DISCLAIMER: ALL PLOTS AND VALUES IN THIS PRESENTATION ARE CURRENTLY IN DRAFT FORM

Revisiting Sustainable Yield in Northeast Illinois

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NWPA TAC Meeting
11-23-2021

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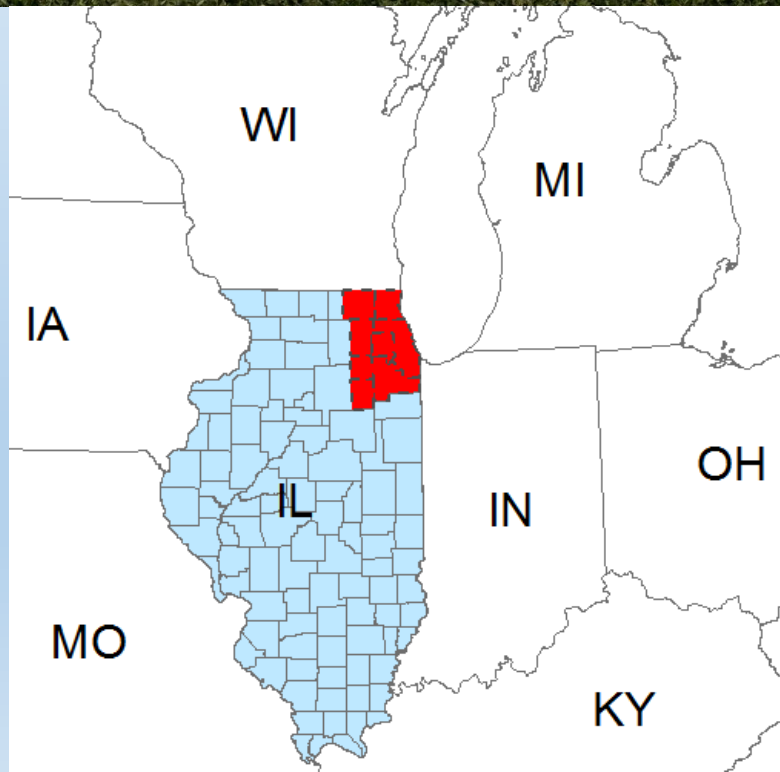
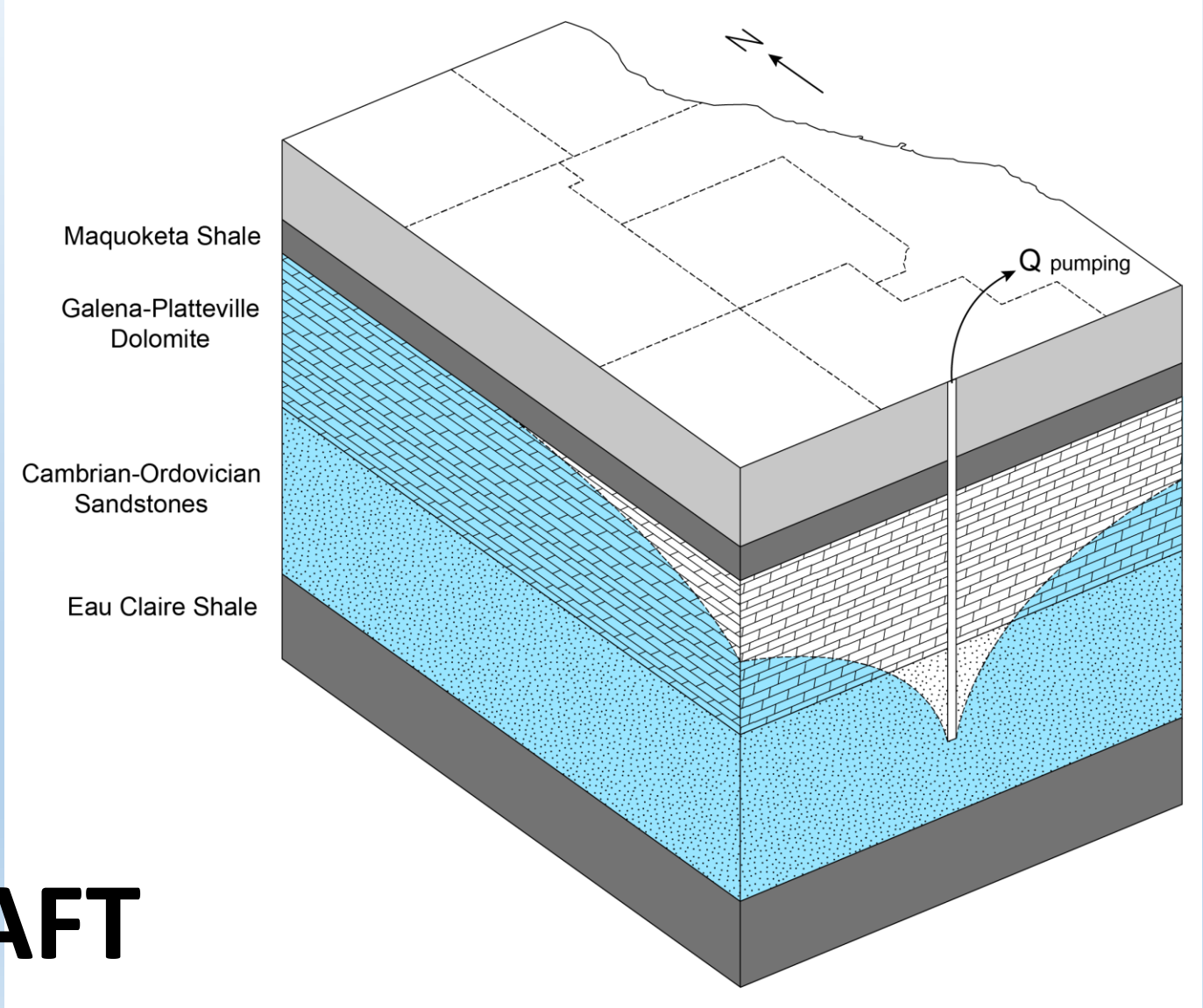


Estimated sources of water in NE Illinois



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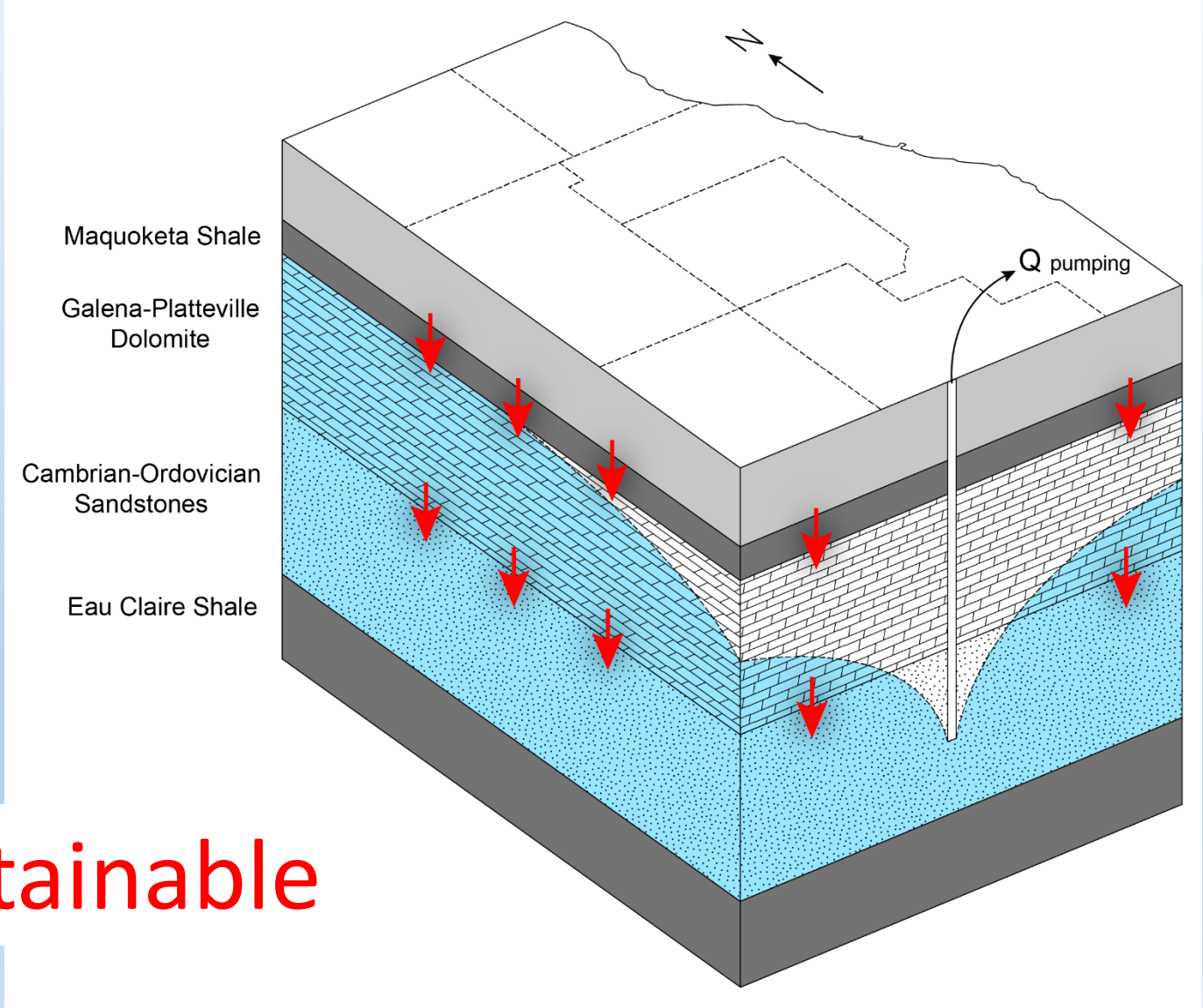
Vertical infiltration into sandstone (natural)



Sustainable

Vertical infiltration into sandstone (total)

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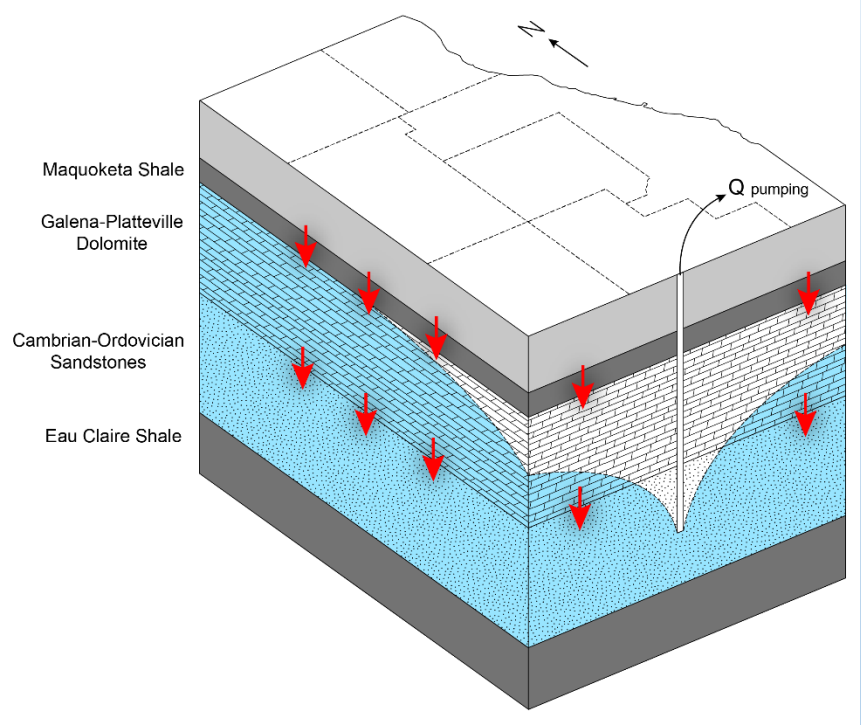

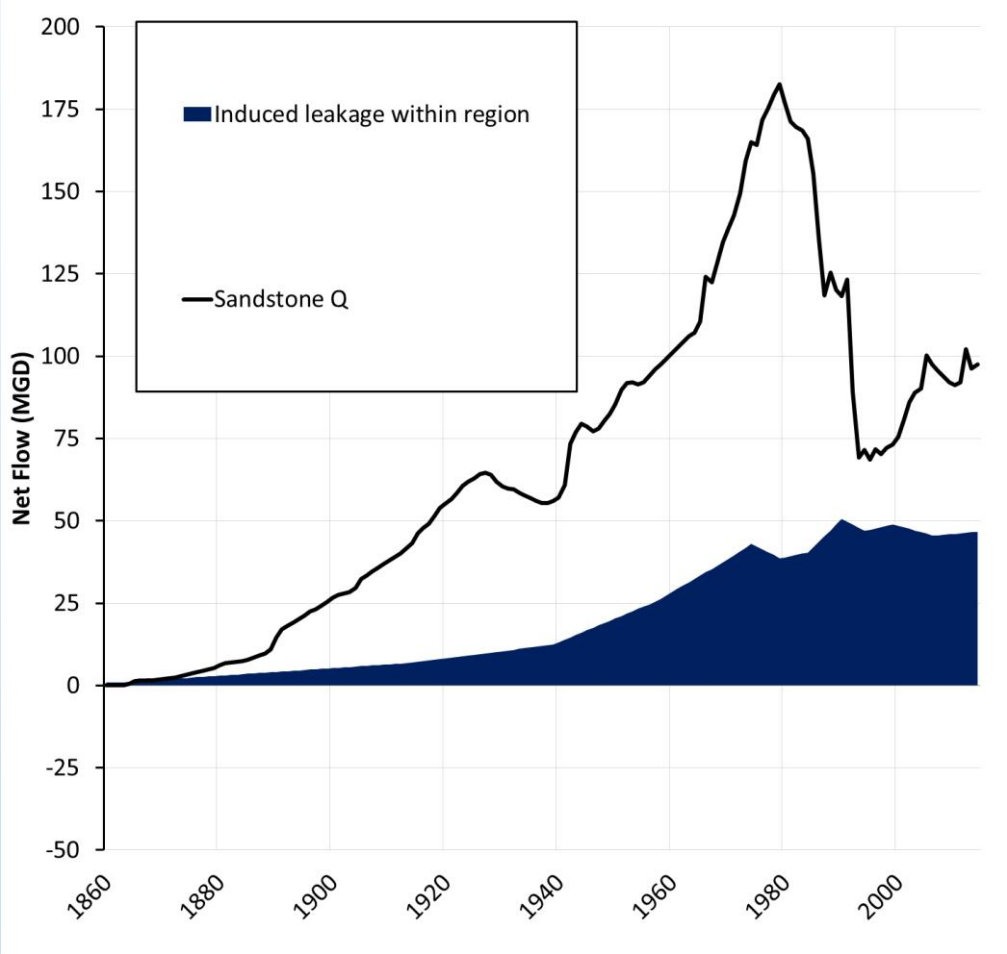

Sustainable

Flow from outside region

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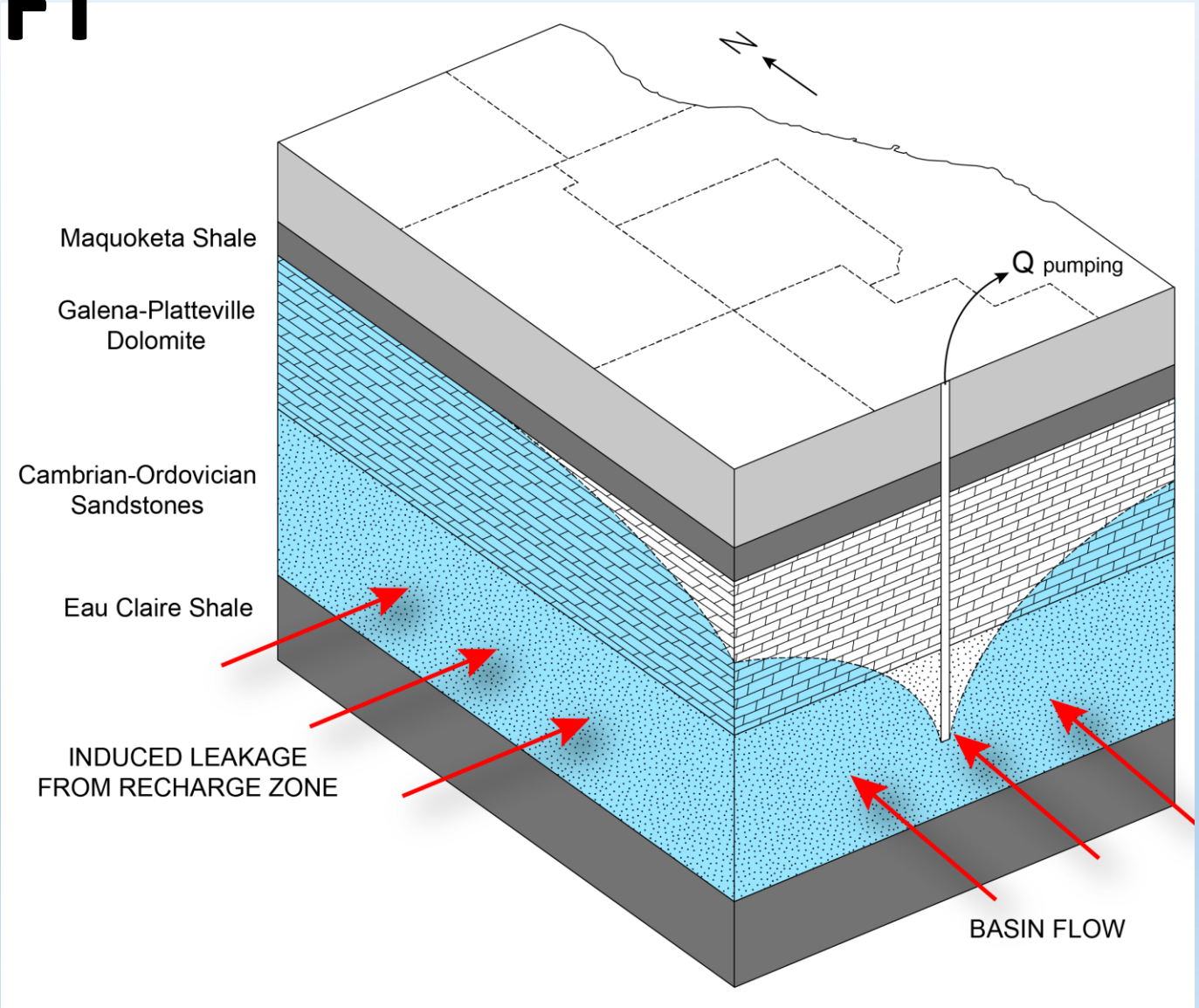

