

# USING GIS TECHNOLOGY

## TO IMPROVE WATERSHED MANAGEMENT PLANNING AND IMPLEMENTATION TRACKING OF SURFACE WATERS

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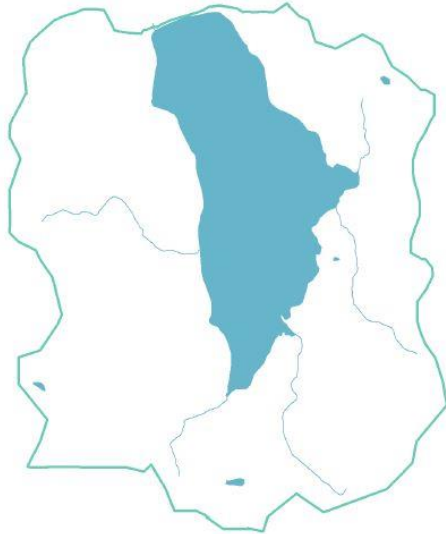


# MERRYMEETING RIVER

# PLEASANT LAKE

# PLEASANT LAKE

## WATERSHED RESTORATION PLAN

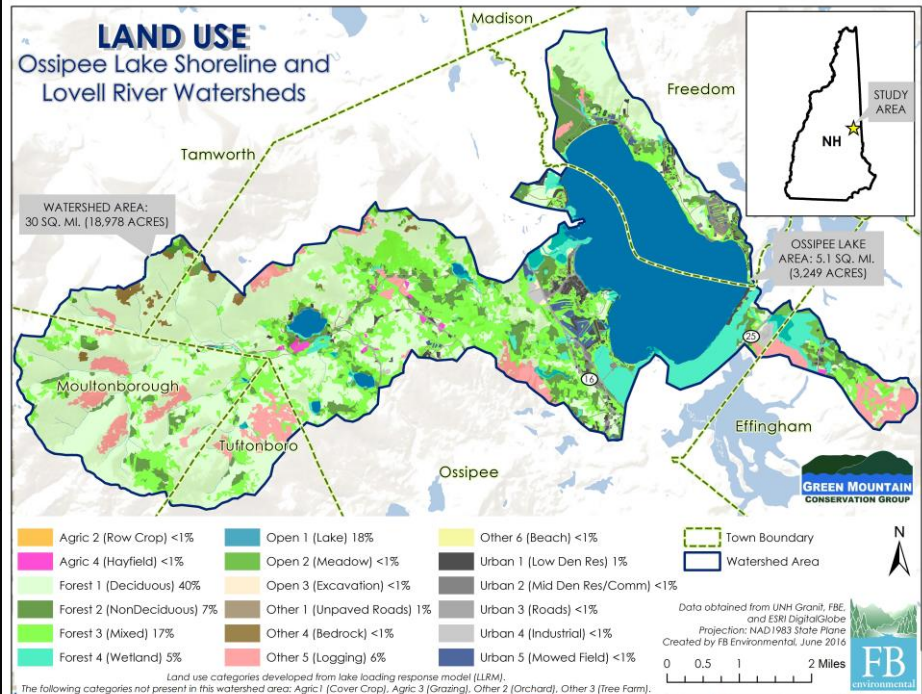
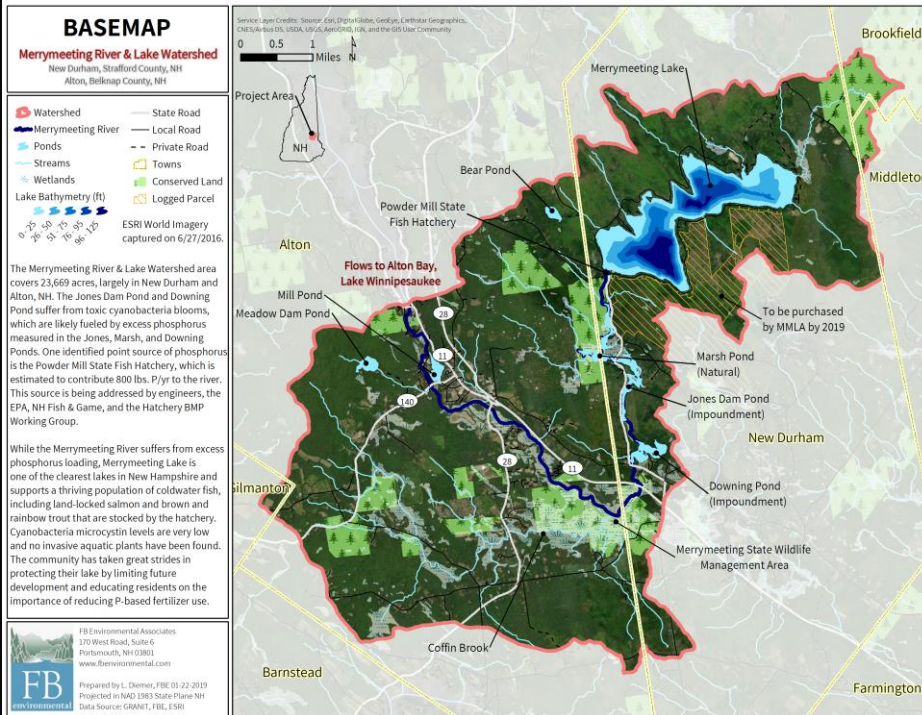


FINAL JANUARY 2017

PREPARED FOR  
SOUTHERN NH PLANNING COMMISSION  
438 Dubuque St  
Manchester, NH 03102

PREPARED BY  
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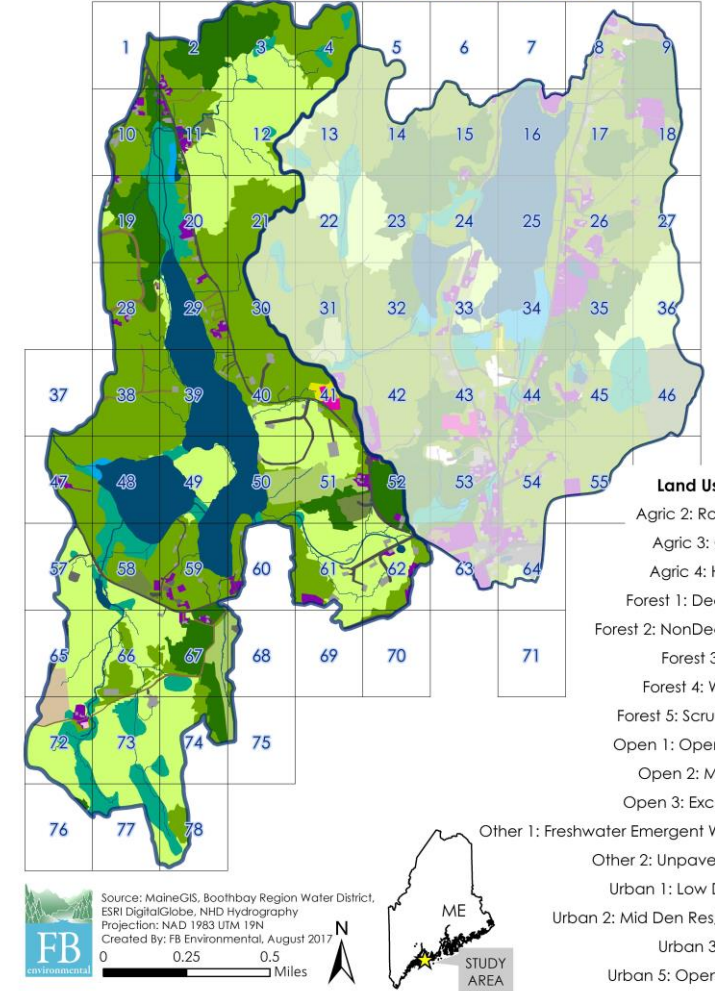
# OSSIPEE LAKE



# KNICKERBOCKER LAKE

## LAND USE QUADS

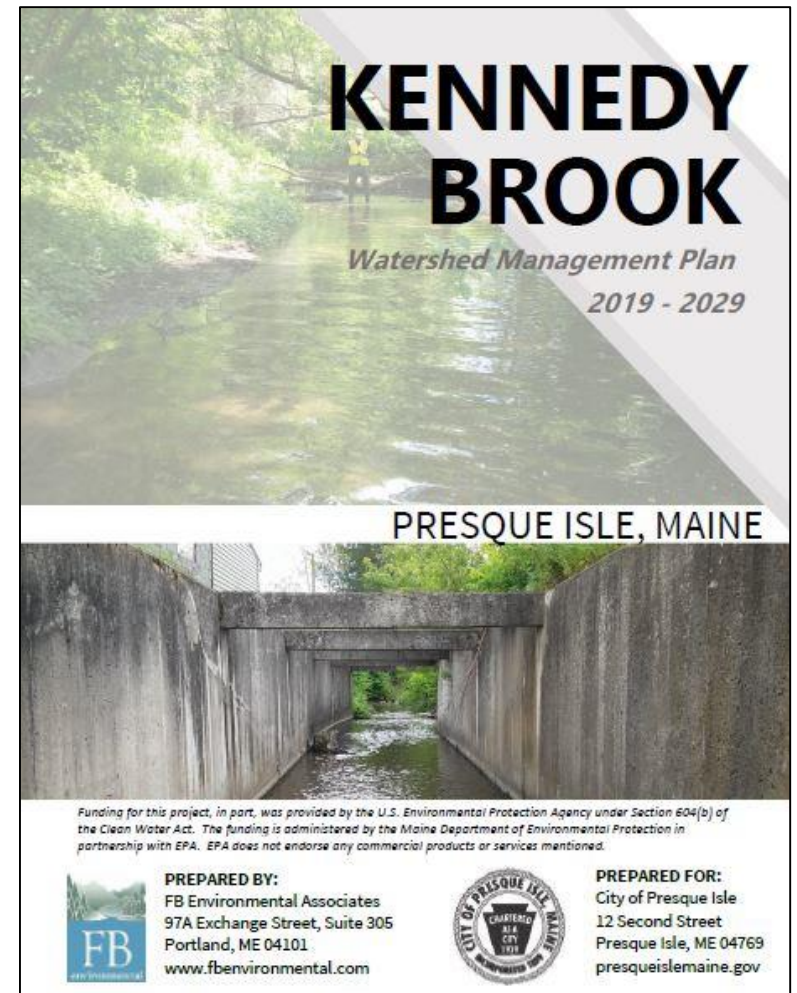
### Knickerbocker Lake



# EPA'S NINE ELEMENTS

1. Identification of causes
2. Estimate pollutant loads + reductions
3. Nonpoint source management
4. Identify technical + financial assistance
5. Perform outreach + education
6. Identify a project timeline
7. Set measurable milestones
8. Identify criteria to measure success
9. Create a water quality monitoring plan

