Which Data Are Important – And Why?

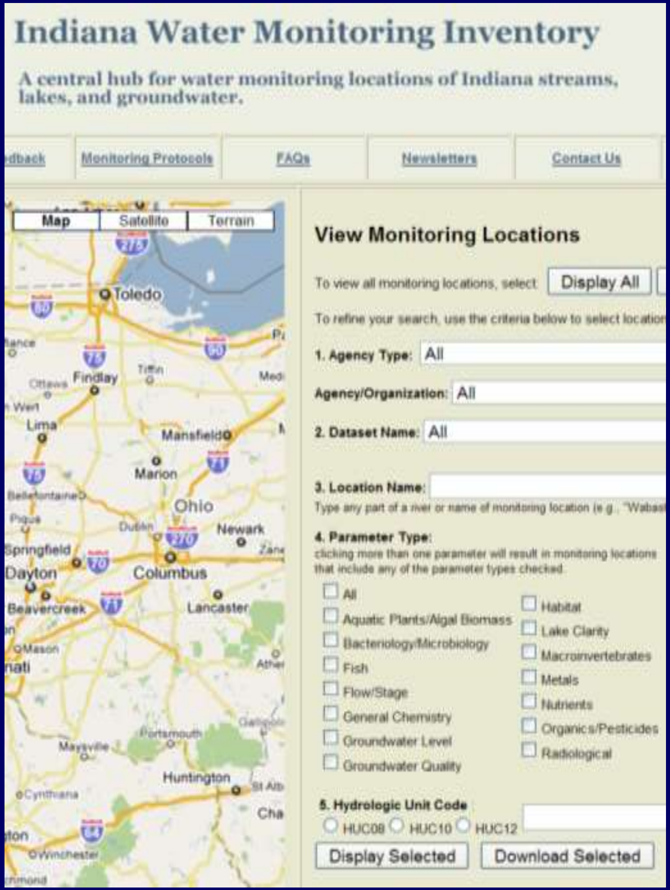
Barry Tonning
Tetra Tech

Last week . . .

- In-stream monitoring parameters
  - Chemical, physical, biological
  - Including in-stream habitat parameters
- Bank area assessment
  - Vegetation, bank stability

Today's Outline

- Assessing land uses, land cover, and land management practices
- Brief (!) background on NPDES discharge permits and Water Quality Standards
- How data are used in assessments
- Identifying which data are important

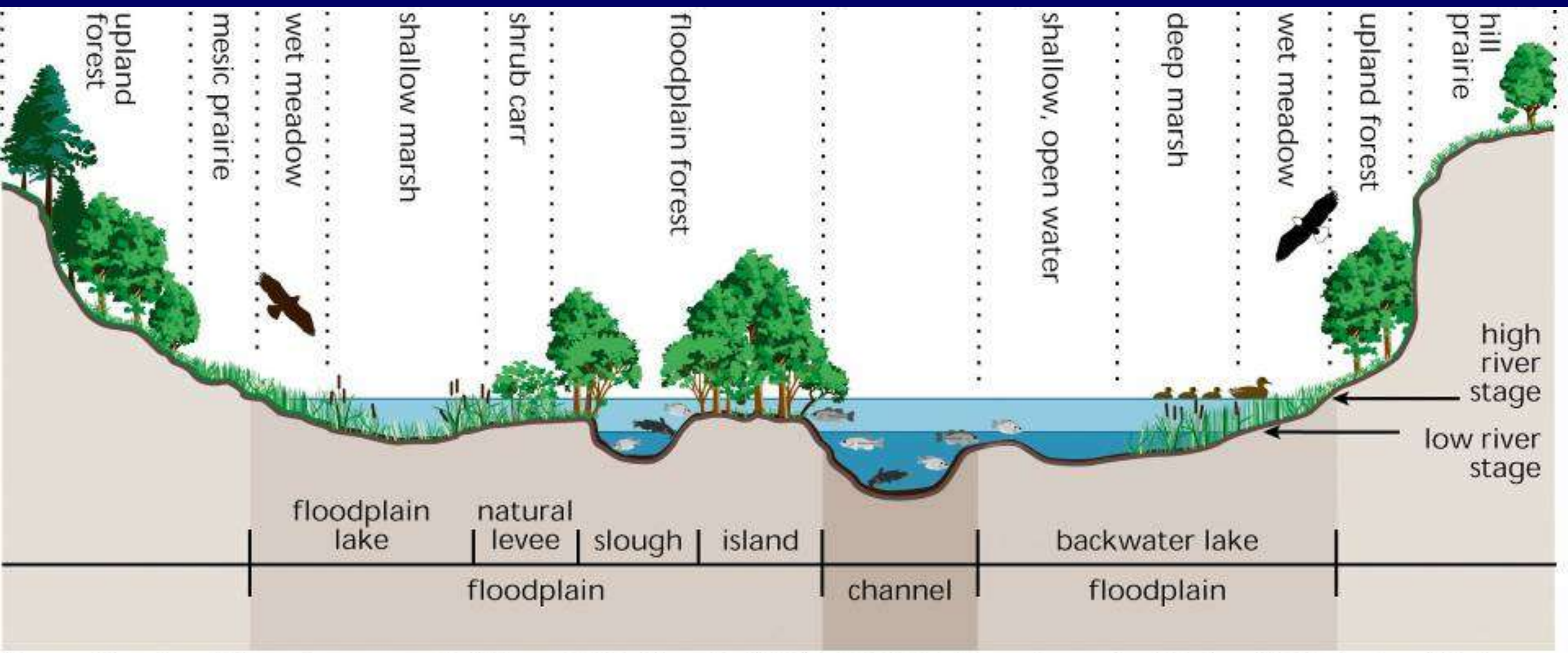


https://engineering.purdue.edu/~inwater/

Measurements and other parameters in the upland regions

Measuring aspects of the upland regions

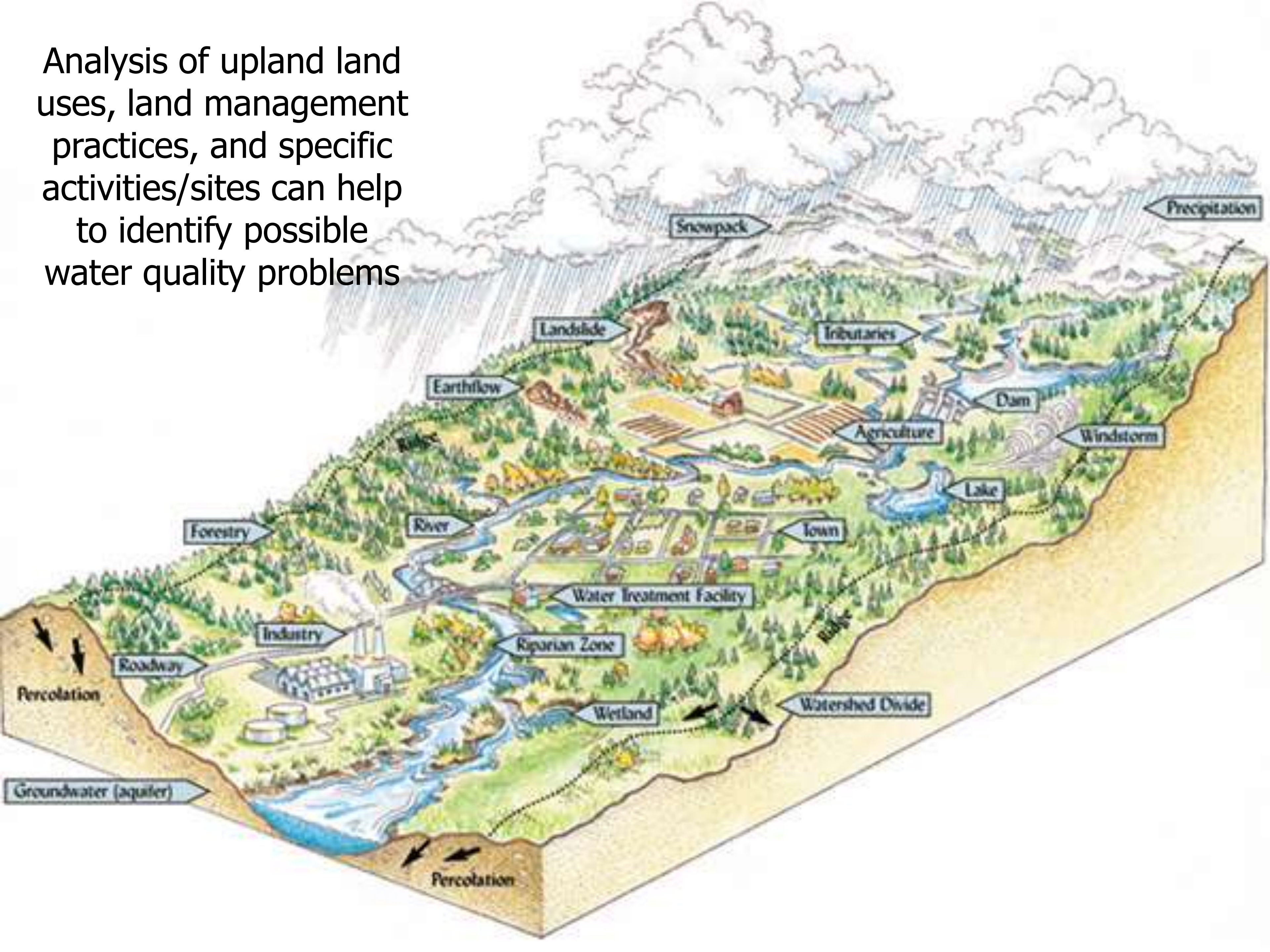
- Agricultural areas
- Logging and mining sites
- Towns and cities
- "Hot" spots
- Commercial strips
- Industrial facilities



From Sparks, Bioscience, vol. 45, p. 170, March 1995. ©1995 American Institute of Biological Science.

