USGS
science for a changing world

Overview of U.S. Geological Survey Stream and groundwater monitoring

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Michigan Commission of Agriculture and Rural Development
September 17, 2014

U.S. Department of the Interior
U.S. Geological Survey

U.S. Geological Survey

- The USGS serves the Nation by providing reliable scientific information to describe and understand the Earth; minimize loss of life and property from natural disasters; manage water, biological, energy, and mineral resources; and enhance and protect our quality of life.
- Founded in 1879
- Science agency within Department of Interior

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USGS Michigan Water Science Center

- *Mission:* collect, analyze and disseminate the impartial hydrologic data and information needed to wisely manage water resources for the people of the United States and the State of Michigan.
- Main Office in Lansing: studies of water resources including quantity and quality
- Field Offices in Lansing, Grayling and Escanaba: primarily field data collection
- Budget:
  - Joint Funding Agreements with state, local, and tribal agencies,
  - USGS appropriations including USGS Cooperative Water Program that provides matching funds for local projects,
  - Projects with other Federal Agencies including EPA and US Army Corps of Engineers.

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Hydrologic Studies

- Water resources evaluations: Ingham-Eaton-Clinton Counties, Kalamazoo County
- Water quality: Silver Lake, Bear Lake, harmful algal blooms, avian botulism and other microbial health studies, Great Lakes Restoration Initiative studies
- Flood inundation studies: Lansing
- Science support to water-withdrawal assessment process, Michigan Water Use Advisory Council, Council of Great Lakes Governors and other regional partners

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Streamgaging

- First streamgage just turned 125 years old
- Established on the Rio Grande River in 1889 in Embudo, New Mexico to evaluate potential for crop irrigation
- 'Rock House' gaging station built in 1912, just after NM became a state

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Student hydrographers at Embudo, New Mexico. Members of the Irrigation Survey, a predecessor to USGS Water Mission Area, circa 1888

What is a streamgage?

- Location where stream stage (water level) is measured at regular intervals – typically every 15 minutes
- Periodically hydrographers measure the streamflow at the location by measuring the velocity of water at many locations across the stream.
- Streamflow is then related to stream stage – called a rating curve for the streamgage

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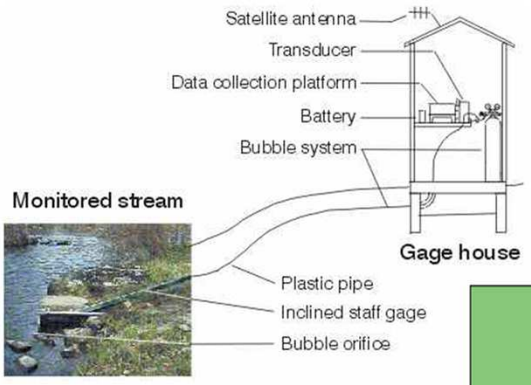
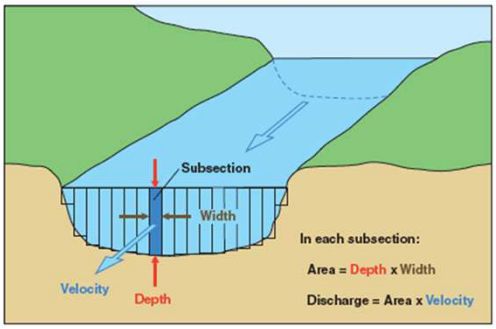
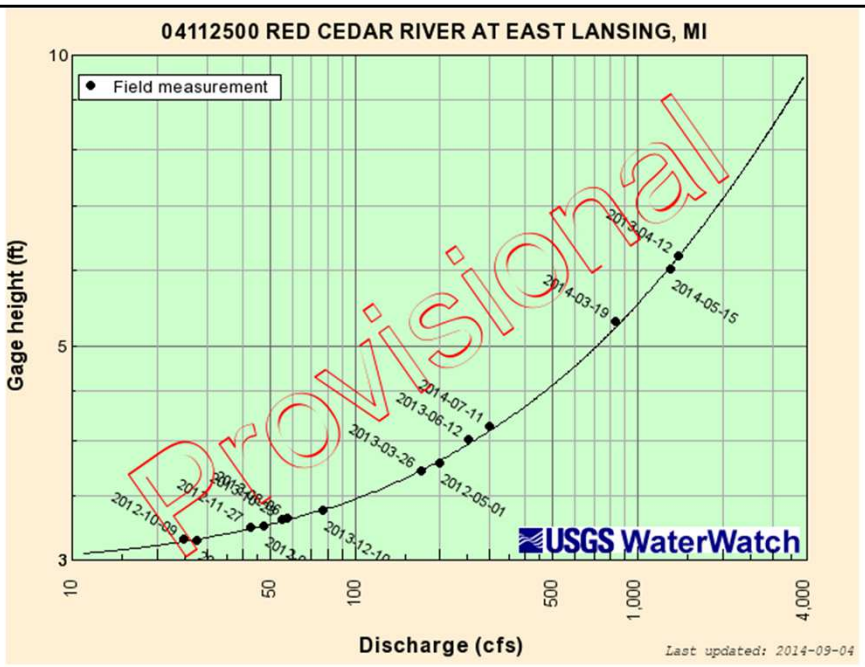


