Hydrology, geology, and history of Hudson Lake, Indiana

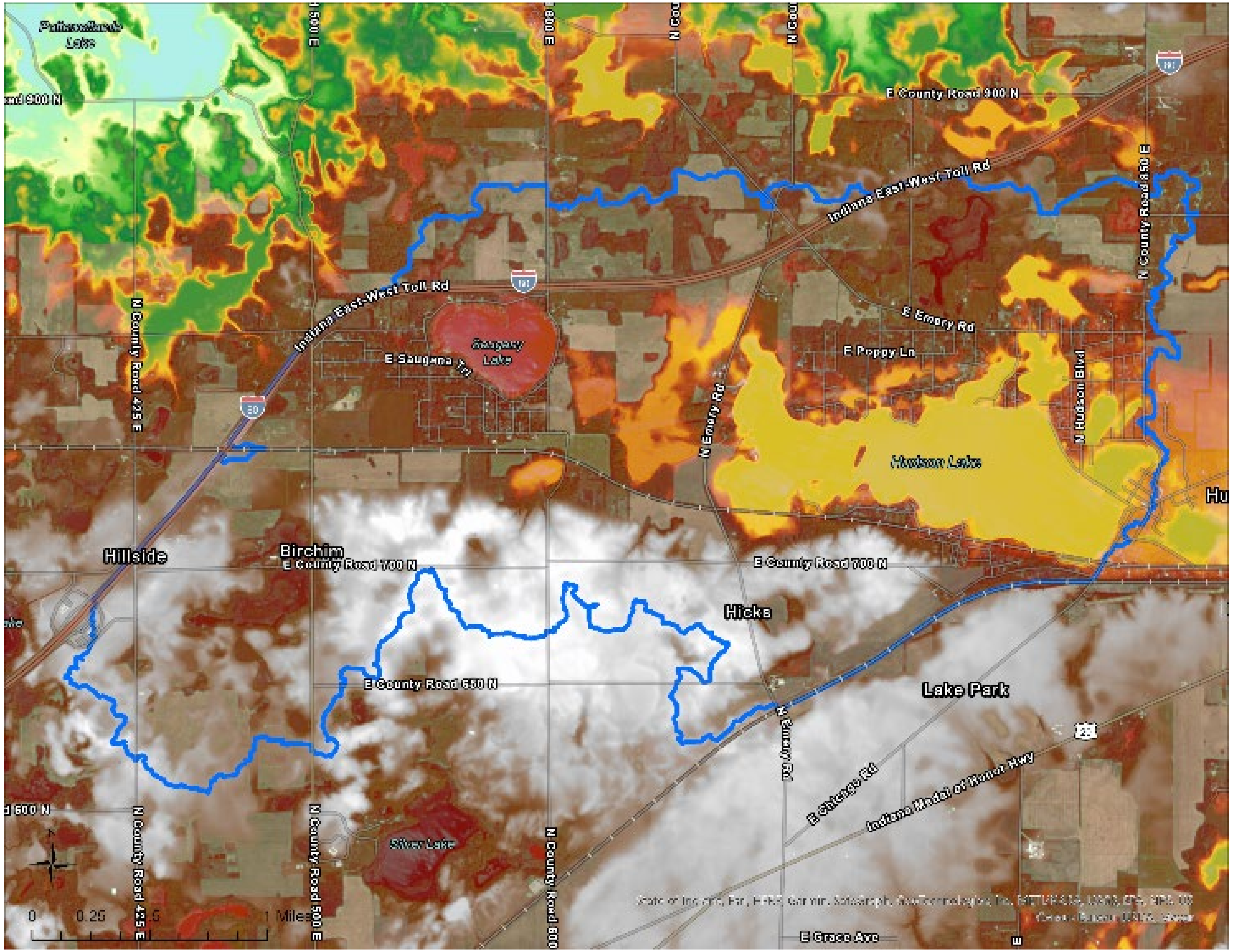
Indiana Department of Natural Resources

Hudson Lake Community Meeting
May 4, 2023

Garth Lindner – Resource Assessment

Agenda

- Introduction – DNR role
- Objectives
- Description of Hudson lake
  - Hydrology
  - Geology
  - History
- Conclusions
- Recommendations



Indiana Department of Natural Resources

Introduction – DNR Role

The mission of the Indiana Department of Natural Resources is to protect, enhance, preserve, and wisely use natural, cultural, and recreational resources for the benefit of Indiana's citizens through professional leadership, management, and education.

The Division of Water is a regulatory and public information agency, having diverse responsibilities associated with the evaluation of Indiana's water resources, and development near Indiana's waterways and lakes. Regulatory responsibilities include floodway construction, floodplain hazard analysis, lakebed and shoreline alteration, dam safety, conservancy districts, water use, and water well construction. The Division provides useful public information related to water availability throughout Indiana, water use, and participation in the National Flood Insurance Program. Supplies a vast array of water resource information for individual citizens, industry, environmental groups, and government agencies; primarily responsible for programs including floodway construction, dam safety, flood hazard planning, flood plain regulations, conservancy districts, and water well construction.

→ https://www.in.gov/dnr/about-us/what-we-do/

The Resource Assessment Section 1) Investigates, monitors, and assesses water resource availability in the State of Indiana through analyses and interpretation of technical information, 2) to provide timely and relevant water resource products, 3) through cooperation with local, state, and federal stakeholders and partners.

Satisfy the Legislative Directives of IC 14-25-7 by conducting a "continuing assessment of the availability of the water resources" of the State of Indiana.

INDIANA DEPARTMENT OF NATURAL RESOURCES · DIVISION OF WATER ·

https://www.in.gov/dnr/water/

Objectives

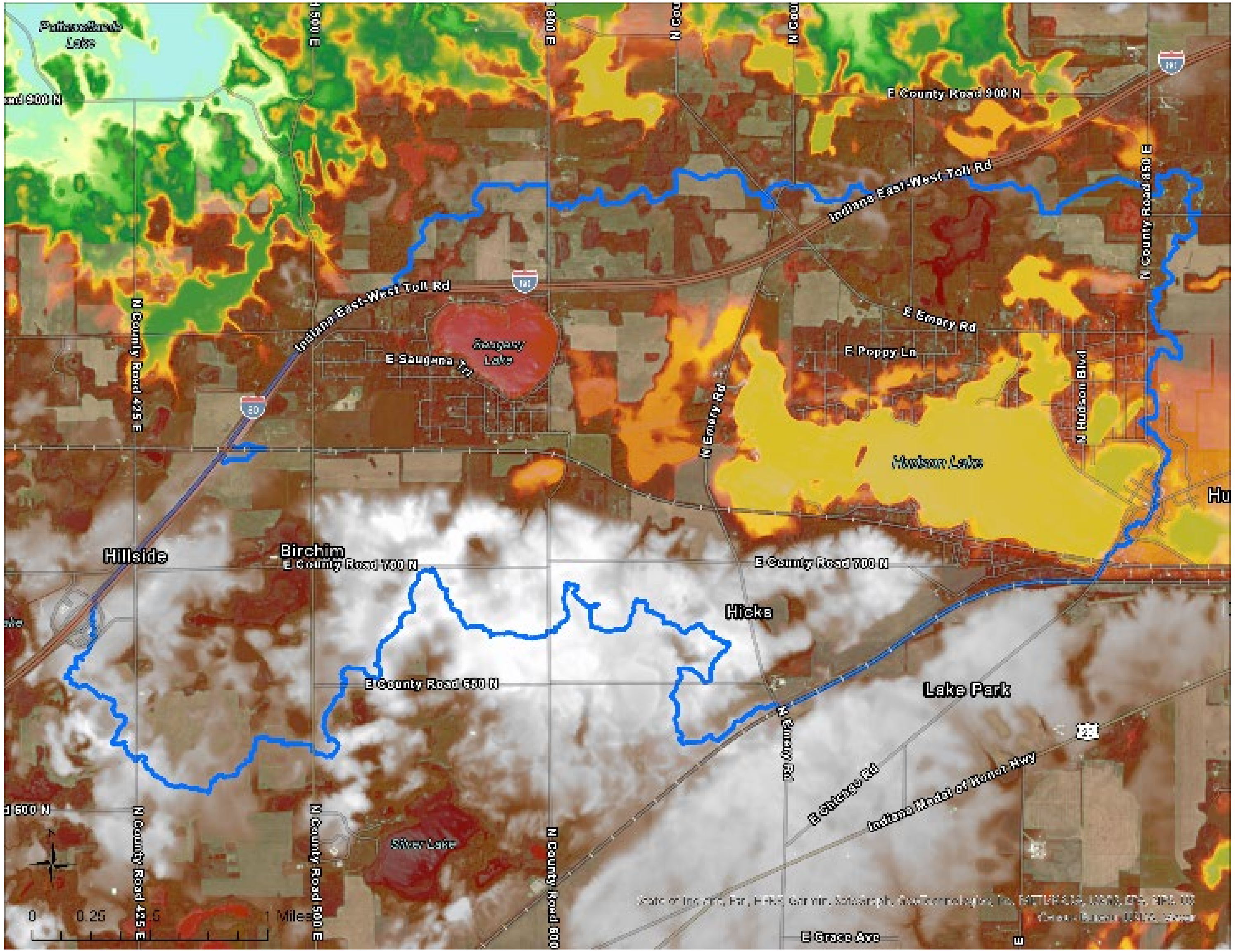
For this meeting:
To inform and educate on the history, hydrology, and geology of the Hudson Lake Indiana region

Long term:
To develop a hydrologic monitoring program

DNR Indiana Department of Natural Resources

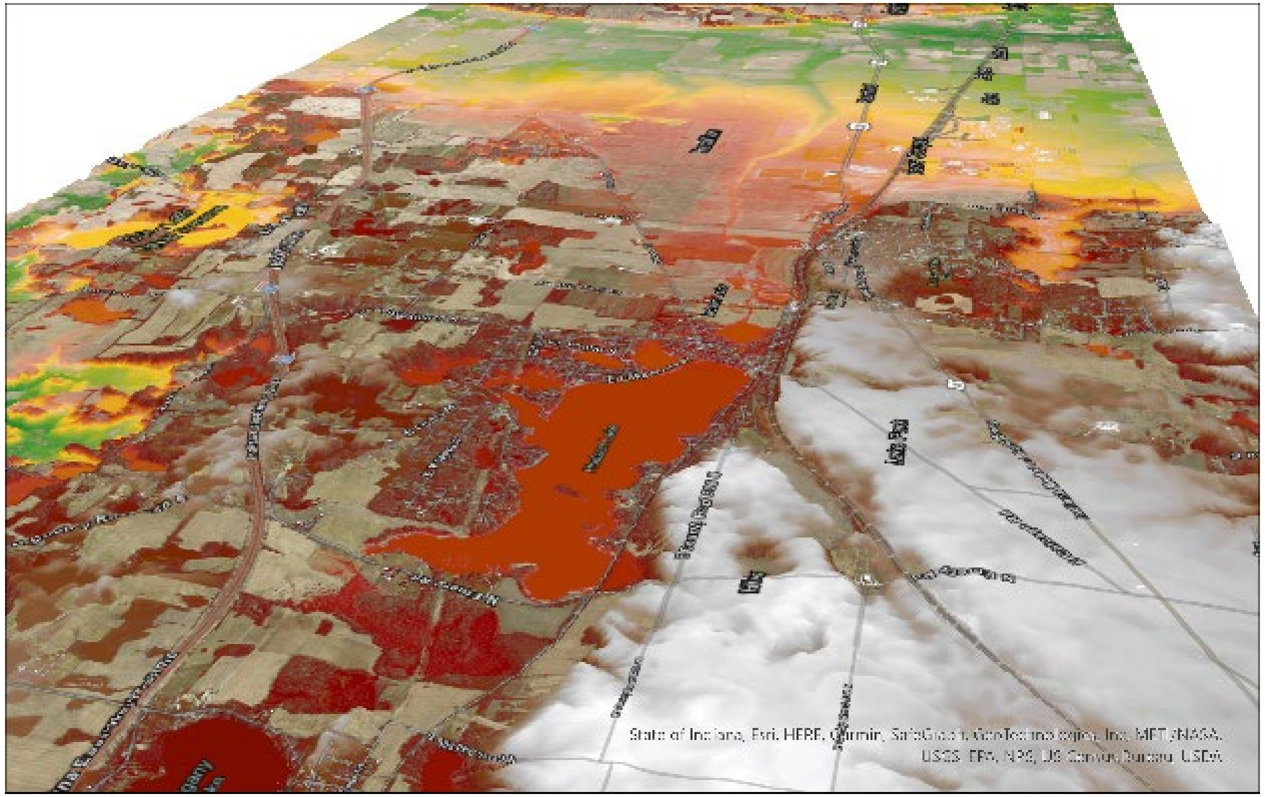
Objectives

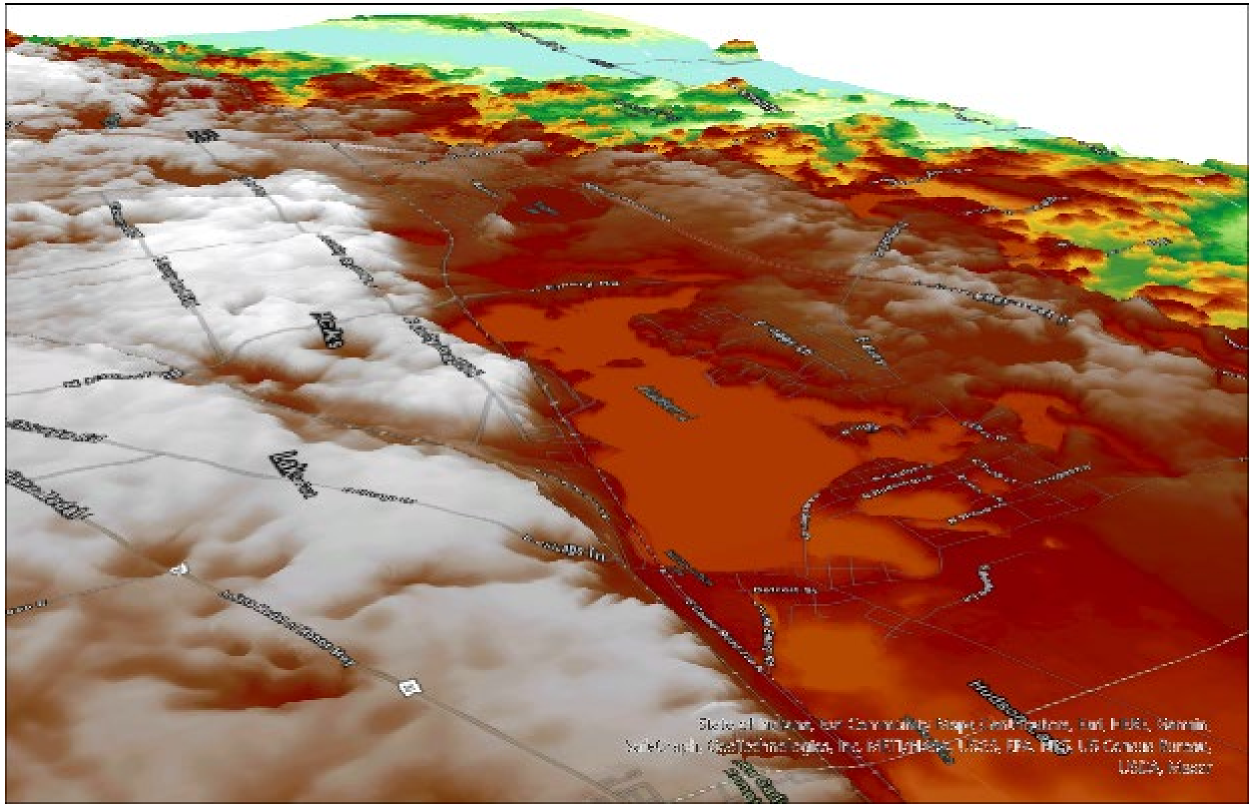
A collaborative effort to develop a hydrologic monitoring network will provide the necessary information to inform our understanding of how water cycles through Hudson Lake, in turn guiding future lake management plans.



Objectives

These collaborative monitoring efforts are best achieved through educating and informing stakeholders.

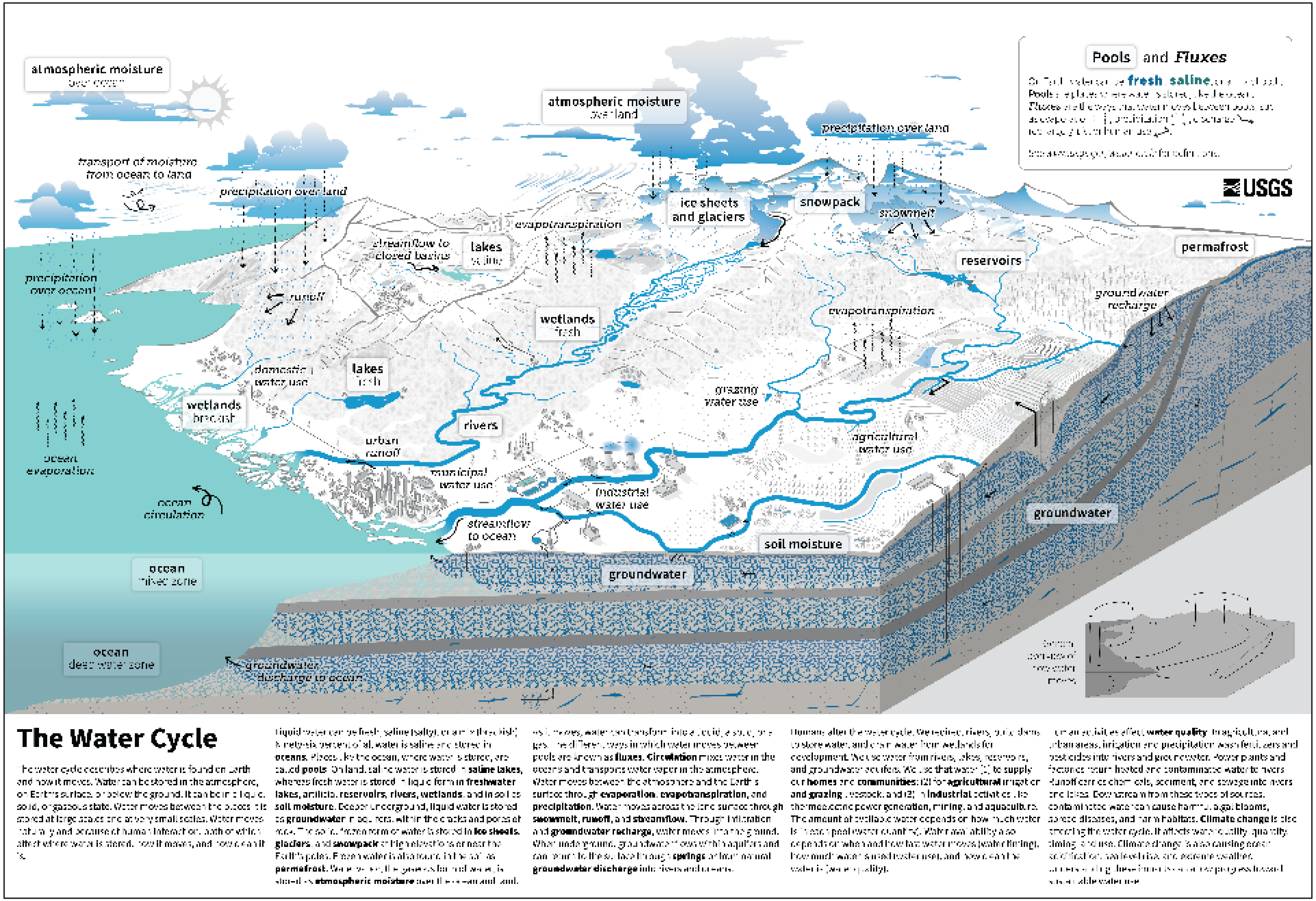




A common and shared understanding of the unique and complex attributes of the Hudson Lake system will aid the collaborative monitoring efforts

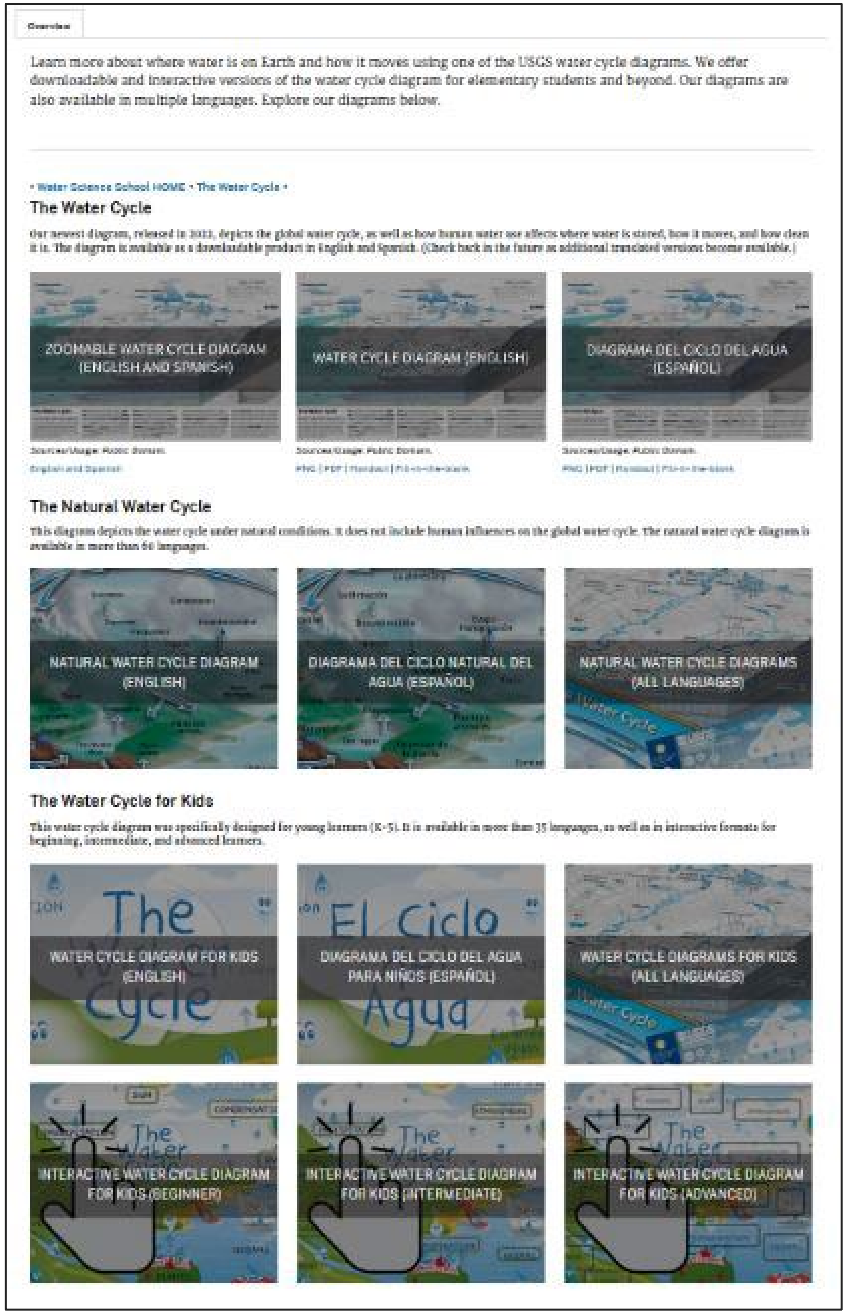
Hydrology Concepts

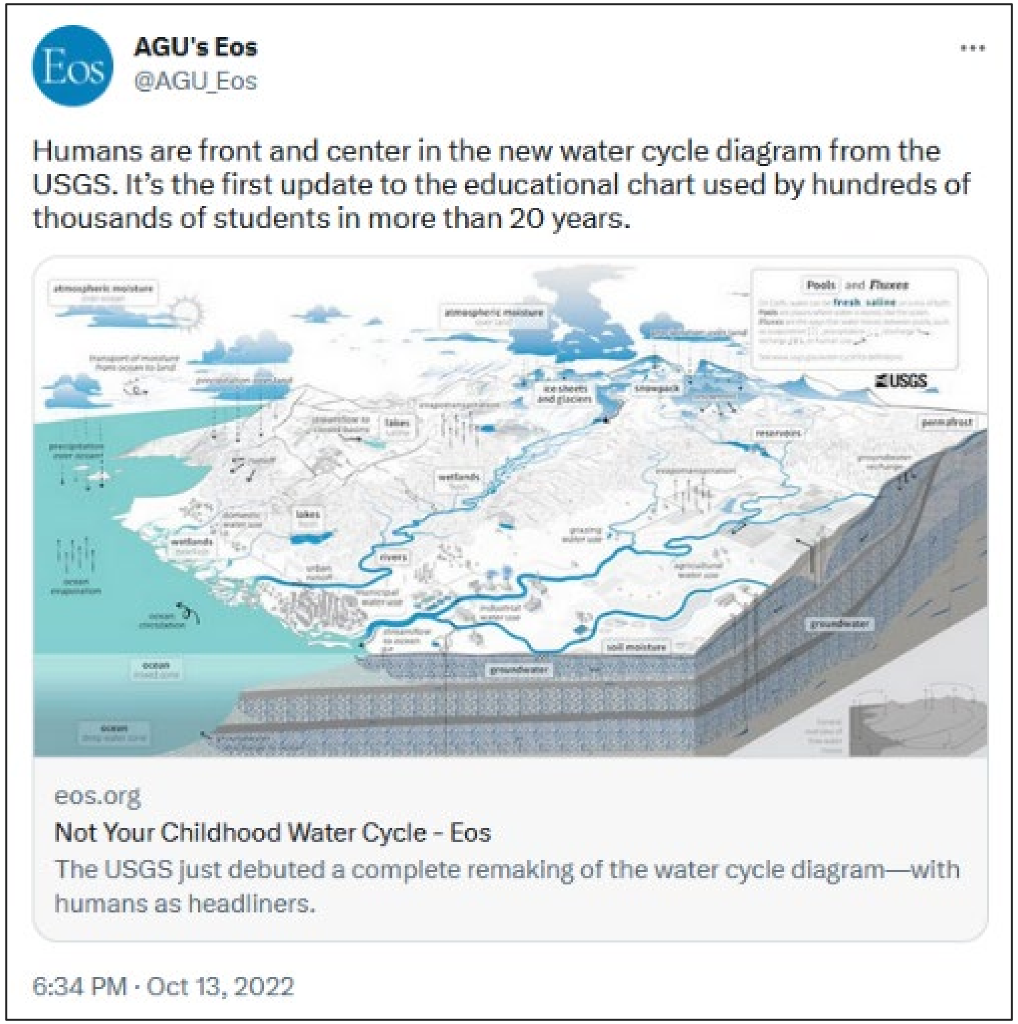
Ultimately, we want to understand the water cycle for Hudson Lake



Hydrology Concepts

- USGS recently published water cycle diagrams
- Explore interactive mapping services
- Newsworthy publication





https://www.usgs.gov/special-topics/water-science-school/science/water-cycle

https://twitter.com/AGU_Eos/status/1580688561913098240

Hydrology Concepts

FIGURE 1-1
Principal storages (boxes) and pathways (arrows) of water in the global hydrologic cycle.

