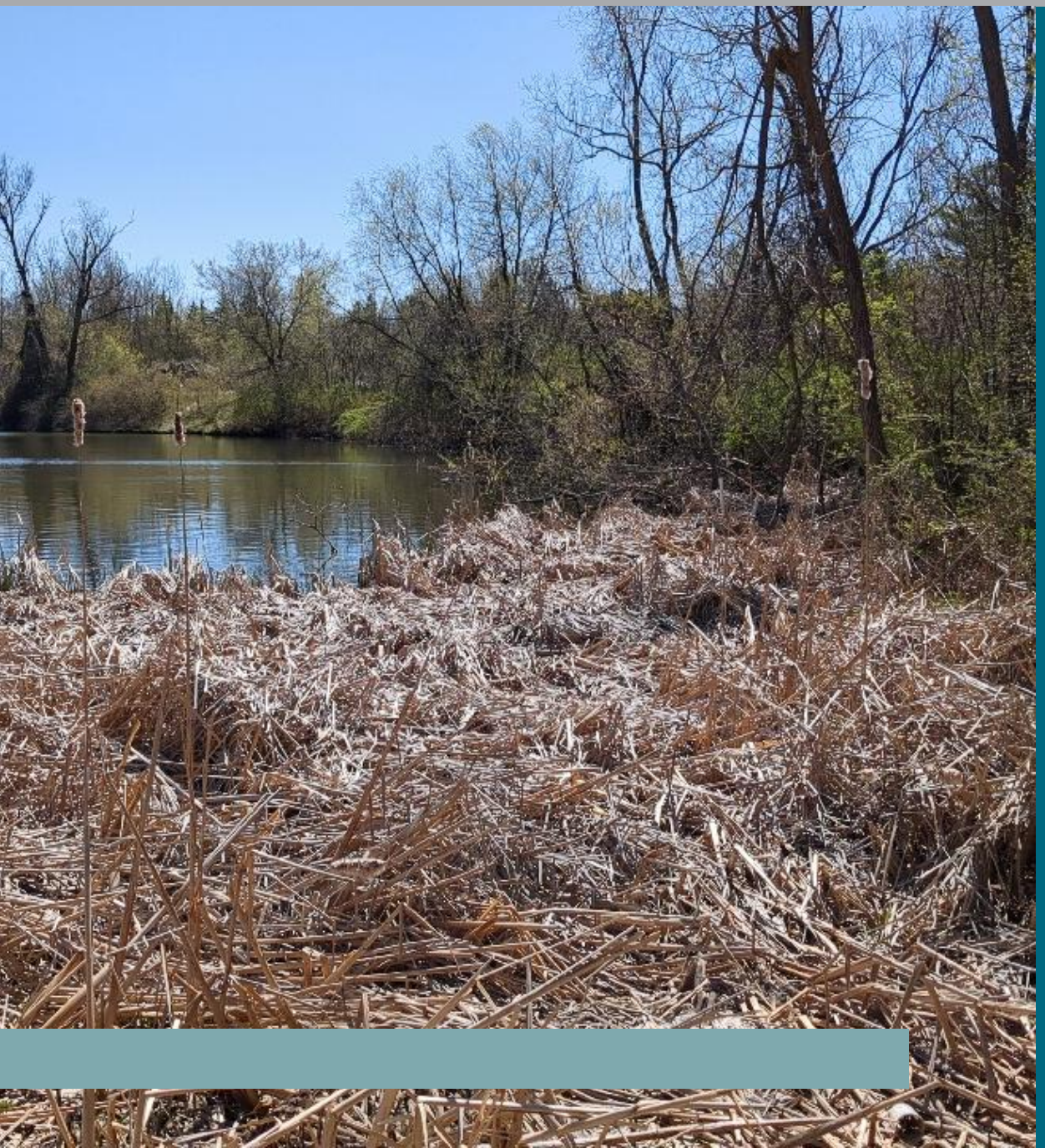
Wetlands and Water Tables

Ecological and Hydrogeological Considerations for New or Expanded Mining Below the Water Table

fishbeck

Engineers | Architects | Scientists | Constructors



What?

- Wetland screening and awareness
- Hydrogeologic relationship of those wetlands to your lake excavation and implications for your success.

So What?

Southern Hardwood Swamp

So What?

- Wetlands are primary drivers for lake creation permitting

Southern Hardwood Swamp

So What?

- Wetlands are primary drivers for lake creation permitting

- Permits DENIED for mining below the water table!

So What?

- Permits DENIED for mining below the water table!
- Wetlands are primary drivers for lake creation permitting
- Valuable aggregate resources remain in the ground. ($$$)

Water level monitoring adjacent to lake excavation

Now What?

There are things we can do…

Water level monitoring adjacent to lake excavation

Now What?

There are things we can do…

- Demonstrate No Impact Is Likely

Water level monitoring adjacent to lake excavation

Now What?

There are things we can do…

- Demonstrate No Impact Likely
- Ways to Avoid/Minimize impacts, especially to wetlands

Kenny McMahon

- Wetland Scientist
- Biologist

Regulations have their place

Pop Quiz: What is a wetland?

Typical identifiers

Some of what I look for

- Muck soils
- Water lines
- Water stains
- Vernal pools

Sparsely vegetated concave surface

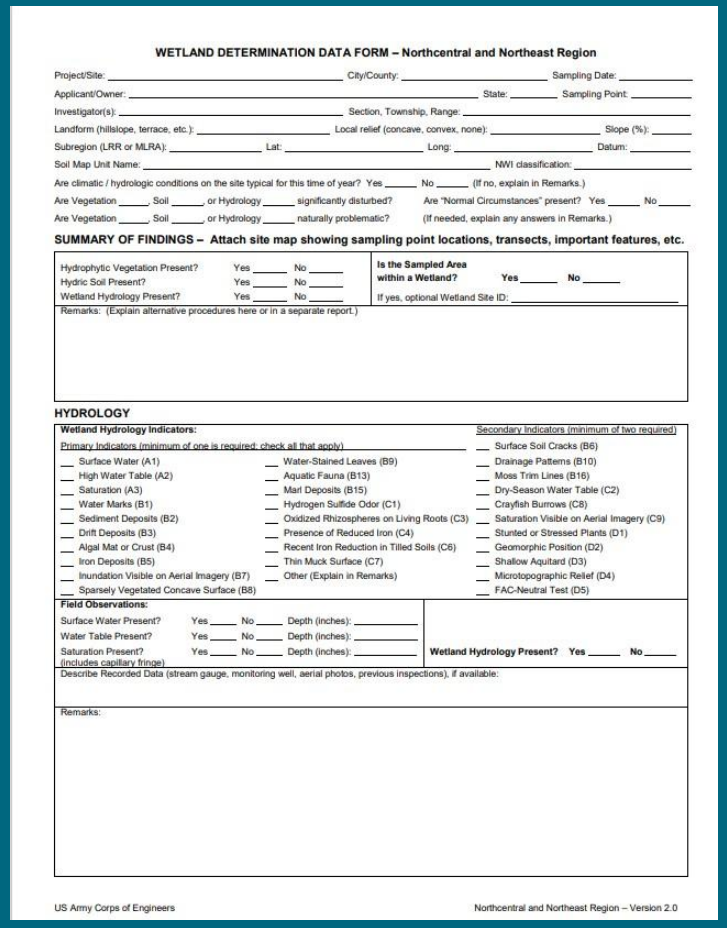
Waterlines on trees

Muck soils

Water stained leaves

Three wetland types and implications

Wetland Determination Data Form



WETLAND DETERMINATION DATA FORM – Northcentral and Northeast Region

Project/Site: _____ City/County: _____ Sampling Date: _____

Applicant/Owner: _____ State: _____ Sampling Point: _____

Investigator(s): _____ Section, Township, Range: _____

Landform (hillslope, terrace, etc.): _____ Local relief (concave, convex, none): _____ Slope (%): _____

Subregion (LRR or MLRA): _____ Lat: _____ Long: _____ Datum: _____

Soil Map Unit Name: _____ NWI classification: _____

Are climatic / hydrologic conditions on the site typical for this time of year? Yes _____ No _____ (If no, explain in Remarks.)

Are Vegetation _____, Soil _____, or Hydrology _____ significantly disturbed? Are "Normal Circumstances" present? Yes _____ No _____

Are Vegetation _____, Soil _____, or Hydrology _____ naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes _____ No _____

Hydric Soil Present? Yes _____ No _____

Wetland Hydrology Present? Yes _____ No _____

Is the Sampled Area within a Wetland? Yes _____ No _____

If yes, optional Wetland Site ID: _____

Remarks: (Explain alternative procedures here or in a separate report.)

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- ___ Surface Water (A1)
- ___ High Water Table (A2)
- ___ Saturation (A3)
- ___ Water Marks (B1)
- ___ Sediment Deposits (B2)
- ___ Drift Deposits (B3)
- ___ Algal Mat or Crust (B4)
- ___ Iron Deposits (B5)
- ___ Inundation Visible on Aerial Imagery (B7)
- ___ Sparsely Vegetated Concave Surface (B8)
- ___ Water-Stained Leaves (B9)
- ___ Aquatic Fauna (B13)
- ___ Marl Deposits (B15)
- ___ Hydrogen Sulfide Odor (C1)
- ___ Oxidized Rhizospheres on Living Roots (C3)
- ___ Presence of Reduced Iron (C4)
- ___ Recent Iron Reduction in Tilled Soils (C6)
- ___ Thin Muck Surface (C7)
- ___ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ___ Surface Soil Cracks (B6)
- ___ Drainage Patterns (B10)
- ___ Moss Trim Lines (B16)
- ___ Dry-Season Water Table (C2)
- ___ Crayfish Burrows (C8)
- ___ Saturation Visible on Aerial Imagery (C9)
- ___ Stunted or Stressed Plants (D1)
- ___ Geomorphic Position (D2)
- ___ Shallow Aquitard (D3)
- ___ Microtopographic Relief (D4)
- ___ FAC-Neutral Test (D5)

Field Observations:

Surface Water Present? Yes _____ No _____ Depth (inches): _____

Water Table Present? Yes _____ No _____ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes _____ No _____ Depth (inches): _____

Wetland Hydrology Present? Yes _____ No _____

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

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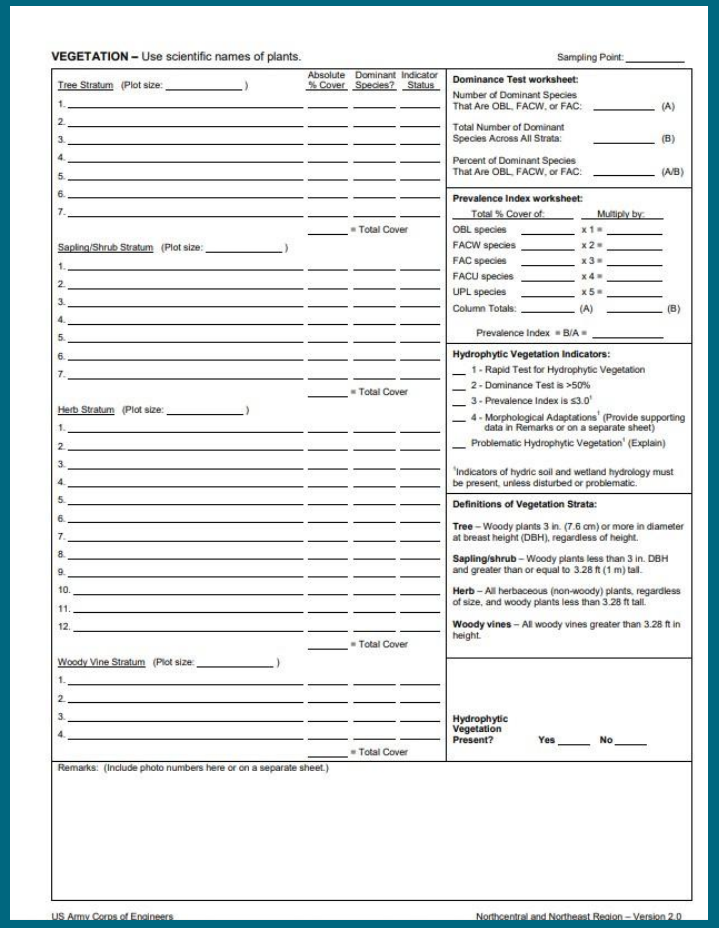

VEGETATION – Use scientific names of plants. Sampling Point: _____

Tree Stratum (Plot size: _____)	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
	= Total Cover		
Herb Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
	= Total Cover		
Woody Vine Stratum (Plot size: _____)			
1.			
2.			
3.			
4.			
	= Total Cover		

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: _____ (A)

Total Number of Dominant Species Across All Strata: _____ (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: _____ (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species	x 1 =
FACW species	x 2 =
FAC species	x 3 =
FACU species	x 4 =
UPL species	x 5 =
Column Totals: (A)	(B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

- ___ 1 - Rapid Test for Hydrophytic Vegetation
- ___ 2 - Dominance Test is >50%
- ___ 3 - Prevalence Index is ≤3.0[1]
- ___ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ___ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Vegetation Strata:

Tree – Woody plants 3 in. (7.6 cm) or more in diameter at breast height (DBH), regardless of height.

Sapling/shrub – Woody plants less than 3 in. DBH and greater than or equal to 3.28 ft (1 m) tall.

Herb – All herbaceous (non-woody) plants, regardless of size, and woody plants less than 3.28 ft tall.

Woody vines – All woody vines greater than 3.28 ft in height.

Hydrophytic Vegetation Present? Yes _____ No _____

Remarks: (Include photo numbers here or on a separate sheet.)

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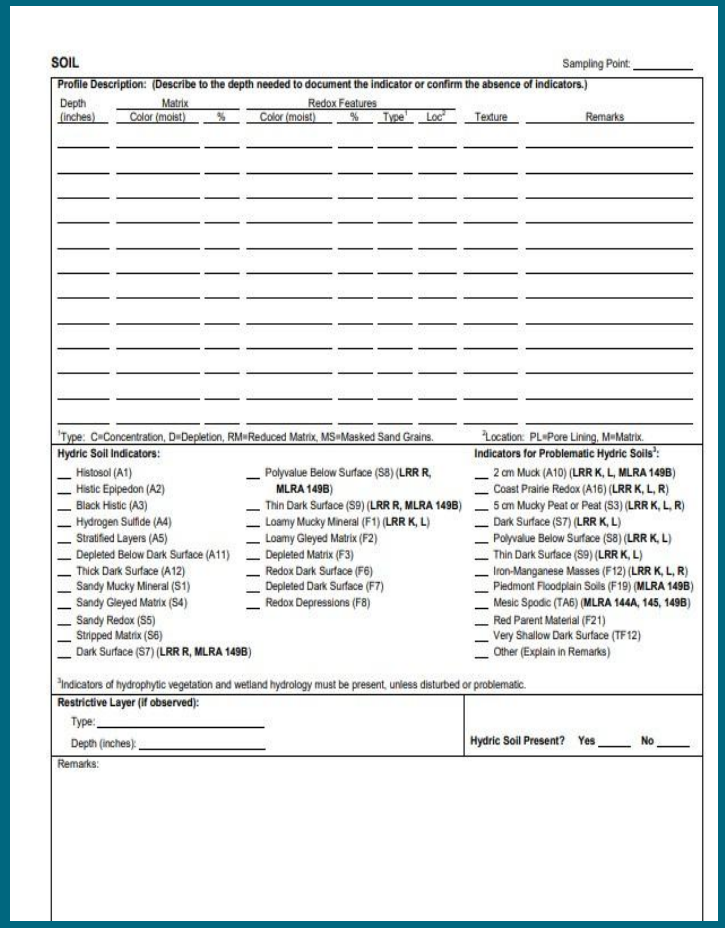


SOIL Sampling Point: _____

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators:

- ___ Histosol (A1)
- ___ Histic Epipedon (A2)
- ___ Black Histic (A3)
- ___ Hydrogen Sulfide (A4)
- ___ Stratified Layers (A5)
- ___ Depleted Below Dark Surface (A11)
- ___ Thick Dark Surface (A12)
- ___ Sandy Mucky Mineral (S1)
- ___ Sandy Gleyed Matrix (S4)
- ___ Sandy Redox (S5)
- ___ Stripped Matrix (S6)
- ___ Dark Surface (S7) (**LRR R, MLRA 149B**)
- ___ Polyvalue Below Surface (S8) (**LRR R, MLRA 149B**)
- ___ Thin Dark Surface (S9) (**LRR R, MLRA 149B**)
- ___ Loamy Mucky Mineral (F1) (**LRR K, L**)
- ___ Loamy Gleyed Matrix (F2)
- ___ Depleted Matrix (F3)
- ___ Redox Dark Surface (F6)
- ___ Depleted Dark Surface (F7)
- ___ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ___ 2 cm Muck (A10) (**LRR K, L, MLRA 149B**)
- ___ Coast Prairie Redox (A16) (**LRR K, L, R**)
- ___ 5 cm Mucky Peat or Peat (S3) (**LRR K, L, R**)
- ___ Dark Surface (S7) (**LRR K, L**)
- ___ Polyvalue Below Surface (S8) (**LRR K, L**)
- ___ Thin Dark Surface (S9) (**LRR K, L**)
- ___ Iron-Manganese Masses (F12) (**LRR K, L, R**)
- ___ Piedmont Floodplain Soils (F19) (**MLRA 149B**)
- ___ Mesic Spodic (TA6) (**MLRA 144A, 145, 149B**)
- ___ Red Parent Material (F21)
- ___ Very Shallow Dark Surface (TF12)
- ___ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes _____ No _____