USGS



Current-meter discharge measurements are made by determining the discharge in each subsection of a channel cross section and summing the subsection discharges to obtain a total discharge.


04112500 RED CEDAR RIVER AT EAST LANSING, MI
Field measurement
Provisional
Gage height (ft)
10
5
3
2013-04-12
2014-03-19
2014-05-15
2014-07-11
2013-06-12
2013-03-26
2012-05-01
2012-11-27
2013-12-10
USGS WaterWatch
10
50
100
500
1,000
4,000
Discharge (cfs)
Last updated: 2014-09-04

USGS

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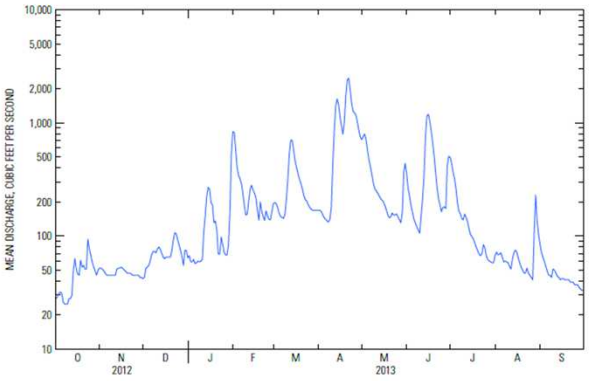
Water-Data Report 2013

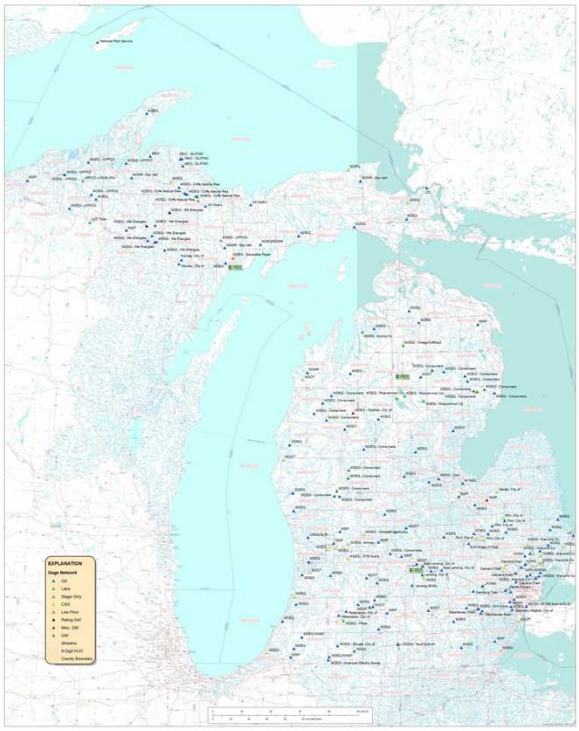
04112500 RED CEDAR RIVER AT EAST LANSING, MI—Continued