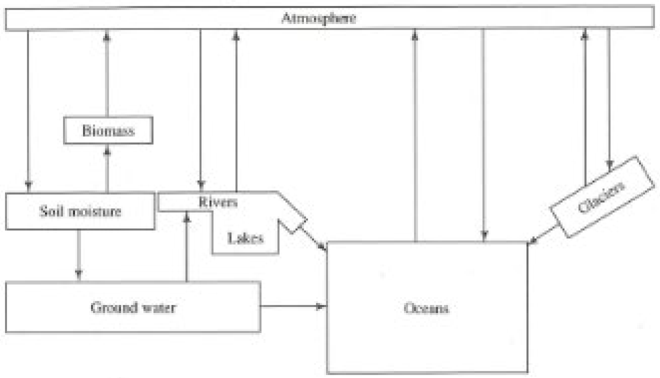
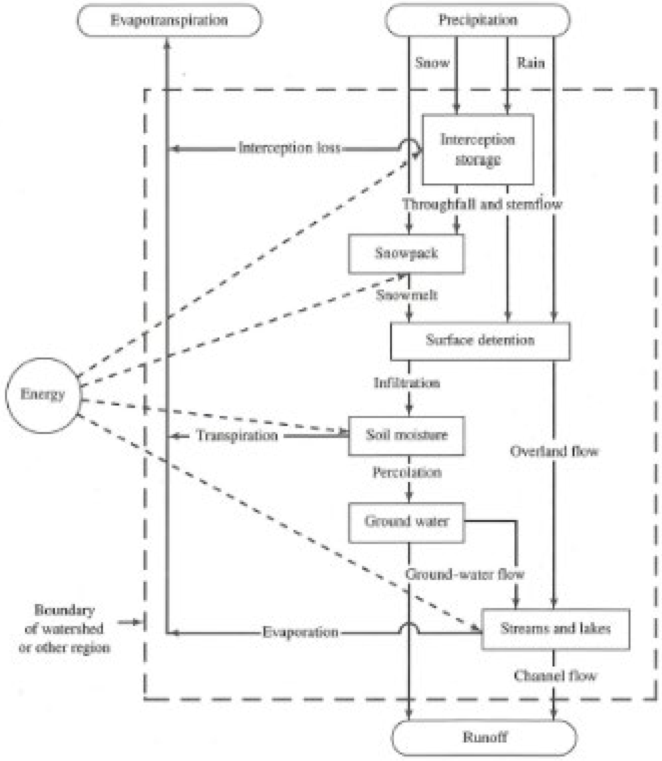


FIGURE 1-2
Principal storages (boxes) and pathways (arrows) of water in the land phase of the hydrologic cycle. From *Fluvial Hydrology* by S. Lawrence Dingman, © 1984, W.H. Freeman and Company. Reprinted with permission.



Water budgets

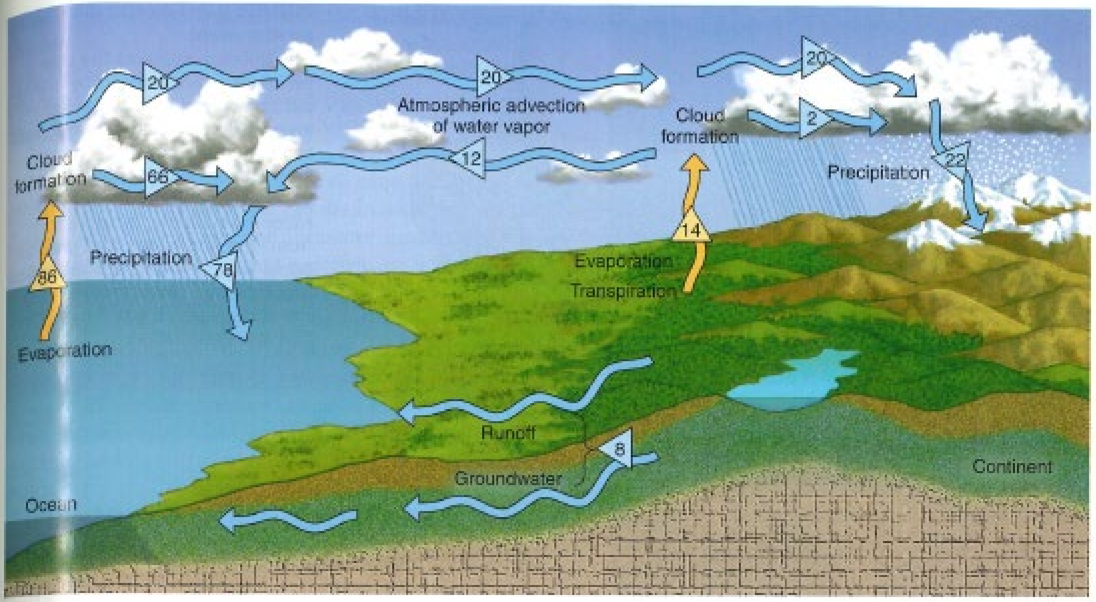


FIGURE 9.1 The hydrologic cycle model.
The model shows how water travels endlessly through the hydrosphere, atmosphere, lithosphere, and biosphere. The triangles show global average values as percentages. Note that all evaporation (86% + 14% = 100%) equals all precipitation (78% + 22% = 100%) when all of Earth is considered. Regionally, various parts of the cycle will vary, creating imbalances and, depending on climate, surpluses in one region and shortages in another.

ANIMATION Earth's Water and the Hydrologic Cycle

Hydrology Concepts

Water budgets

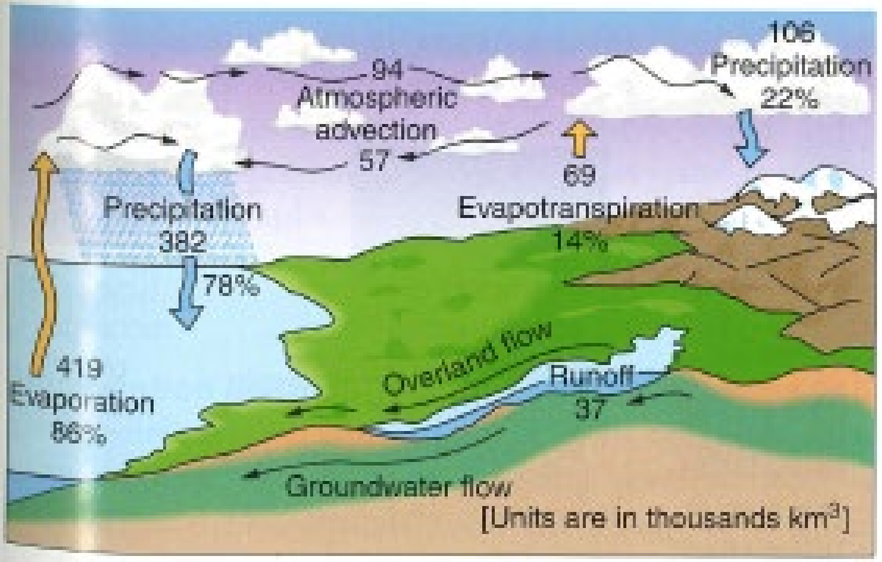


FIGURE 9.2 The global water balance in the hydrologic cycle.
The annual volume of water in all parts of the hydrologic cycle as measured in thousands of cubic kilometers. A balance exists between total evaporation and transpiration and precipitation, and between advection in the atmosphere and surface runoff of water (1 km^3 × 0.24 = 1 mi^3). Percentages are drawn from Figure 9.1, as given in the small directional arrows.

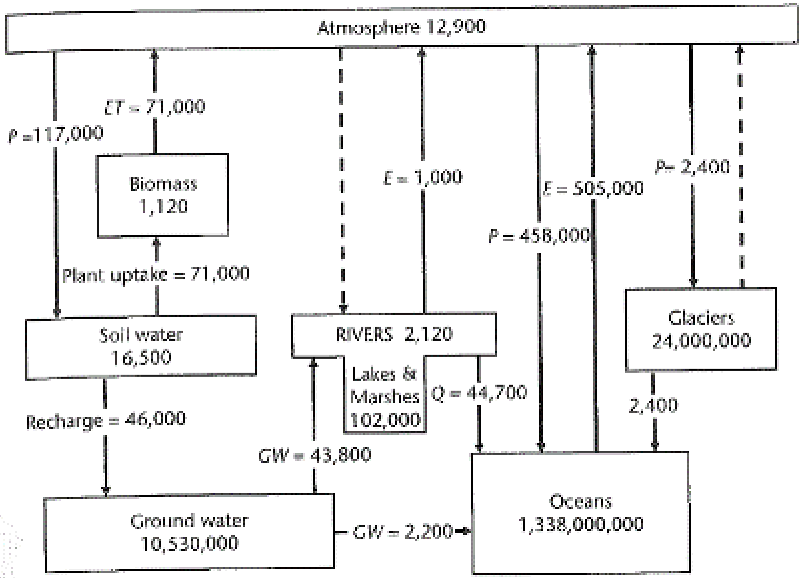


Figure 1.1 Schematic diagram of stocks (km^3) and annual fluxes (km^3/year) in the global hydrological cycle. E, evaporation; ET, evapotranspiration; GW, groundwater discharge; P, precipitation; Q, river discharge. Data on stocks, land and ocean precipitation, ocean evaporation, and river discharge are from Shiklomanov (1993) (see table 1.1); other fluxes are adjusted from Shiklomanov's values to give an approximate balance for each stock. Dashed arrows indicate negligible fluxes on the global scale

Table 1.1 Volume of water in compartments of the global hydrologic cycle.

Compartment	Area covered (1,000 km^2)	Volume (km^3)	Percentage of total water	Percentage of freshwater
Oceans	361,300	1,338,000,000	96.5	—
Groundwater	134,800	23,400,000	1.7	—
Fresh		10,530,000	0.76	30.1
Soil water		16,500	0.001	0.05
Glaciers and permanent snow	16,227	24,064,000	1.74	68.7
Antarctica	13,980	21,600,000	1.56	61.7
Greenland	1,802	2,340,000	0.17	6.68
Arctic Islands	226	83,500	0.006	0.24
Mountains	224	40,600	0.003	0.12
Permafrost	21,000	300,000	0.022	0.86
Lakes	2,059	176,400	0.013	—
Fresh	1,236	91,000	0.007	0.26
Saline	822	85,400	0.006	—
Marshes	2,683	11,470	0.0008	0.03
Rivers	148,800	2,120	0.0002	0.006
Biomass	510,000	1,120	0.0001	0.003
Atmosphere	510,000	12,900	0.001	0.04
Total water	510,000	1,385,984,000	100	—
Total freshwater	148,800	35,029,000	2.53	100

The global cycle is diagrammed in figure 1.1. From Shiklomanov (1993), with permission of Oxford University Press.

Hydrology Concepts

Water budget for the Hudson Lake system

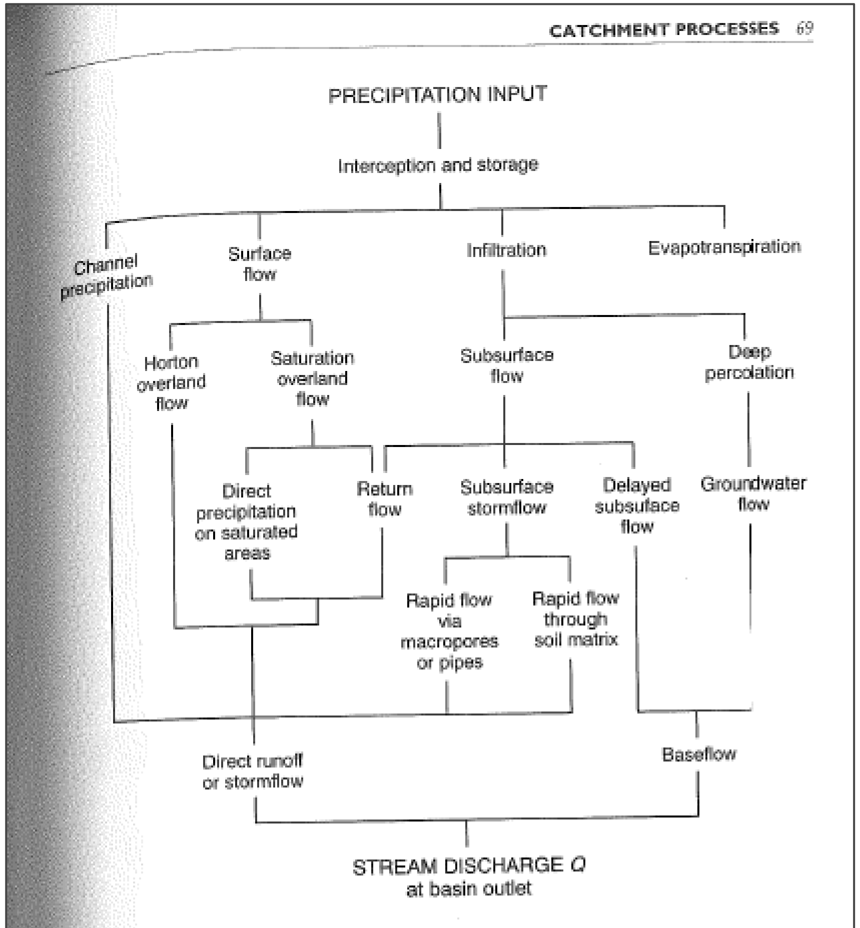
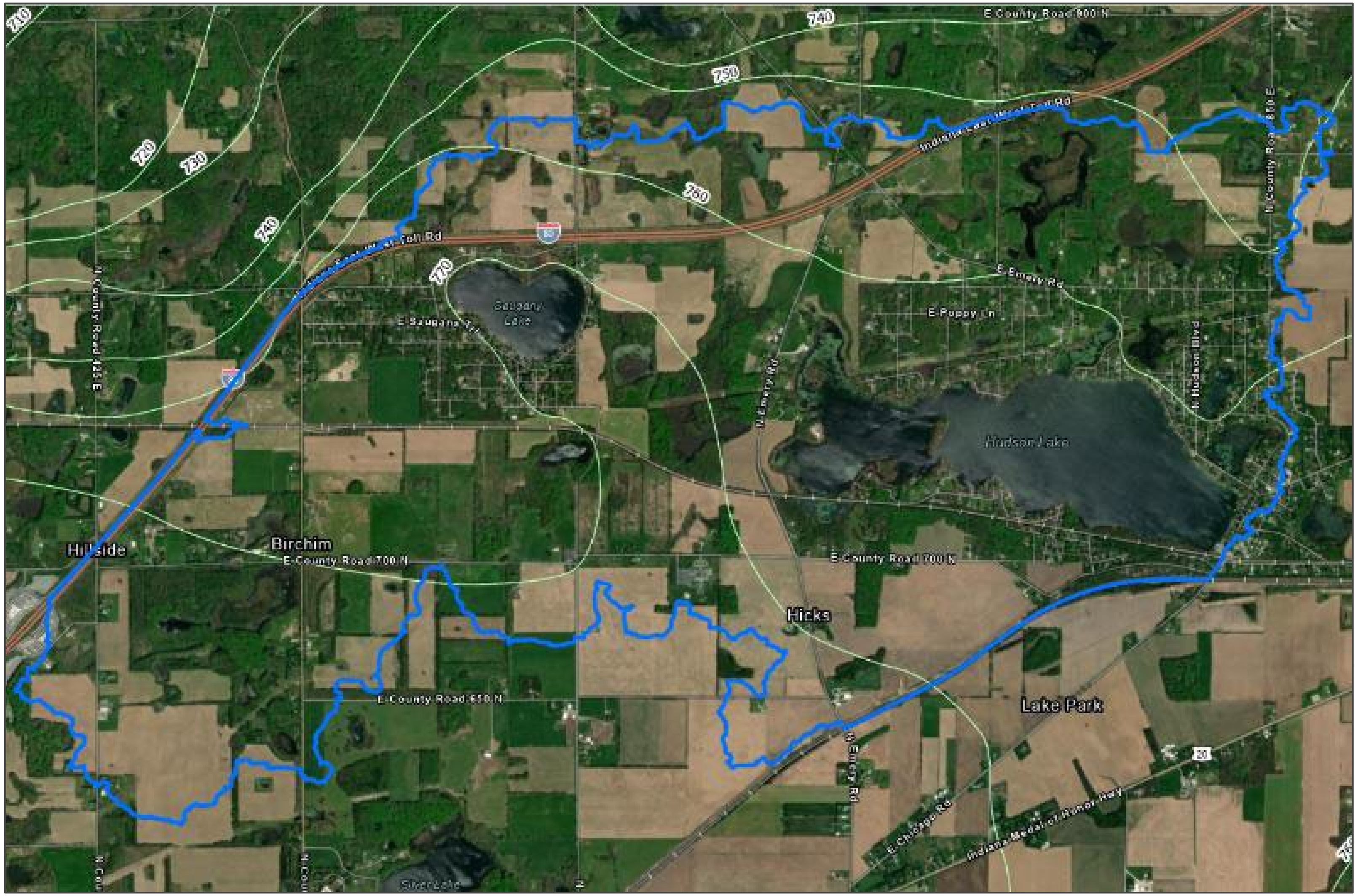


Figure 3.2 Schematic diagram of the runoff process.

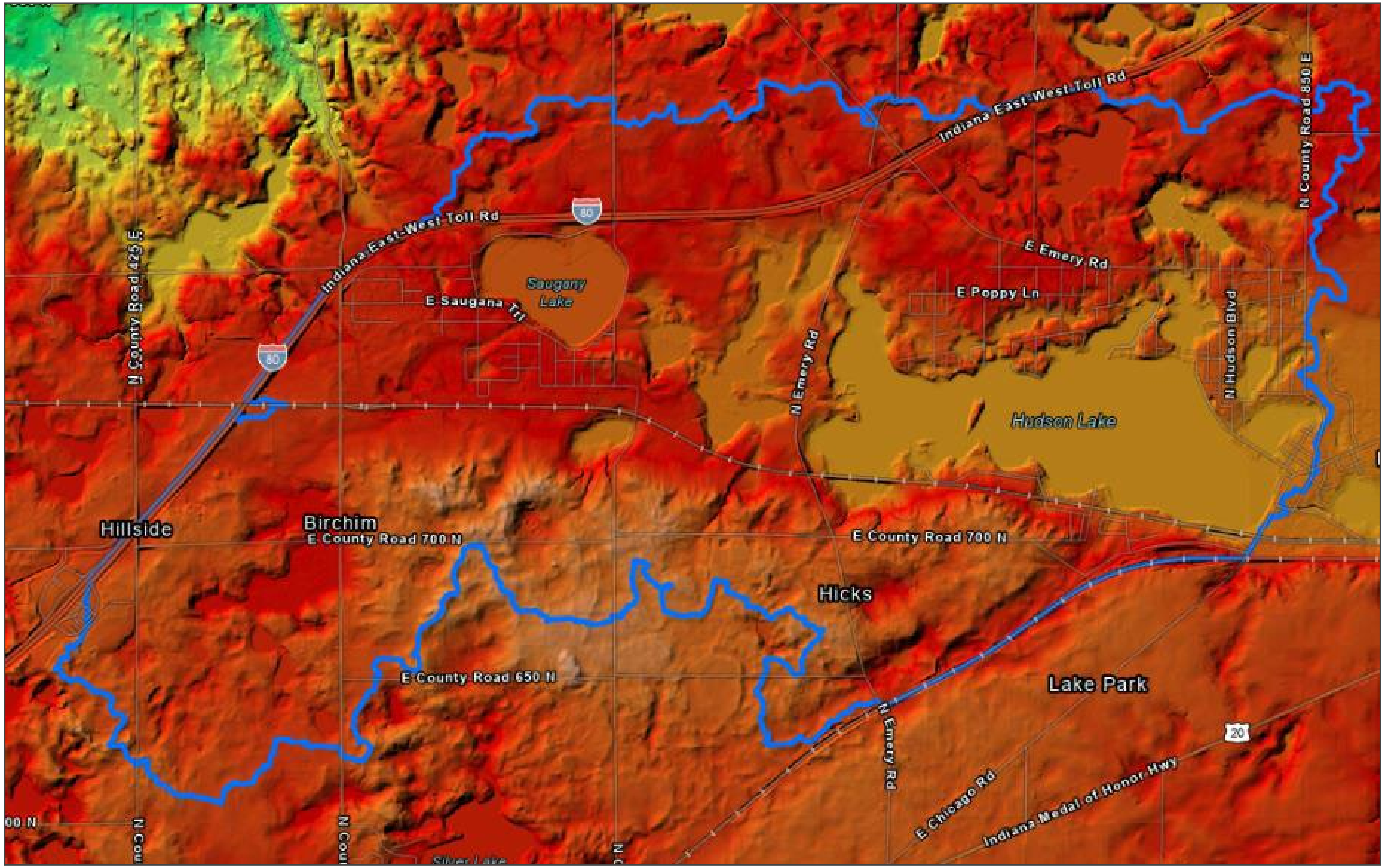


Geology of Hudson Lake

Concept of watershed

Geology drives how water moves through the landscape

Hudson Lake landscape is unique



Geology of Hudson Lake

Till

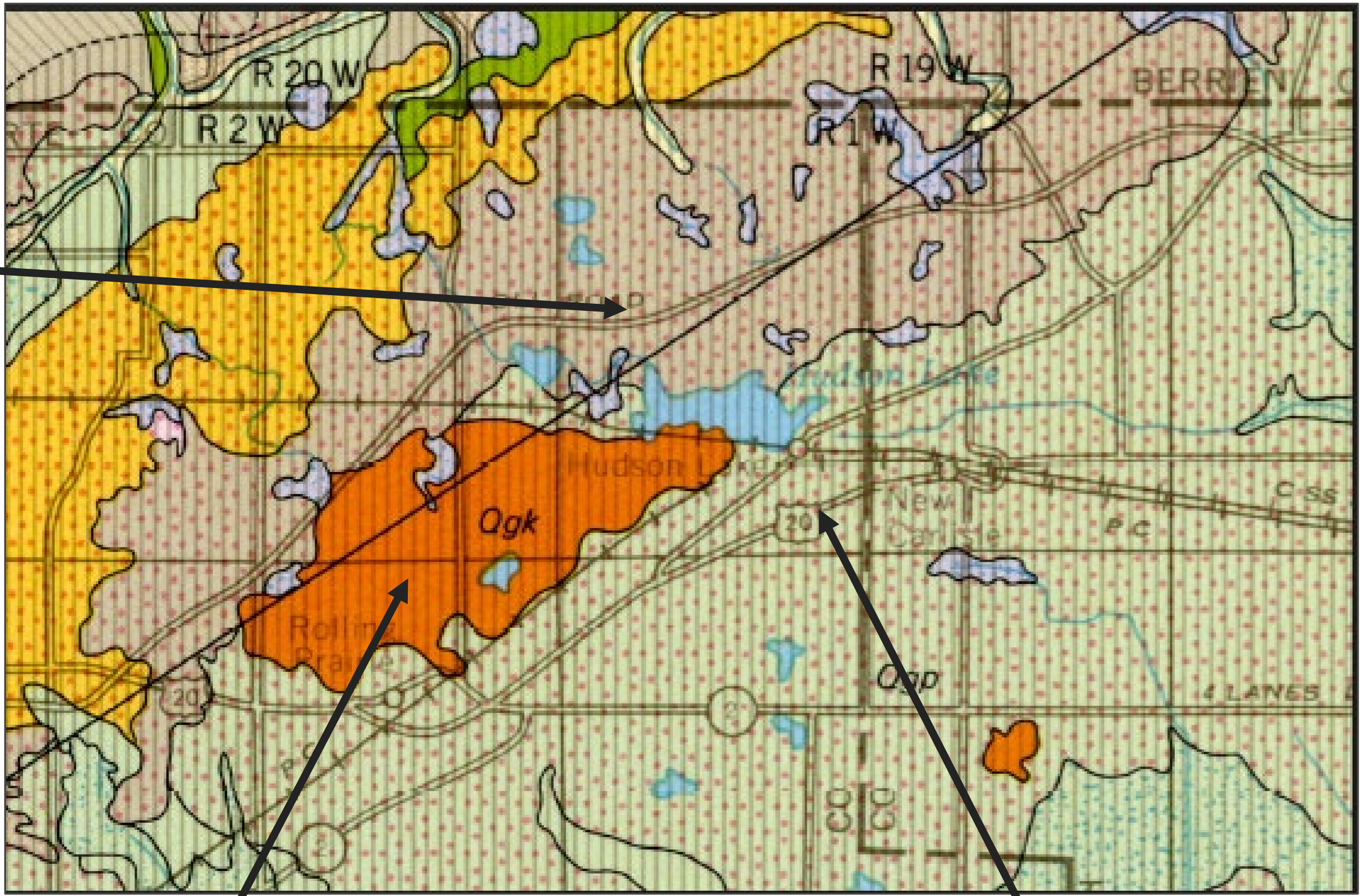
Includes some ice-contact stratified drift. Qt, mainly ground-moraine deposits; Qte, mainly end-moraine deposits; Qtl, wave-scoured lake-bottom till. Mostly Lagro Formation in Indiana

End moraine – more clay

Glacial geology

Young landscape - 10-15k years old

- Complex soils
- Higher clay content to the N
- Depressional to the SW
- Sand and gravel to the SE
- Aeolian too



Gravel, sand, and some silt

Ice-contact stratified drift in kames and kame moraines. Kame facies of Lagro Formation in Indiana

Kame and kettle – depressional

Gravel, sand, and silt

Outwash deposits. Qgv, valley-train deposits; Qgp, outwash-plain deposits. Outwash facies of Atherton Formation in Indiana

Outwash – sand and gravel

Geology of Hudson Lake

Glacial geology (View in GIS viewer)

Valparaiso Moraine

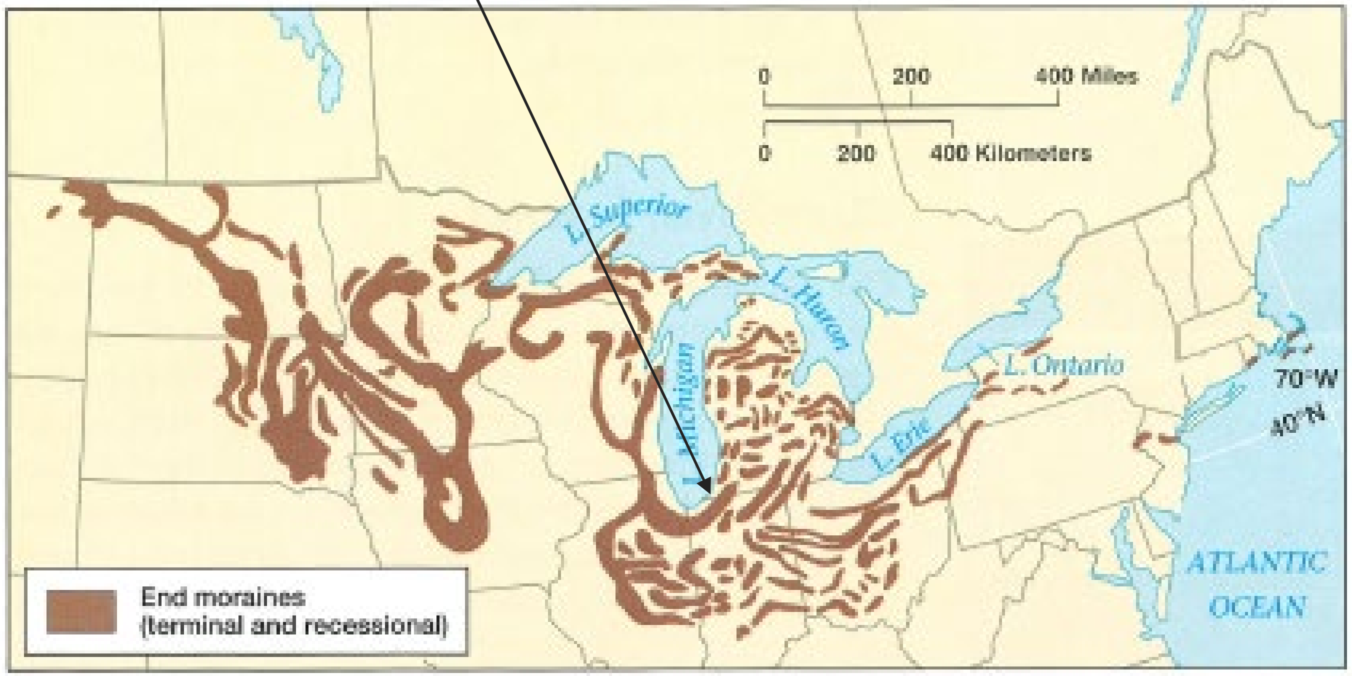


Figure 19–19 Terminal and recessional moraines in the United States resulting from the Wisconsin glaciation.