Remarks:

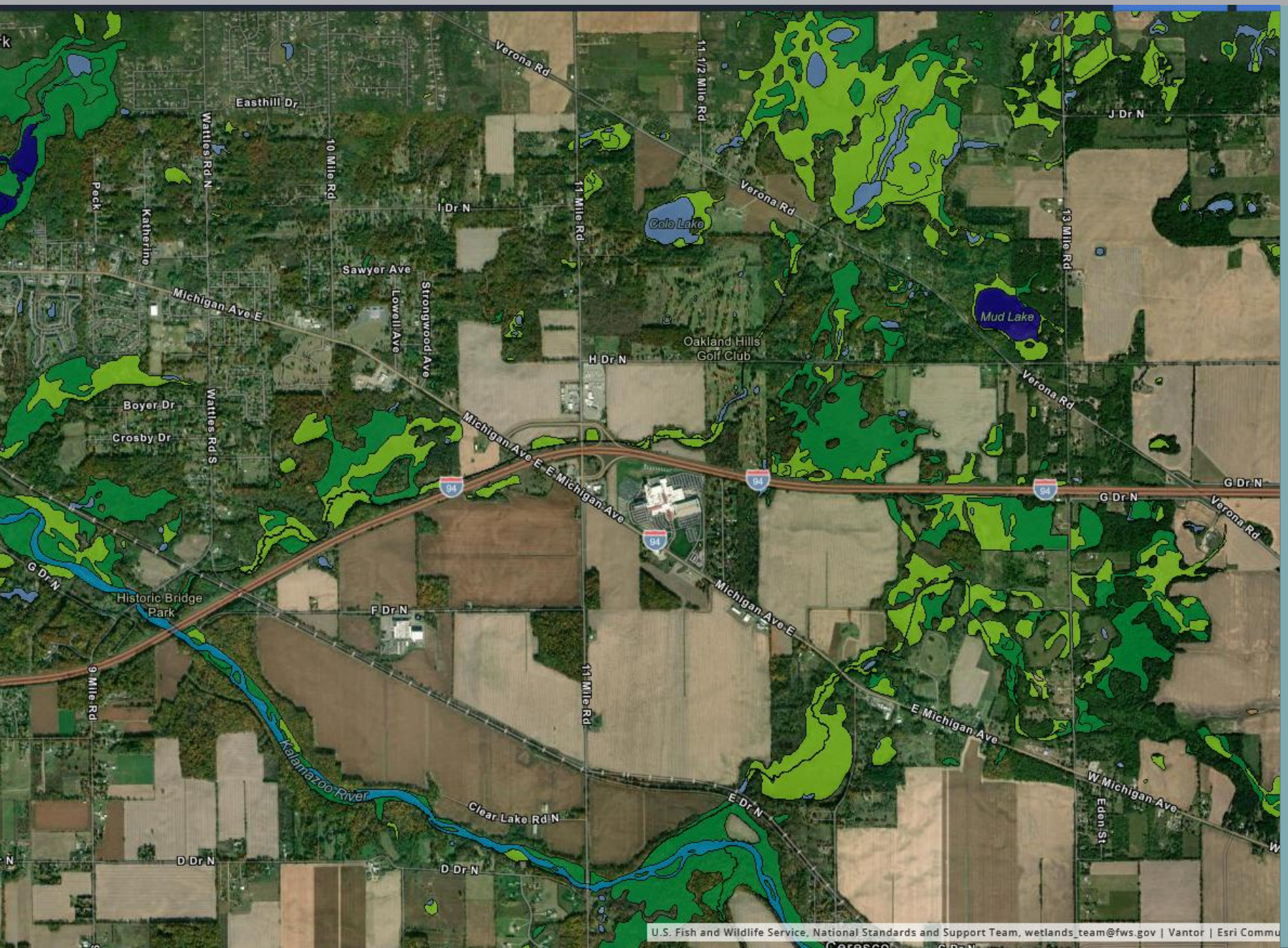
Good news and bad news

BAD NEWS:

Wetlands are defined by regulatory criteria

GOOD NEWS:

I'm here to make your life easier



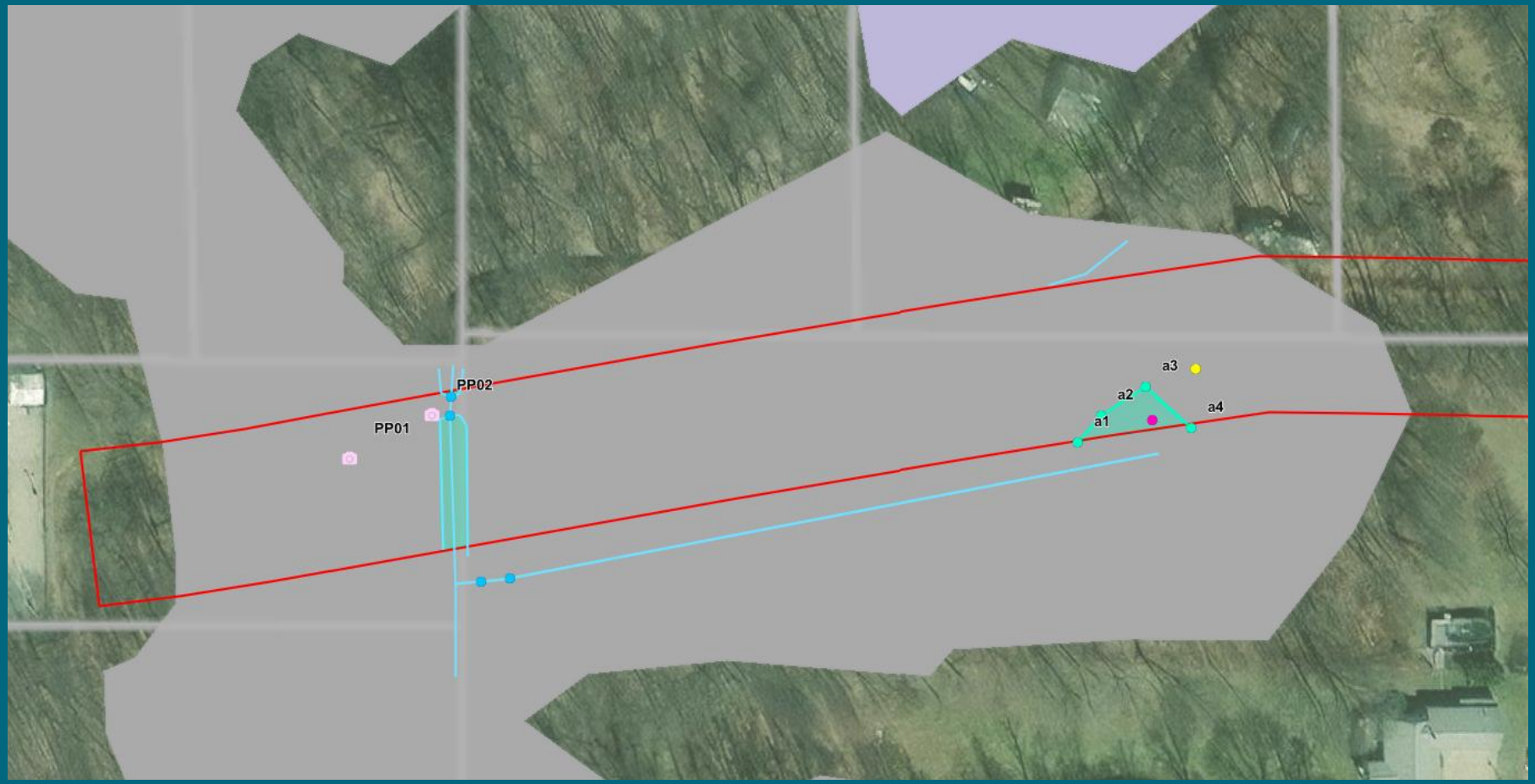
NWI

Always a first step

Only a first step

Different than a wetland

Larger than a wetland



Even if a drain connects to a lake…

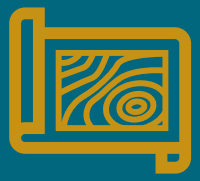
So, what can EGLE regulate?

When is a permit needed?

- Within 500 feet of a regulating feature
- If hydrologically connected to a regulating feature
- Within 500ft of a regulating feature.

Groundwater Dependent?

- Some wetlands get their water from rain and runoff.



- Others get water from the ground.

Questions?

fishbeck
Engineers | Architects | Scientists | Constructors

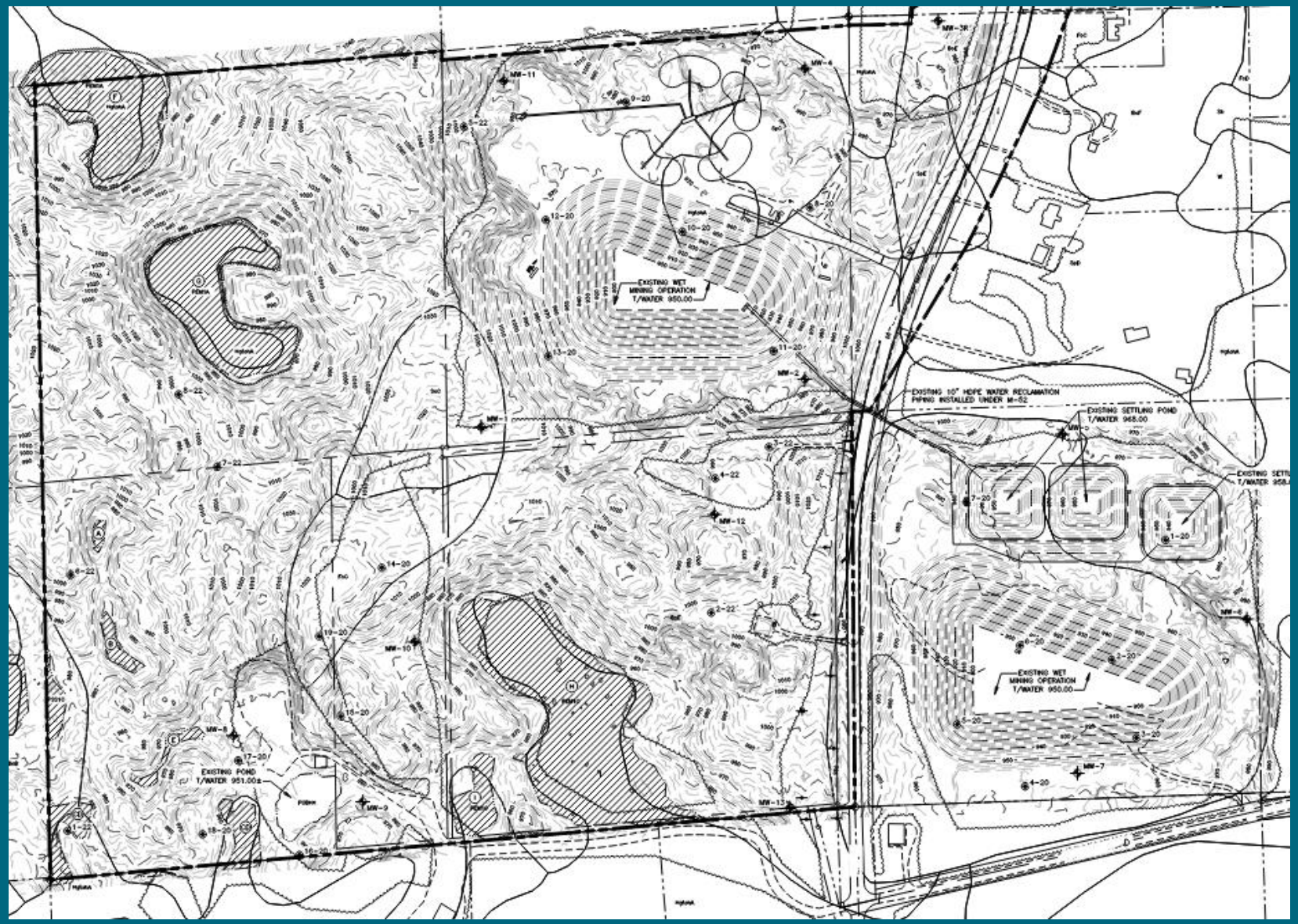
Bruce Gillett, CPG

Senior Hydrogeologist

Wetland?

The Hydrogeology of Lake Creation

A. Regulatory and Environmental Concerns
B. Hydrogeology and Water Level Changes – What Happens?
C. Mitigating Factors/Options



Mining and Reclamation Plans

Regulatory and Environmental Concerns

- Special Use Permits
- Part 301 – Inland Lakes & Streams
- Part 303 – Wetlands

Regulatory and Environmental Concerns

- Special Use Permits
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Regulatory and Environmental Concerns

- Special Use Permits
- Part 301 – Inland Lakes & Streams
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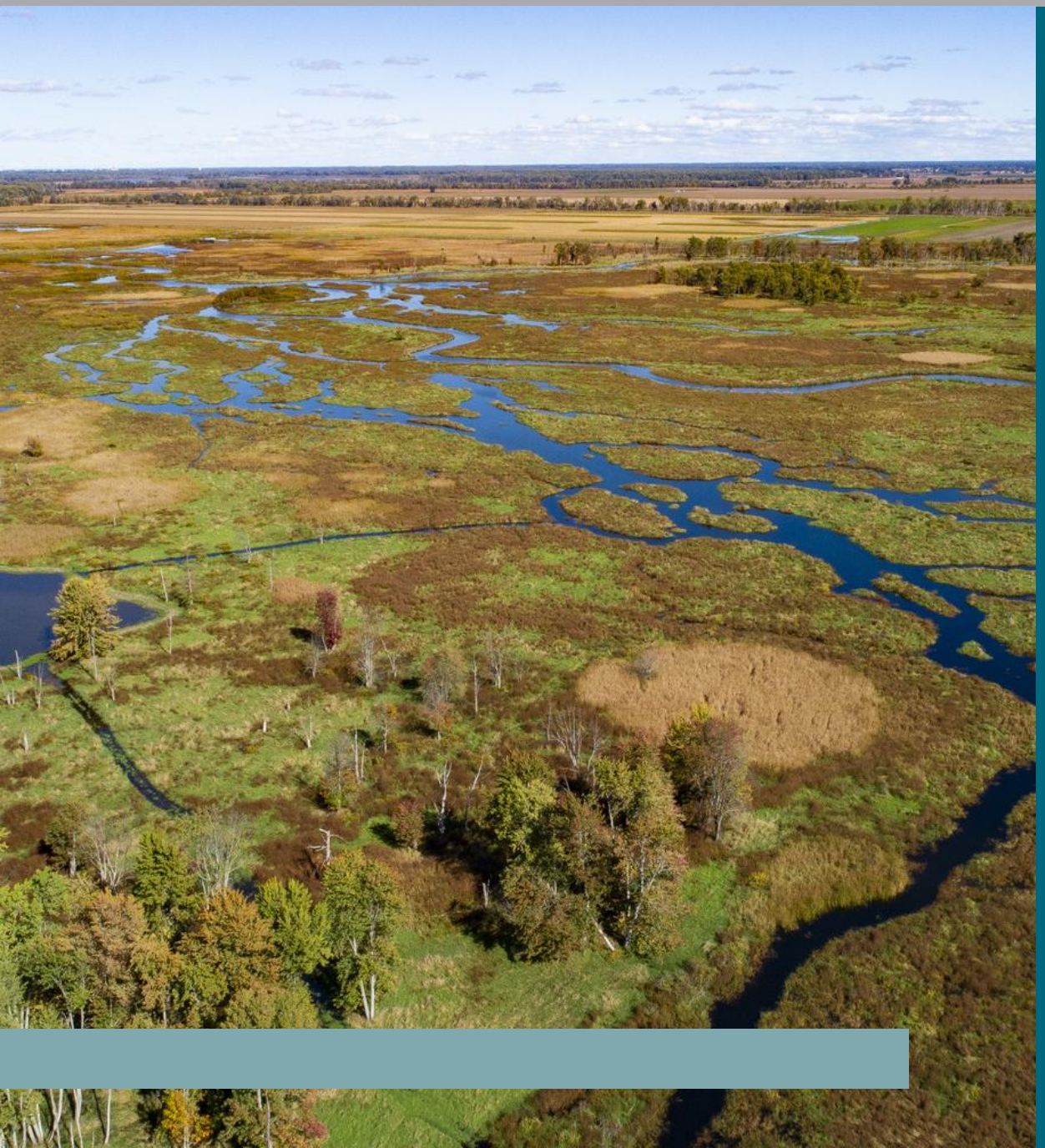
Regulatory and Environmental Concerns