Flow from outside region (recharge)

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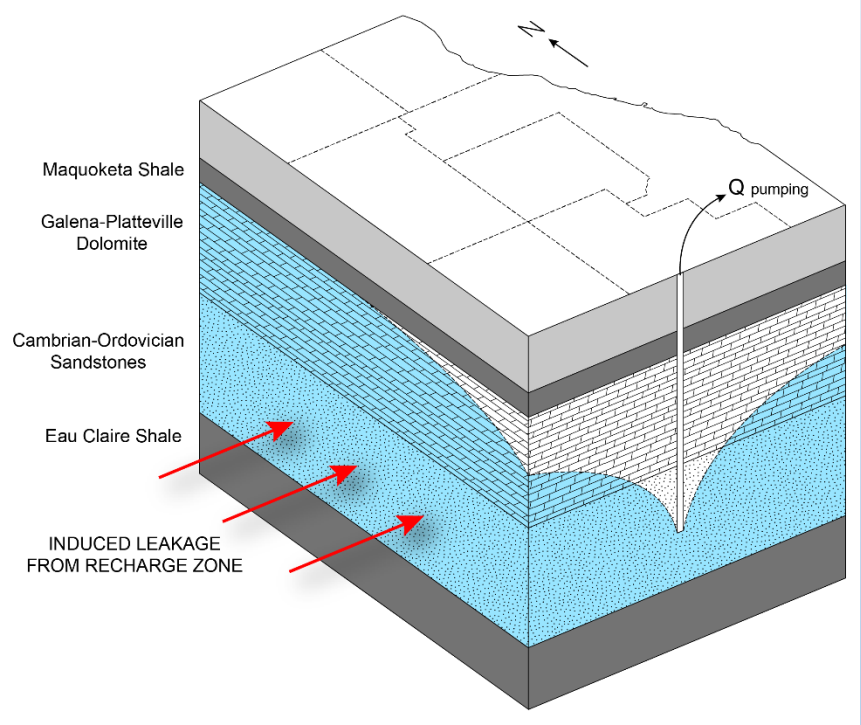

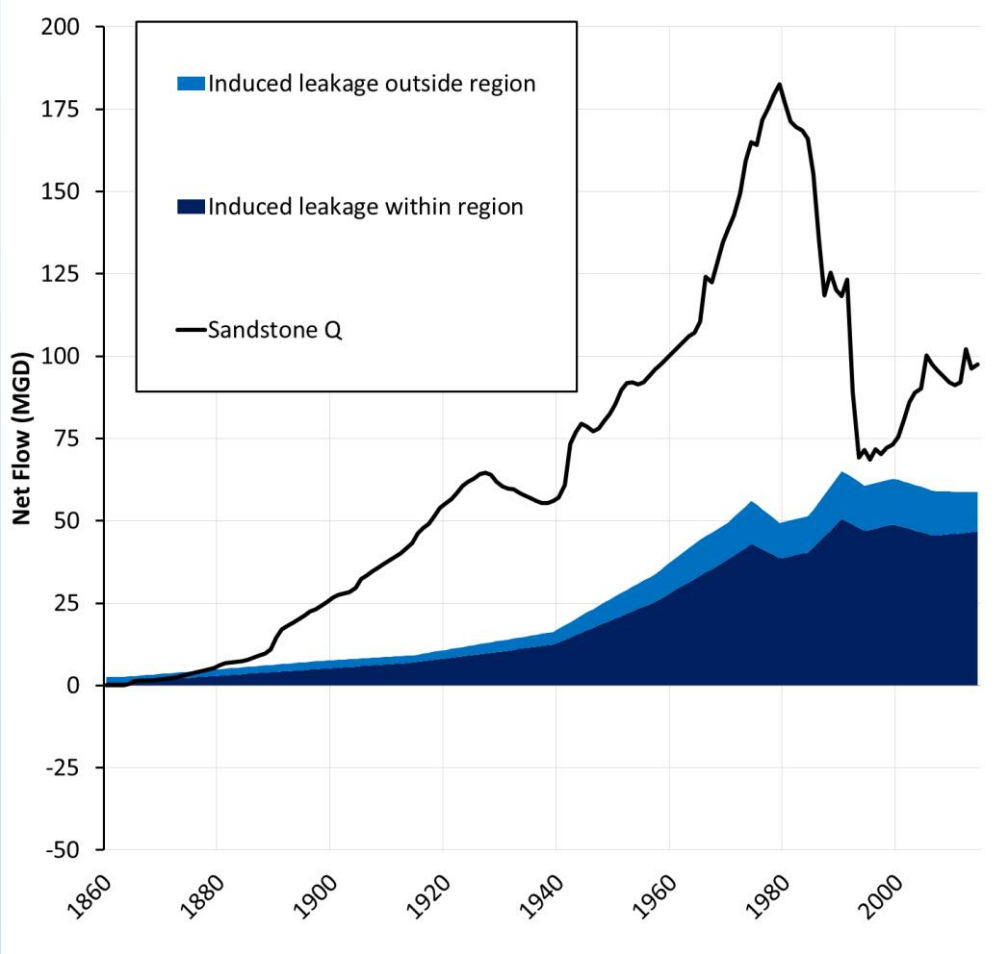

Is this sustainable?

Flow from outside region (basin)

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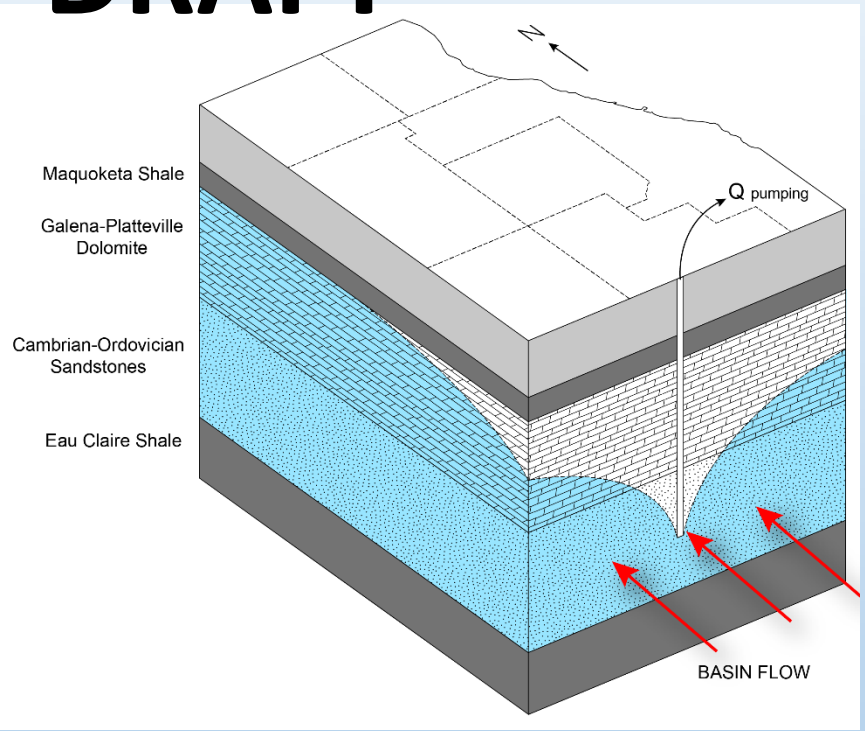

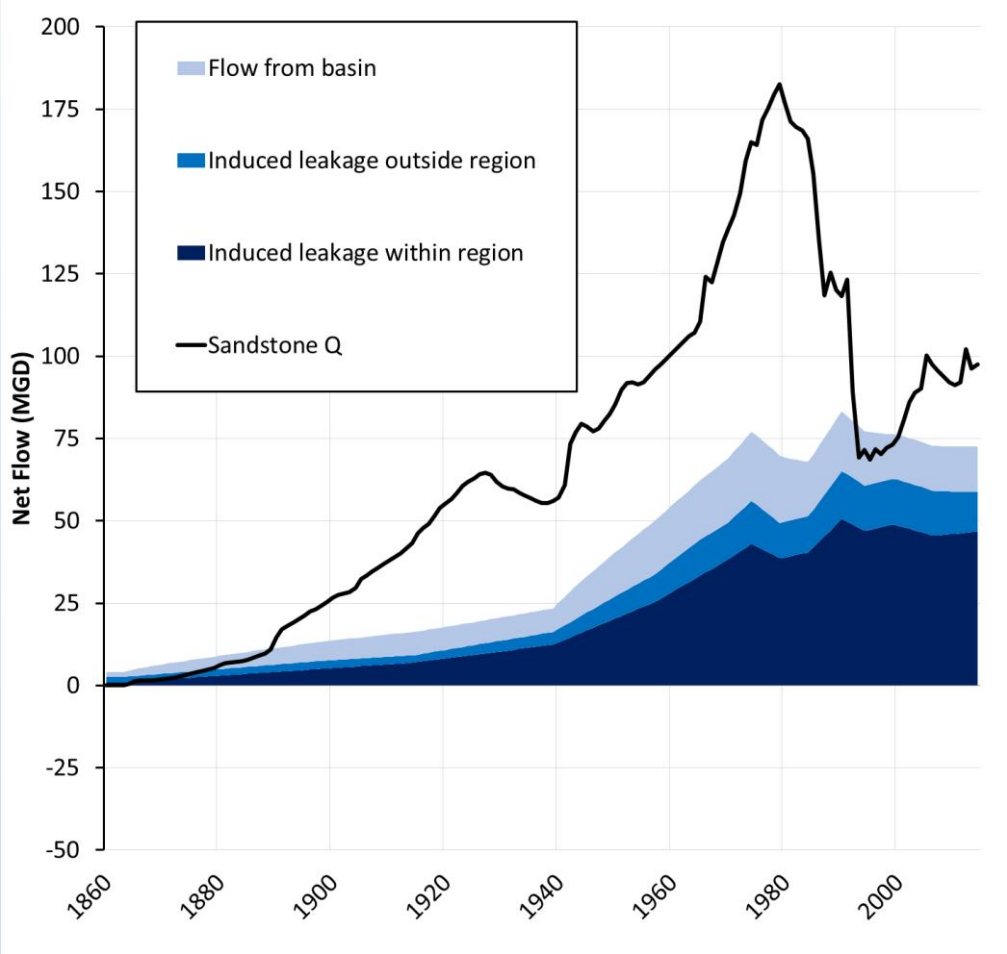

Unsustainable but must be counted if water is leaving

Flow from outside region (basin)

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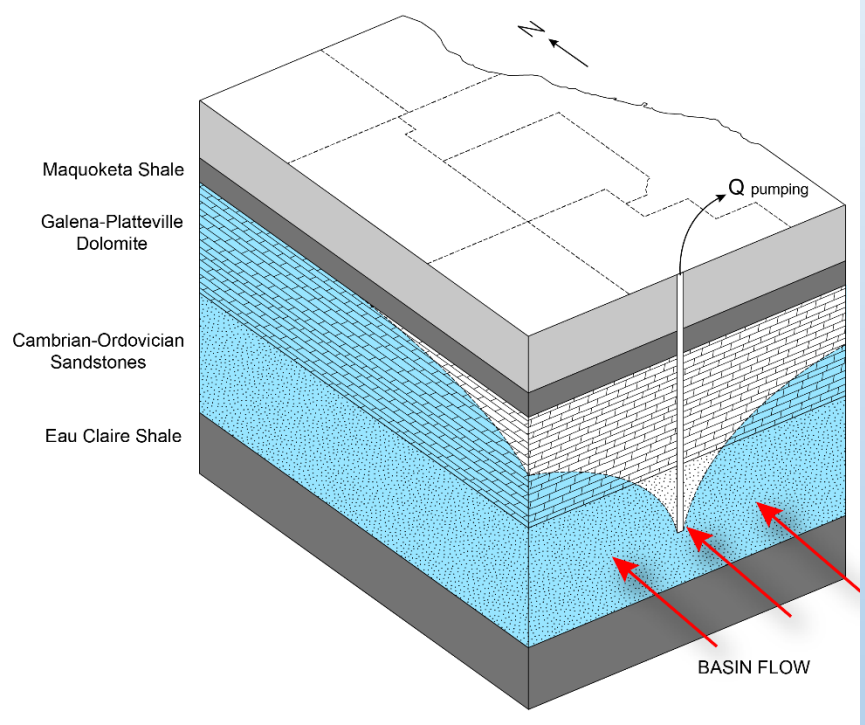

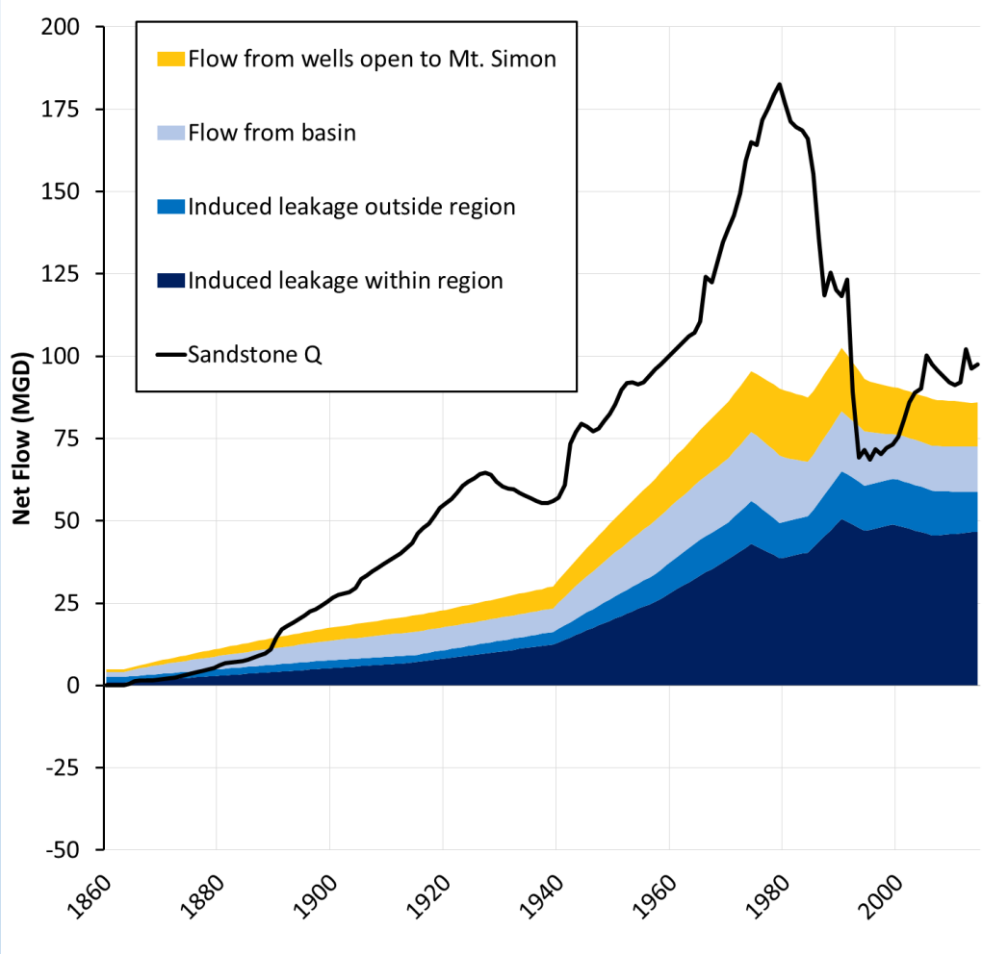

Vertical infiltration into sandstone (anthropogenic)

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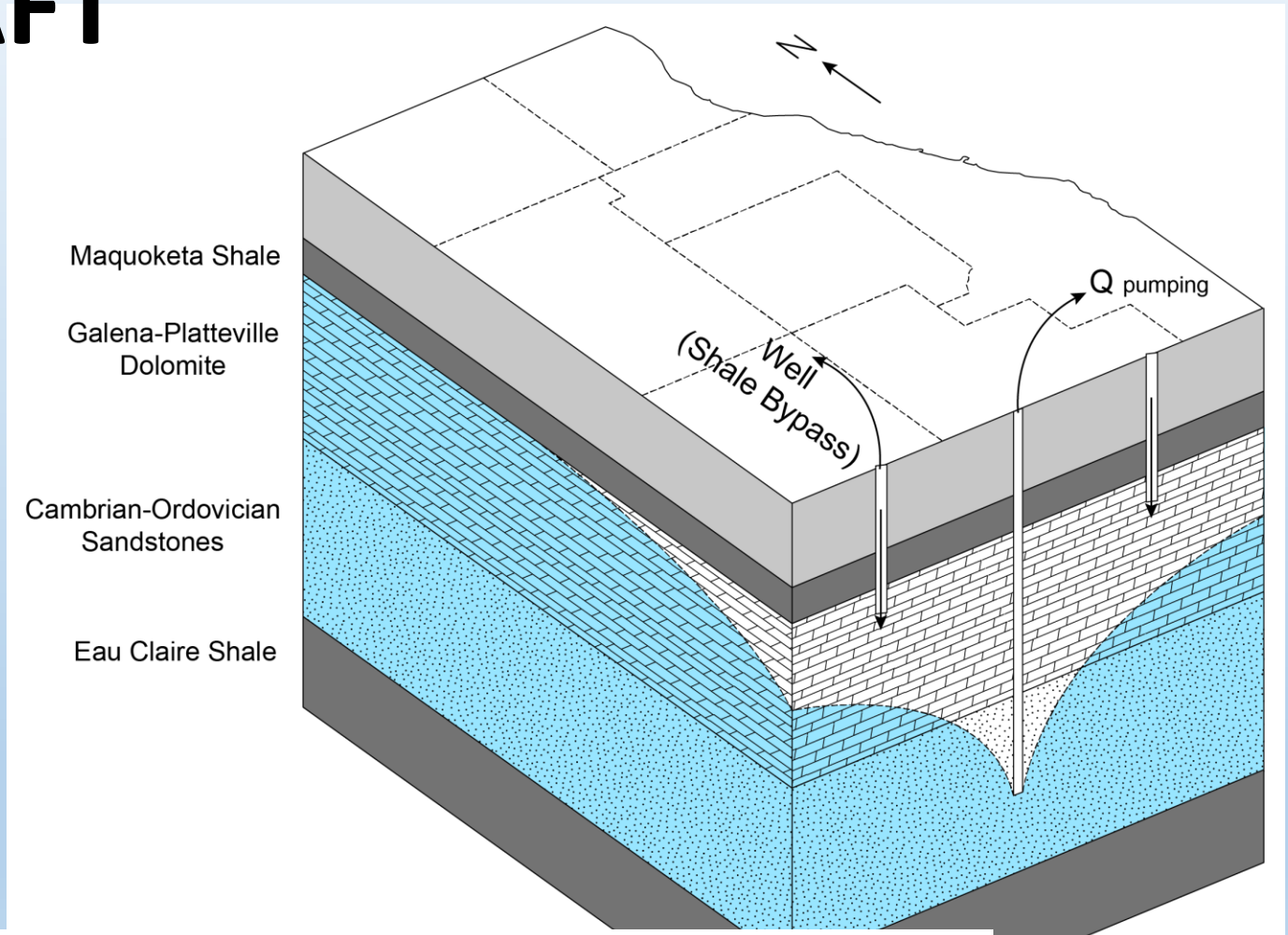

Debated: to include or not?