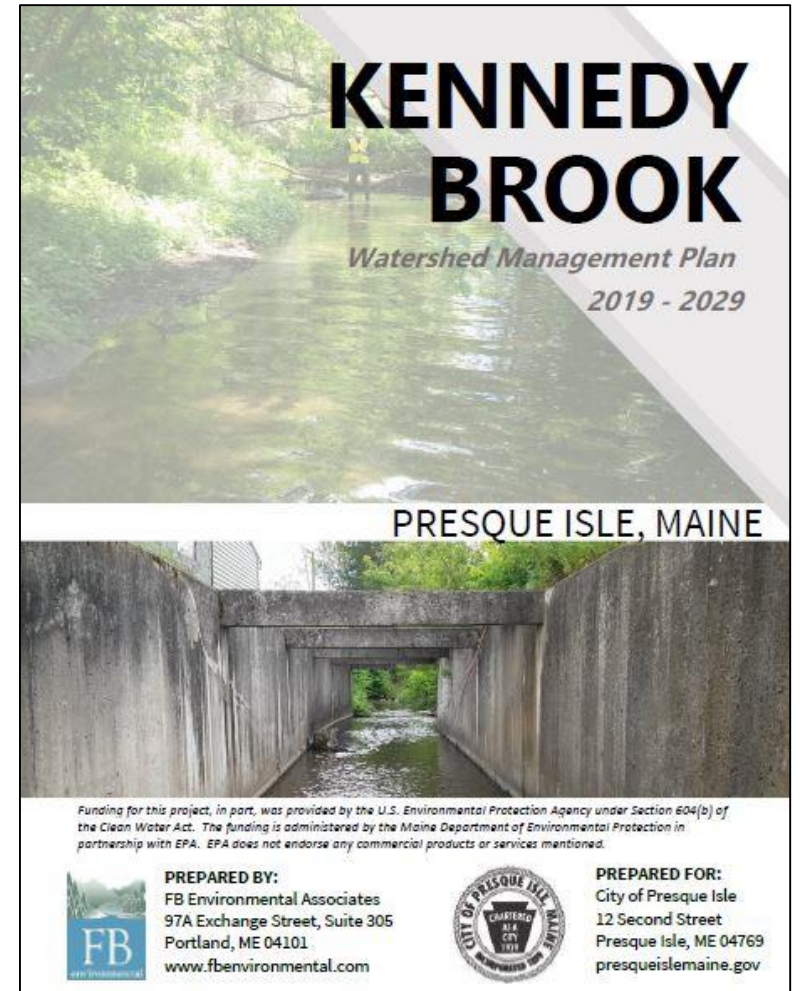
## Example Nine-Element Plan



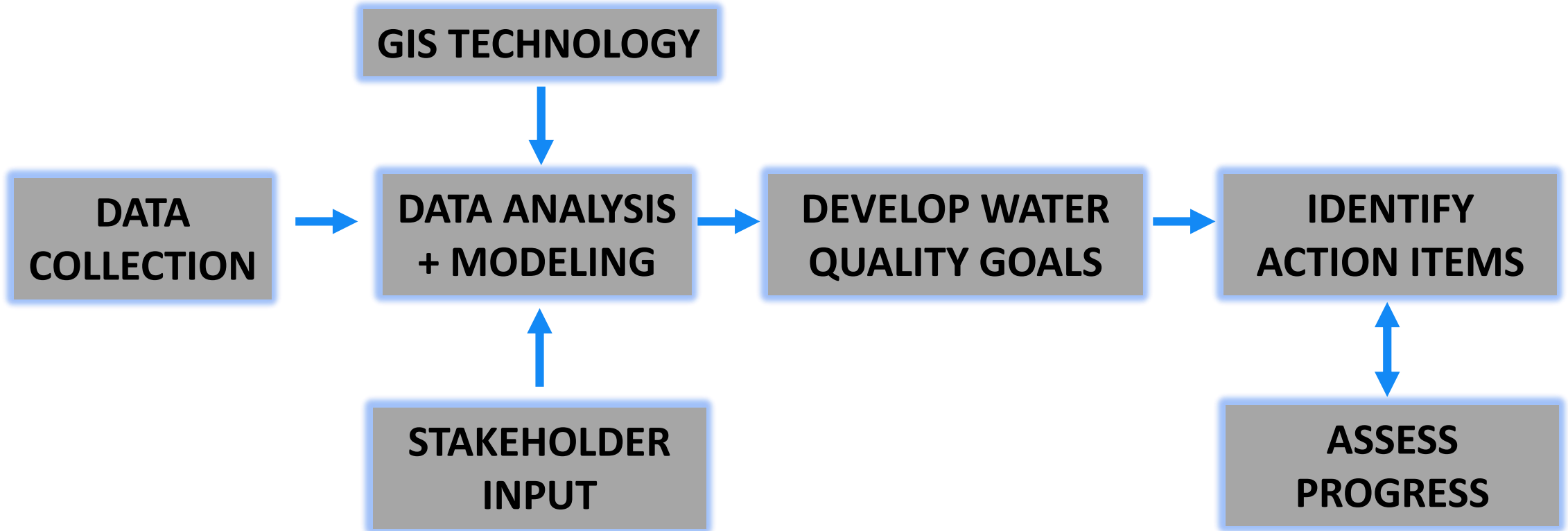
# EPA'S NINE ELEMENTS

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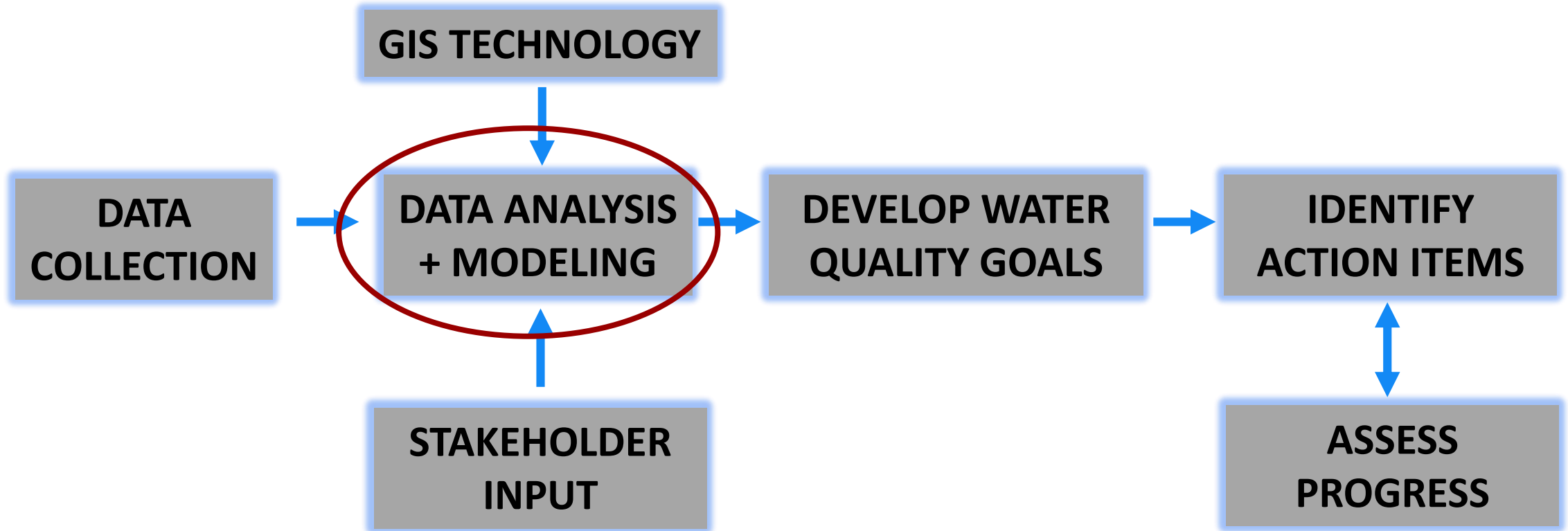
## Example Nine-Element Plan