- Special Use Permits
- Part 301 – Inland Lakes & Streams
- Part 303 – Wetlands
- Other:
  - Part 327 Large Quantity Water Withdrawal
  - Part 22 – Groundwater Discharge or NPDES permit
  - Part 31 – Floodplains
  - Air/Stormwater/SESC

Regulatory and Environmental Concerns

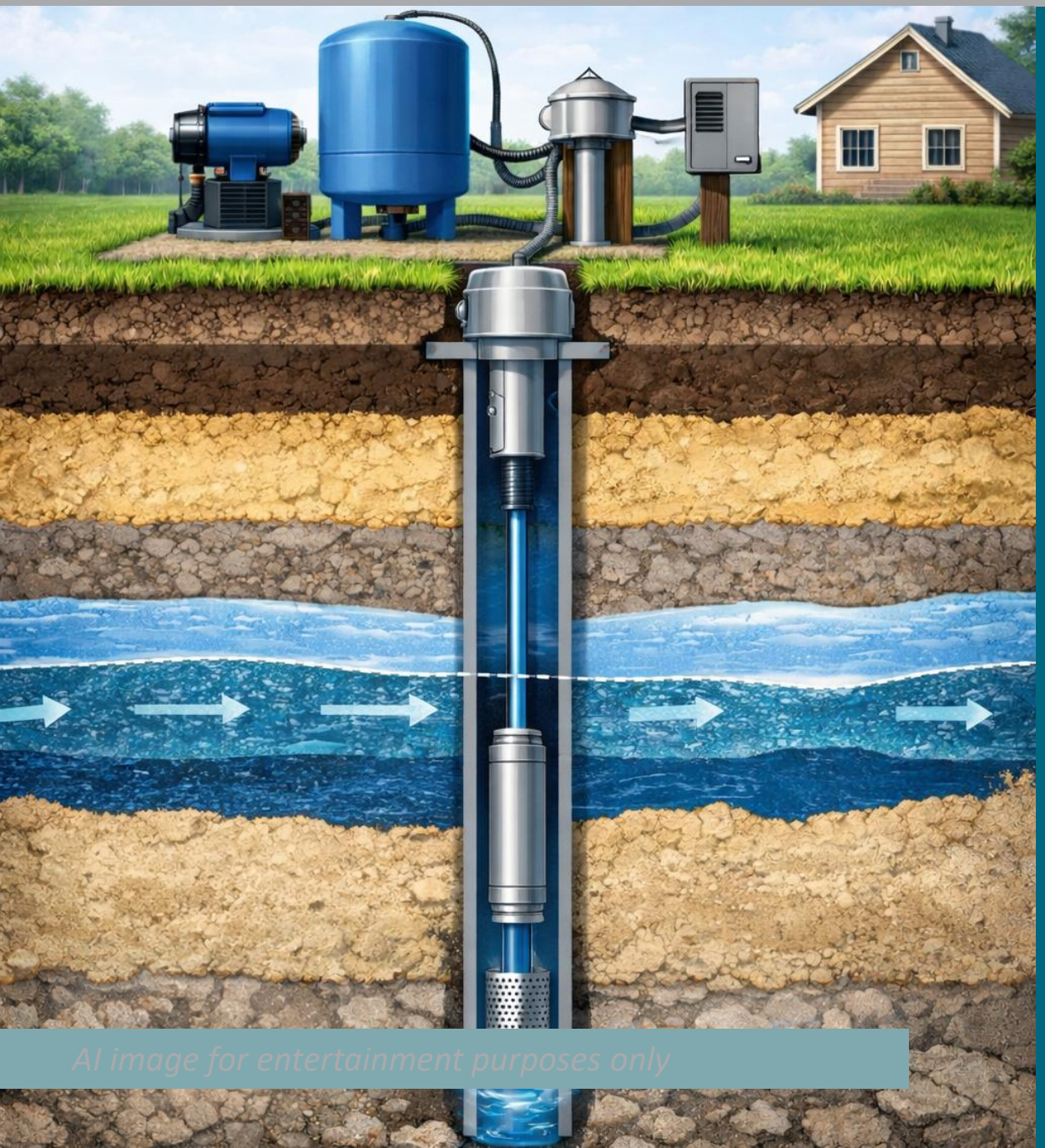
- Special Use Permits
- Part 301 – Inland Lakes & Streams
- Part 303 – Wetlands
- Other:
  - Part 31 – Floodplains
  - Part 22 – Groundwater Discharge
  - Part 327 Large Quantity Water Withdrawal
  - Air/Stormwater/SESC



Regulatory and Environmental Concerns

Drivers Behind the Regulations:

- Potential adverse impact to wetlands (primary)
- Potential adverse impact to water supply wells



Regulatory and Environmental Concerns

Drivers Behind the Regulations:

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The Hydrogeology of Lake Creation

A. Regulatory and Environmental Concerns

B. Hydrogeology and Water Level Changes – What Happens?

C. Mitigating Factors/Options

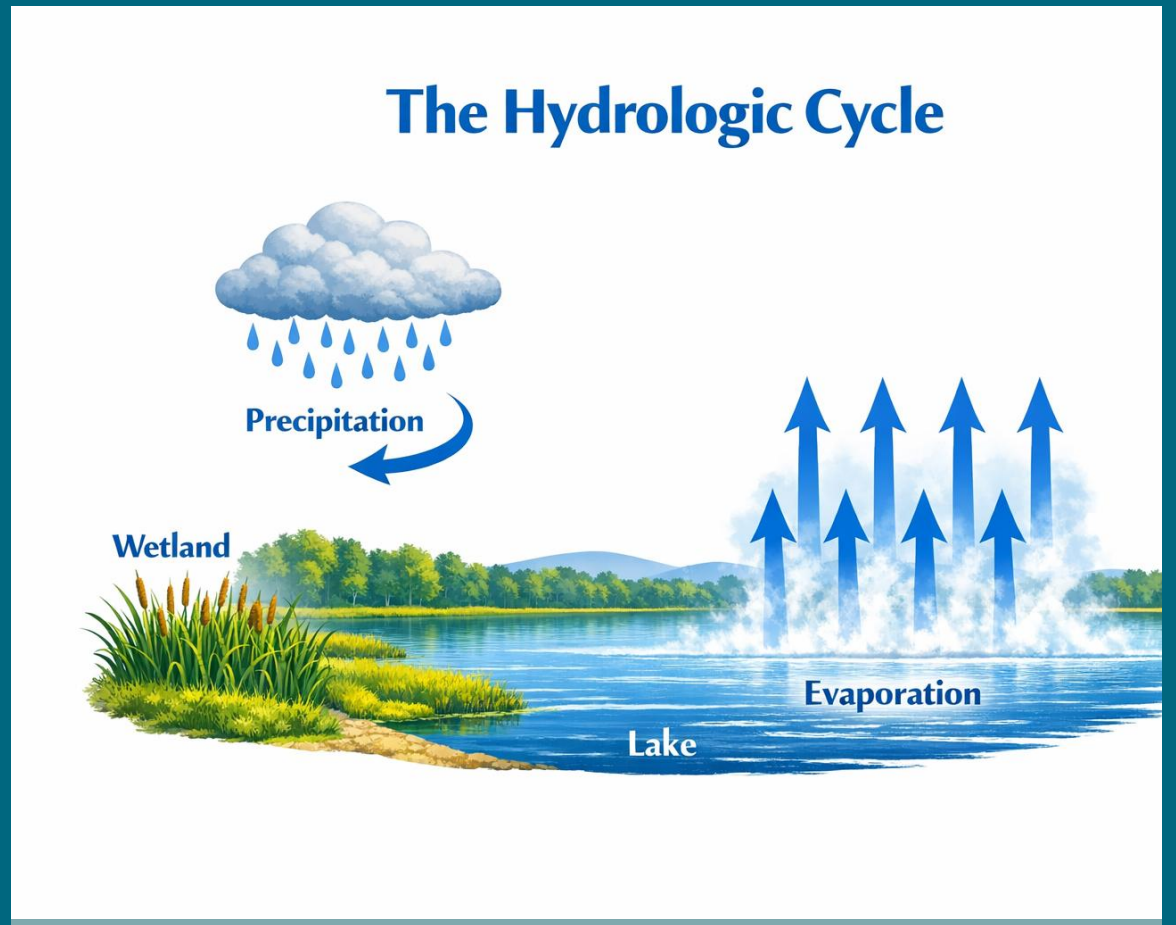
Hydrogeology and Water Level Changes – What Happens?

- Dewatering
- Evaporation from Lake Surface
- Flattening of the Water Table

Hydrologic cycle and water budget

Hydrogeology and Water Level Changes – What Happens?

- Dewatering (often a gravel washing operation)
- Evaporation from Lake Surface
- Flattening of the Water Table



Pump for gravel washing operation

Evaporation from Lake Surface – The Process

Lake Acreage	Pumping Rate (GPM)
5	1.5
20	6.2
50	15.4

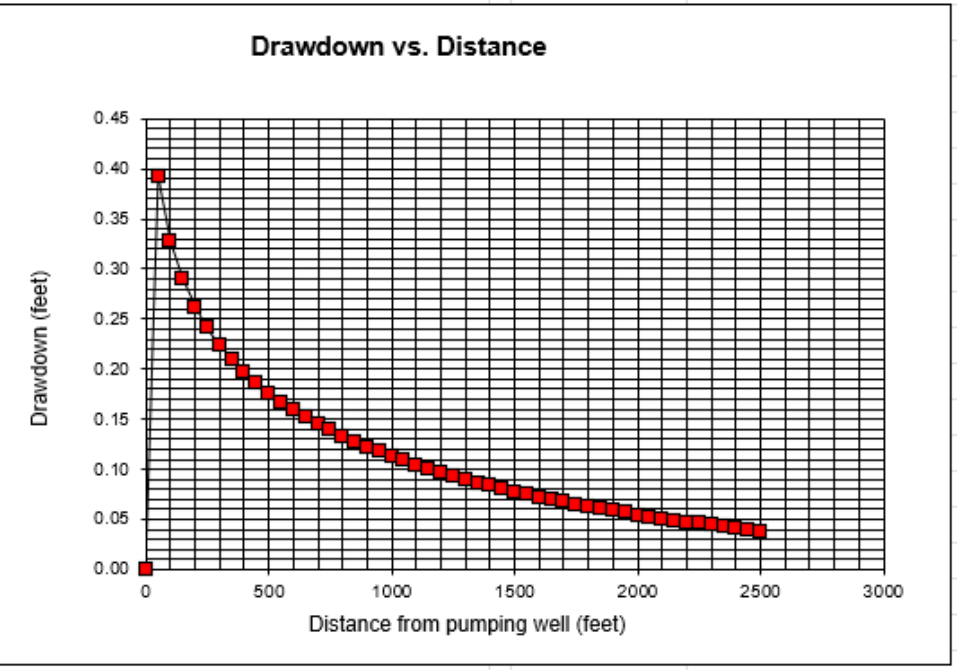
1. Calculate evaporation

Using average values

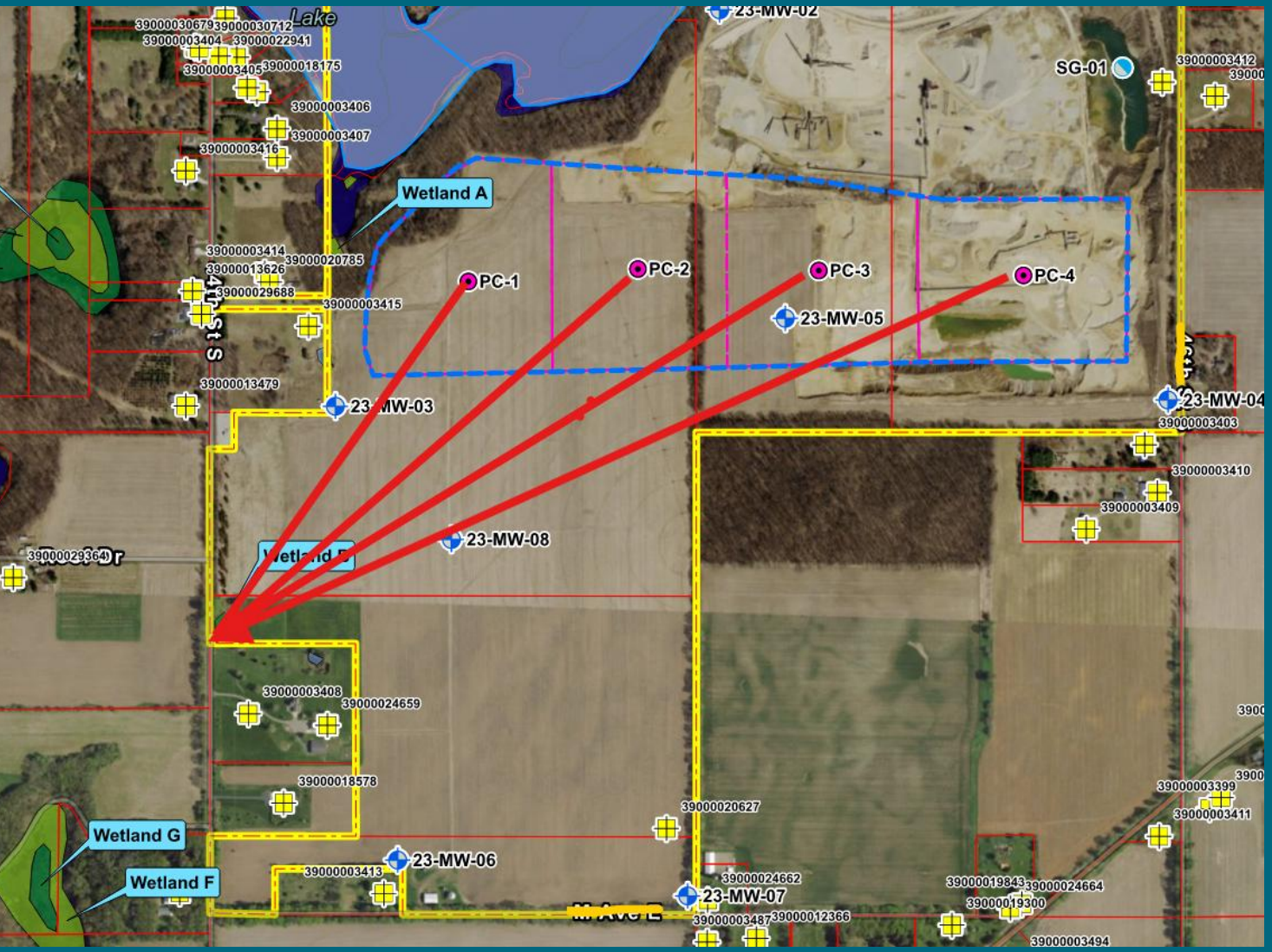
Evaporation from Lake Surface – The Process

1. Calculate evaporation rate.
2. Input pumping rate into a distance-drawdown calculator

			Distance (feet)	u	W(u)	Drawdown (feet)
Transmissivity (ft2/day)	5000.000	(K= 100 ft/d, b= 50 ft)	0			
Storativity	2.000E-01		50	1.4E-04	8.33	0.39
Well pumping rate (gpm)	15.400		100	5.4E-04	6.94	0.33
Time (days)	184.000		150	1.2E-03	6.13	0.29
			200	2.2E-03	5.56	0.26
Distance to calculate drawdown (feet)	3000.000		**250**	**3.4E-03**	**5.11**	**0.24**
Increment to calculate drawdown (feet)	50.000		300	4.9E-03	4.75	0.22
			350	6.7E-03	4.44	0.21
			400	8.7E-03	4.18	0.20
			450	1.1E-02	3.94	0.19
			500	1.4E-02	3.73	0.18
			550	1.6E-02	3.55	0.17
			600	2.0E-02	3.38	0.16
			650	2.3E-02	3.22	0.15
			700	**2.7E-02**	**3.07**	**0.15**
			750	3.1E-02	2.94	0.14
			800	3.5E-02	2.82	0.13
			850	3.9E-02	2.70	0.13
			900	4.4E-02	2.59	0.12
			950	4.9E-02	2.49	0.12
			1000	**5.4E-02**	**2.39**	**0.11**
			1050	6.0E-02	2.30	0.11
			1100	6.6E-02	2.21	0.10
			1150	7.2E-02	2.13	0.10
			1200	7.8E-02	2.05	0.10
			1250	8.5E-02	1.97	0.09
			1300	9.2E-02	1.90	0.09
			1350	9.9E-02	1.83	0.09
			1400	1.1E-01	1.77	0.08
			1450	1.1E-01	1.70	0.08



