



# CE 5361 SURFACE WATER HYDROLOGY

WATERSHEDS; WATERSHED DELINEATION; WATERSHED METRICS



# WHAT IS A WATERSHED?

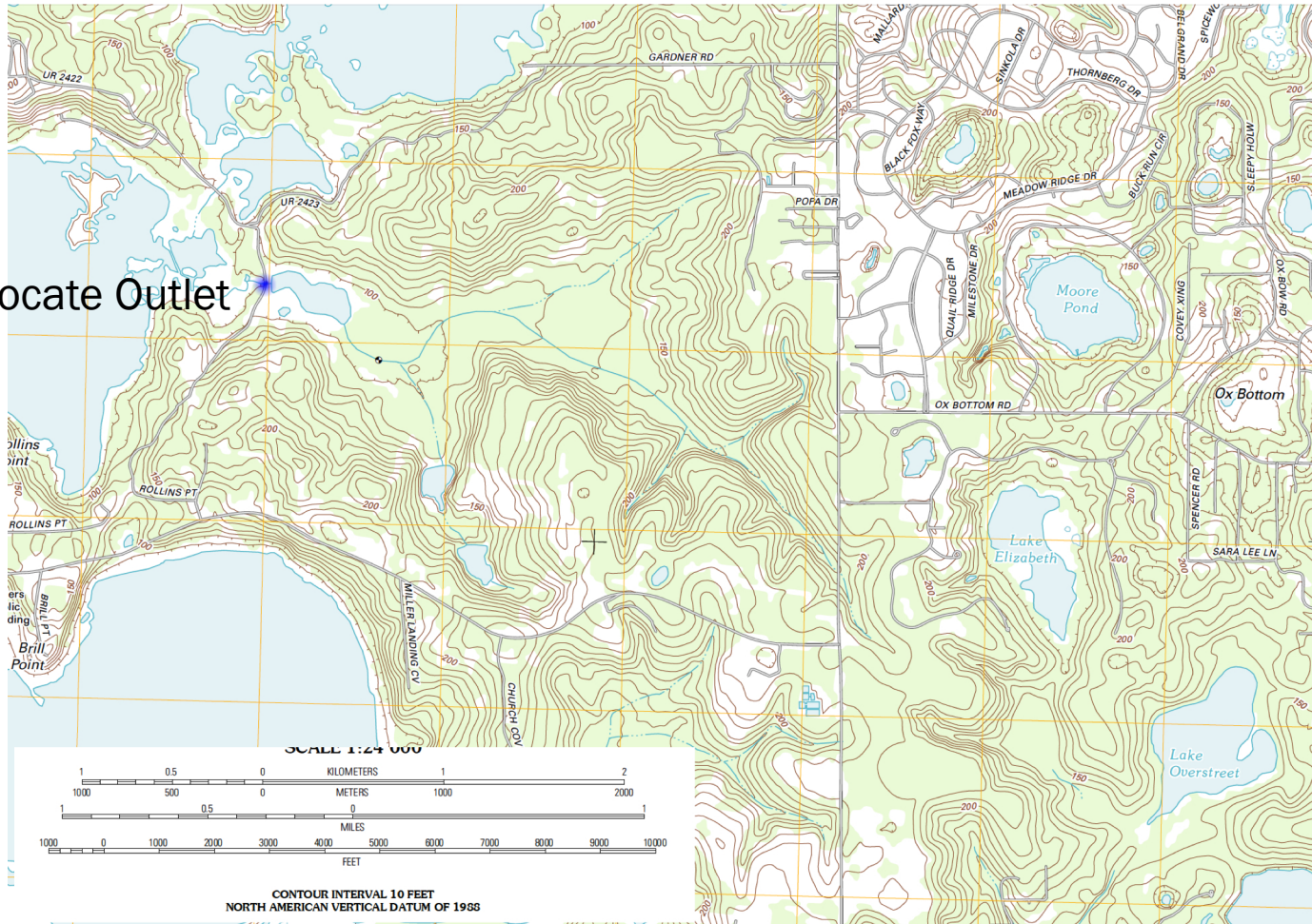
- Topographic area that collects and discharges surface streamflow through one outlet or mouth (pour point)
- The area on the surface of the Earth that drains to a specific location
- In groundwater a similar concept is called a groundwater basin – only the boundaries can move depending on relative rates of recharge and discharge