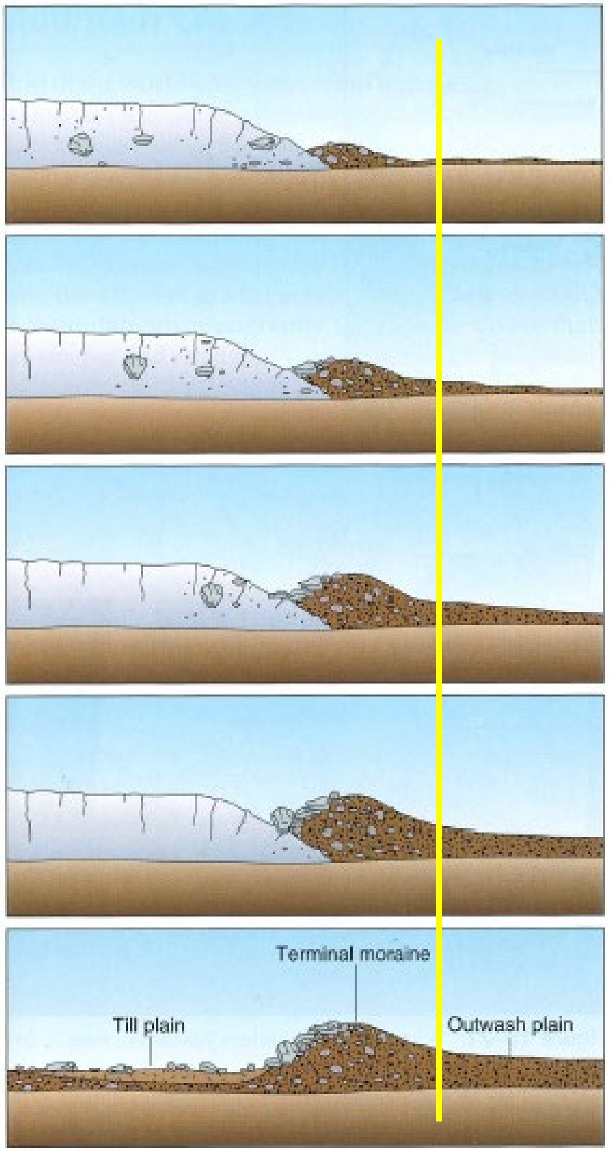


Figure 19–18 Terminal moraine growth at the toe of a stable glacier. The movement of a large boulder is shown from the time it is plucked from the bedrock until it is deposited as part of the moraine. The final diagram represents the situation after the ice has melted. (After Sheldon Judson, Marvin E. Kauffman, and L. Don Leet, *Physical Geology*. Englewood Cliffs, NJ: Prentice Hall, 1987.)

Yellow line shows hypothetical Hudson Lake location

Geology of Hudson Lake

Kettles and kames

Hudson Lake is a kettle lake

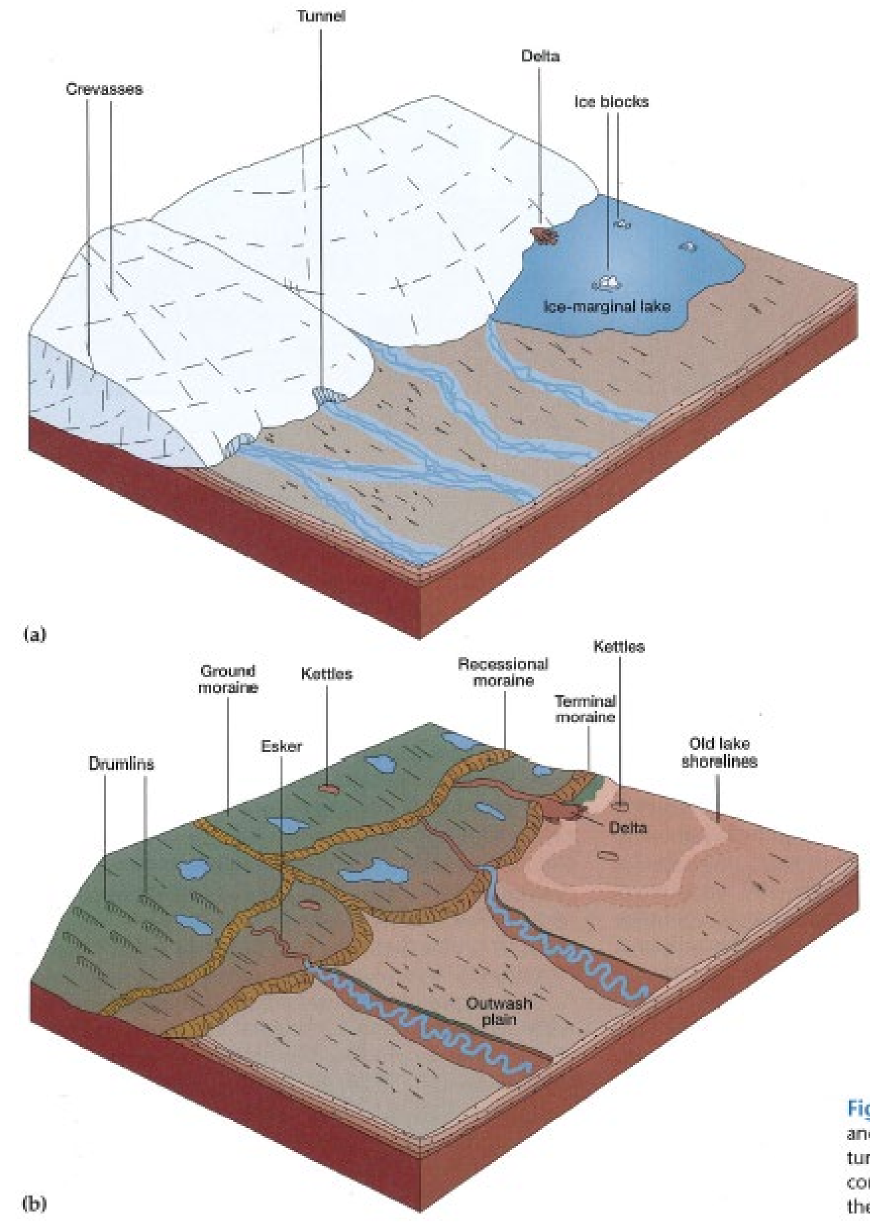


Figure 19–17 Glacier-deposited and glaciofluvially deposited features of a landscape (a) covered by a continental ice sheet and (b) after the sheet has retreated.

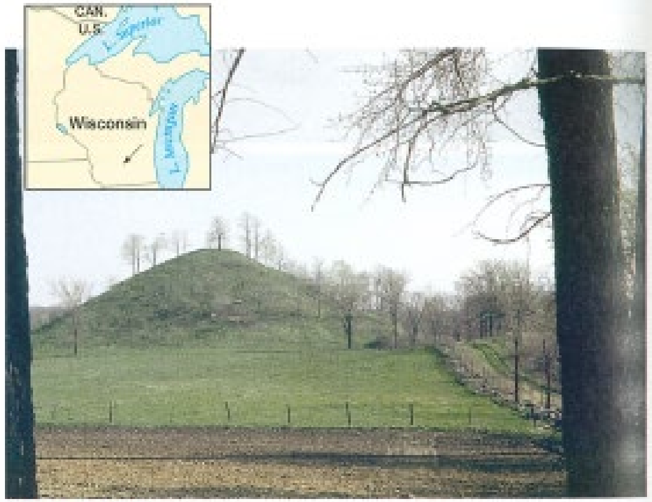


Figure 19–21 A kame in southeastern Wisconsin, near Dundee. (*TLM photo*)

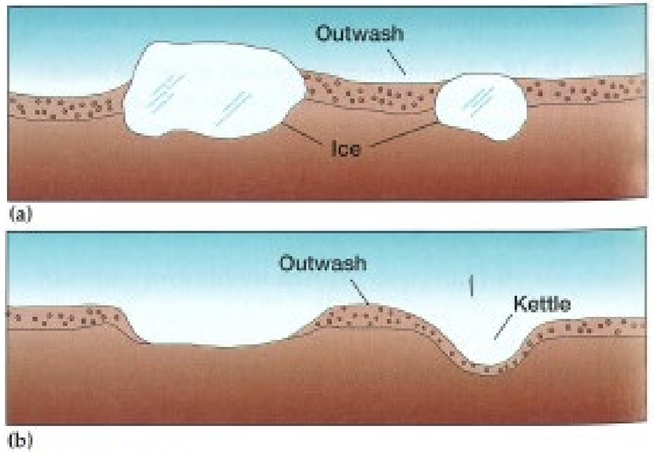
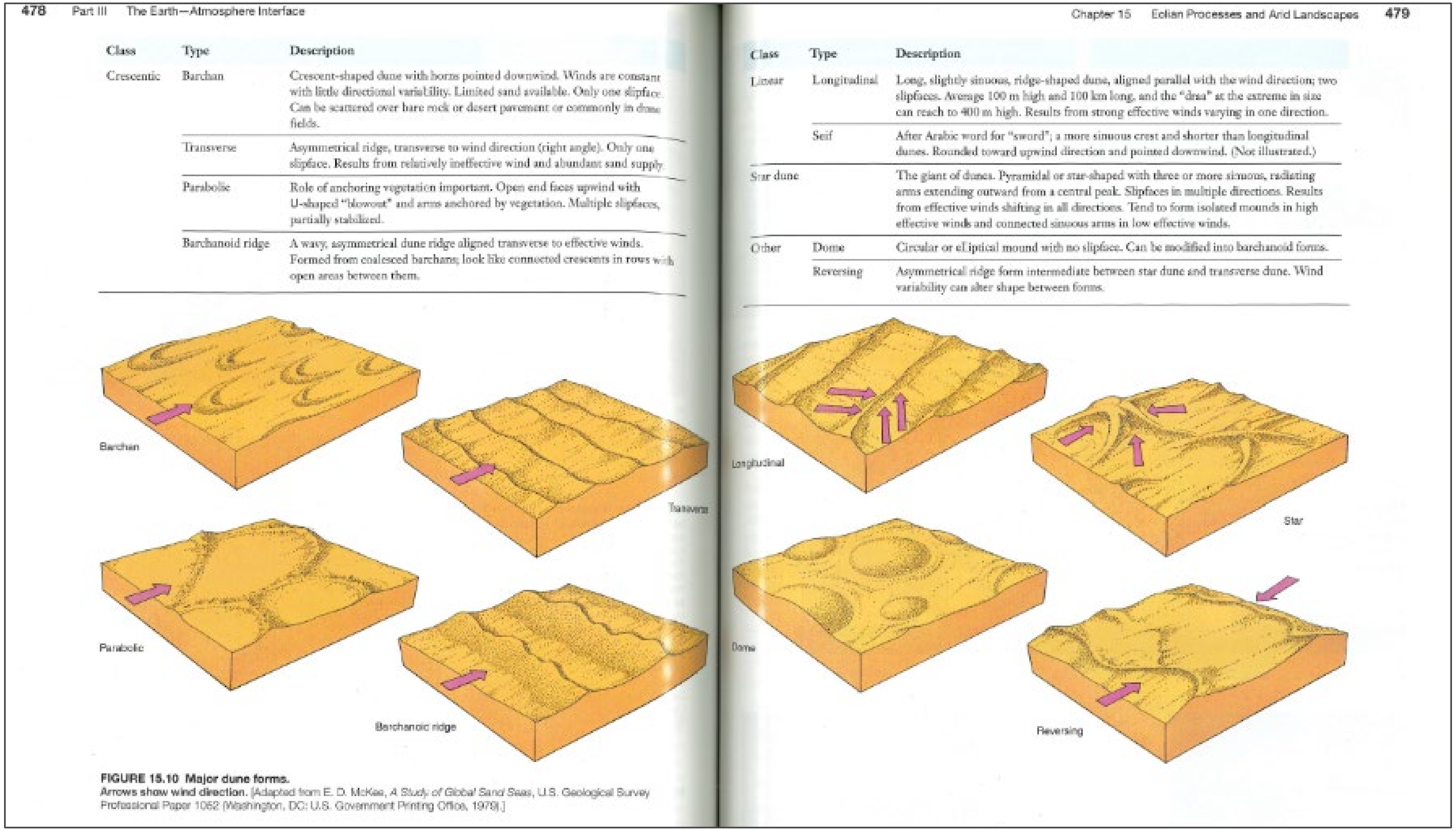


Figure 19–22 The formation of kettles. During deglaciation isolated masses of ice are often mixed in with the glacial debris and outwash, and melt only slowly because of the insulation provided by the surrounding debris. When the ice does eventually melt, sizable irregularities (known as kettles) may pit the surface of the outwash.

Geology of Hudson Lake

Aeolian (wind-driven) deposits south of Hudson Lake



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Class	Type	Description
Crescentic	Barchan	Crescent-shaped dune with horns pointed downwind. Winds are constant with little directional variability. Limited sand available. Only one slipface. Can be scattered over bare rock or desert pavement or commonly in dune fields.
	Transverse	Asymmetrical ridge, transverse to wind direction (right angle). Only one slipface. Results from relatively ineffective wind and abundant sand supply.
	Parabolic	Role of anchoring vegetation important. Open end faces upwind with U-shaped "blowout" and arms anchored by vegetation. Multiple slipfaces, partially stabilized.
	Barchanoid ridge	A wavy, asymmetrical dune ridge aligned transverse to effective winds. Formed from coalesced barchans; look like connected crescents in rows with open areas between them.

FIGURE 15.10 Major dune forms.
Arrows show wind direction. [Adapted from E. D. McKee, *A Study of Global Sand Seas*, U.S. Geological Survey Professional Paper 1052 (Washington, DC: U.S. Government Printing Office, 1979).]

Chapter 15 Eolian Processes and Arid Landscapes 479

Class	Type	Description
Linear	Longitudinal	Long, slightly sinuous, ridge-shaped dune, aligned parallel with the wind direction; two slipfaces. Average 100 m high and 100 km long, and the "draa" at the extreme in size can reach to 400 m high. Results from strong effective winds varying in one direction.
	Seif	After Arabic word for "sword"; a more sinuous crest and shorter than longitudinal dunes. Rounded toward upwind direction and pointed downwind. (Not illustrated.)
Star dune		The giant of dunes. Pyramidal or star-shaped with three or more sinuous, radiating arms extending outward from a central peak. Slipfaces in multiple directions. Results from effective winds shifting in all directions. Tend to form isolated mounds in high effective winds and connected sinuous arms in low effective winds.
Other	Dome	Circular or elliptical mound with no slipface. Can be modified into barchanoid forms.
	Reversing	Asymmetrical ridge form intermediate between star dune and transverse dune. Wind variability can alter shape between forms.

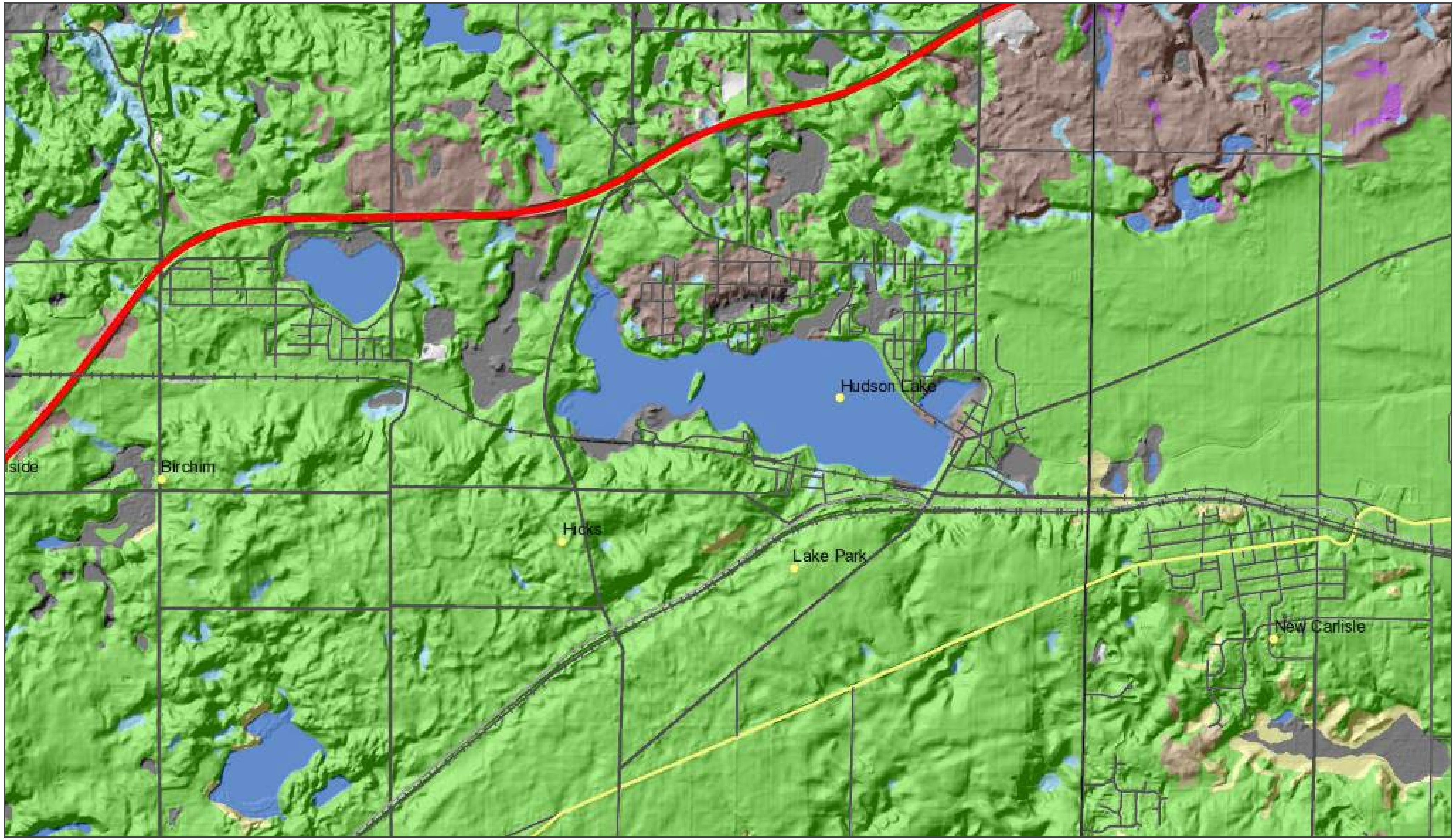
(a)

(b)

(b)

Geology of Hudson Lake

Soil explorer - Let's visit: https://soilexplorer.net/



Geology of Hudson Lake

Young landscape

Hudson Lake is here:

- 10-15k year old since glaciation
- Drainage area, or watershed, is difficult to determine

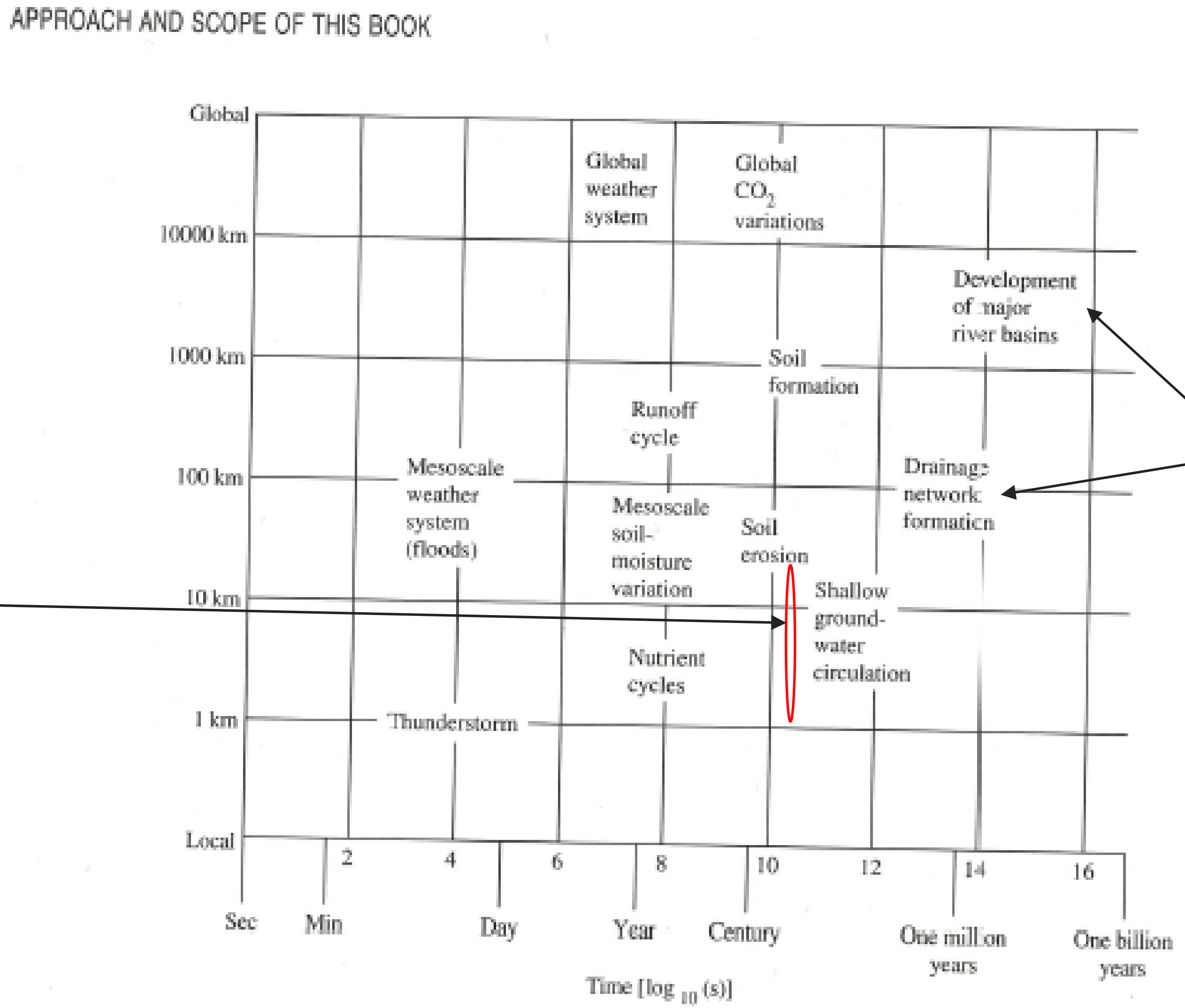


FIGURE 1-3
Range of space and time scales of hydrologic processes. Reprinted with permission from *Opportunities in the Hydrologic Sciences*, © 1991 by the National Academy of Sciences. Courtesy of the National Academy Press, Washington DC.

Too young for the formation of stream networks

Geomorphology of Hudson Lake

Steam network patterns

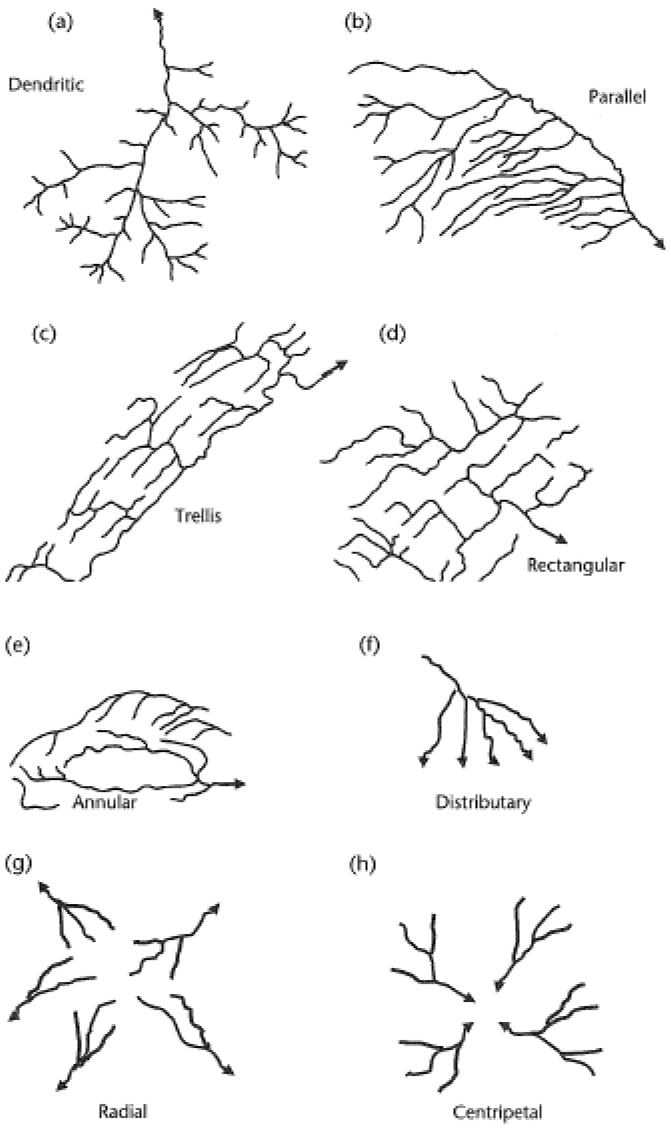


Figure 2.2 Drainage-network patterns (see table 2.1). Panels a–e are from Morisawa (1985).

Table 2.1 Stream-network patterns and metapatterns and their relation to geological controls.

Type	Description	Geological control	Figure
Dendritic	Treelike, no preferred channel orientation, acute interstream angles	None	2.2a
Parallel	Main channels regularly spaced and subparallel to parallel, very acute interstream angles	Closely spaced faults, monoclines, or isoclinal folds	2.2b
Trellis	Channels oriented in two mutually perpendicular directions, elongated in dominant drainage direction, nearly perpendicular interstream angles	Tilted or folded sedimentary rocks with alternating resistant/weak beds	2.2c
Rectangular	Channels oriented in two mutually perpendicular directions, lengths similar in both directions, nearly perpendicular interstream angles	Rectangular joint or fault system	2.2d
Annular	Main streams in approximately circular pattern, nearly perpendicular interstream angles	Eroded dome of sedimentary rocks with alternating resistant/weak beds	2.2e
Distributary	Single channel splits into two or more channels that do not rejoin	Thick alluvial deposits (alluvial fans, deltas)	2.2f
Radial (metapattern)	Stream networks radiate outward from central point	Volcanic cone or dome of intrusive igneous rock	2.2g
Centripetal (metapattern)	Stream networks flow inward to a central basin	Calderas, craters, tectonic basins	2.2h

After Summerfield (1991) and Twidale (2004).

Geomorphology of Hudson Lake

Dendritic stream networks

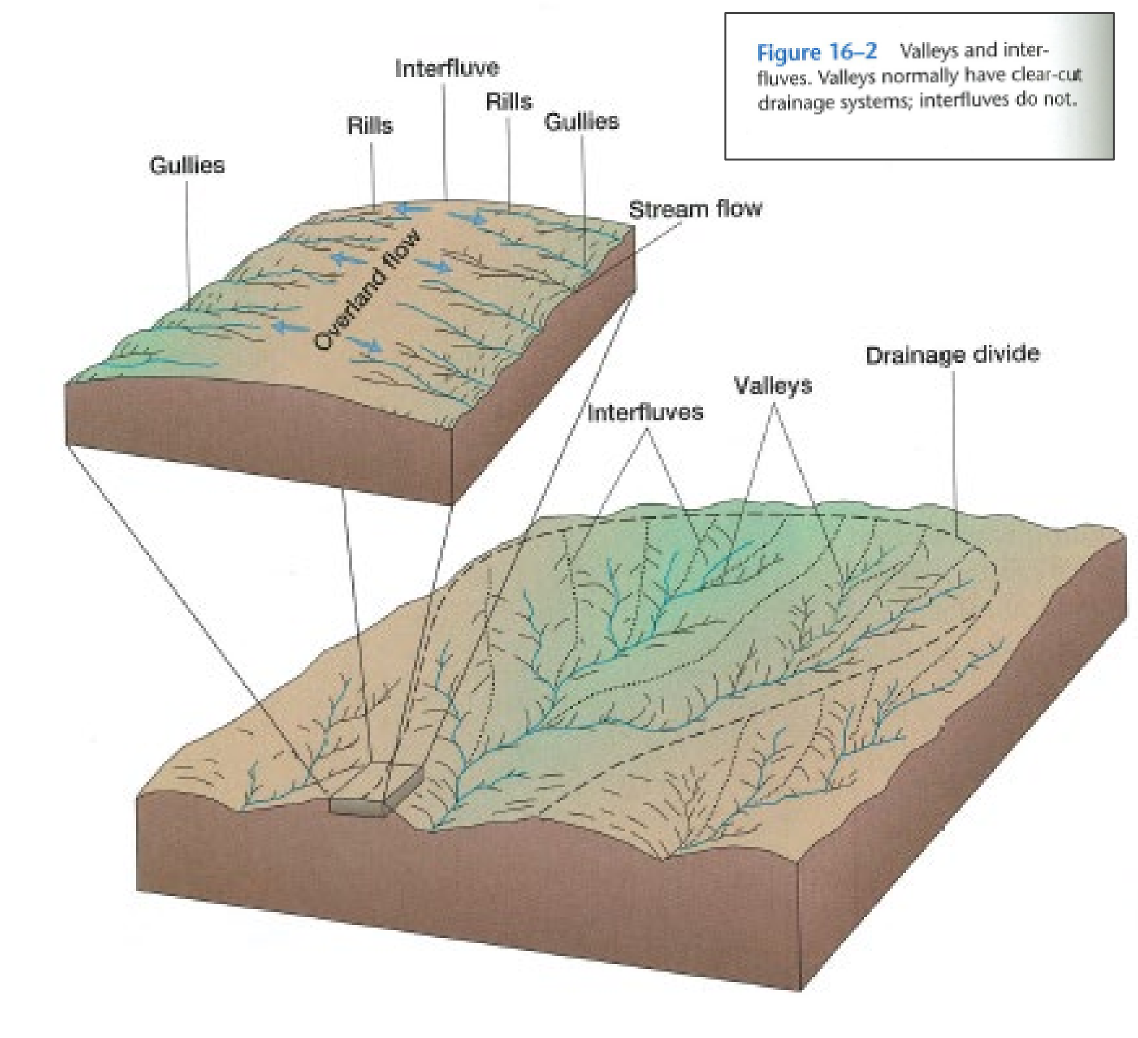


Figure 16–2 Valleys and interfluves. Valleys normally have clear-cut drainage systems; interfluves do not.