Vertical infiltration into sandstone (anthropogenic)

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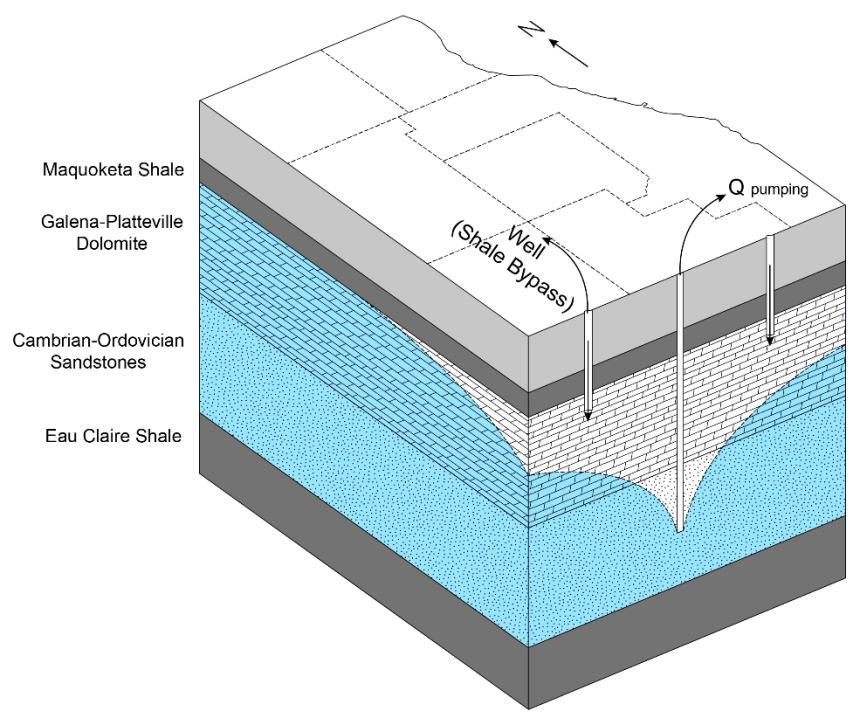

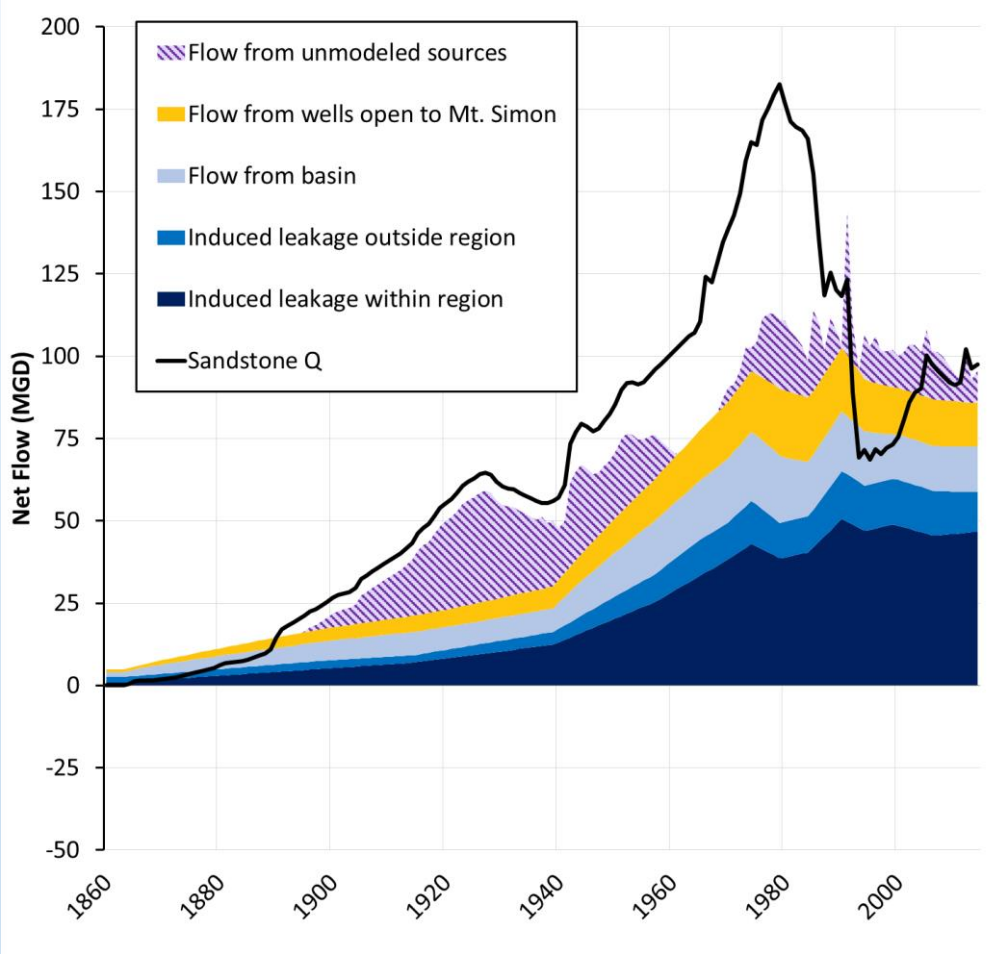

Debated: to include or not?

Removal of water from storage

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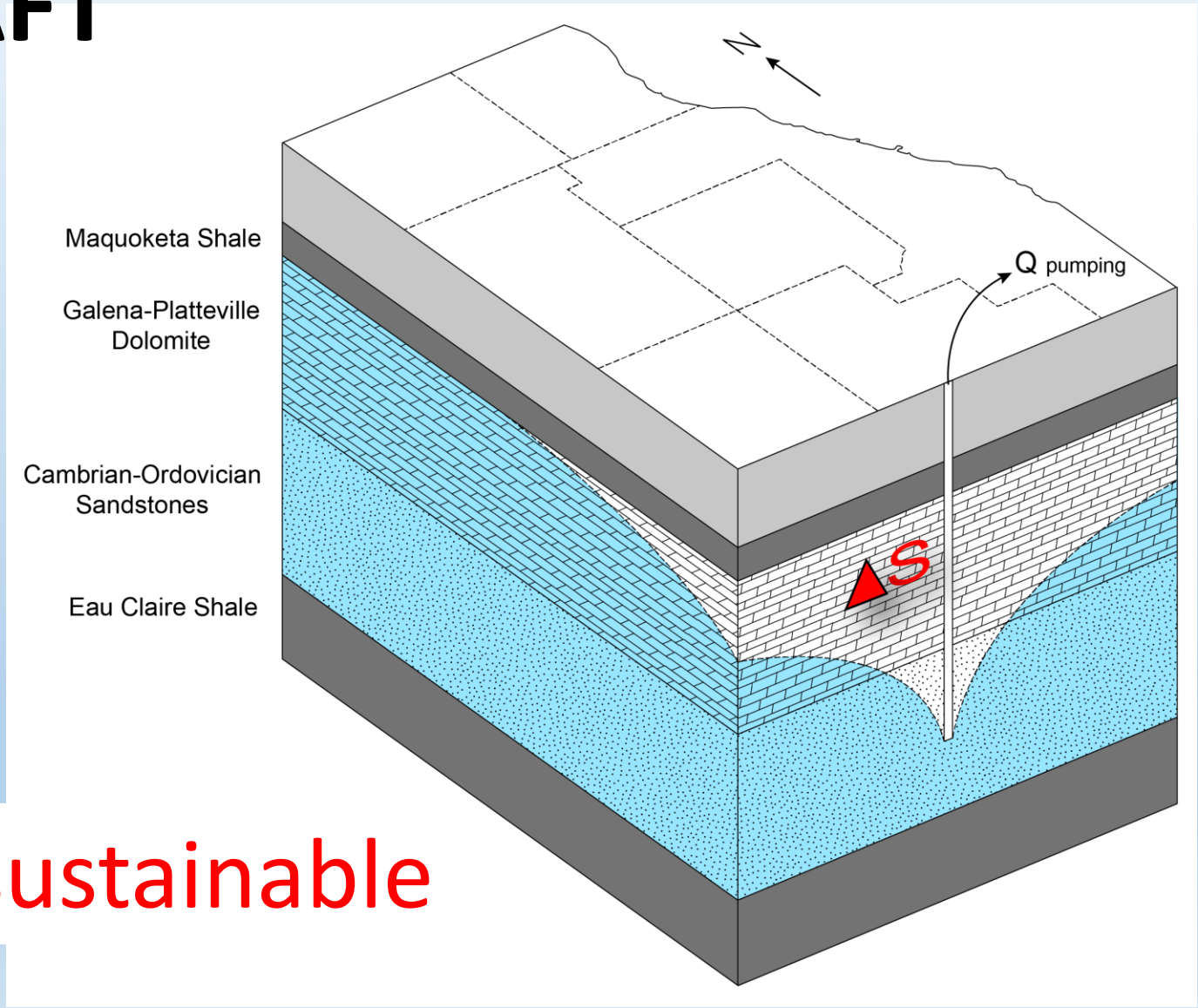

Unsustainable

Removal of water from storage

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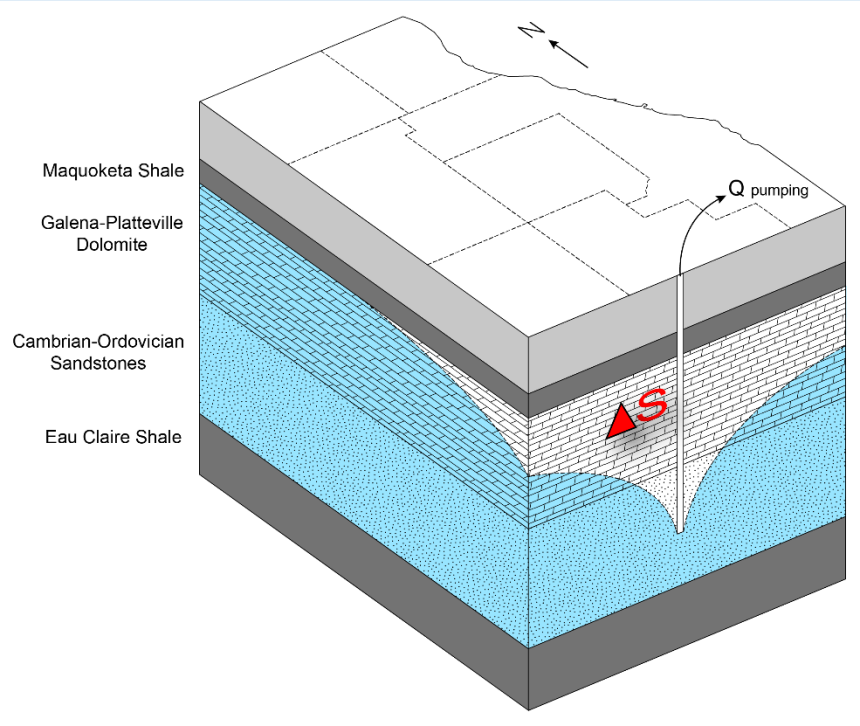
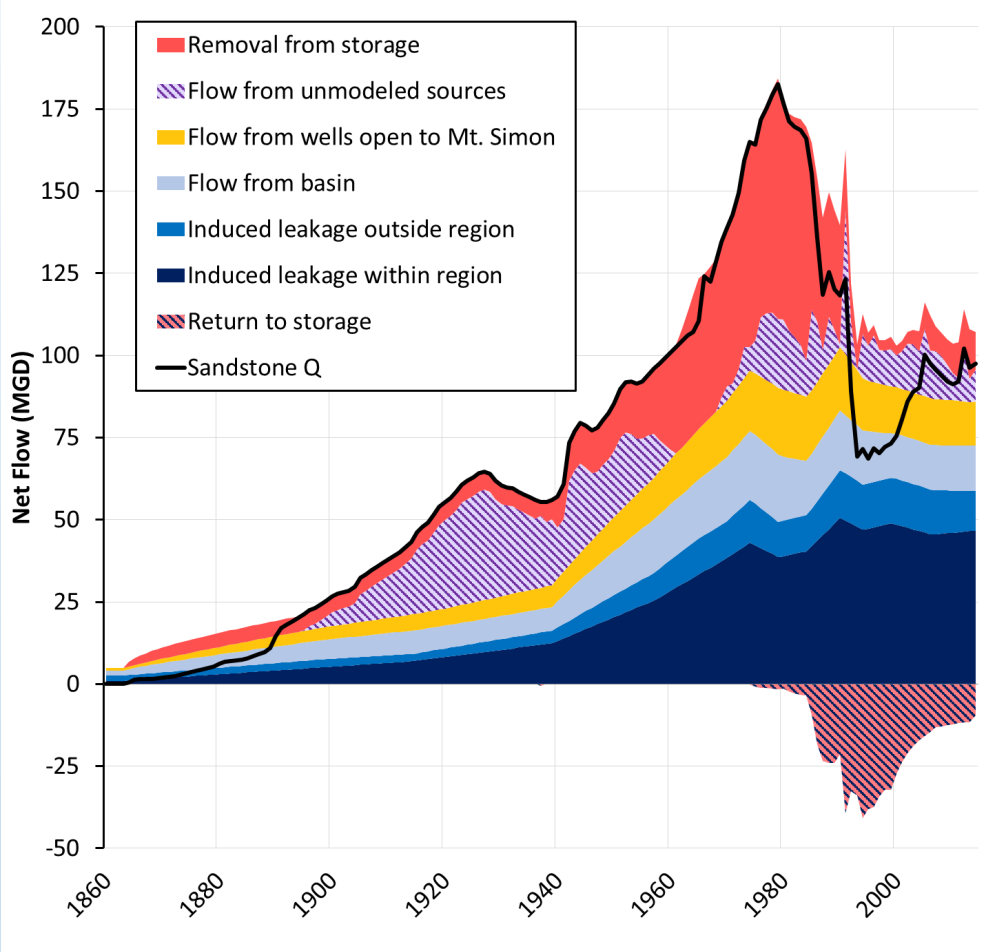
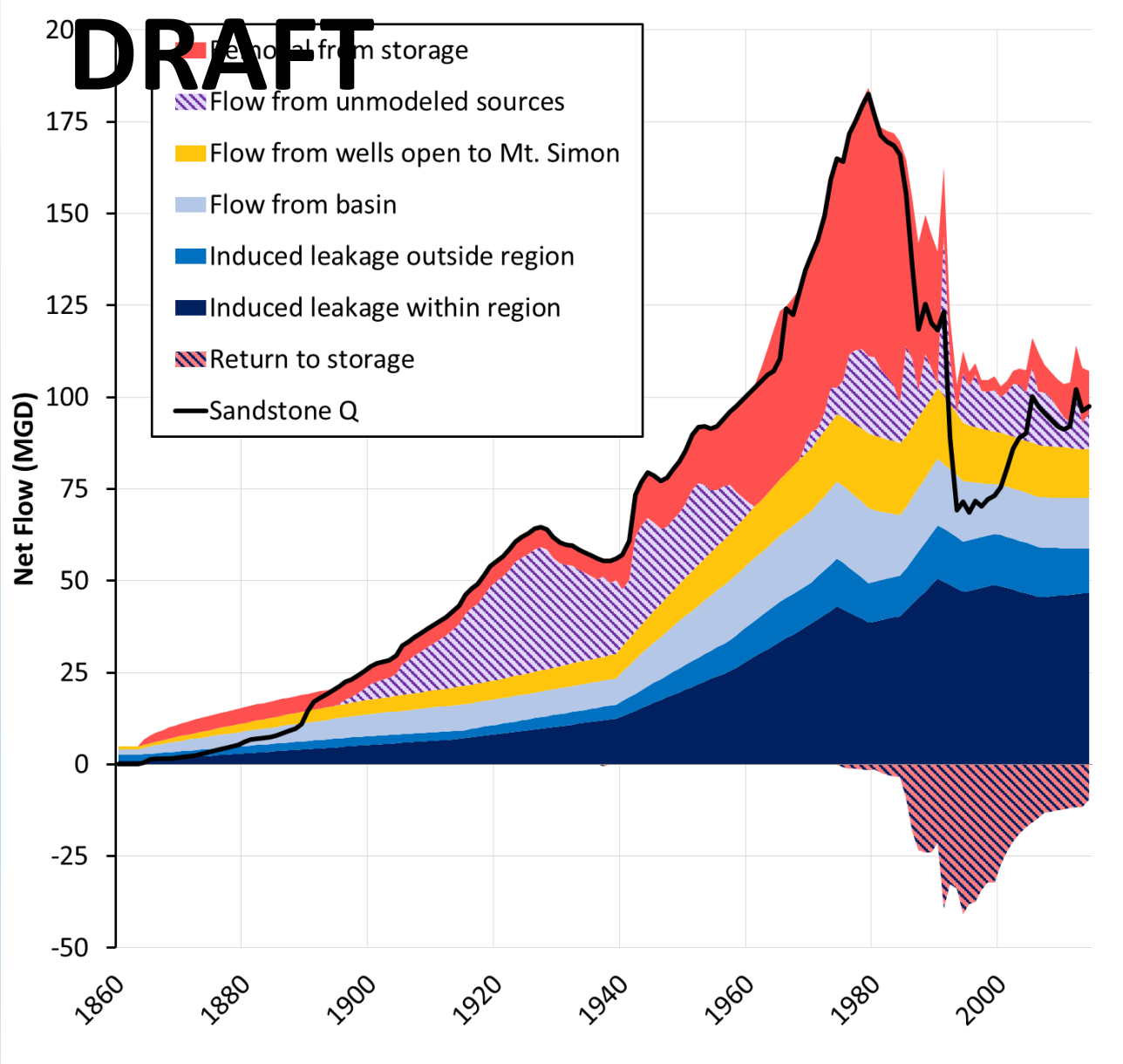