# WATERSHED DELINEATION

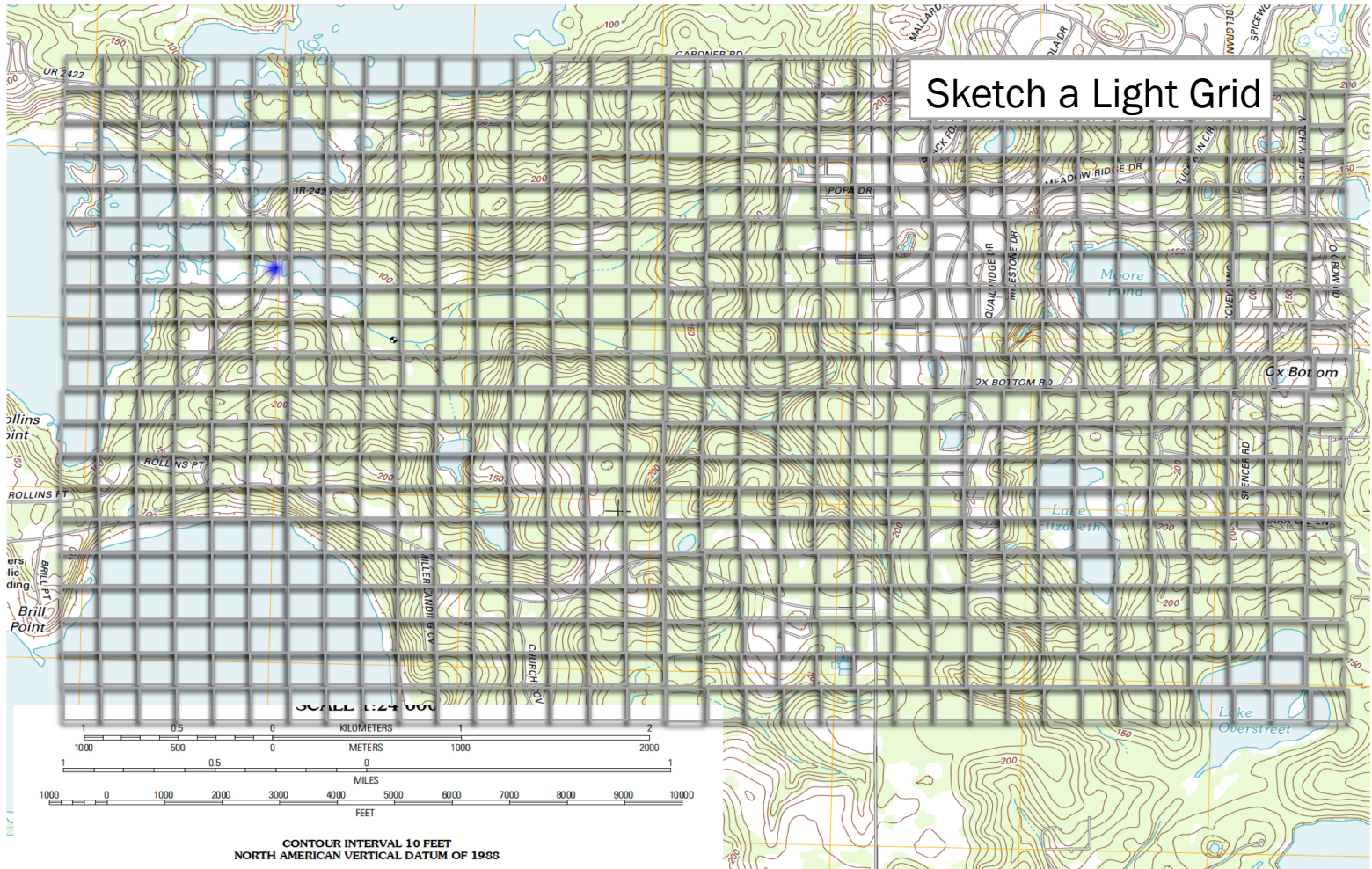
- Identifies the boundaries of our hydrologic unit / area of study.
  - Need to interpret topographic maps (or DEM/DTM) to construct the boundary
  - Steps to manual delineation
    - Superimpose a grid to estimate average elevations
    - Trace/outline outline the main stem of the stream that you want to examine
    - Trace all perennial or influential tributaries
    - Locate the lowest point/outlet of the main stem and work uphill