# PLANNING + IMPLEMENTATION PROCESS



# PLANNING + IMPLEMENTATION PROCESS



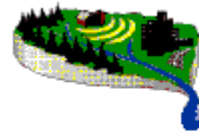
# ANALYSIS TOOLS



**ArcGIS**



**Google** Earth



**BASINS**

Better Assessment  
Science Integrating Point  
and Nonpoint Sources

# PLANNING + IMPLEMENTATION PROCESS

1. LAND COVER ASSESSMENT →



+



2. SUB-BASIN DELINEATION →



+





# 1. LAND COVER ASSESSMENT



ArcGIS



esri®

Spatial Analyst



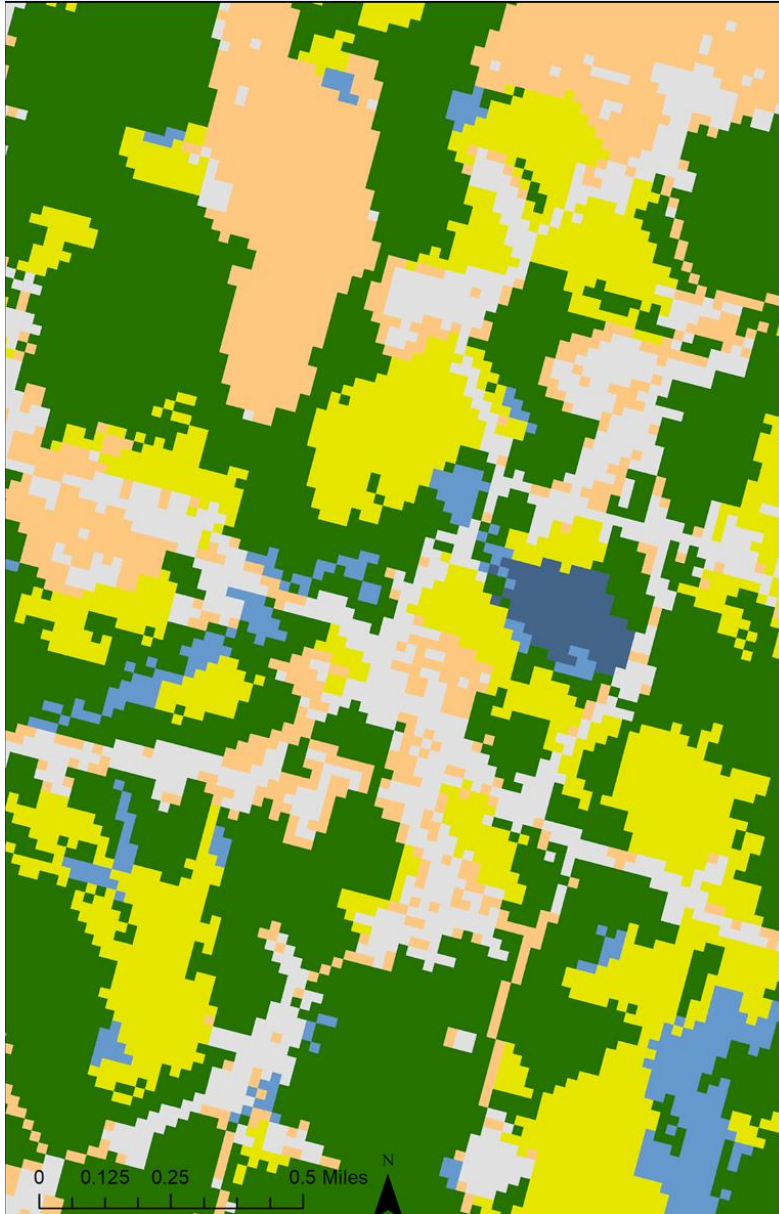
Google Earth

# LAND COVER ASSESSMENT

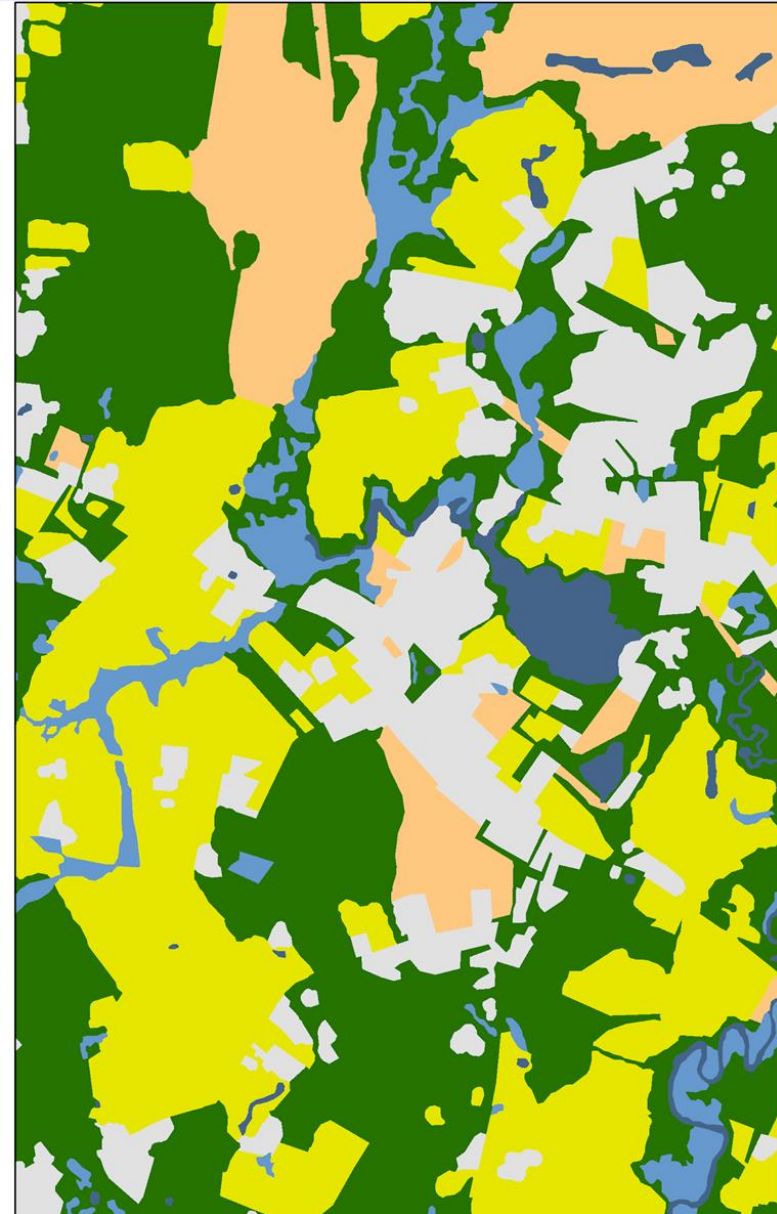


# LAND COVER ASSESSMENT

National  
Land Cover  
Dataset
















State Specific  
Land Cover  
Dataset


















# LAND COVER ASSESSMENT

- DIFFERENCES IN LAND COVER CLASSIFICATION

## NH LAND COVER CATEGORIES

	Residential/Commercial/Industrial
	Transportation
	Row Crops
	Hay/Pasture
	Orchards
	Beech/Oak
	Paper Birch/Aspen
	Other Hardwoods
	White/Red Pine
	Spruce/Fir
	Hemlock
	Pitch Pine
	Mixed Forest
	Alpine (Krumholz)

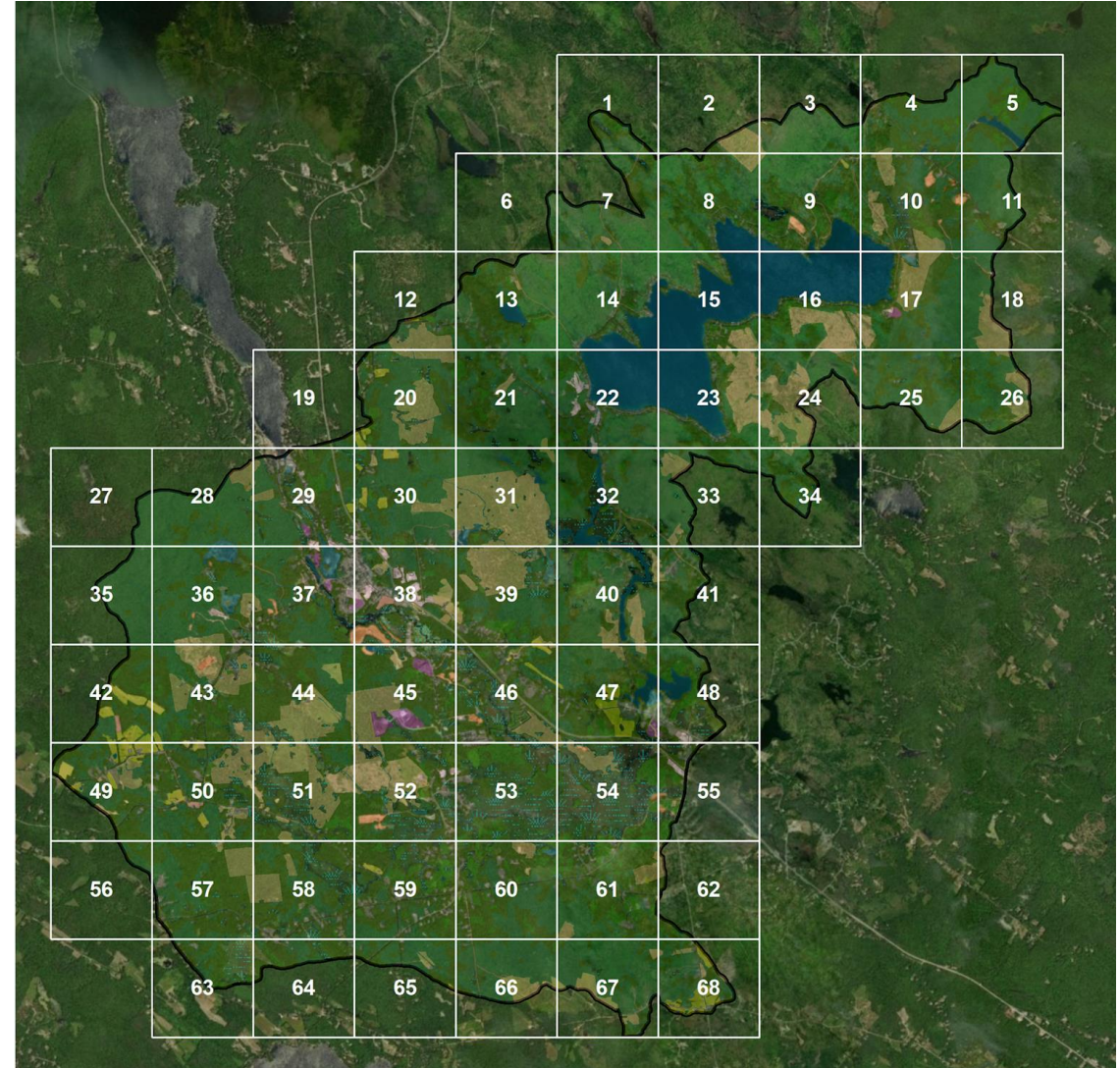
## LAKE LOADING RESPONSE MODEL CATEGORIES

Agric 2: Row Crop	
Agric 3: Grazing	
Agric 4: Hayfield	
Forest 1: Deciduous	
Forest 2: NonDeciduous	
Forest 3: Mixed	
Forest 4: Wetland	
Forest 5: Scrub-Shrub	
Open 1: Open Water	
Open 2: Meadow	
Open 3: Excavation	
Other 1: Freshwater Emergent Wetland	
Other 2: Unpaved Road	
Urban 1: Low Den Res	
Urban 2: Mid Den Res/Comm	
Urban 3: Roads	
Urban 5: Open Space	



# LAND COVER ASSESSMENT

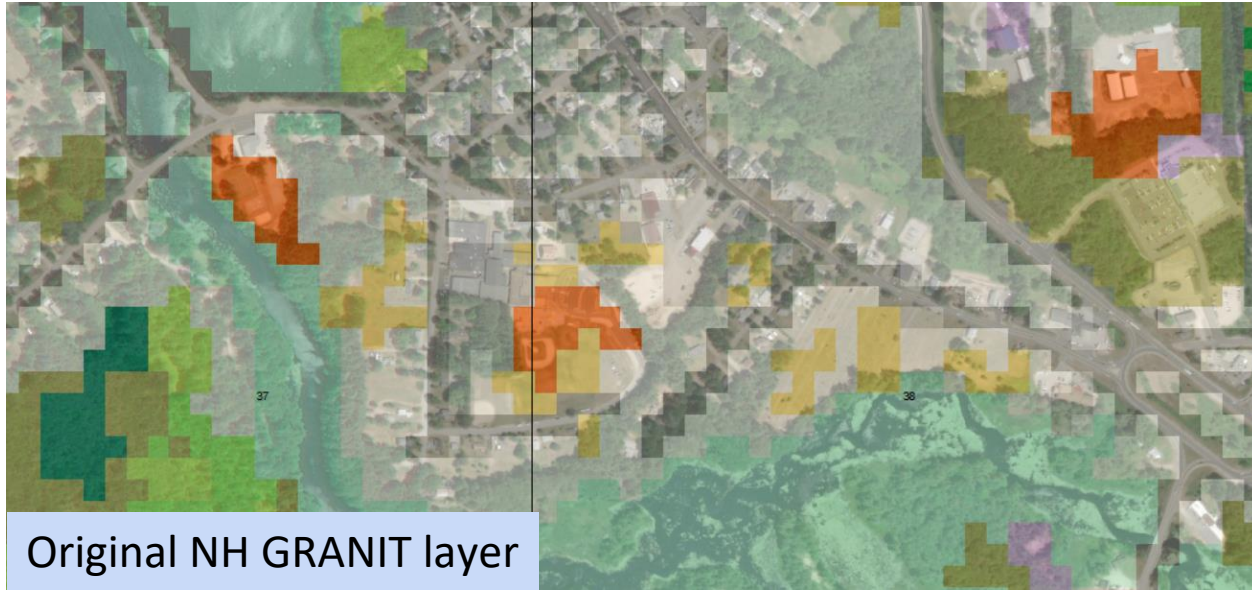
1. Clip to watershed
2. Convert to polygon
3. Simplify or expand your land cover categories to relate to your project goal
4. Overlay paved/unpaved roads, add wetlands, add streams
5. Create fishnet
6. Edit land cover layer and update!