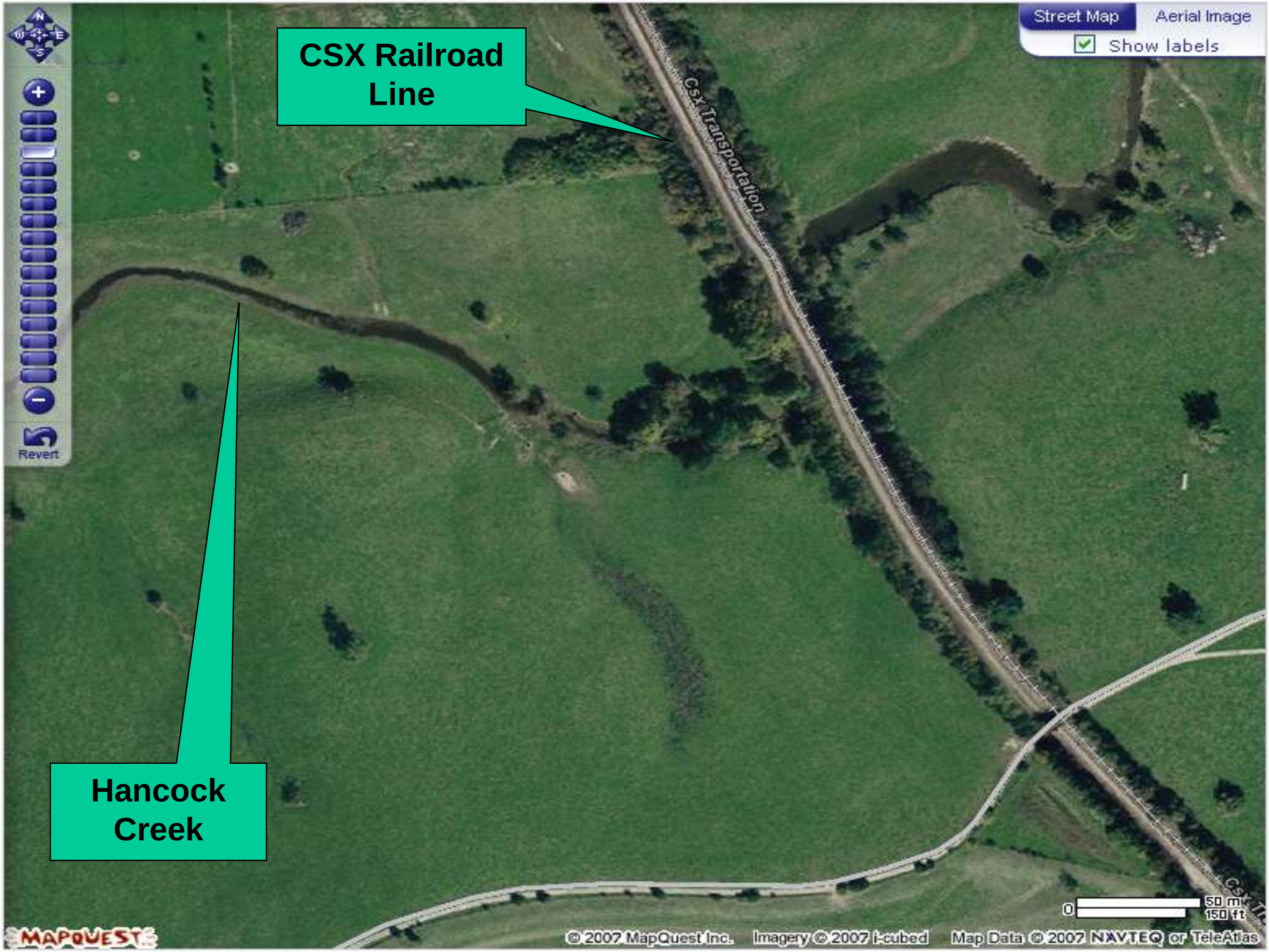
Fig. 1.11 – A cross section of a river corridor. Vertical scale and channel width are greatly exaggerated.
In Stream Corridor Restoration: Principles, Processes, and Practices, 10/98.

Analysis of upland land uses, land management practices, and specific activities/sites can help to identify possible water quality problems



Aerial photography – good screening and targeting tool

Check photo dates!


CSX Railroad Line
Hancock Creek
Csx Transportation
Street Map
Aerial Image
Show labels
Revert
MAPQUEST
50 m
150 ft
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Street Map
Aerial Image
Show labels
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MAPQUEST
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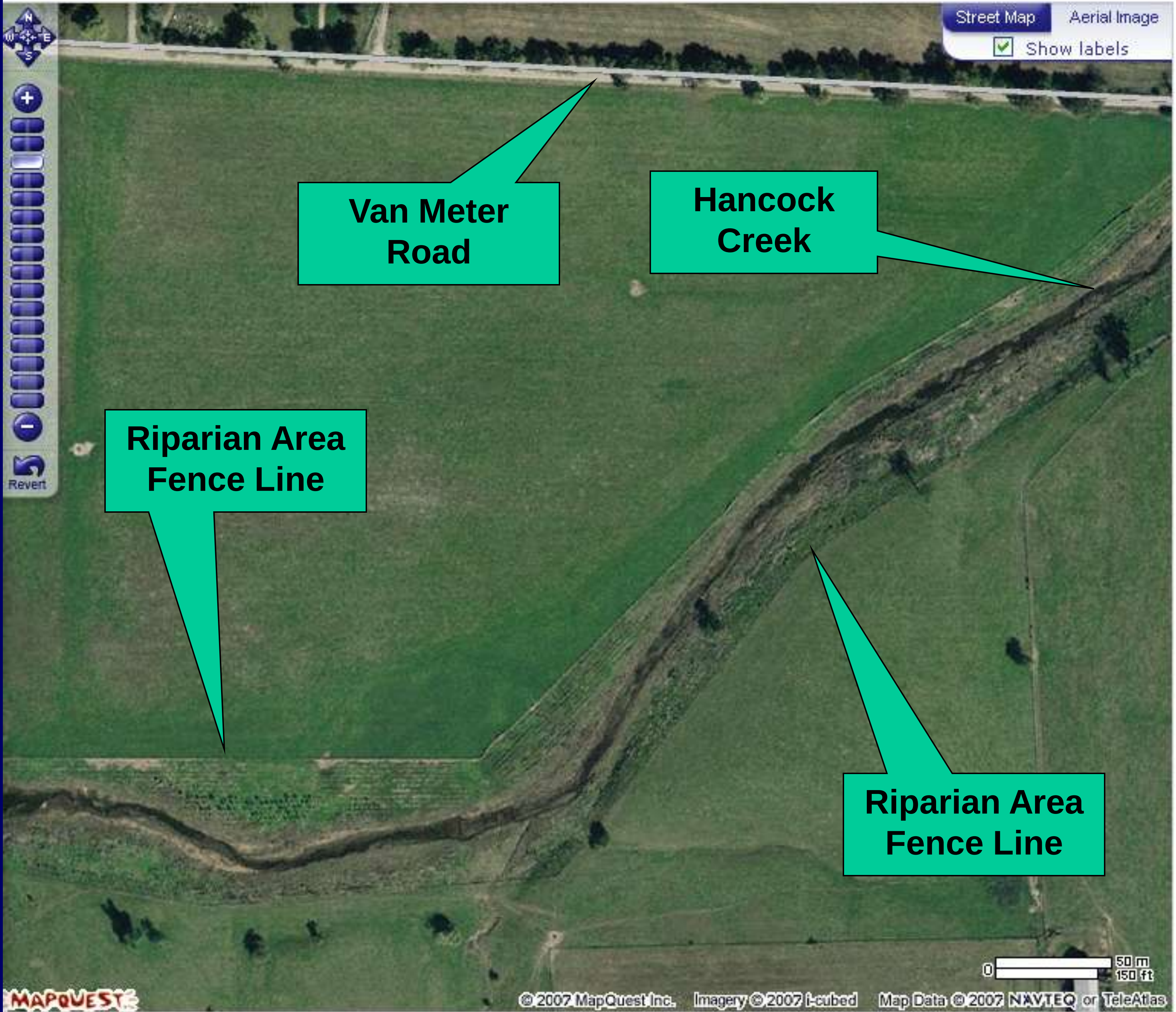
Street Map
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N
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Van Meter Road
Hancock Creek
Riparian Area Fence Line
Riparian Area Fence Line
0
50 m
150 ft
MAPQUEST
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Topography: how does it affect rainfall & snowmelt runoff?