# WATERSHED DELINEATION

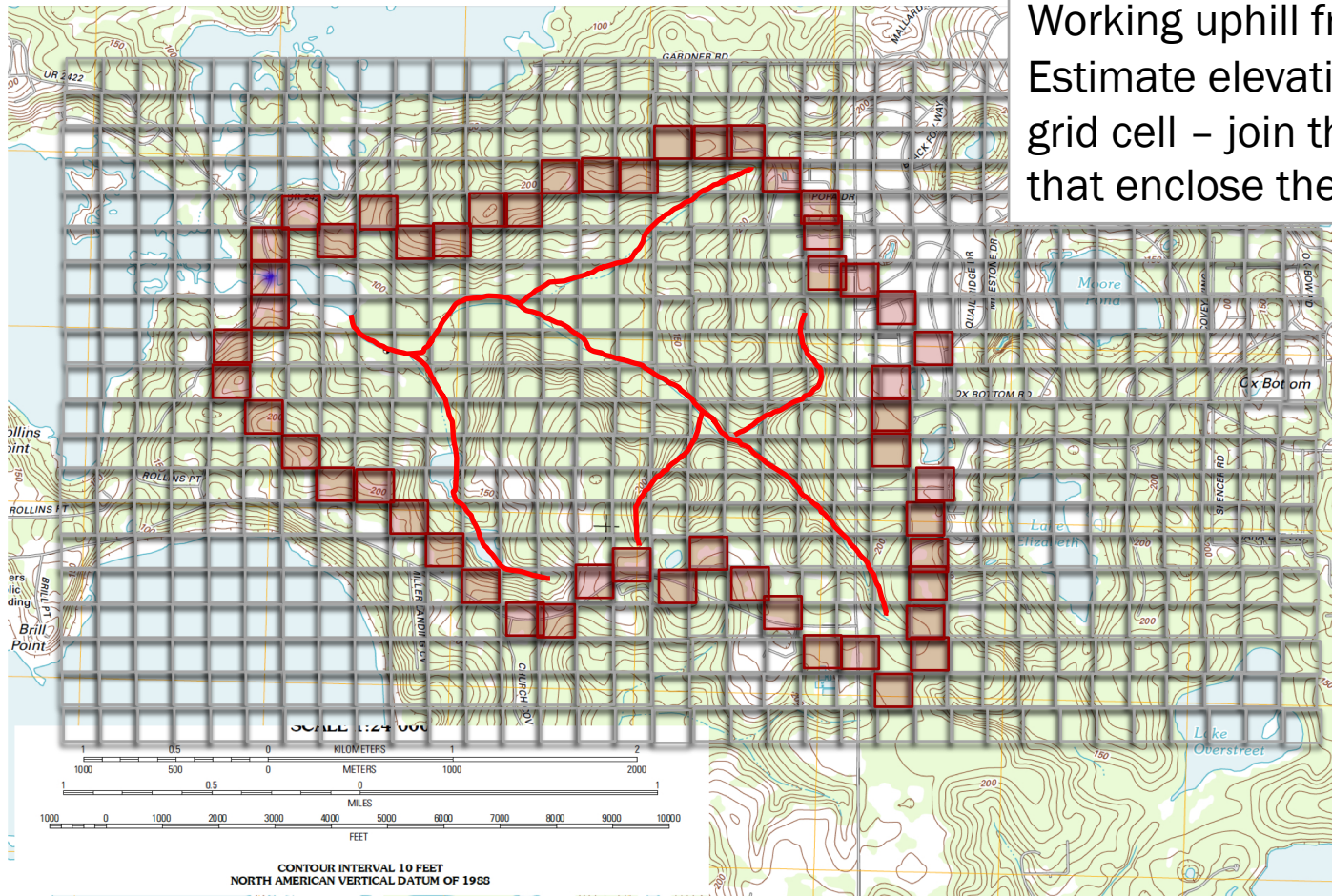
Locate Outlet



# WATERSHED DELINEATION

