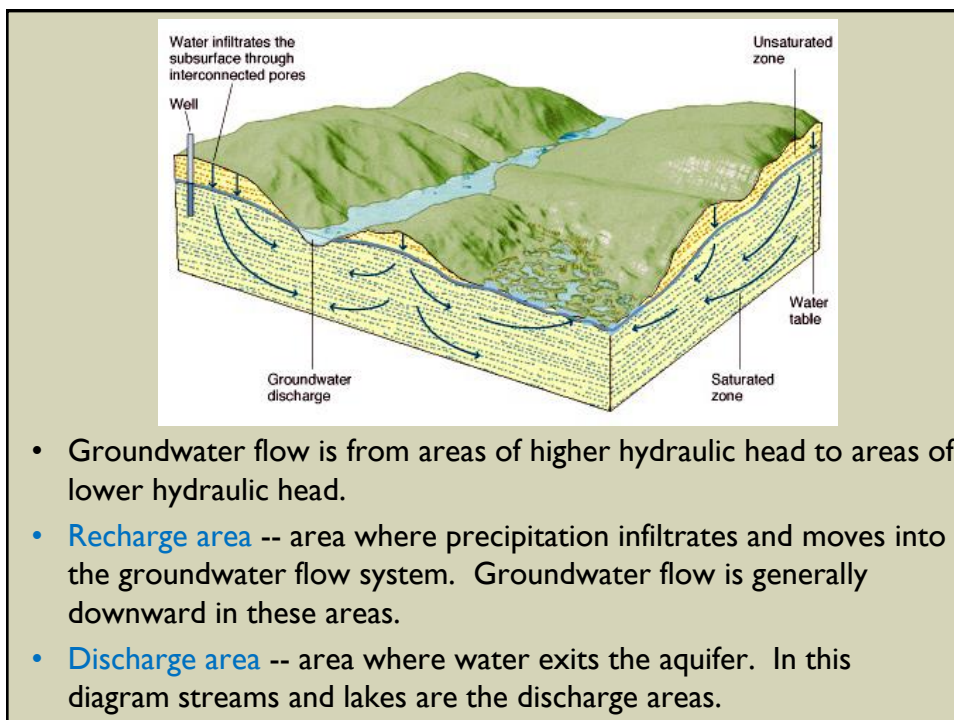


Figure from WI Geological and Natural History Survey

20

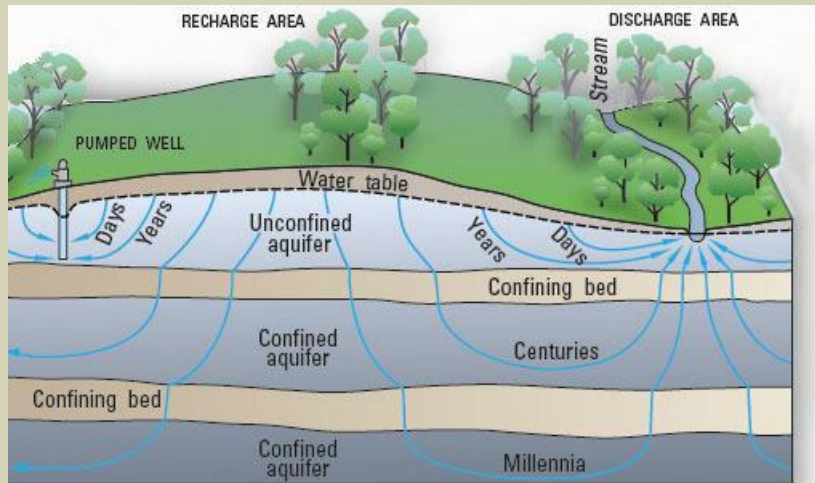


21



22

Groundwater Flow in Multi-Aquifer Systems

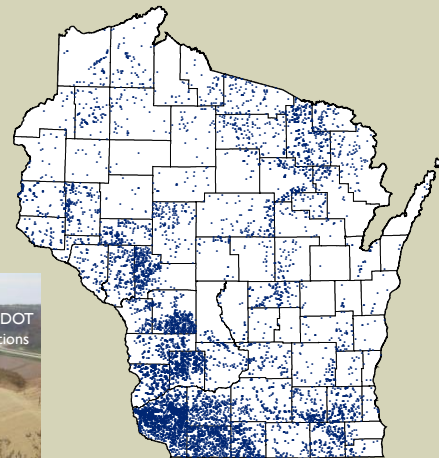


- Different rock layers have differing abilities to transport water
- Shale layers often serve to separate aquifers

23

Flow Patterns in Southwestern Wisconsin

- Short flow paths from ridgetop to adjacent creek or river
- Different rock layers can cause perching and significant lateral movement of water
- Springs common

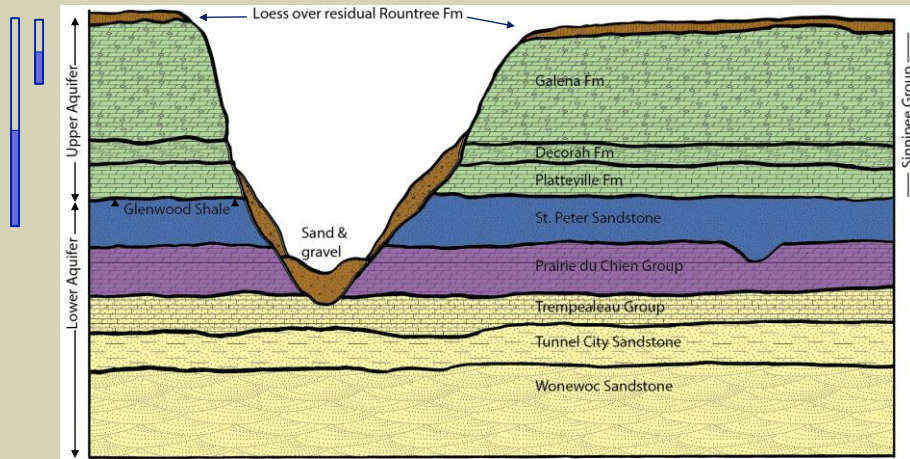


WGNHS Springs database

Above is modified from "Bedrock Stratigraphic Units of Wisconsin"
<https://wgnhs.wisc.edu/catalog/publication/000200/resource/es051>

24

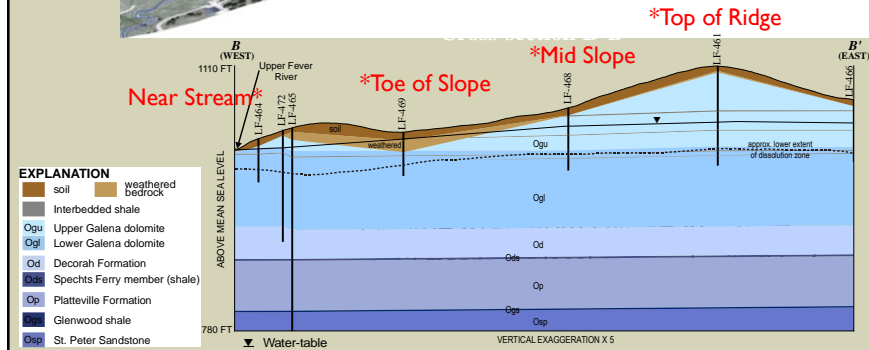
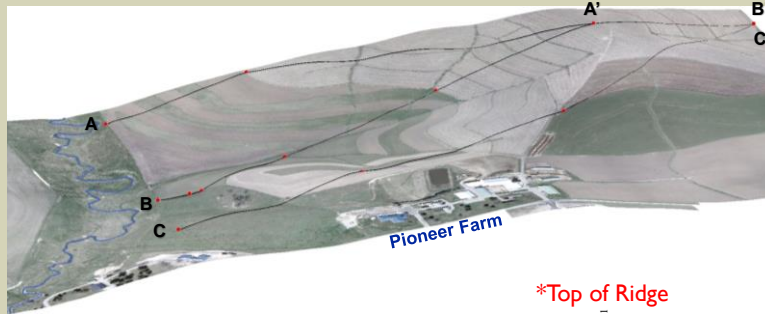
Multiple Aquifers in Southwestern WI



- Upper Aquifer consists of the Sinnipee Group (Galena, Decorah, & Platteville Fm)
- Separated from Lower Aquifer by the Glenwood Shale
- Lower Aquifer includes the St Peter sandstone, Prairie du Chien dolomite and underlying Cambrian sandstones