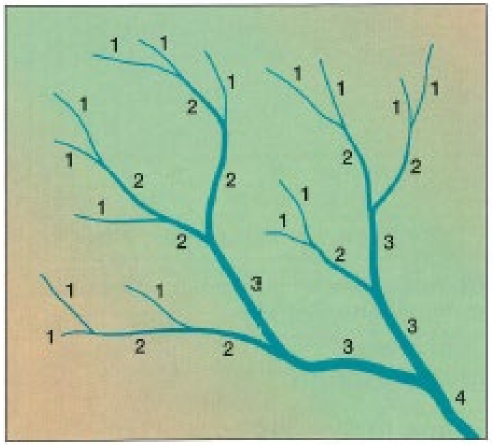


Figure 16–4 Stream orders. The branching component of a stream and its tributaries can be classified into a hierarchy ol segments, ranging from smallest to largest (in this case, from 1 to 4).

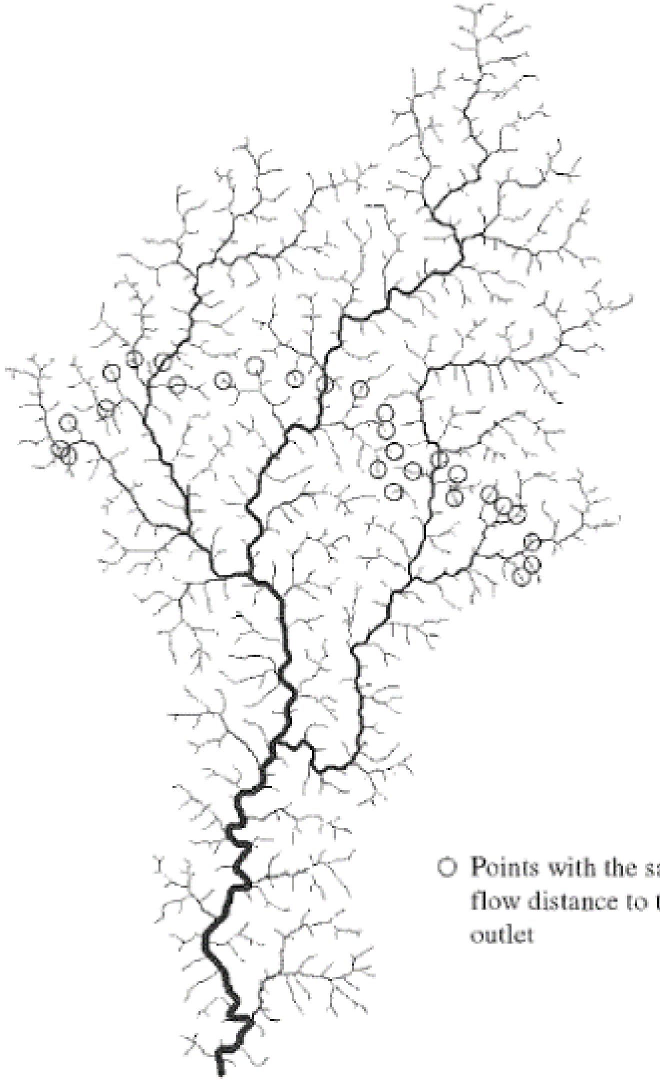


Figure 1.10. Definition of width function.

automatically extrac

Geomorphology of Hudson Lake

Dendritic stream networks:

- Time to formation is long
- Hudson Lake is young

Highly permeable and deep sandy soils also play a role

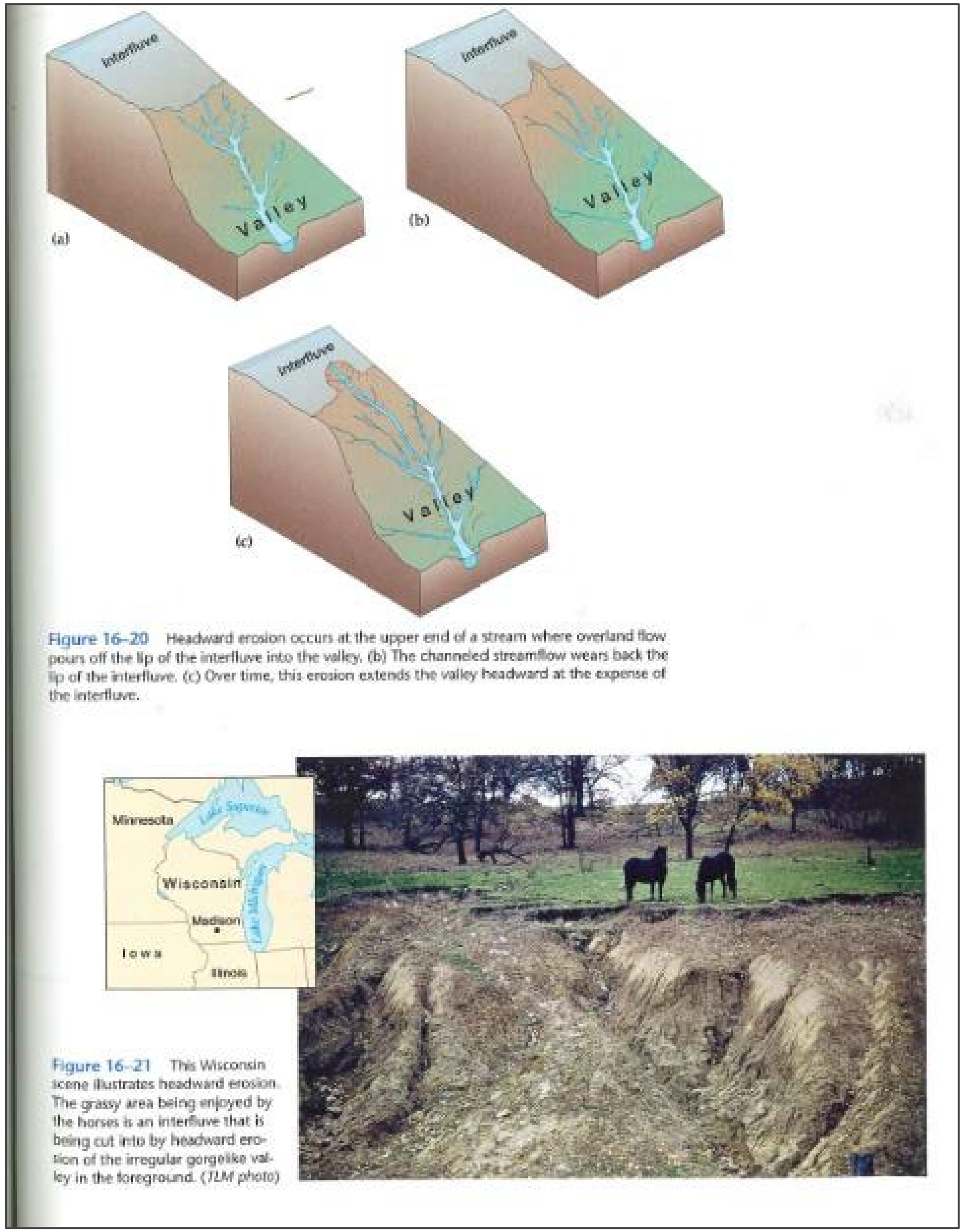


Figure 16-20 Headward erosion occurs at the upper end of a stream where overland flow pours off the lip of the interfluve into the valley. (b) The channeled streamflow wears back the lip of the interfluve. (c) Over time, this erosion extends the valley headward at the expense of the interfluve.

Figure 16-21 This Wisconsin scene illustrates headward erosion. The grassy area being enjoyed by the horses is an interfluve that is being cut into by headward erosion of the irregular gorgelike valley in the foreground. (*JLM photo*)

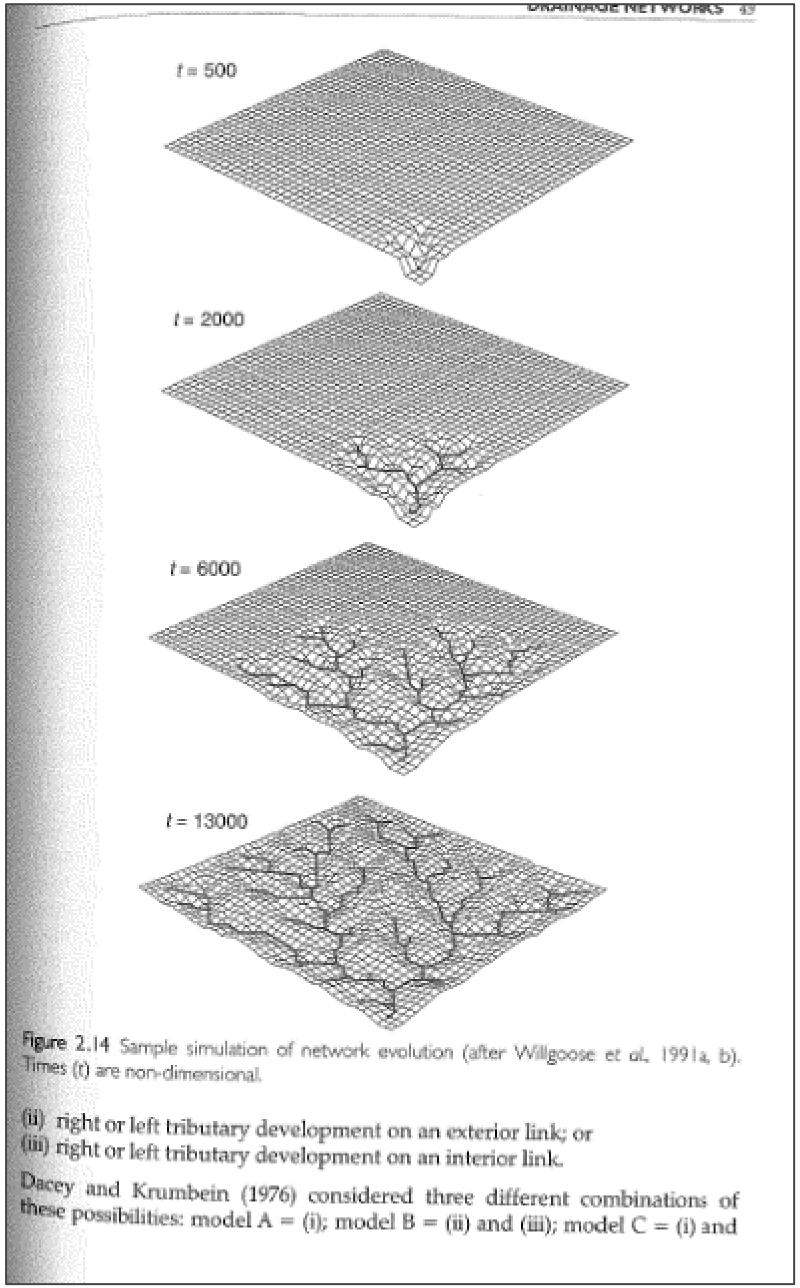


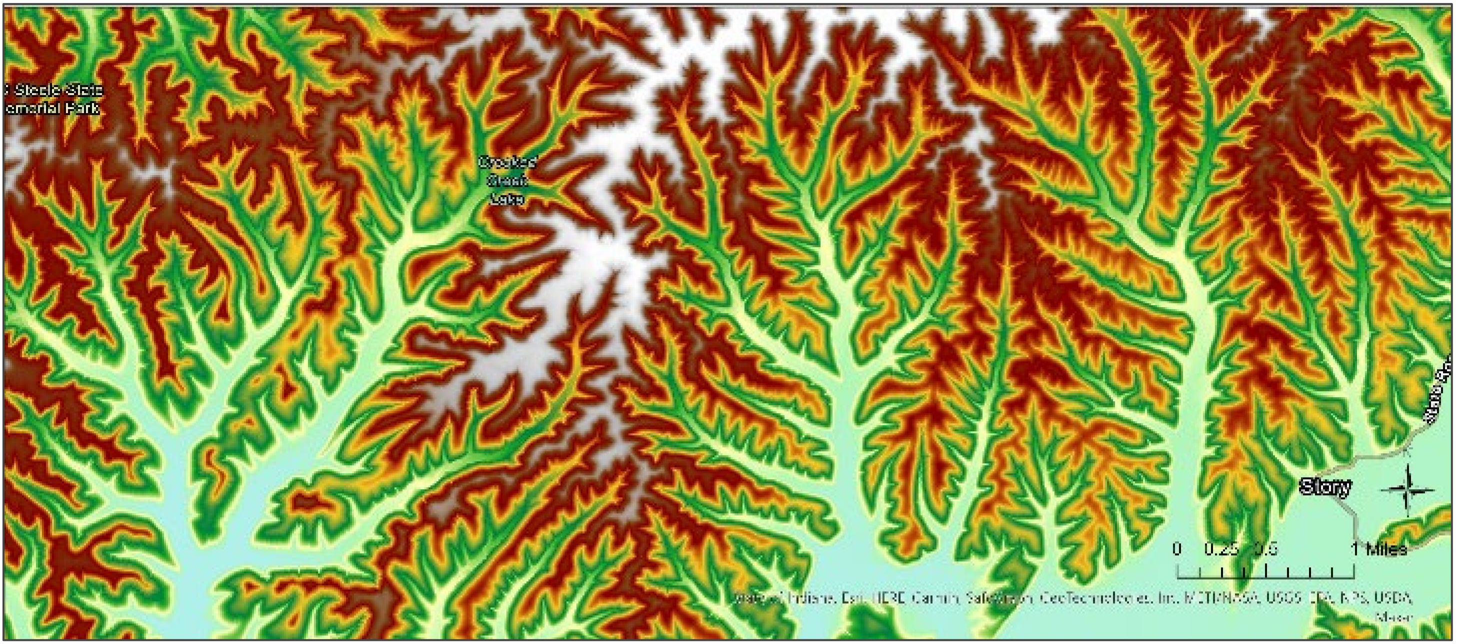
Figure 2.14 Sample simulation of network evolution (after Willgoose *et al.*, 1991a, b). Times (t) are non-dimensional.

(ii) right or left tributary development on an exterior link; or
(iii) right or left tributary development on an interior link.

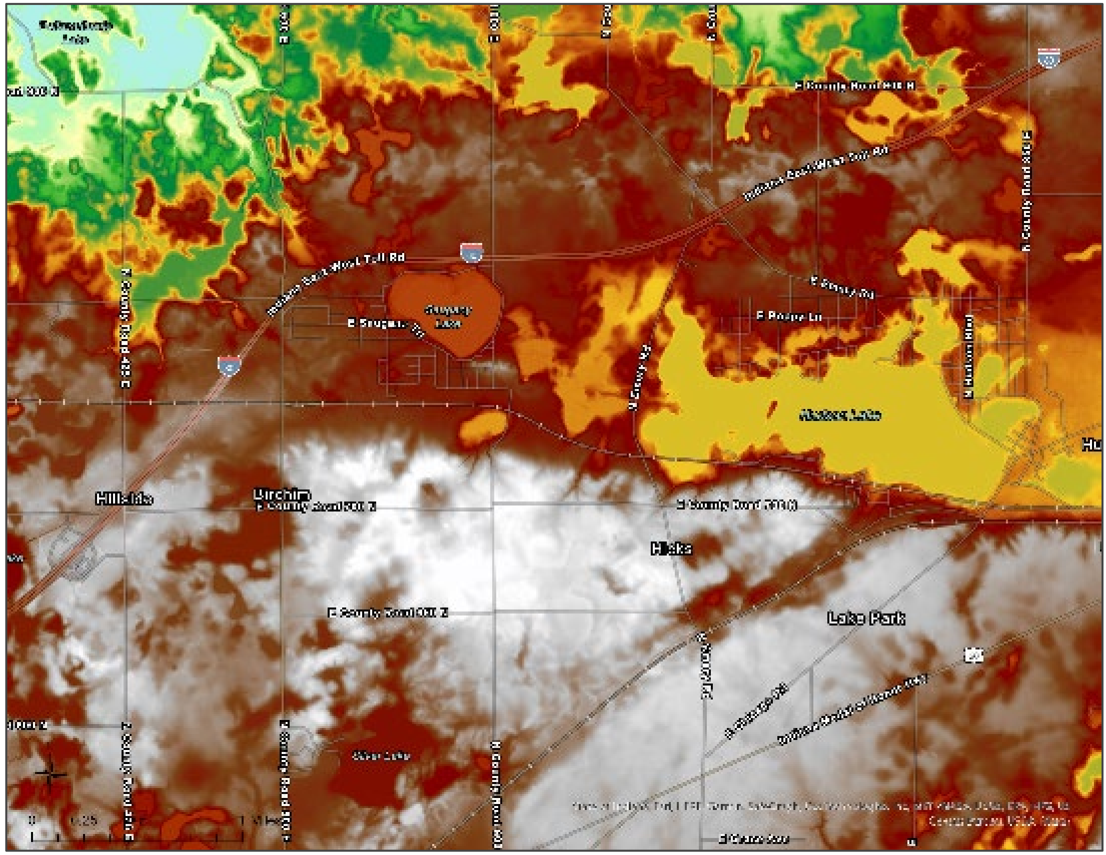
Dacey and Krumbein (1976) considered three different combinations of these possibilities: model A = (i); model B = (ii) and (iii); model C = (i) and

Geomorphology of Hudson Lake

Dendritic vs nondendritic surface drainage networks



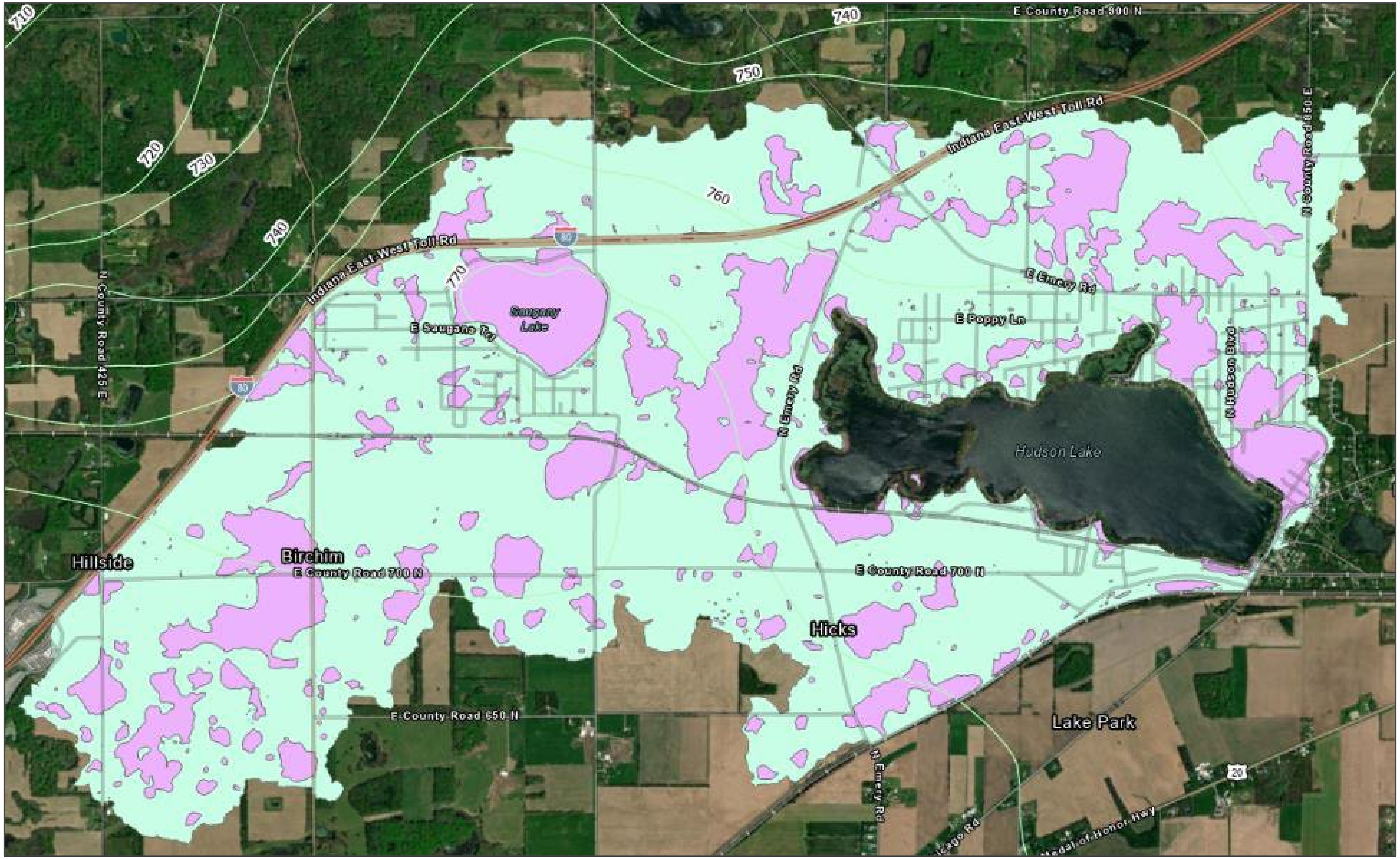
Unglaciated Brown County



Recently glaciated LaPorte County

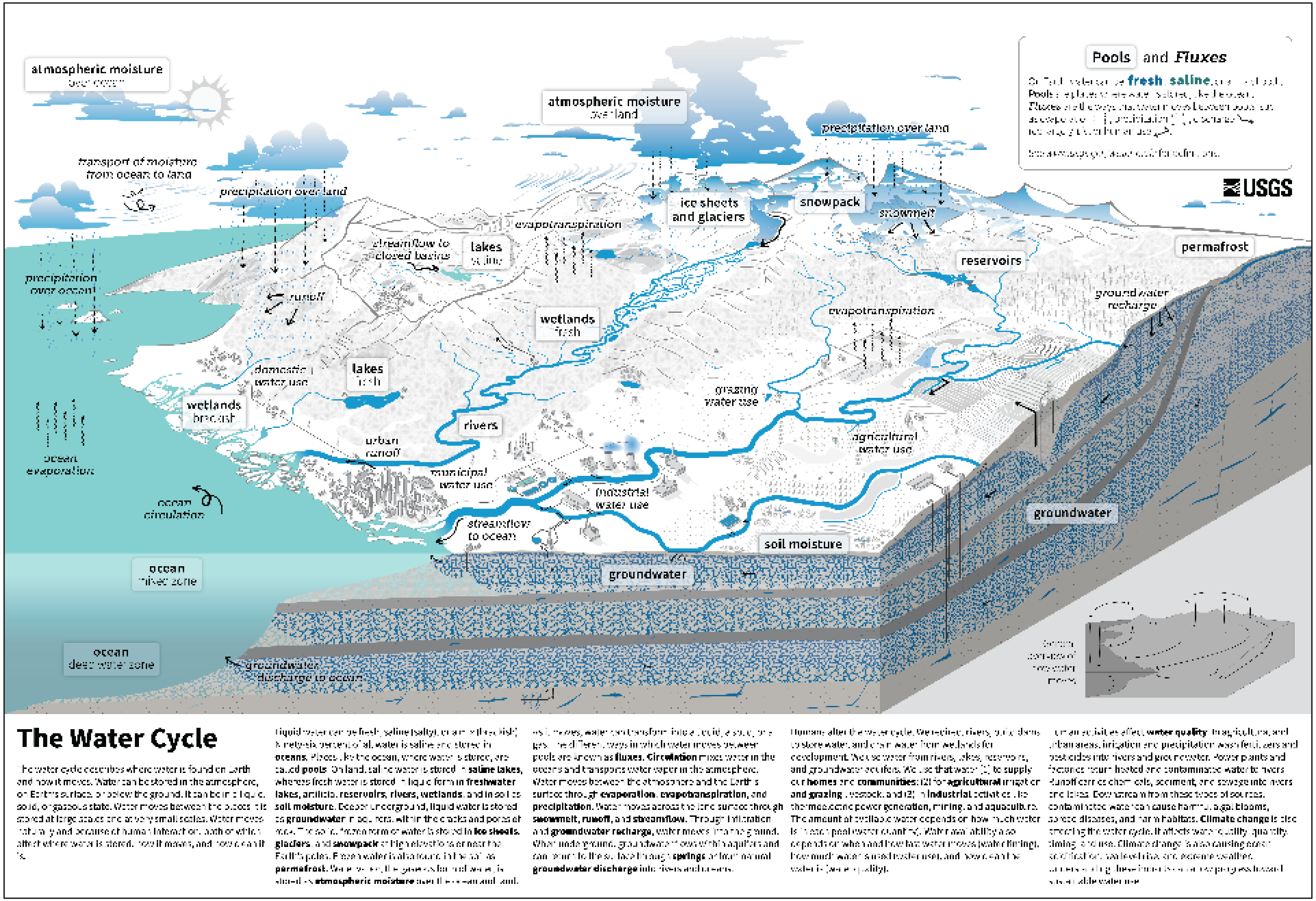
Geomorphology of Hudson Lake

Nondendritic surface drainage networks - 23.9% of watershed is depressional – Fuzzy drainage area



Hydrology of Hudson Lake

The Hudson Lake watershed and groundwater systems are unique



Hydrology of Hudson Lake

Watersheds as transfer functions – Precipitation is transferred to lake levels

CHAPTER 2 • BASIC HYDROLOGIC CONCEPTS

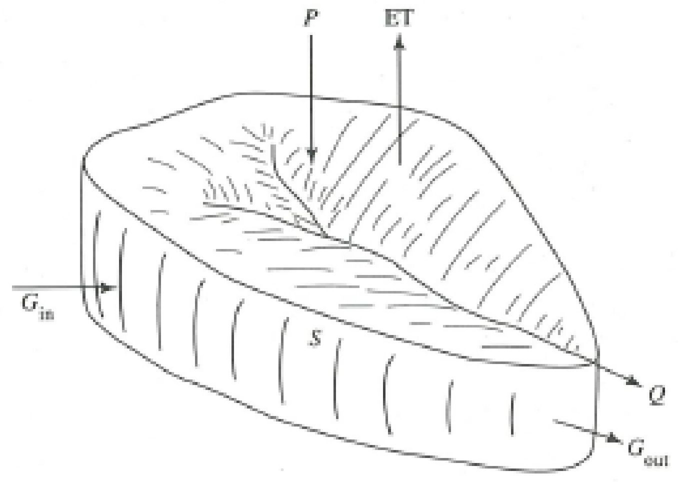


FIGURE 2-6
Schematic diagram of a watershed, showing the components of the regional water balance: P = precipitation, ET = evapotranspiration, Q = stream outflow, G_{in} = ground-water inflow, G_{out} = ground-water outflow.