Unsustainable

What is sustainable?



1. Induced Leakage Within Region

2. Flow from anthropogenic wells (labeled as flow from unmodeled sources)

3. Induced Leakage Outside Region (we will look at this closer)

Let's define sustainability

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a) Safe Yield: Redistribute pumping such that no additional drawdown would occur from the current potentiometric surface

b) Modeled Sustainable Leakage: Only consider vertical leakage into the aquifer

c) Maximum Sustainable Leakage: Considers the maximum water that can leak vertically into the aquifer

d) Sustainable Yield: Considers horizontal flow as well as vertical leakage into the aquifer

Metric #1: Safe Yield

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a) Methodology: Assign to the model withdrawals such that there are no simulated changes in storage (thus stable water level conditions)
b) Benefit: Solution ensures that the optimized distribution of pumping will capture the safe yield
c) Problem: This approach assumes a pumpage distribution that does not match current demands. It also includes flow from the deep basin with undesirable water quality.

Shown for completion, this was ruled out in a previous meeting as being overly academic and lacking any real-world, practical application

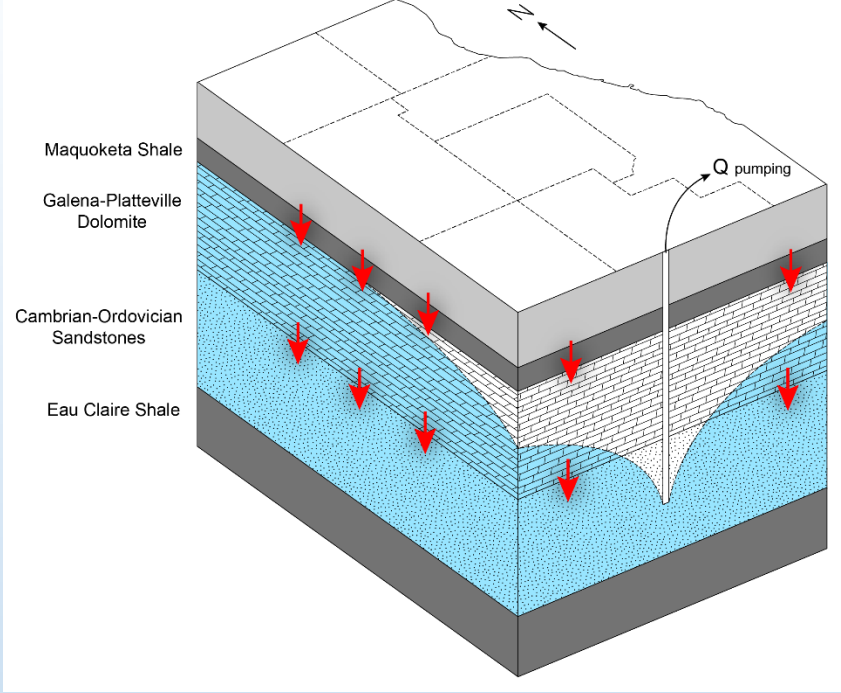
Metric #2: Modeled Sustainable Leakage

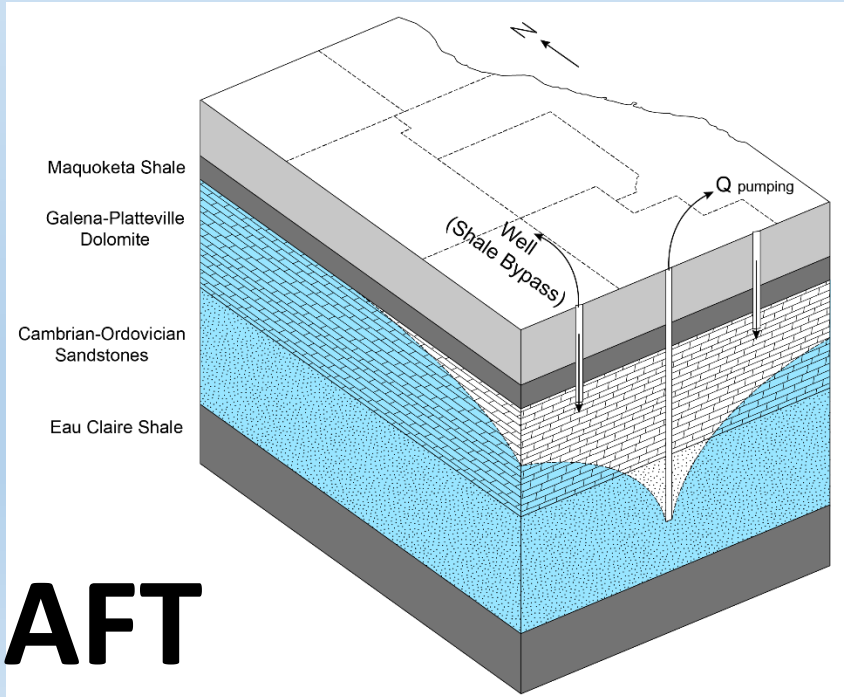
a) Methodology: Vertical leakage simulated flowing into the aquifer. Considers both natural and anthropogenic flow **as things are now**

b) Benefit: Conservative approach- sustainability is determined only by water that enters within the county

c) Problem: Ignores the horizontal flow component, which is reality in northeastern Illinois and not going away

A Contender





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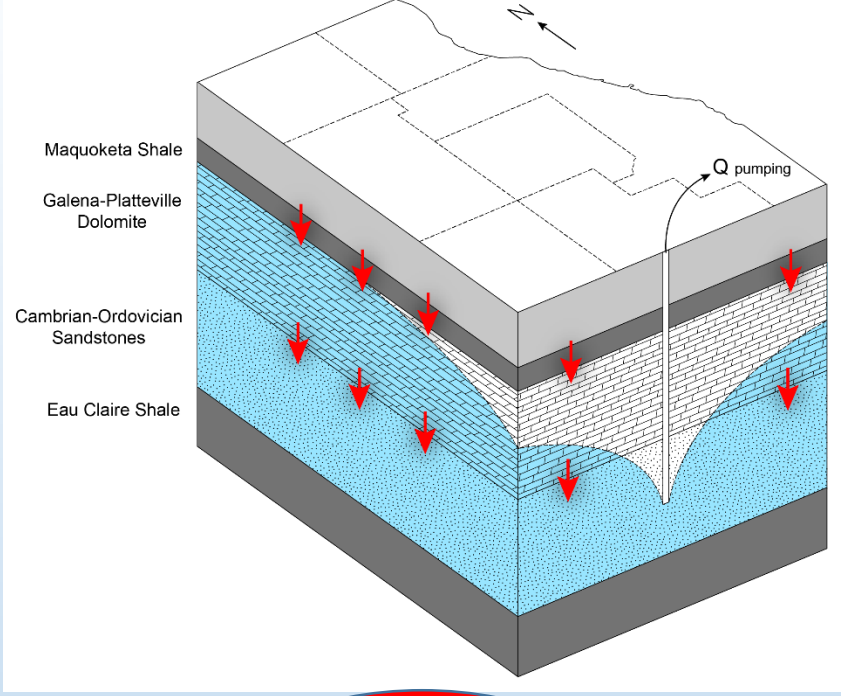
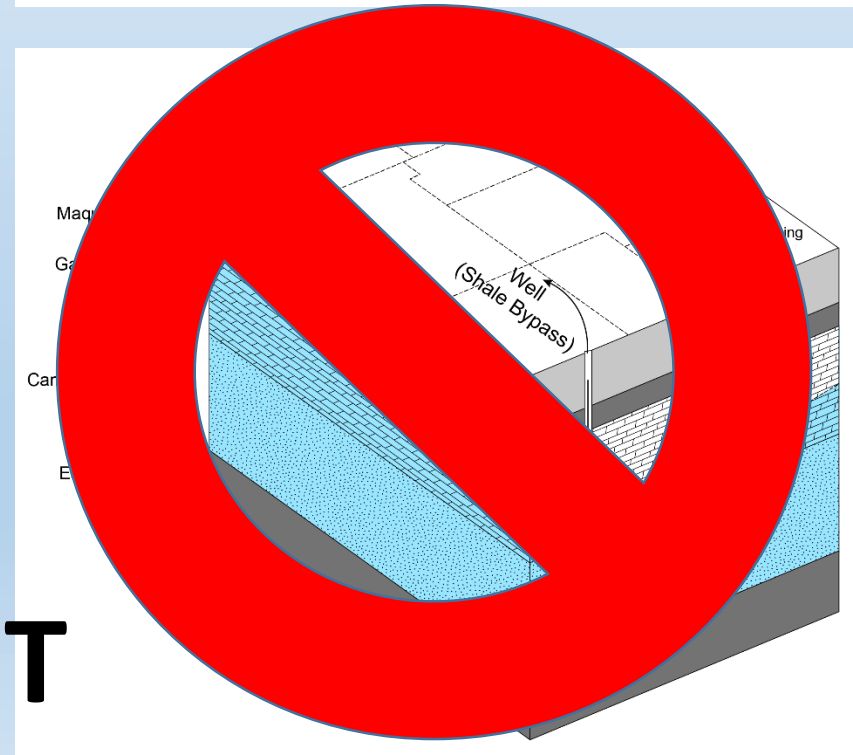
Metric #3: Maximum Sustainable Leakage

a) Methodology: Draw water levels below the shale to simulate the maximum vertical leakage to an aquifer
b) Benefit: The most conservative approach
c) Problem: Ignores the horizontal flow component, which is reality in northeastern Illinois and not going away. Does not include anything but the natural geology





A Contender

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Modeled vs Maximum Sustainable Leakage

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Modeled = How things are now

Maximum = How they could be

- What about McHenry County?

Modeled: 10. 2 MGD

Maximum: 17.8 MGD

- Does not make a big difference until we reach counties where drawdown is minimal

Maximum Sustainable Leakage

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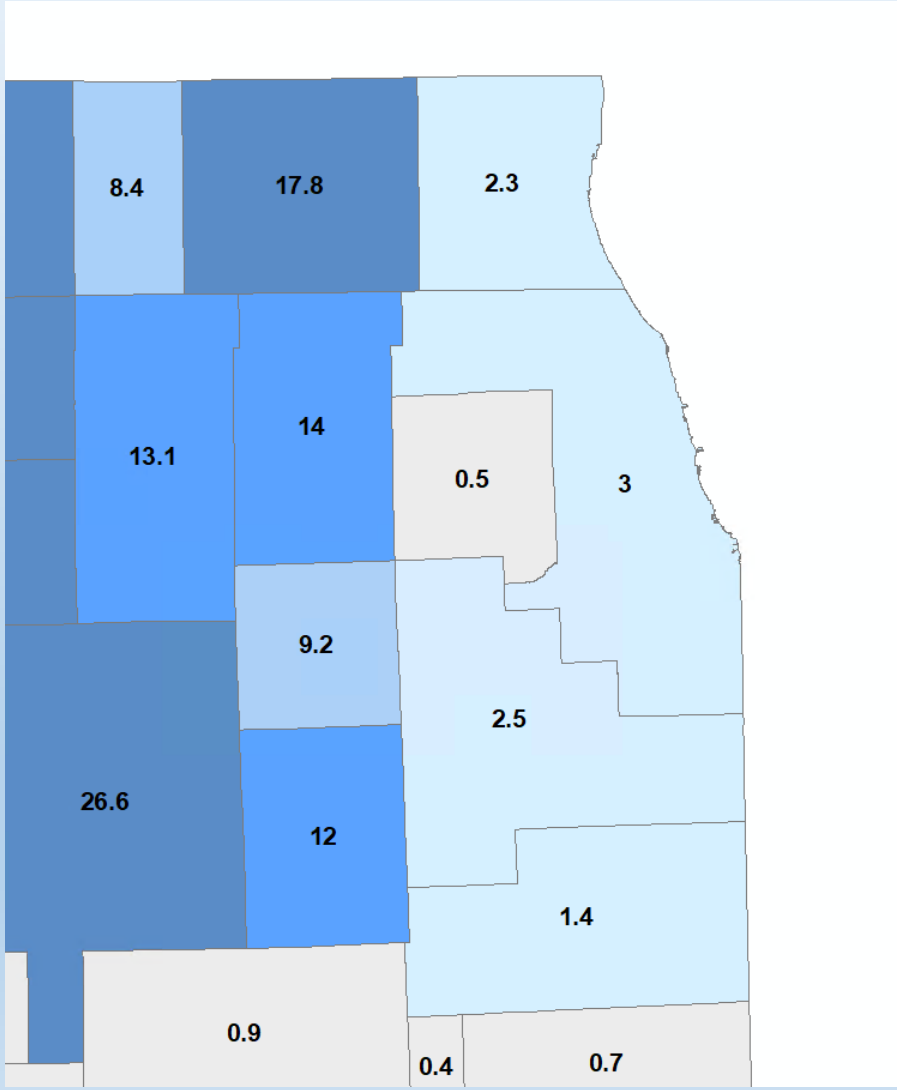
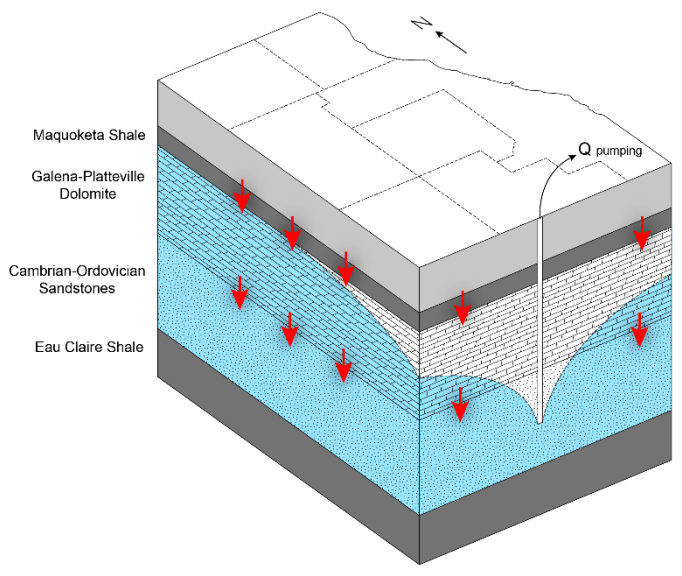
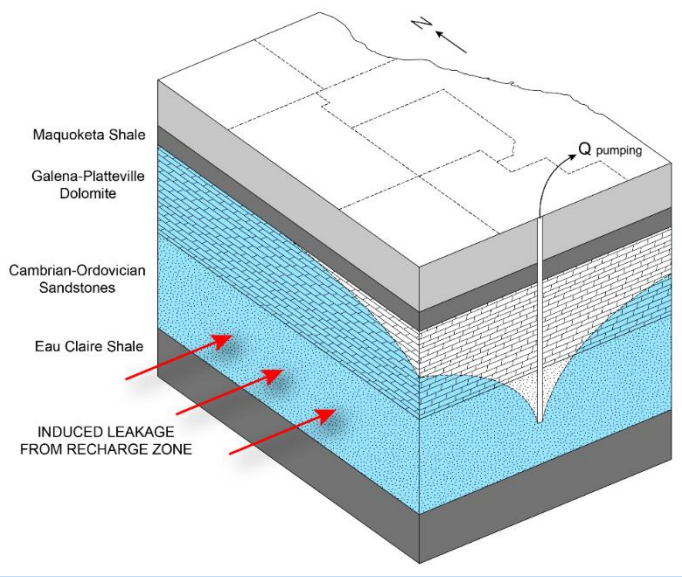