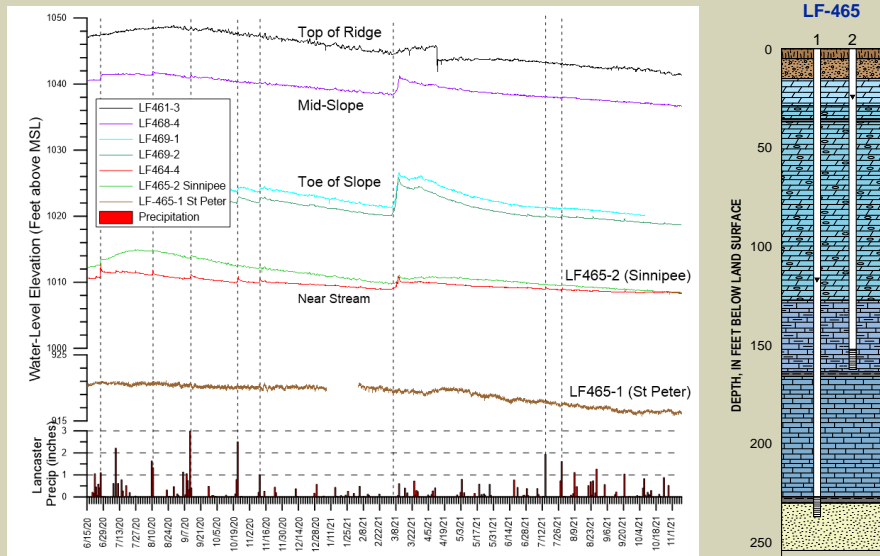
25

Hydrogeological Investigations: Pioneer Farm



26

Hydrogeological Investigations: Pioneer Farm



- Recharge to the upper aquifer is rapid
- Significant difference in water levels from upper to lower aquifer

27

Groundwater quality and risk factors for contamination

Joel Stokdyk
U.S. Geological Survey
Laboratory for Infectious Disease & the Environment
Marshfield, WI



28

Study design & objectives

Objectives

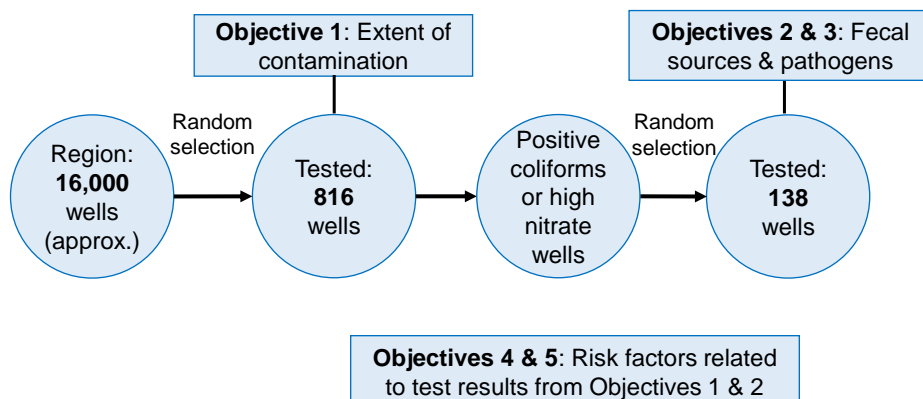
- 1) Determine the extent of contamination
- 2) Identify fecal sources
- 3) Test for pathogens
- 4) Assess well & geologic risk factors
- 5) Assess land use risk factors

Presentation organized by objective

- Approach
- Key findings
- Context & interpretation

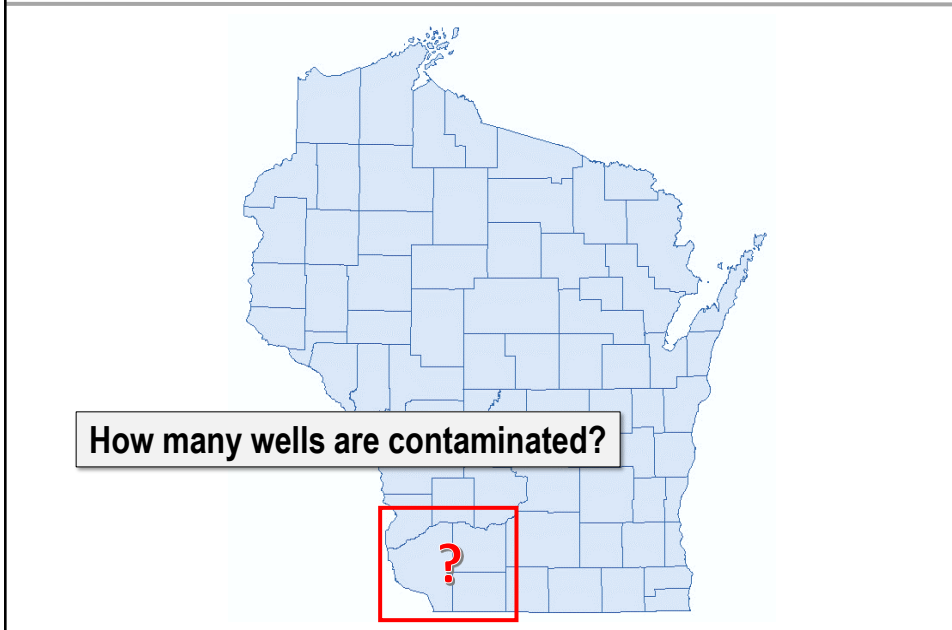
29

Study design & objectives



30

Objective 1: Extent of private well contamination



31

Objective 1: Approach

Random selection across the 3 counties

- Similar geology & land use
- Represent the 3-county region

Two 2-day synoptic events (“snap-shots”)

- Nov. 2018 & Apr. 2019
- 3,333 total solicitations, 25% participation
- 840 total samples

Total coliform bacteria, *E. coli*, & nitrate

- Analyzed by UW-Stevens Point WEAL
- Homeowner collection; free to participants

32

Objective 1: Approach

Nitrate

- Source: manure, wastewater, chemical fertilizers
- Groundwater quality standard: 10 mg NO₃⁻-N/L (10 ppm)

Total coliforms

- Source: fecal & non-fecal
- Groundwater quality standard: 0 per 100 mL

E. coli

- Source: fecal
- Groundwater quality standard: 0 per 100 mL

All 3 are commonly used to assess private well water quality

Wisconsin groundwater quality standards for bacteria & nitrate are consistent with US EPA standards for public water supplies. WDNR (2021) Groundwater quality standards, § NR 140.10. USEPA (2022). National primary drinking water regulations, 40 CFR Part 141.

33

Objective 1: Key findings

42% of wells in November & 27% of wells in April were positive for total coliforms or had high nitrate.

Private wells	Wells sampled	Total coliform	<i>E. coli</i>	High nitrate*
SWIGG: November 2018	301	34%	4%	16%
SWIGG: April 2019	539	16%	2%	15%
Statewide 1997 ^a	534	23%	3%	7%
Statewide 2013 ^b	3838	18%	-	10%
Statewide 2017 ^c	401	-	-	8%

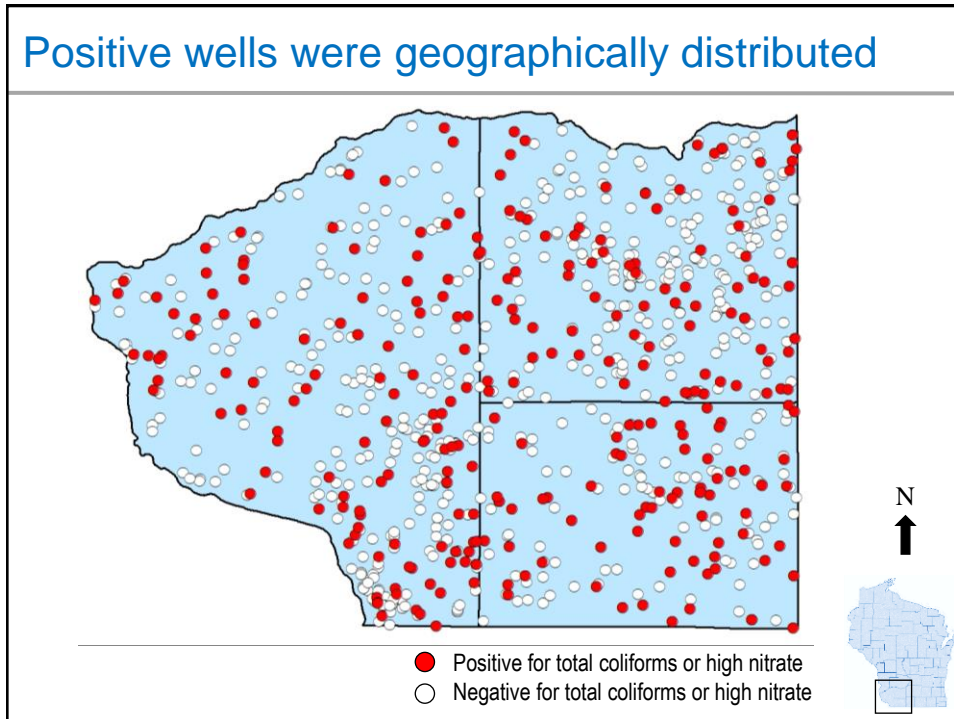
*High nitrate: NO₃⁻-N > 10 mg/L. "-" indicates data were not reported.

^a US General Accounting Office. 1997. Information on the quality of water found at community water systems and private wells. United States GAO/RCED-97-123.