SUMMARY STATISTICS

	Calendar Year 2012		Water Year 2013		Water Years 1902 - 2013	
Annual total	59,323		81,116			
Annual mean	162		222		221	
Highest annual mean					431	1993
Lowest annual mean					43.3	1964
Highest daily mean	926	Mar 3	2,490	Apr 21	5,720	Apr 20, 1975
Lowest daily mean	18	Sep 2	25	Oct 7	3.0	Jul 31, 1931
Annual seven-day minimum	21	Aug 28	27	Oct 6	3.9	Jul 15, 1934
Maximum peak flow			2,550	Apr 21	5,940	Apr 20, 1975
Maximum peak stage			7.86	Apr 21	11.95	Apr 20, 1975
Instantaneous low flow			25	Oct 6[a]	3.0	Jul 31, 1931
Annual runoff (cfsm)	0.457		0.626		0.624	
Annual runoff (inches)	6.22		8.50		8.47	
10 percent exceeds	413		545		526	
50 percent exceeds	70		103		112	
90 percent exceeds	28		43		31	

[a] Also occurred Oct. 7, 8, 9, 10.




EXPLANATION
Gage Network
GS
Lake
Stage Only
CSG
Lake Flow
Rating Curt
Misc. Diff
Diff
Streams
8-Digit HUC
County Boundary

USGS

How is streamgage data used?

- Flood planning and warning, drought monitoring
- Design of bridges, roads, culverts, water treatment plants, navigation control structures
- Water-resource planning
  - Water budget – how much water is available?
  - How does the stream respond to climate and development?
- Operation of locks and dams
- Power production
- Water-quality assessment
- Habitat assessment
- Recreation

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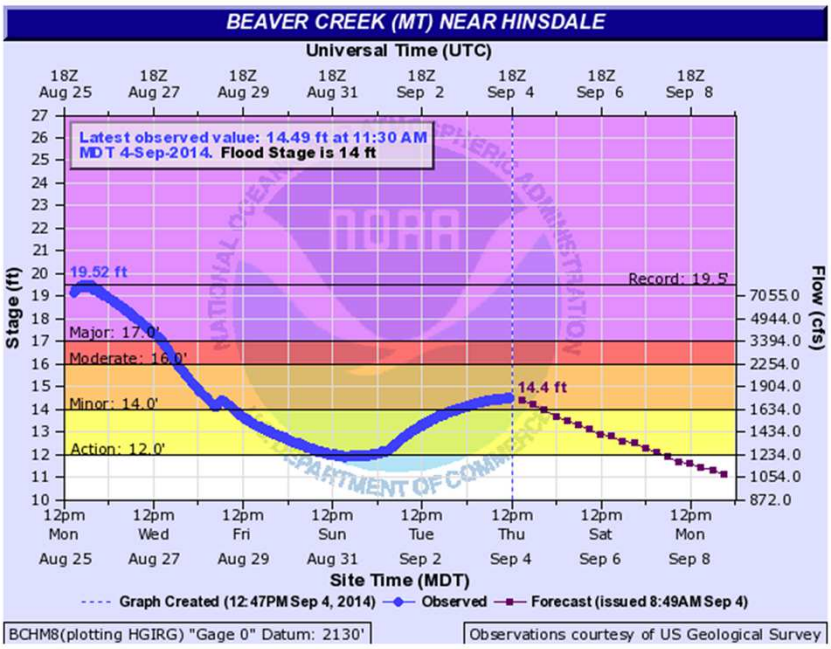
BEAVER CREEK (MT) NEAR HINSDALE
Universal Time (UTC)
18Z Aug 25
18Z Aug 27
18Z Aug 29
18Z Aug 31
18Z Sep 2
18Z Sep 4
18Z Sep 6
18Z Sep 8
Latest observed value: 14.49 ft at 11:30 AM MDT 4-Sep-2014. Flood Stage is 14 ft
19.52 ft
Record: 19.5'
Major: 17.0'
Moderate: 16.0'
Minor: 14.0'
Action: 12.0'
14.4 ft
Stage (ft)
Flow (cfs)
27
26
25
24
23
22
21
20
19
18
17
16
15
14
13
12
11
10
7055.0
4944.0
3394.0
2254.0
1904.0
1634.0
1434.0
1234.0
1054.0
872.0
12pm Mon Aug 25
12pm Wed Aug 27
12pm Fri Aug 29
12pm Sun Aug 31
12pm Tue Sep 2
12pm Thu Sep 4
12pm Sat Sep 6
12pm Mon Sep 8
Site Time (MDT)
Graph Created (12:47PM Sep 4, 2014)
Observed
Forecast (issued 8:49AM Sep 4)
BCHM8(plotting HGIRG) "Gage 0" Datum: 2130'
Observations courtesy of US Geological Survey