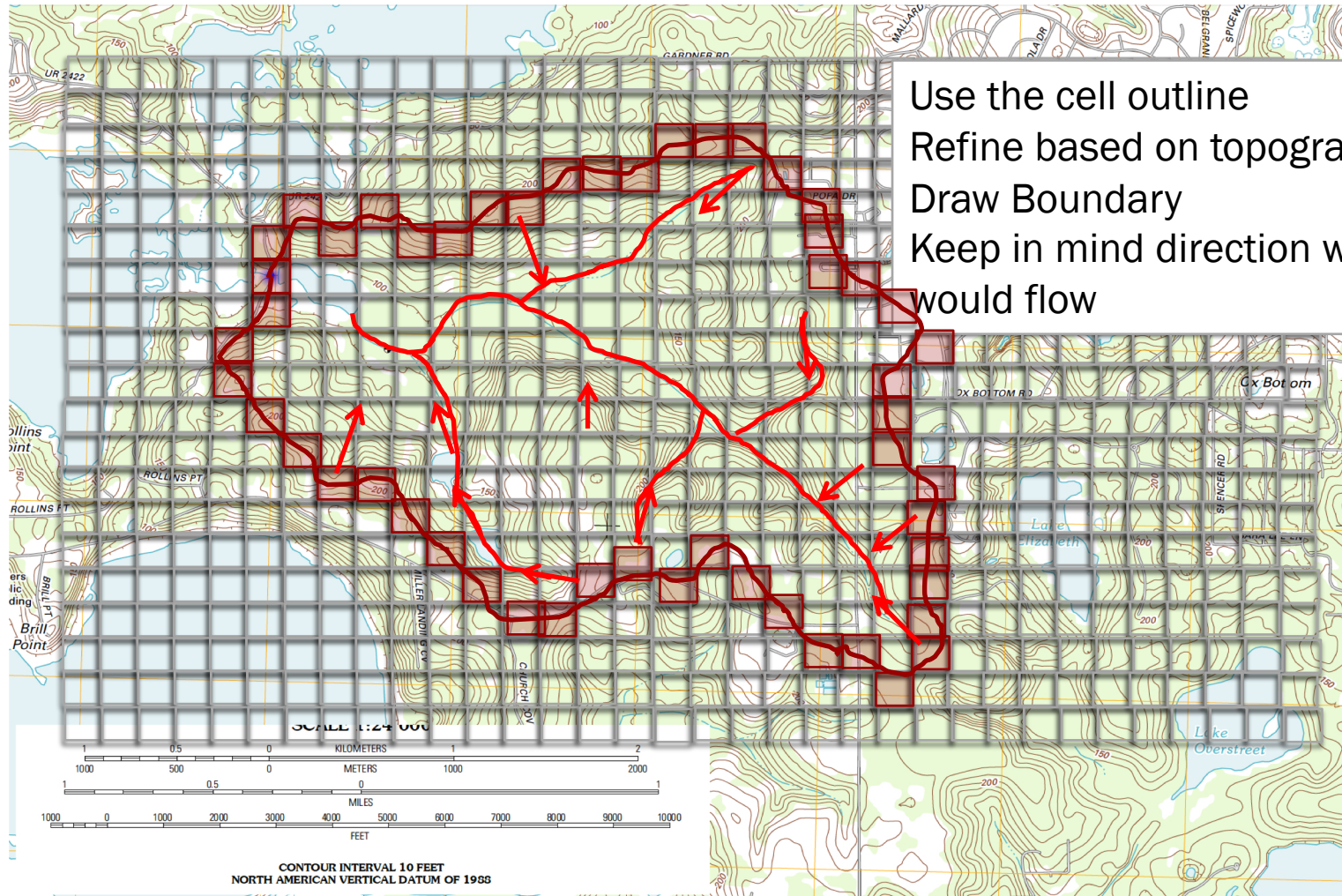


# WATERSHED DELINEATION



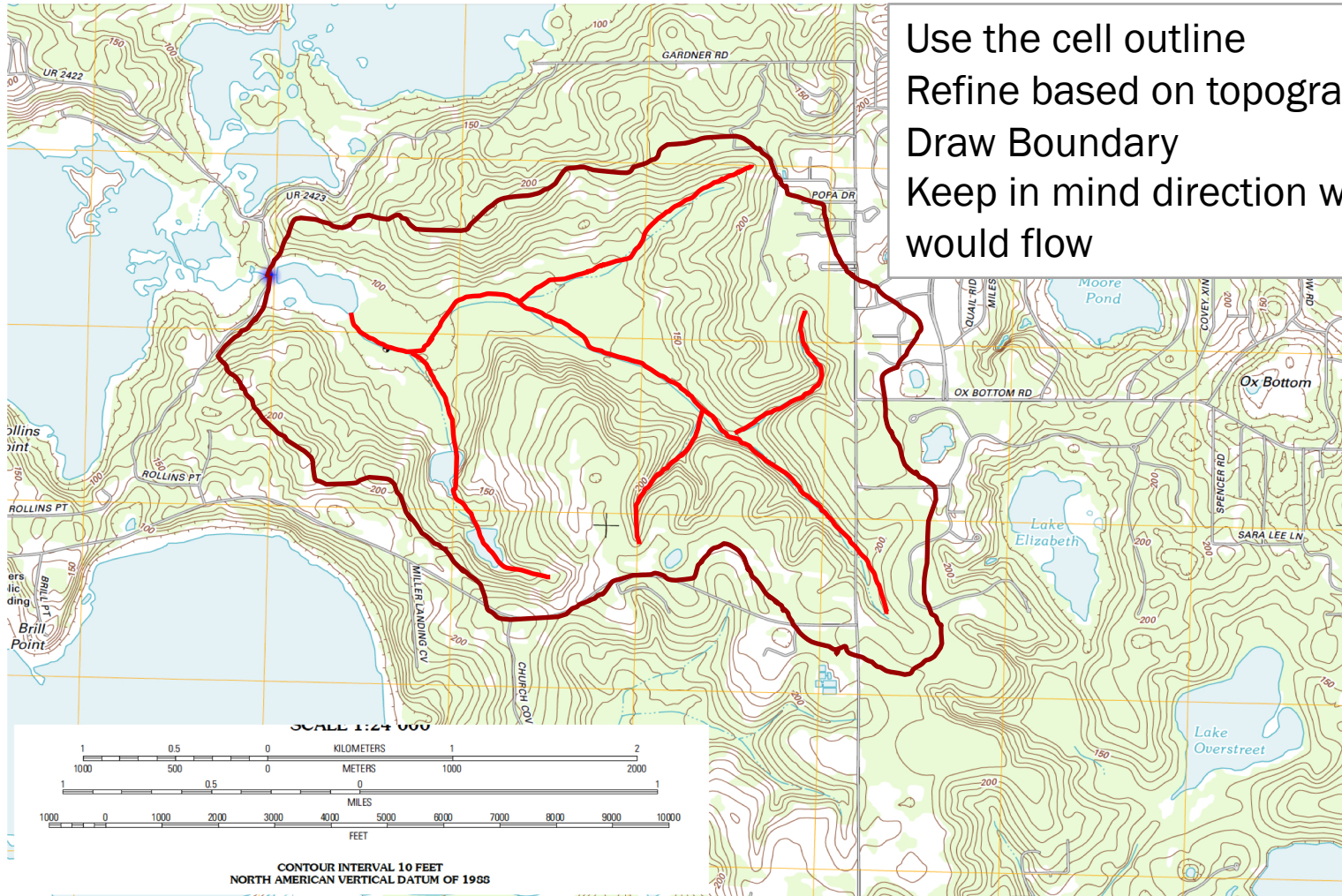
Working uphill from outlet  
Estimate elevations in each  
grid cell - join the high cells  
that enclose the outlet