^b Knobeloch L, Gorski P, Christenson M., and Anderson H. 2013. Private drinking water quality in rural Wisconsin. Journal of Environmental Health 75:16-20.

^c Agricultural chemicals in Wisconsin groundwater. 2017. Wisconsin Department of Agriculture, Trade, and Consumer Protection, ARM-PUB-264.indd.

34



35

Objective 1: Context & interpretation

1. Comparison to statewide private well data

2. Groundwater contamination can change

- Contaminant sources & weather change
- Synoptic events: 2 snap-shots with different conditions

3. Representative assessment using standard tests

- Random selection, many wells, geographically distributed
- Facilitates comparison, provides benchmark

36

Objective 2: Fecal sources



Septic systems: 16,000
 Septage/sludge: 449 permitted fields



Hogs & pigs: 77,600
 Cattle & calves: 368,128

Identifying the fecal source:
“Microbial Source Tracking”

Data from County records; WI DNR; USDA National Agriculture Statistics Service 2017 Census of Agriculture, AC-17-A-51, Washington DC.

37

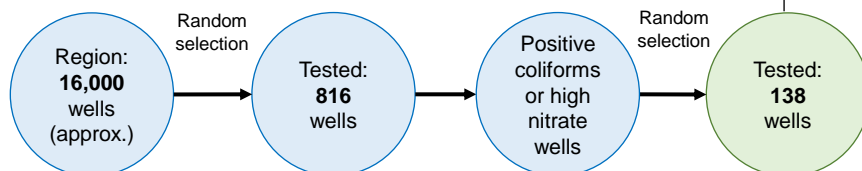
Objective 2: Approach

Sample collection

- Random selection from wells positive for total coliforms, *E. coli*, or high nitrate
- 34 or 35 wells per season, 138 wells total
- 200 gal. through hemodialysis filters & 1 L grab samples


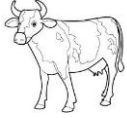
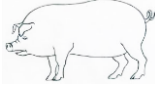


Objectives 2 & 3: Fecal sources & pathogens



38

Microbes specific to fecal sources

	Fecal source	Fecal microbe
	Human wastewater	<i>Bacteroidales-like Hum M2</i>
		<i>Cryptosporidium hominis</i>
		Human adenovirus groups A-F
		Human enterovirus
		Human polyomavirus
		Norovirus genogroup I
	Cattle/ruminant manure	Human <i>Bacteroides</i>
		<i>Bacteroidales-like cow M2</i>
		<i>Bacteroidales-like cow M3</i>
		Bovine adenovirus
		Bovine enterovirus
		Bovine polyomavirus
	Pig manure	Ruminant <i>Bacteroides</i>
		Pig-1- <i>Bacteroidales</i>
		Pig-2- <i>Bacteroidales</i>
		Porcine adenovirus
		Porcine epidemic diarrhea virus

39

Objective 2: Key findings

Human wastewater & livestock manure contribute to private well contamination, & human wastewater was more common.

Wells positive for fecal microbes (138 tested)

Fecal source	No. positive wells
Human wastewater	64
Cattle/ruminant manure	33
Pig manure	13

26 wells were positive for multiple fecal sources.

40

Objective 2: Context & interpretation

1. Few private well studies for comparison

- Human or livestock fecal microbes in 0 – 61% of wells
- Kewaunee County
 - Human: 33 of 131 wells (25%)
 - Bovine: 44 of 131 wells (34%)

2. Common fecal sources

- Septic systems: Continuous, subsurface
- Manure: Intermittent/variable

Take note!

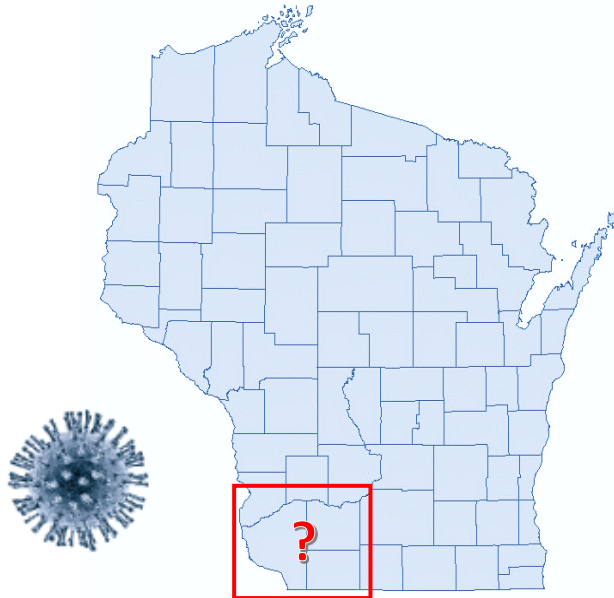


Fecal source tests don't identify sources of nitrate & total coliforms.

1. Non-fecal sources possible
2. Multiple sources possible
3. Sources can change

41

Objective 3: Pathogens



42

Objective 3: Approach

138 wells from Objective 2

- Random selection from wells positive for total coliforms, *E. coli*, or high nitrate

19 genetic tests for pathogens

- Viruses, bacteria, & protozoa
- Human & zoonotic

Take note!



Zoonotic pathogens can be passed between animals & humans.

43

Pathogen genes detected in 66 of 138 wells.

Type	Pathogen	No. positive Wells
Human	<i>Cryptosporidium hominis</i>	8
	Human adenovirus A-F	2
	Human enterovirus	1
	Human polyomavirus	0
	Norovirus genogroup I	0
Zoonotic or not host-specific	<i>Campylobacter jejuni</i>	3
	<i>Cryptosporidium parvum</i>	8
	<i>Cryptosporidium spp.</i>	29
	<i>Giardia duodenalis</i>	1
	Hepatitis E virus	0
	Norovirus genogroup II	2
	Pathogenic <i>E. coli</i>	0
	Rotavirus A (2 tests)	9
	Rotavirus C	2
	<i>Salmonella</i> (2 tests)	13
	Shiga toxin 1-producing bacteria	1
Shiga toxin2-producing bacteria	0	

44

Objective 3: Context & interpretation

1. Health risk depends on pathogen type, amount, water treatment, susceptibility

2. Pathogen sources

- Wastewater, manure, & other feces
- Source unknown for zoonotic pathogens

3. Comparison to other studies

Take note!



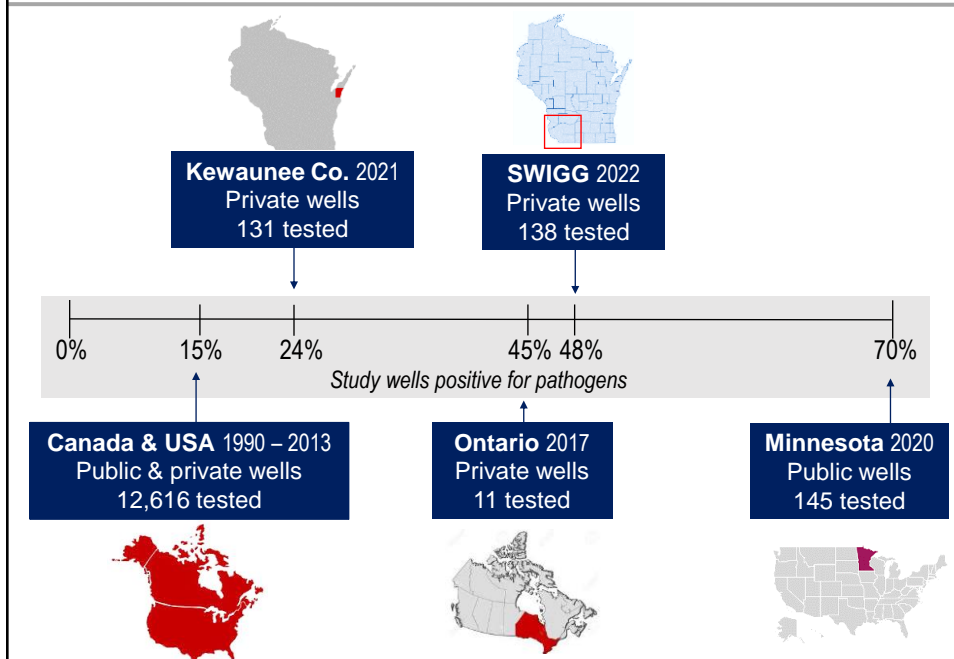
Genetic tests don't distinguish between living & dead pathogens, but they do:

1. Show pathogen contamination is possible
2. Correspond to other tests
3. Correspond to illness

Allen et al. 2017, Hydrogeol. J. 25(4); Borchardt et al. 2021, Env. Health Persp. 129(6) p.067004; Borchardt et al. 2003, Appl. Env. Micro. 69(2); Hynds et al. 2014, PLoS One. 9(5), p.e93301; Stokdyk et al. 2020, Water Res. 178 p115814