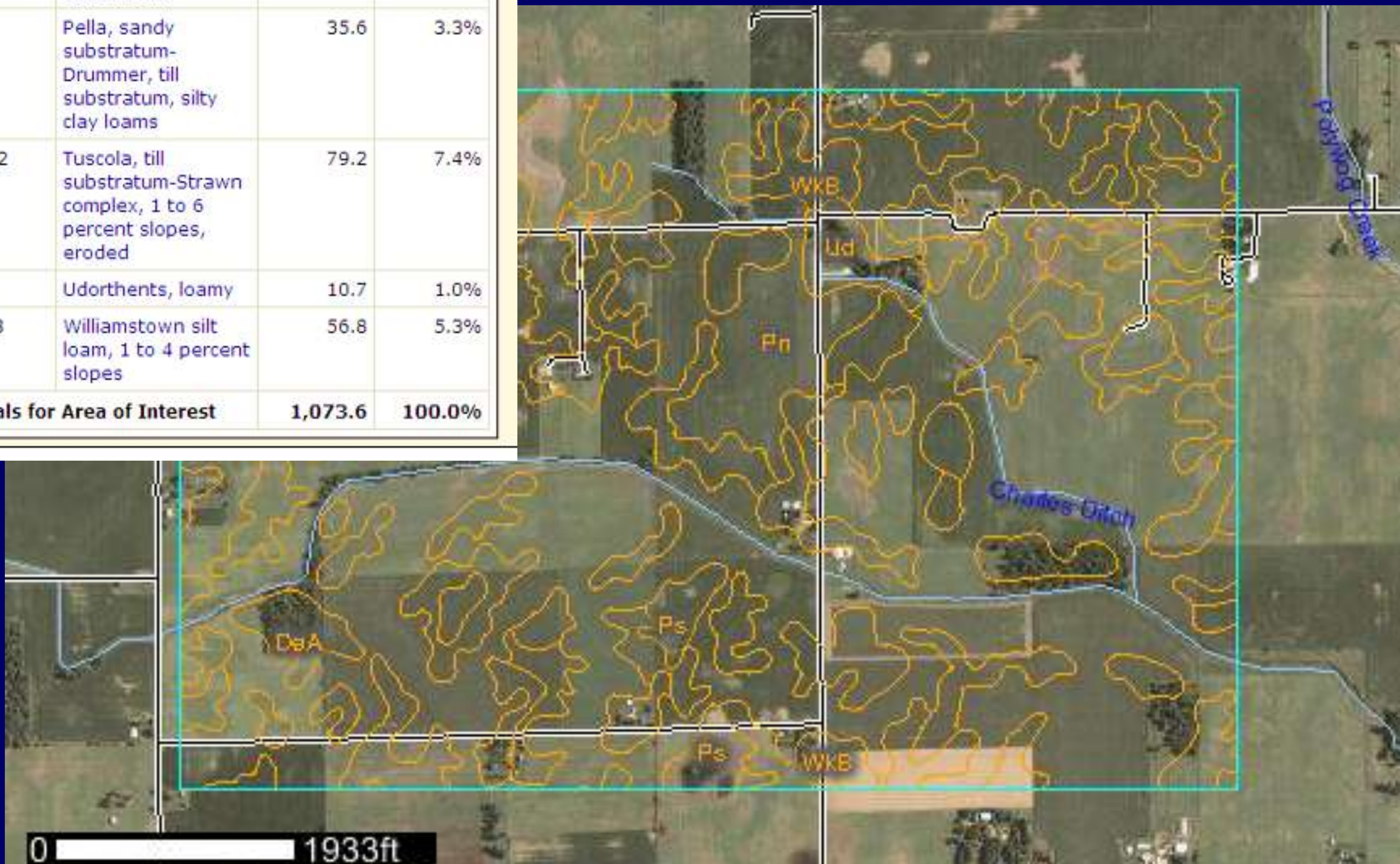
Map
Satellite
Hybrid
Terrain
USGS
Zoom Box
17
USGS
USGS
USGS
957
Quarry
912
950
Moscow
BM
917
930
900
RIVER
USGS
USGS
USGS
930
900
1000 ft
200 m
Google
TerraServer Imagery: USGS - Terms of Use

Soil data – type, infiltration, erodibility, slopes

http://websoilsurvey.nrcs.usda.gov/app/

Tipton County, Indiana (IN159)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
DeA	Del Rey, sandy substratum-Crosby silt loams, 0 to 2 percent slopes	265.0	24.7%
Pn	Patton silty clay loam, sandy substratum	626.3	58.3%
Ps	Pella, sandy substratum-Drummer, till substratum, silty clay loams	35.6	3.3%
TuB2	Tuscola, till substratum-Strawn complex, 1 to 6 percent slopes, eroded	79.2	7.4%
Ud	Udorthents, loamy	10.7	1.0%
WkB	Williamstown silt loam, 1 to 4 percent slopes	56.8	5.3%
Totals for Area of Interest		**1,073.6**	**100.0%**



Description of Patton

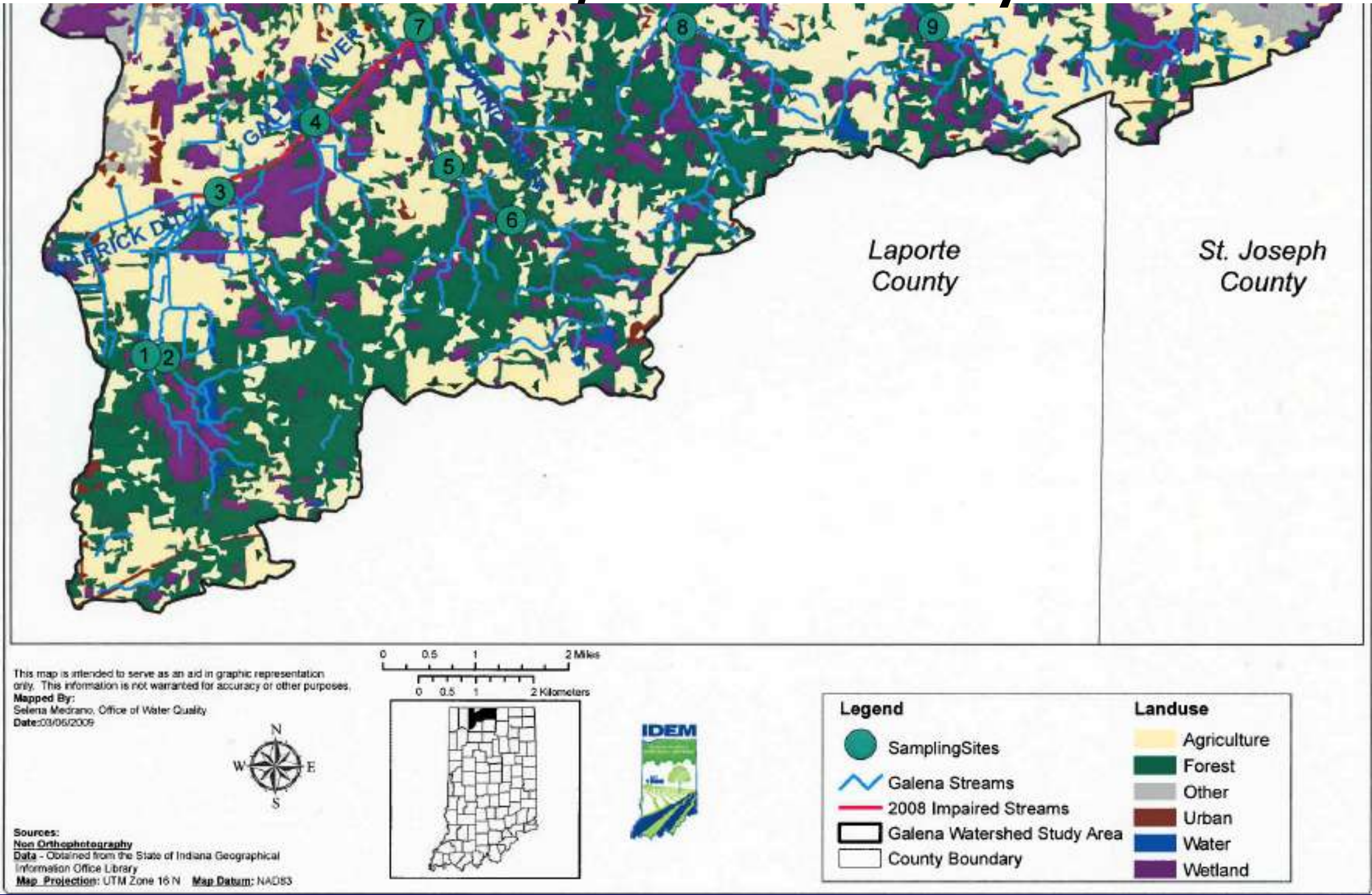
Setting

Landform: Depressions on till plains, depressions on lake plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Flat
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loamy glaciolacustrine deposits over loamy outwash

