# Town of Lincoln Groundwater Study: Kewaunee County, Wisconsin

## AWRA – WI Section Annual Meeting

## March 9th, 2017

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Wisconsin Geological & Natural History Survey

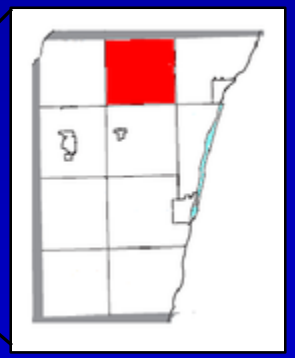
Ahnapee River Photo – David Mickelson

# Study overview

- Started fall 2015

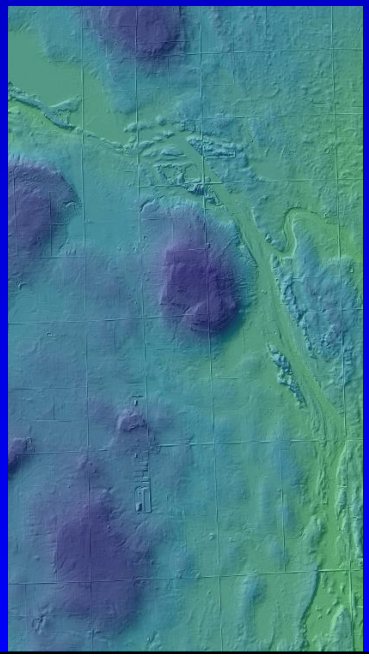
**Project team at WGNHS**

Hydrogeologist, GIS Specialist, & Geophysicist



**Map deliverables include:**

- **Depth to bedrock**
- Water table
- **Groundwater recharge**
- Groundwater contaminant susceptibility
- **Closed depressions**



**1.5 year study:**

- Complete in summer 2017
- Includes existing data + new field data
- Received support from landowners, town, county, and farmers

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# Study overview

- Study Commissioned by the Town of Lincoln
- Kewaunee County developed a new ordinance in 2014 to limit winter and early spring waste spreading on thin soils over carbonate bedrock.
- The ordinance was passed by all towns in the county in April 2015.
- Existing regional depth to bedrock maps (USGS/DNR, 1979) provide limited detail for enforcing the ordinance.

# Depth to bedrock

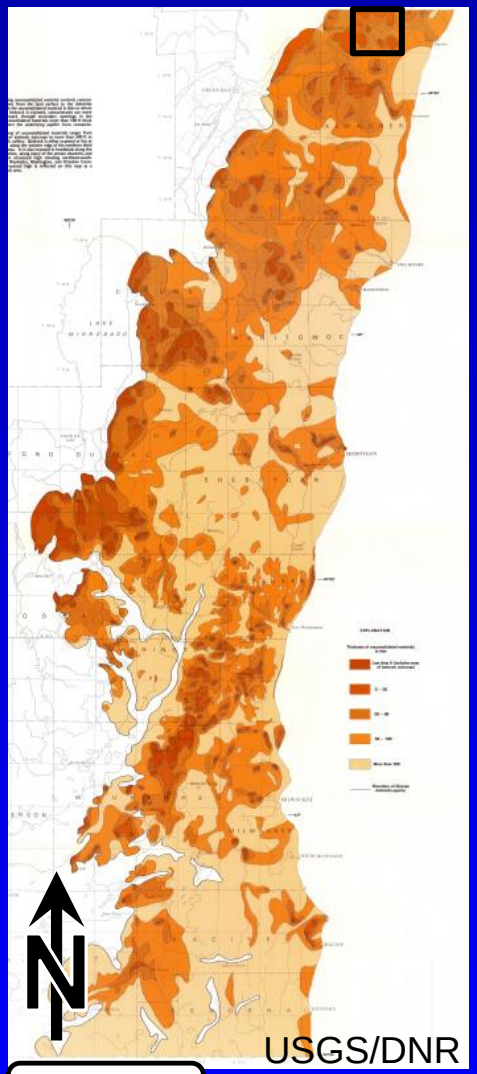
THICKNESS OF UNCONSOLIDATED MATERIALS

BY
M. G. SHERRILL
1979

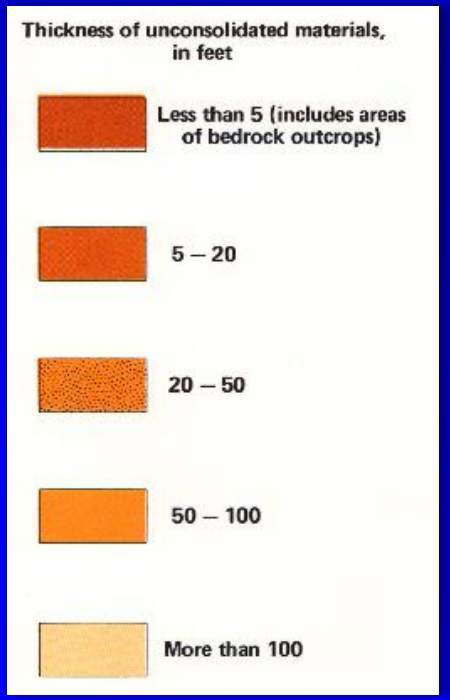
This map is the basis for all existing Kewaunee Co. depth-to-bedrock maps.

Developed for eastern WI, from Kenosha Co. to Kewaunee Co.

Mapped at a regional scale, not at the County or Town scale!