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International streamgage

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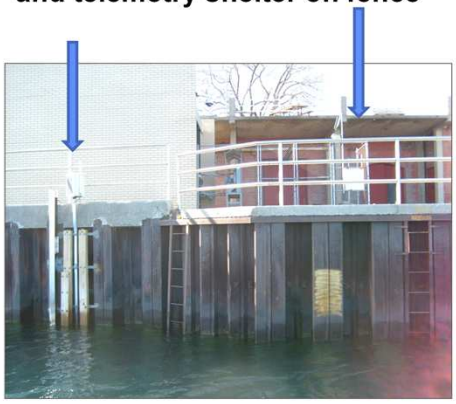
St. Clair River
Instrumentation

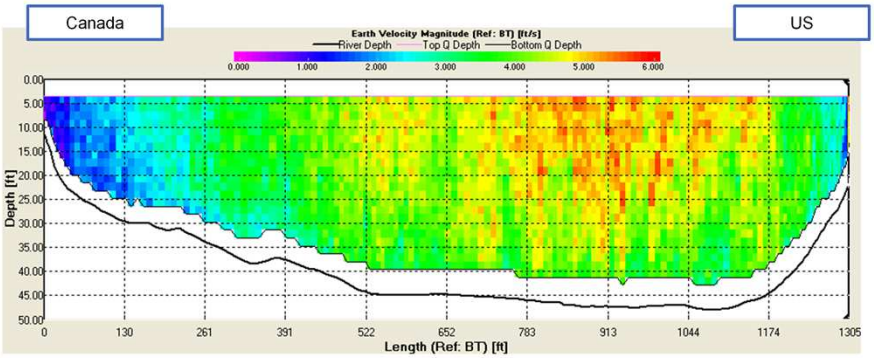
Instrument shelter on seawall and telemetry shelter on fence



Fixed track mounted on seawall with sliding mount and meter

USGS

St. Clair River Cross section
192,000 ft^3/s (5,437 m^3/s)
124,000 million gallons per day



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Baseflow estimation

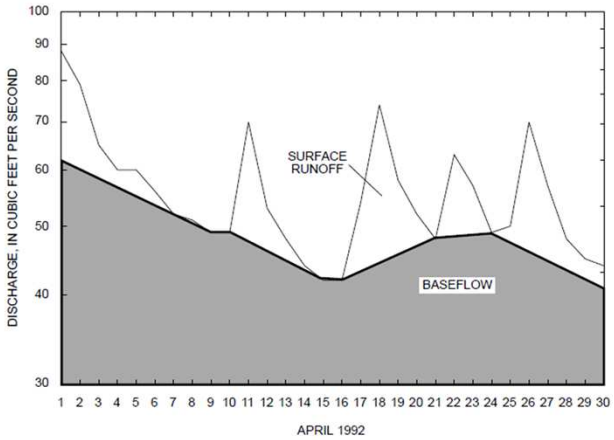


Figure 4. Hydrograph analysis using the local minimum method for French Creek near Phoenixville, Pa., April 1992.