# LAND COVER ASSESSMENT



# LAND COVER ASSESSMENT

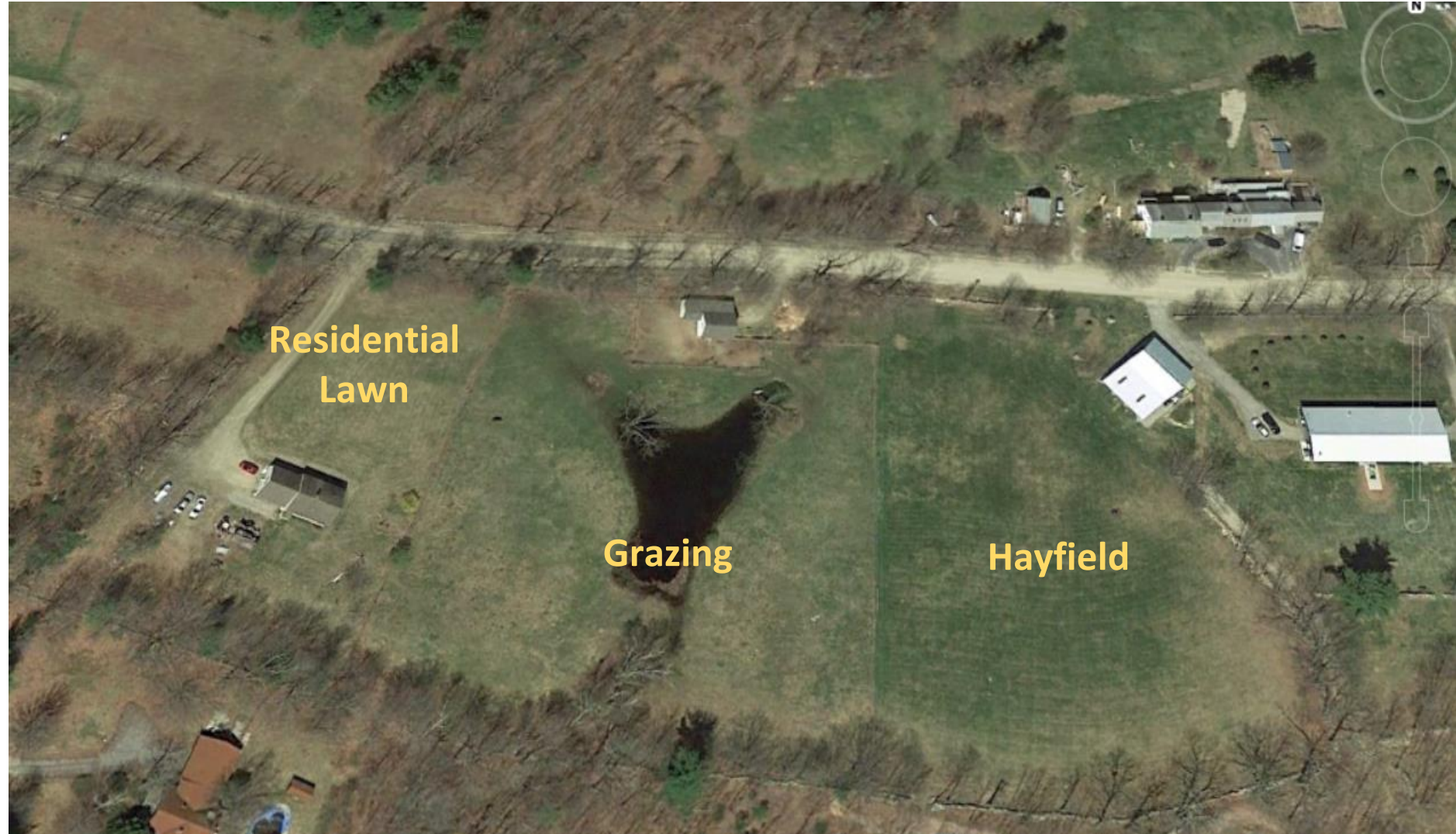


- |                         |   |                                  |
|-------------------------|---|----------------------------------|
| Agric 2: Row Crop       | Forest 4: Wetland (National Wetlands Inventory) | Urban 1: Low Den Res             |
| Agric 3: Grazing        | Open 1: Water (Batnymetry Lakes Polygons)       | Urban 2: Commercial/Mid Den Res  |
| Agric 4: Hayfield       | Open 2: Meadow                                  | Urban 3: Roads (NH Public Roads) |
| Forest 1: Deciduous     | Open 3: Excavation                              | Urban 5: Open Space              |
| Forest 2: Non-Deciduous | Other 1: Logging                                | NHD Flowlines                    |
| Forest 3: Mixed         | Other 2: Unpaved Road (NH Public Roads)         |                                  |



# LAND COVER ASSESSMENT

It is very important to have a precise representation of the land use in the watershed because different forms of land use (e.g. agriculture) are associated with different pollutant loads and load reductions





## 2. SUB-BASIN DELINEATION

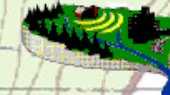


ArcGIS



esri®

Spatial Analyst

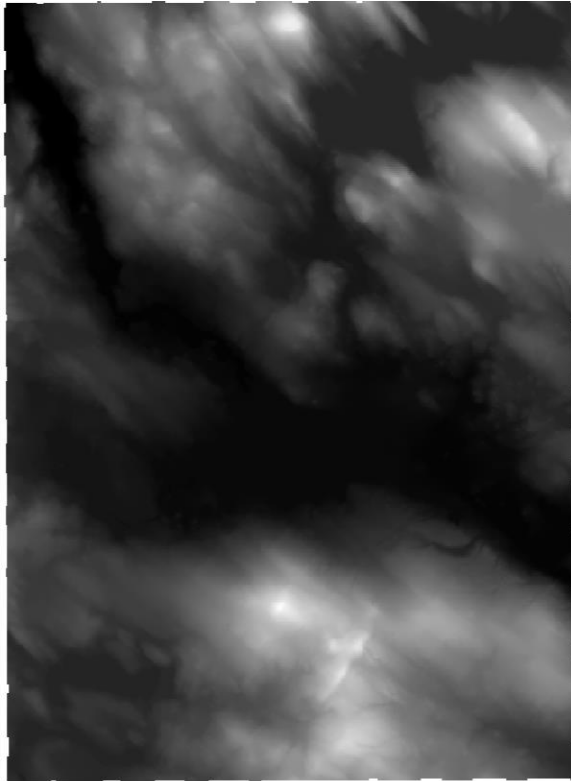


**BASINS**

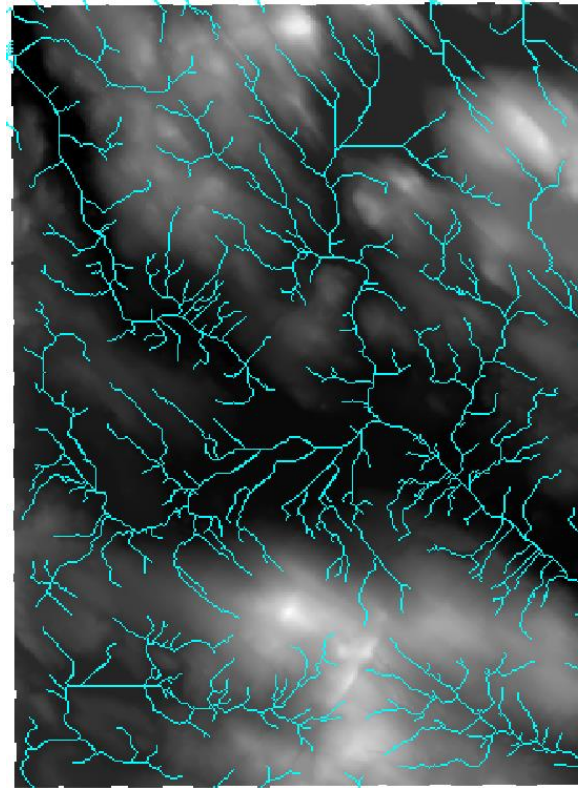
Better Assessment  
Science Integrating Point  
and Nonpoint Sources



# SUB-BASIN DELINEATION



Inputs original DEM Layer  
(NH GRANIT)



Extrapolates stream  
segments and surface  
flow direction

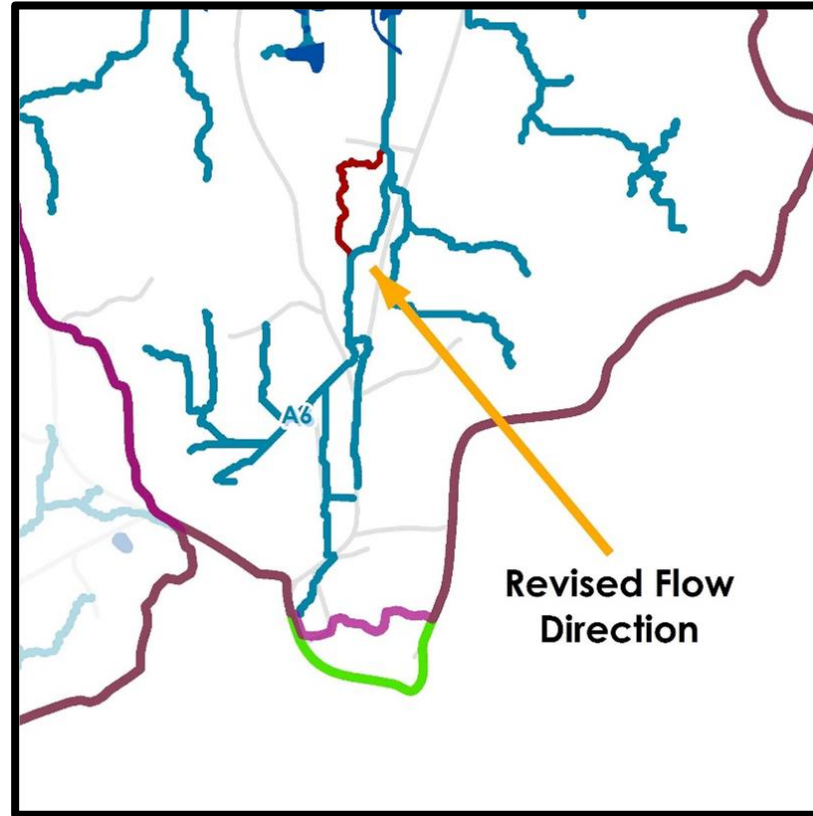
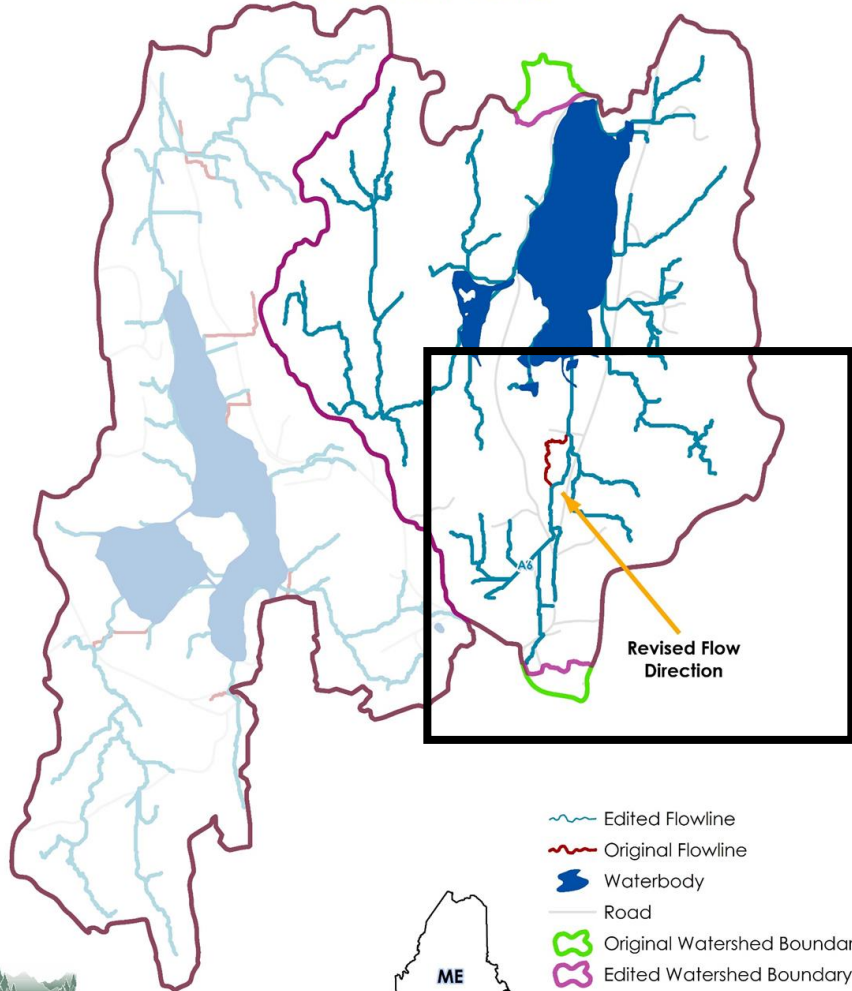