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: Frequent

Land use/cover analysis

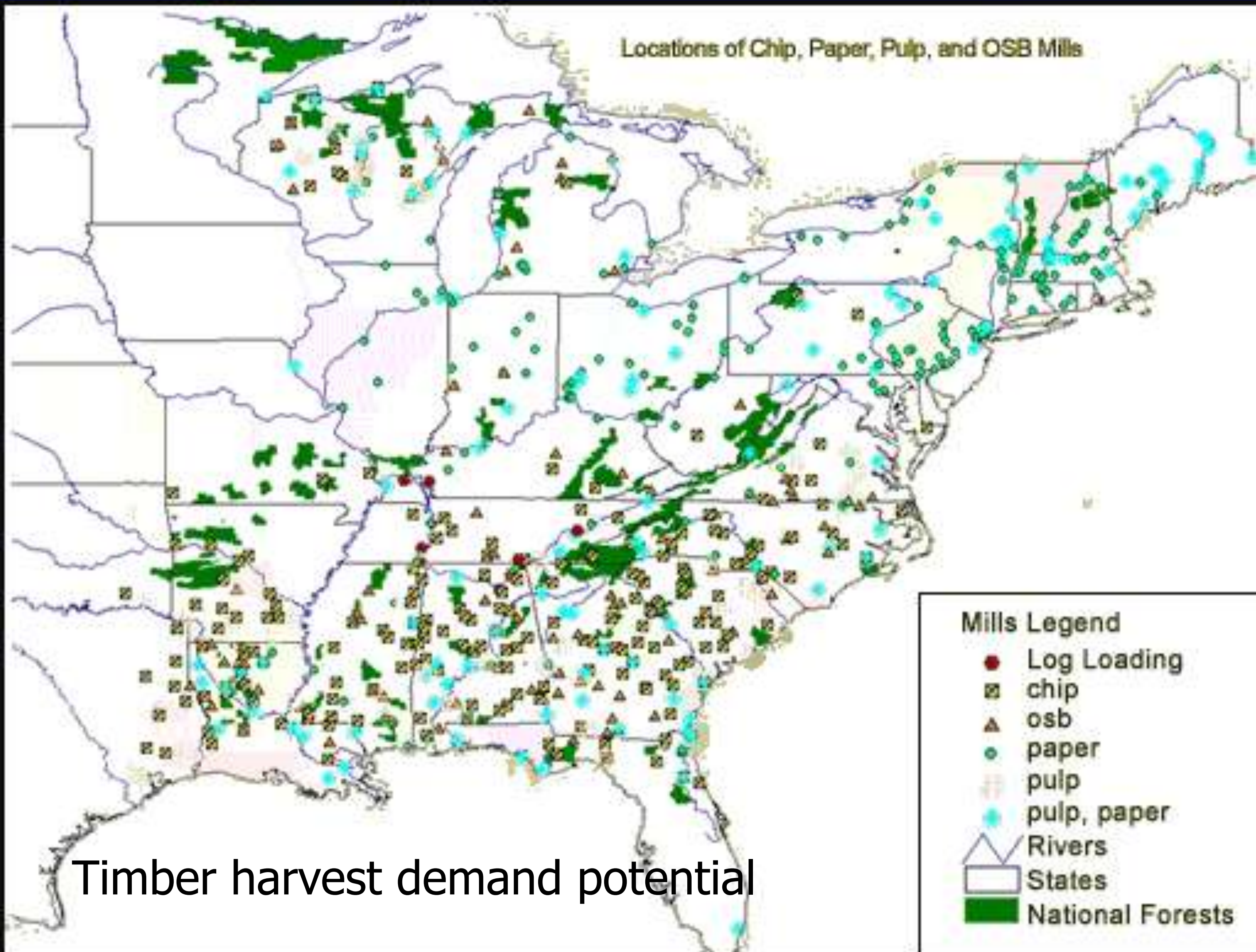


What does land use/cover tell you about water quality?

- Urbanized landscapes
  - Rapid runoff, channel erosion, more metals, higher temperatures, oil & grease
- Suburban areas
  - Lots of sediment during construction, lawn fertilizer, pet waste
- Row crop land
  - More sediment, fertilizer, pesticides, herbicides
- Livestock operations
  - Manure-related nutrients (nitrogen & phosphorus), compacted soils

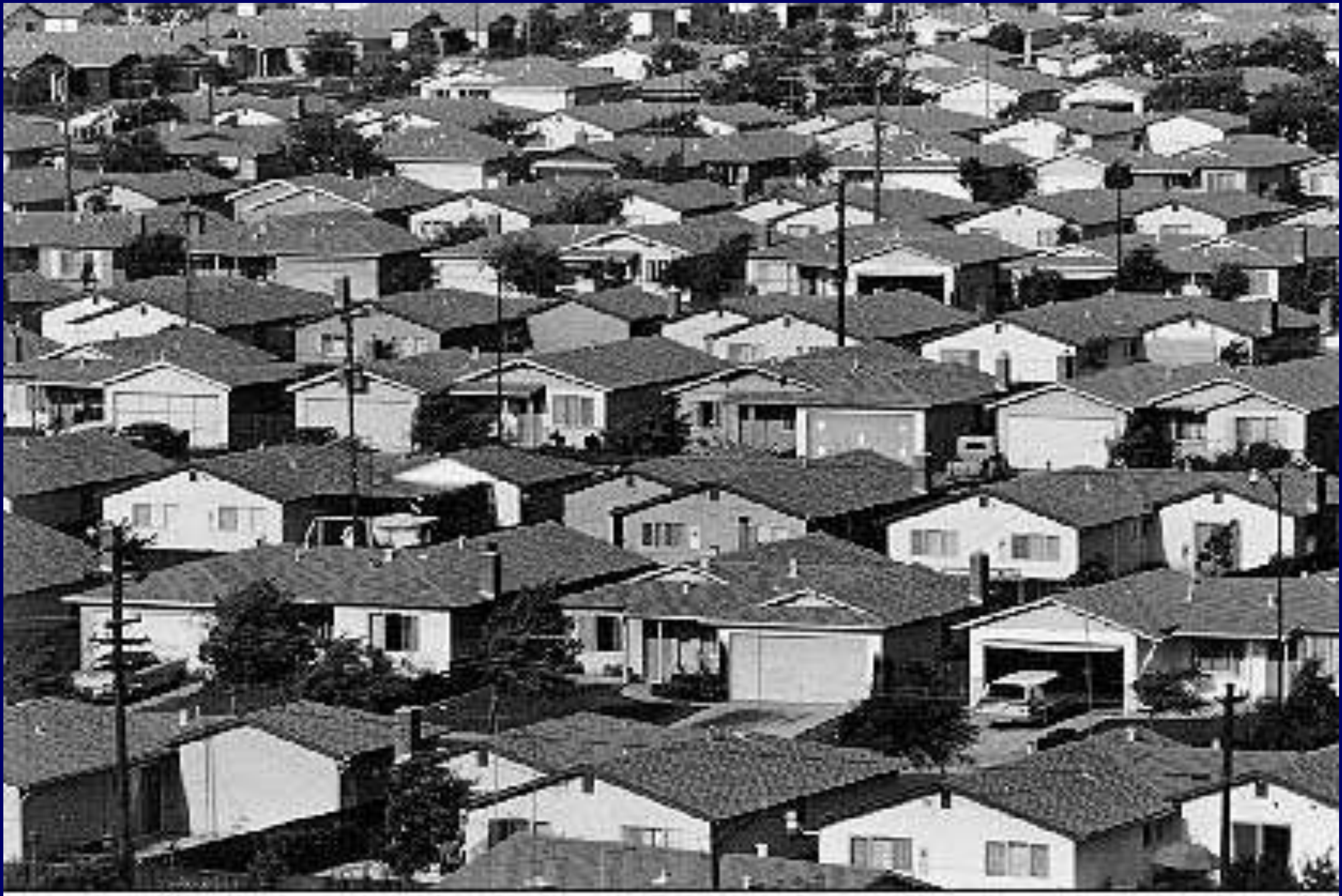
Land management practices can also affect water quality

Windshield & detailed surveys of management practices provide info on potential sites for BMPs



Timber harvest demand potential

Urban impacts: imperviousness, sewage treatment & management



Photograph by Joe Munroe/Ohio Historical Society Collections

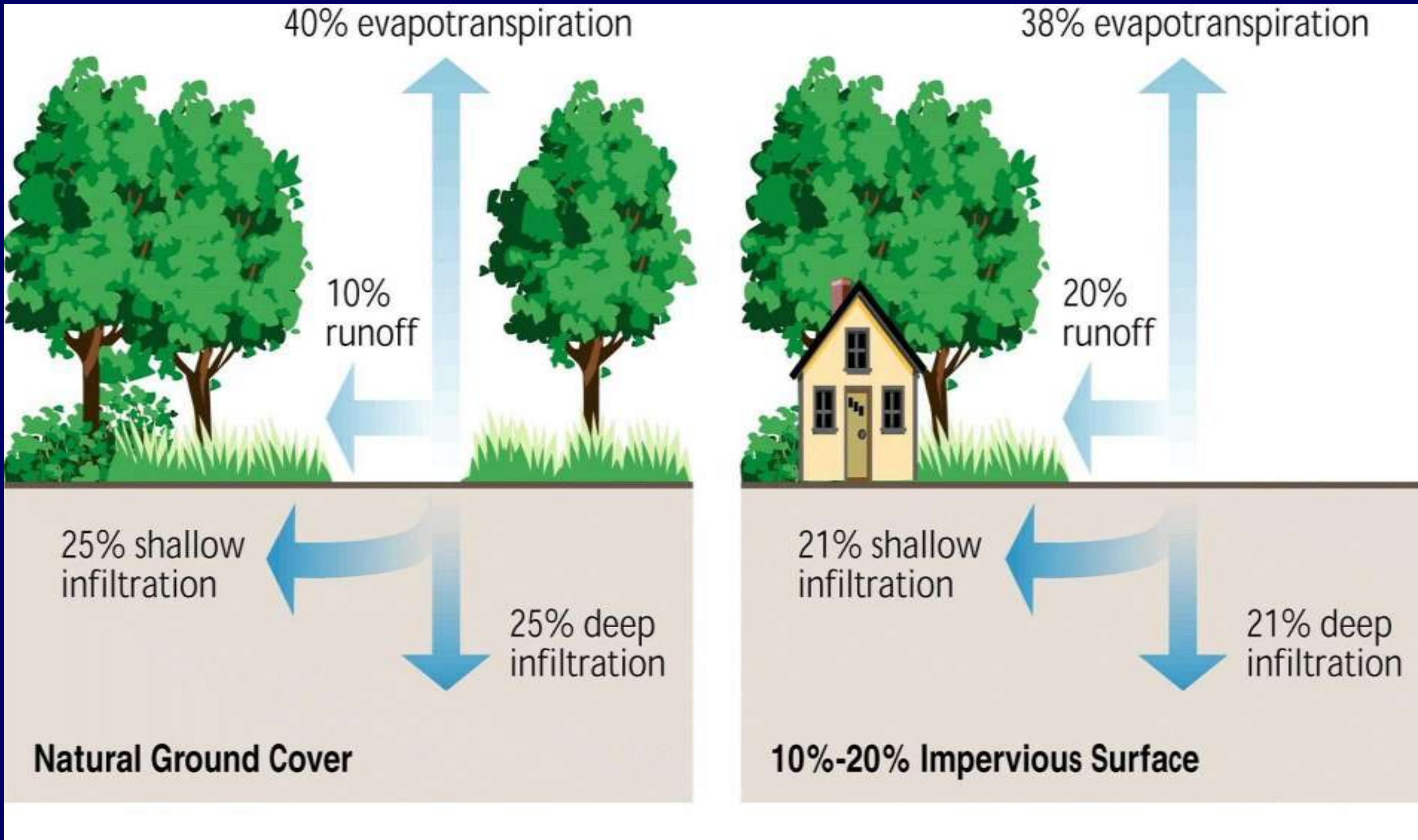
Effects of Development on Stormwater Runoff