Using typical average values



Drawdown at wetlands and wells

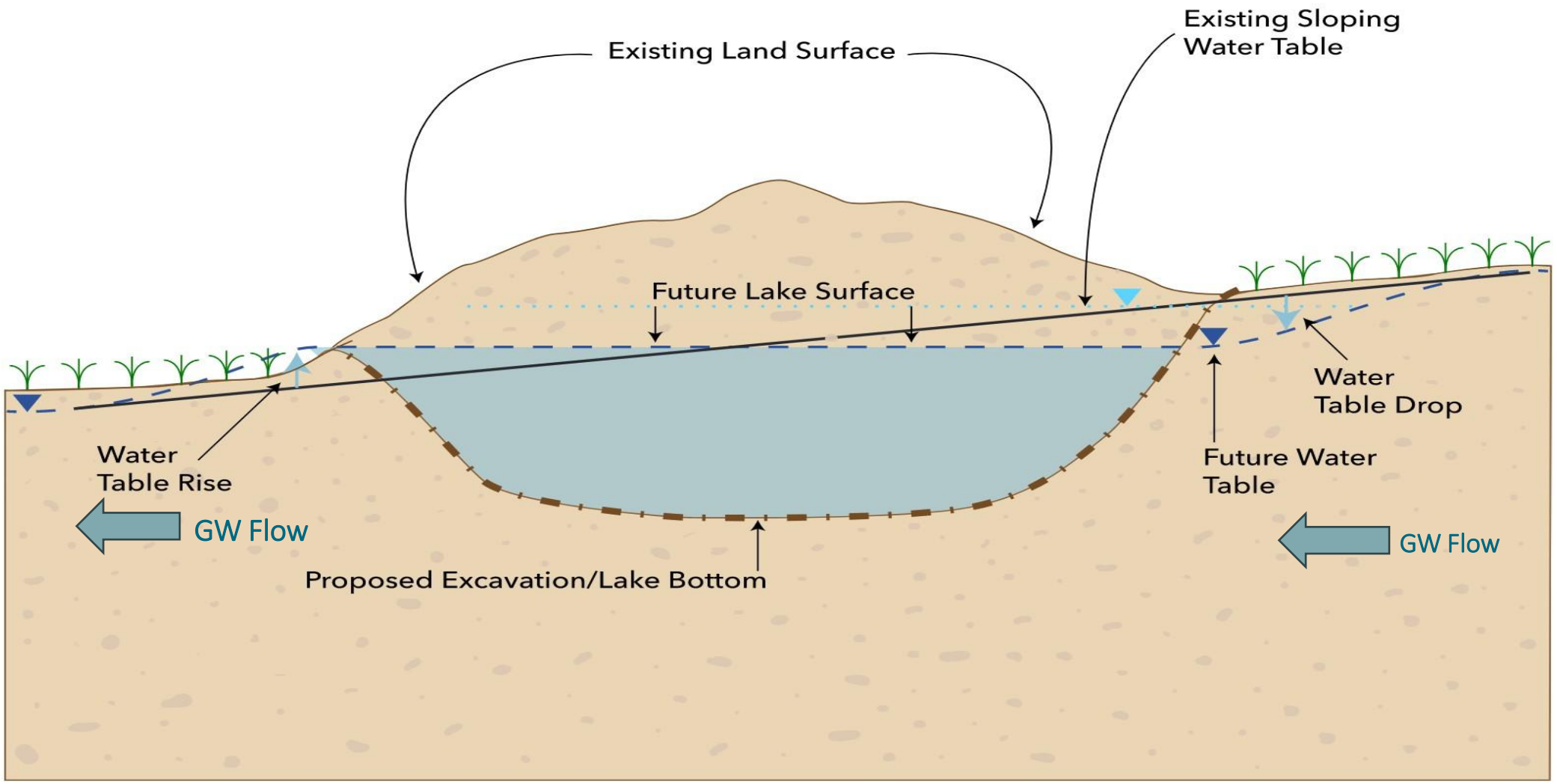
Evaporation from Lake Surface – The Process

1. Calculate evaporation rate.
2. Input pumping rate into a distance-drawdown calculato
3. Determine drawdown at sensitive features.

Fishbeck survey drone view

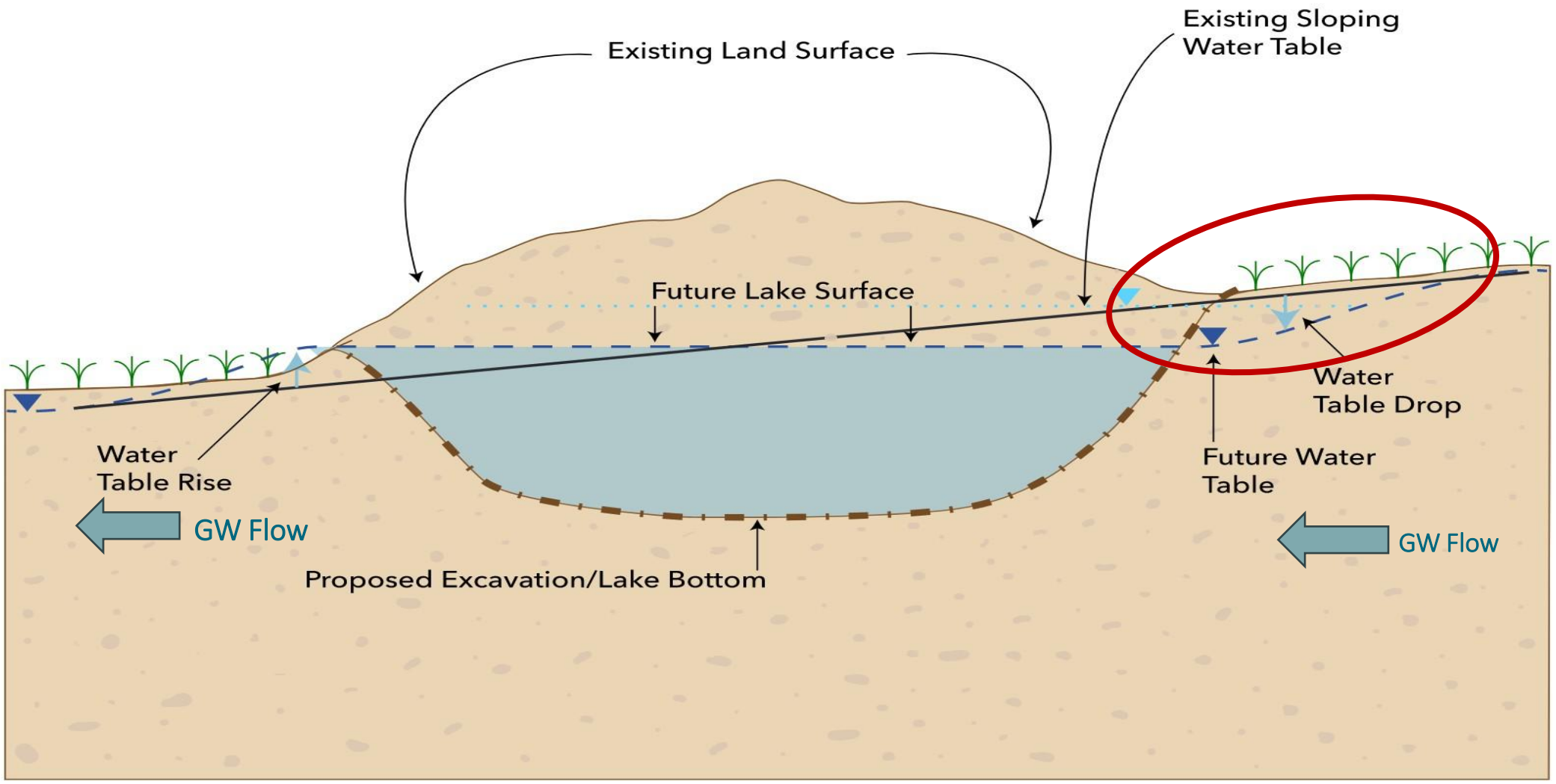
Hydrogeology and Water Level Changes – What Happens?

- Evaporation from Lake Surface
- Flattening of the Water Table



Water Table Diagram

Static Water Level Water Table Wetland NOT TO SCALE



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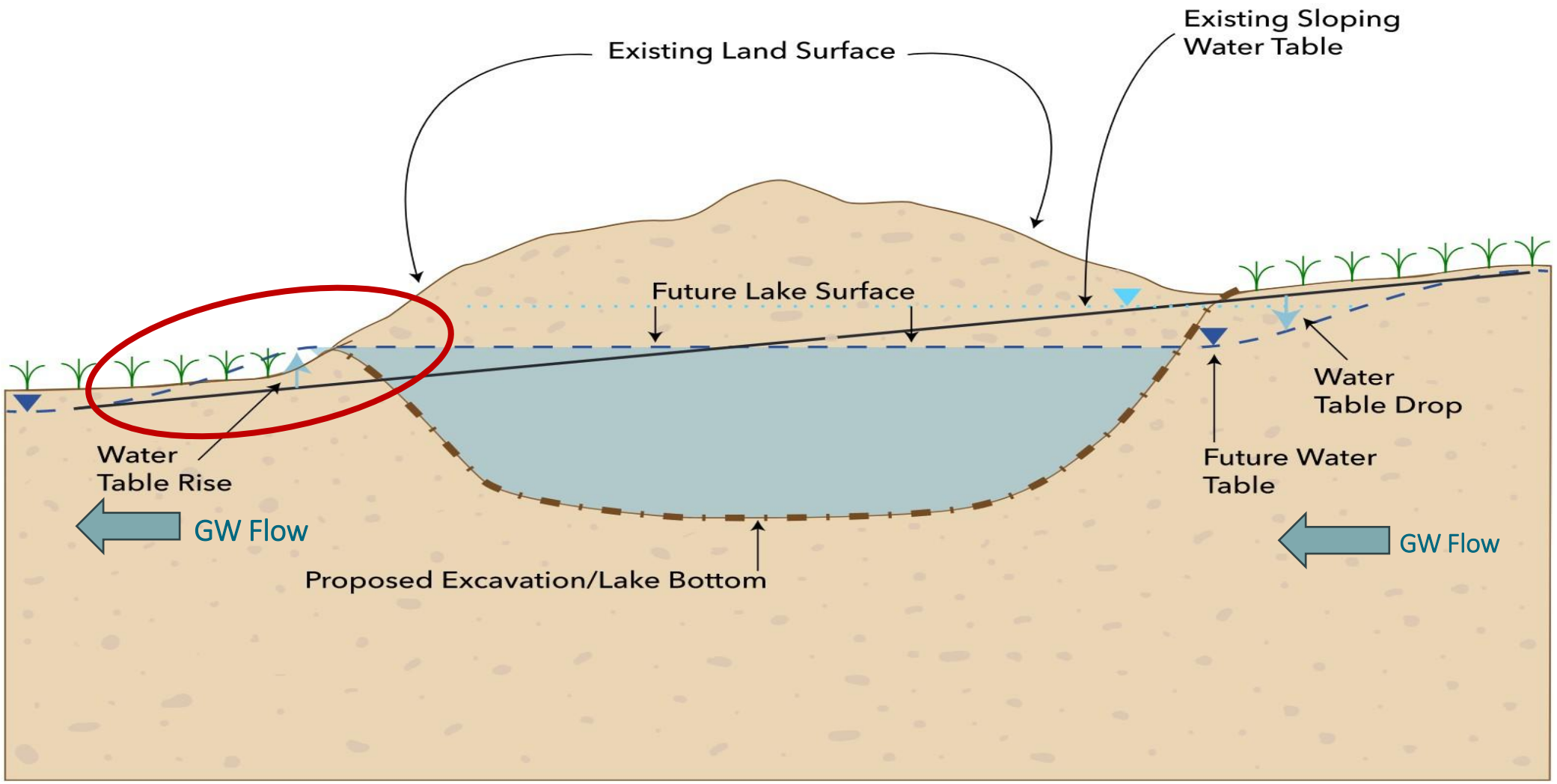
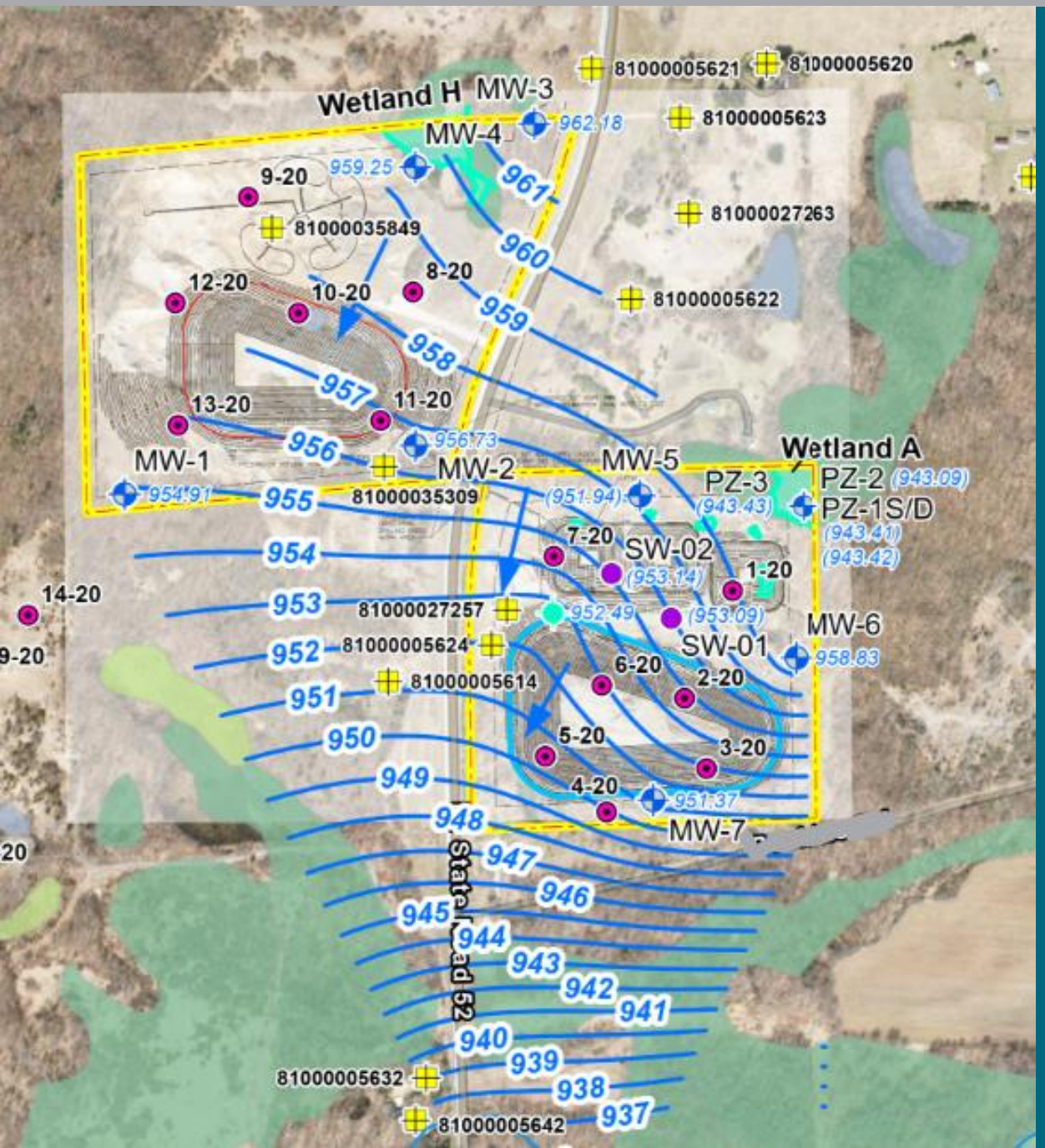