Town of Lincoln

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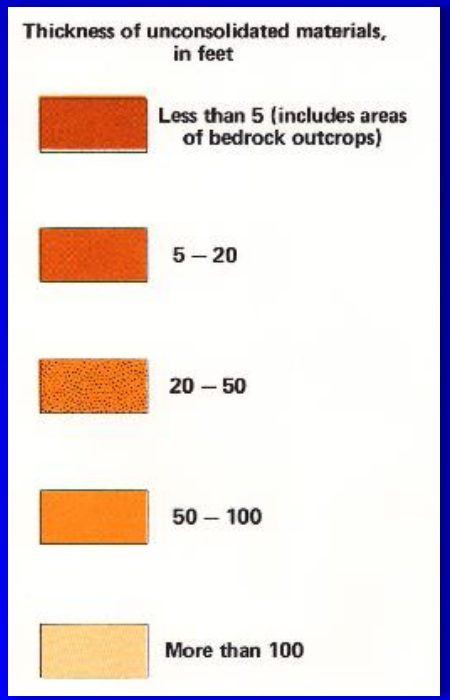
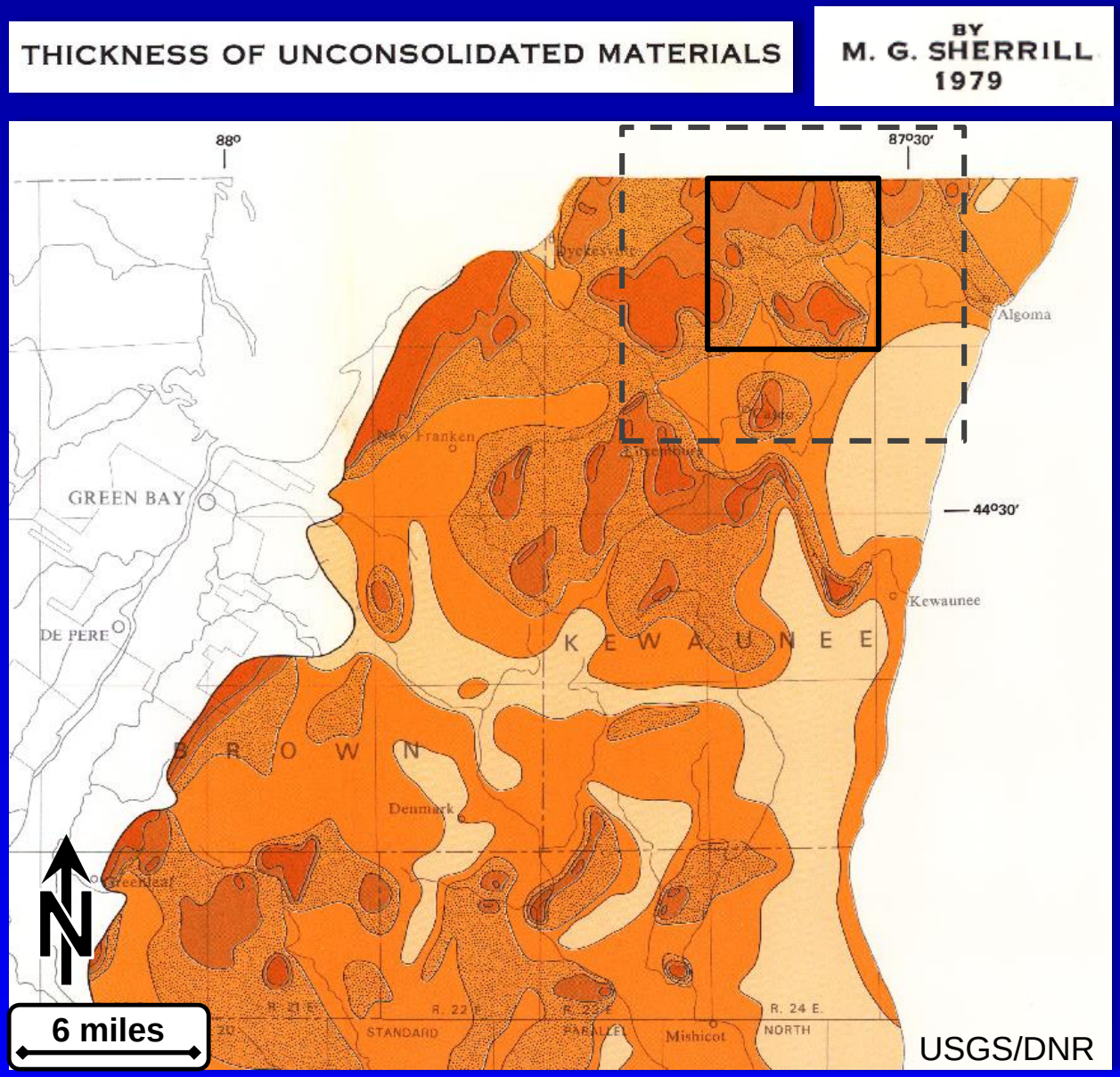
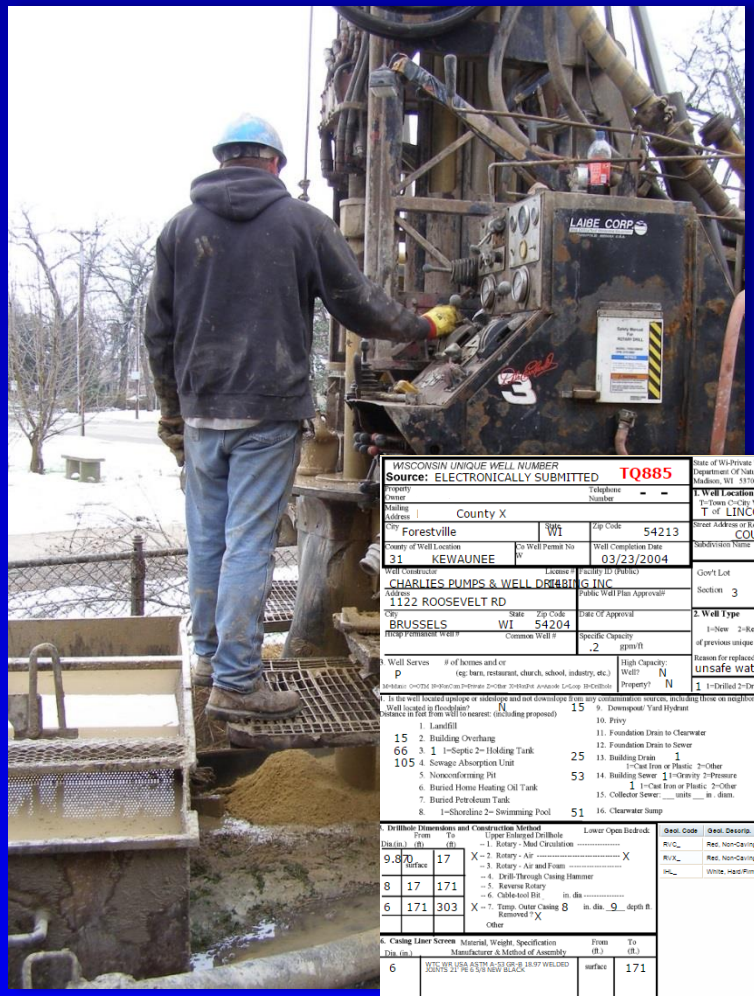
# Depth to bedrock

Today, the mapping can be improved with more recent data sets and techniques



# Depth to bedrock






WISCONSIN UNIQUE WELL NUMBER
Source: ELECTRONICALLY SUBMITTED TQ885

State of WI-Private Water Systems-DG/2 Department Of Natural Resources, Box 7921 Madison, WI 53707 Form 3300-77A (Rev 02/02)bw

Depth 303 FT

1. Well Location
T=Town C=City V=Village T of LINCOLN
Fire# E3853
Street Address or Road Name and Number COUNTY X
Subdivision Name | Lot# | Block #
Gov't Lot | or NE 1/4 of NW 1/4 of
Section 3 T 25 N R 24 E

Property Owner | Telephone Number - -
Mailing Address County X
City Forestville | State WI | Zip Code 54213
County of Well Location 31 KEWAUNEE | Co Well Permit No | Well Completion Date 03/23/2004
Well Constructor CHARLIES PUMPS & WELL DRILLING INC | License # | Facility ID (Public)
Address 1122 ROOSEVELT RD | Public Well Plan Approval#
City BRUSSELS | State WI | Zip Code 54204 | Date Of Approval
Pump Permanent Well # | Common Well # | Specific Capacity .2 gpm/ft

2. Well Type 2 (See item 12 below)
1=New 2=Replacement 3=Reconstruction
of previous unique well # _____ constructed in _____
Reason for replaced or reconstructed Well? unsafe water
1 1=Drilled 2=Driven Point 3=Jetted 4=Other

3. Well Serves P # of homes and/or (eg: barn, restaurant, church, school, industry, etc.)
High Capacity: Well? N Property? N

4. Is the well located upslope or sideslope and not downslope from any contamination sources, including those on neighboring properties? Y
Well located in Floodplain? N
Distance in feet from well to nearest: (including proposed)
15 1. Landfill
15 2. Building Overhang
66 3. 1 1=Septic 2= Holding Tank
105 4. Sewage Absorption Unit
5. Nonconforming Pit
6. Buried Home Heating Oil Tank
7. Buried Petroleum Tank
8. 1=Shoreline 2= Swimming Pool
9. Downspout/ Yard Hydrant
25 10. Privy
11. Foundation Drain to Clearwater
12. Foundation Drain to Sewer
53 13. Building Drain 1 1=Cast Iron or Plastic 2=Other
14. Building Sewer 1 1=Gravity 2=Pressure 1 1=Cast Iron or Plastic 2=Other
15. Collector Sewer: __ units __ in . diam.
51 16. Clearwater Sump
105 17. Wastewater Sump
105 18. Paved Animal Barn Pen
19. Animal Yard or Shelter
93 20. Silo
21. Barn Gutter
22. Manure Pipe 1=Gravity 2=Pressure 1=Cast Iron or Plastic 2=Other
23. Other manure Storage
24. Ditch
25. Other NR 812 Waste Source

5. Drillhole Dimensions and Construction Method — Lower Open Bedrock; Upper Enlarged Drillhole

| Dia (in.) | From (ft) | To (ft) | |
|---|---|---|---|
| 9.87 | surface | 17 | |
| 8 | 17 | 171 | |
| 6 | 171 | 303 | |