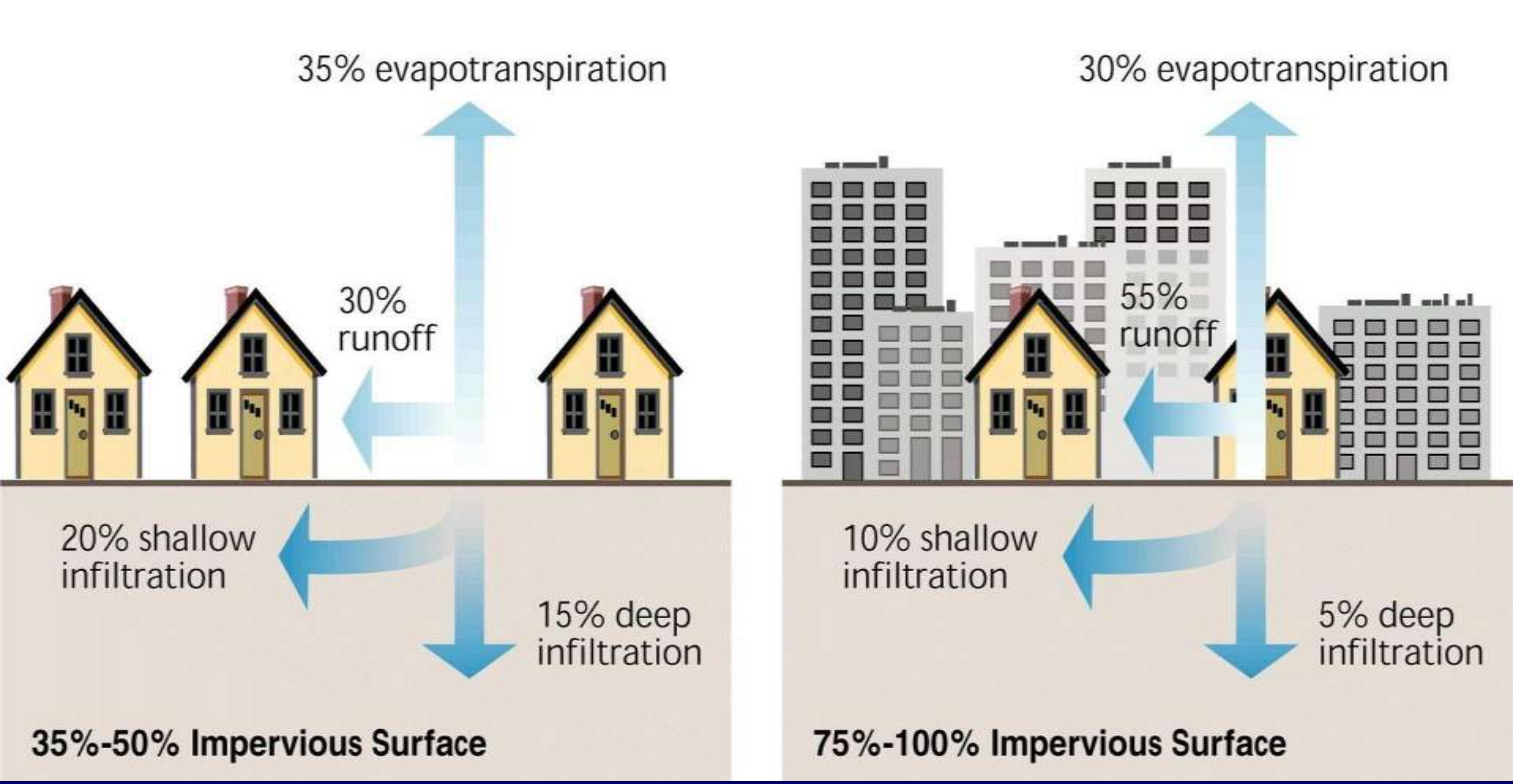
Increases:

- Impervious surface area
- Stormwater volume
- Stormwater velocity
- Deposition of pollutants

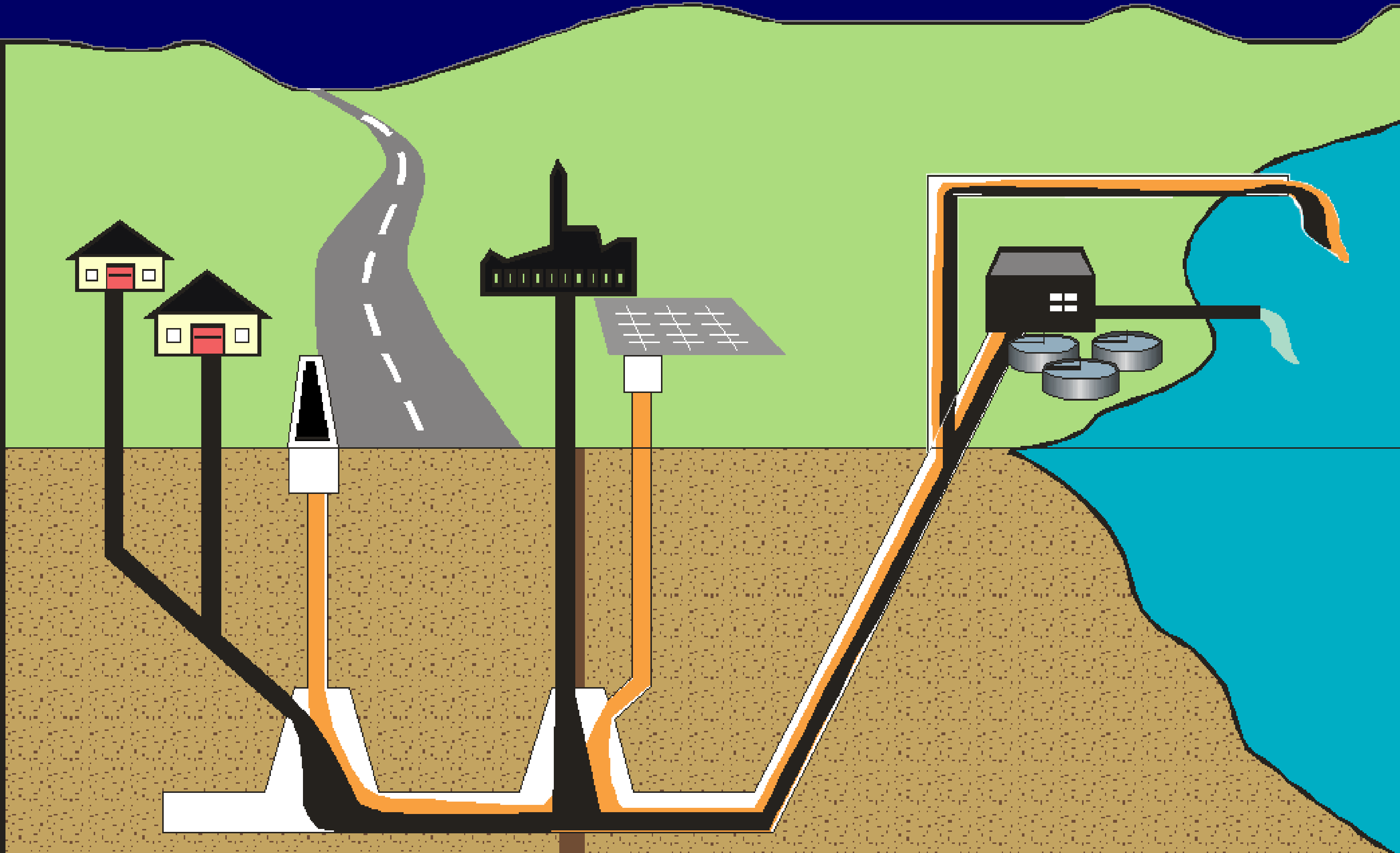
Decreases:

- Stormwater quality
- Ground water recharge
- Base flow
- Natural drainage systems including riparian vegetative cover


40% evapotranspiration
10% runoff
25% shallow infiltration
25% deep infiltration
Natural Ground Cover
38% evapotranspiration
20% runoff
21% shallow infiltration
21% deep infiltration
10%-20% Impervious Surface