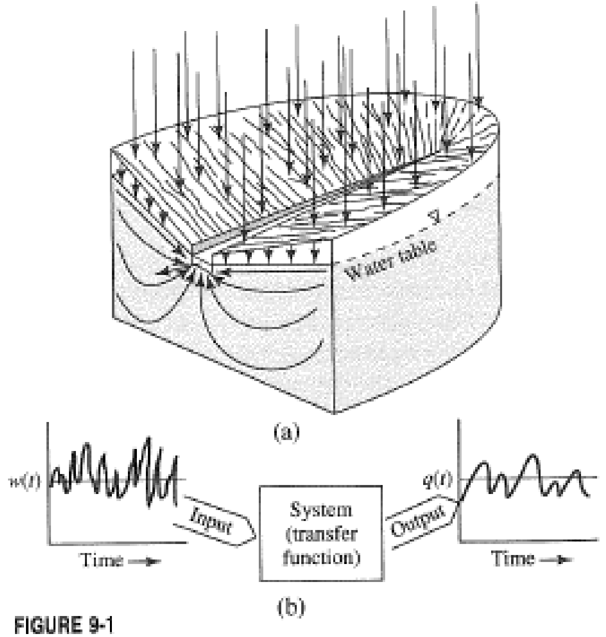


FIGURE 9-1
(a) Schematic flow paths in a small upland watershed receiving water inputs: the transparent box view of a watershed. (b) The black box (systems) view of a watershed as an algorithm generating outputs from specified inputs.

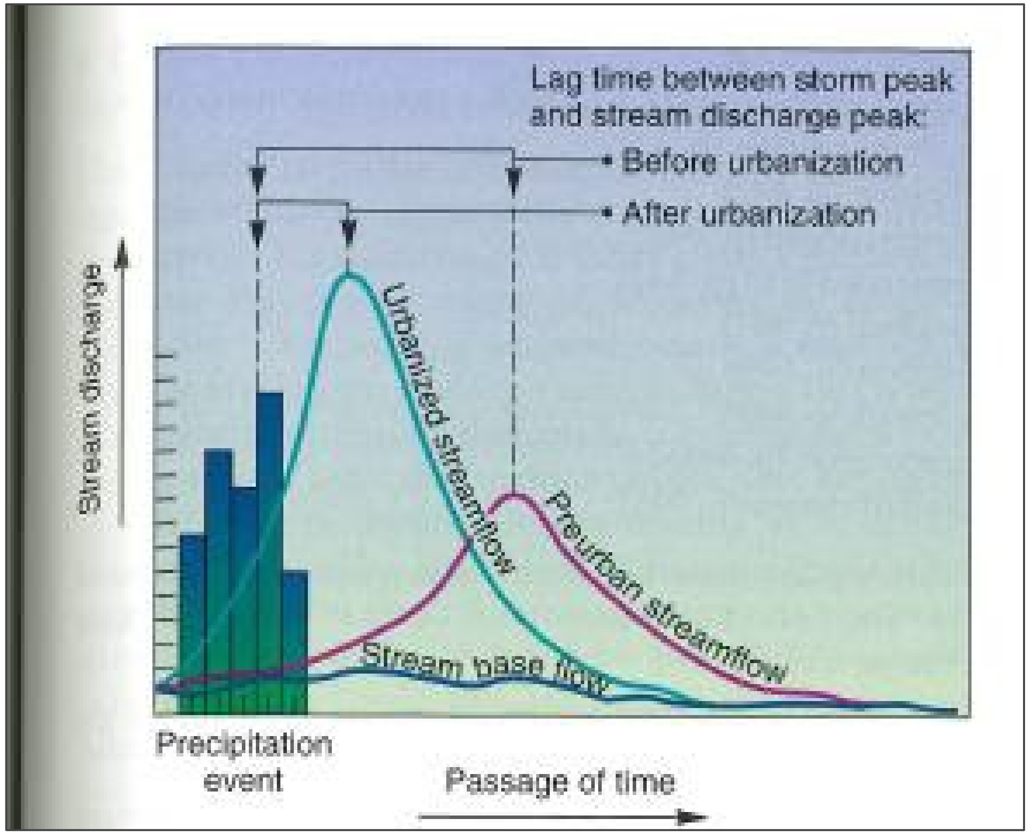
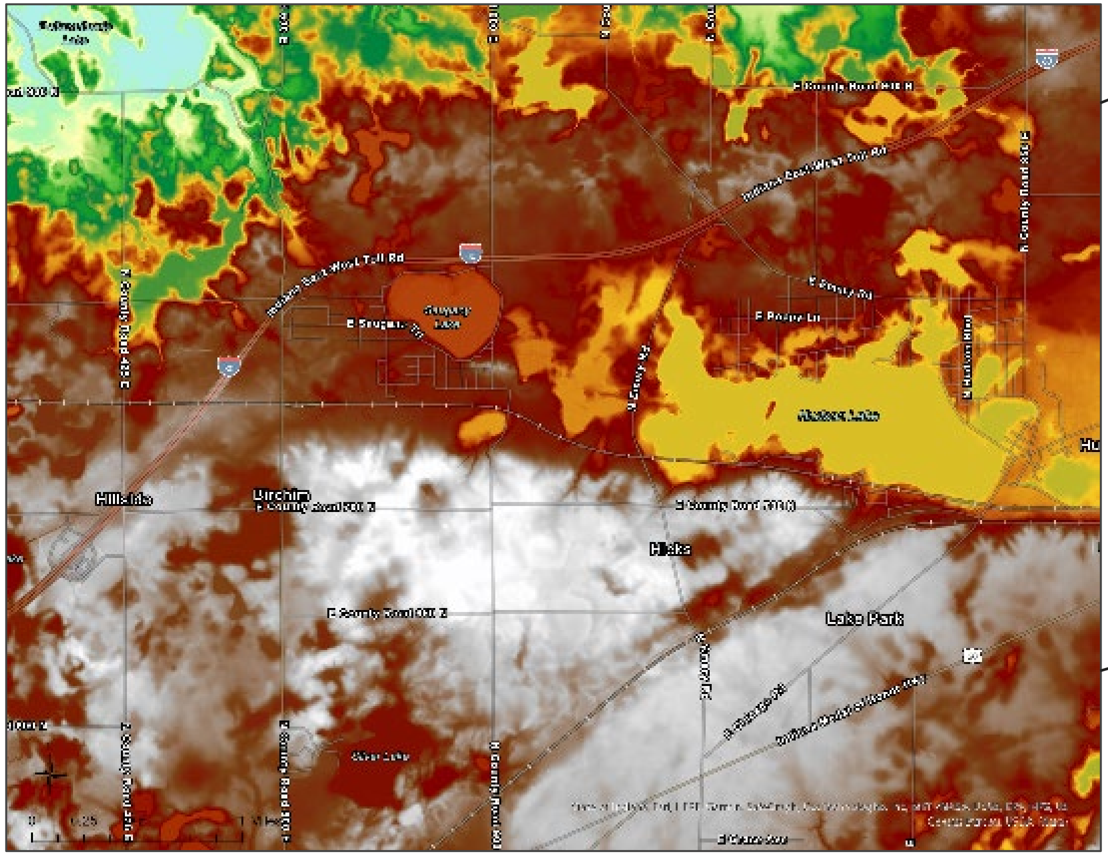


FIGURE 14.31 Urban flooding.
(a) Effect of urbanization on a typical stream hydrograph. Normal base flow is indicated with a dark blue line. The purple line indicates discharge after a storm, before urbanization. Following urbanization, stream discharge dramatically increases, as shown by the light blue line. (b) Severe flooding of an urban area in Linda, California, after a levee break on the Sacramento River in 1986; and it flooded again in 1997. [(b) Photo from California Department of Water Resources.]

Hydrology of Hudson Lake

Landscape age and dominant soil type drive how precipitation moves over and through the landscape



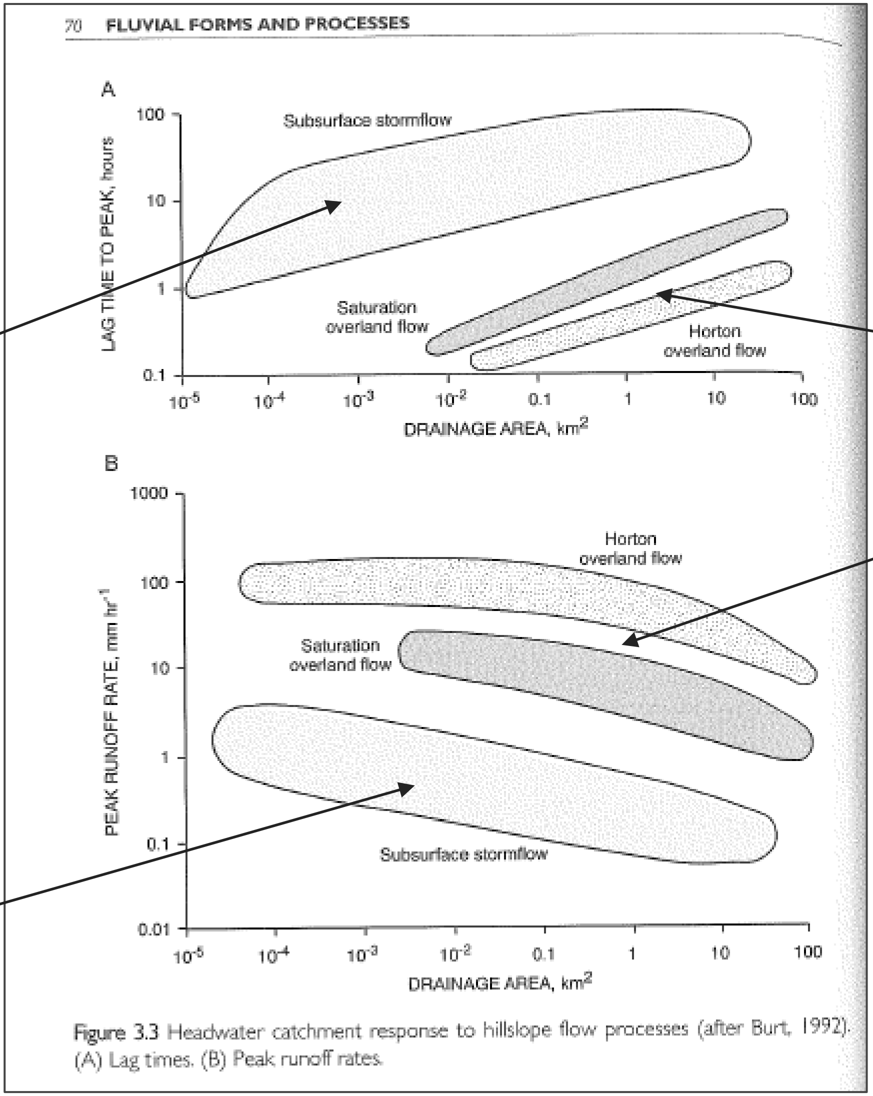
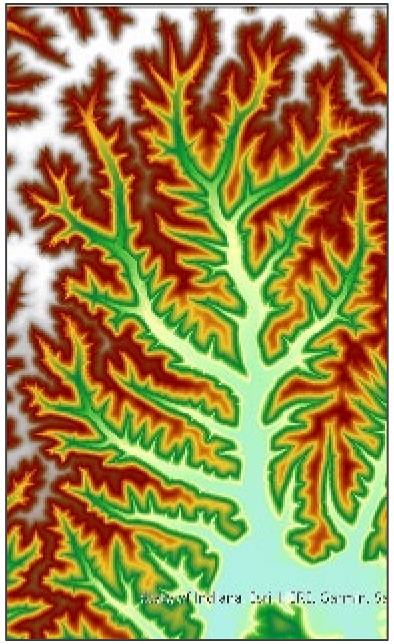


Figure 3.3 Headwater catchment response to hillslope flow processes (after Burt, 1992). (A) Lag times. (B) Peak runoff rates.



Hydrology of Hudson Lake

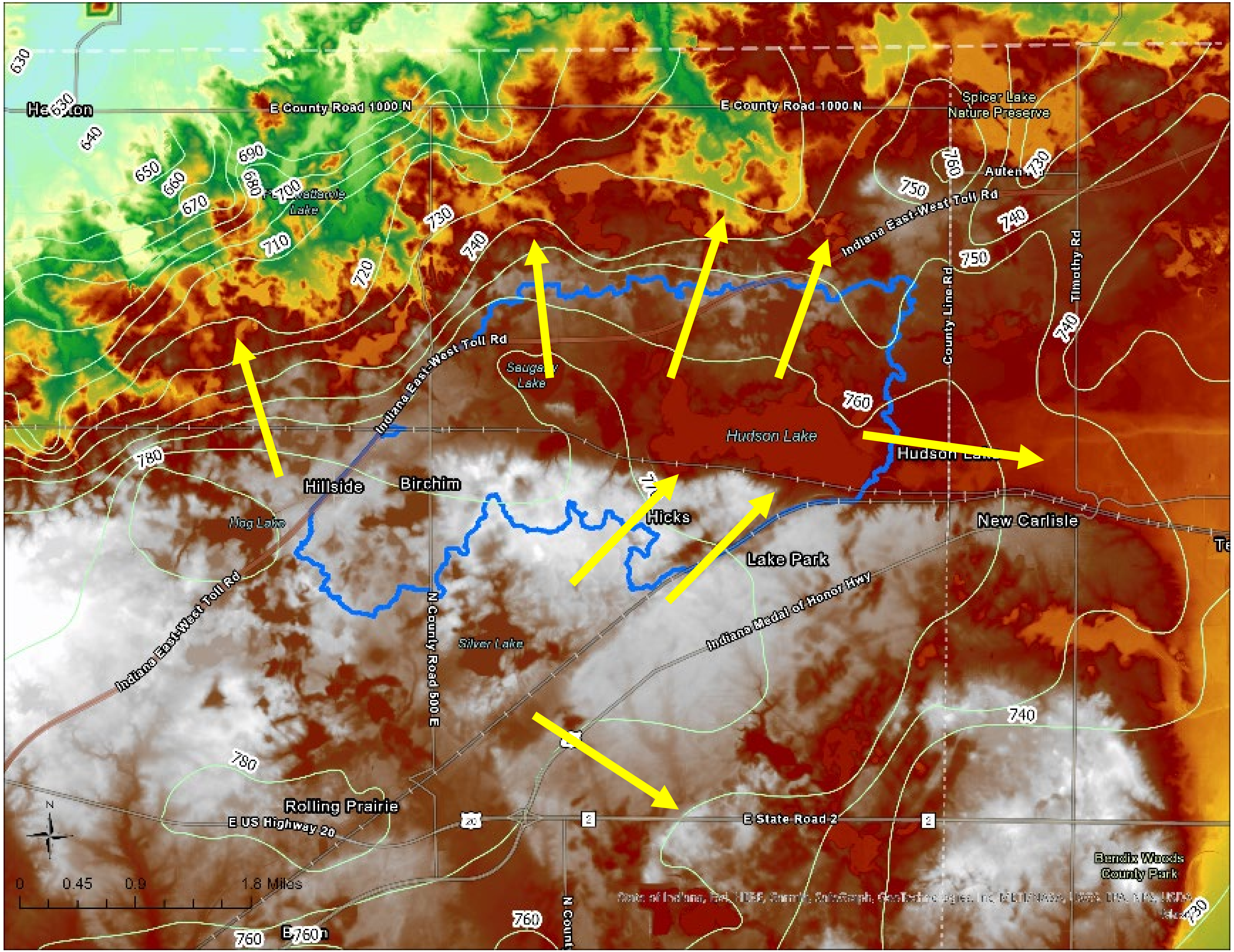
- Hinge and/or flow-through lake

- Movement of water towards the lake from the west and south, away from the lake on the north and east

- Groundwater gradient does not always match surface gradient

- These flow paths can change as groundwater levels fluctuate

- Residence time is 2.5 years (V3 report)



Hydrology of Hudson Lake

- Hinge and/or flow-through lake
- From the SW to the N and E
- Analog at Long Lake

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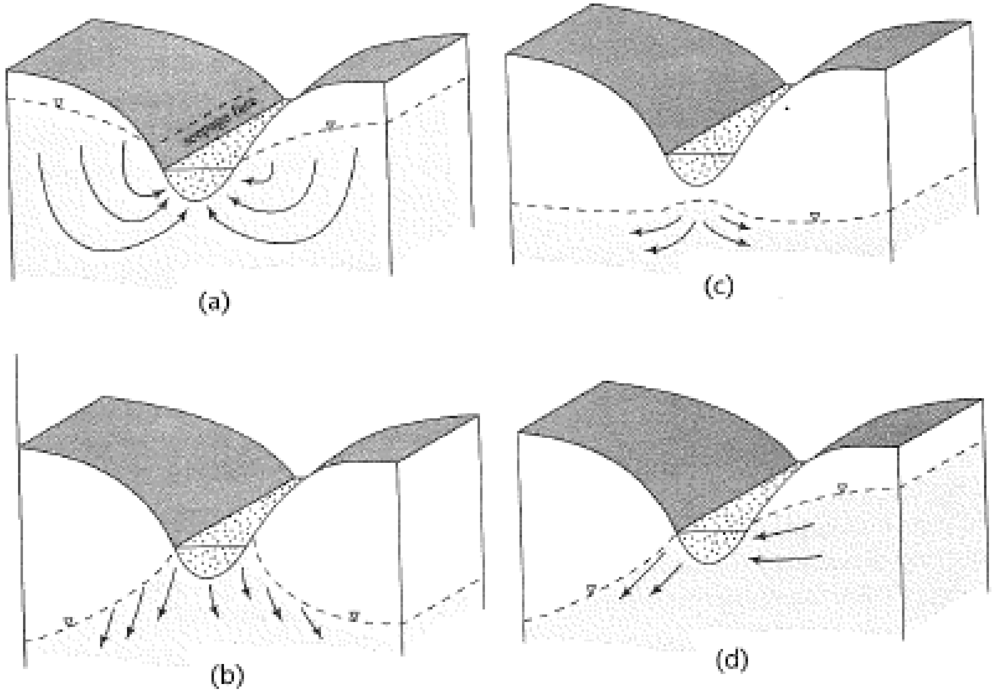
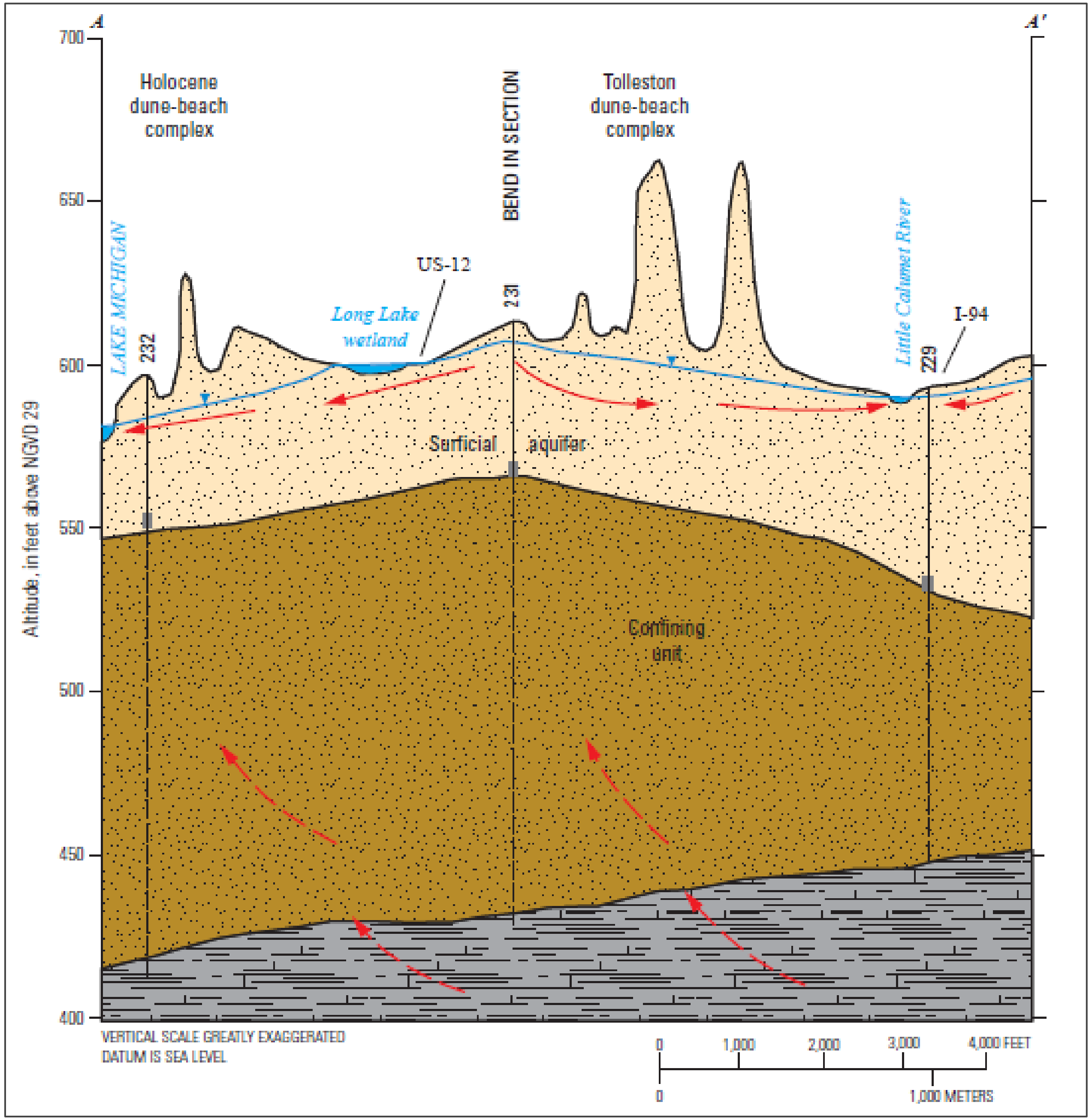


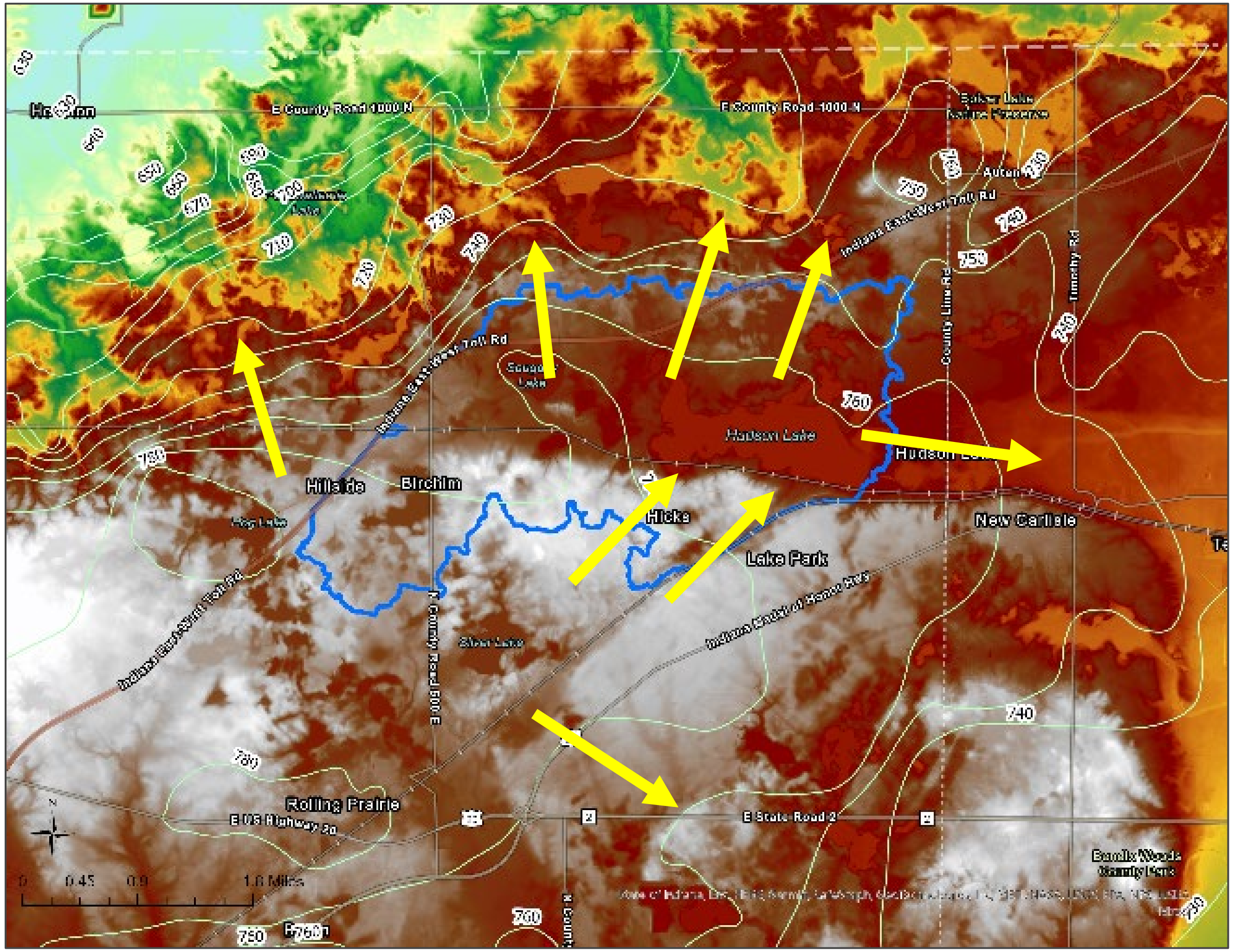
Figure 2.28 Groundwater–stream relations. A gaining reach (a) receives groundwater inputs from permanent, seasonal, or temporary aquifers. A losing reach lies above the local groundwater surface and may be connected (b) or unconnected (c) to it. In a flow-through reach (d), the groundwater enters on one bank and exits on the other.

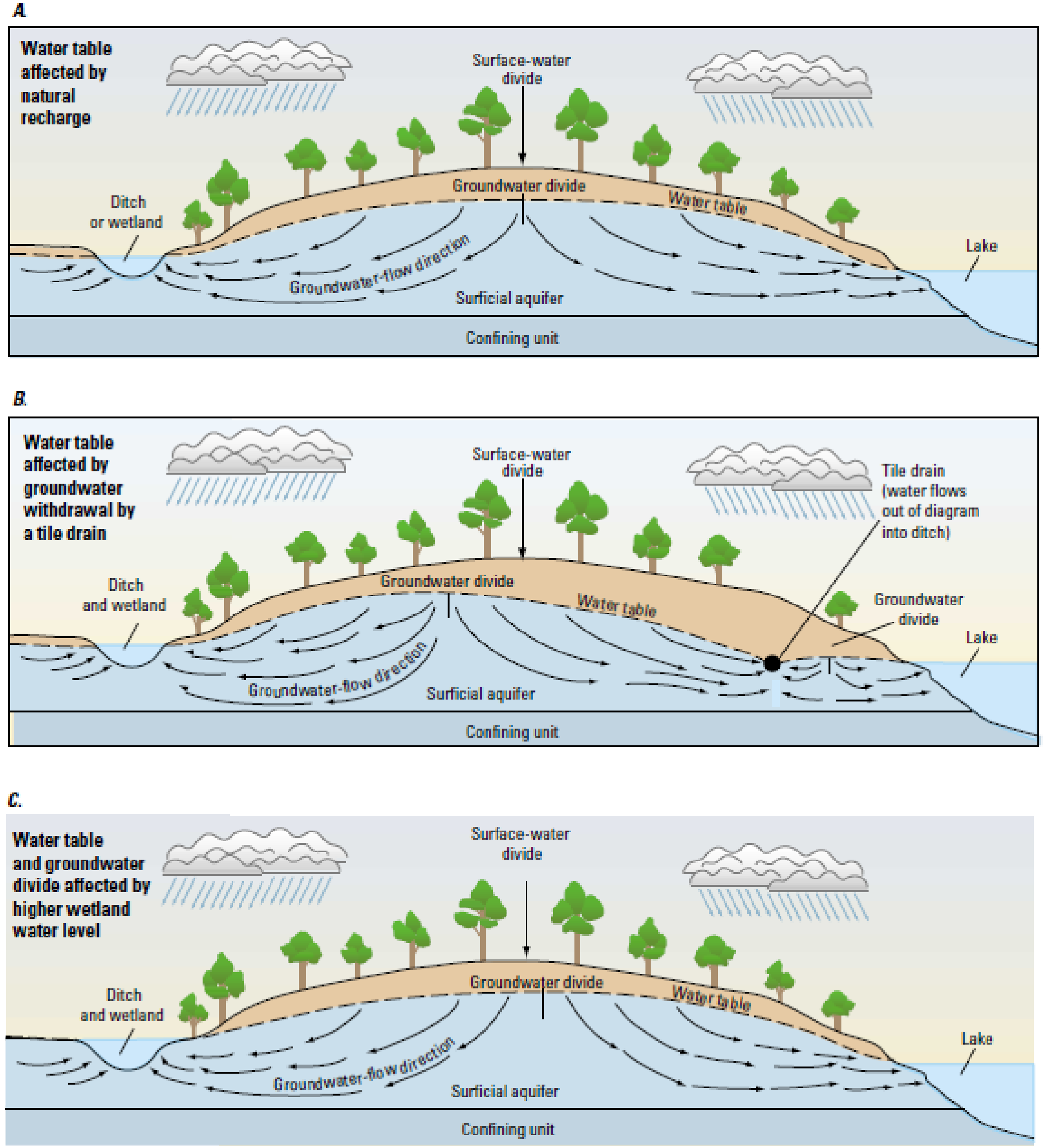


Lampe, D.C., and Bayless, E.R., 2013, Hydrologic data and groundwater flow simulations in the vicinity of Long Lake, Indiana Dunes National Lakeshore, near Gary, Indiana: U.S. Geological Survey Scientific Investigations Report 2012–5003, 96 p.