Outputs unique label for  
each sub basin

# SUB-BASIN DELINEATION

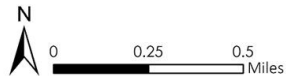
# FLOWLINES and HYDROGRAPHY

MAP UPDATES  
Adams Pond

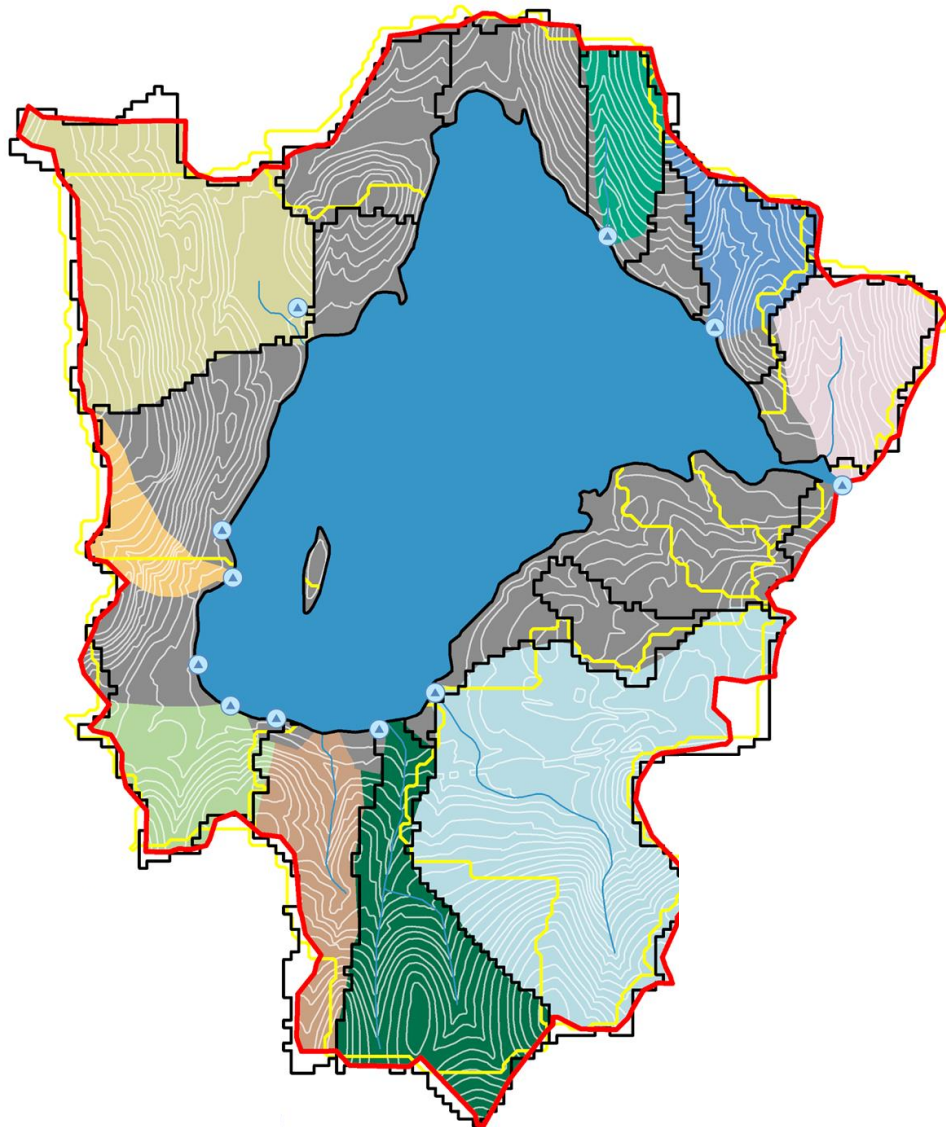


- Edited Flowline
- Original Flowline
- Waterbody
- Road
- Original Watershed Boundary
- Edited Watershed Boundary

- Edited Flowline
- Original Flowline
- Waterbody
- Road
- Original Watershed Boundary
- Edited Watershed Boundary



# SUB-BASIN DELINEATION

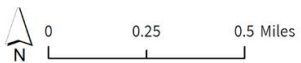


## Legend

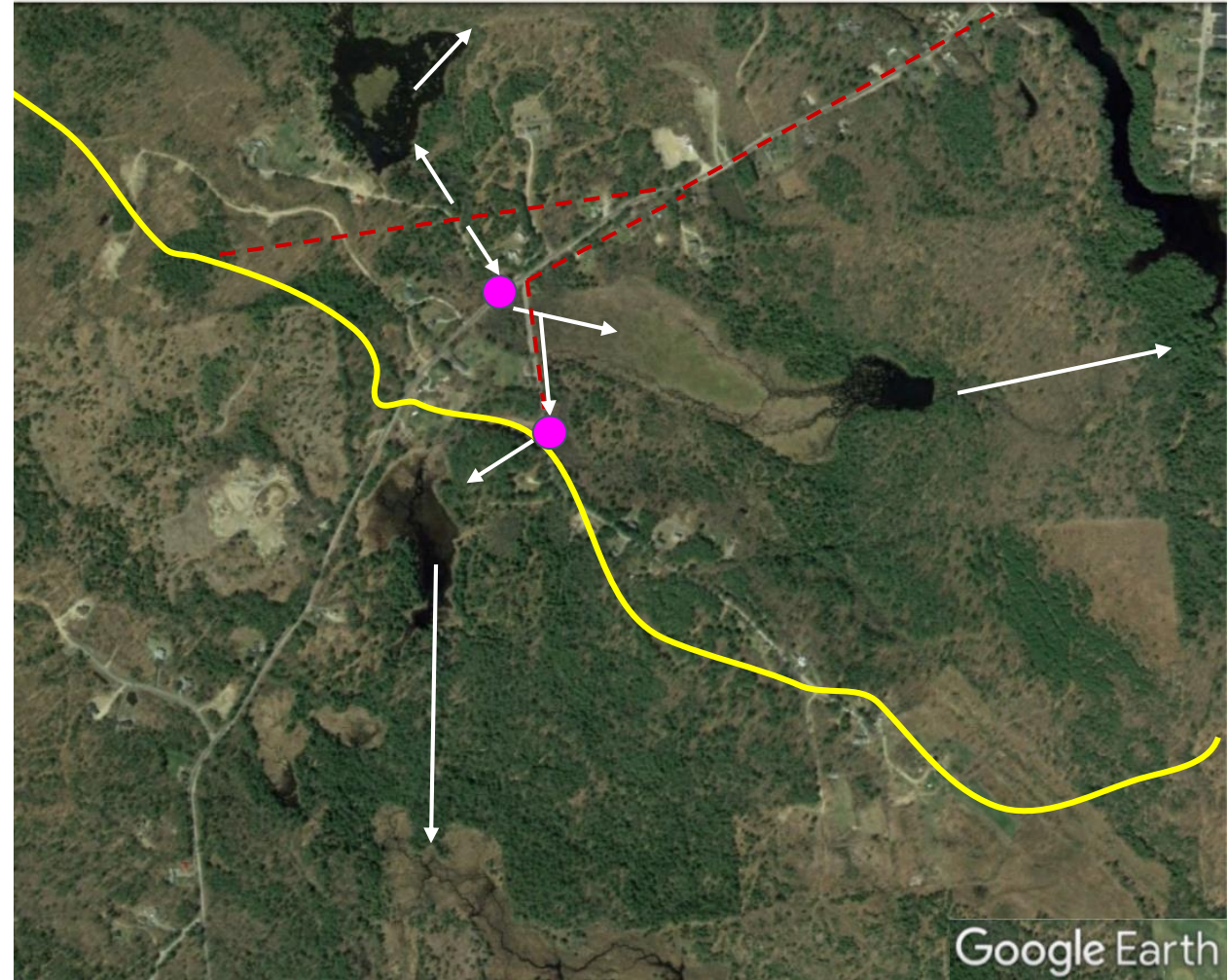
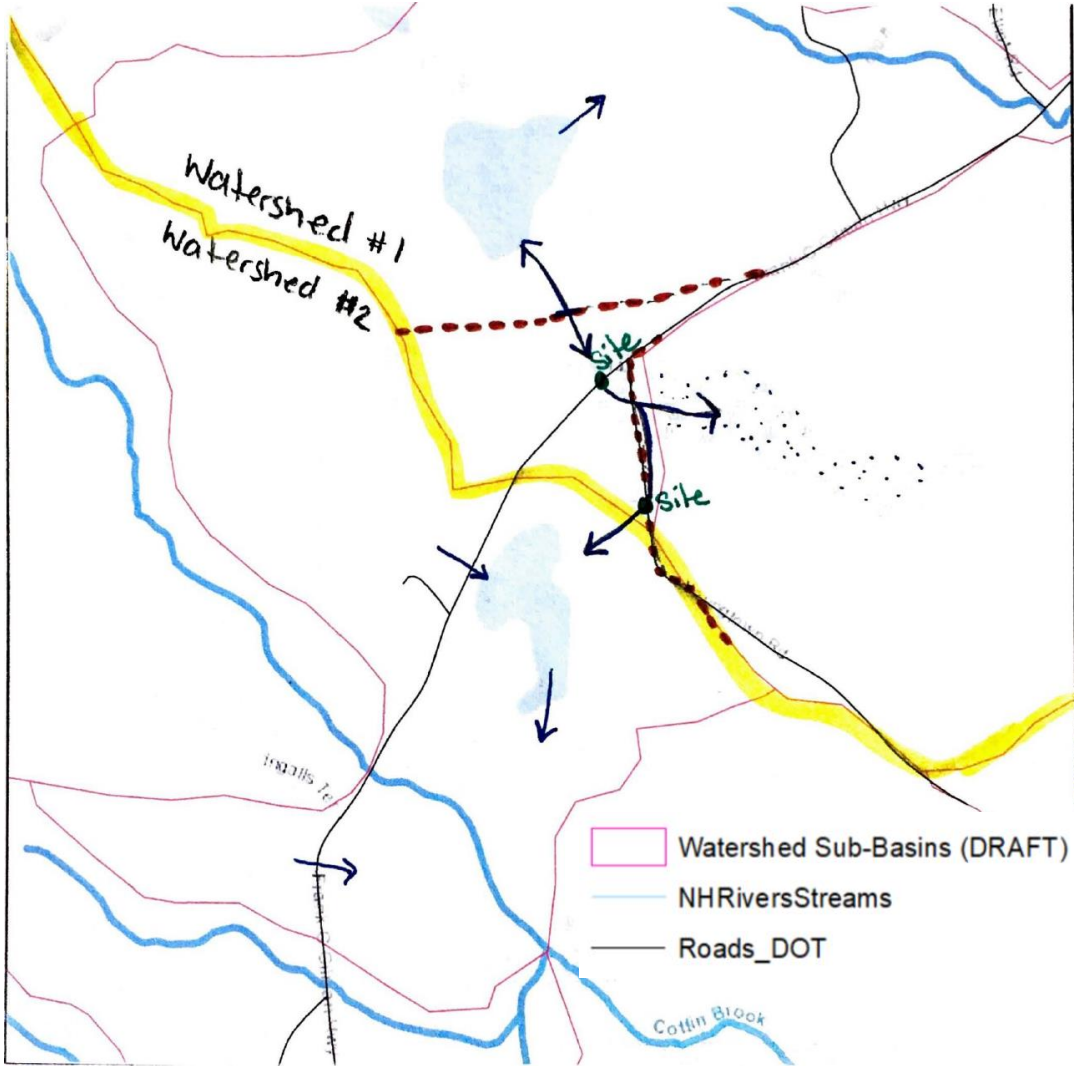
- Spofford Lake
- Spofford Lake Watershed
- NHD Flowline
- Stream TP Sampling Sites
- Modeled Sub-basins (QGIS)
- Modeled Sub-basins (BASINS)