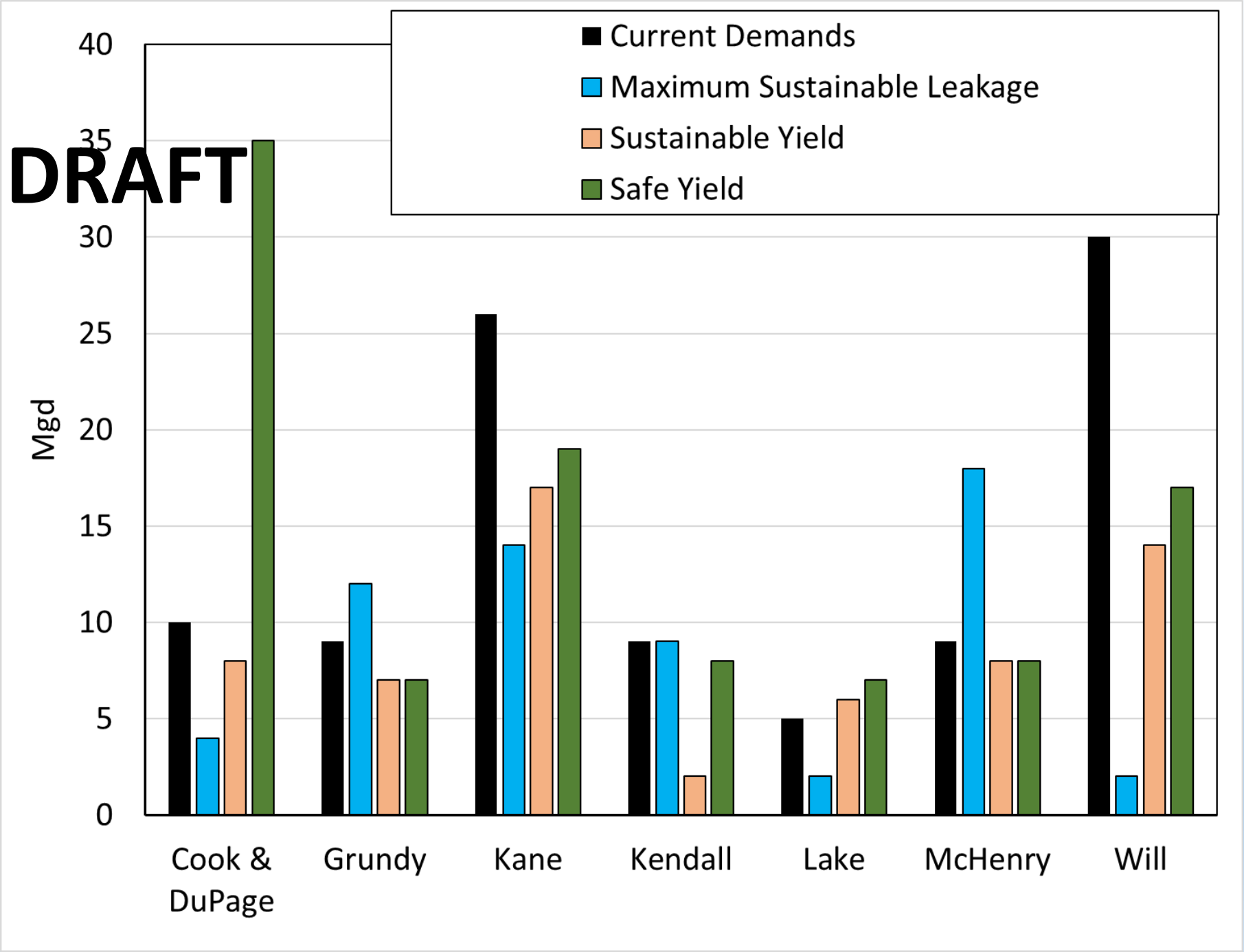
Metric #4: Sustainable Yield

a) Methodology: Using current gradients, sum the vertical and horizontal inflow/outflow of the sandstone. Horizontal inflow is limited to water originating from natural recharge sources.
b) Benefit: Most grounded in reality (based off of current pumping conditions and gradients)
c) Problem: Reducing demands to this value will also reduce horizontal inflow (hence value does not truly represent a sustainable withdrawal rate)





A Contender **DRAFT**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Current Demands
Maximum Sustainable Leakage
Sustainable Yield
Safe Yield
Mgd
40
35
30
25
20
15
10
5
0
Cook & DuPage
Grundy
Kane
Kendall
Lake
McHenry
Will

What were some preferences?

a) **<u>Unanimous</u>**: Safe Yield is too theoretical to consider for our sustainability assessment
b) **<u>Discussion</u>**: Should we consider anthropogenic flow through aquitards as sustainable. While some wells may be sealed, the integrity of the aquitard has been damaged
c) **<u>Disagreement</u>** over whether to proceed with maximum sustainable leakage (vertical flow only) or sustainable yield (horizontal flow included)
   i. Stakeholders: prefer to consider the horizontal flow gained and lost in reality as long as it originates from natural recharge
   ii. ISWS: concerned about impacts of changing water users on sustainable values

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Vertical flow only or vertical + horizontal

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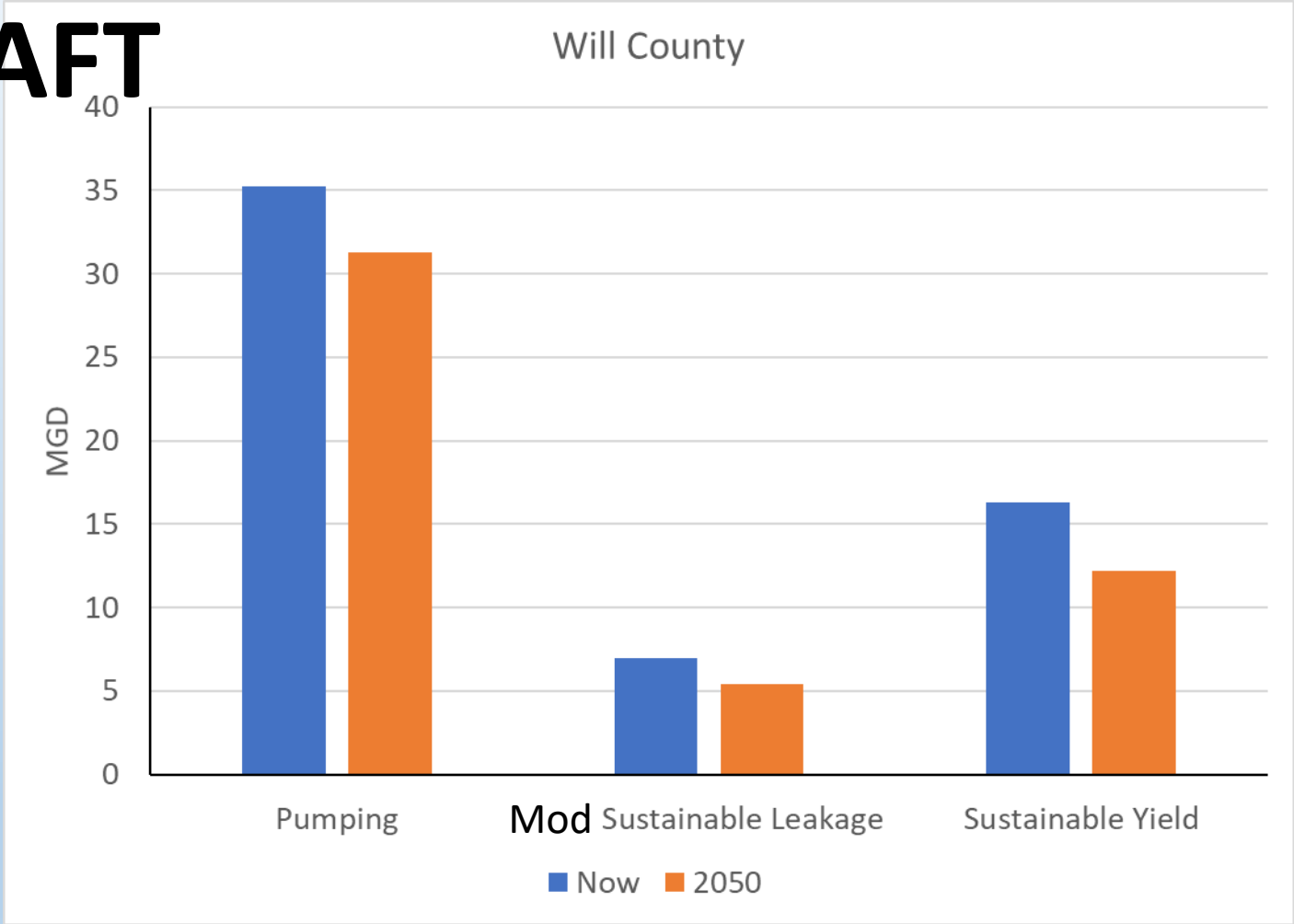
Will County
MGD
40
35
30
25
20
15
10
5
0
Pumping
Mod Sustainable Leakage
Sustainable Yield
Now
2050

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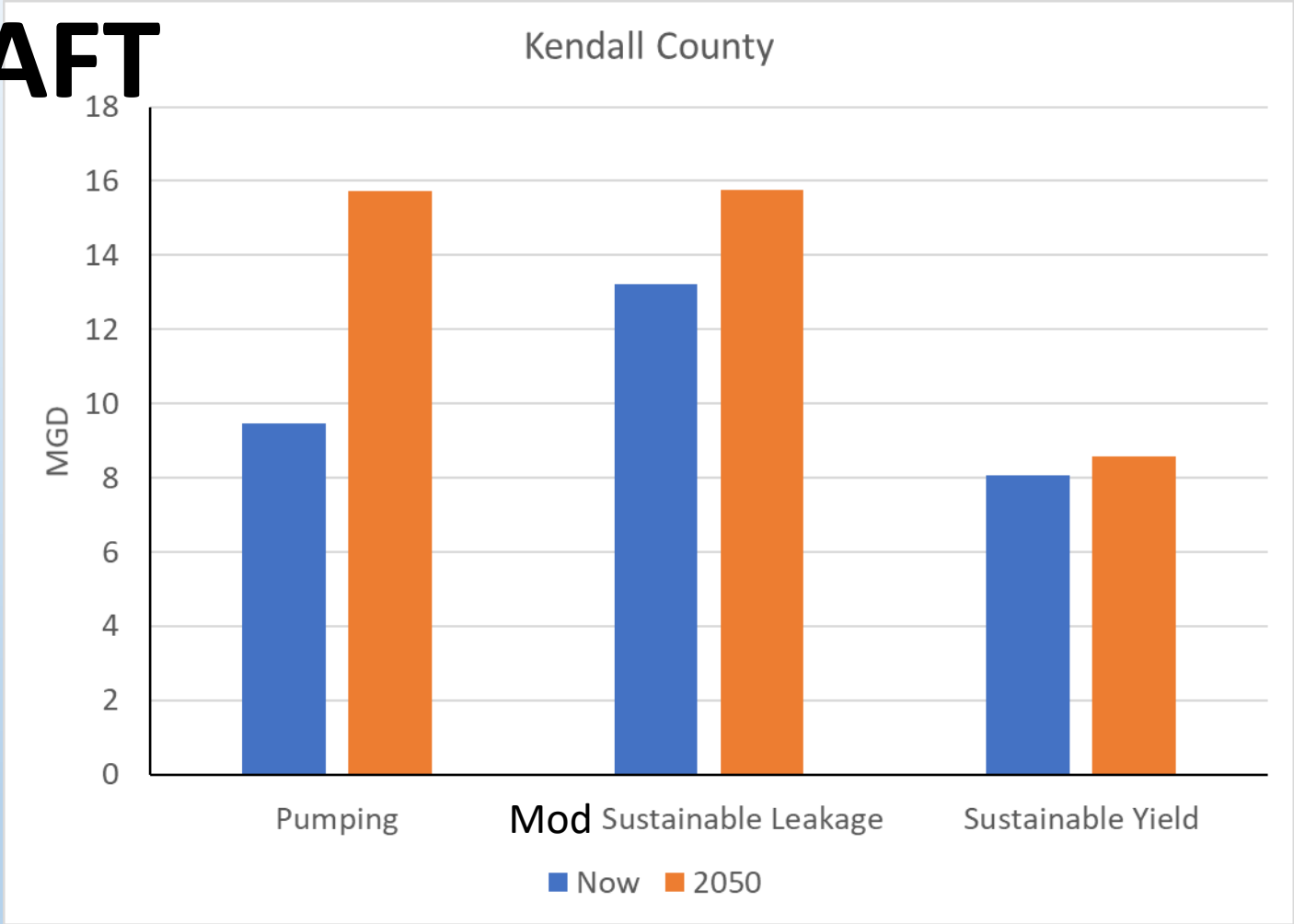
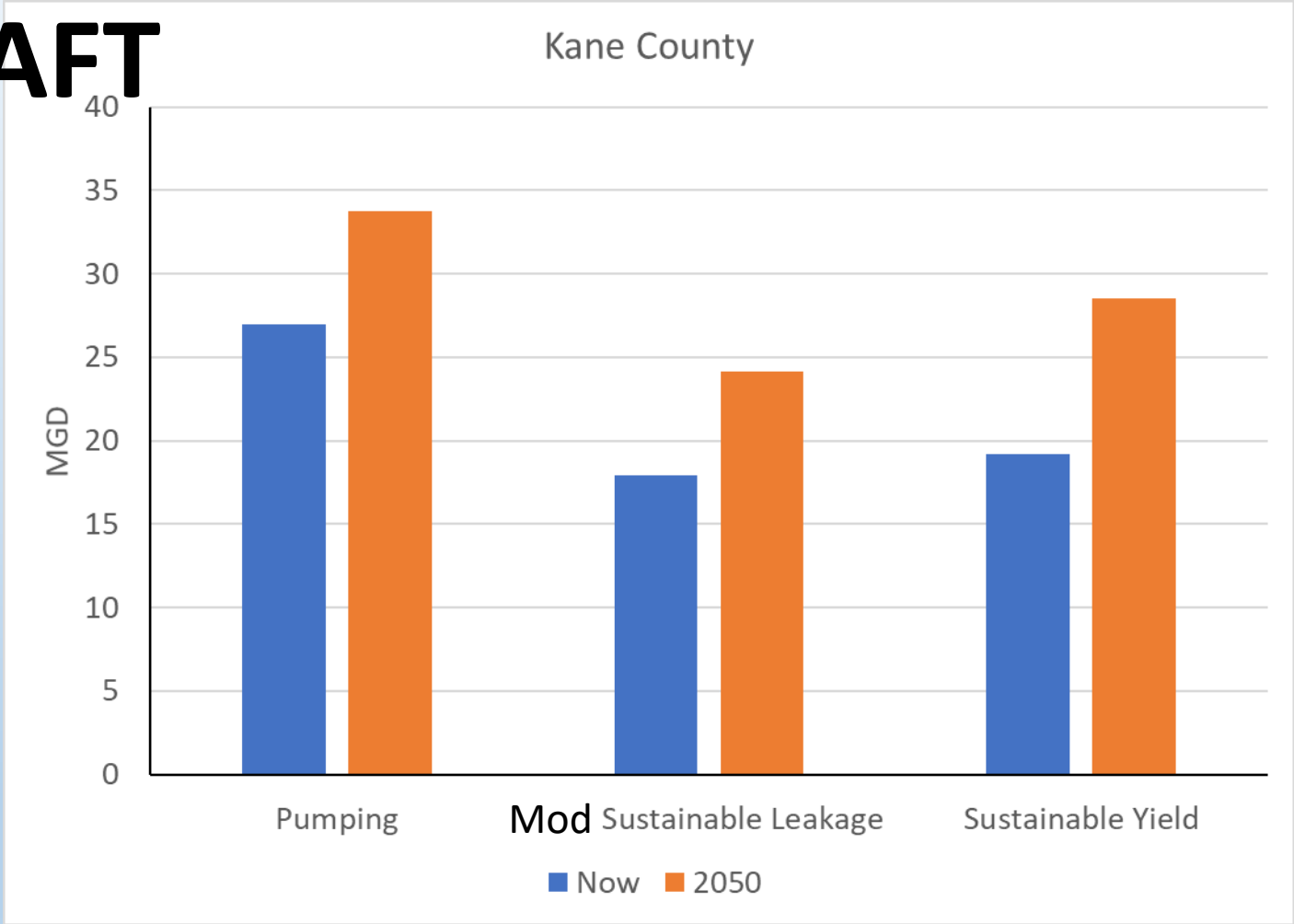
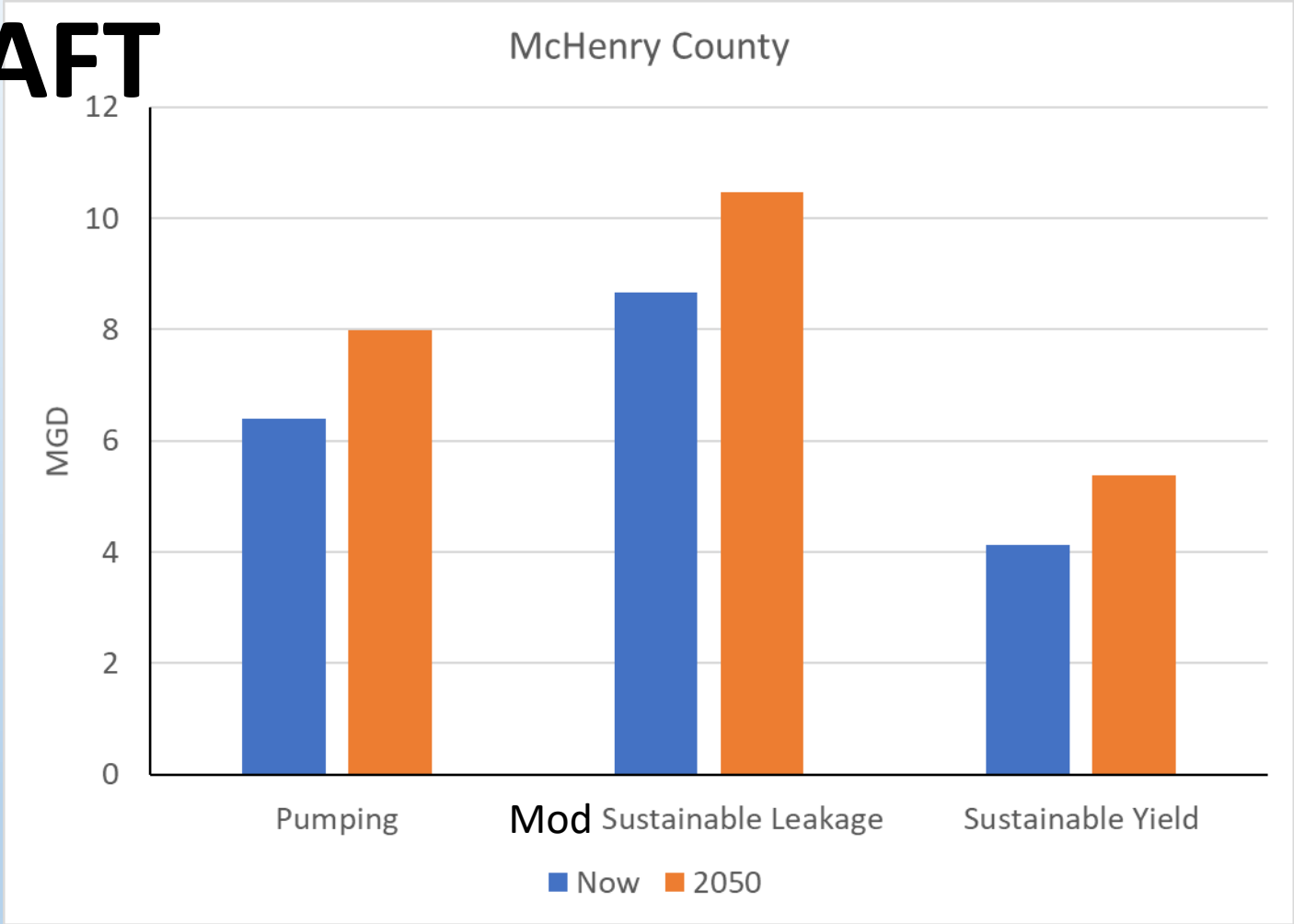