1. Rotary - Mud Circulation
X 2. Rotary - Air X
3. Rotary - Air and Foam
4. Drill-Through Casing Hammer
5. Reverse Rotary
6. Cable-tool Bit in. dia
X 7. Temp. Outer Casing Removed X — 8 in. dia. 9 depth ft.
Other

| Geol. Code | Geol. Descrip. | From (ft) | To (ft) |
|---|---|---|---|
| RVC_ | Red, Non-Caving, Clay | 0 | 6 |
| RVK_ | Red, Non-Caving, Sand & Clay | 6 | 14 |
| IHC_ | White, Hard/Firm, Limestone/Dolomite | 14 | 303 |

6. Casing Liner Screen

| Dia (in.) | Material, Weight, Specification Manufacturer & Method of Assembly | From (ft.) | To (ft.) |
|---|---|---|---|
| 6 | WTC WR USA ASTM A-53 GR-B 18.97 WELDED JOINTS 21 PE 8 5/8 NEW BLACK | surface | 171 |

| Dia (in.) | Screen type, material & slot size | From | To |
|---|---|---|---|

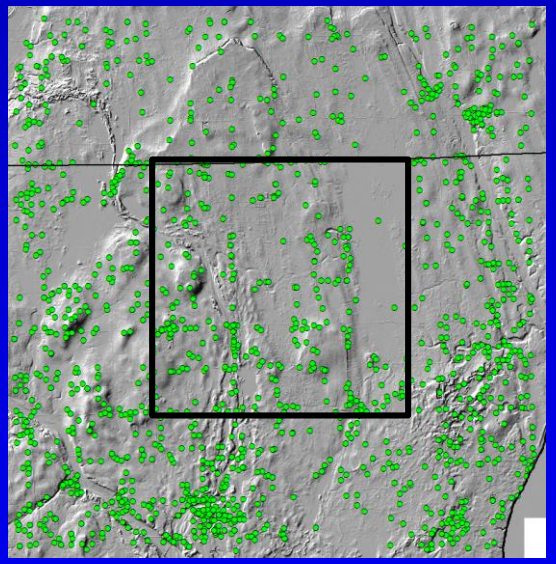
7. Grout or Other Sealing Material

| Method | Kind of Sealing Material | From (ft.) | To (ft.) | # Sacks Cement |
|---|---|---|---|---|
| Bradenhead | Neat cement grout | 0 surface | 171 | 20 |

8. Static Water Level 25 feet B ground surface A=Above B=Below
10. Pump Test Pumping level 100 ft. below surface Pumping at 15 GPM 1 Hrs
11. Well Is: 14 in. A Grade A=Above B=Below
Developed? Y
Disinfected? Y
Capped? Y
12. Did you notify the owner of the need to permanently abandon and fill all unused wells on this property? Y If no, explain
13. Initials of Well Constructor or Supervisory Driller RM Date Signed 04/26/2004
Initials of Drill Rig Operator (Mandatory unless same as above) Date Signed

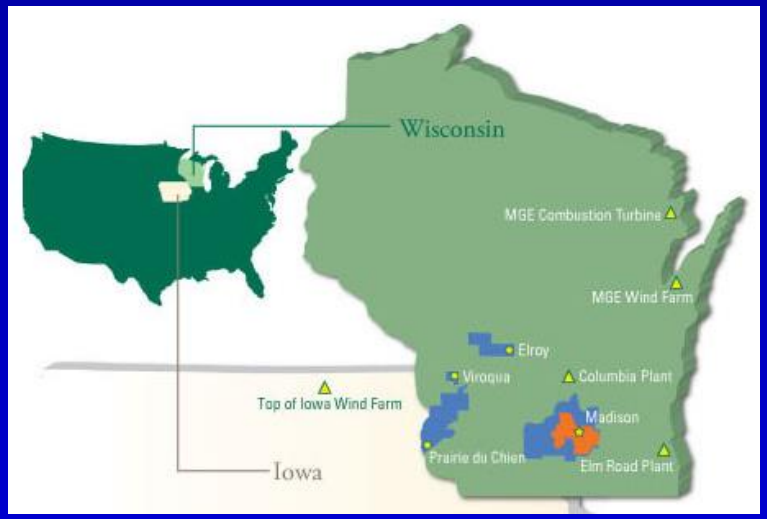
## Well construction records

- Obtained from DNR
- Included earlier scanned WCRs
- WGNHS confirmed locations
- 1,780 WCRs (entire study area)



*Only as accurate as the driller completing form, but many records exist*

# Depth to bedrock



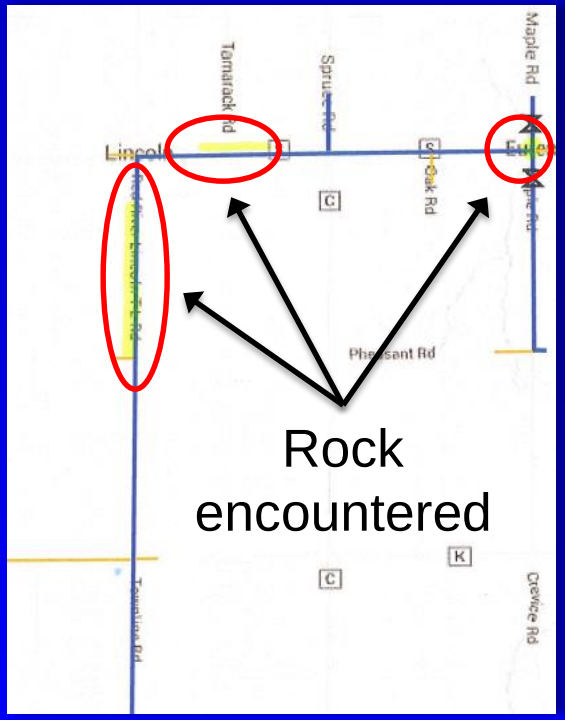

**Wind turbine borings**

- Obtained from MG&E and Wisconsin Public Service Corp.
- At least 1 boring/turbine
- Often shallow depth to rock