# WATERSHED DELINEATION



Use the cell outline  
Refine based on topography  
Draw Boundary  
Keep in mind direction water  
would flow

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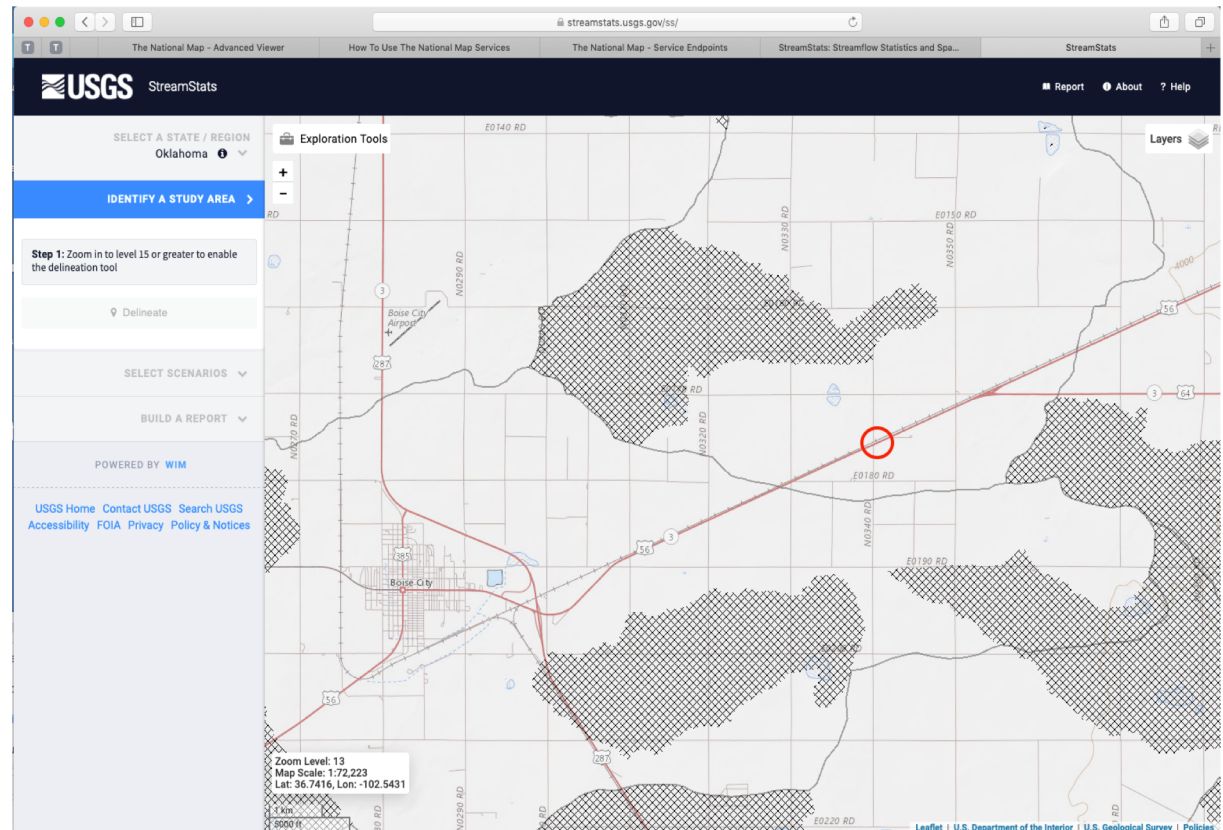


# WATERSHED DELINEATION USING STREAM STATS

➔ An online tool that can identify a watershed is the USGS StreamStats (<https://streamstats.usgs.gov/ss/>) tool

Consider a project in Oklahoma. The red circle indicates the project location. The circle lies on a stream that is crossed by the project – perhaps a culvert or similar hydraulic structure.

For watershed mitigation strategies to be employed, it is useful to know what the upstream drainage area is relative to the project.