Kendall County
MGD
18
16
14
12
10
8
6
4
2
0
Pumping
Mod Sustainable Leakage
Sustainable Yield
Now
2050

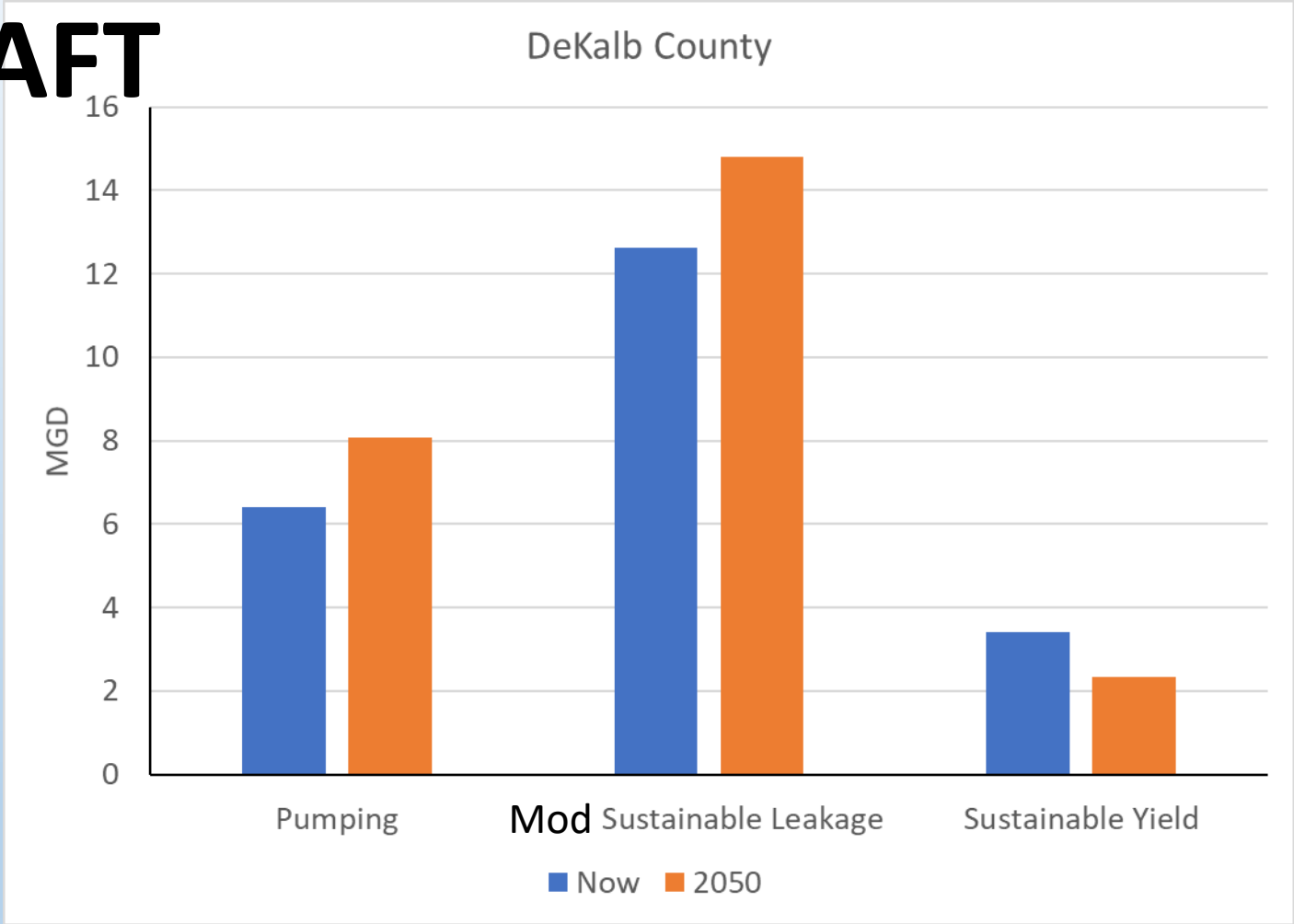
DRAFT


Kane County
MGD
40
35
30
25
20
15
10
5
0
Pumping
Mod Sustainable Leakage
Sustainable Yield
Now
2050

DRAFT


McHenry County
MGD
12
10
8
6
4
2
0
Pumping
Mod Sustainable Leakage
Sustainable Yield
Now
2050

DRAFT


DeKalb County
MGD
16
14
12
10
8
6
4
2
0
Pumping
Mod Sustainable Leakage
Sustainable Yield
Now
2050

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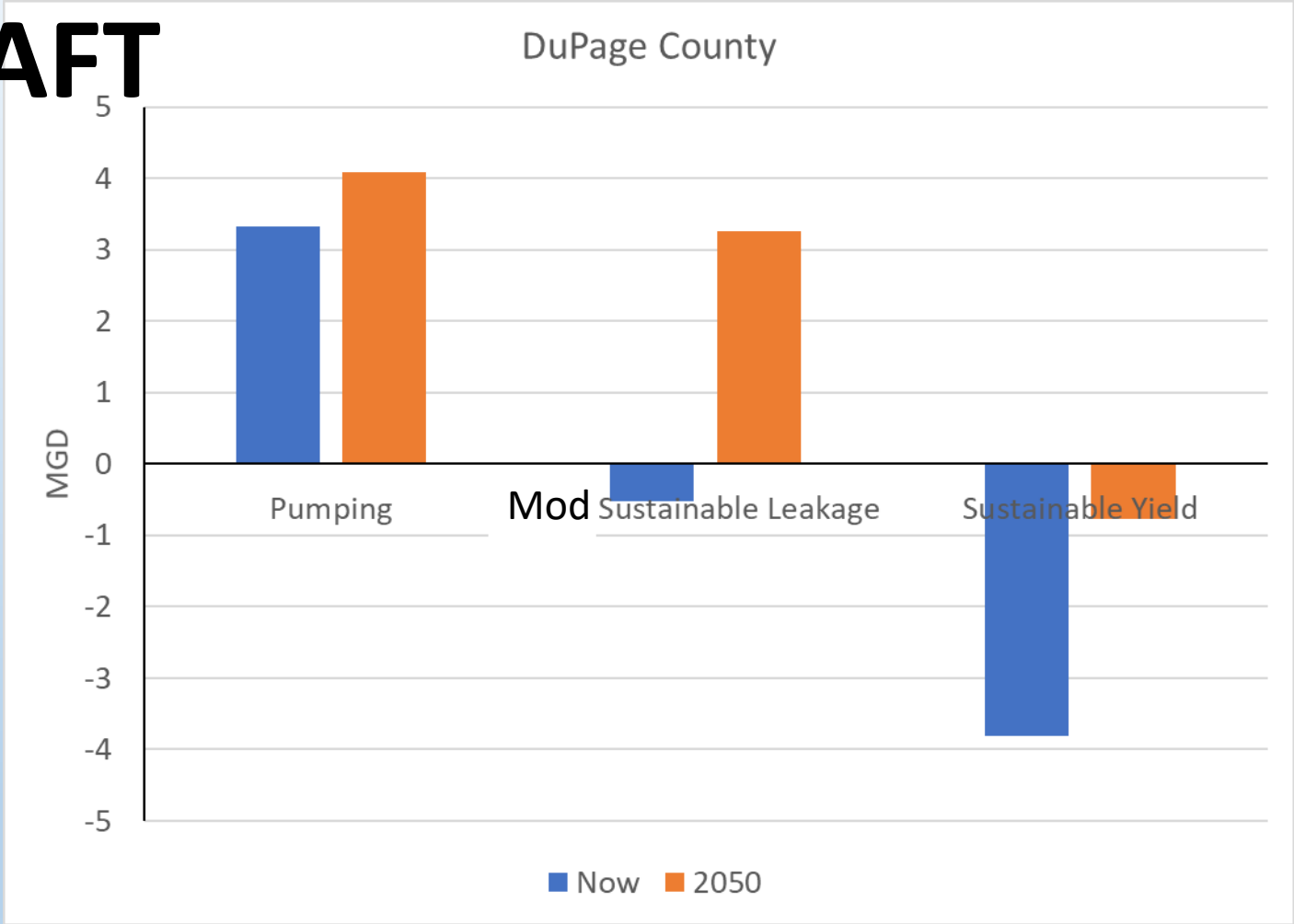
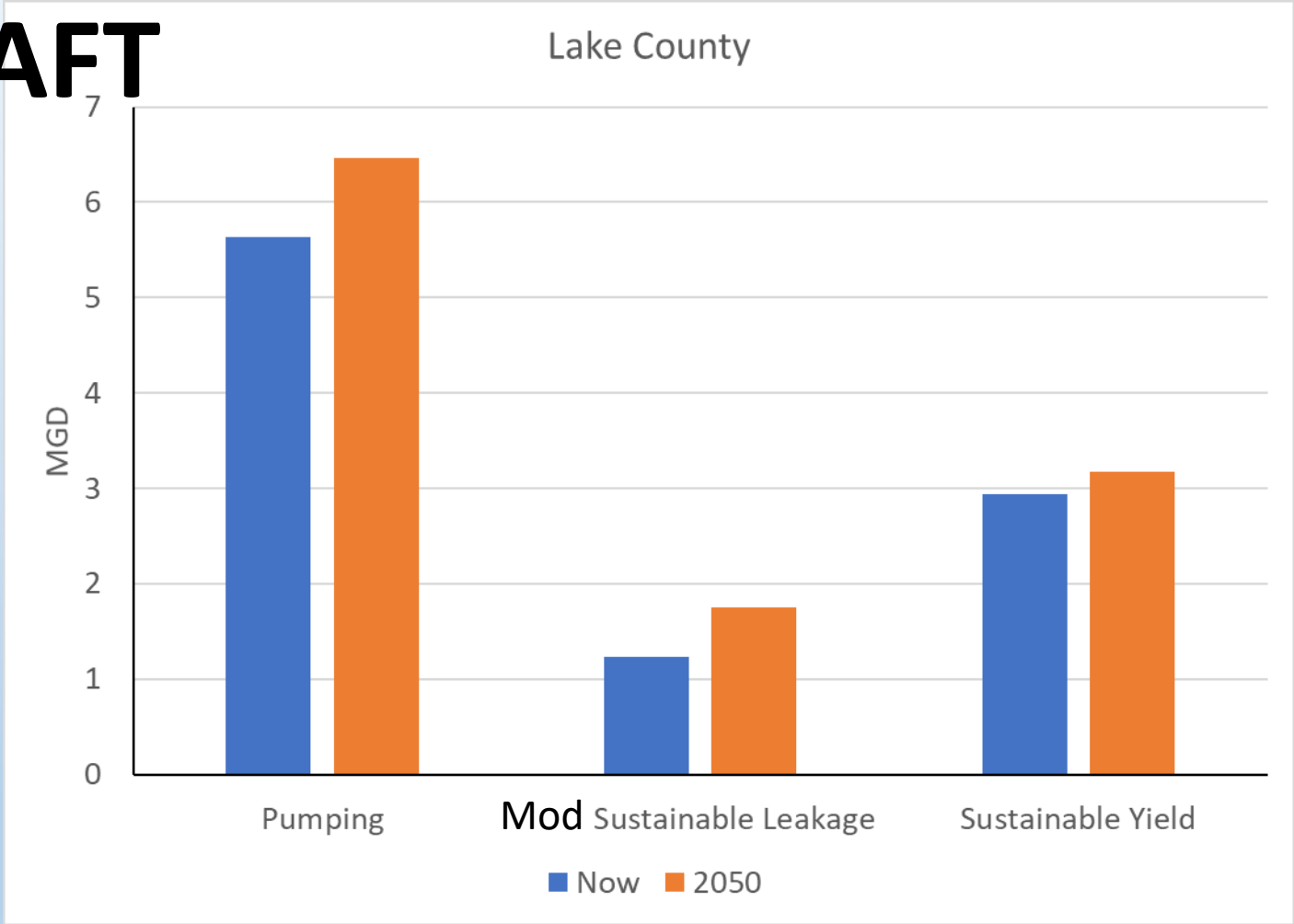

DuPage County
MGD
5
4
3
2
1
0
-1
-2
-3
-4
-5
Pumping
Mod Sustainable Leakage
Sustainable Yield
Now
2050

DRAFT


Lake County
MGD
7
6
5
4
3
2
1
0
Pumping
Mod Sustainable Leakage
Sustainable Yield
Now
2050

Gain Water When Considering Horizontal Flow

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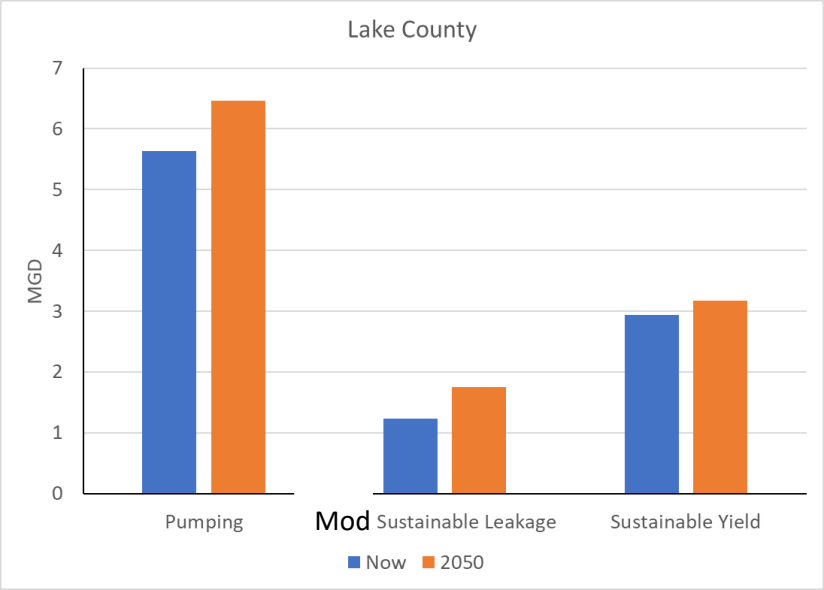