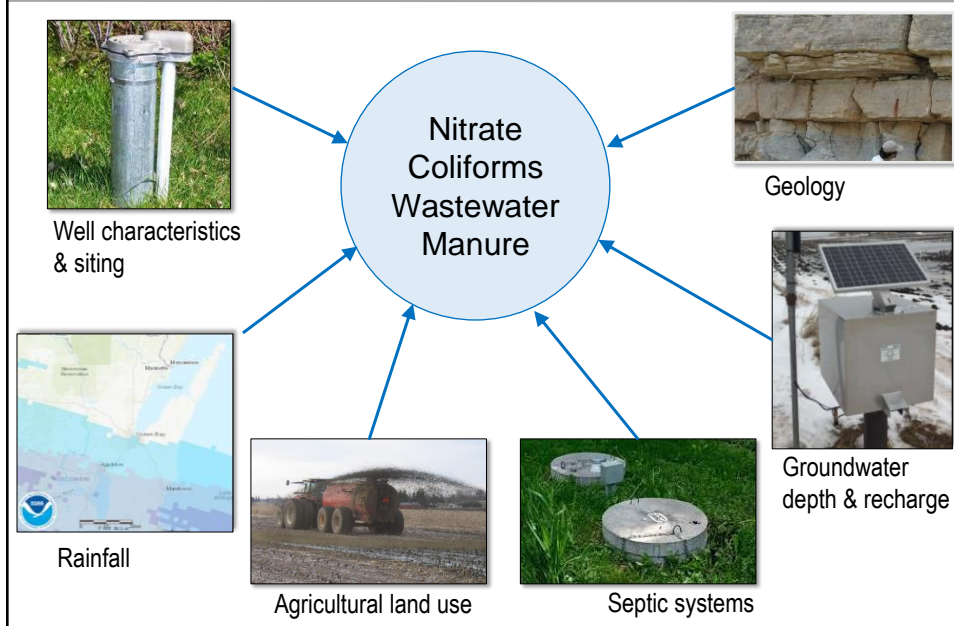
45

Pathogens in wells: Comparison to other studies



46

Objectives 4 & 5: Factors associated with contamination



47

Objective 4: Risk factors investigated

Well characteristics

Well age
Well depth
Casing depth
Groundwater depth at construction
Casing length below water table
Casing length into bedrock
Open interval length
Specific capacity

Well siting

Slope (within 750, 1500, & 3000 ft)
Soil hydrologic group
Surficial sediment type
Well elevation

Geology

Bedrock depth
Open interval geology
Topmost geology

Groundwater & rainfall

2, 7, 14, 21 days prior to sampling:

- Groundwater depth
- Groundwater recharge
- Rainfall

Data sources

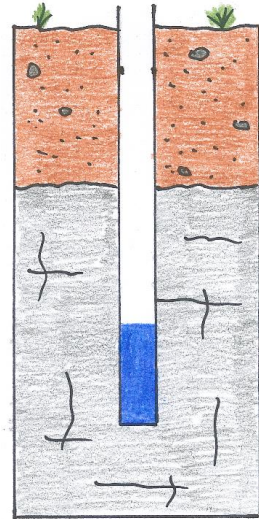
Well construction reports
Geologic maps & soil survey
Digital elevation model
National Weather Service (QPE)
Groundwater monitoring wells

48

Well characteristics were important

Significant factors (one or more contaminants)

- Well age
- Well depth
- Casing depth
- Open interval length
- Casing length into bedrock
- Casing length into groundwater
- Slope
- Elevation
- Soil

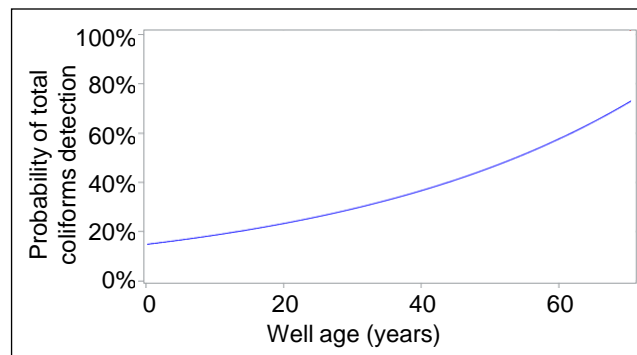


Cross-section of well

49

Examples of important well risk factors

Probability of total coliforms contamination increases with well age

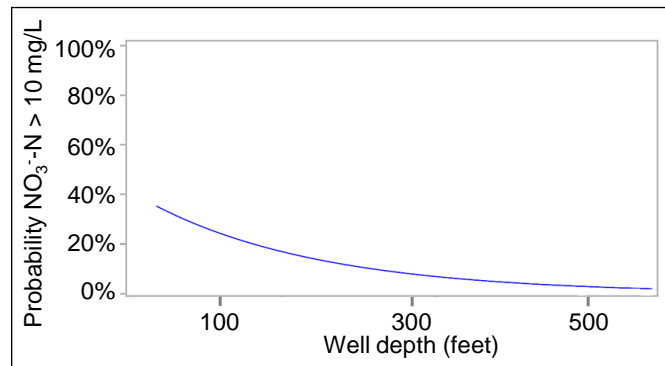


The plot shown is for the November synoptic event.

50

Examples of important well risk factors

Probability of high nitrate contamination decreases with well depth



The plot shown is for the April synoptic event.

51

Geology was important

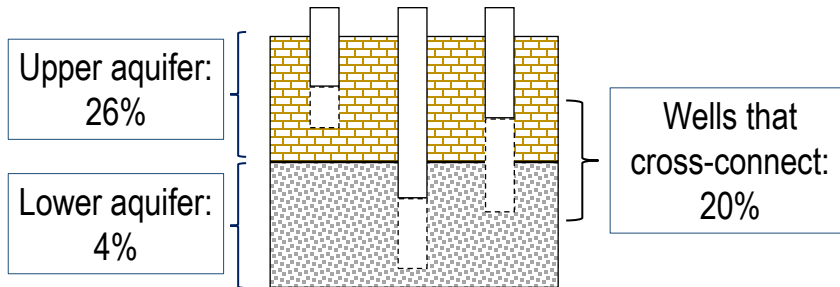
Significant factors (one or more contaminants)

- Open interval geology
- Topmost geology
- Bedrock depth

52

Example of geology factors

Open interval geology: Probability of high nitrate is greater for the upper aquifer



The data shown are for the November synoptic event.

53

Rainfall & groundwater depth were important

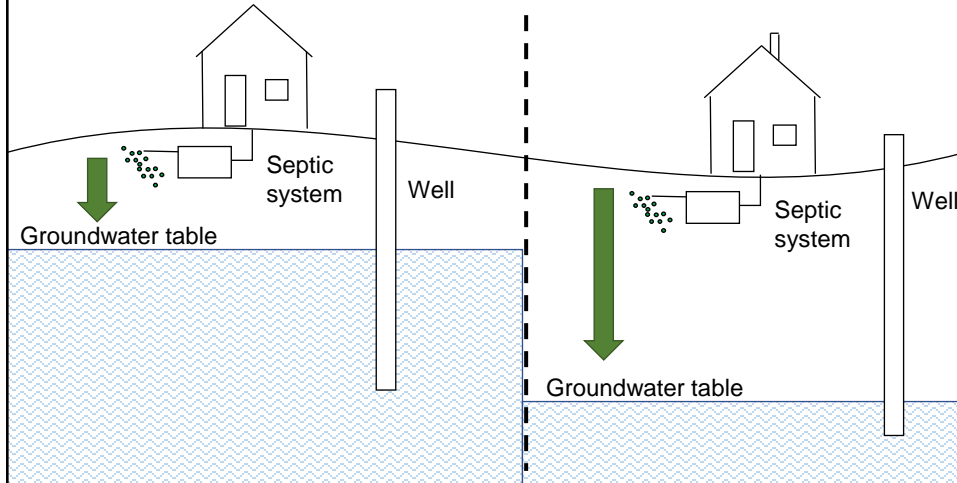
Significant factors for wastewater contamination

- Rainfall
- Groundwater depth

54

Example of rainfall & groundwater factors

Wastewater contamination is more likely when groundwater is shallow.