Hydrology of Hudson Lake

Groundwater and surface water divides





Diagrams reproduced and modified from Grannemann and others (2000, fig. 5, p. 5).

Figure 5. Generalized groundwater flow. *A*, Under natural conditions. *B*, Affected by tile drain flow. *C*, Affected by surface-water-level change in adjacent discharge ditch. (Note that surface-water and groundwater divides coincide in *A* but not in *B* or *C*.)

Hydrology of Hudson Lake

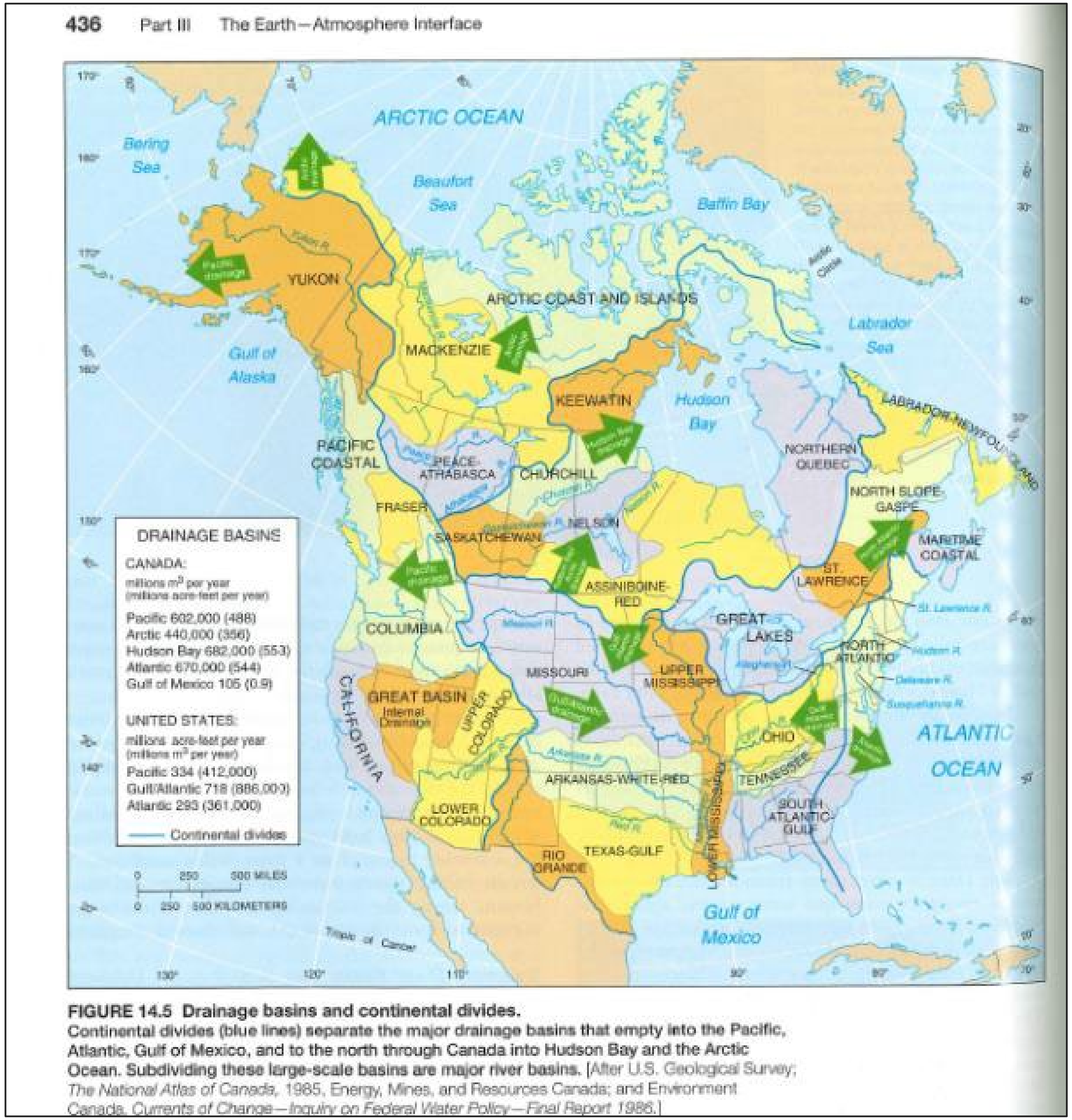

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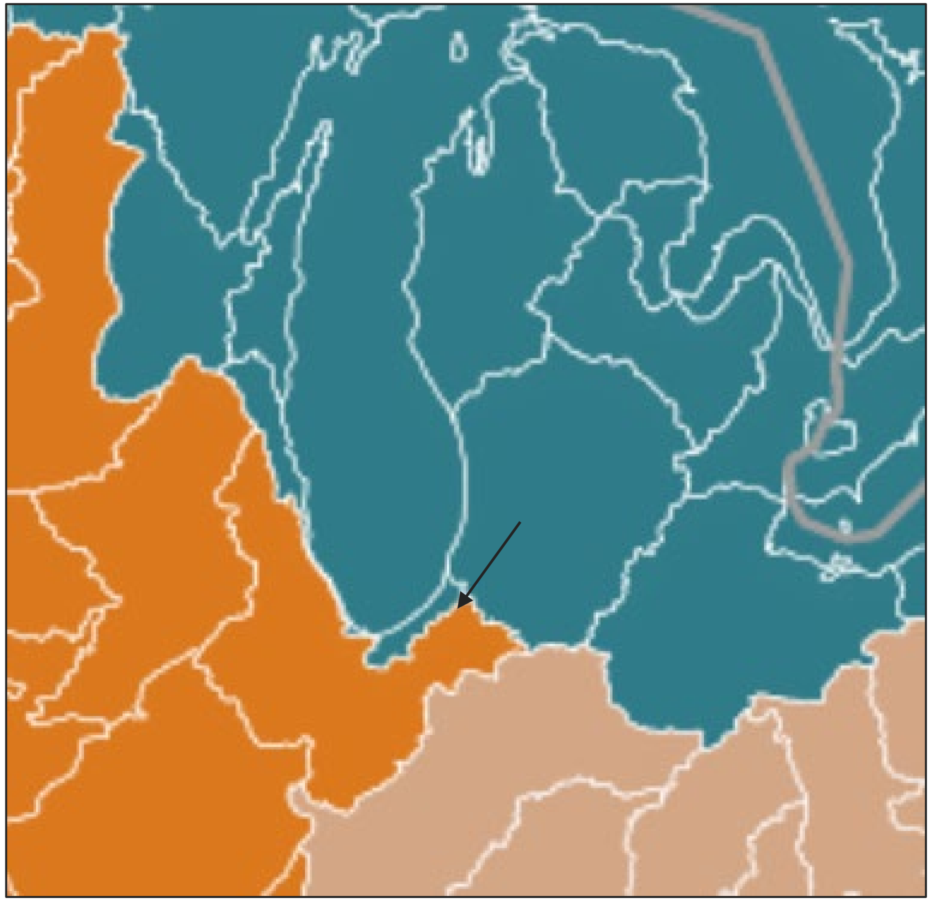
FIGURE 14.5 Drainage basins and continental divides. Continental divides (blue lines) separate the major drainage basins that empty into the Pacific, Atlantic, Gulf of Mexico, and to the north through Canada into Hudson Bay and the Arctic Ocean. Subdividing these large-scale basins are major river basins. [After U.S. Geological Survey; *The National Atlas of Canada*, 1985, Energy, Mines, and Resources Canada; and Environment Canada, *Currents of Change—Inquiry on Federal Water Policy—Final Report 1986*.]

Hudson Lake – On the continental divide

Hydrology of Hudson Lake

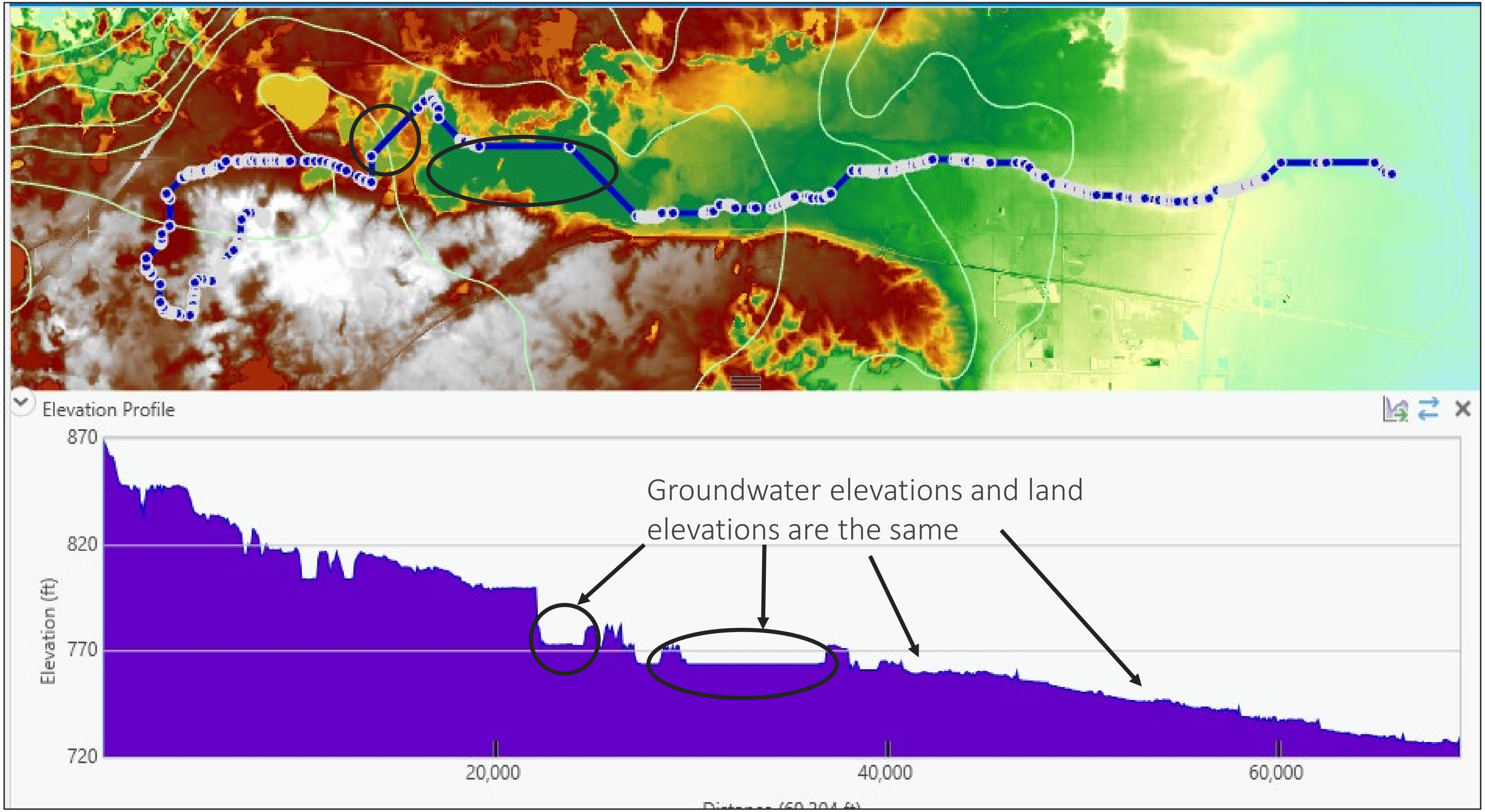
Hudson Lake – On the continental divide

***View in GIS viewer**



https://www.usgs.gov/media/images/watershed-map-north-america

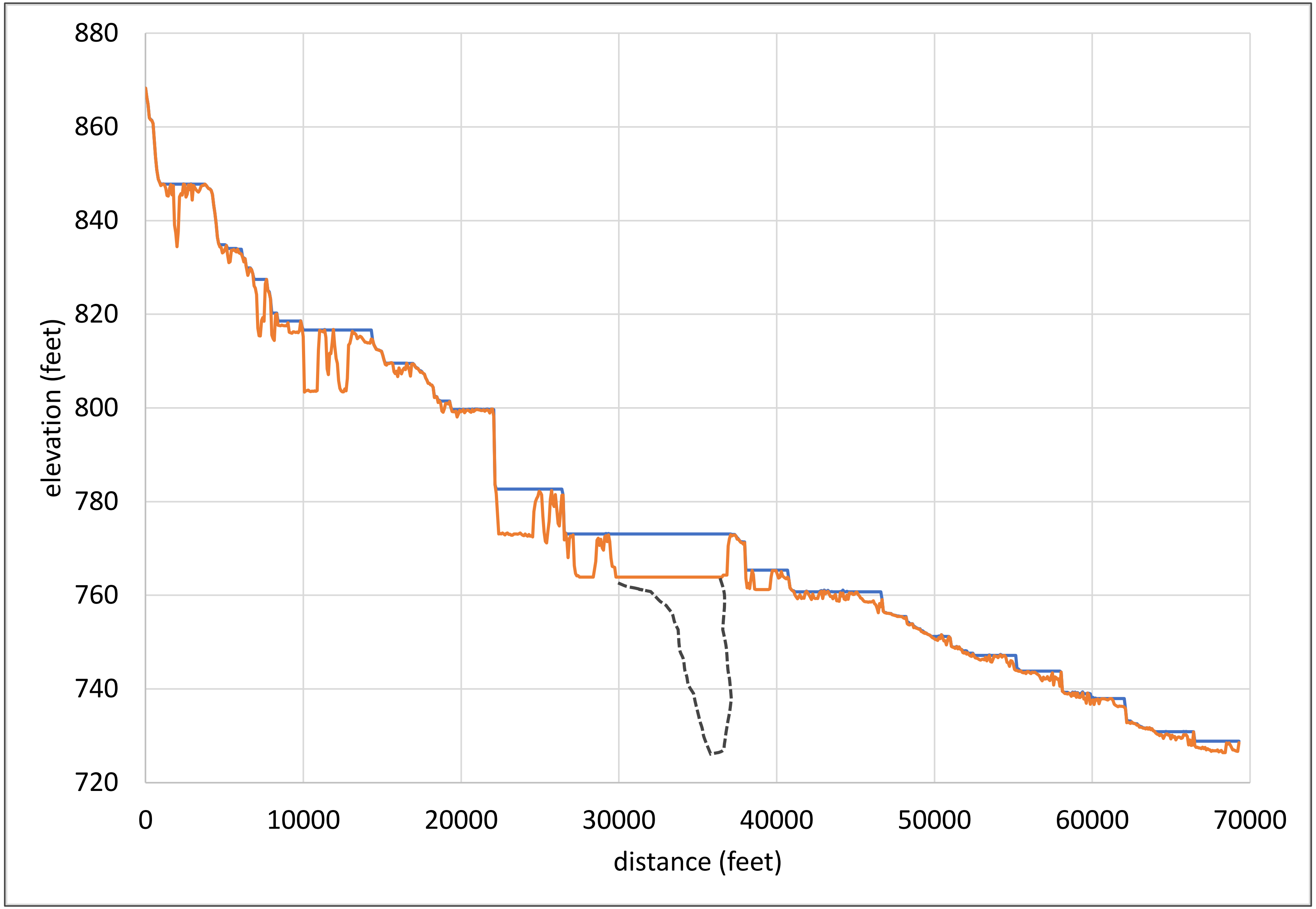
Hydrogeology of Hudson Lake



Potentiometric (groundwater levels) approximate the Legal Lake Level – well logs confirm this

Hydrogeology of Hudson Lake

Hudson lake is 35-40 feet deep on the west end



Hydrogeology of Hudson Lake

Lake vulnerability – 35-40 feet deep, shallow and discontinuous clay confining layer, sandy soils – high communication with local water table and deeper aquifer system(s)

Upon investigating the geology and hydrogeology of the area around Hudson Lake, using the IDNR water well database records, it was determined that there are two aquifer systems at Hudson Lake. The first is a shallow sand and gravel aquifer that supplies local groundwater flow towards the lake and the second is a deeper more conductive sand and gravel aquifer beneath the lake bottom. The two aquifer systems are separated by a thin stratigraphic layer of clay and silt mixed with gravel and sand. The lower aquifer is a regional system, which naturally has a higher conductivity. Cross sections are provided in Exhibits 5 and 6.

The higher conductivity aquifer beneath, creates a system that attracts water flow from the lower conductivity unit above. This downward type flow is only found at the bottom depths of the upper aquifer, which happens to be where the lake bottom is located. The lake's net loss to the groundwater makes the water balance sensitive and dependent on surface water to maintain water levels.

V3 report

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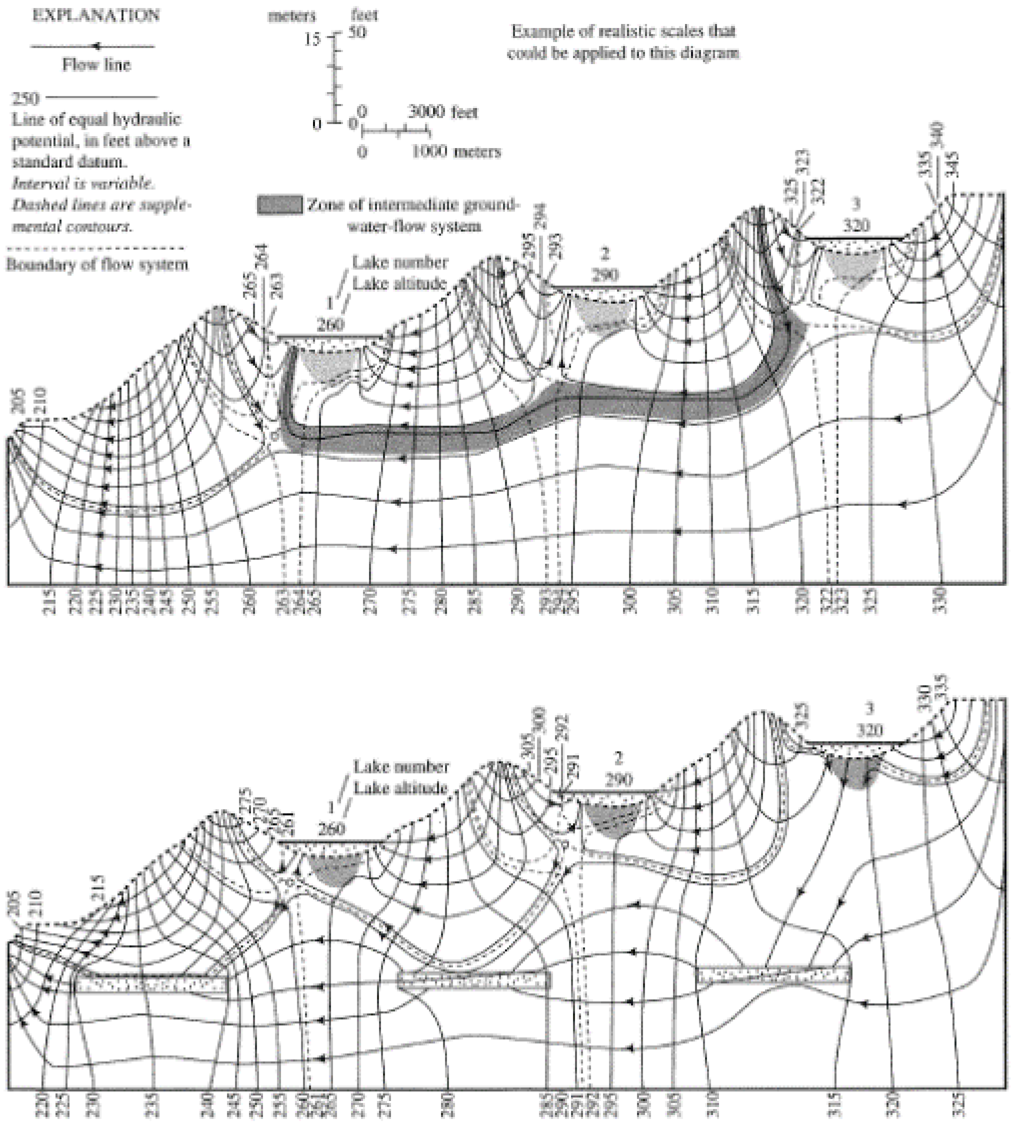
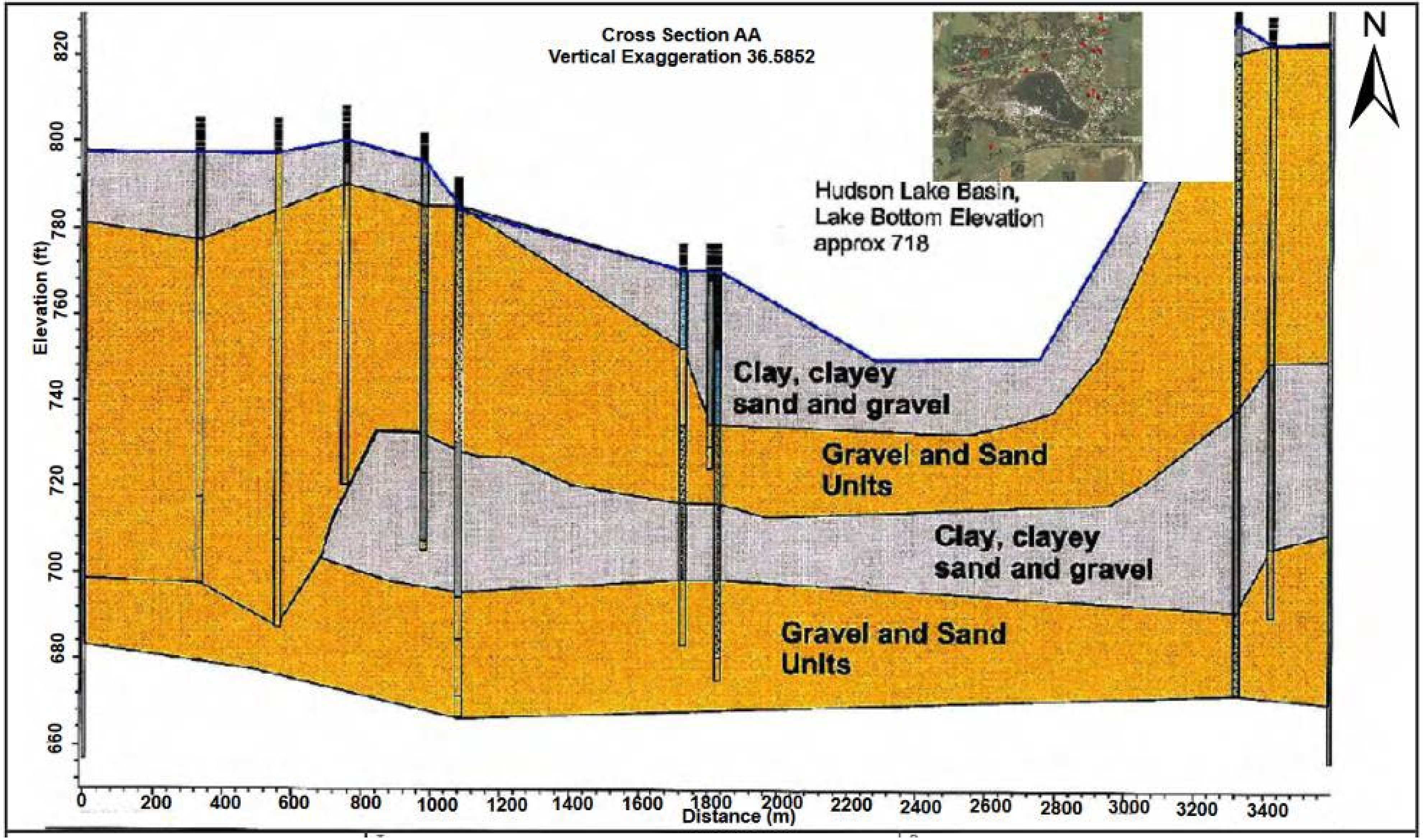


FIGURE 8-21
Flow nets for a hypothetical system of three lakes above a main stream. (a) With a homogeneous aquifer there are local, intermediate, and regional flow systems and the lakes are zones of discharge for local systems. (b) With three high-conductivity lenses at depth the intermediate system disappears and the highest lake receives discharge near its edge and contributes recharge in its center. Note vertical exaggeration. From Winter (1976).