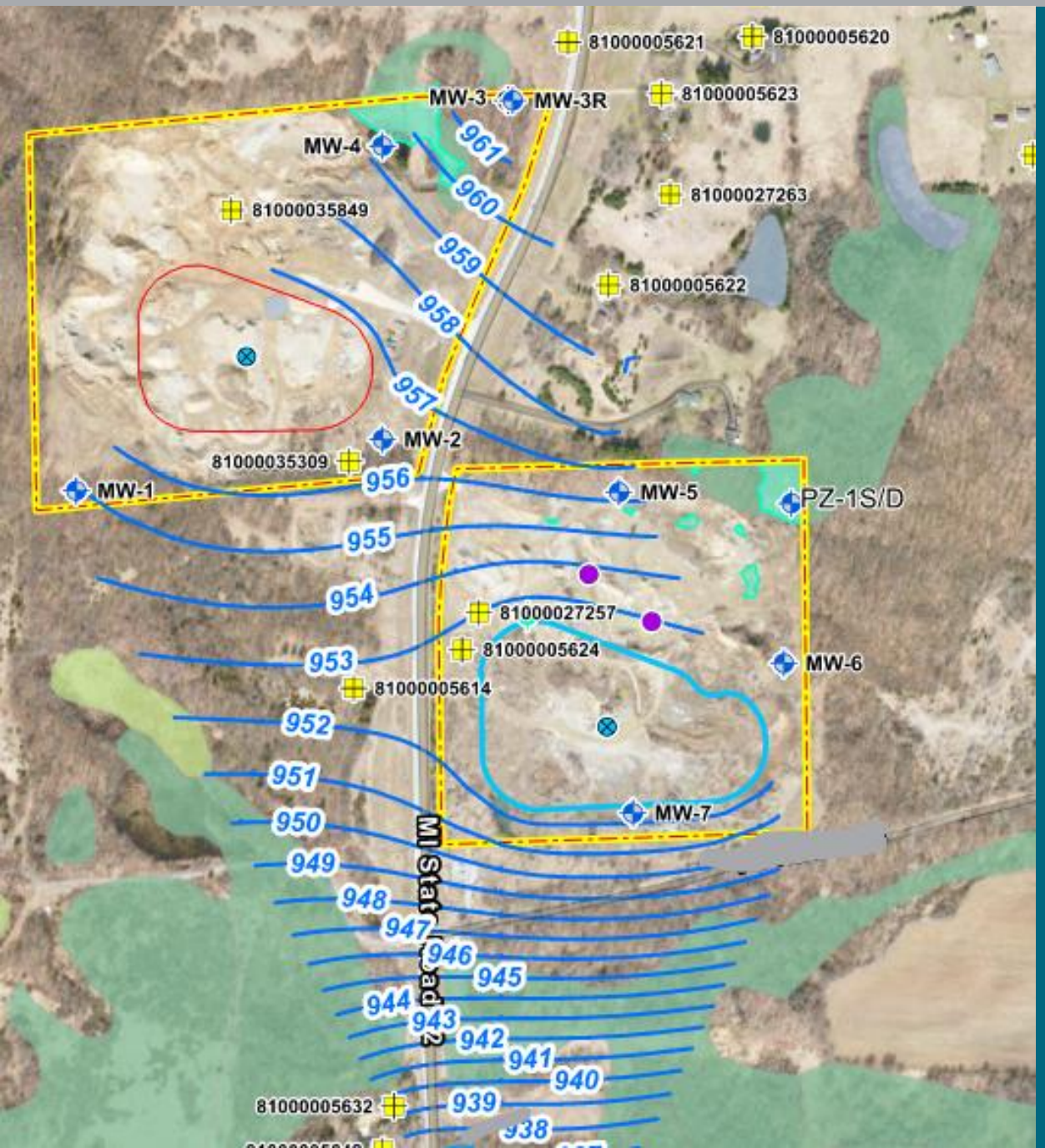
Water Table Diagram

Static Water Level Water Table Wetland NOT TO SCALE



Changes to Water Levels – What Happens?

- Evaporation from Lake Surface
- Flattening of the Water Table
  - Pre-excavation groundwater elevation contours



Changes to Water Levels – What Happens?

- Evaporation from Lake Surface
- Flattening of the Water Table
  - Pre-excavation groundwater elevation contours
  - Post-excavation groundwater elevation contours

The Hydrogeology of Lake Creation

A. Regulatory and Environmental Concerns

B. Hydrogeology and Water Level Changes – What Happens?

C. Mitigating Factors/Options

Water level monitoring adjacent to lake excavation

Now What?
Mitigating Factors/Options

- Demonstrate No Impact Likely
- Ways to Avoid/Minimize impacts

Now What?
Mitigating Factors/Options

Water Supply Wells

- Available Drawdown >> Impacts

Now What?
Mitigating Factors/Options

Water Supply Wells

- Available Drawdown >> Impacts
- Lower the pump

Now What?
Mitigating Factors/Options

Water Supply Wells

- Available Drawdown >> Impacts
- Lower the pump
- Deepen or replace their well

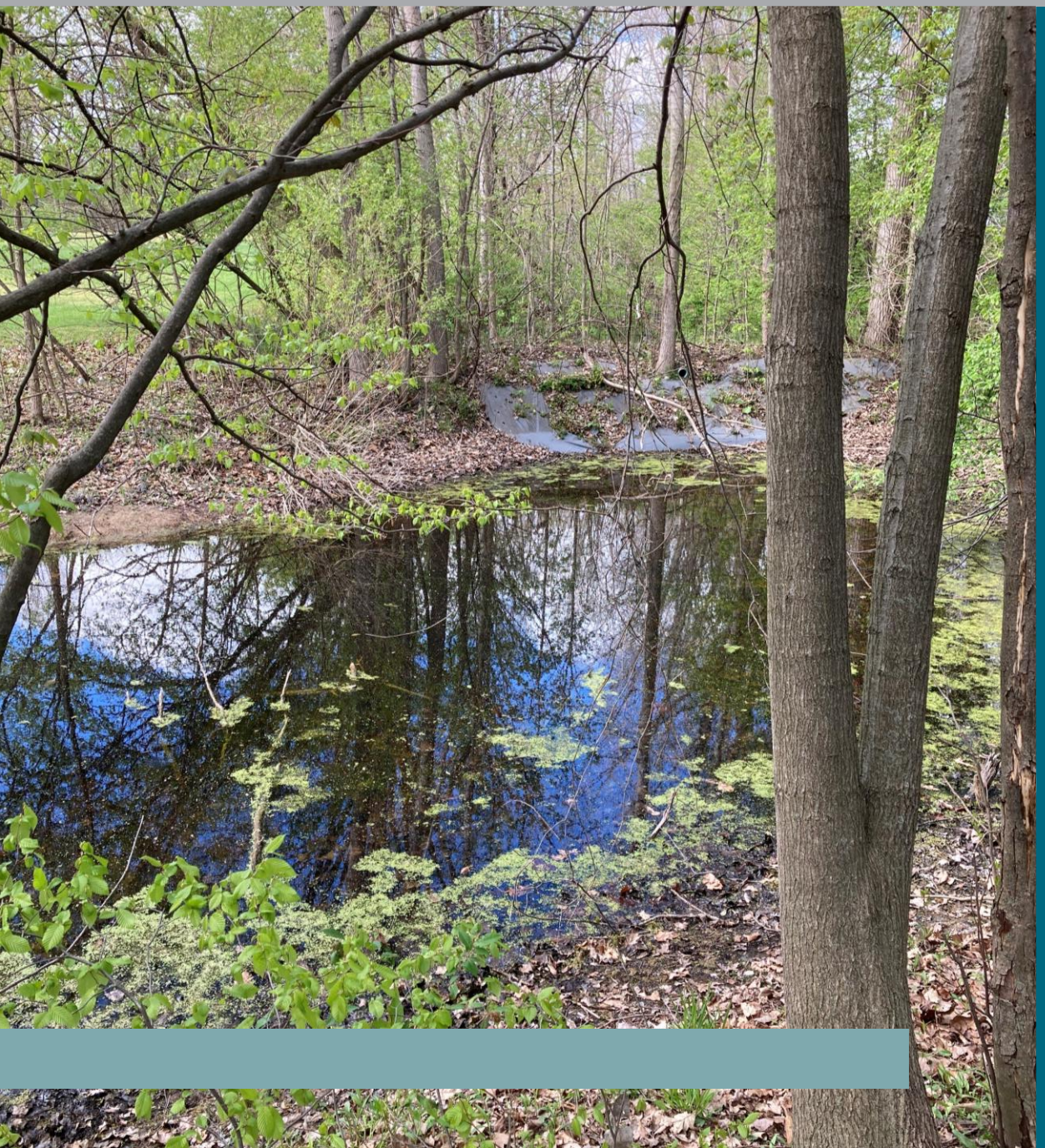
Now What?
Mitigating Factors/Options

Water Supply Wells

IMPORTANT DISCLAIMER:

“Perception is Reality”

NIMBY



Now What?

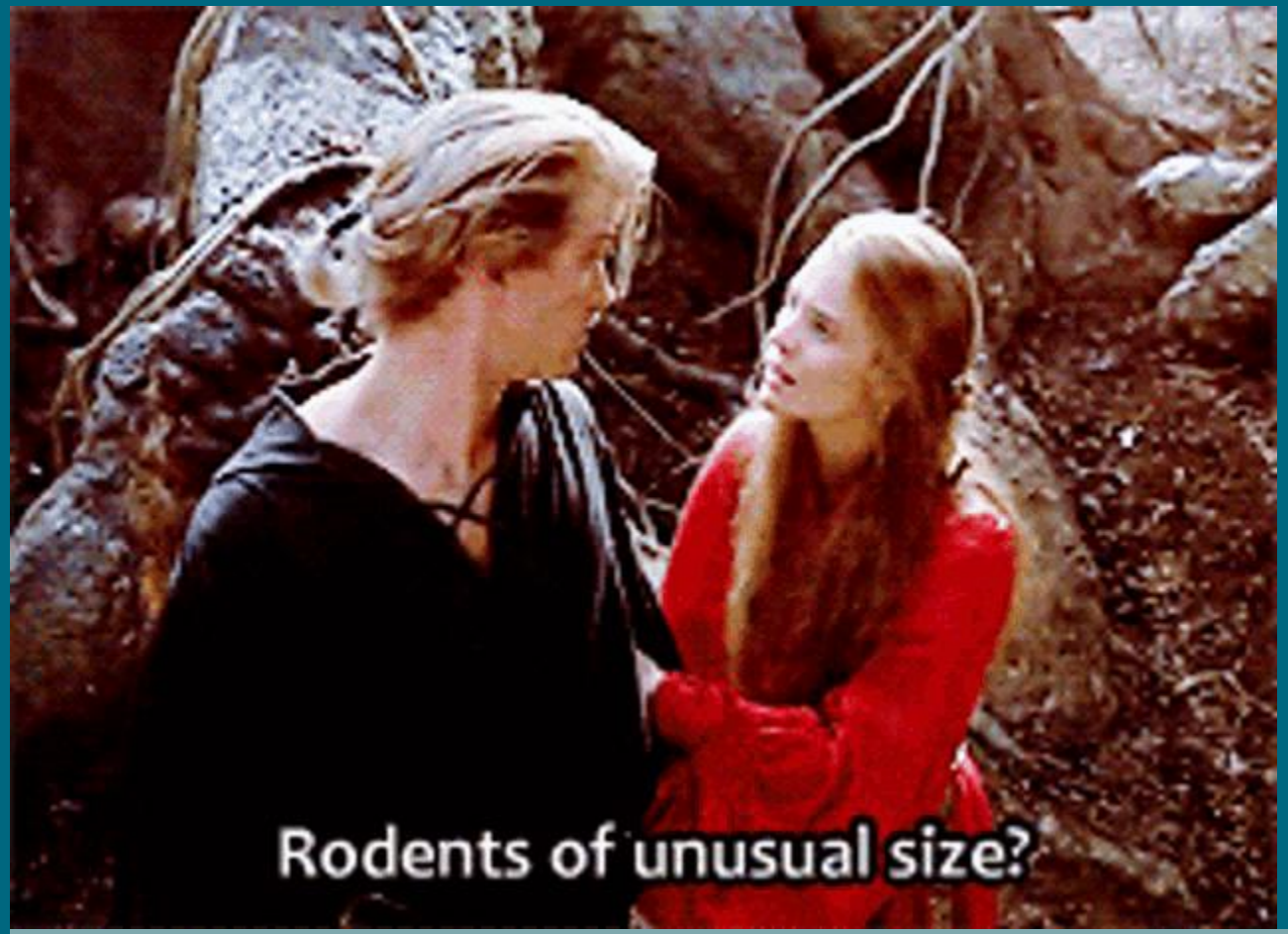
Mitigating Factors/Options

Wetlands:

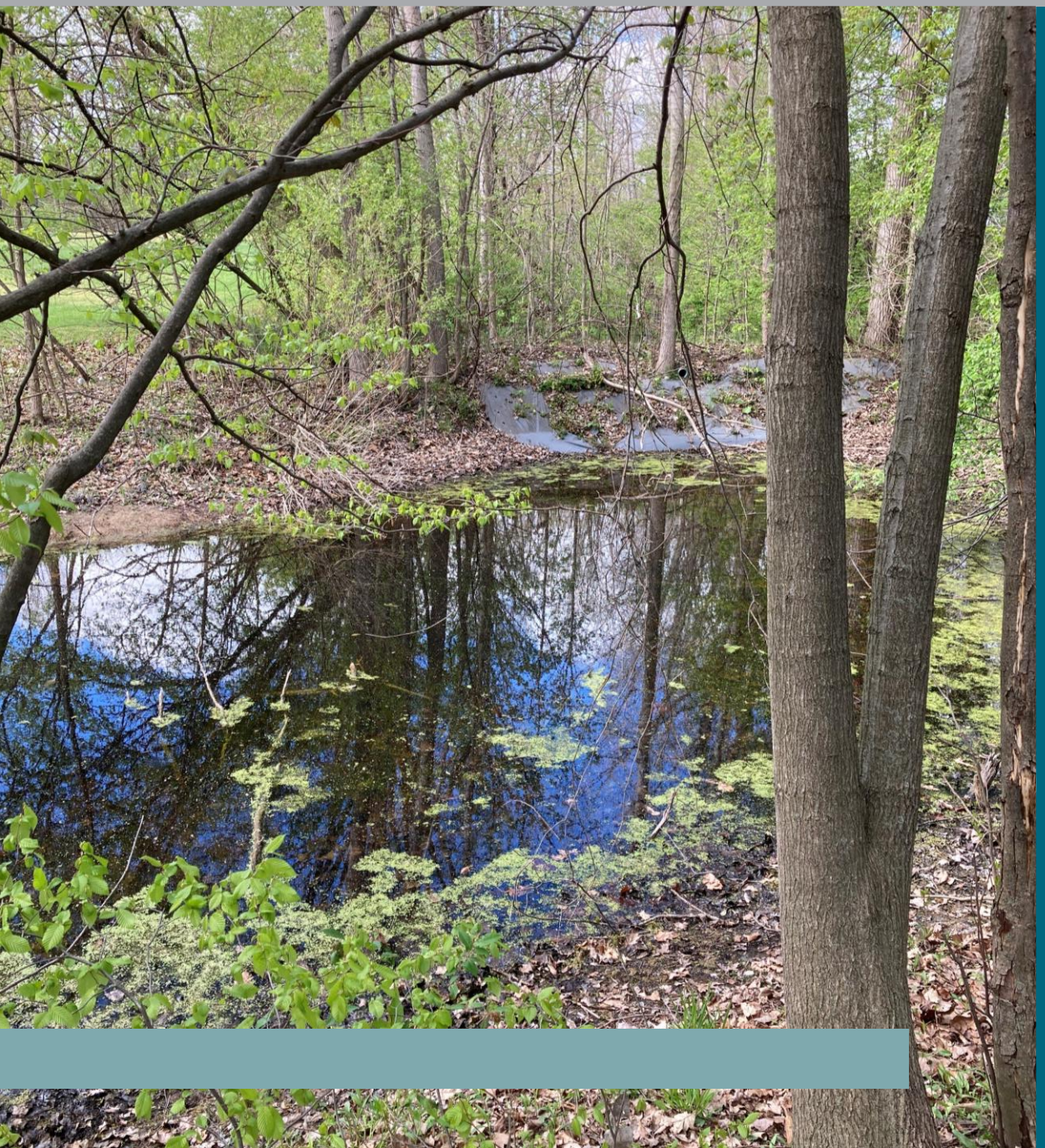
Often more problematic than water supply wells.


The dreaded wooded wetland!

The dreaded wooded wetland!