55

Objective 5: Risk factors investigated

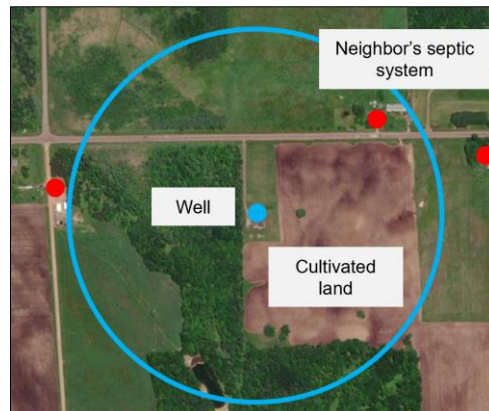
Land use

Distance; count or acres within 750, 1500, & 3000 ft of well

- Cultivated land
- Livestock farms
- Septage/municipal sludge fields
- Septic systems
- Drainfield septic systems

Data sources

USDA Cultivated Land Layer
 WI DNR
 Aerial imagery
 County records



56

Land use was important

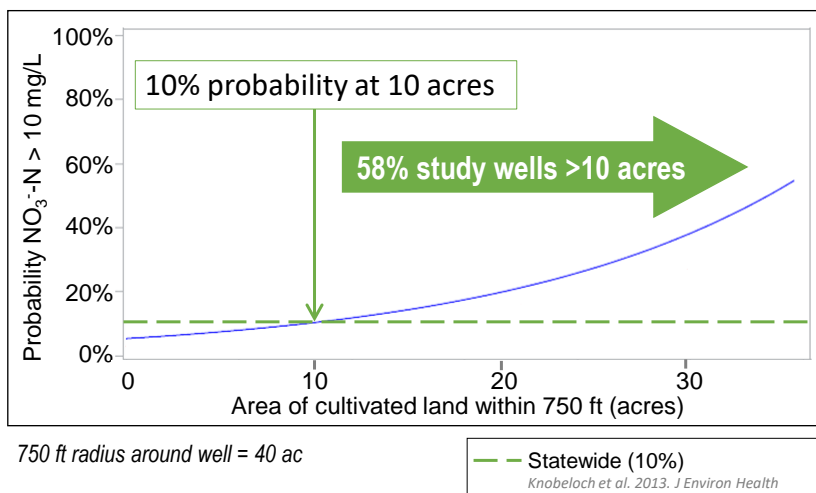
Agricultural factors were associated with nitrate, total coliforms, & manure

- Area of cultivated land nearby
- Distance to cultivated land
- Distance to livestock farm



57

Example: Probability of high nitrate increased with the area of cultivated land nearby



The plot shown is for the November synoptic event.

58

Land use was important

Septic system factors were associated with human wastewater

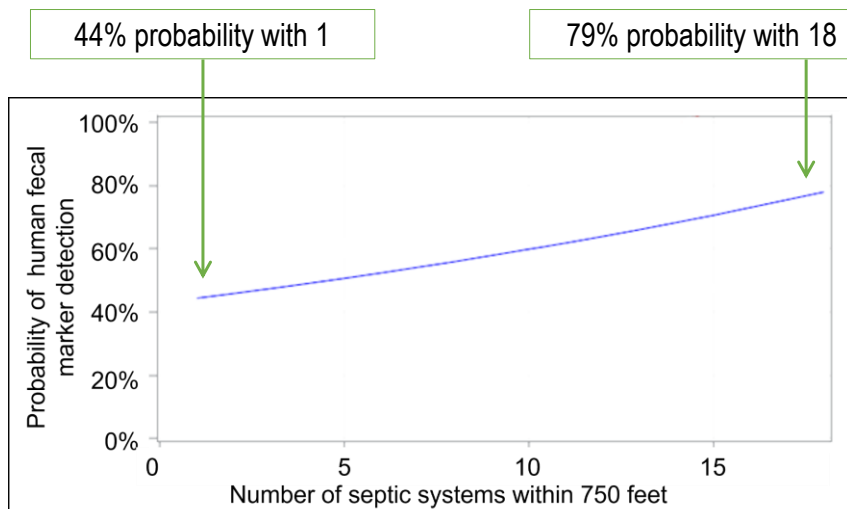
- Number of septic systems nearby
- Distance to neighbor's septic system

Septic system factors were not associated with nitrate & total coliforms



59

Example: Probability of human wastewater contamination increased with the number of septic systems nearby



60

Two study goals

An assessment of private well contamination

- Extent of contamination (Obj. 1)
- Pathogens were detected (Obj. 3)

Findings that help identify potential ways to address contamination

- Contamination from wastewater & manure (Obj. 2)
- Well, geology, & land use factors were important (Obj. 4 & 5)

61

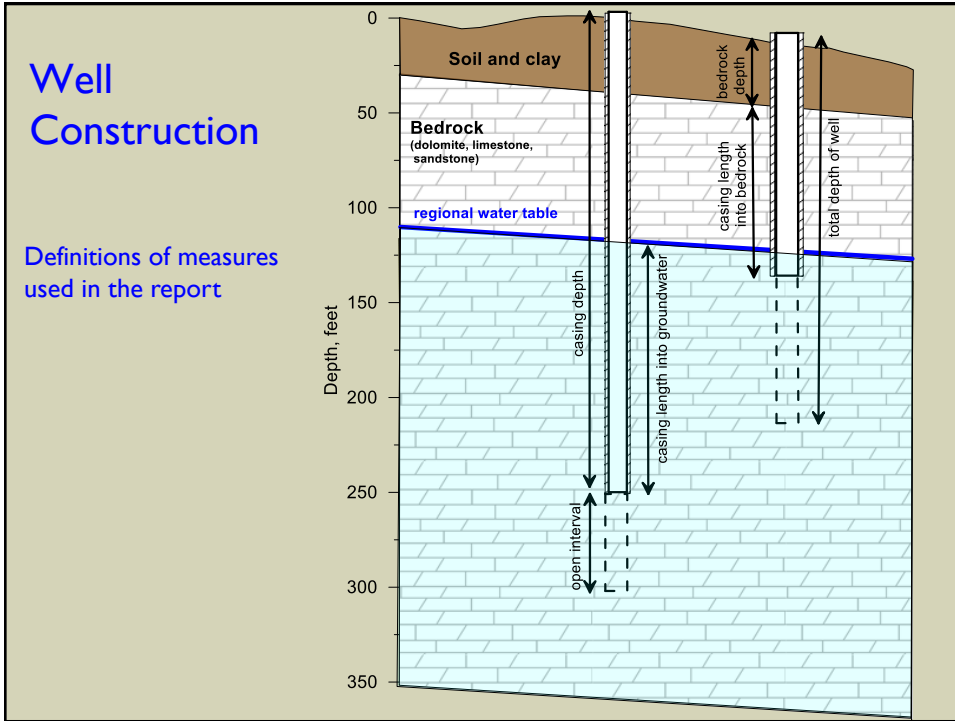
Understanding wells and what a private well owner can do

Ken Bradbury, Ph.D.
State Geologist and Director
Wisconsin Geological & Natural History Survey