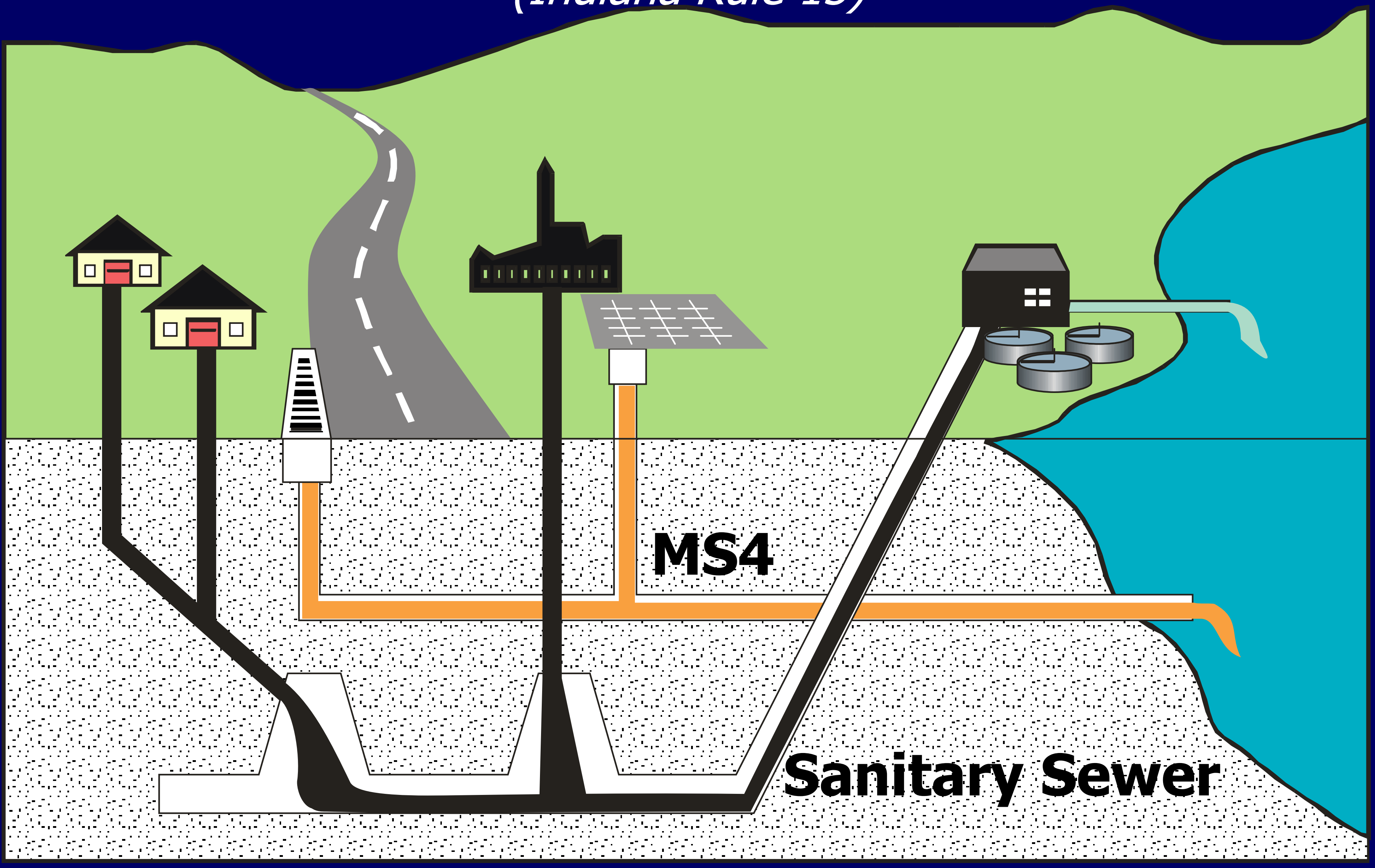

35% evapotranspiration
30% runoff
20% shallow infiltration
15% deep infiltration
35%-50% Impervious Surface
30% evapotranspiration
55% runoff
10% shallow infiltration
5% deep infiltration
75%-100% Impervious Surface

Sewage treatment plants and CSOs



Municipal separate storm sewer systems (MS4s)

(Indiana Rule 13)



Storm water, septic systems, & construction site management (Rule 5)

Storm water samples taken by an automatic sampler during a one-inch rain

Hot spots: legacy and/or existing contaminant sources

T & T Mine Blowout, 1994

Questions

What makes your monitoring and assessment data important?

- When it:
  - Indicates if water poses a human health threat
  - Determines if it can support fish & other aquatic life
  - Identifies a significant and likely source of problems
  - Shows trends that water quality is declining . . . or improving!

A point to ponder . . .

"If you have one data point on a water body, you have infinitely more information about that water body than if you have zero data points . . . . because one is infinitely greater than zero"

Brian Reeder

Identifying and characterizing point and nonpoint pollution

- Some pollutants come from point sources
- Others come from nonpoint sources
- Some come from both . . .

How the Clean Water Act implements the public's demand for clean, healthy surface waters:

- Pollutant discharge controls and limits thru NPDES permits
- Water quality standards that specify beneficial water body uses, minimum criteria, and prevention of degradation

CWA Discharge Permits (Section 402)

If you discharge:

- Pollutants (chemical, physical, biological)
- From a man-made pipe or conveyance
- Into a regulated water body ("water of the U.S.")

You must have permit coverage under the National Pollutant Discharge Elimination System (NPDES)

NPDES Program: Coverage

- Industrial and municipal wastewater
- Industrial, urban, and construction-related storm water runoff
- Concentrated animal feeding operations (CAFOs)
- Active, inactive, and some abandoned mines
- Discharges from RCRA remedial action activity meeting point source definition

Water Quality Standards

- State's yardstick to measure health of waters
- Three key elements of WQSs:
  - Designated uses
  - Water quality criteria
  - Antidegradation provisions

Example Use Designations

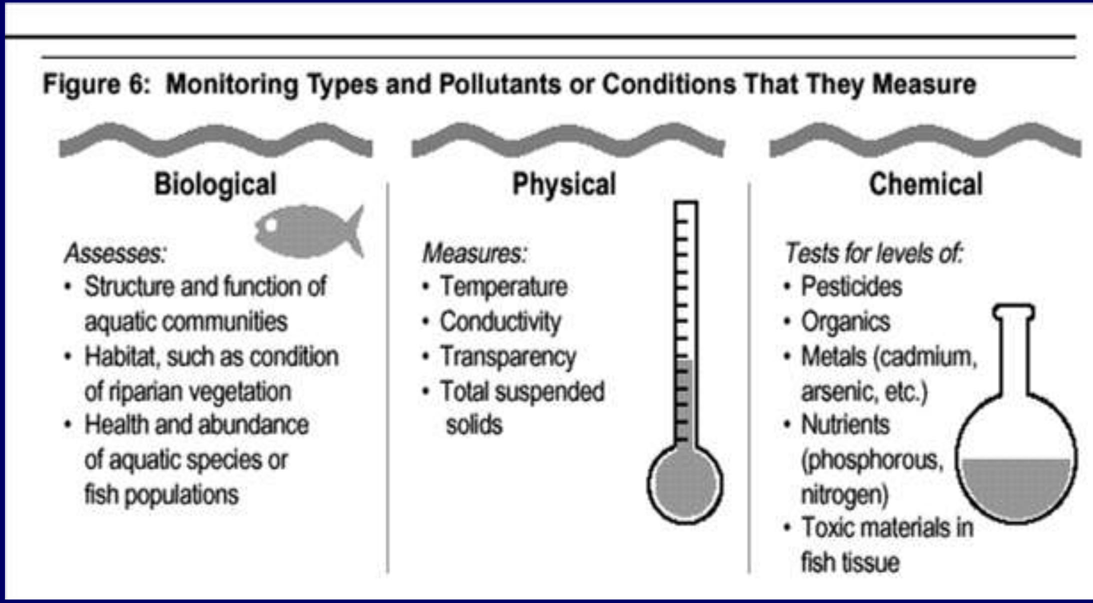
- Aquatic life support – warmwater & coldwater aquatic habitat
- Primary contact recreation – swimming
- Secondary contact recreation – boating and fishing
- Fish consumption – eating fish
- Drinking water – domestic water supply






Water Quality Criteria

- Developed to protect designated uses
- Basic types of criteria
  - Narrative/numeric
  - Water column/ sediment/fish tissue
- Criteria can relate to:
  - Aquatic life
  - Human health
  - Wildlife



Water quality criteria in Indiana code

Parameter	Target	Reference/Other Information
Total Ammonia (NH3)	Range between 0.0 and 0.21 mg/L depending upon temperature and pH	Indiana Administrative Code (IAC)
Atrazine	Max: 3.0 ppb	U.S. EPA Drinking Water Standard
Dissolved Oxygen (DO)	Min: 4.0 mg/L Max: 12.0 mg/L	Indiana Administrative Code (IAC)
	Min: 6.0 mg/L in coldwater fishery streams	Indiana Administrative Code (IAC)
	Min: 7.0 mg/L in spawning areas of coldwater fishery streams	Indiana Administrative Code (IAC)
E. coli	Max: 235 CFU/ 100mL in a single sample	Indiana Administrative Code (IAC)
	Max: Geometric Mean of 125 CFU/ 100mL from 5 equally spaced samples over a 30-day period	Indiana Administrative Code (IAC)
Nitrate	Max: 10 mg/L in waters designated as a drinking water source	Indiana Administrative Code (IAC)
Nitrite	Max: 1 mg/L in waters designated as a drinking water source	Indiana Administrative Code (IAC)
Nitrate-N + Nitrate-N	Max: 10 mg/L in waters designated as a drinking water source	Indiana Administrative Code (IAC)
Temperature	Dependant on time of year and whether stream is designated as a cold water fisheries	Indiana Administrative Code (IAC)