## Ground-Truthed Sub-basins

- Camp Spofford Inlet
- Clarkdale Pipe
- Direct Shoreline
- Lachance Inlet
- RT.63 #3
- Seamans Inlet
- Shield Inlet
- Silverdale Inlet
- Unknown Trib Drainage
- Wares Grove Inlet



# GROUNDTRUTHING



# POLLUTANT LOAD MODEL ANALYSIS

## Spofford Lake Watershed

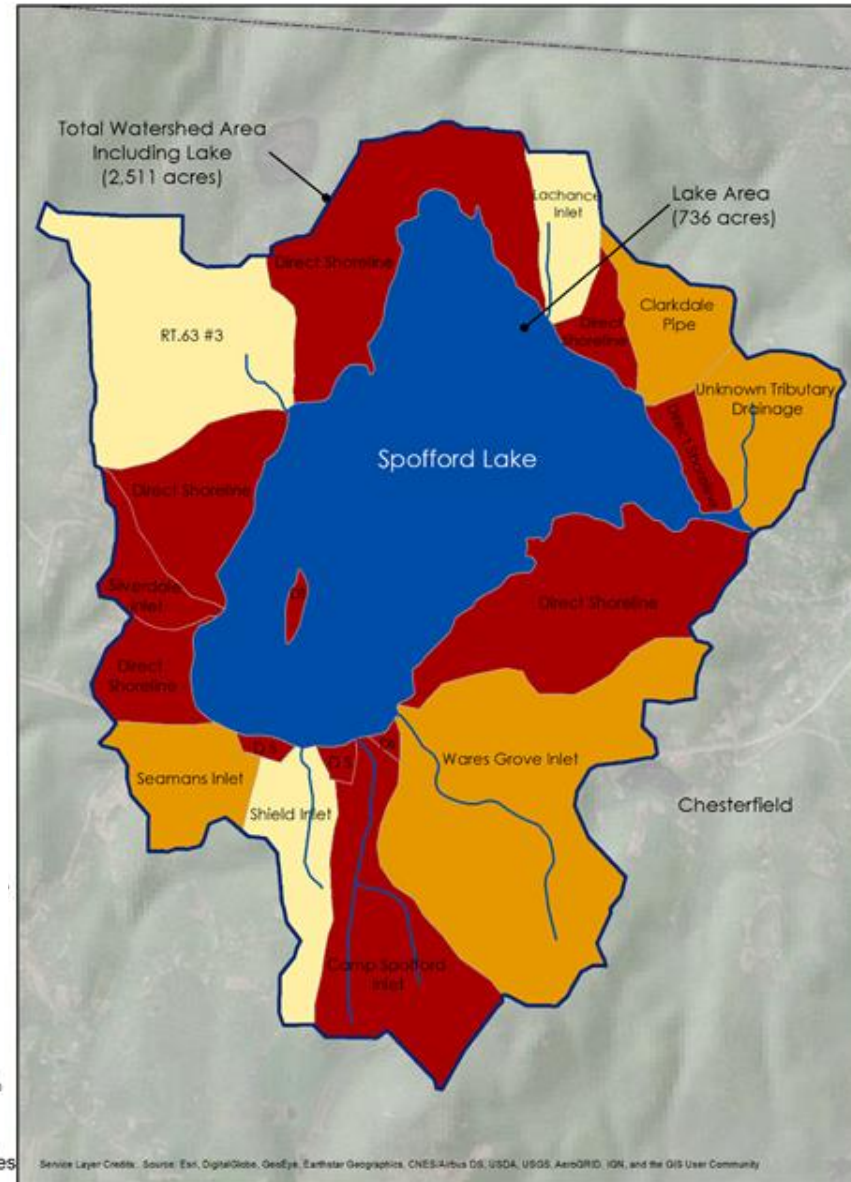
Cheshire County  
Chesterfield, New Hampshire

### Total Phosphorus Load

#### Total Phosphorus Load (kg/ha/yr)

- 0-0.10 (Low)
- 0.11-0.19 (Moderate)
- 0.20-0.29 (High)

- Lake
- Stream
- Spofford Lake Watershed
- Town Boundary



Source: New Hampshire GRANIT,  
National Wetland Inventory,  
FB Environmental, ESRI, Lake Area from  
National Hydrography Dataset, Watershed  
Area from NHDES/ SWRPC  
Projection: NAD 1983 New Hampshire State Plane FIPS 2800  
Created by FB Environmental  
(C. Bunyan), July 2018



1 Miles

Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES-Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



ArcGIS

# TAKEAWAY LESSONS

- Make standardized workflows
- Create metadata to track updates
- Make sure you groundtruth results
- The mapping technologies shown here work best when used together and each has its advantages