62

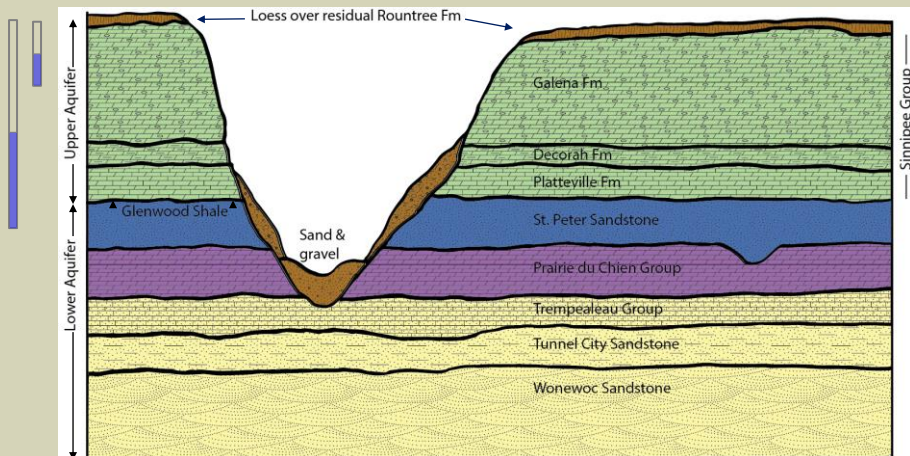
Well Construction

Definitions of measures used in the report



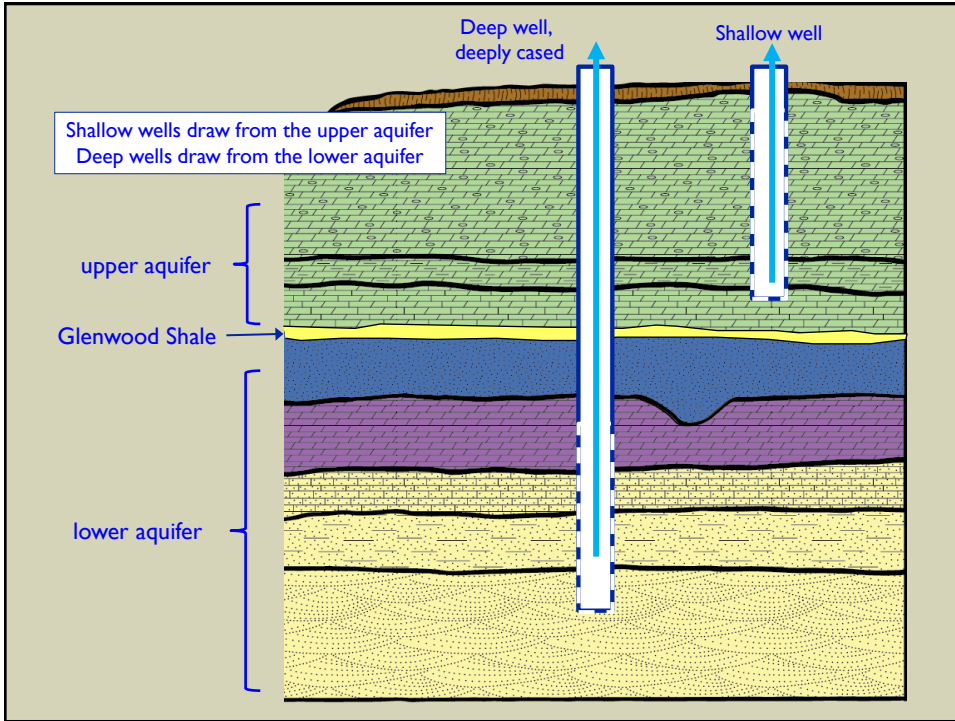
63

Multiple Aquifers in Southwestern WI

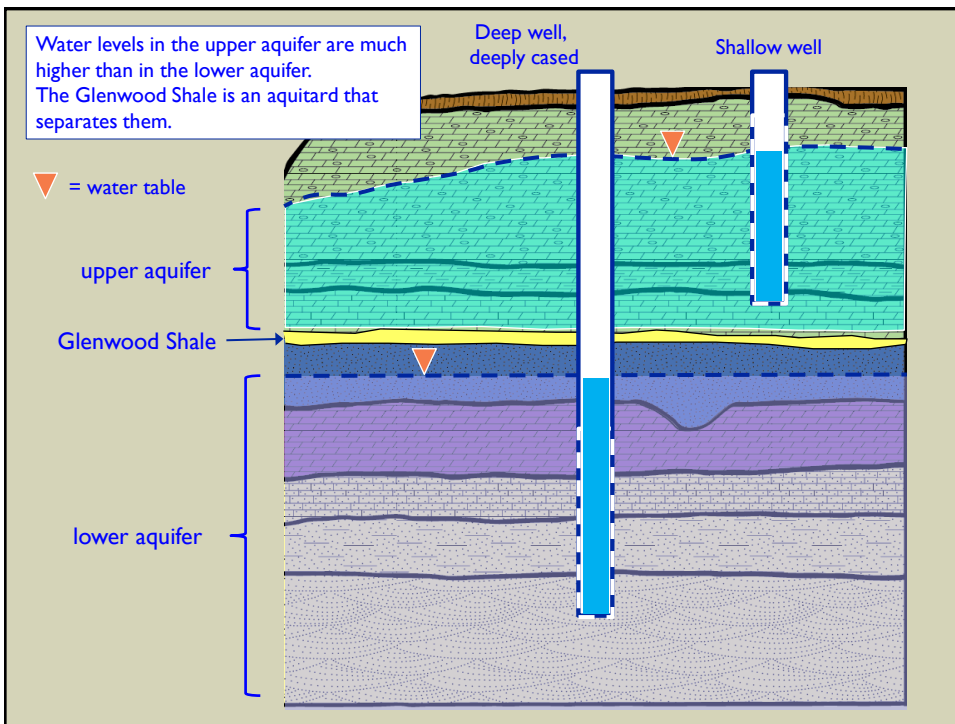


- Upper Aquifer consists of the Sinnipee Group (Galena, Decorah, & Platteville Fm)
- Separated from Lower Aquifer by the Glenwood Shale
- Lower Aquifer includes the St Peter sandstone, Prairie du Chien dolomite and underlying Cambrian sandstones