Examples of non-regulatory water quality targets used in Indiana

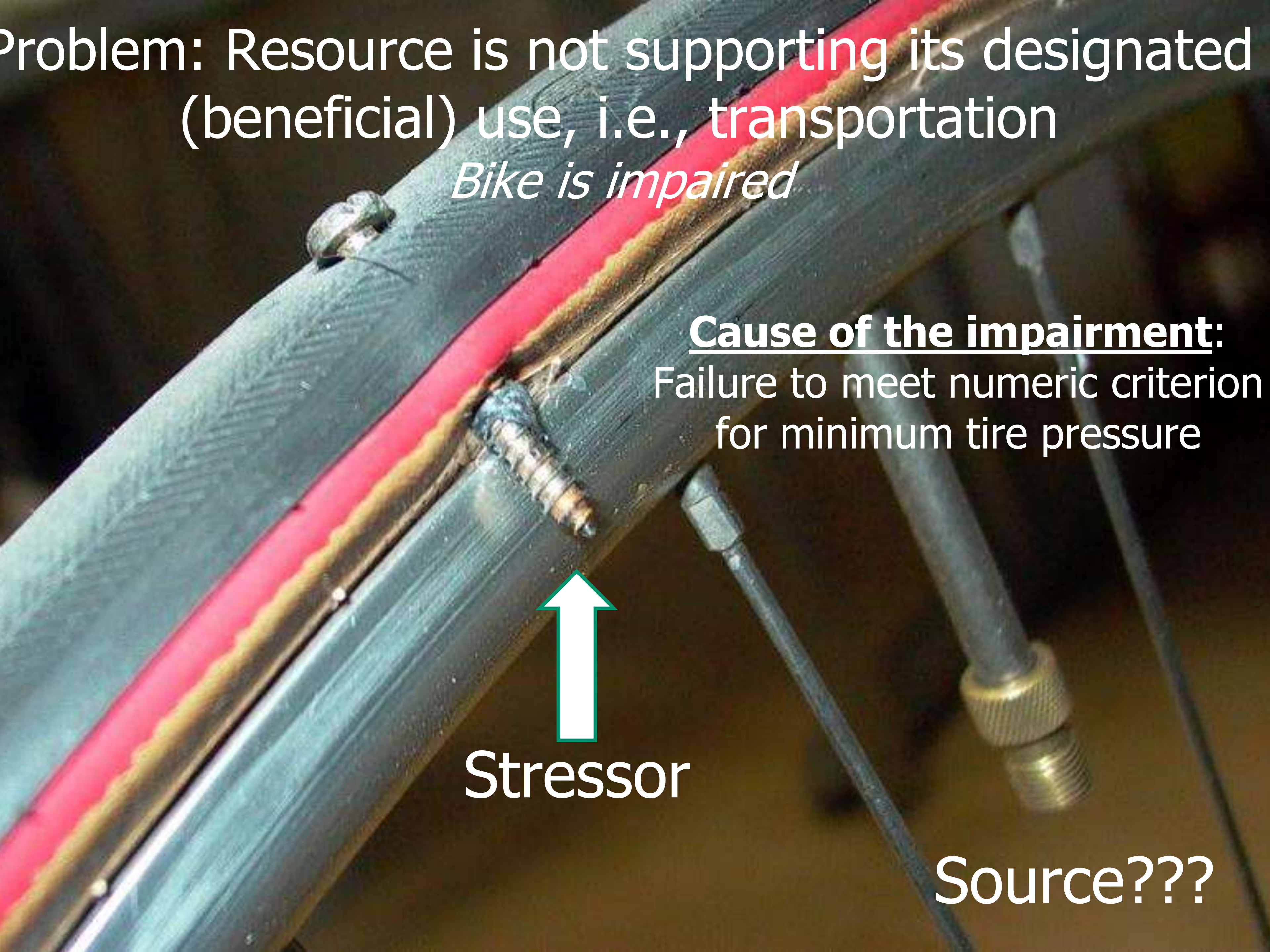
Parameter	Target	Reference/Other Information
Nitrate-nitrogen (NO3)	Max: 0.633 mg/L	U.S. EPA recommendation *
	Max: 1.0 mg/L	Ohio EPA recommended criteria for Warm Water Habitat (WWH) headwater streams and Modified Warm Water Habitat (MWH) headwater streams
	1.5 mg/L	Dividing line between mesotrophic and eutrophic streams (Dodd et al. 1998)
	10.0 mg/L	IDEM draft TMDL target
Ortho-Phosphate also known as Soluble reactive phosphorus (SRP)	Max: 0.005 mg/L	Wawasee Area Conservancy Foundation recommendation for lake systems
Suspended Sediment Concentration (SSC)	Max: 25.0 mg/L	U.S. EPA recommendation for excellent fisheries
	Range: 25.0-80.0 mg/L	U.S. EPA recommendation for good to moderate fisheries
Total Kjeldahl Nitrogen (TKN)	Max: 0.591 mg/L	U.S. EPA recommendation *
Total Phosphorus	Max: 0.076 mg/L	U.S. EPA recommendation
	0.07 mg/L	Dividing line between mesotrophic and eutrophic streams (Dodd et al. 1998)
	Max: 0.08 mg/L	Ohio EPA recommendation to protect aquatic biotic integrity in WWH
	Max: 0.3 mg/L	IDEM draft TMDL target
Total Suspended Solids (TSS)	Max: 80.0 mg/L	Wawasee Area Conservancy Foundation recommendation to protect aquatic life in lake systems
	Max: 30.0 mg/L	IDEM draft TMDL target
	Range: 25.0-80.0 mg/L	Concentrations within this range reduce fish concentrations (Waters, 1995)
	Max: 40.0 mg/L	New Jersey criteria for warm water streams
	Max: 46.0 mg/L	Minnesota TMDL criteria for protection of fish/macroinvertebrate health
Turbidity	Max: 25.0 NTU	Minnesota TMDL criteria for protection of fish/macroinvertebrate health
	Max: 10.4 NTU	U.S. EPA recommendation

What we're trying to do:

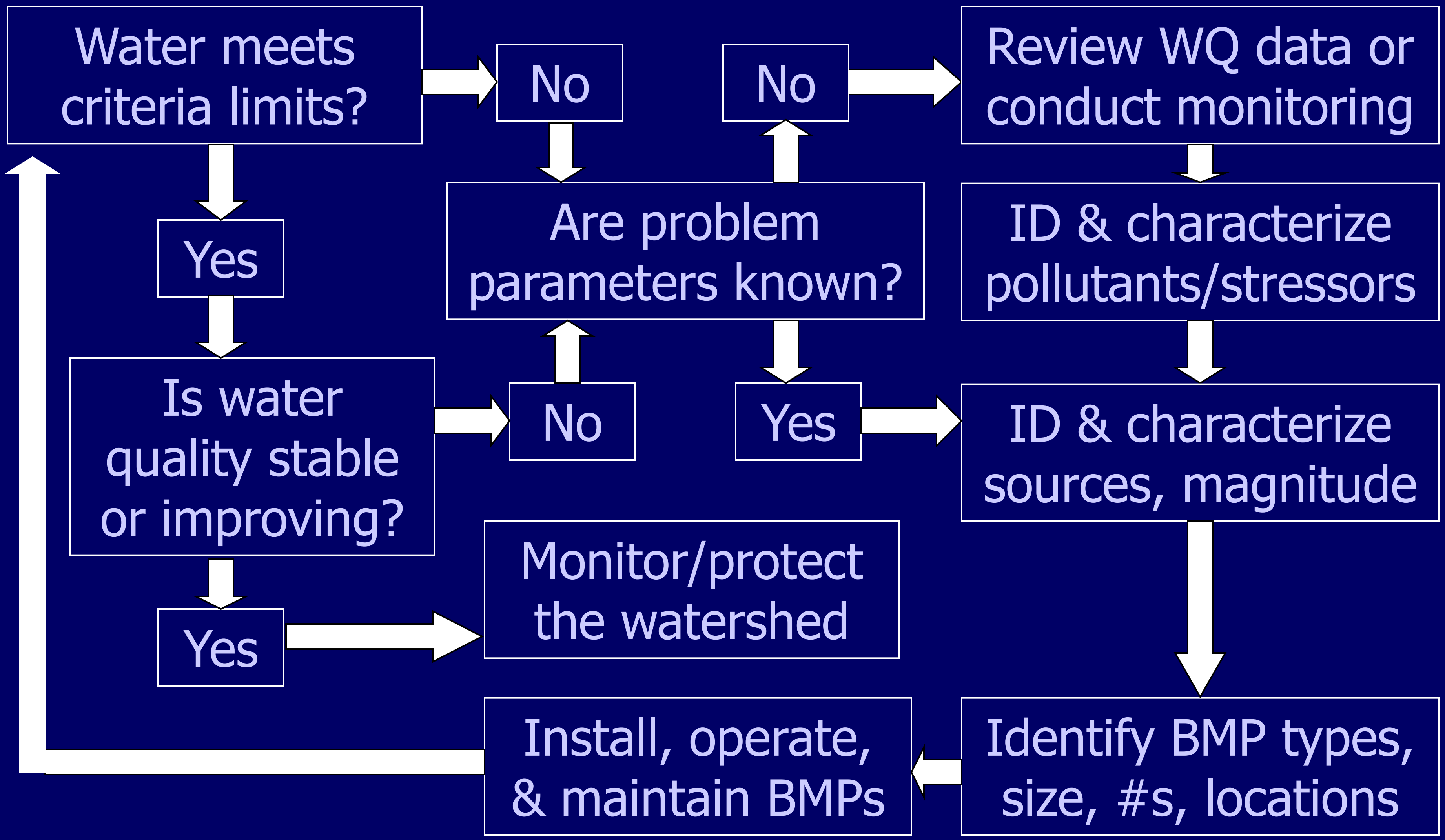
- Identify problems
  - Water quality impairments, threats, trends downward
- Characterize problems
  - Use indicators to ID stressors, sources, and relative magnitude
- Fix problems
  - BMPs selected, sited, sized, and operated to address specific issues
- Check up on the fix
  - Post implementation monitoring & adjustment

Screening for problems & threats

- What do you know about water quality, land use, land cover, and management?
- Does the water body meet the numeric and narrative criteria for its designated uses?
- If not, what are the problems & sources?
- If so, what are the trends – improving, or declining?