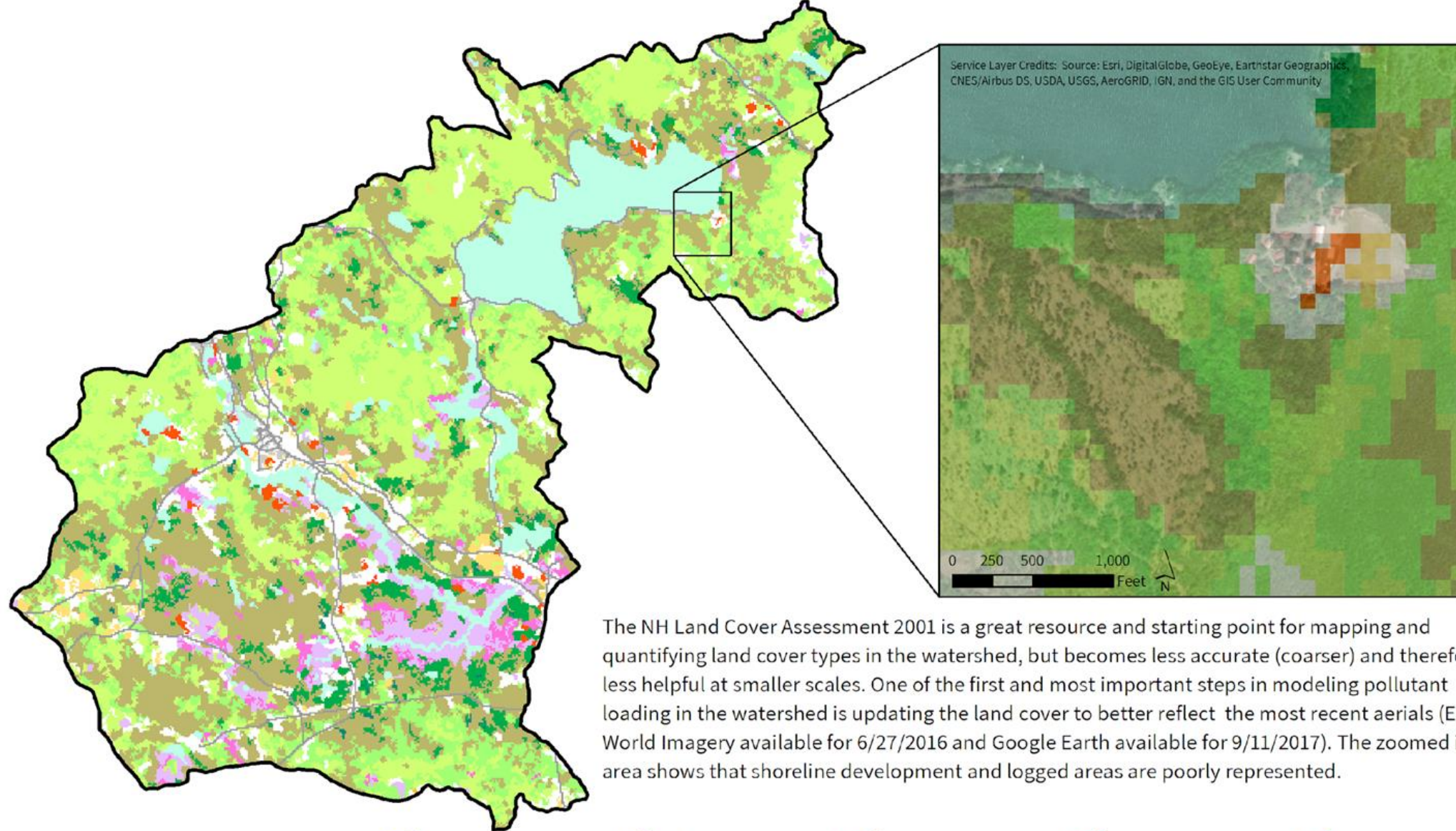


# Questions?









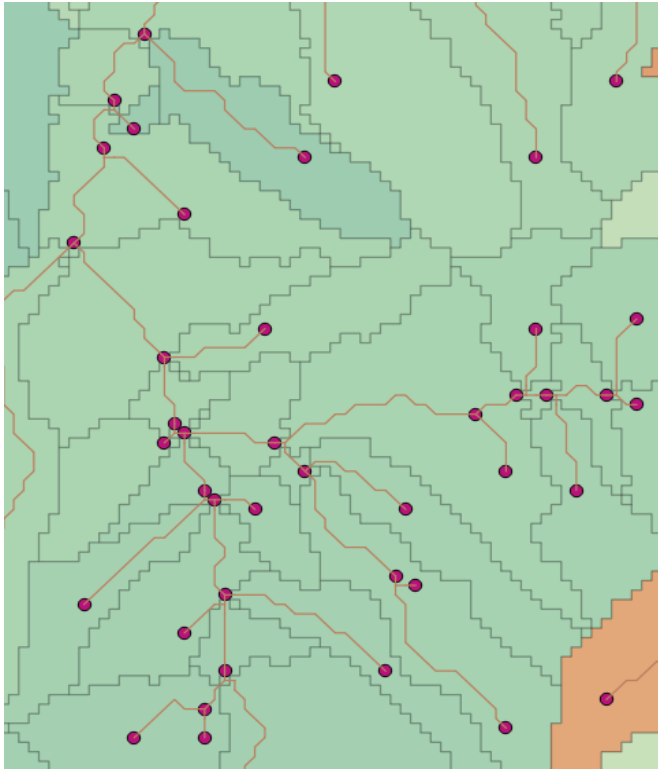
The NH Land Cover Assessment 2001 is a great resource and starting point for mapping and quantifying land cover types in the watershed, but becomes less accurate (coarser) and therefore less helpful at smaller scales. One of the first and most important steps in modeling pollutant loading in the watershed is updating the land cover to better reflect the most recent aerials (ESRI World Imagery available for 6/27/2016 and Google Earth available for 9/11/2017). The zoomed in area shows that shoreline development and logged areas are poorly represented.

NH Land Cover Assessment 2001

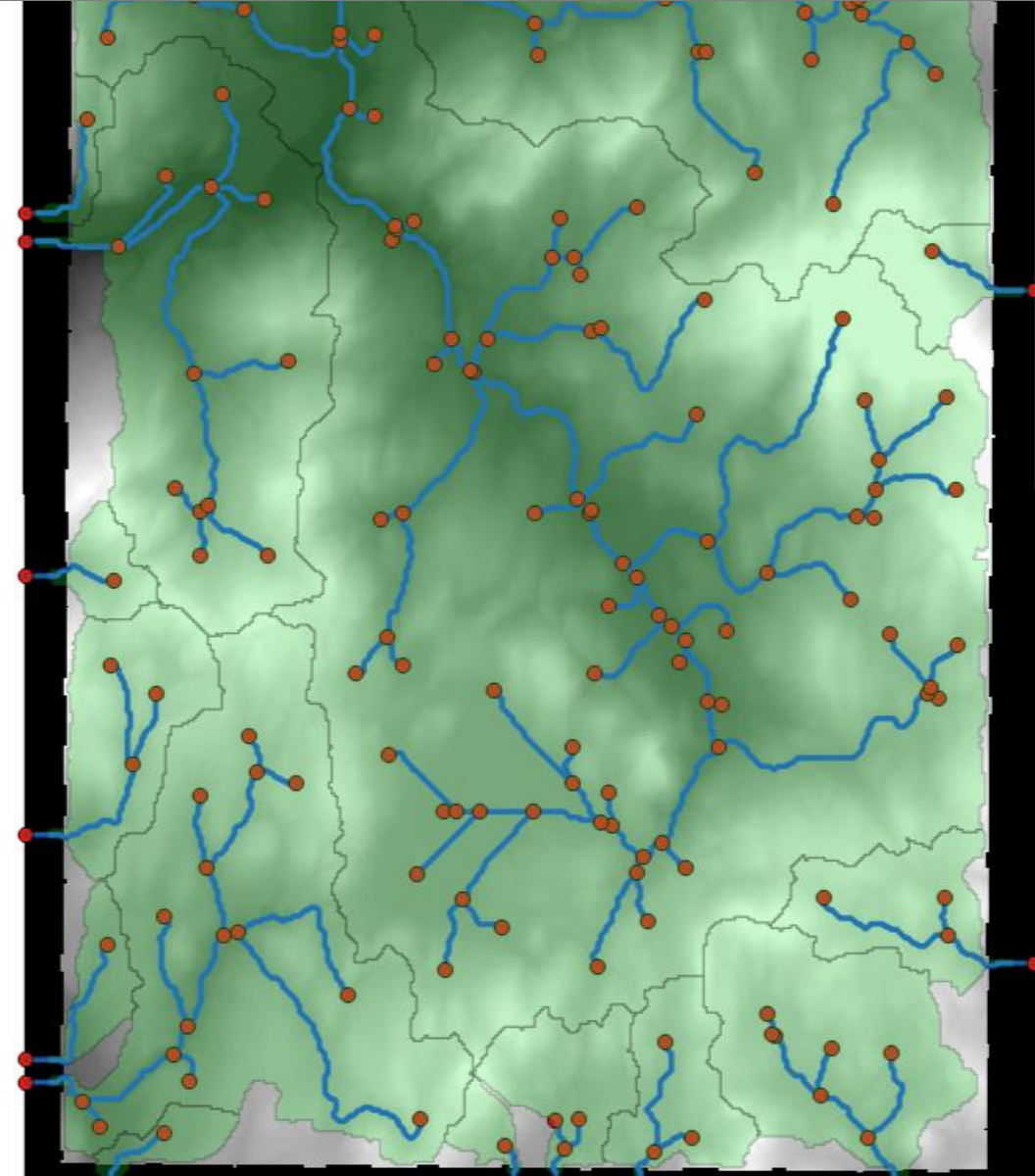
- |                                   |                   |                 |                   |                  |                   |
|-----------------------------------|-------------------|-----------------|-------------------|------------------|-------------------|
| Residential/Commercial/Industrial | Hay/Pasture       | Other Hardwoods | Pitch Pine        | Forested Wetland | Bedrock/Vegetated |
| Transportation                    | Orchards          | White/Red Pine  | Mixed Forest      | Open Wetland     | Sand Dunes        |
| Row Crops                         | Beech/Oak         | Spruce/Fir      | Alpine (Krumholz) | Tidal Wetland    | Other Cleared     |
|                                   | Paper Birch/Aspen | Hemlock         | Open Water        | Disturbed Land   | Tundra            |

## Sub-basin Delineation Workflow 4- QGIS

A critical next step to define the study area(s) is to generate sub-drainage delineations using both automatic delineation tools (e.g., QGIS, BASINS) and manual edits based on topographic maps and ground truthing.

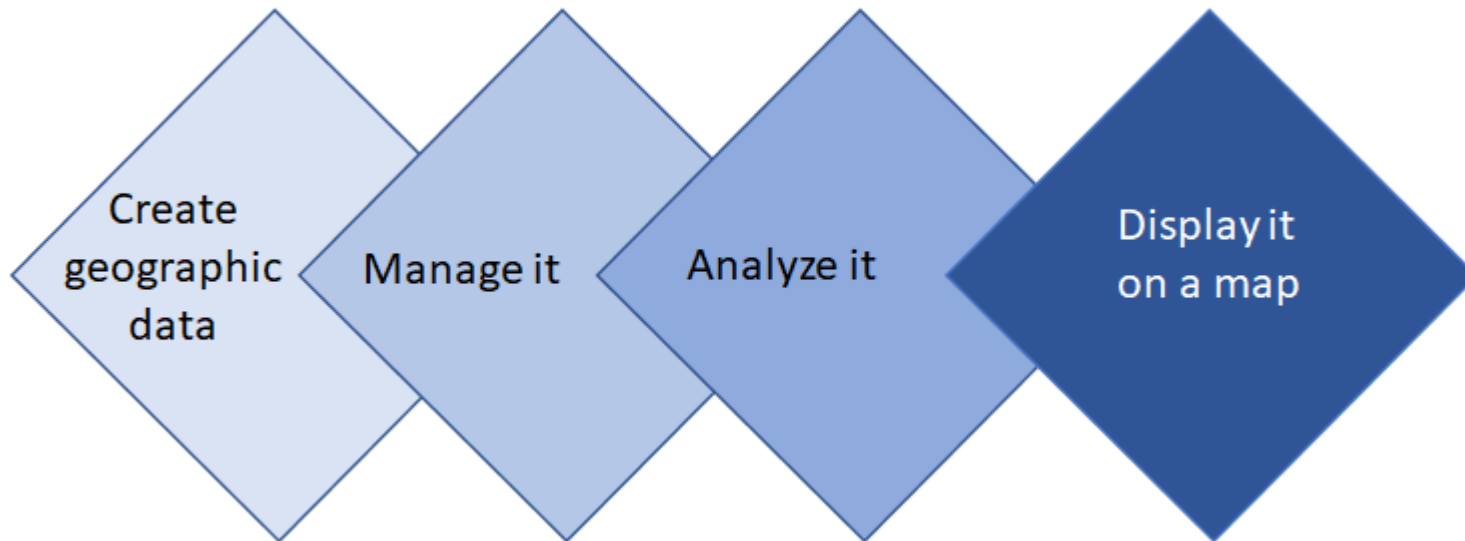


- Download Digital Elevation Model (DEM) layers from NH GRANIT
- Add raster layer to workspace
- Grass functions: allow you to represent your data in three dimensions- very helpful for watershed sub basin delineations and flow directions



# PROJECT GOALS

*To support the development of accurate water quality goals for lake and stream modeling.*