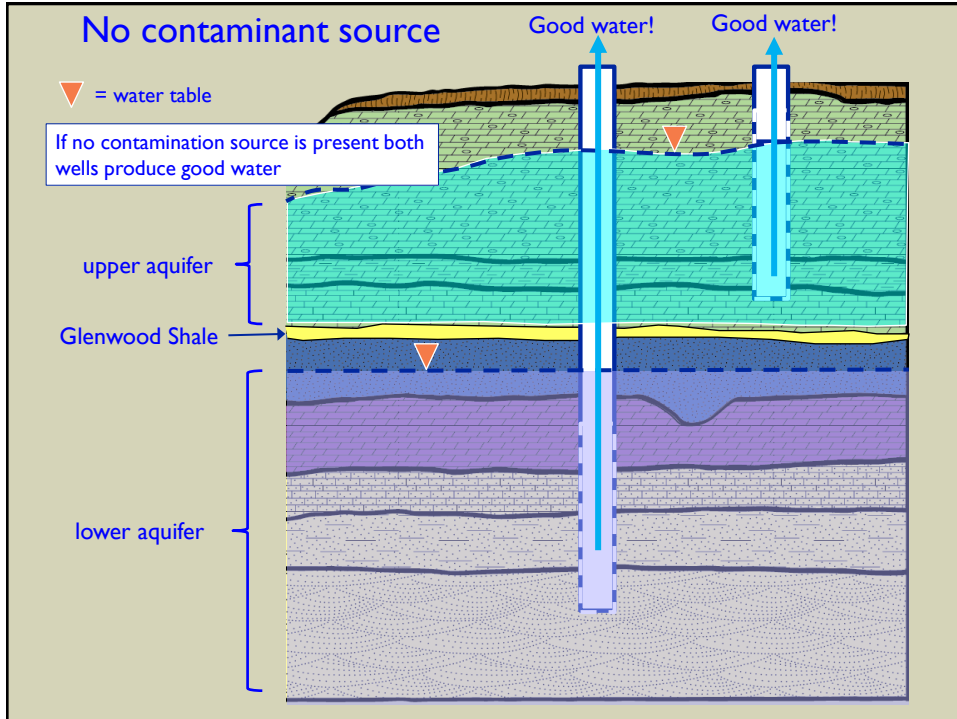
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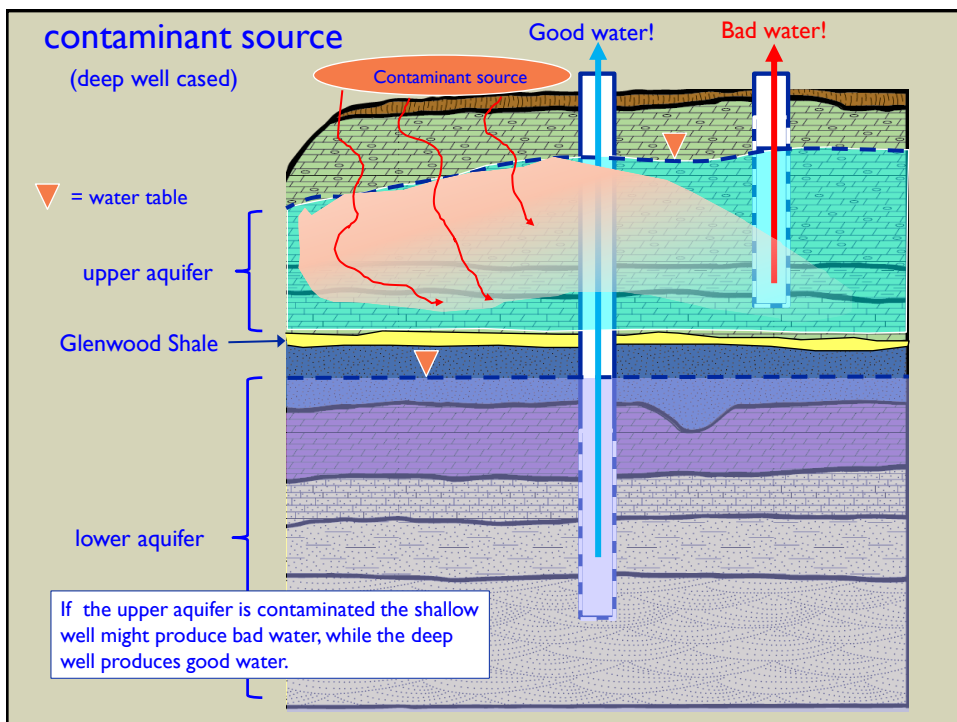
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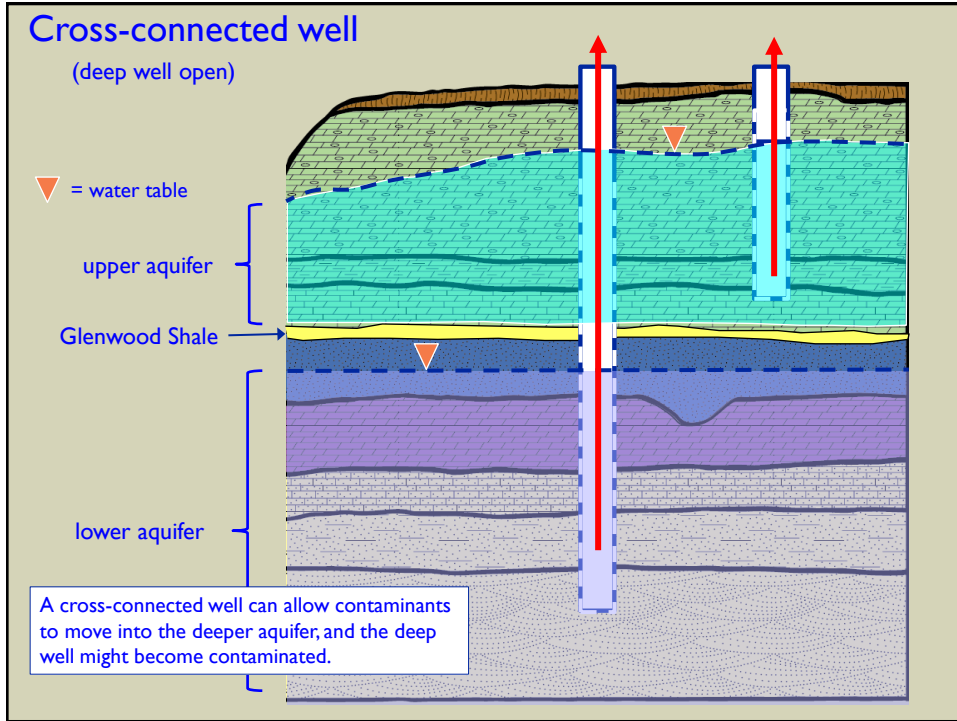
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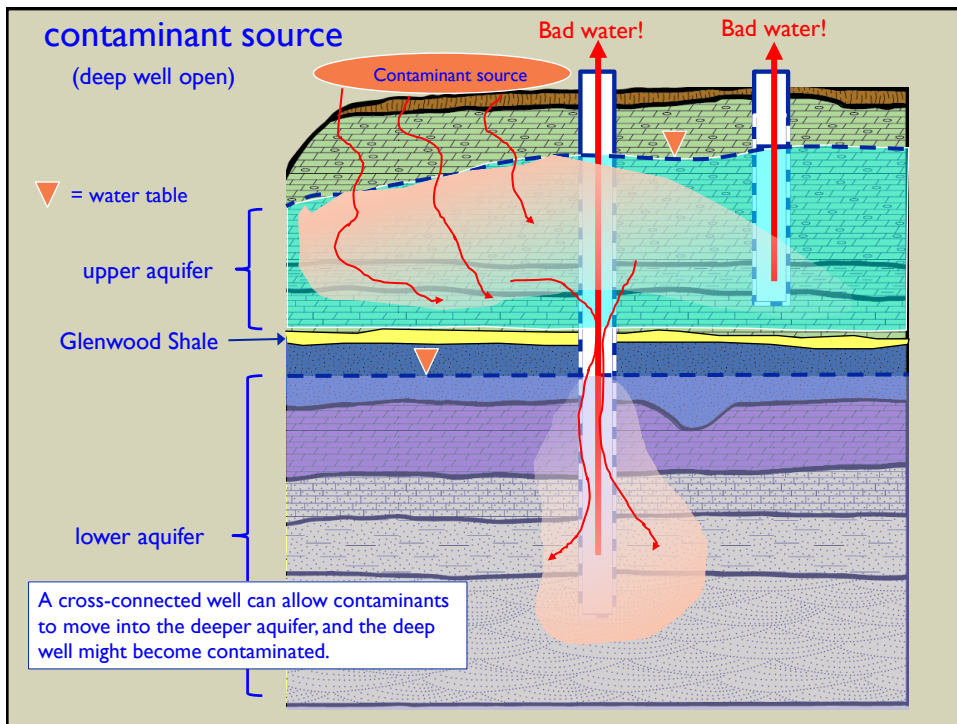
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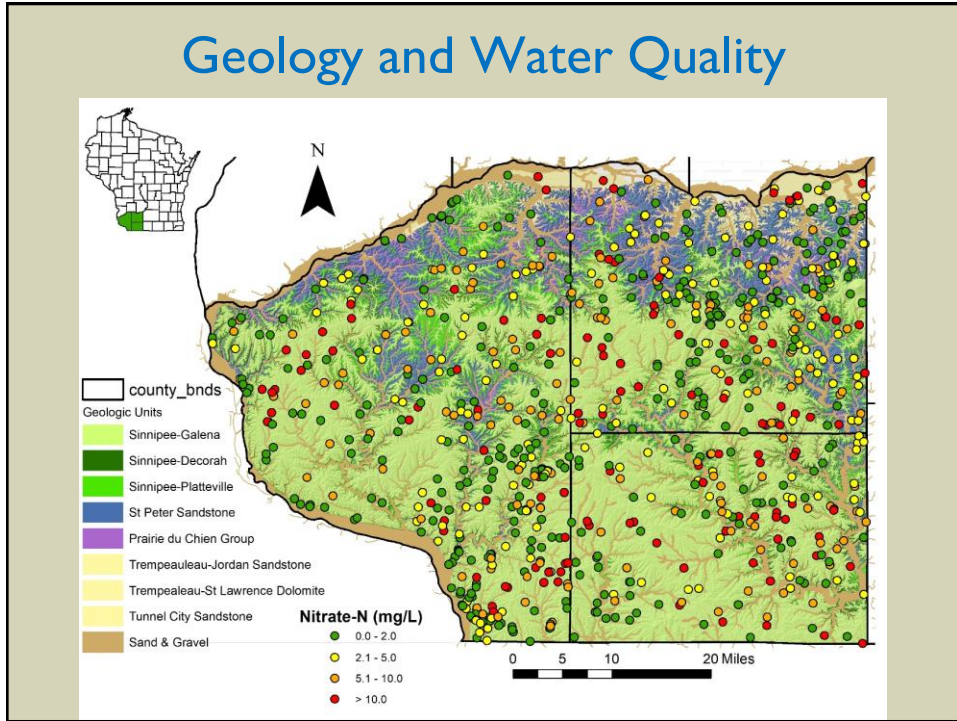
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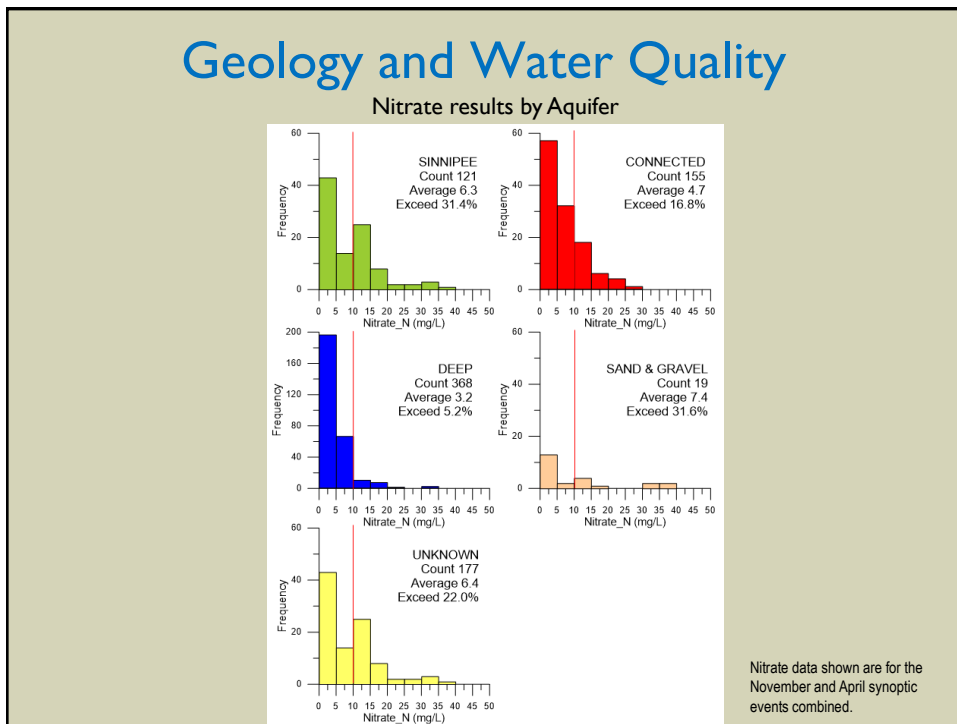
69



70



71



72

Information on Well Construction

Well construction reports (WCRs) contain information about private wells.