Gif via Tenor.com

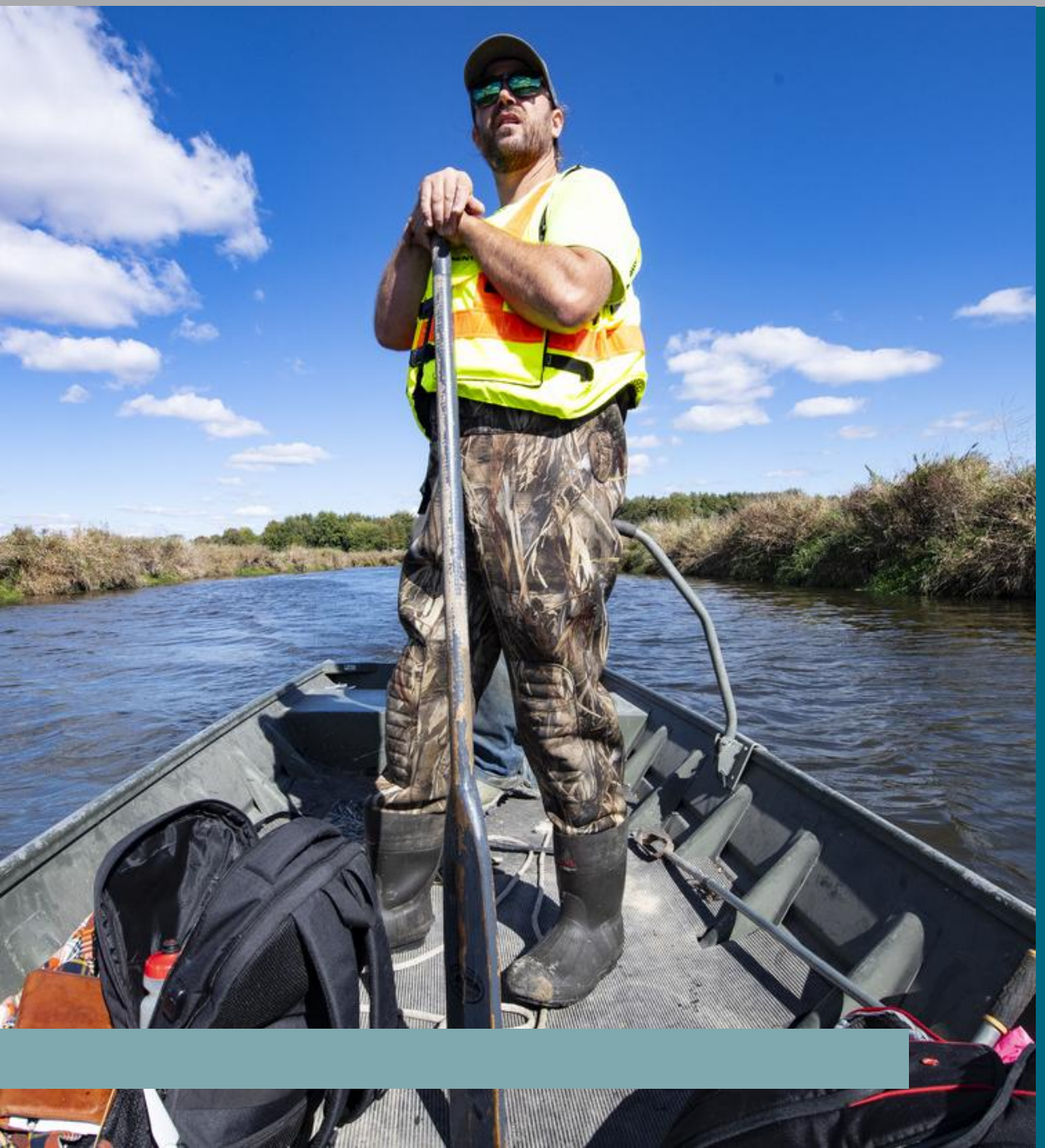


Now What?

Mitigating Factors/Options

Wetlands:

1. Demonstrate non-regulated
2. Mitigation ($$$)
3. Demonstrate not groundwater dependent
4. Minimize Impact



Now What?
Mitigating Factors/Options

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Now What? Mitigating Factors/Options

Wetlands:

1. Demonstrate non-regulated
2. Mitigation ($$$)
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Now What?

Mitigating Factors/Options

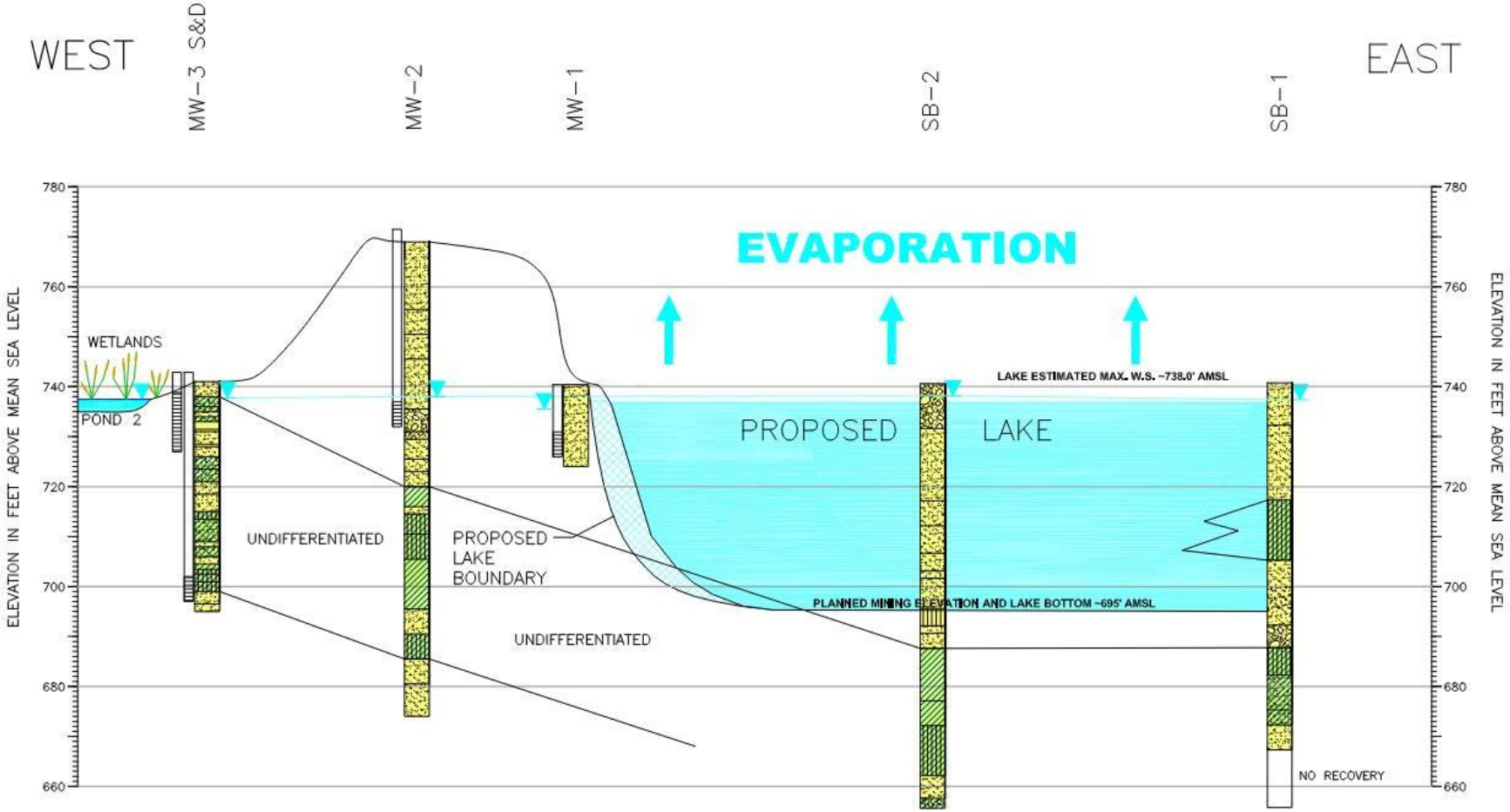
Wetlands:

1. Demonstrate non-regulated
2. Mitigation ($$$)
3. Demonstrate not groundwater dependent
4. Minimize Impact

Not Groundwater Dependent

Multiple lines of evidence:

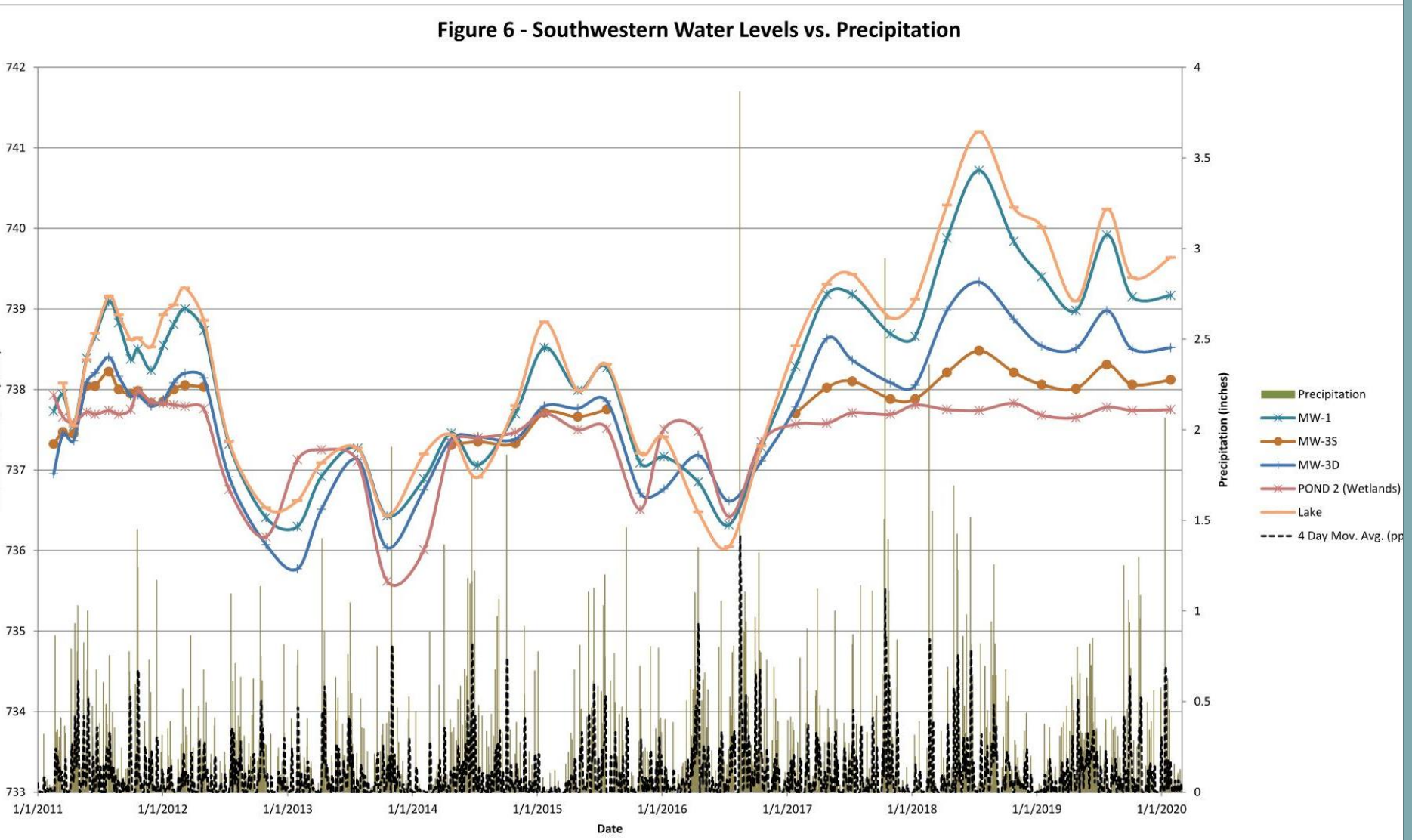
1. Compare water levels in wetland vs aquifer
2. Geology
3. Water level monitoring



Not Groundwater Dependent

Multiple lines of evidence:

1. Compare water levels in wetland vs aquifer.
2. Geology
3. Water level monitoring



Not Groundwater Dependent

Multiple lines of evidence:

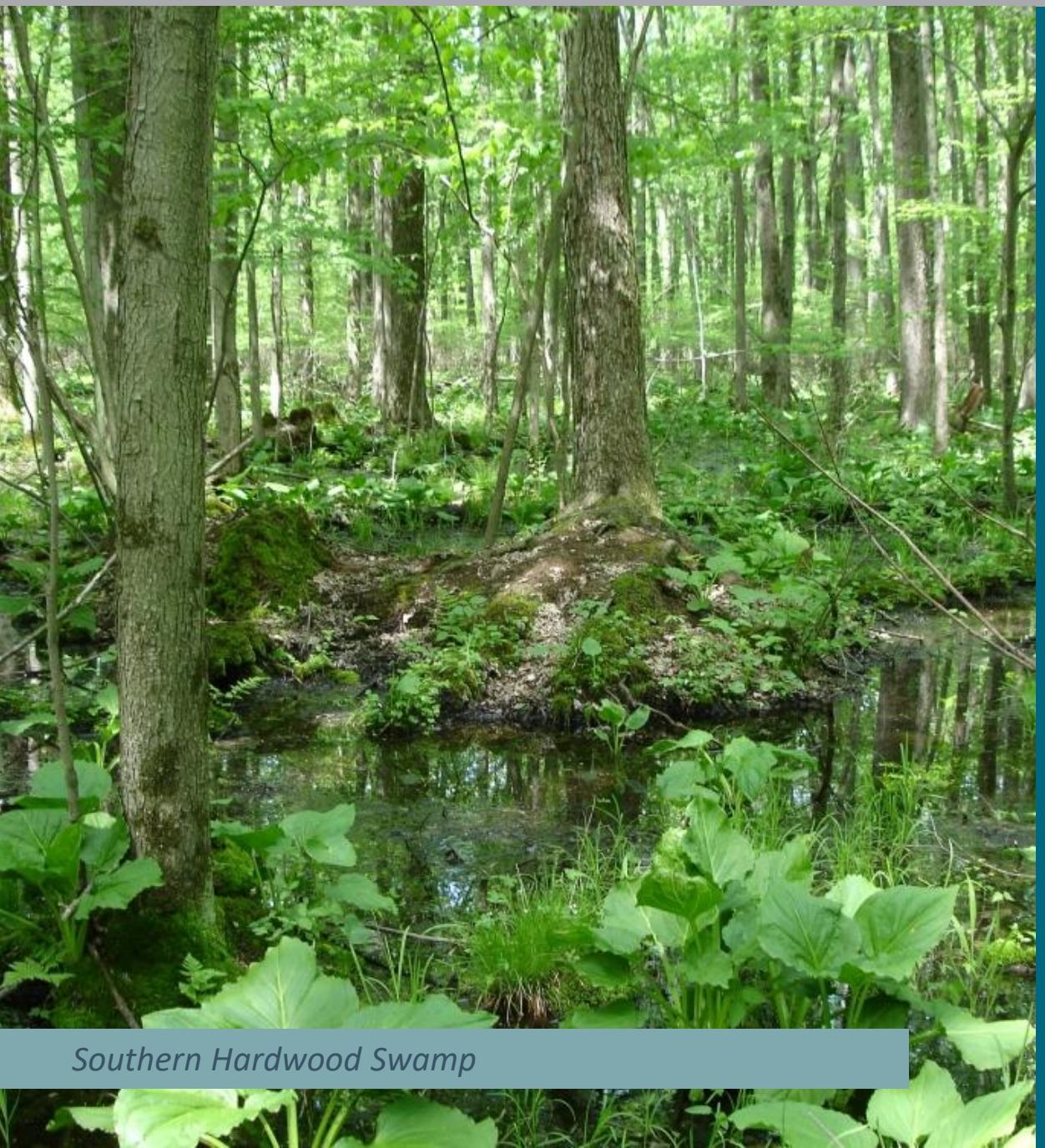
1. Compare water levels in wetland vs aquifer vs precipitation
2. Geology
3. Water level monitoring

Now What?