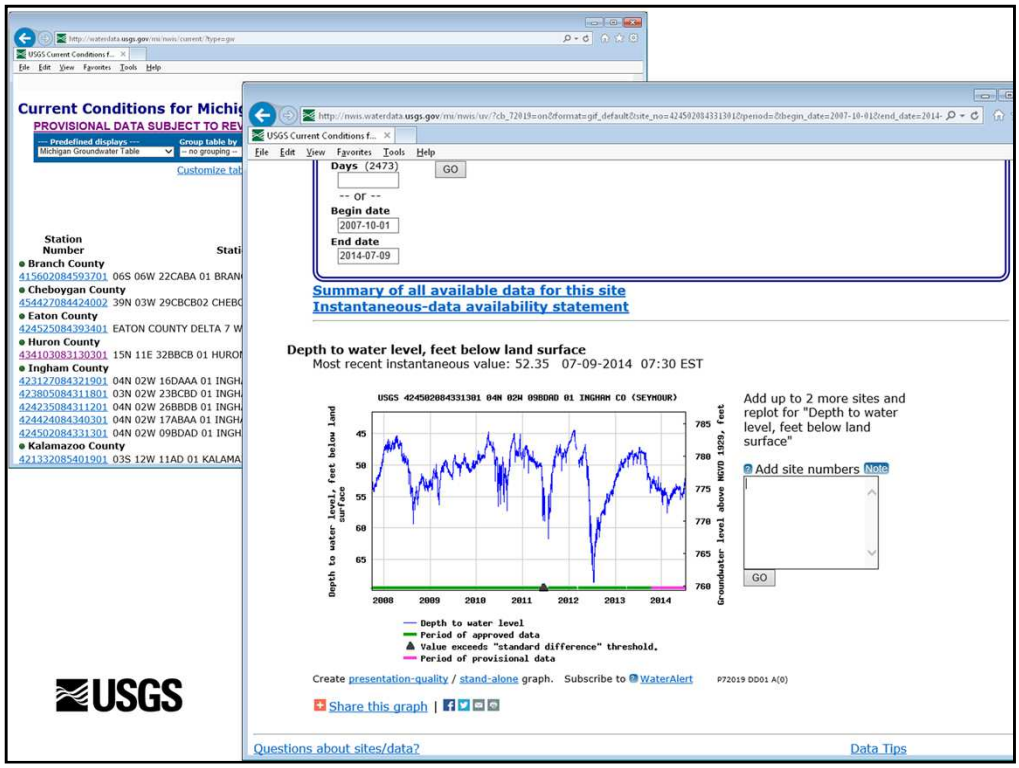
USGS

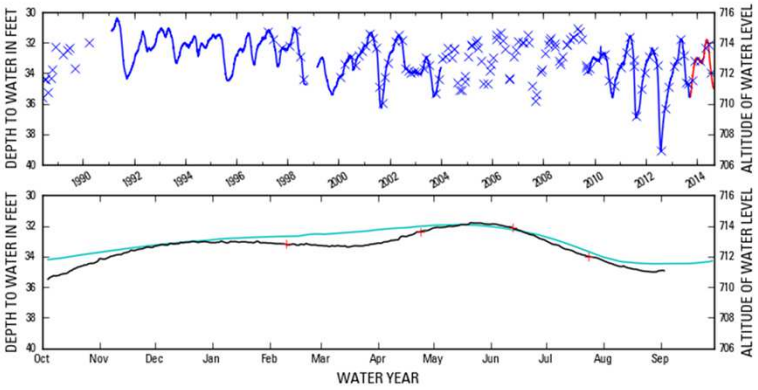
From, Sloto, R.A. and Crouse, M.Y., 1996, HYSEP— A computer program for streamflow hydrograph separation and analysis: U.S. Geological Survey Water-Resources Investigations Report 96-4040, 46 p.

Groundwater-level monitoring

- Simpler: direct measurement of depth to water in a well
- Can display in real-time like streamgage data
- Used to monitor conditions:
  - Drought
  - Flood
  - Water Quality
- Combine with other data to estimate water budget

USGS


Current Conditions for Michi
PROVISIONAL DATA SUBJECT TO REV
Michigan Groundwater Table
Customize tab
Station Number
Branch County
Cheboygan County
Eaton County
Huron County
Ingham County
Kalamazoo County
USGS
Days (2473)
GO
-- or --
Begin date
2007-10-01
End date
2014-07-09
Summary of all available data for this site
Instantaneous-data availability statement
Depth to water level, feet below land surface
Most recent instantaneous value: 52.35 07-09-2014 07:30 EST
USGS 424502084331301 04N 02W 09BDAD 01 INGHAM CO (SEYMOUR)
Depth to water level, feet below land surface
Groundwater level above NGVD 1929, feet
2008
2009
2010
2011
2012
2013
2014
Depth to water level
Period of approved data
Value exceeds "standard difference" threshold.
Period of provisional data
Add up to 2 more sites and replot for "Depth to water level, feet below land surface"
Add site numbers
Note
GO
Create presentation-quality / stand-alone graph. Subscribe to WaterAlert
P72019 DD01 A(0)
Share this graph
Questions about sites/data?
Data Tips