To find a well construction report visit the DNR website:

<https://dnr.wi.gov/WellConstructionSearch/#!/PublicSearch/Index>

Well Construction Report
 Bottle No. 2
 State of Wisconsin
 DEPARTMENT OF RESOURCE DEVELOPMENT
 SEP 19 1972
 Well 6

1. LOCATION: Lafayette, WI
 2. OWNER: J.P.D. 3, Darlington, Wisconsin

3. DISTANCE TO NEAREST WELL: 26' 59'

4. DEPTH TO WATER TABLE: 60'

5. WELL INTENDED TO SUPPLY WATER FOR: Household & Livestock

6. WELL LOG:

DEPTH (ft.)	FROM (ft.)	TO (ft.)	DESCRIPTION	THICKNESS (ft.)	REMARKS
0	Surface	6"	Black Top Soil	6"	1
6"	6"	110'	Yellow Clay	104'	7
110'	110'	113'	Sand & Clay	3'	13
113'	113'	127'	Sand & Gravel	14'	27
127'	127'	190'	Plattville Dolomite	63'	90
190'	190'	110'	Sandstone	110'	110

7. CASING LINE, CURBING, AND SCREEN: 8" Surface

8. GROUT OR OTHER SEALING MATERIAL: Puddled Clay

9. WELL CONSTRUCTION COMPLETED ON: June 15, 1973

10. SIGNATURE: [Signature]

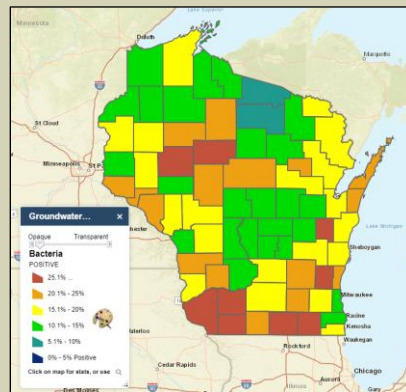
73

Information on Groundwater Quality

- UW Stevens Point Center for Watershed Science
 - Interactive program that allows you to view groundwater quality data at a variety of scales

Well Water Quality Viewer: Private Well Data for Wisconsin

Introduction: The Well Water Quality Interactive Viewer was created as an educational tool to help Wisconsin citizens understand groundwater quality and the state of their own private wells.



<https://www3.uwsp.edu/cnr-ap/watershed/Pages/WellWaterViewer.aspx>

74

Where to get help with your water

WISCONSIN DEPARTMENT OF NATURAL RESOURCES
HUNTING FISHING PARKS CLIMATE ENVIRONMENT FORES

Open all private well owners resources

Contact information for licensed well drillers and pump installers

Test your private well

- [Test your private well water annually](#)
- [Tests for drinking water from private wells \[pdf\]](#)
- Laboratories certified to test private well drinking water for:
 - [bacteria](#)
 - [other contaminants](#)

Your well's water quality and possible water problems

- [What's wrong with my water?](#) — pinpoint your water problem and what can be done about it.
- [Identify your water's symptoms](#) — does your water smell, look, taste or feel funny?
- [Statewide water quality viewer \[ext. link\]](#)
- [Water quality and contamination](#)
- [Arsenic in drinking water \[pdf\]](#)
- [Bacteria in drinking water \[pdf\]](#)
- [Nitrate in drinking water \[pdf\]](#)
- [Manure and drinking water](#)
- [Flooded wells](#)

The WDNR has a variety of publications

<https://dnr.wisconsin.gov/topic/Wells/homeowners.html>

75

The Center for Watershed Science and Education at UW Stevens Point has numerous education resources about groundwater and wells

<https://www3.uwsp.edu/cnr-ap/watershed/Pages/GWHome.aspx>

62826

Improving Your Private Well Water Quality

Kevin Masarik

While most private wells in Wisconsin provide water that is safe and good quality, many private well owners may have one or more water quality problems. Some are quite noticeable. Others, particularly those that are health-related, often require testing to detect them. The search for ways to improve water quality can be challenging. This publication describes options for improving private residential well water quality, including water treatment methods.

What's in your water?

Groundwater, the source of water for private wells, is never simply a pure combination of hydrogen and oxygen atoms (H₂O). It naturally contains many impurities, reflecting the composition of the soil, sand, gravel and rock through which it travels. Groundwater contains: 1) dissolved minerals such as iron, calcium, magnesium, bicarbonate, chloride, and sulfate; 2) gases such as carbon dioxide, oxygen, and nitrogen; and 3) dissolved organic compounds. As a result of human activity, groundwater can also contain contaminants such as pesticides, nitrate and volatile organic chemicals (VOCs).

Typical concentrations of most impurities are not considered harmful to health, but private well owners may find some of their non-health-related problems objectionable. Too much iron, for example, can discolor laundry or clog filters. Excessively high calcium can cause scale, such as in water heaters and plumbing. High-nitrate water quality is more serious if the water contains substances that pose a health concern such as bacteria, nitrites, nitrate, metals such as lead or arsenic, pesticides or VOCs.

While private well owners are under no obligation to correct water quality problems, safe drinking water standards are good guidelines for homeowners to determine whether their private well water is safe to drink.

What to do if you have water quality problems

What are the best options available to homeowners who have water quality problems? If your water is persistently contaminated with substances that pose a health concern or the water is extremely objectionable, consider the following options before resorting to water treatment.

Eliminate sources of contamination

Human activities, the ideal solution is to eliminate the contaminant source. Sometimes the source is local, such as a septic system, an unsealed well, fertilizers or pesticides, sink holes, a chemical spill, leaking storage tank, or seepage from a barnyard. If you are able to, eliminate the source and water quality should eventually improve through filtration, breakdown of the contaminants, dilution and movement of the contaminants away from your well. Depending on the local geology and type of pollutant, however, the improvement may take far too long—years or decades—and an additional solution may still be required to provide a safe source of water.

Repair or replace the existing system

Correct construction faults. Making sure that your well has a vermin-proof cap and diverting surface water drainage away from the well may both help in some cases. Persistent bacterial contamination or cloudy water may indicate problems such as a cracked casing, poor gravel and seals, or rock fractures that allow rapid movement of surface water into the well. Your plumber, well installer, county sanitizer or Wisconsin Department of Natural Resources water supply specialist can help diagnose and correct such problems.

62899

Maintaining your home well water system

Christine Meacham, George Gibson, Jim Peterson, Byron Shaw and Gary Jackson

Your well system is usually installed, properly constructed and maintained, correctly maintained and regularly tested, you should have few problems with water quantity and quality. Construction, maintenance and protection of home wells are the keys to safe water.

This fact sheet provides a place for you to record and save vital information about your well water. This information will be valuable to any professional asking you about your water system. It should be filed with other documents about your home and property, and passed on to future owners.

Since 1988, well construction reports have been required for all wells installed by licensed well drillers. Some law requires the driller to provide one copy to the homeowner and another to the Wisconsin Department of Natural Resources. If you did not receive a report, ask your well driller, or request one (for a fee) from the Wisconsin Geological and Natural History Survey in Madison (see back page for address).

The well construction report provides much of the basic information you need to record. If a report cannot be located, it is doubly important to record information about the well as opportunities arise. For example, if a pump must be replaced, the pump installer may be able to measure the depth of the well and depth to water at that time.

The hydrologic cycle—your water source

Water on or over the earth falls to the earth's surface, some water runs off into lakes or streams. Much of the rest soaks into the soil (see figure 1). Plants use some of it. Some evaporates. Some trickles slowly downward through the soil until it reaches the saturated zone, where all the spaces between rock and soil particles are filled with water. The top of this zone is called the water table. Water below the water table is groundwater. Wells extend below the water table to collect groundwater for your use.

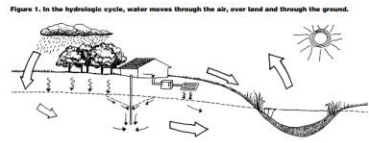
Groundwater flows slowly underground from high to low areas. The slope of the water table often parallels the slope of the land surface. Groundwater becomes surface water again when it discharges into lakes, streams and springs. Surface water may then evaporate to form clouds and begin the cycle again. So groundwater, far from being new water from within the earth, is water that has been recycled many times since the earth was young.

Protect your water supply

Proper well siting and construction are a homeowner's first defense against unsafe water. The Wisconsin DNR administers a well code, which provides minimum standards for well depth, construction materials and distance from potential pollution sources. In addition to meeting construction standards, it's important to locate your well upgradient (usually uphill) from potential pollution sources. Contact the regional DNR office for advice on well construction or placement.

If a groundwater supply is initially adequate and safe, homeowners must protect it by installing a proper withdrawal and distribution system. You can also protect your water supply with the following measures:

- Gravel your fill of surface water runoff away from the well.
- Check to make certain that the well cap or seal is clean and tightly secured. Ensure that insects and other vermin cannot enter. A vermin-proof well cap is one solution.
- Avoid using gasoline and lawn, household or agricultural chemicals near the well.



76

The Wisconsin Geological and Natural History Survey provides maps, publications, and data about geology and groundwater

<https://wgnhs.wisc.edu/>

Preliminary Quaternary Geology of Grant County, Wisconsin

Eric C. Carson
2012

SHADED RELIEF OF GRANT COUNTY
Eric Carson

Consolidated Map Units

PUBLICATIONS CATALOG
Wisconsin Geological and Natural History Survey

WGNHS HOME CATALOG BROWSE PUBLICATIONS

Publications

LOCATION

12 PUBLICATIONS FOUND FOR 'IOWA COUNTY' Order by: Best Match

Groundwater Resources, Iowa County, Wisconsin
This four-part series describes the results of a comprehensive inventory and assessment of Iowa County's groundwater resources. Covers water table elevation, groundwater recharge, groundwater susceptibility, and the springs of Iowa County.

Water Table Elevation, Iowa County, Wisconsin
Coffredo, M.B.
2000
Report 12

Groundwater Recharge, Iowa County, Wisconsin
Coffredo, M.B.
2000
Report 12

77