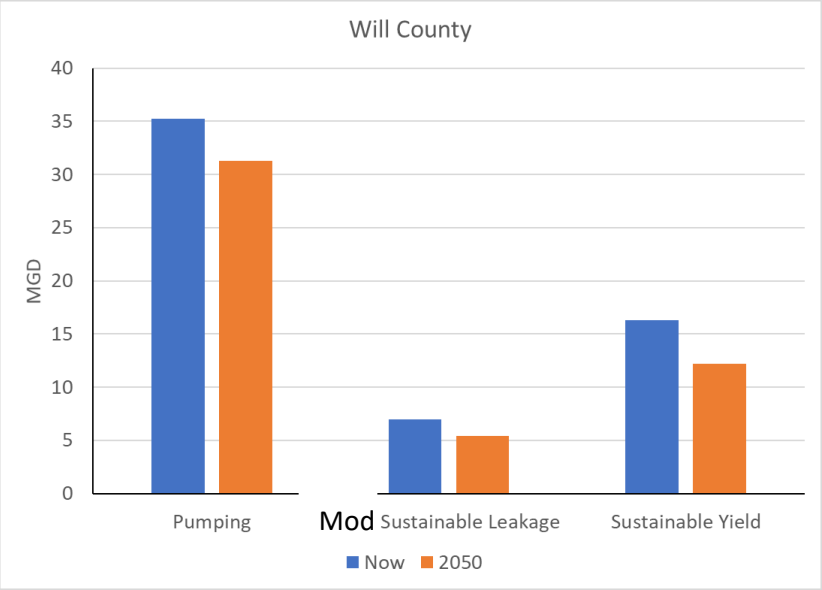

Inflow >>>> Outflow

Small Impact When Considering Horizontal Flow

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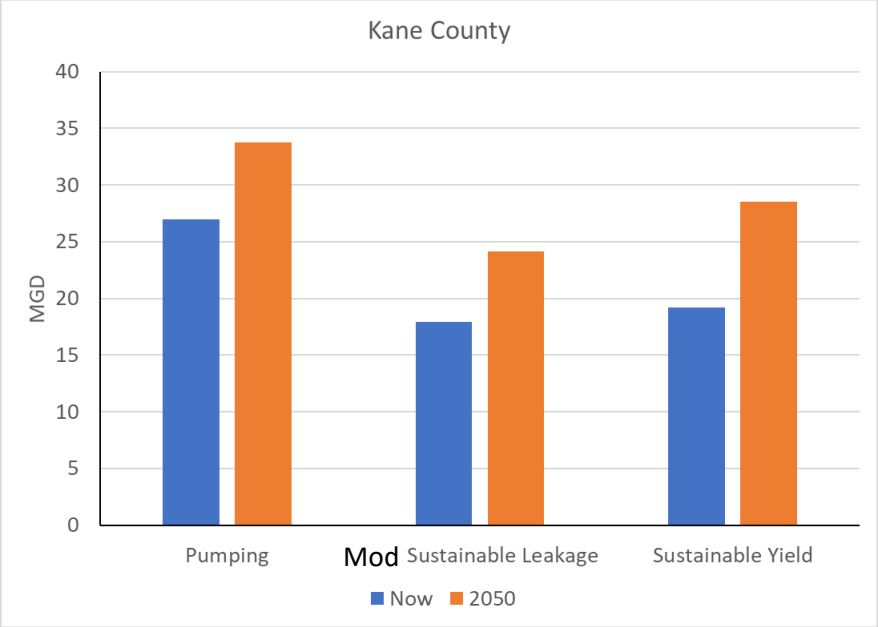

Does not mean that the magnitude of inflow and outflows horizontally is small, just that they offset

Lose Water When Considering Horizontal Flow

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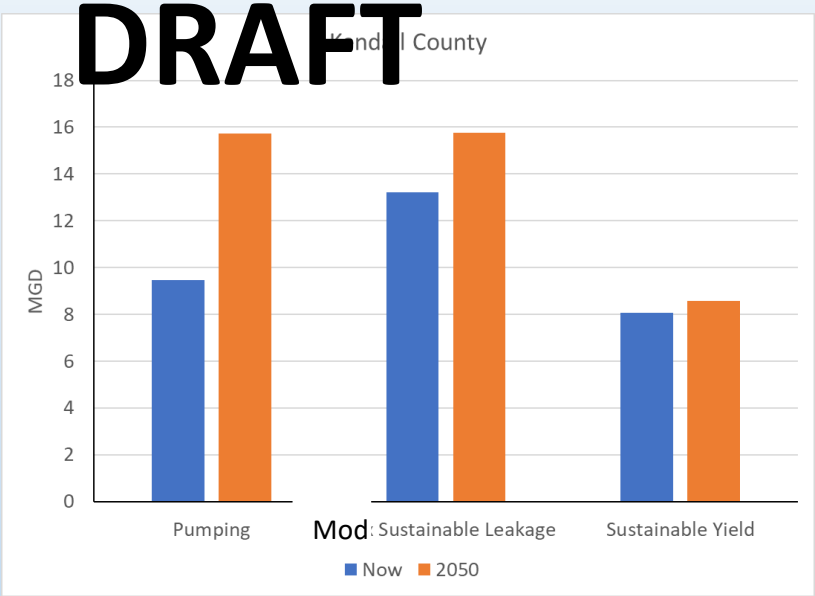

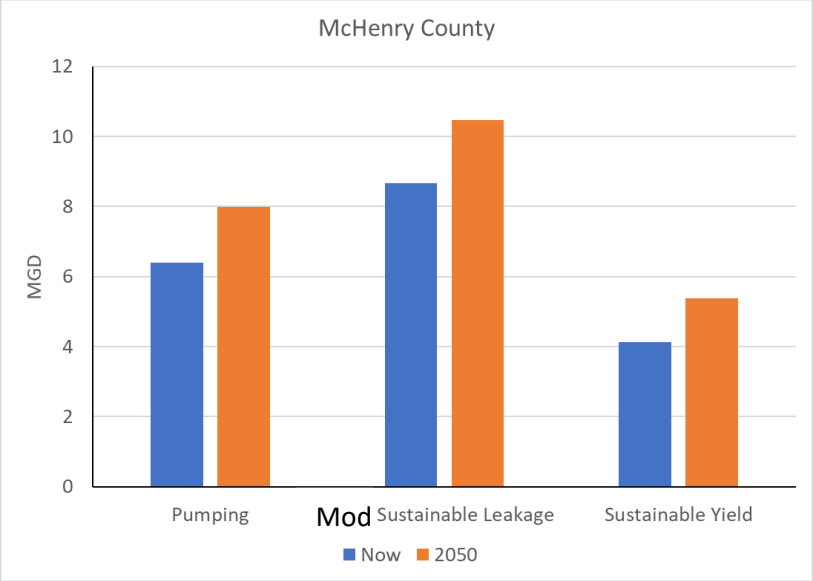

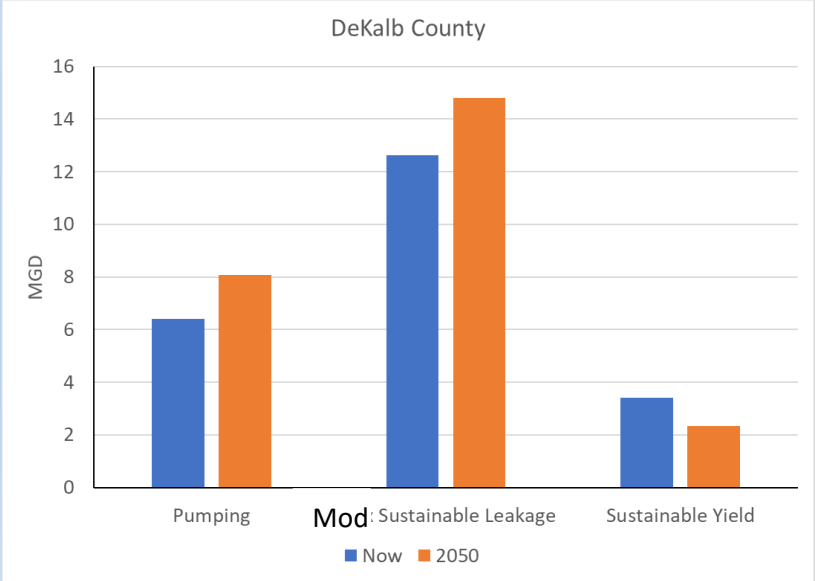

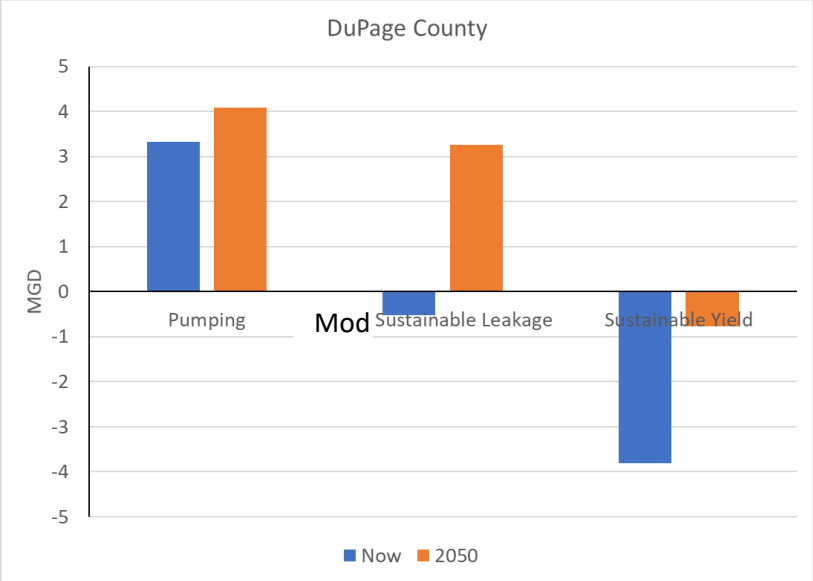

Outflow <<< Inflow

Survey

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How to Quantify Shallow Aquifer Resources

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a) **<u>Reductions in Natural Groundwater Discharge:</u>** this is a simple mass balance assessment of sustainability that has regional applicability. This is the planned Tier 1 analysis.
b) Drawdown: some shallow aquifers, like the sandstone, are unsustainably pumped and can become at-risk. Local geology is key, as are local data. This will be a Tier 2 investigation, but local feedback will be needed.
c) Water Quality: there are a lot of questions to consider here. Treatment costs, regulations on discharge of wastewater, and changing land use. Not a Tier 1 analysis.

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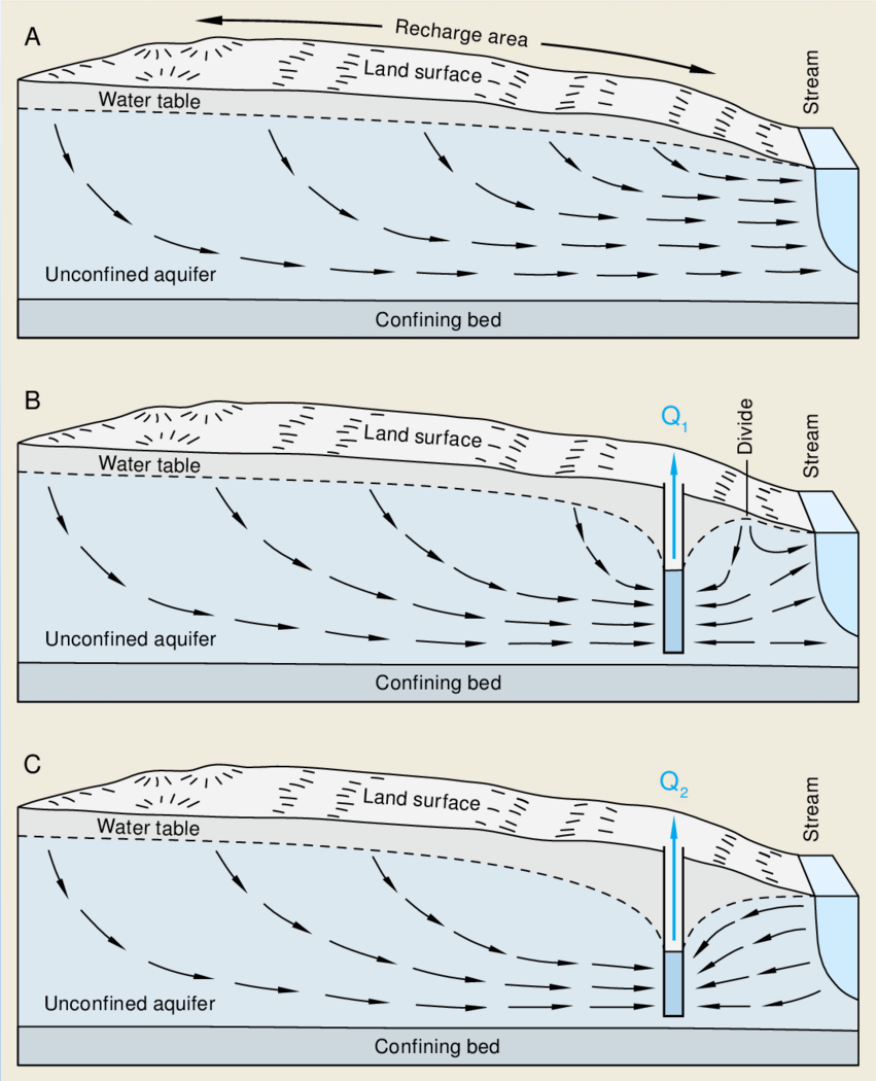
How do we calculate shallow supply?

1. Pumping that could result in a XX% reduction in natural groundwater discharge to a stream (averaged over a county)
2. For the Tier 1 analysis, this is assumed to be total pumping equal to XX% of the predevelopment flow



Reid et al. 2009. Catalogue of conceptual models for groundwater–stream interaction in eastern Australia

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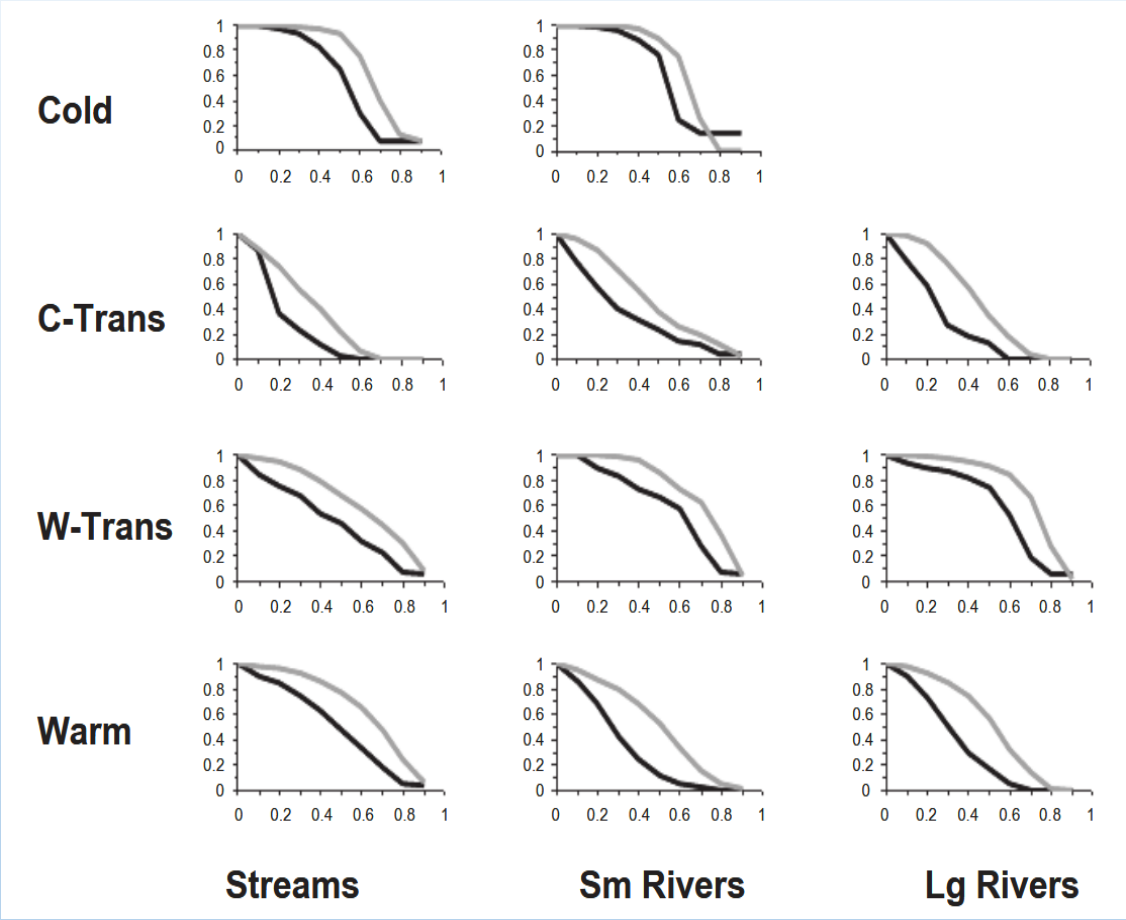
What % to use?

Zorn et al (2012) remains the most relevant study I have found looking at the impact of reduced natural groundwater discharge on fish communities.

10% is a conservative estimate without additional studies, but a reasonable case could be made for 20%.