Mitigating Factors/Options

Wetlands:

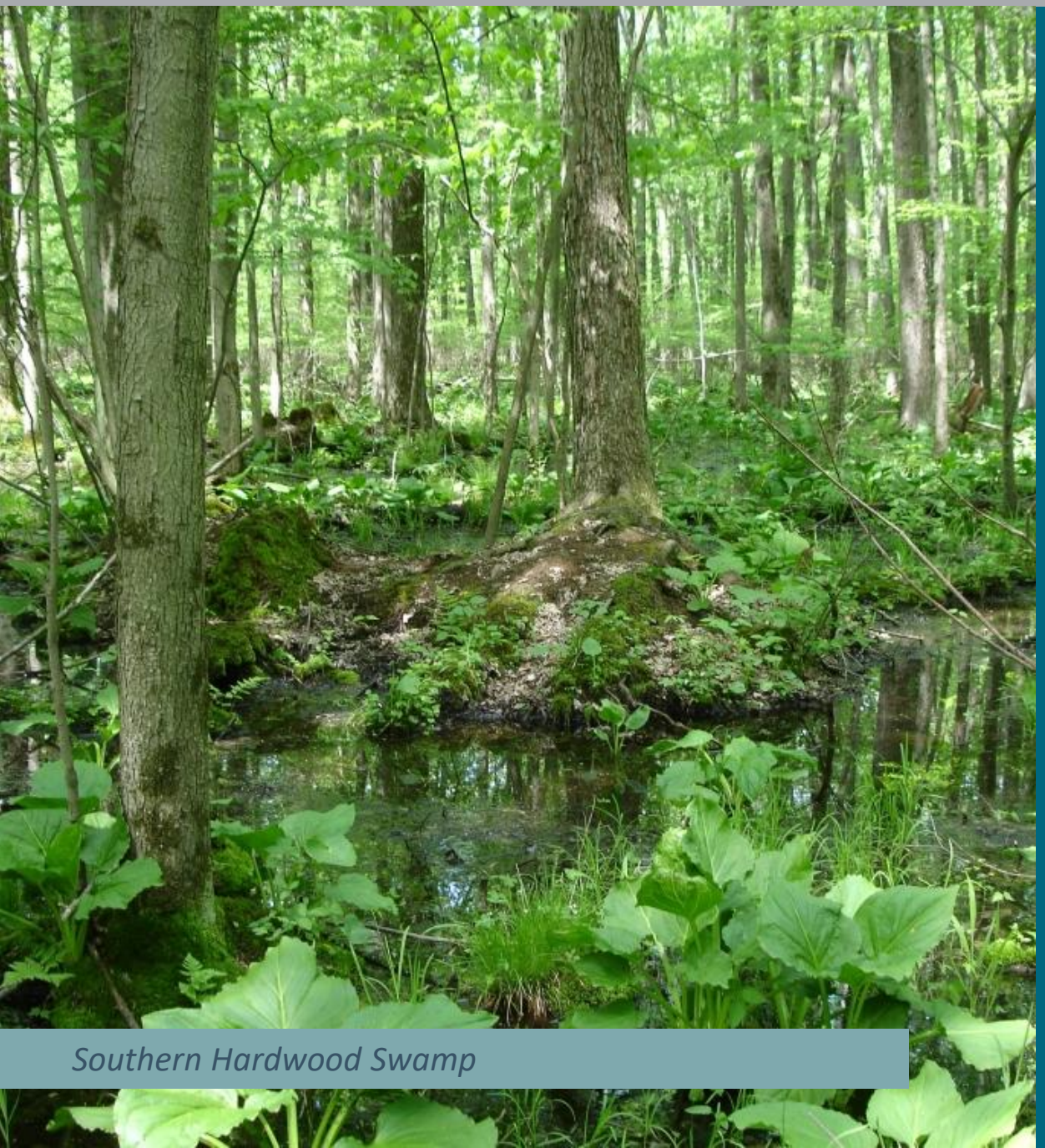
1. Demonstrate non-regulated
2. Mitigation ($$$)
3. Demonstrate not groundwater dependent
4. Minimize Impact



Southern Hardwood Swamp

How to Minimize Impact

1. Lake size and distance from wetland
2. Lake shape/orientation
3. Multiple lakes



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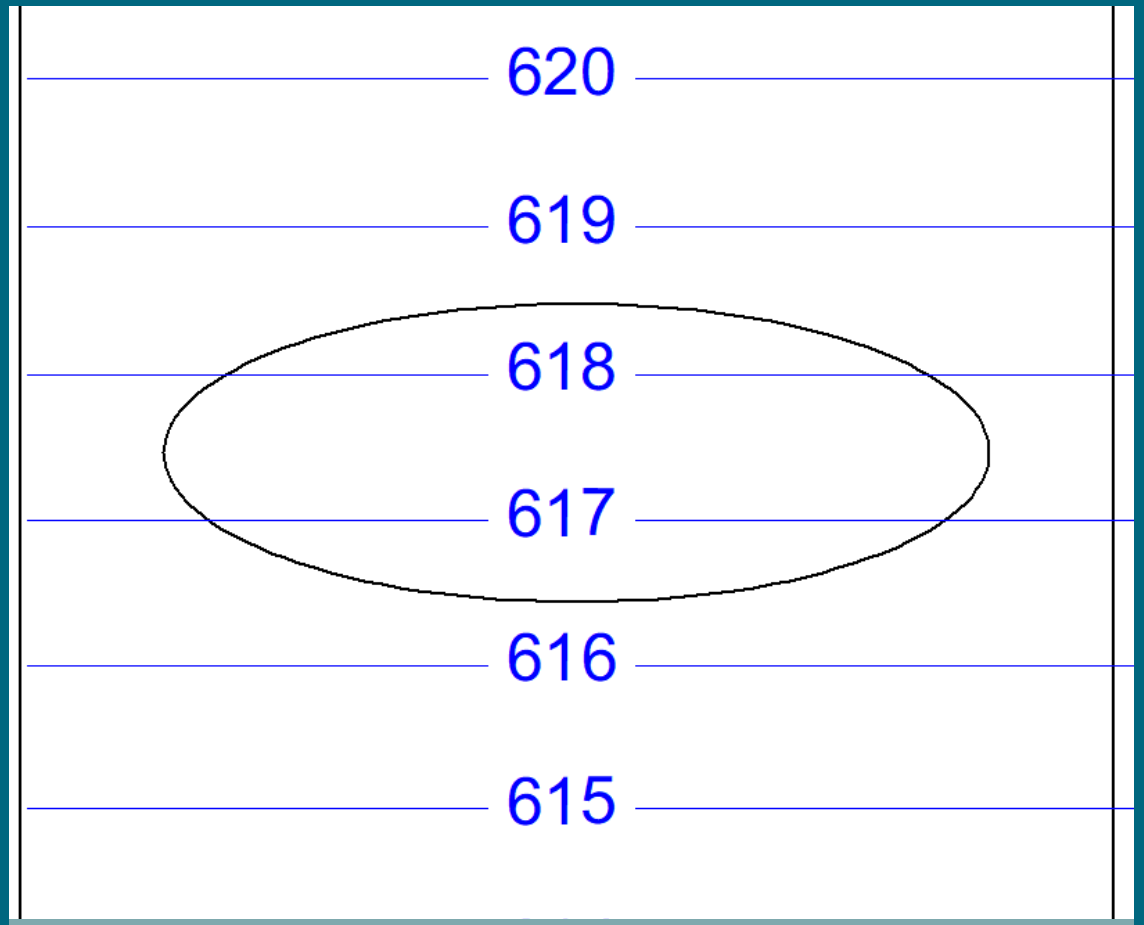
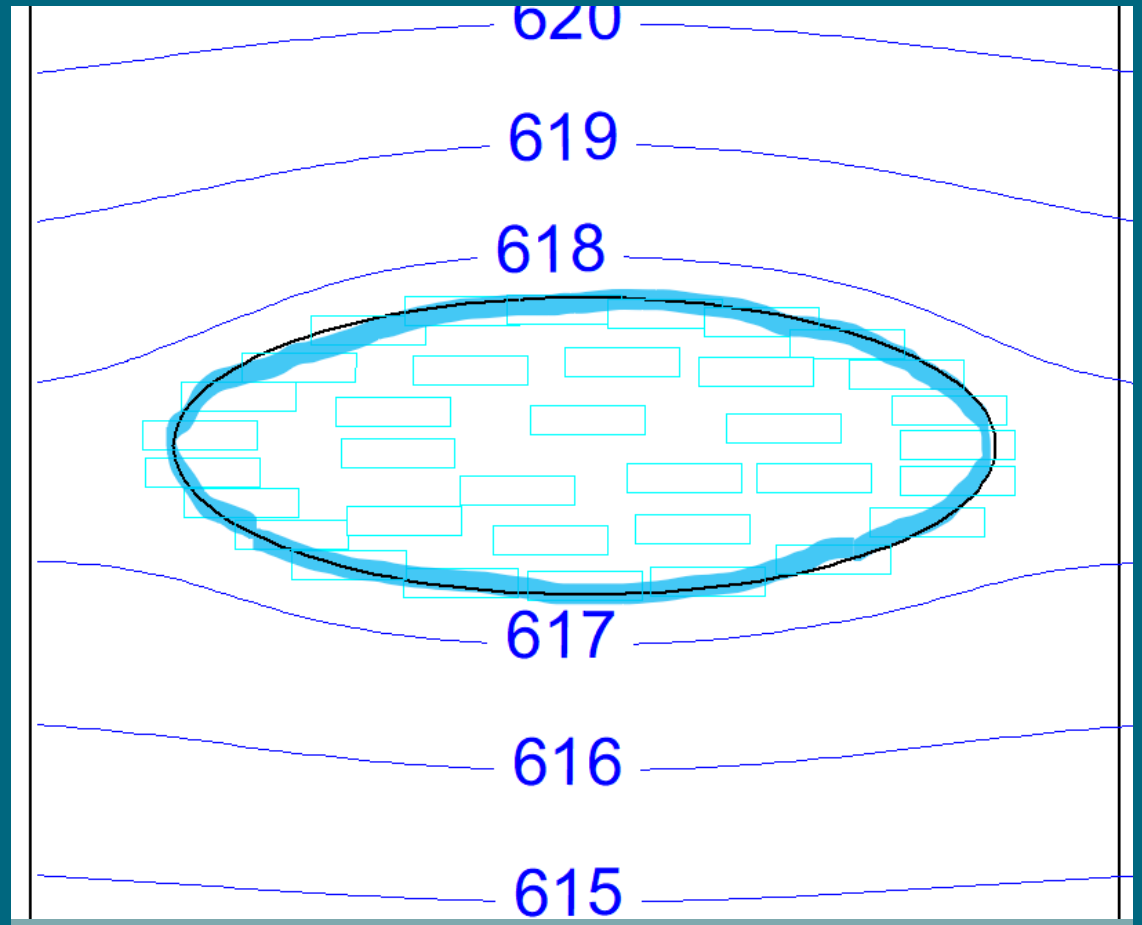
How to Minimize Impact: Lake Shape/Orientation

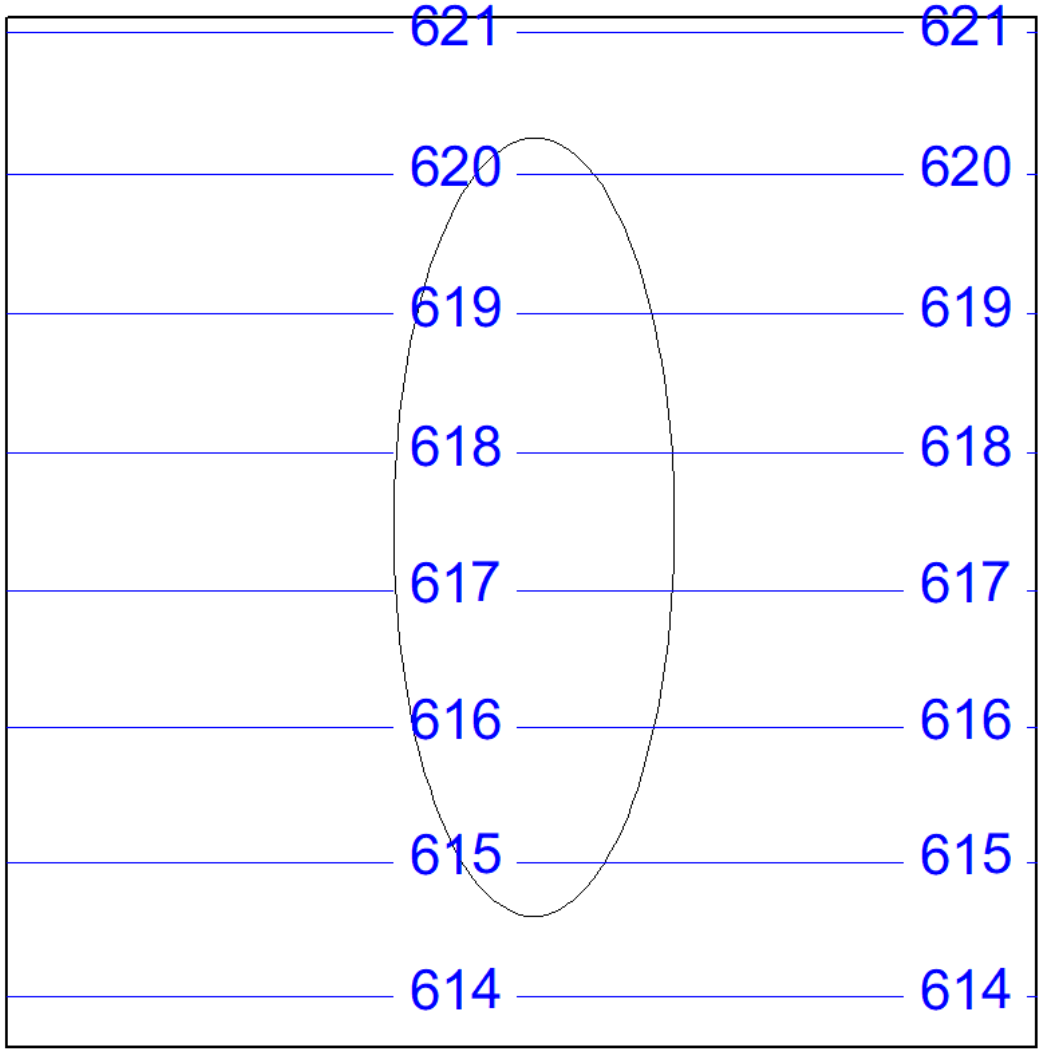


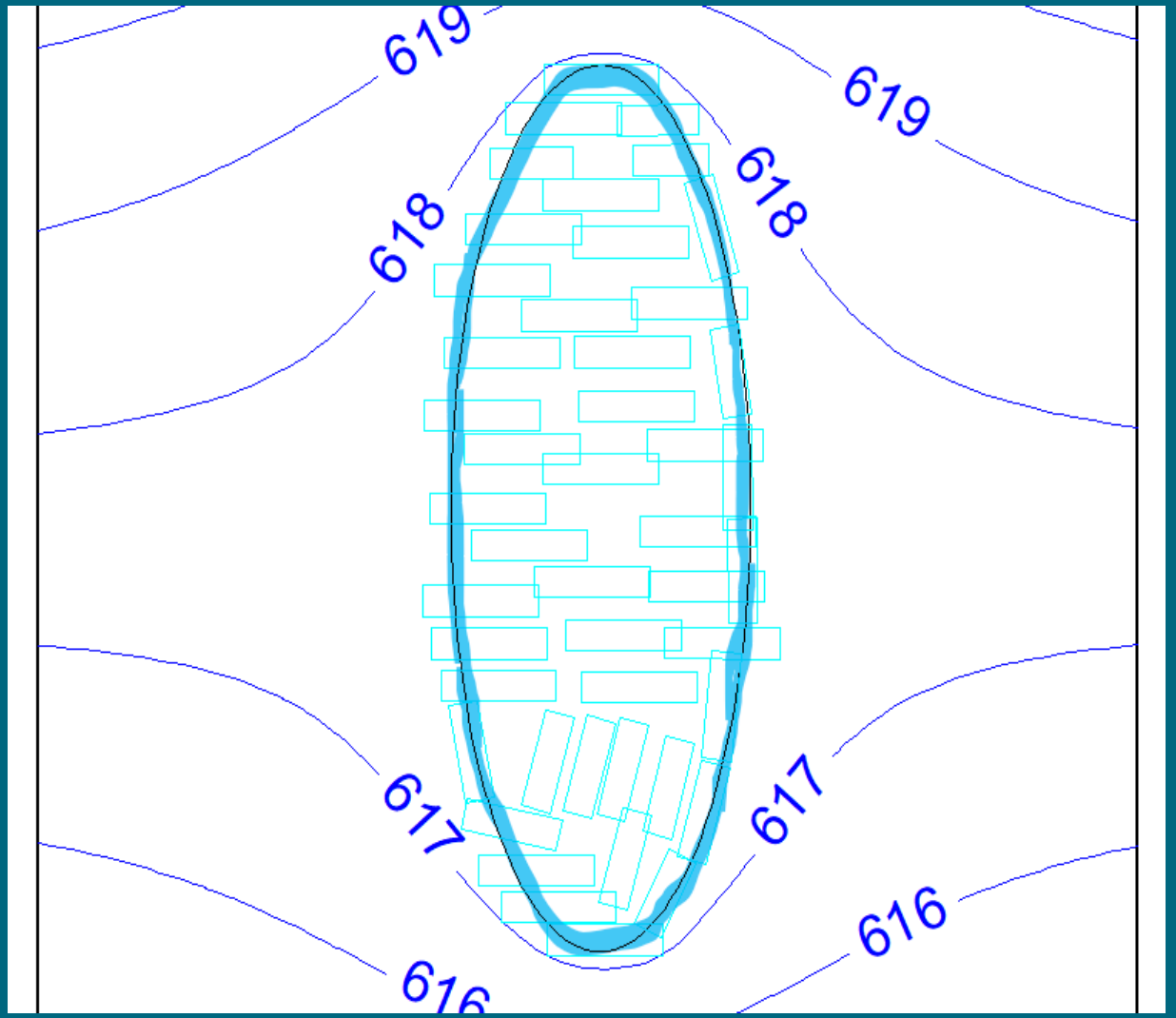
Pre-excavation groundwater elevation contours