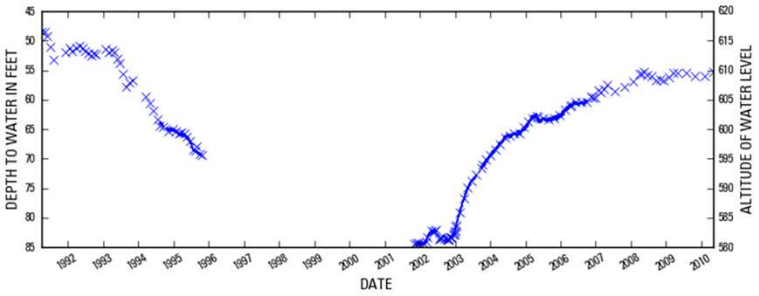


EXPLANATION

- APPROVED DAILY DEPTH TO WATER
- PROVISIONAL DAILY DEPTH TO WATER
- TAPEDOWN DEPTH TO WATER
- AVERAGE DAILY MAXIMUM DEPTH TO WATER
- DAILY MAXIMUM DEPTH TO WATER CURRENT WATER YEAR
- TAPEDOWN DEPTH TO WATER CURRENT WATER YEAR

USGS Site ID: 434103083130301
15N 11E 32BBCB 01 HURON CO (GRANT TWP, H2R WELL)
Altitude of Land surface: 746 Feet NGVD29, Depth of Well: 91 Feet
Local Aquifer Code: Sand Deposits
National Aquifer Code: Sand and gravel aquifers (glaciated regions)