10%, large rivers only

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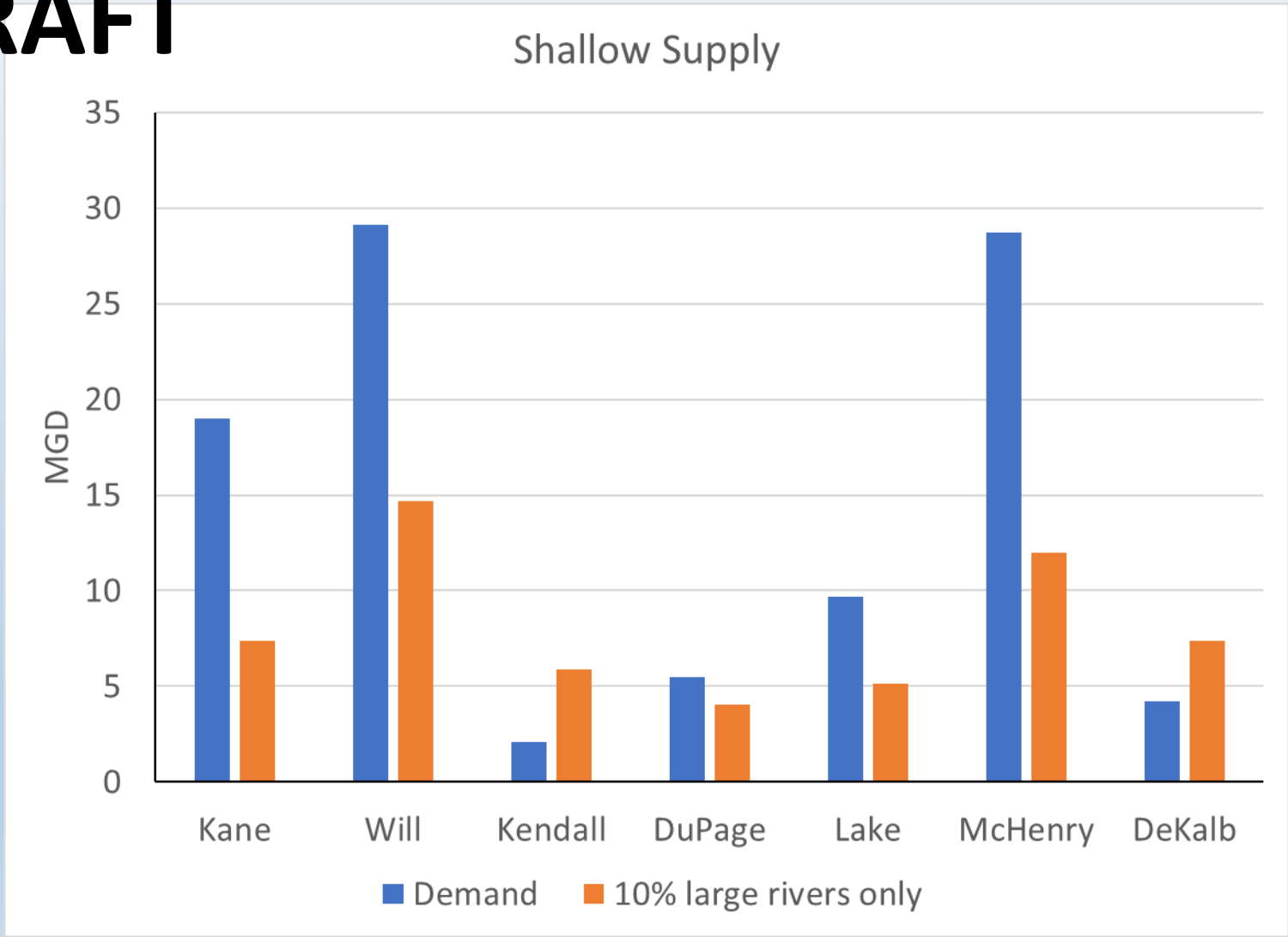
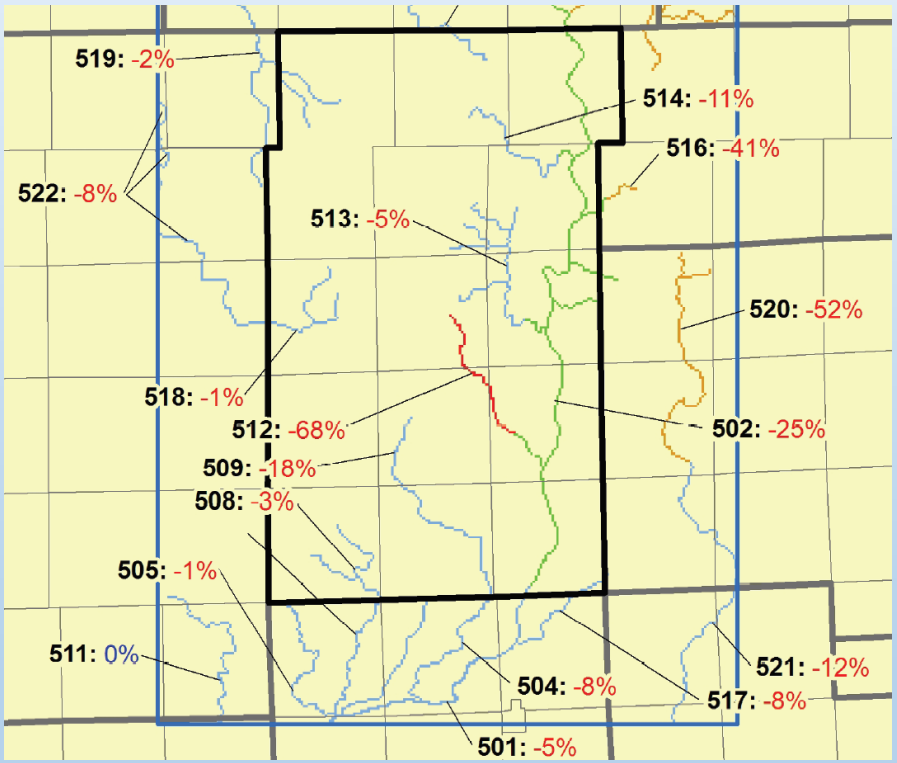


Important things to note



Advantage: Even if a 10% reduction is overly conservative, some local streams may have an exceedance of 10% reductions in natural groundwater discharge (reductions will not be distributed evenly)

Disadvantage: Groundwater discharging to smaller streams is unaccounted for

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10%, large and small rivers

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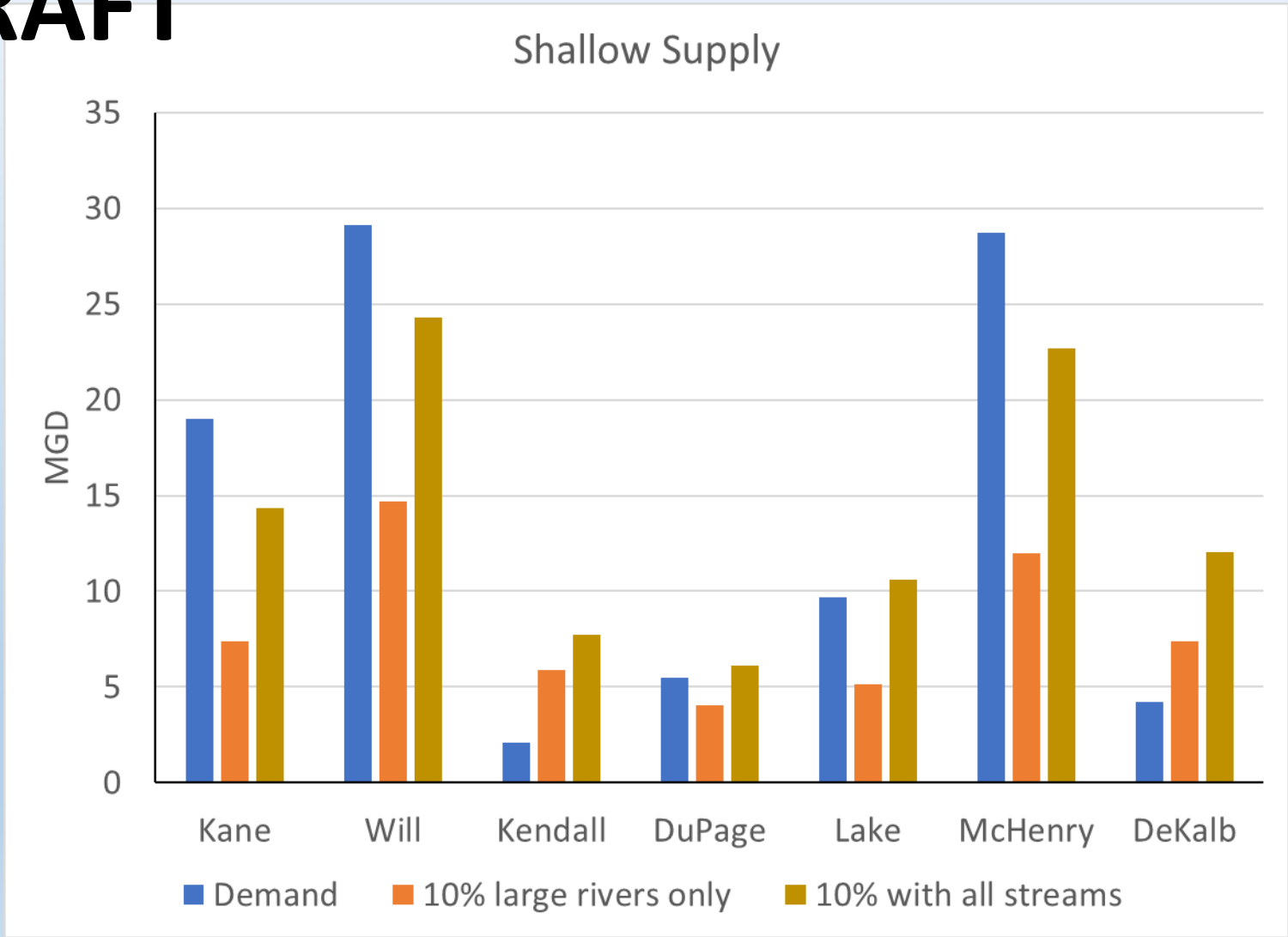

Important things to note

- Small rivers are simulated in the model as much too coarse (model cells are 2500 ft on a side)
- Small rivers are simulated as drain cells, which are also used to represent paved areas
  - Water added to a drain cell that does not enter an aquifer is still added to the mass balance and is not easily separated
  - In other words, drain cells over-exaggerate the water available in a system

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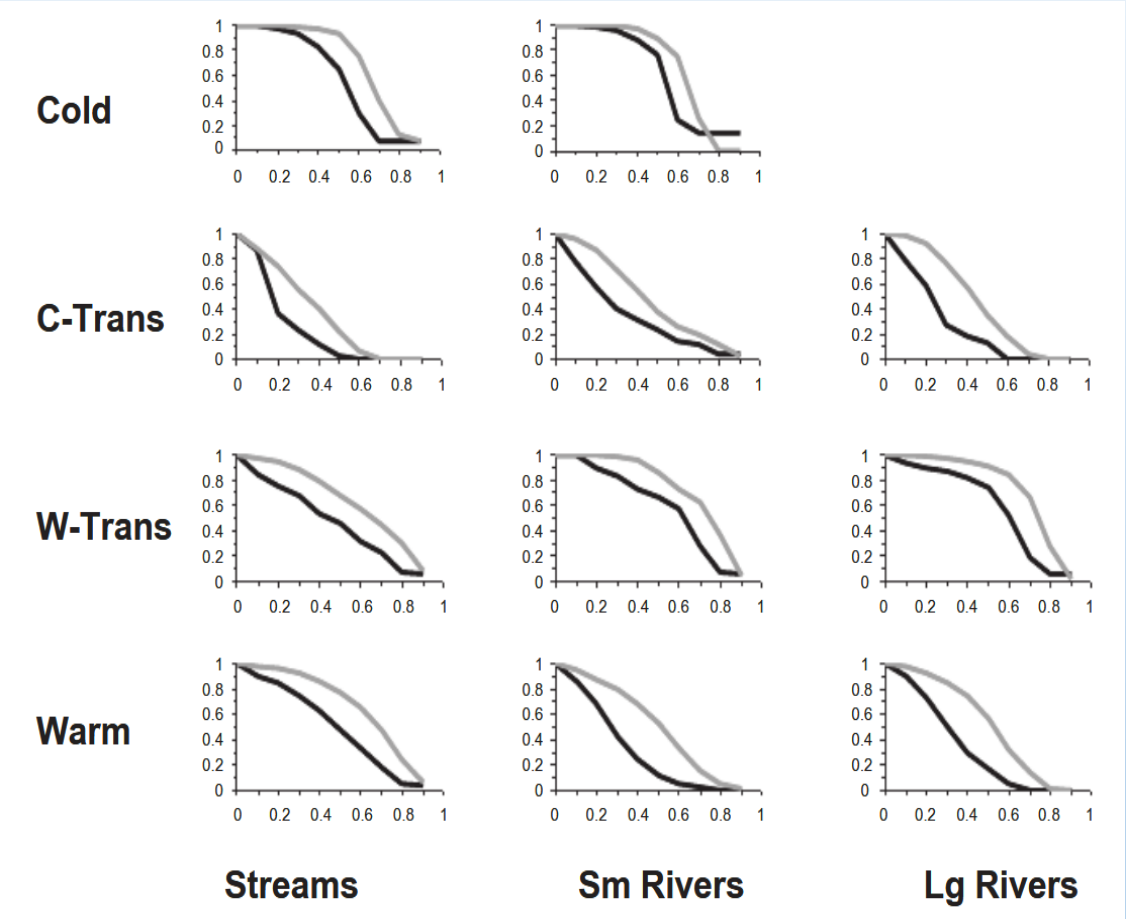
Is 10% too conservative? Perhaps

Streams are highly variable, and the impacts differ per type of stream

The Zorn study does not consider anthropogenically influenced streams, only natural streams

A reasonable argument has been made by many people that 20% is a better value to use



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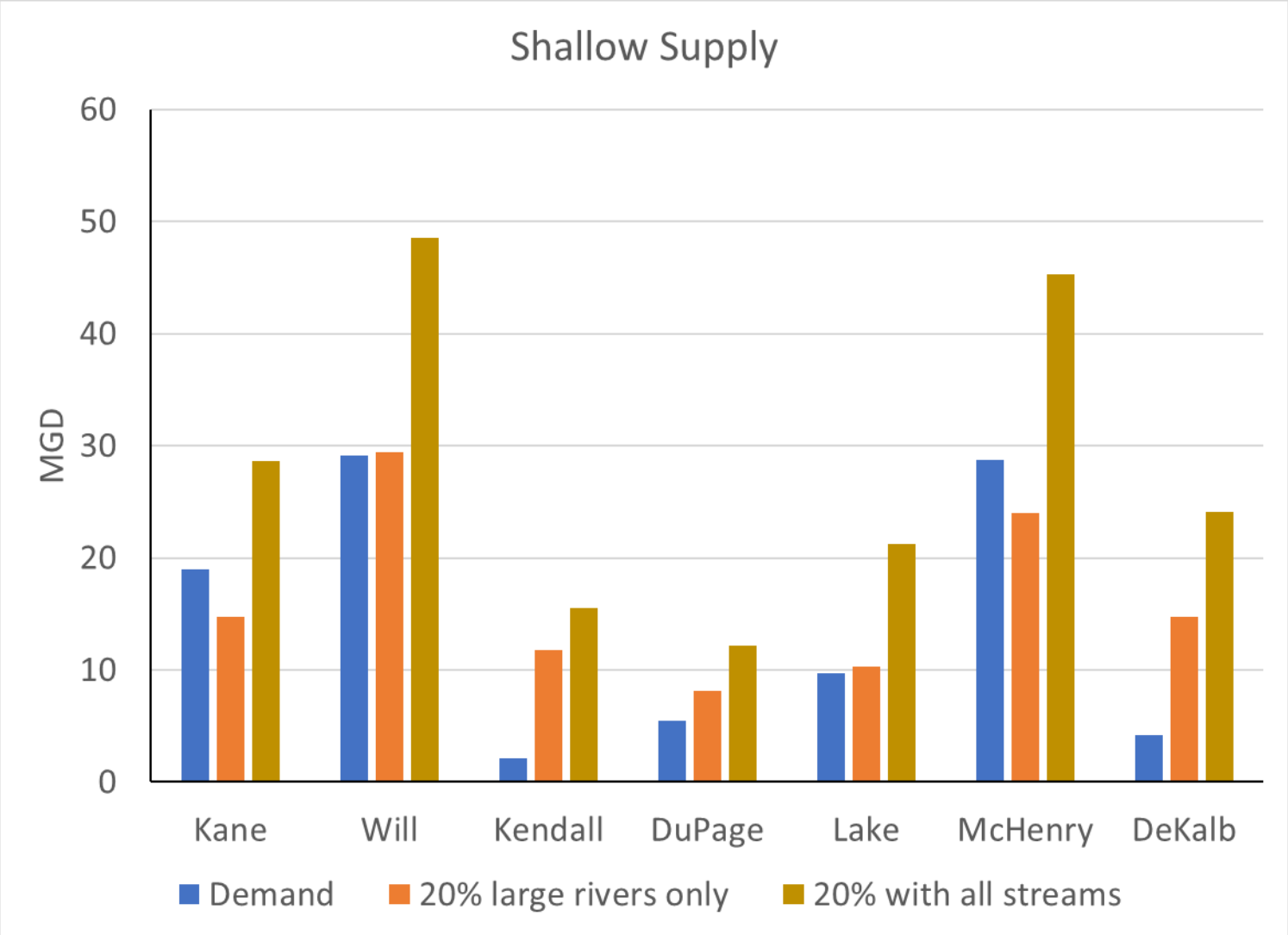
20%


Shallow Supply
MGD
60
50
40
30
20
10
0
Kane
Will
Kendall
DuPage
Lake
McHenry
DeKalb
Demand
20% large rivers only
20% with all streams

Discussion **DRAFT**

- Let's decide on one version
  - 10% only considering large rivers; the most conservative solution
  - 10% considering large and small rivers; conservative ecologically but not conservative in terms of calculating groundwater discharging to streams
  - 20% only considering large rivers; not conservative ecologically but conservative in terms of calculating groundwater discharging to streams
  - 20% considering large and small rivers; this solution is not conservative but may be appropriate given the anthropogenic modifications of the streams

- Abrams Opinion: Ecology is not my field of expertise, but I would be more conservative: using the less conservative groundwater solution paired with a more conservative ecological solution or vice versa. As a modeler, I will always lean to the more conservative solution, though. Other scientists will have varying opinions on how to handle this.

- As with all things, Tier 2 and 3 analyses will improve on these estimates with local data

Survey

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