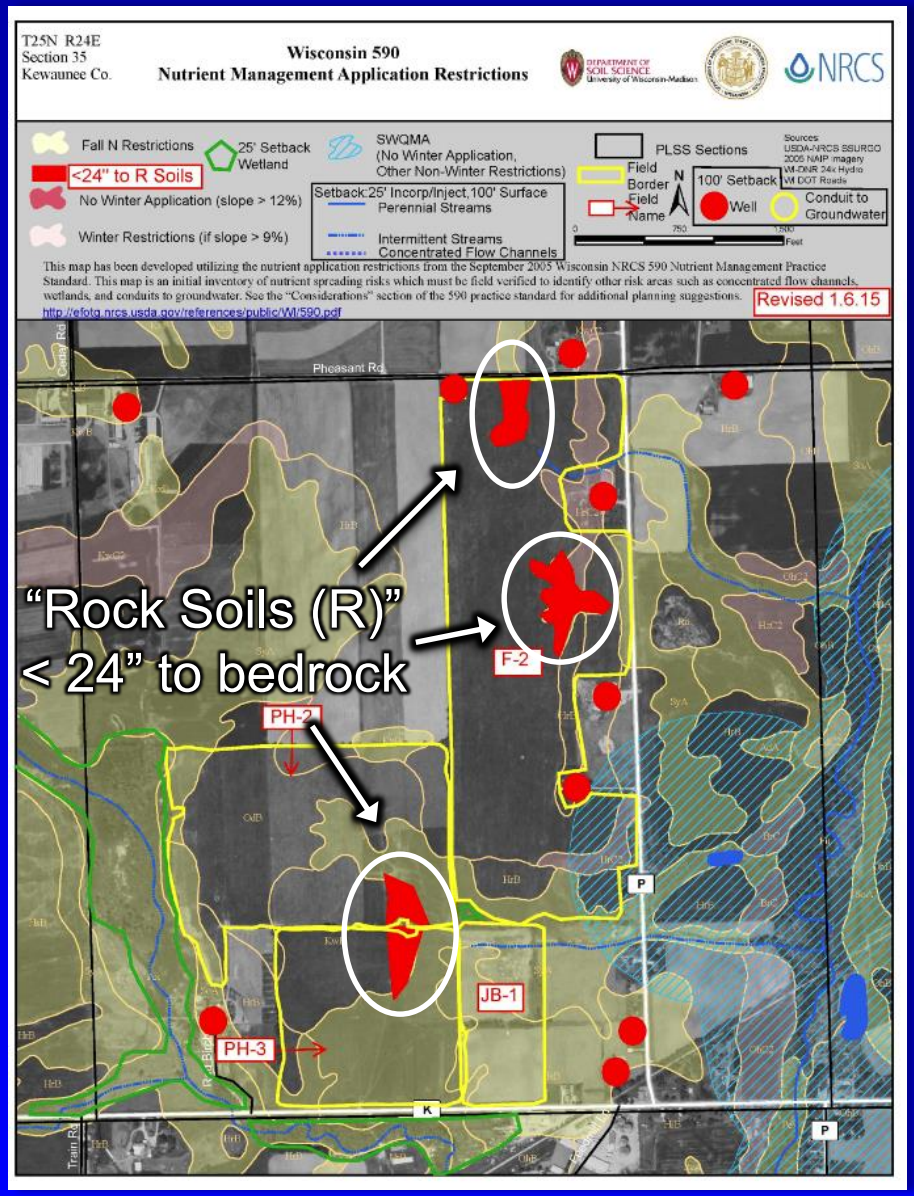
# Depth to bedrock

**Utility trenching records**

- Maps obtained from Wisconsin Public Service Corp.
- Gas lines to private homes and businesses
- Rock trenched if <30-36” from land surface

# Depth to bedrock



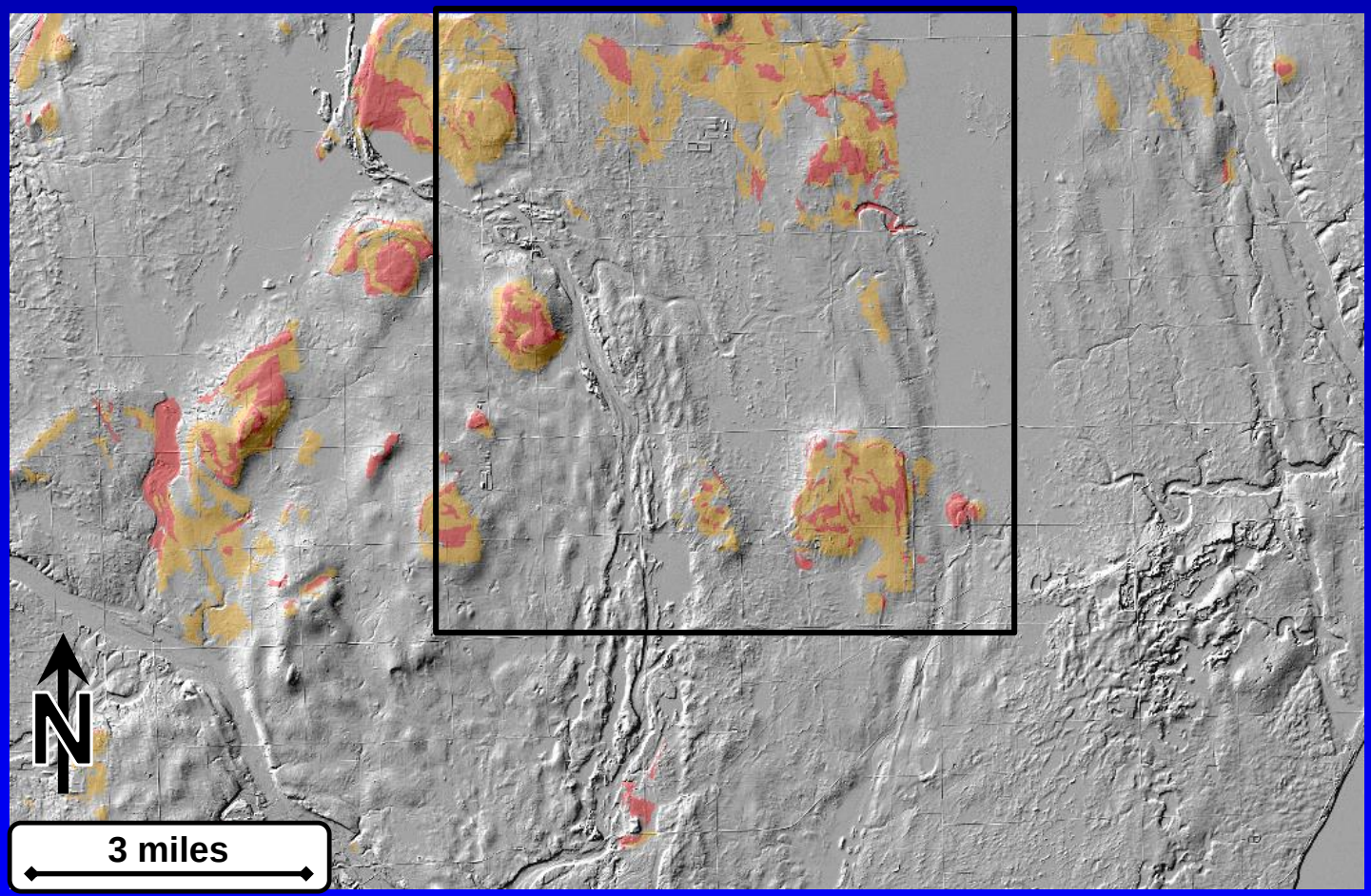

**Shallow depth to rock mapping**

- Farmer NRCS 590 permit Nutrient Management Plans

# Depth to bedrock

**Shallow depth-to-bedrock mapping**

- NRCS soil survey mapping




Minimum soil depth to bedrock

0 – 50 cm

51 – 100cm

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# Depth to bedrock

**Geoprobe**

- Push probe boring and sampling
  - Refusal on competent bedrock
  - Sample collection
- 20 confirmation borings within study area