Post-excavation groundwater elevation contours

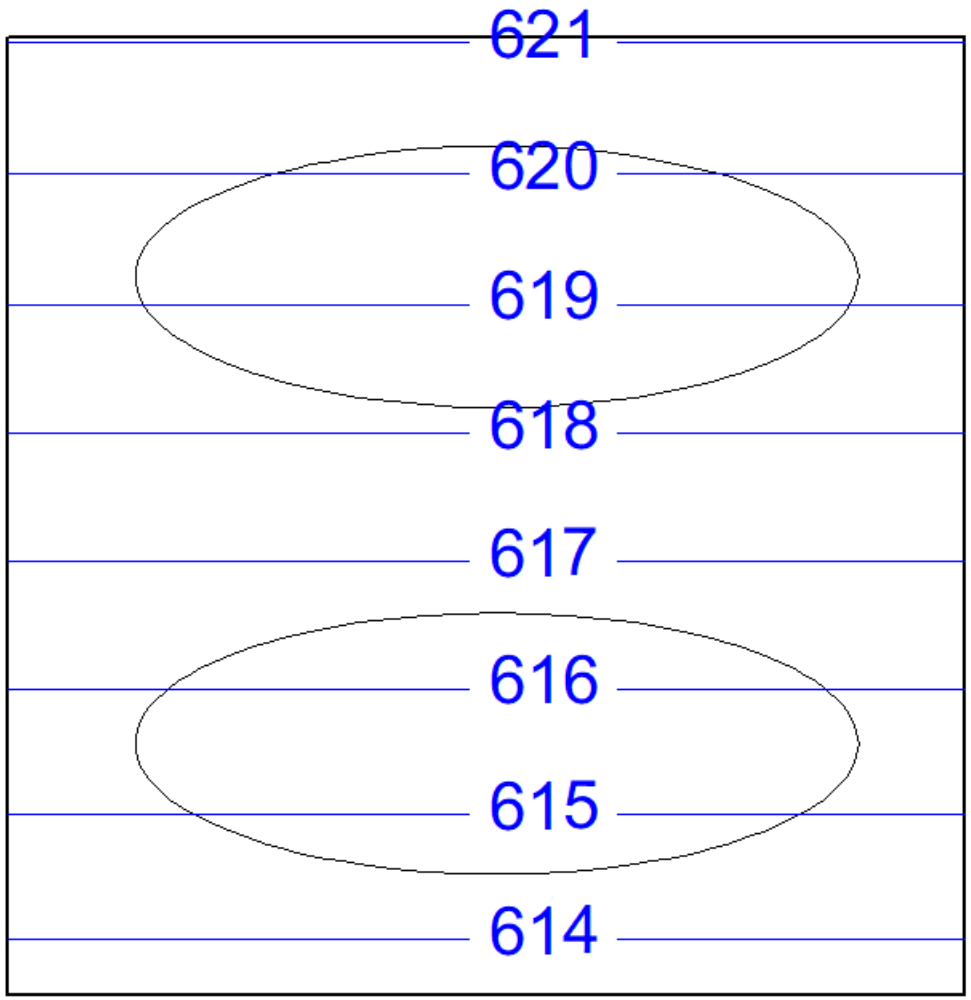
How to Minimize Impact: Lake Shape/Orientation

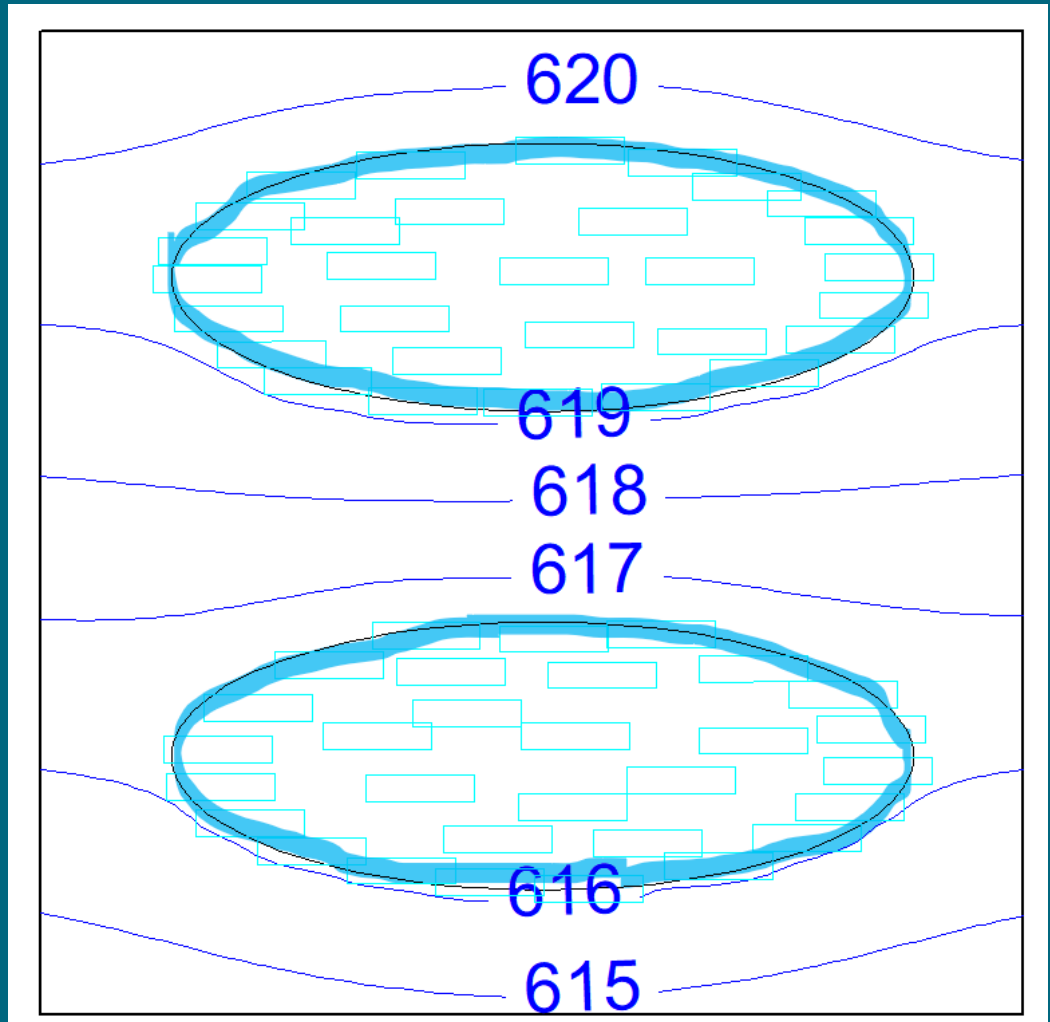




Lake Shape/Orientation

How to Minimize Impact: Multiple Lakes



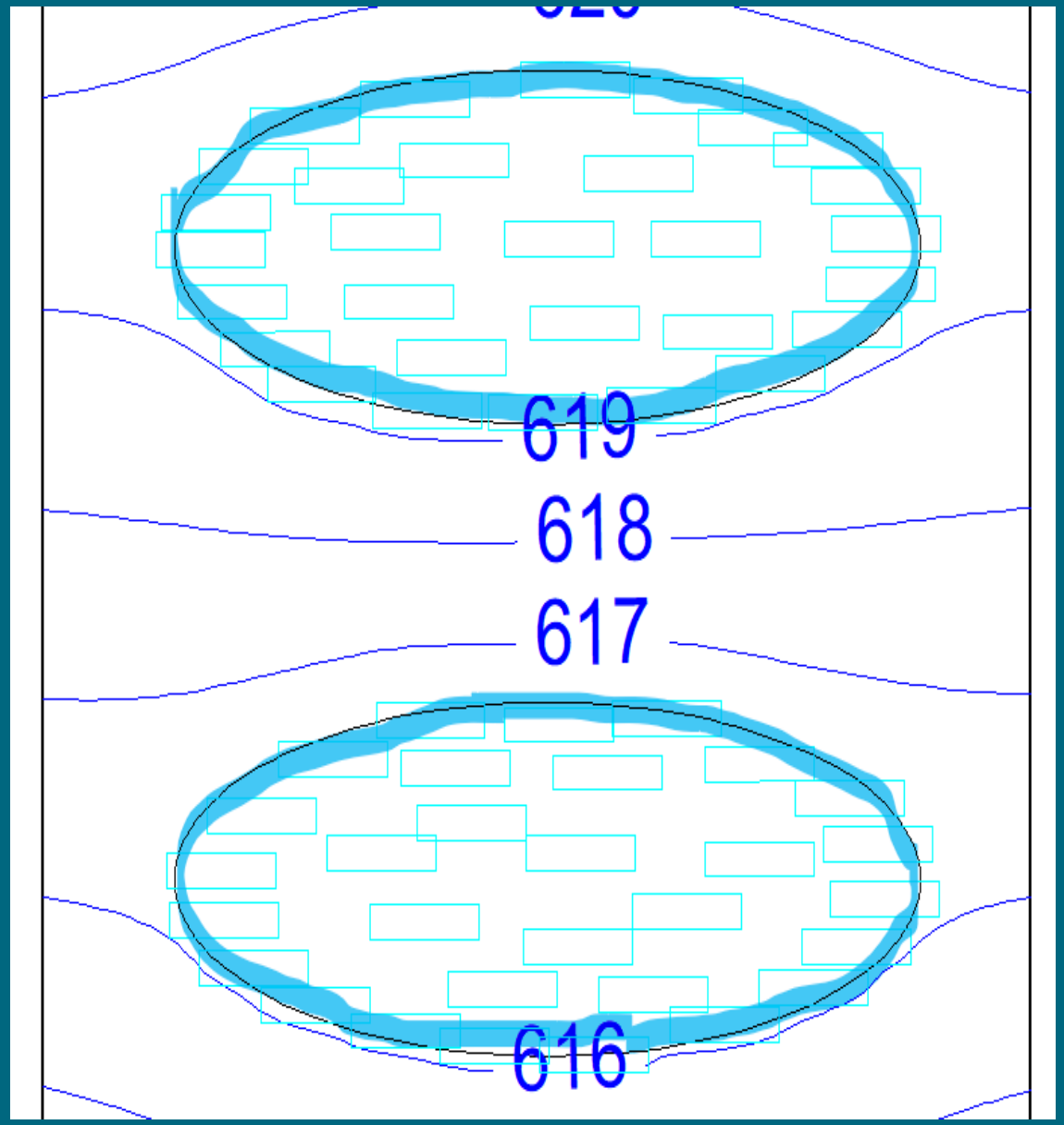


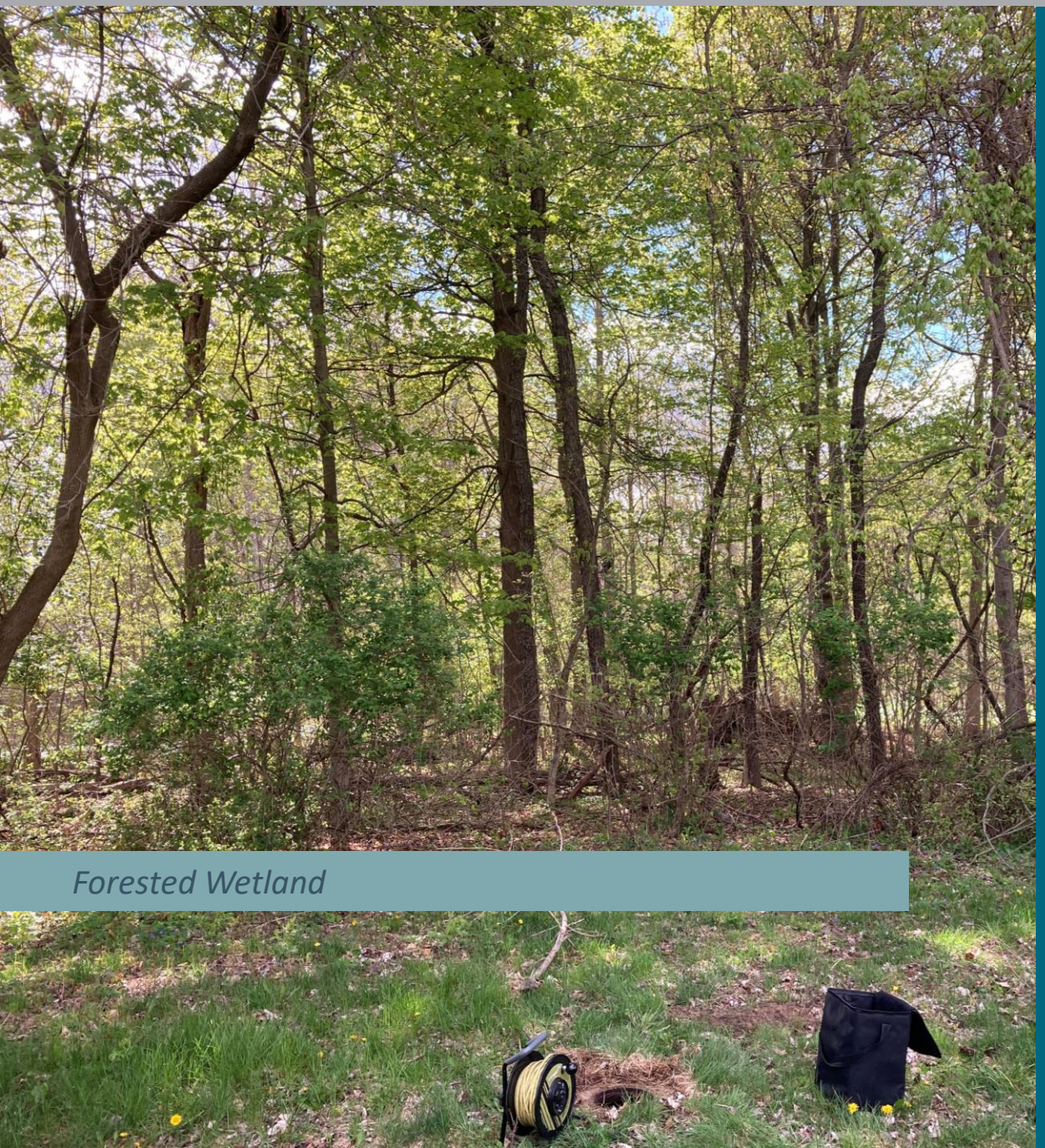
2. Lake shape/orientation

3. Multiple lakes

Pop Quiz: If lakes are 400 feet apart – how long does it take on average for groundwater to flow from one to the other?

1. 2 days
2. 2 weeks
3. 4 months
4. 9 months





Forested Wetland

Recommendations

- Screen sites ahead of time
- Test borings
- Water level monitoring
- Pre-application meeting

Glacial Erratics

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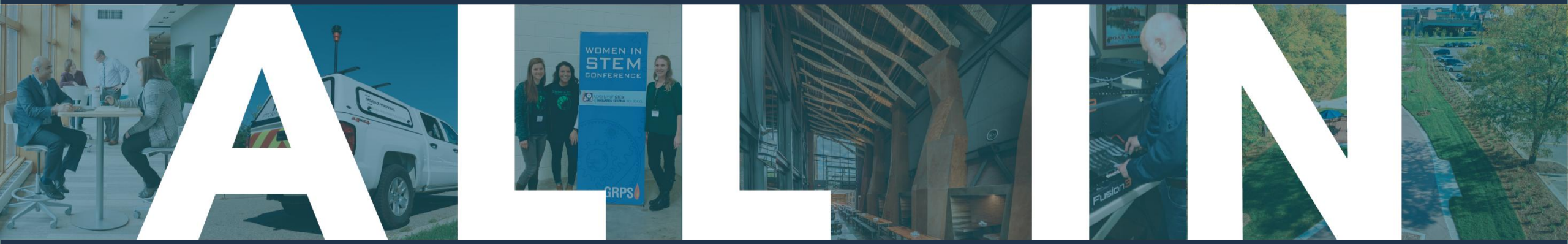

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Engineers | Architects | Scientists | Constructors

Questions?

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Engineers | Architects | Scientists | Constructors