USGS

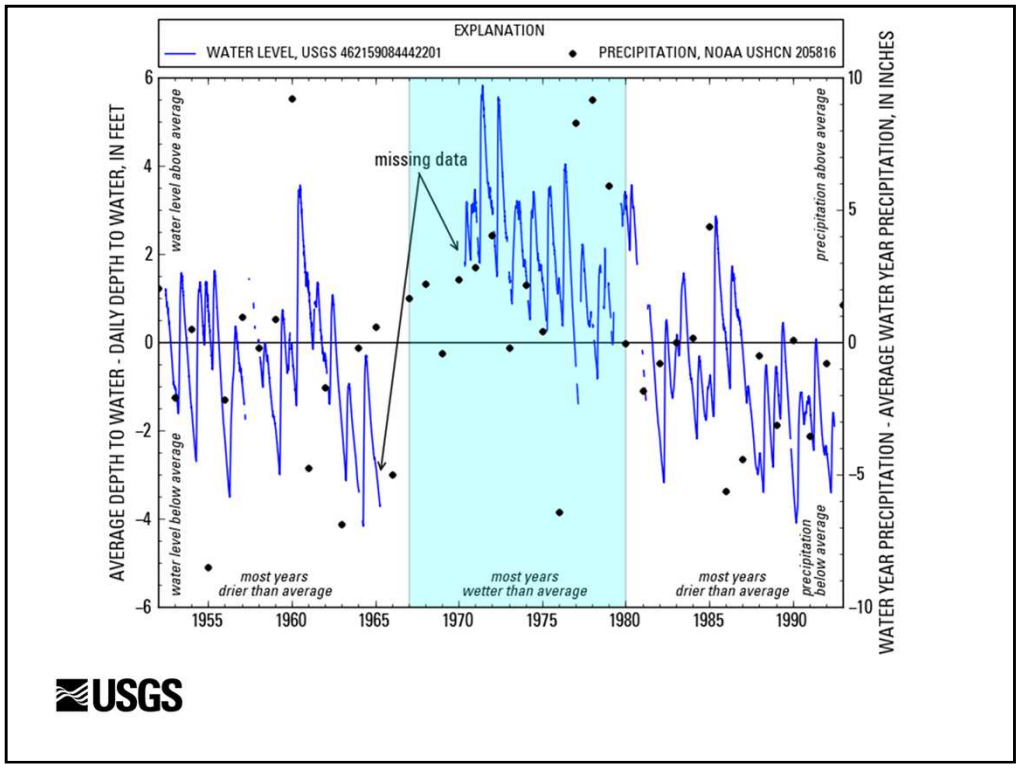


EXPLANATION

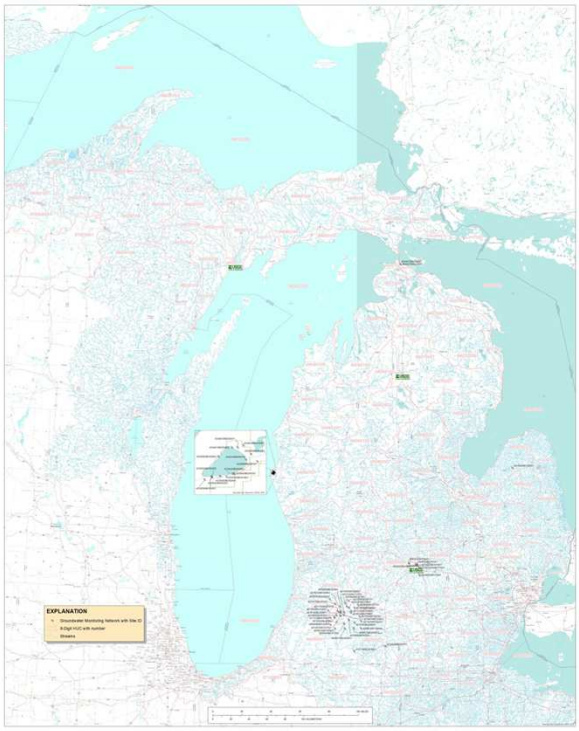
APPROVED DAILY DEPTH TO WATER
PROVISIONAL DAILY DEPTH TO WATER
TAPEDOWN DEPTH TO WATER

USGS Site ID: 420414083351501
05S 07E 10 ABB01 MONROE CO (WELL G-7)
Altitude of Land surface: 665 Feet NGVD29, Depth of Well: 95 Feet
Local Aquifer Code: Devonian-Silurian Systems
National Aquifer Code: Silurian-Devonian aquifers

USGS


EXPLANATION
WATER LEVEL, USGS 462159084442201
PRECIPITATION, NOAA USHCN 205816
AVERAGE DEPTH TO WATER - DAILY DEPTH TO WATER, IN FEET
WATER YEAR PRECIPITATION - AVERAGE WATER YEAR PRECIPITATION, IN INCHES
water level above average
water level below average
precipitation above average
precipitation below average
missing data
most years drier than average
most years wetter than average
most years drier than average
6
4
2
0
−2
−4
−6
10
5
0
−5
−10
1955
1960
1965
1970
1975
1980
1985
1990

USGS


EXPLANATION
Groundwater Monitoring Network with Site ID
8-Digit HUC with number
Streams

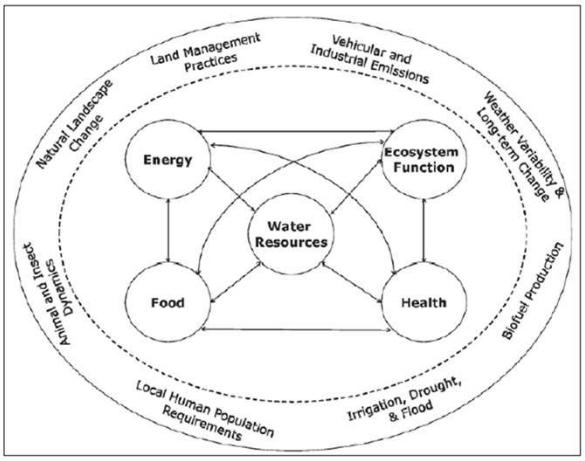


Fig. 1. The relationships among five key resources (water, food, energy, health, and ecosystem function). Outer ring shows a nonexhaustive list of stressors that affect availability or quality of the resources.

From: Hossain, Faisal, and others, 2011, Making sense of water resources that will be available for future use: Eos, v. 90, no. 17, p. 26.

USGS