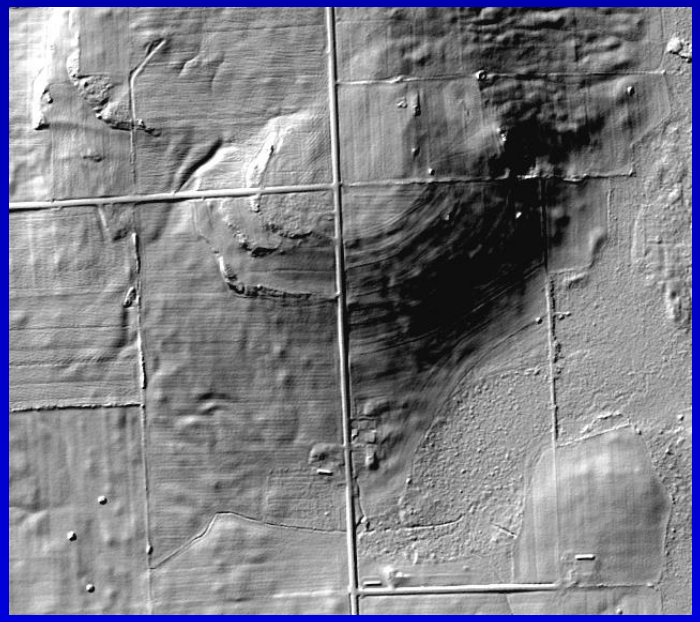
# Depth to bedrock

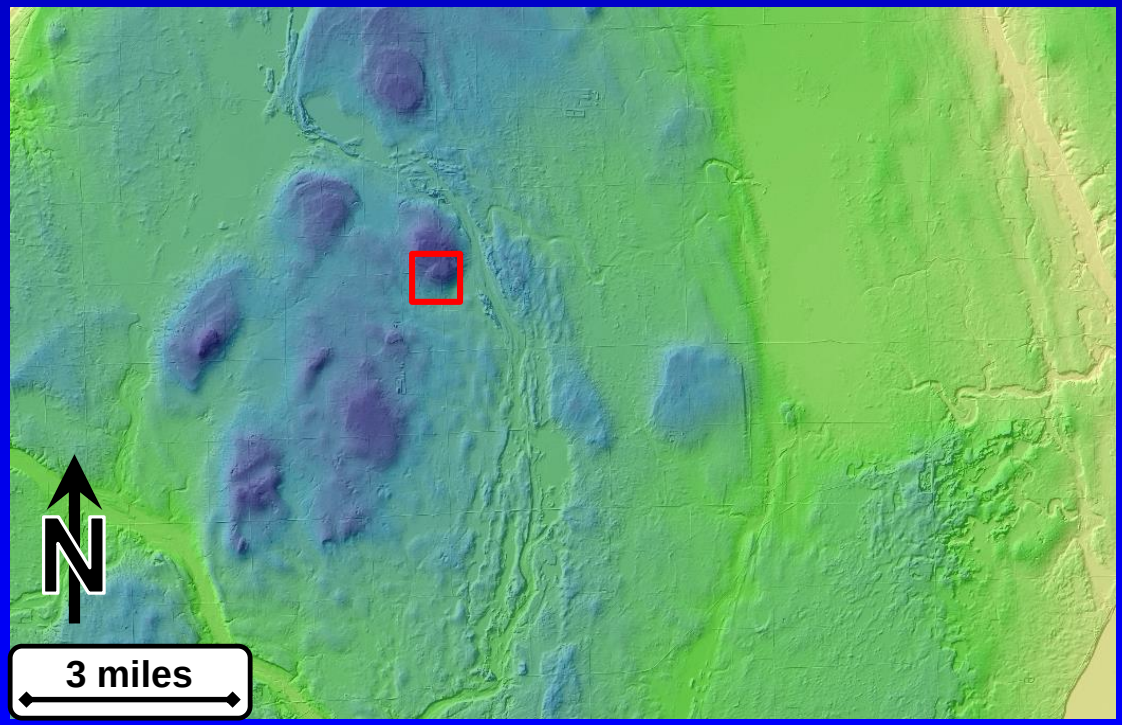
## Geophysics

# Depth to bedrock

**LIDAR data – land surface elevation mapping**

- Portmanteau for “light radar”
- High-resolution elevation mapping
- Evaluate bedrock features by elevation






1,020 ft msl

576 ft msl

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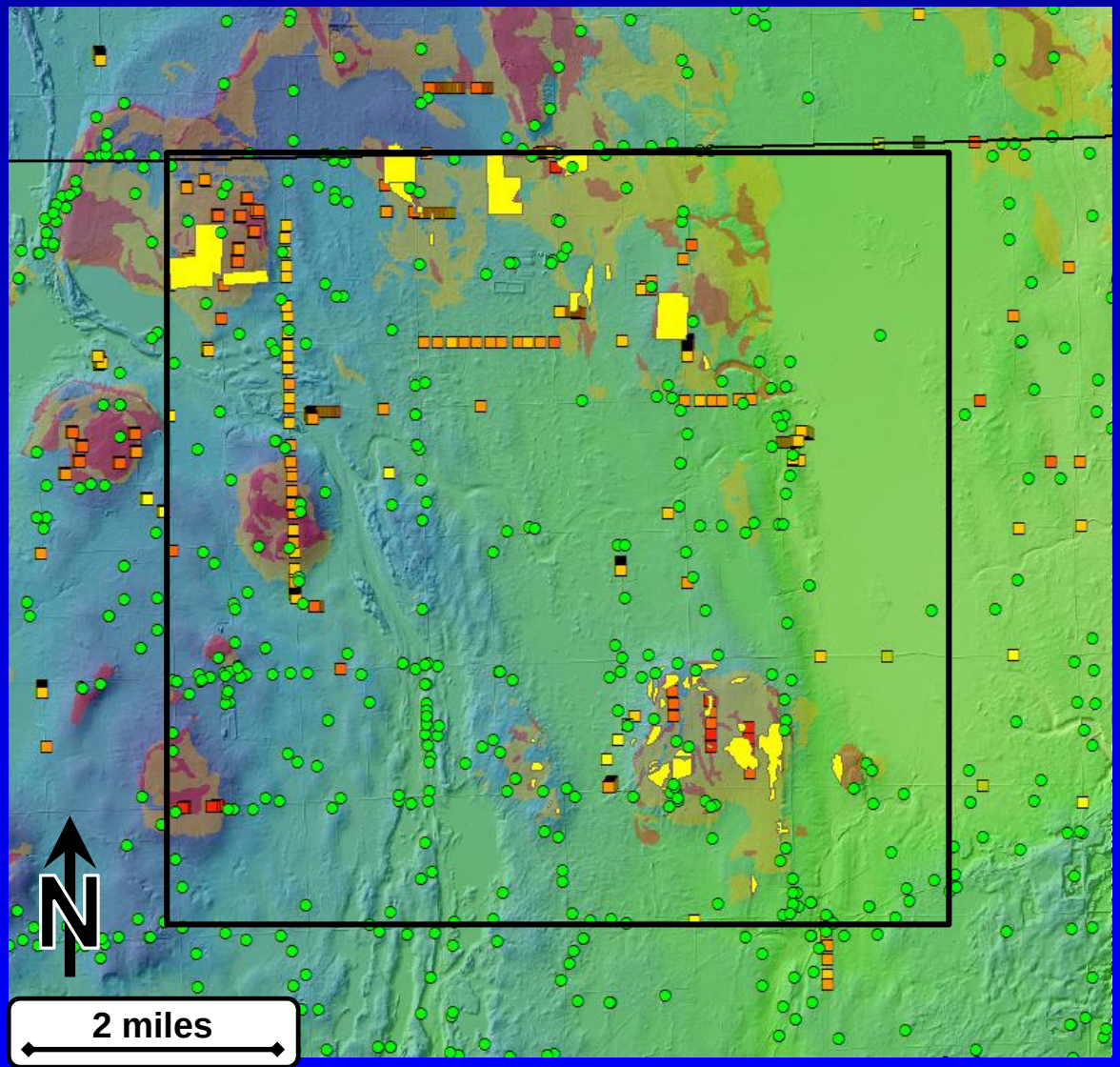
# Preliminary bedrock interpretation