Problem: Resource is not supporting its designated
(beneficial) use, i.e., transportation
Bike is impaired
Cause of the impairment:
Failure to meet numeric criterion
for minimum tire pressure
Stressor
Source???

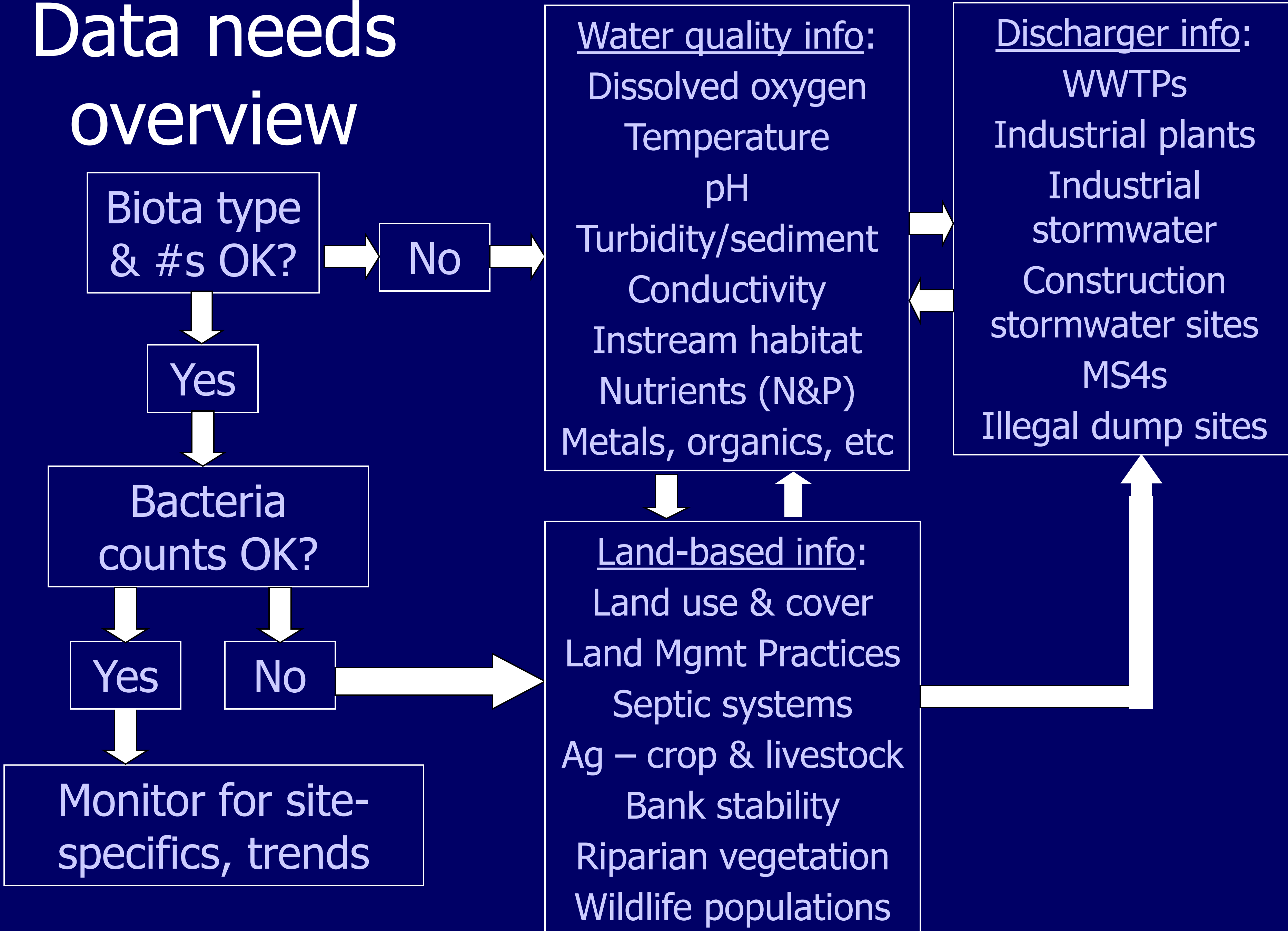
Summary of the overall process



We can’t monitor for everything

- We need to focus our efforts
  - Use existing data to get started
  - Biological & visual assessments are good for screening purposes
  - If necessary, follow up with instream (or upland) assessments

Data needs overview



Which data are most important?

- Water quality data
  - Defined to support use(s)
- Land use information
  - Clues to pollutant sources
- Land cover mapping
  - IDs rapid runoff areas
- Land management practices
  - Tips on where BMPs needed

Water quality data

- Key monitoring info includes
  - Dissolved oxygen, pH, temperature, nutrients, sediment, bacteria, pesticides, herbicides, metals
  - Biological assessments can help screen out healthy sites
- Look at your results as compared to the water quality criteria and targets

Land “quality” data . . .

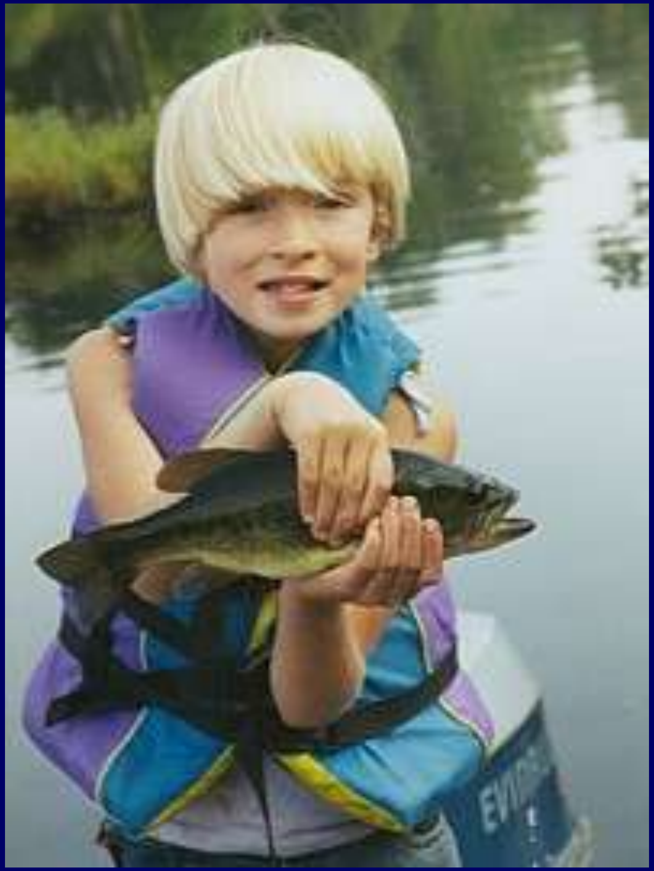
- Land use
  - Percentage in row crops, pasture, animal feeding operations, residential, commercial, urban
- Land cover
  - Matches land use; key info is what’s impervious (paved, buildings, etc.), what’s well vegetated, what’s not
- Land management
  - Are potential pollutants associated with the land uses managed, to prevent polluted runoff?
  - Includes crop & livestock practices, stormwater management, lawn & garden measures

Pollutant	Potential Sources	
	Point Sources	**Nonpoint Sources**
Nutrients (N&P)	WWTPs CSOs & SSOs CAFOs MS4s	Cropland and pastures Manure application sites Landscaped/lawn/fertilized areas Pets, wildlife, & other animals Eroded soil & stream banks Malfunctioning septic systems
Pathogens	WWTPs CSOs & SSOs CAFOs MS4s	Pets, wildlife, & other animals Land application of manure Land application septage Malfunctioning septic systems
Sediment	WWTPs Urban stormwater	Row crop land Overgrazed pastures Timber harvest areas Stream bank erosion Unmanaged construction sites Unpaved roads / ditches Stream channel modification

Best management practices

Scoping and engaging others

- Somebody probably has data for your watershed
- Including water quality data, land use/cover info, ag stats, etc.
- A data search is always a good first step – check web sites, e.g., https://engineering.purdue.edu/~inwater/



We want a lot from our data!

- We want it to be:
  - Inclusive: covering key parameters of concern
  - Credible: to accurately reflect water quality conditions
  - Robust: to reflect conditions under a variety of rainfall/flow regimes
  - Useful: helping us identify appropriate solutions
  - Efficient: the least cost for the most benefit!

The All-In-One Hammer Flask