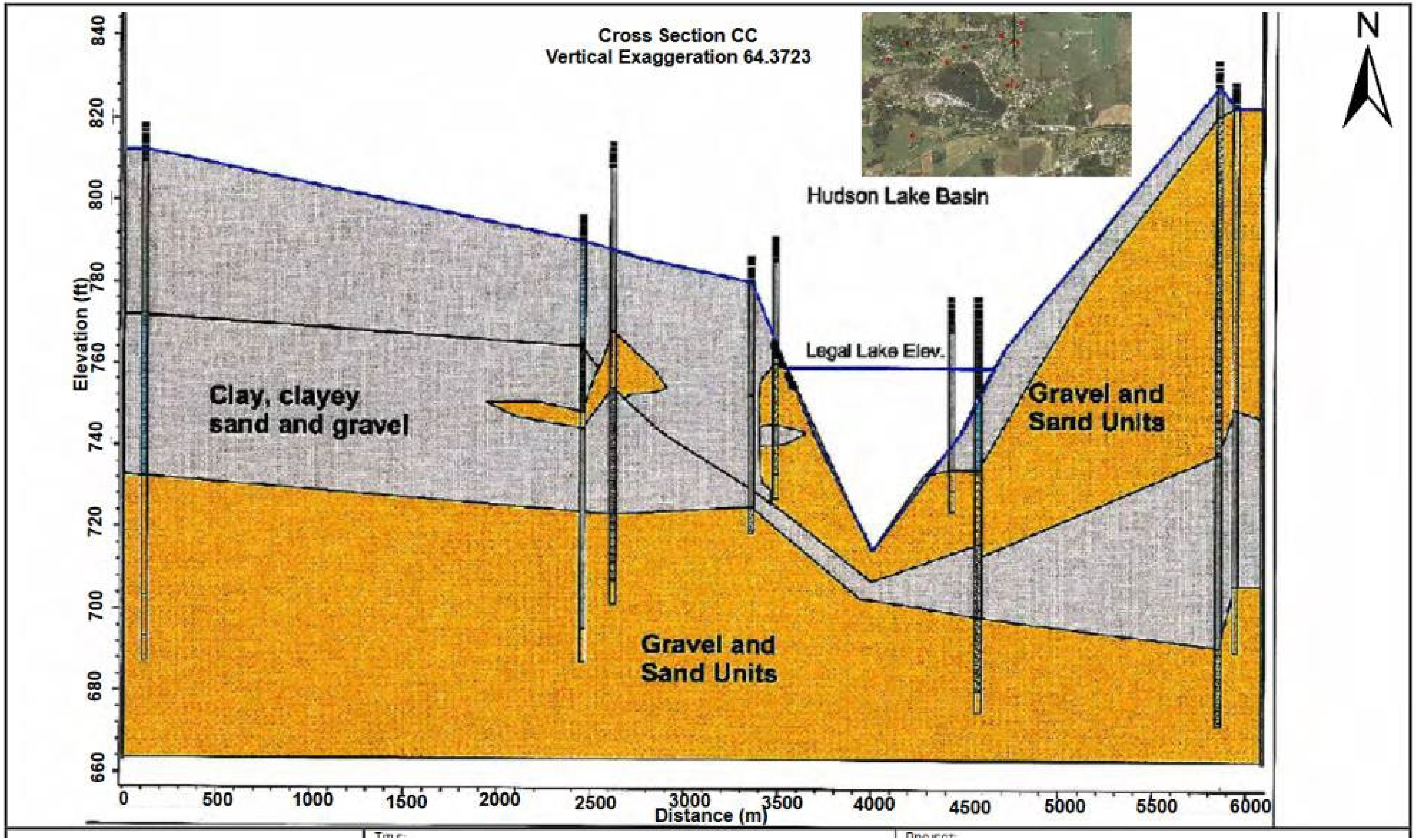
Hydrogeology of Hudson Lake

Shallow and discontinuous clay confining layer, sandy soils (V3 report)



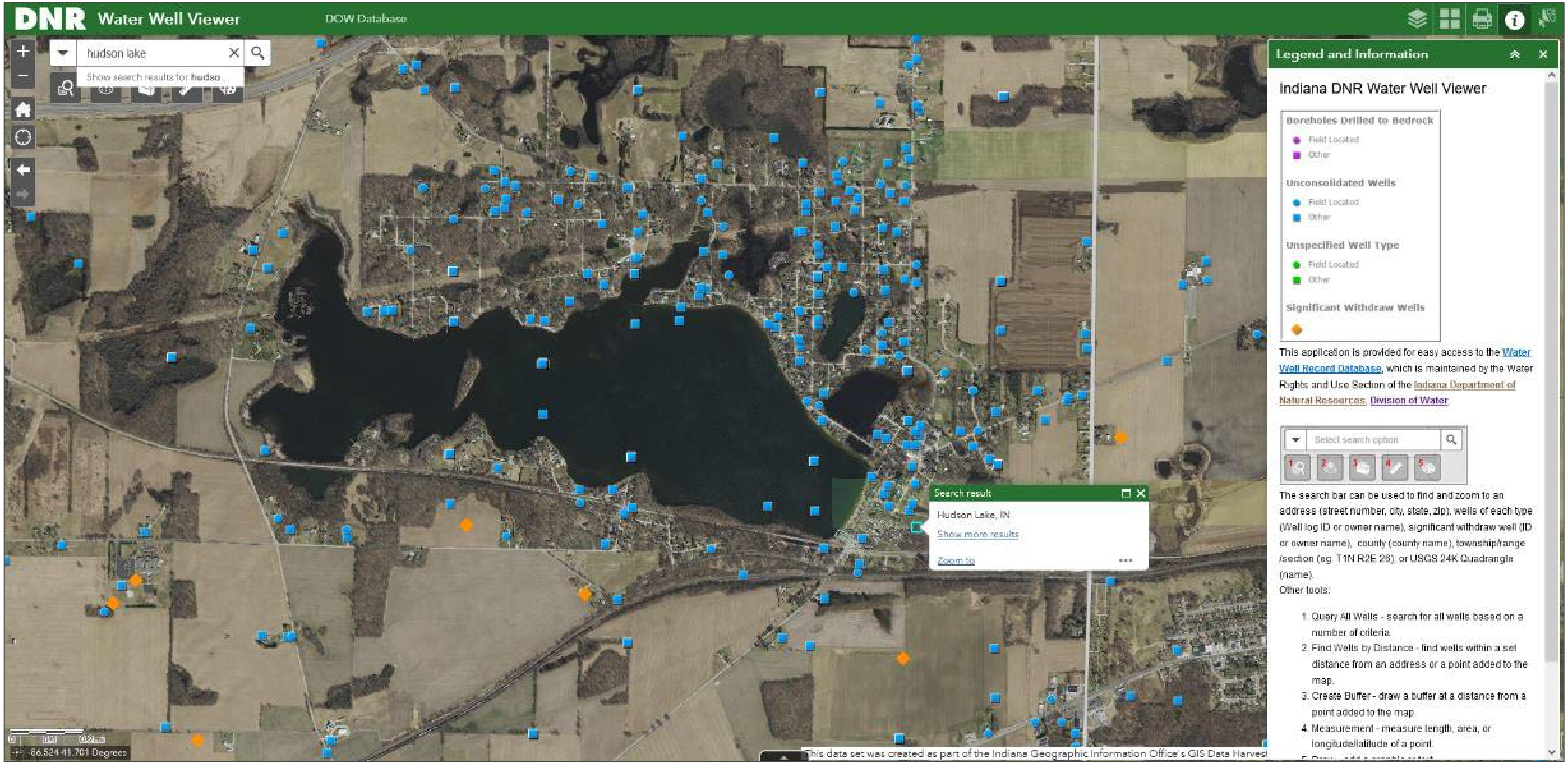
Hydrogeology of Hudson Lake

Shallow and discontinuous clay confining layer, sandy soils (V3 report)



Hydrogeology of Hudson Lake

Indiana water well viewer - https://www.in.gov/dnr/water/ground-water-wells/water-well-record-database/



Historical information for Hudson Lake

Transfer of precipitation to lake levels is complex

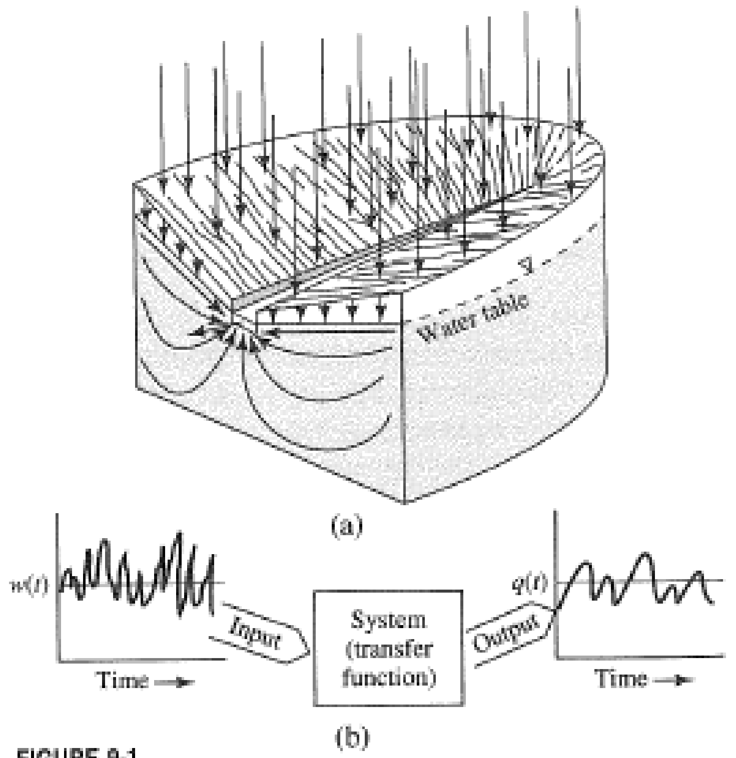
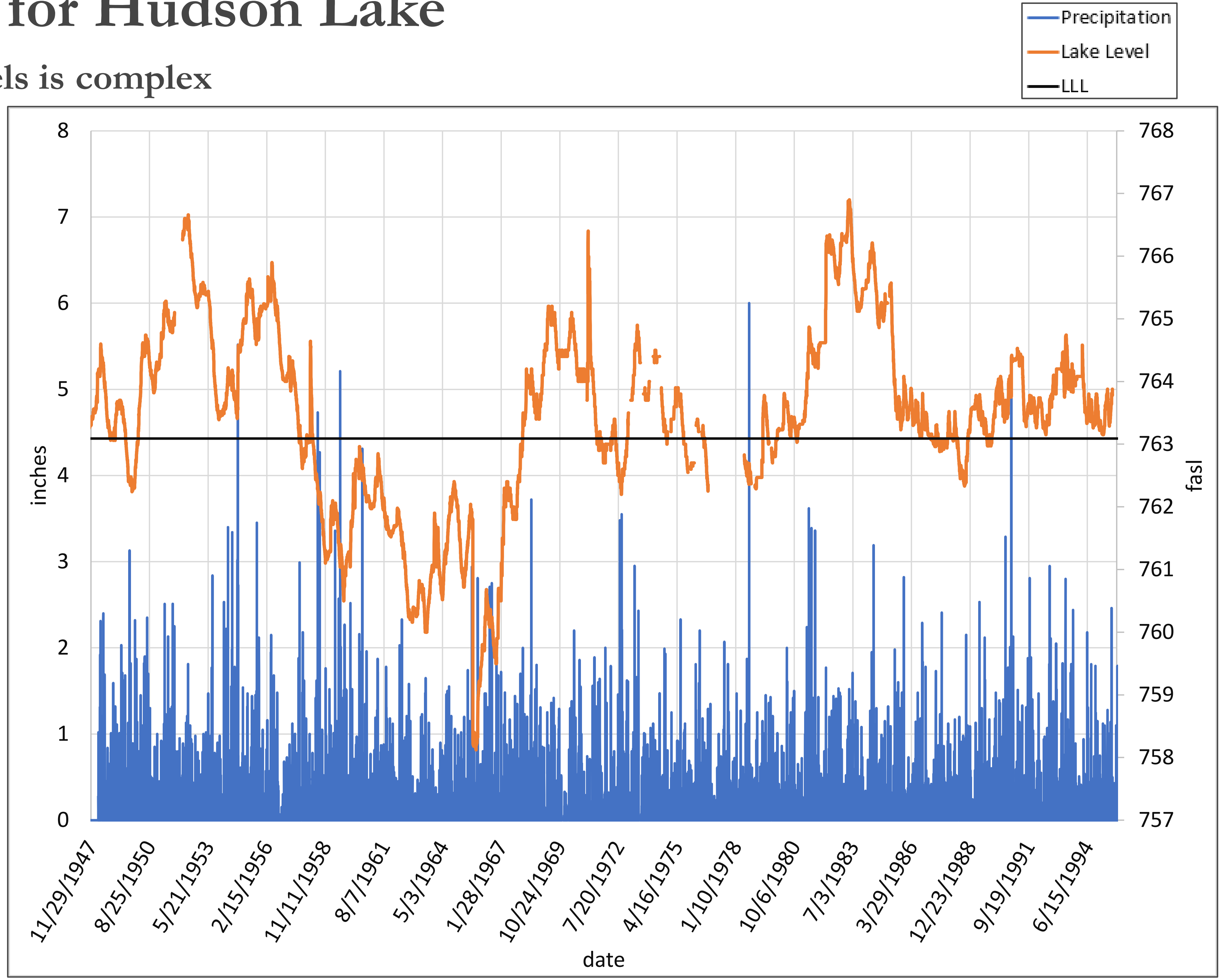
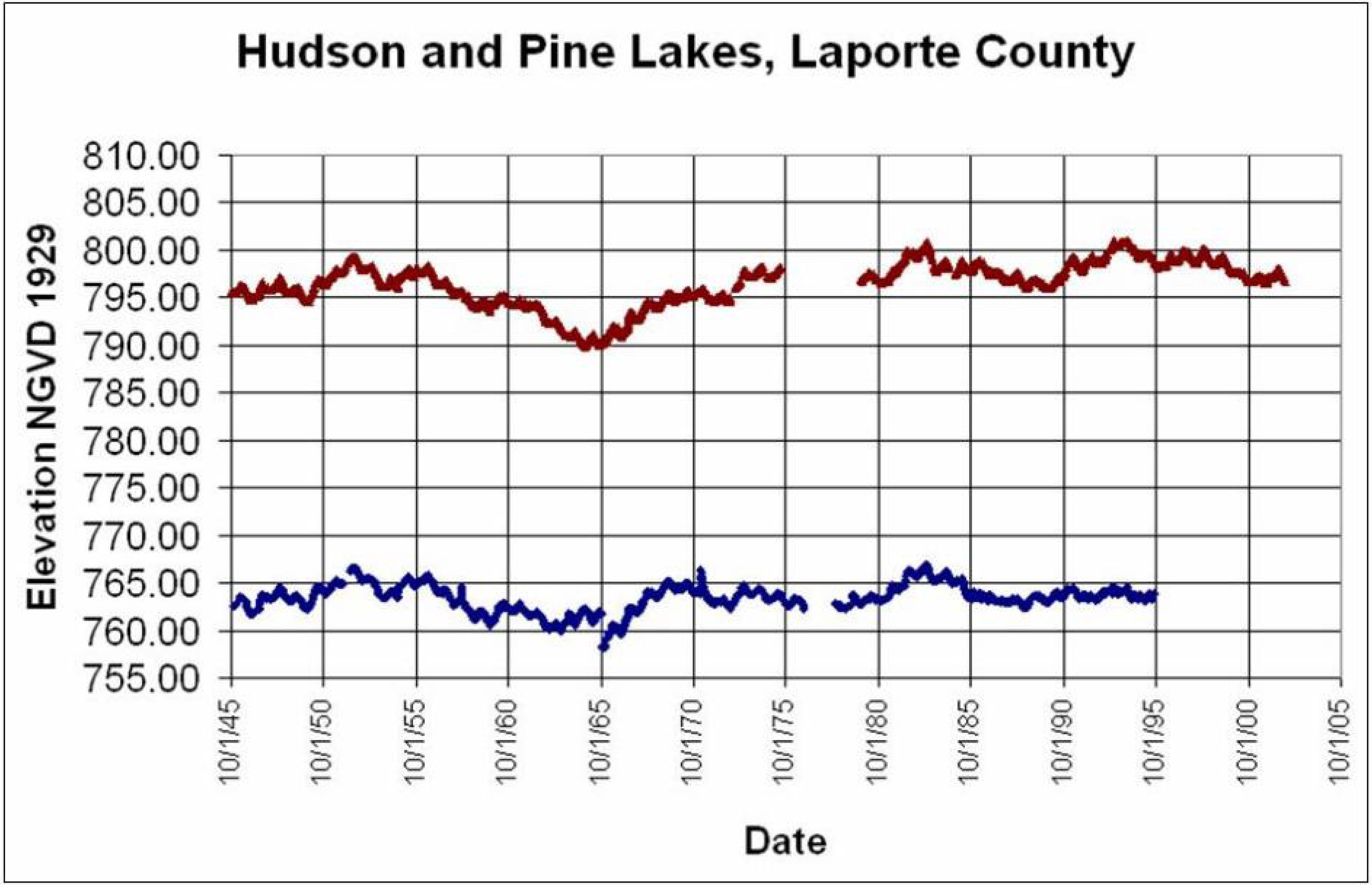


FIGURE 9-1
(a) Schematic flow paths in a small upland watershed receiving water inputs: the transparent box view of a watershed. (b) The black box (systems) view of a watershed as an algorithm generating outputs from specified inputs.



Historical information for Hudson Lake

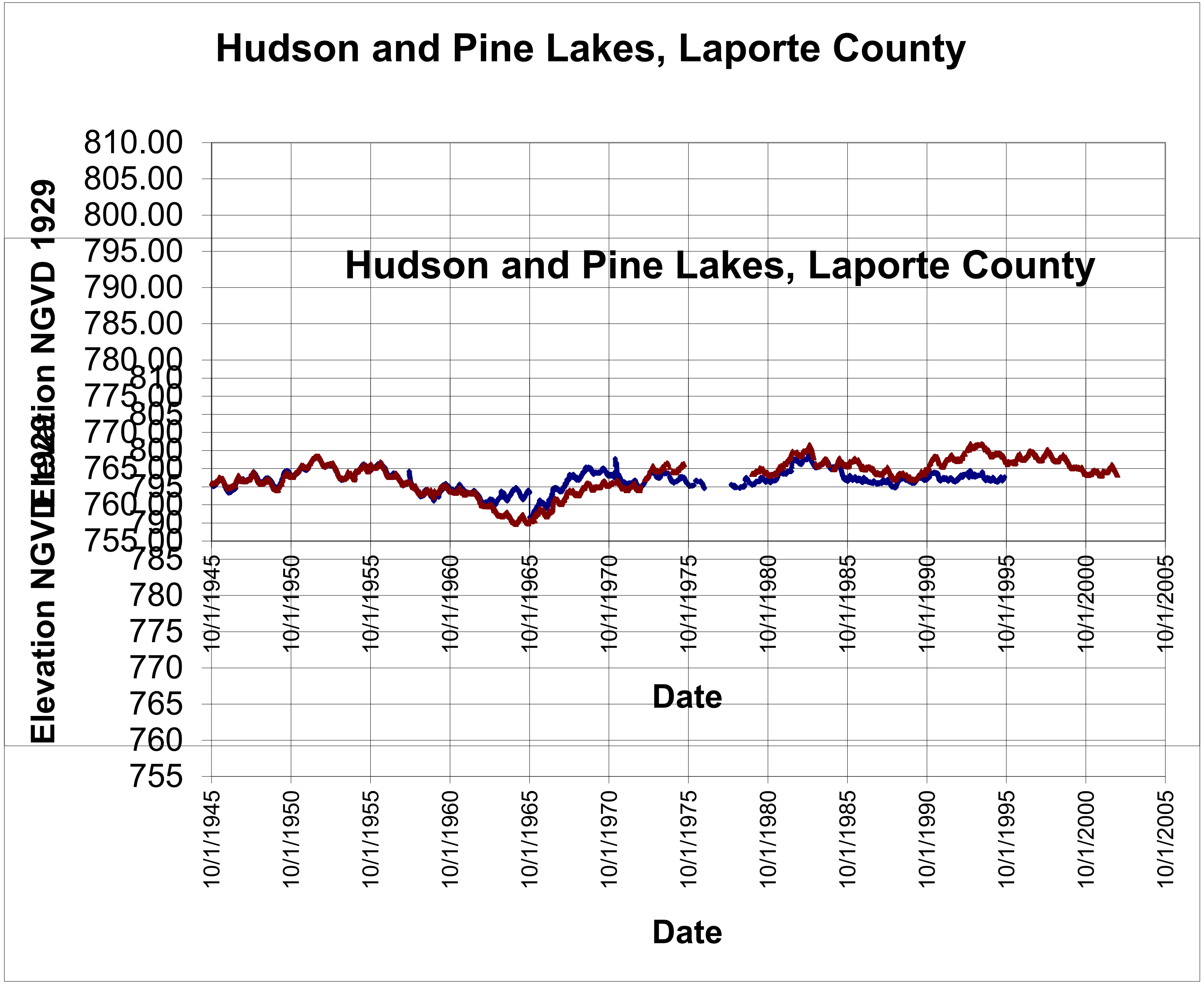
Hudson Lake high and low cycles are complex – seasonal, multi-year, and decadal



Pike – red
Hudson - blue

Historical information for Hudson Lake

Hudson Lake and Pike Lake water levels approximately track each other until 1985

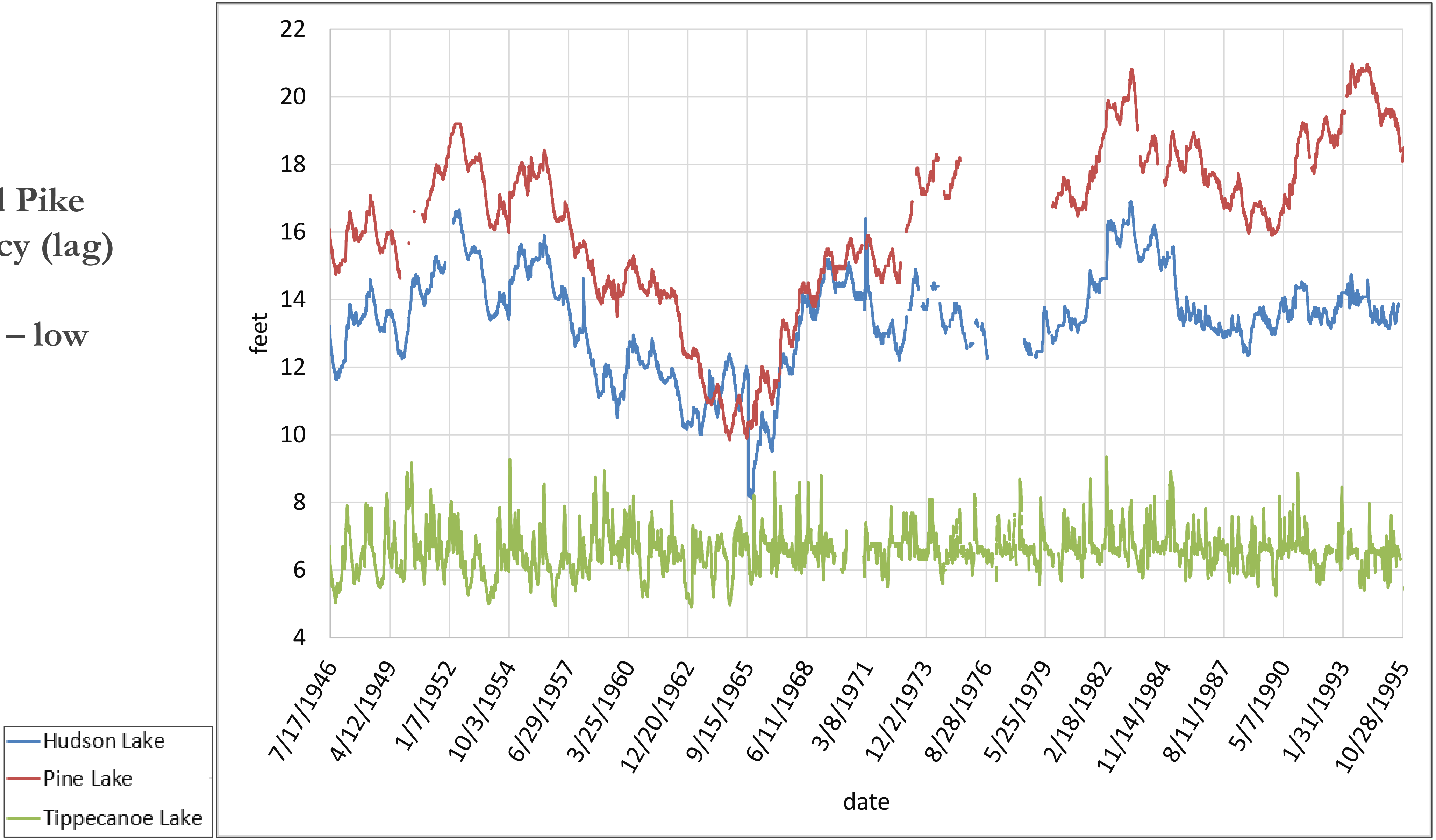


Pike – red
Hudson - blue

Historical information for Hudson Lake

Hudson Lake and Pike Lake – high latency (lag)

Tippecanoe Lake – low latency (lag)

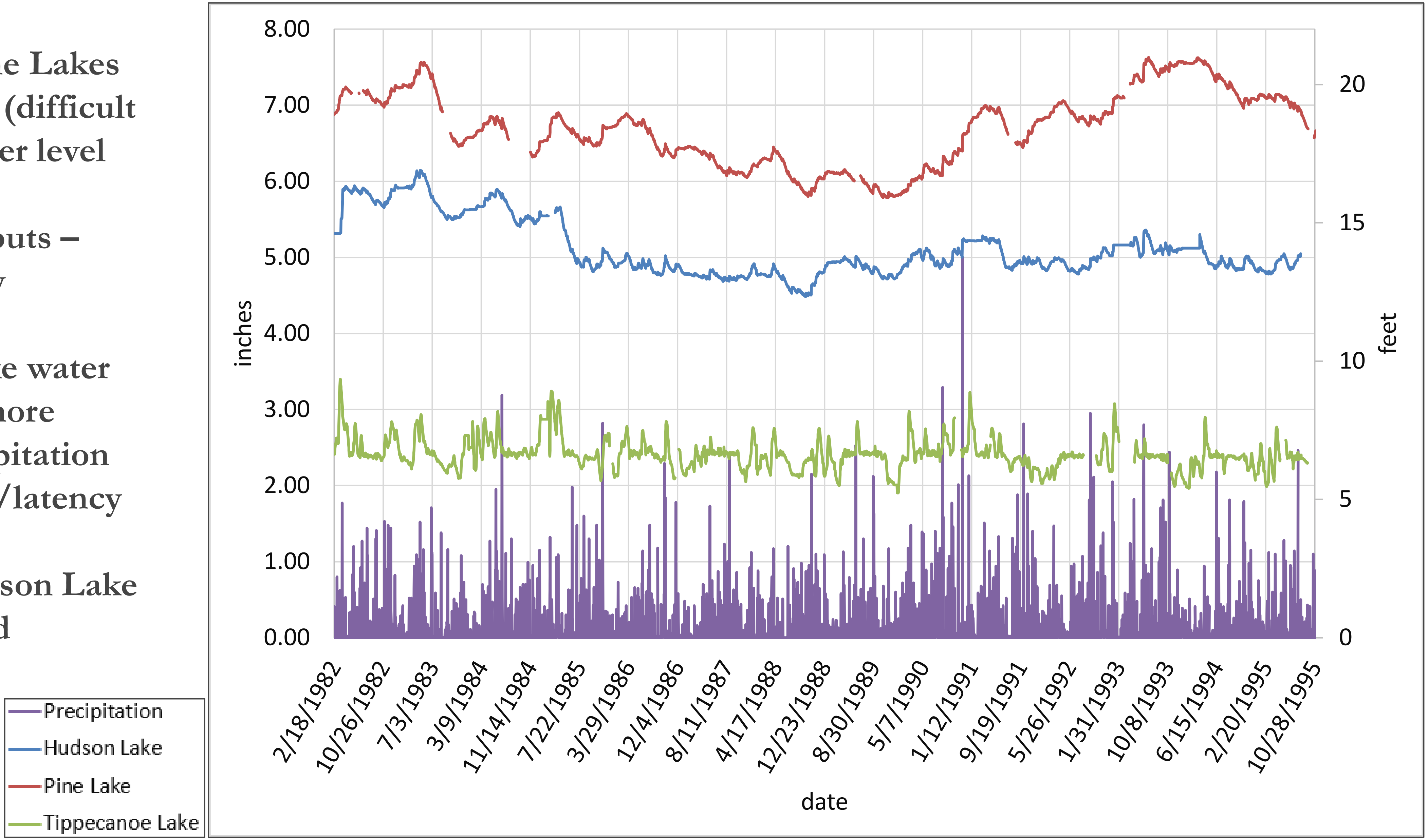


Historical information for Hudson Lake

Hudson and Pine Lakes have an indirect (difficult to interpret) water level signature from precipitation inputs – high lag/latency

Tippecanoe Lake water levels respond more directly to precipitation inputs – low lag/latency