Consider all data inputs

- Well construction records
- Geophysics, borings, visual observations…
- NRCS soils map
- Farmer maps
- LIDAR elevation map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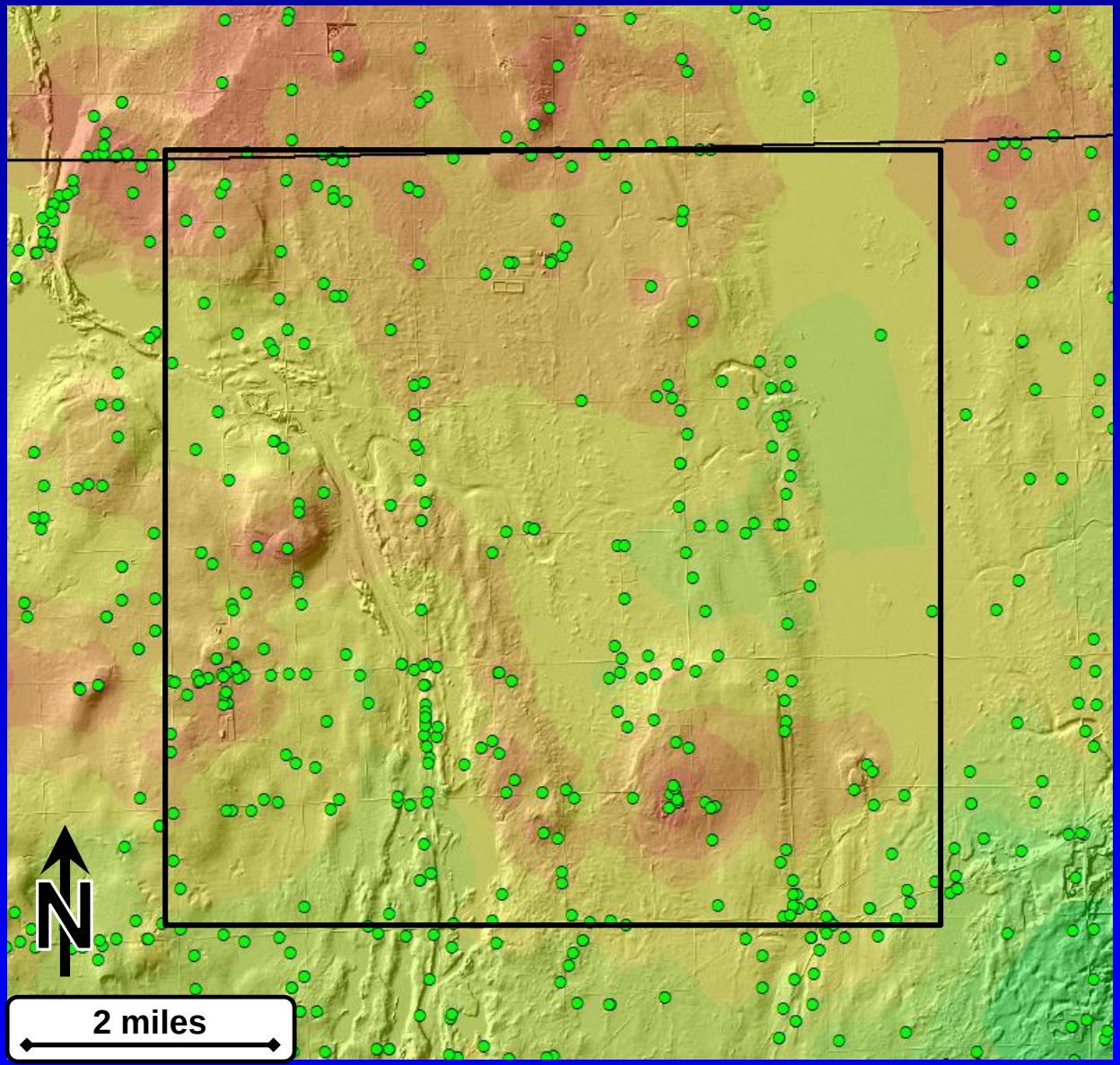
# Preliminary bedrock interpretation




Initial interpolation using WCRs

Will refine with other collected data sets

- Geophysics
- Borings
- Soils
- LIDAR…

<5 ft to bedrock

>100 ft to bedrock

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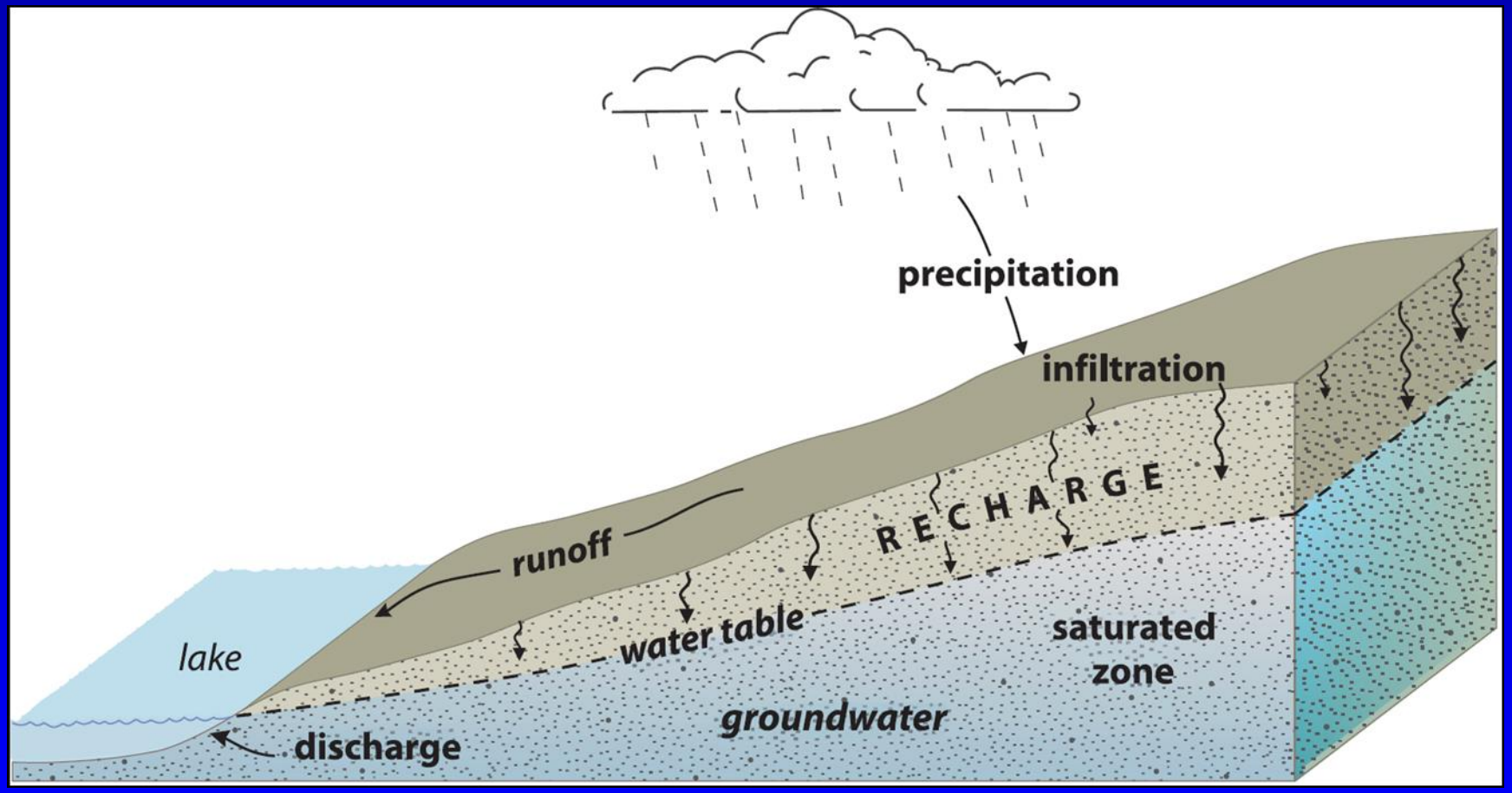
# Recharge estimation