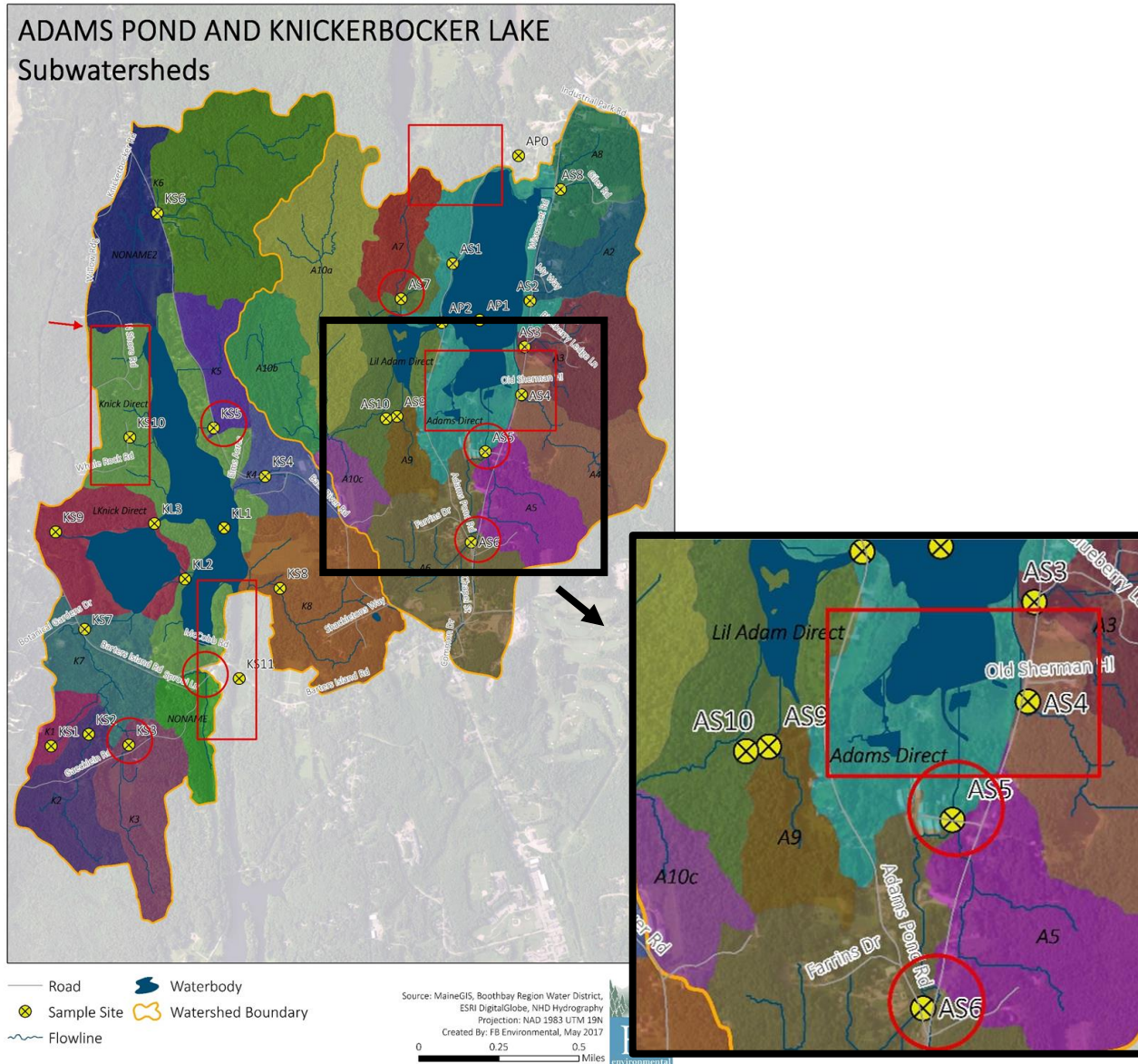
# MANAGE GEOGRAPHIC DATASETS

Code	Source	Land Use Description	Land Use Category
13	MA 2011	Low Density Residential	Urban 1: Low Den Res
38	MA 2011	Very Low Density Residential	
115	RI 2011	Low Density Residential (>2 acre lots)	
12	MA 2011	Medium Density Residential	Urban 2: Med Den Res
113	RI 2011	Medium Density Residential (1 to 1/4 acre lots)	
114	RI 2011	Medium Low Density Residential (1 to 2 acre lots)	
10	MA 2011	Multi-Family Residential	Urban 3: High Den Res
11	MA 2011	High Density Residential	
111	RI 2011	High Density Residential (<1/8 acre lots)	
112	RI 2011	Medium High Density Residential (1/4 to 1/8 acre lots)	
31	MA 2011	Urban Public/Institutional	Urban 4: Institutional
170	RI 2011	Institutional (schools, hospitals, churches, etc.)	
8	MA 2011	Spectator Recreation	Urban 5: Commercial
15	MA 2011	Commercial	
18	MA 2011	Transportation	
150	RI 1988	Commercial/Industrial Mixed	
152	RI 2011	Commercial/Industrial Mixed	
120	RI 2011	Commercial (sale of products and services)	
16	MA 2011	Industrial	Urban 6: Industrial
19	MA 2011	Waste Disposal	
39	MA 2011	Junkyard	
32	MA1985	Transportation Facilities	
145	RI 2011	Waste Disposal (landfills, junkyards, etc.)	
147	RI 2011	Other Transportation (terminals, docks, etc.)	
130	RI 2011	Industrial (manufacturing, design, assembly, etc.)	
144	RI 2011	Water and Sewage Treatment	

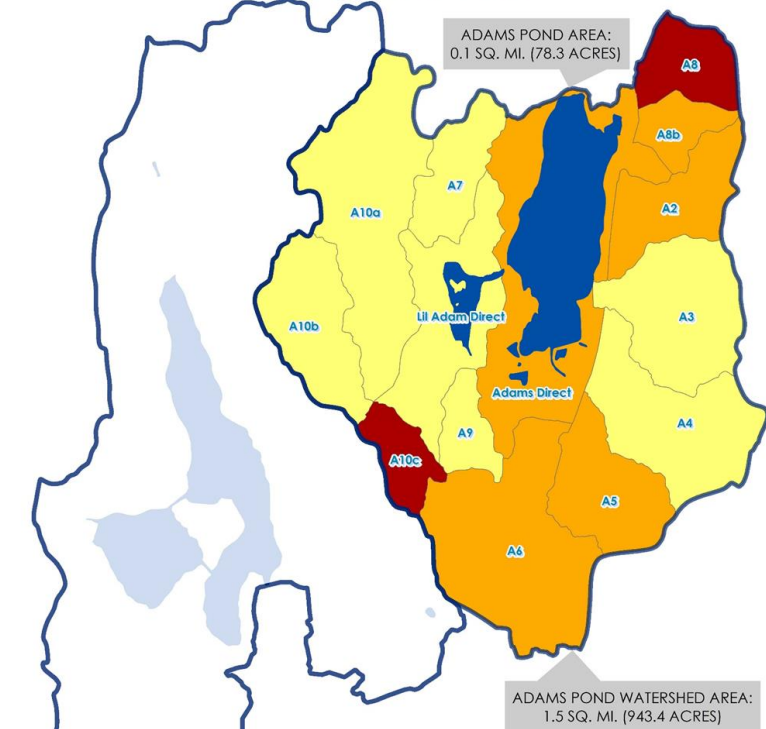
Simplify your land Use Categories to relate to your project goal

1. Copy the attribute table into excel
2. Add your new Land Use Category column
3. Join your new excel table to the existing attribute table in ArcMap
4. Edit the land use symbology to draw from your new Land Use Categories

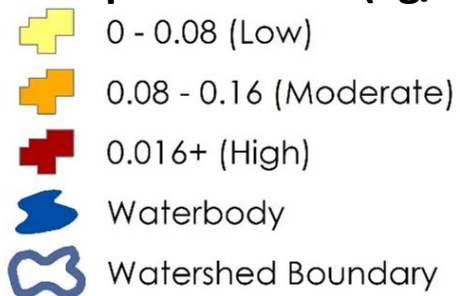
# ADAMS POND AND KNICKERBOCKER LAKE Subwatersheds



## TOTAL PHOSPHORUS LOAD Adams Pond



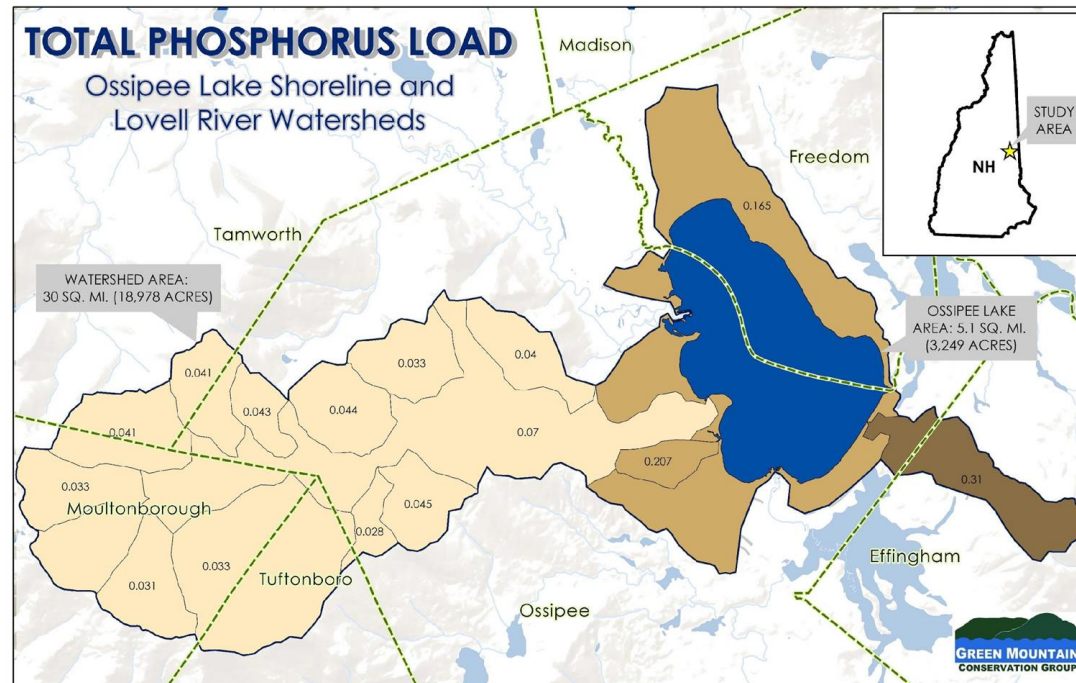
### Total Phosphorus Load (kg/ha/yr)



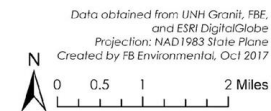
Source: MaineGIS, Boothbay Region Water District,  
ESRI DigitalGlobe, NHD Hydrography  
Projection: NAD 1983 UTM 19N  
Created By: FB Environmental, December 2017

## TOTAL PHOSPHORUS LOAD

### Ossipee Lake Shoreline and Lovell River Watersheds



### Total Phosphorus Load (kg/ha/yr)



ArcGIS

## **2019 NH Water & Watershed Conference**

### **Abstracts**

#### **Using GIS technology to improve watershed management planning and implementation tracking of surface waters**

***Key words: Pollutant modeling, GIS technology, Watershed planning***

**GIS technology serves as a vital tool for pollutant load models requiring data on land cover and sub-drainage areas. National or state-wide land cover databases provide coarse resolution data that become increasingly inaccurate at local scales. A critical first-step to improve the accuracy of models is to manually update land cover based on recent aerials. A critical next step to define the study area(s) is to generate sub-drainage delineations using both automatic delineation tools (e.g., QGIS, BASINS) and manual edits based on topographic maps and groundtruthing. We present on the challenges and lessons learned with using certain types of GIS technology (from open source databases and programs, wherever possible) for use in pollutant load models and how GIS technology can help improve the accuracy of pollutant load estimates, and thus, develop better water quality goals for watershed plans and better track progress toward achieving water quality goals through implementation projects.**