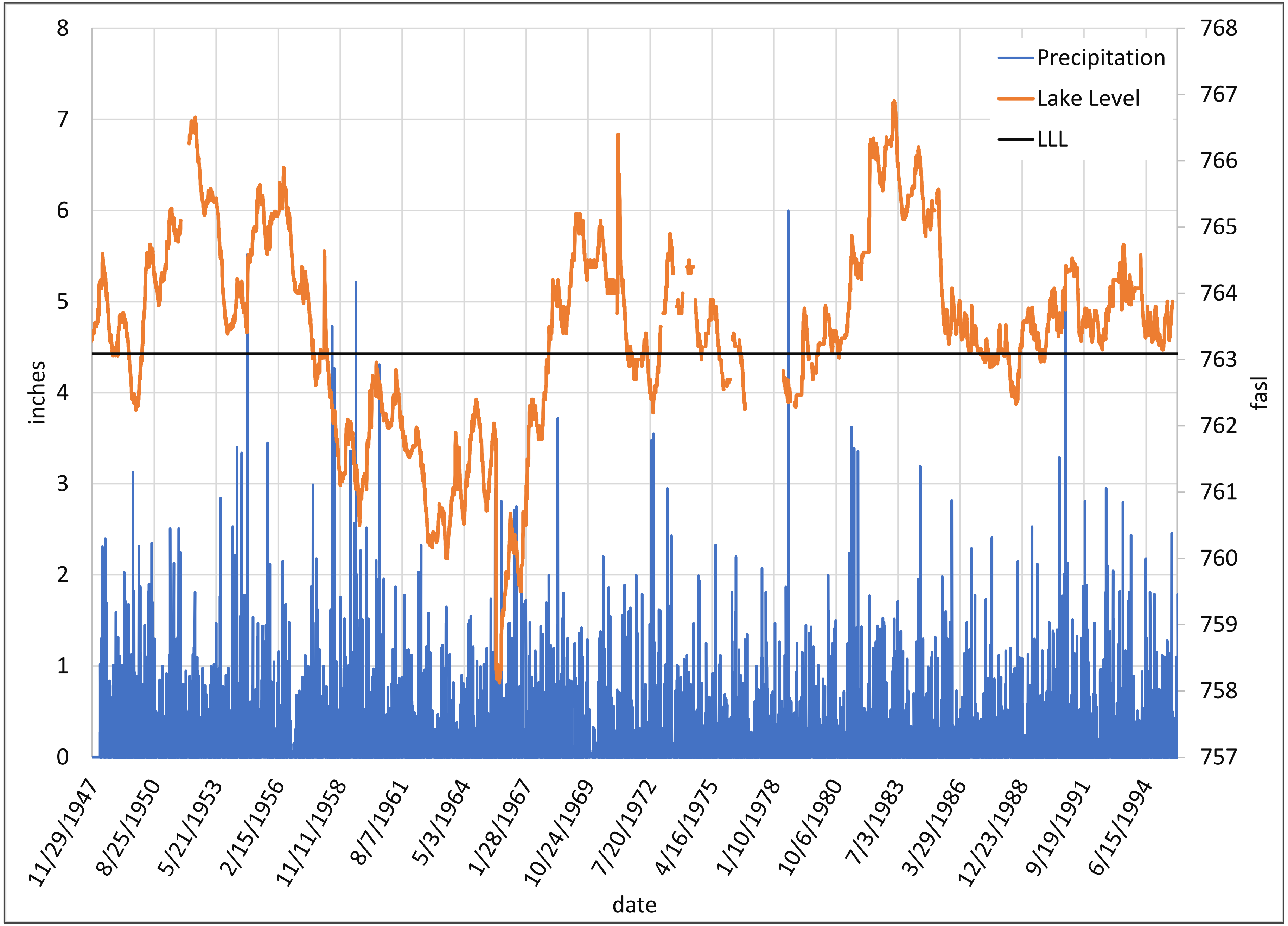
Post 1985 – Hudson Lake peaks attenuated



Historical information for Hudson Lake

Extreme highs in historical record – need to avoid

Extreme lows in historical record – difficult (or impossible) to avoid



Precipitation
Lake Level
LLL

Historical information for Hudson Lake

1876 report

- Description of the east 'berm' matches
  - 60 rods ≈ 1000 ft
- 1837 noted low water by 4 feet

By the year 1833 many settlers had sought homes in Hudson township, and a village, known at the time as Lakeport, but the name of which was afterward changed to Hudson, began to be recognized in the surrounding country as a place of importance. There is not a town in the county more pleasantly located. It is situated on the east shore of Hudson lake, sloping gently toward the lake, and, under more favorable circumstances, might have become a town of considerable importance. This place was the rival of La Porte, and indeed a formidable one for the trade of the north part of the county. In 1833 its growth commenced. In that year the first school-house after the mission was built there. The school was

In the year 1837, Andrew Avery commenced building a saw mill. The power used by him was of rather a novel kind. On the east bank of Du Chemin lake, the land is quite high for some sixty rods, it then sinks below the level of the lake. Through this mound it was proposed to dig a ditch. A large force of men were employed, and after an immense amount of work, a canal was perfected through which the water ran to the depth of four feet. With this power he contrived to run a wheel. For a while he succeeded very well, but like all the lakes in the country, it became less in volume as the land was cleared up, the timber cut off and the sod broken, until two years after, the project was entirely abandoned. The lake is now at least four feet below its former level. During this year Robert Stanfield opened a tailoring establishment, and four large stores were in operation, not little trading posts, but they were well stocked with all kinds of goods, and an immense trade was carried on. The monetary crash had impeded the growth of the town, but the people were not disheartened. They still believed in the Michigan canal, and that its construction was only a matter of time, and the panic of temporary duration.

1901 report

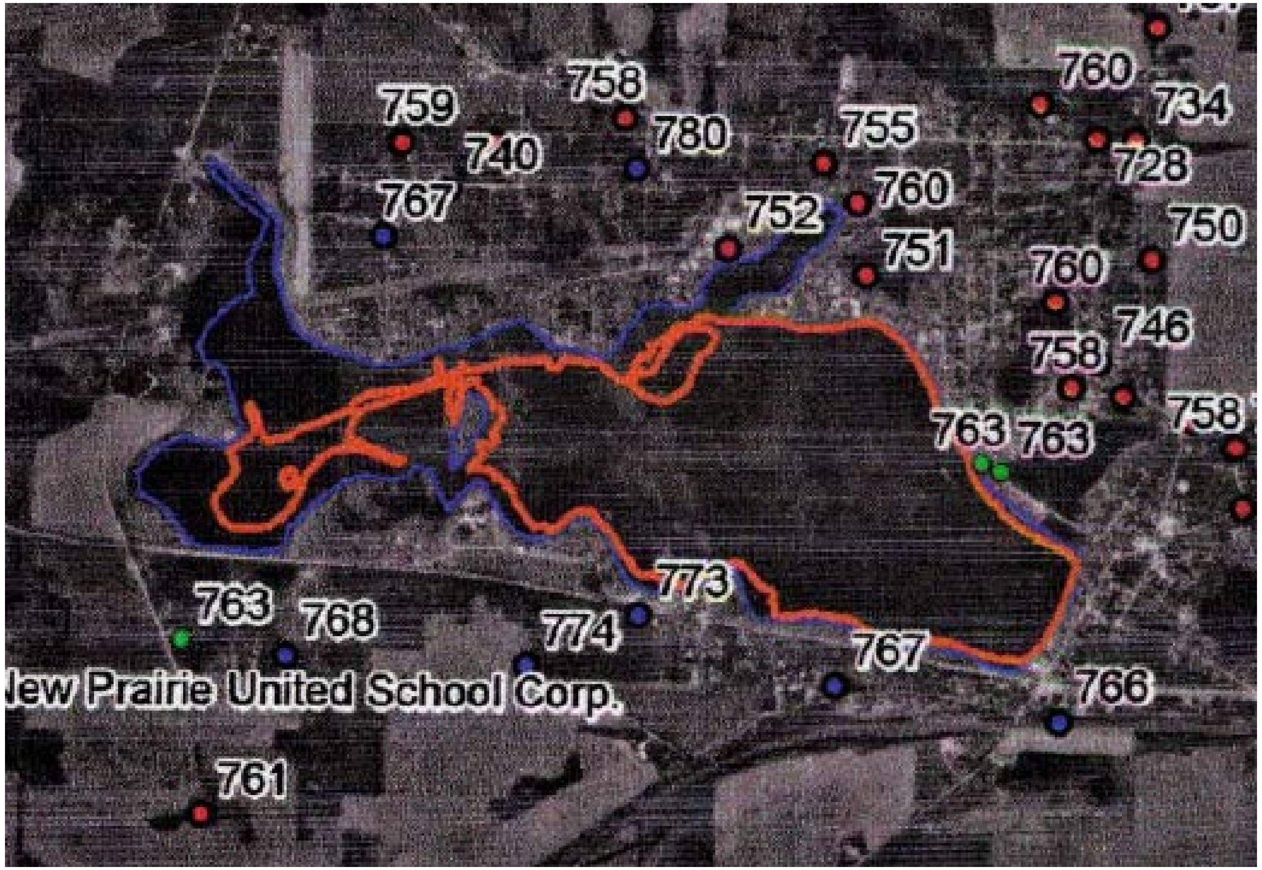
- Whole lake underlain by marl, not very thick, thinner at the central, east, and northern areas
- Noted low water – matches present day dry areas in the west

end. West of the island the lake was nearly dry when examined in September, 1899, there being only a small body of water, mostly in the southwest lobe, and much of that was less than a foot deep.

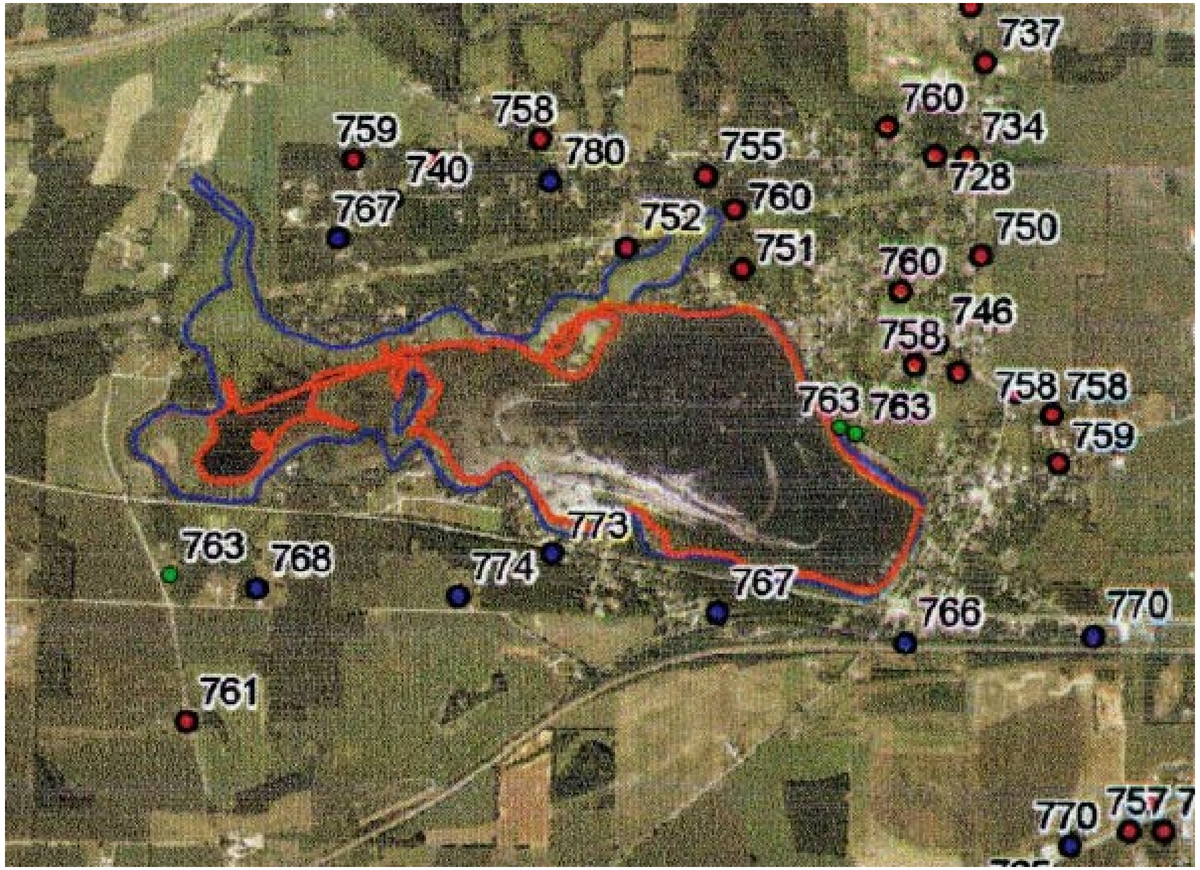
Historical information for Hudson Lake

Lake level boundaries fluctuate over time

1998



2003



Conclusions

- Hudson lake is a unique and complex hydrologic system

- What do we know:
  - Entirely groundwater fed lake
  - Highly permeable soils

- What is poorly understood:
  - Hydroclimatic drivers of high and low lake levels
  - Seasonal and multi-year fluctuations of the groundwater and lake levels

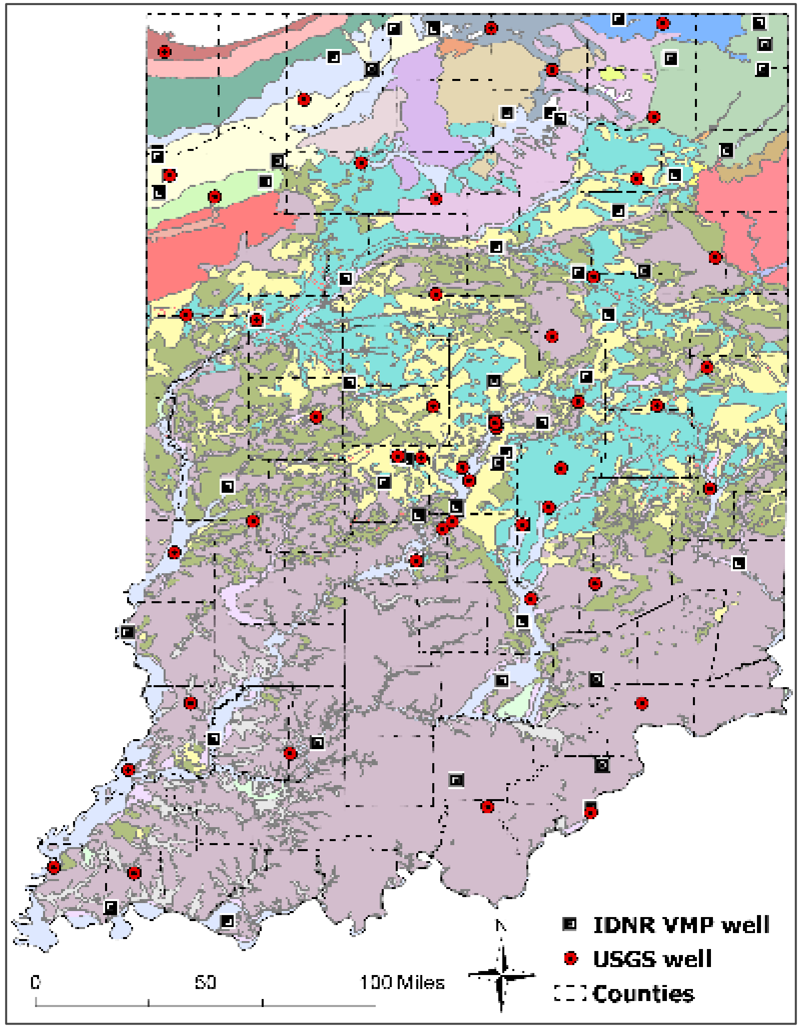
Indiana Department of Natural Resources

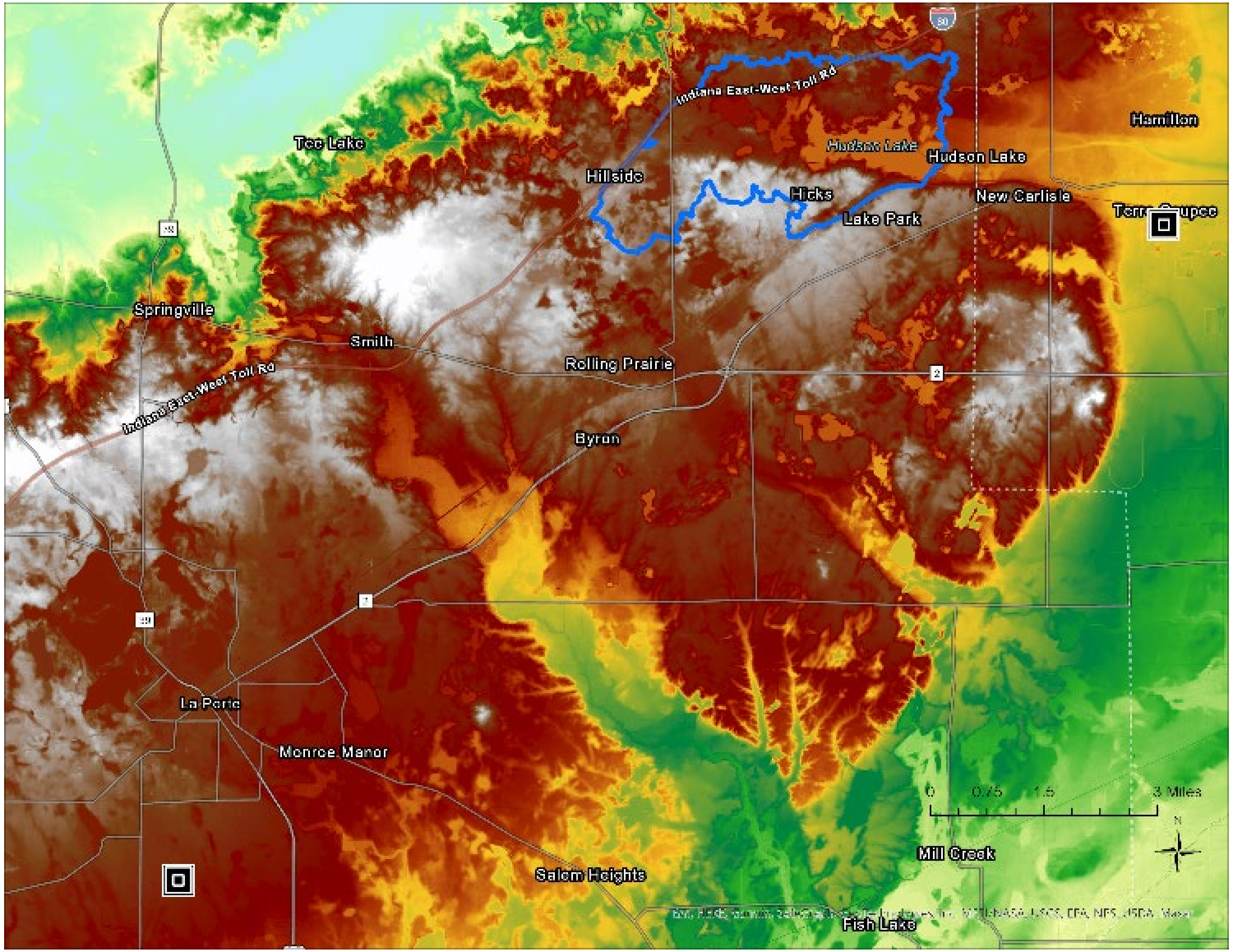
Recommendations

Monitoring – surface water and atmosphere

Recommendations

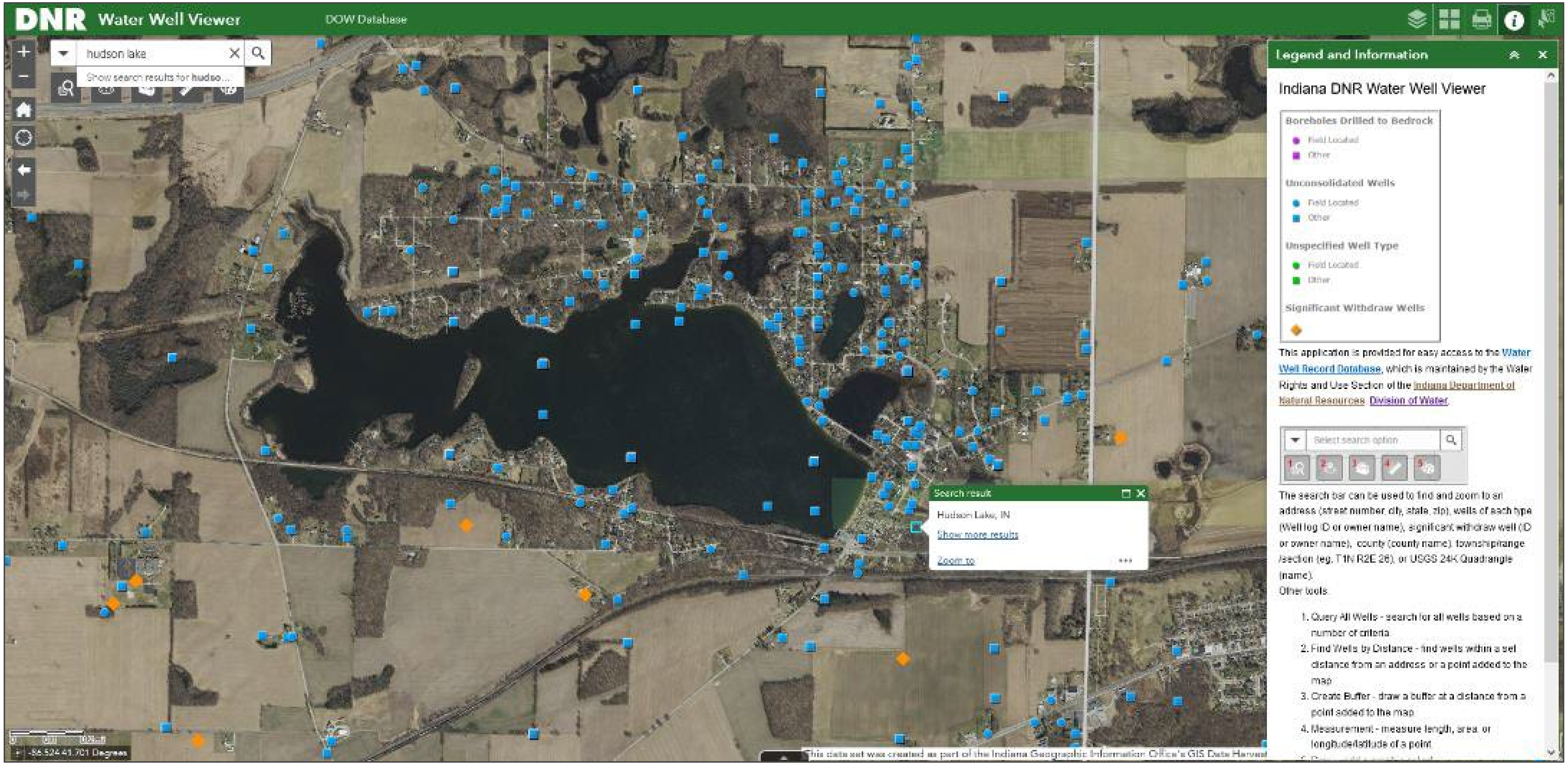
Monitoring – groundwater





Recommendations

Monitoring – groundwater



Recommendations

Modeling

- Monitoring data are model inputs
- Provide water balance calculations – inputs and outputs
- Describe water movement through the landscape
- Identify the factors and relevant timescales that influence lake levels, to guide management strategies

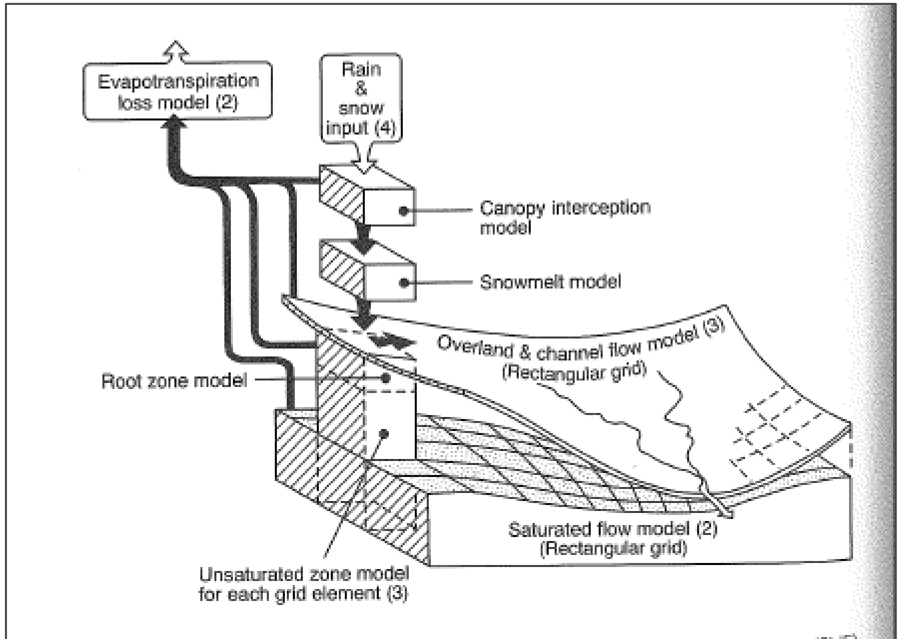
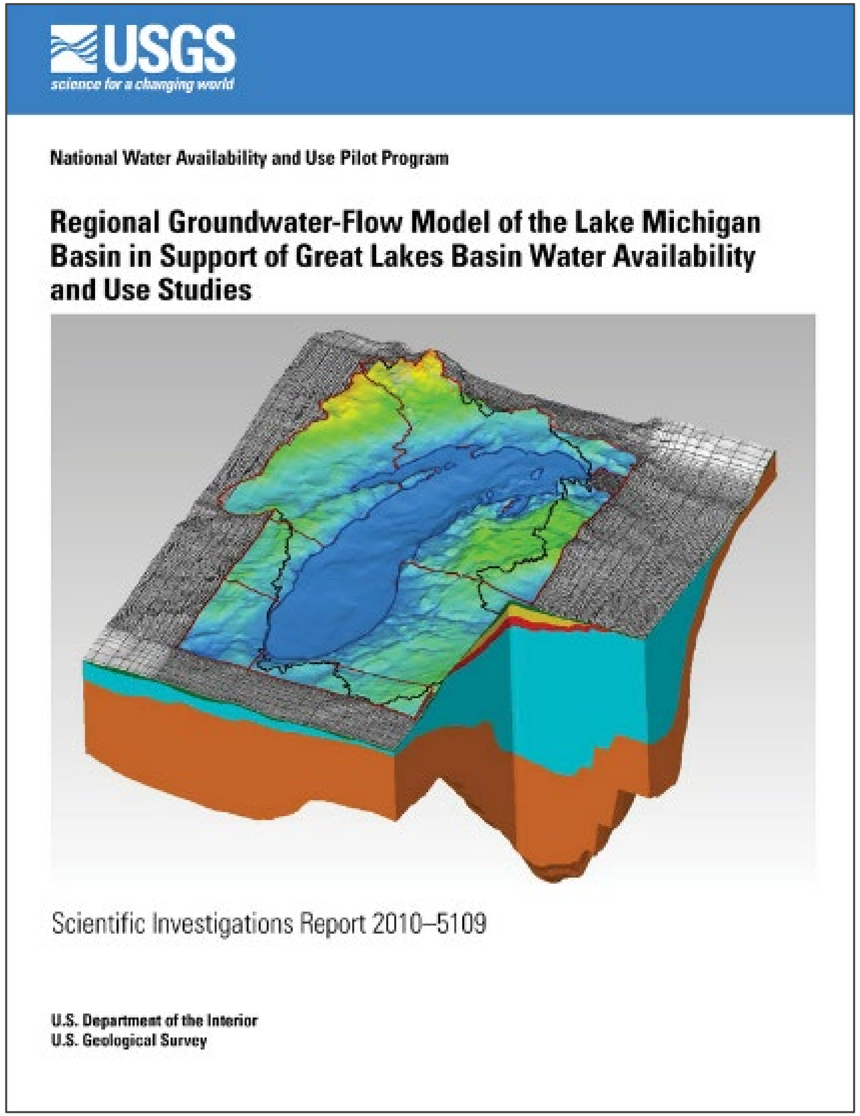


Figure 3.5 Schematic representation of the Système Hydrologique Européen (SHE) model, the bracketed numbers indicating the number of parameters involved in each component part (after Abbott et al., 1986).



Final thoughts

Funding is key!

Fulfills the Legislative Directives of IC 14-25-7 by conducting a "continuing assessment of the availability of the water resources" of the State of Indiana.

Resource Assessments

- Monthly Water Resource Summary
- Water Shortage Plan
- Ground Water Basics
- Basin Studies
- Aquifer Systems Mapping
- Potentiometric Surface Mapping
- Water Availability

https://www.in.gov/dnr/water/

Thank you!

Hudson Lake Community Meeting
May 4, 2023

Garth Lindner – Resource Assessment