**Recharge (R) is water that enters the groundwater system**

*R = Precipitation – Runoff – Interception – Evapotranspiration*

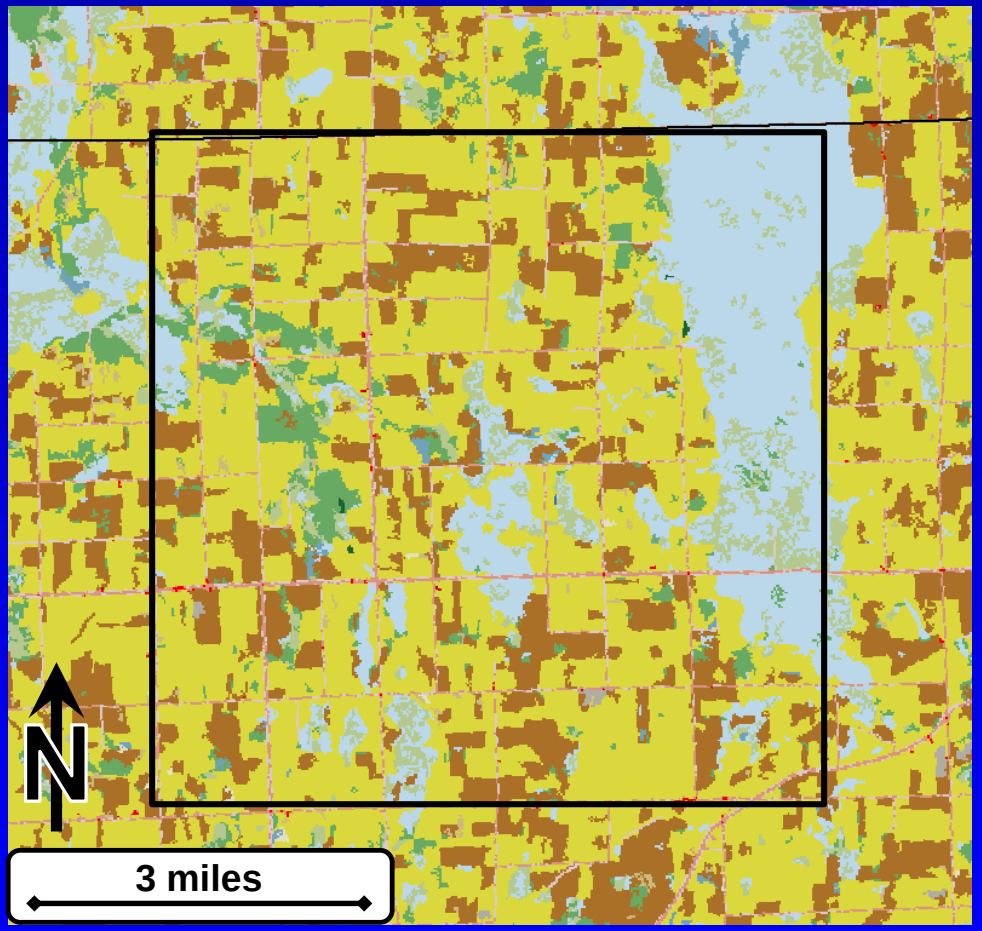


# Soil water balance model

## SWB model uses 4 input maps

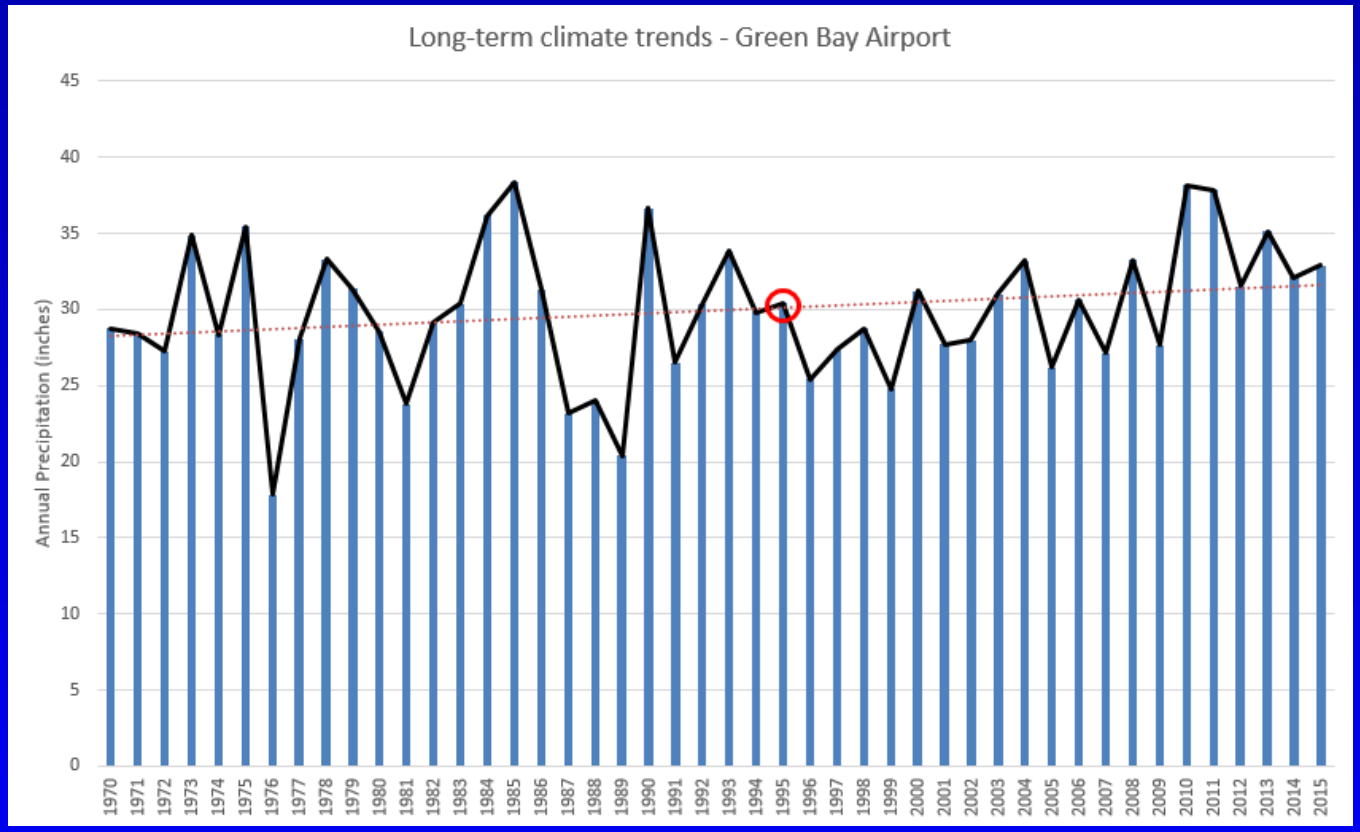
**Land surface slope**:
runoff direction
**Soil type**:
infiltration rate
available water storage
**Land use**


Land use - Town of Lincoln



# Soil water balance model

## Precipitation trend 1970 to 2015




Annual precipitation
Average 30 inches
Min. 18 inches
Max. 38 inches

*1995 selected as a typical year for the preliminary SWB model run*

# Soil water balance model

## Estimated recharge 1995

Low recharge:
- wetlands, clayey soil

Moderate recharge
- Shallow bedrock,

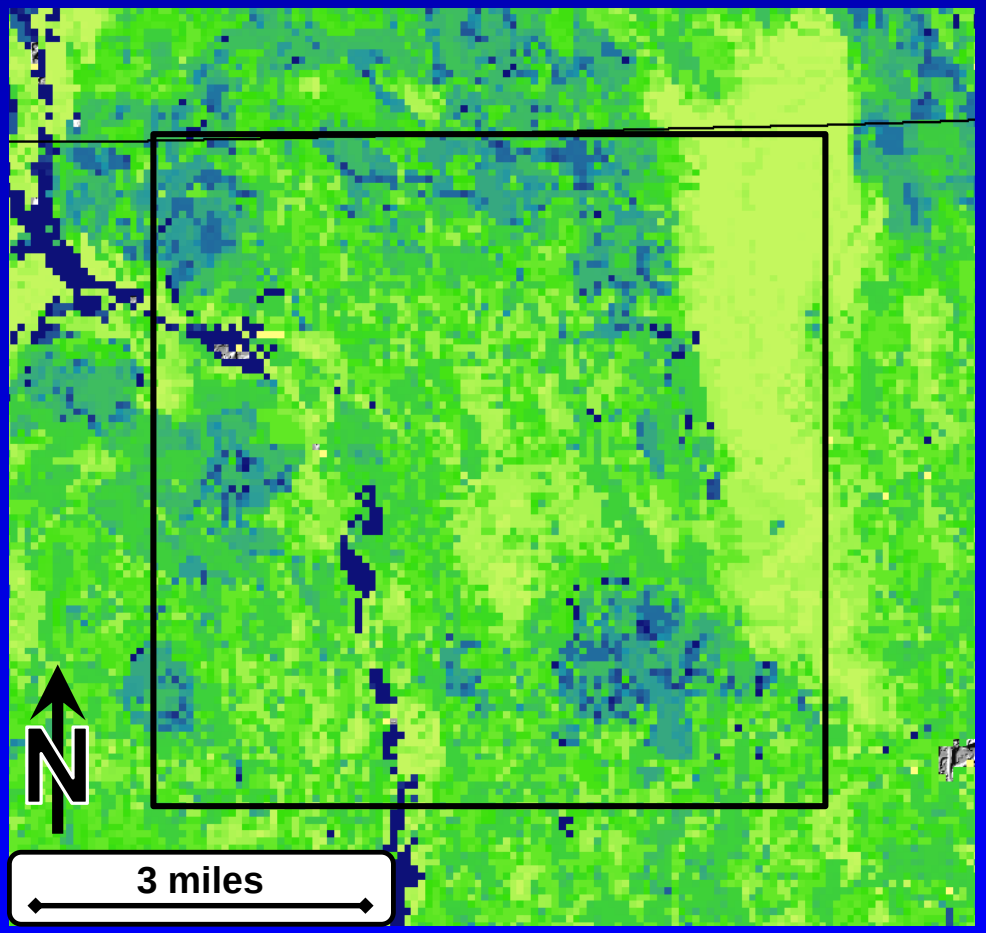
High recharge:
- Coarse sediments
- Exposed rock

14 in/yr

0 in/yr

*30m DEM cell size*

Results of preliminary model run

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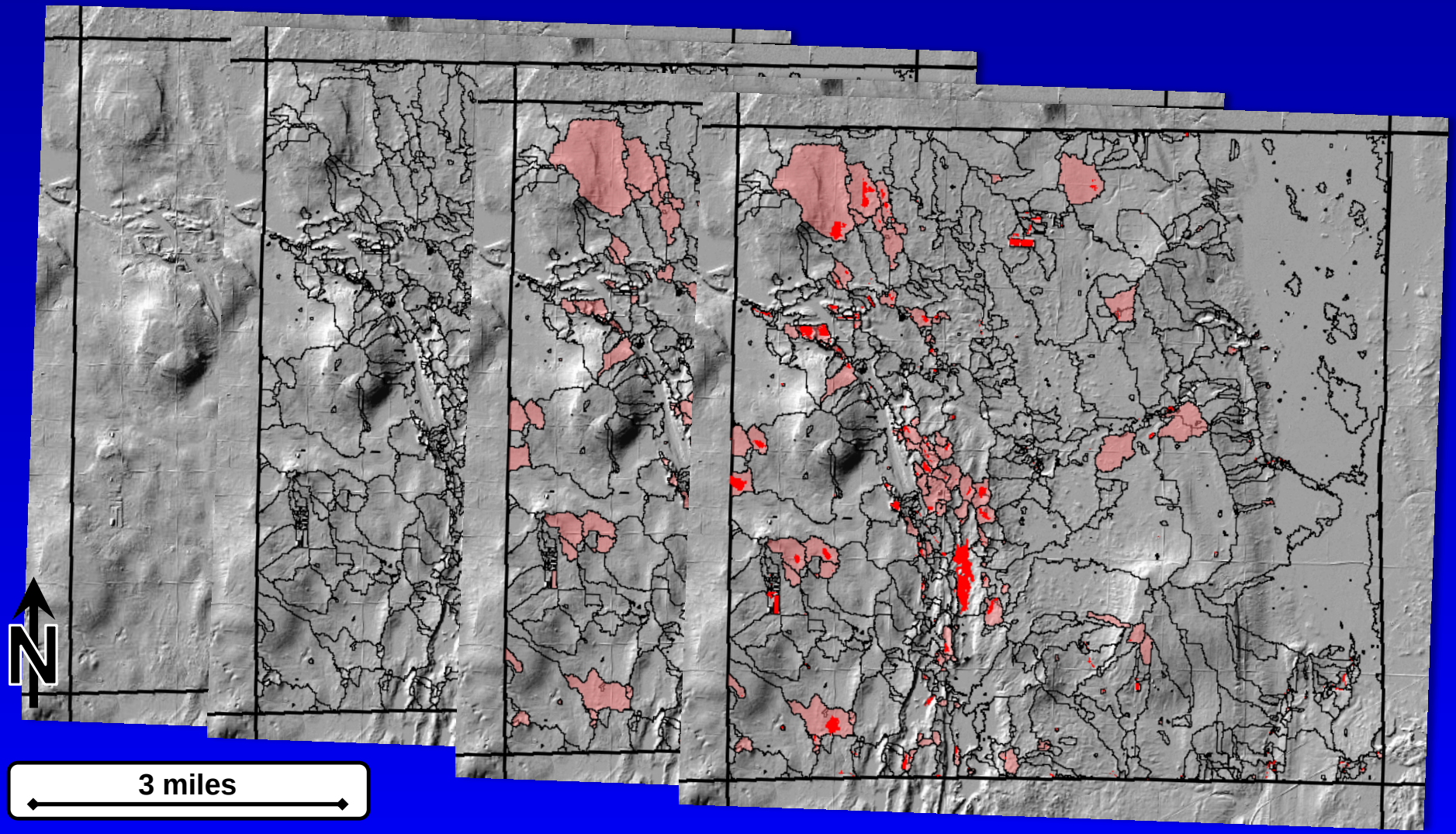
# Closed depression mapping

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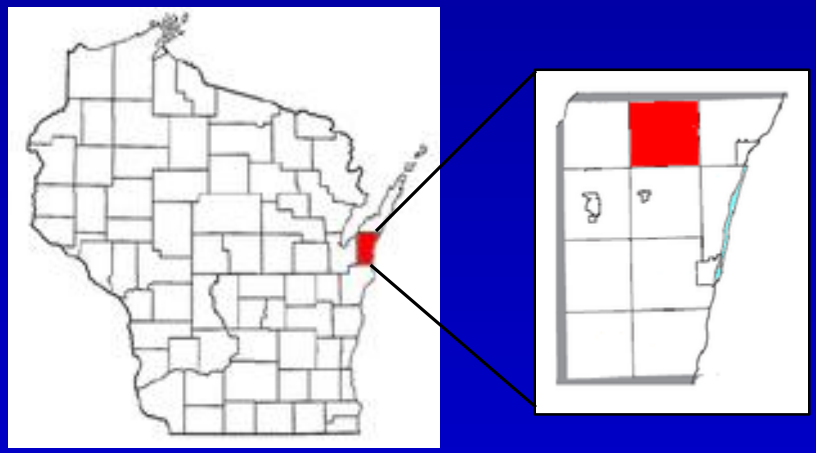
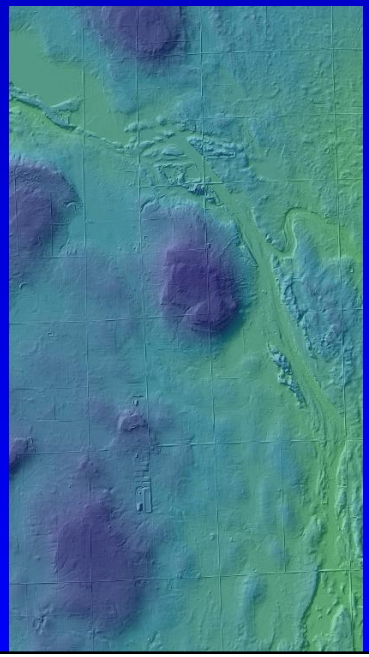
# Next steps

- Project completion: Summer 2017
  - Report to Town (Maps, GIS files)
  - Presentations to Town and County
  - Farm Tech Days summer 2017



- Use of maps and data
  - Town and County can use new maps as tools for making informed land-use management decisions



- Potential future projects
  - Expanded geophysical surveys
  - Continue comparison testing depth-to-bedrock methods
    - With local and county government, farmers, private homeowners

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## Thank you, questions?

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Ahnapee River Photo – David Mickelson