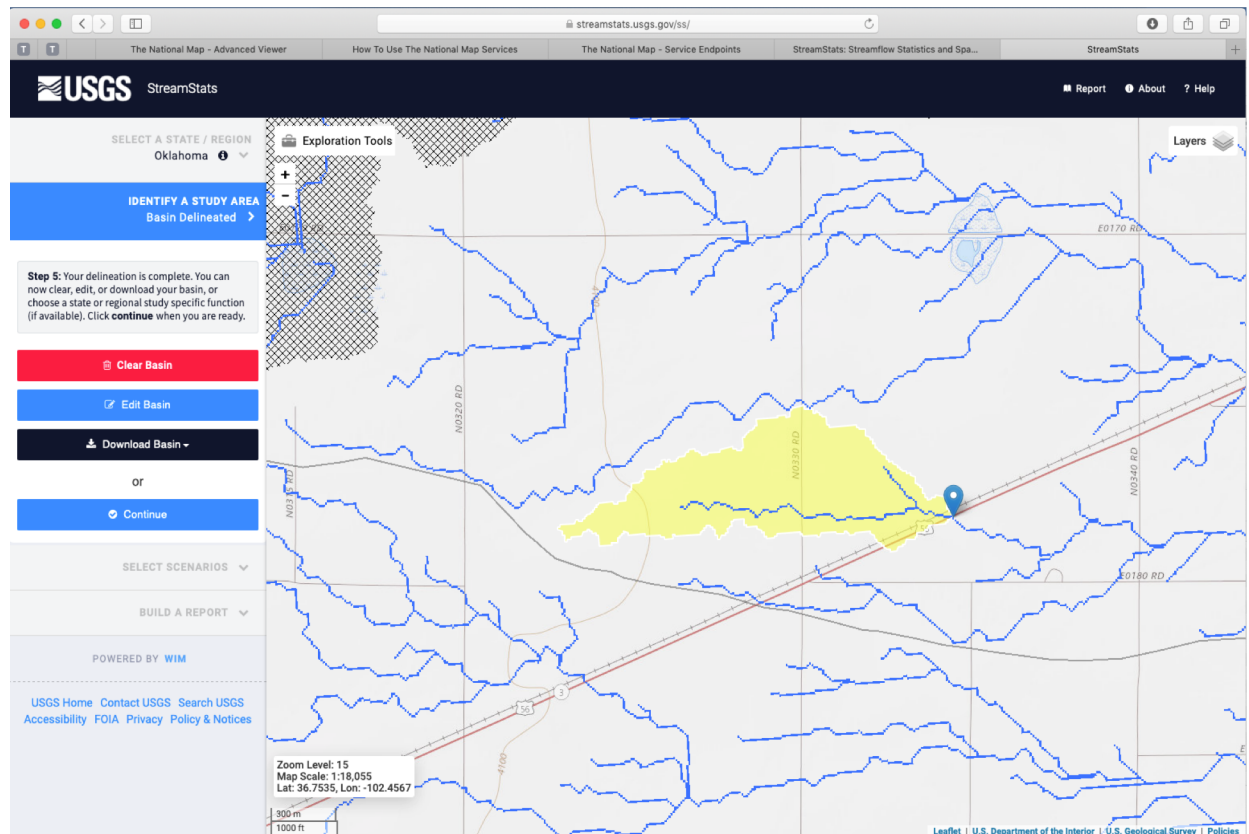


# WATERSHED DELINEATION USING STREAM STATS

- ➔ An online tool that can identify a watershed is the USGS StreamStats (<https://streamstats.usgs.gov/ss/>) tool

To the right is a screen capture of the StreamStats delineated watershed, UPSTREAM of the project location.

The next step is to download the shapefile bundle and process for various watershed metrics; important in the bundle is the boundary, which can be used to obtain an elevation model



# WATERSHED DELINEATION USING STREAM STATS

- Within any of the identified watersheds (yellow areas) a set of physical metrics is available, some examples are:
  - outlet elevation (the pour point identified by the location selection!),
  - various precipitation values, including mean annual,
  - composite soil permeability,
  - 10-85 channel slope, mean basin slope from 10-meter DEM.
  - As important, the shape file is generated so that analysts can use it as a boundary file to extract an elevation raster from the National Elevation Dataset (embedded within the National Map).
  - In the present context this is the link that can allow for effective hydrologic model construction.

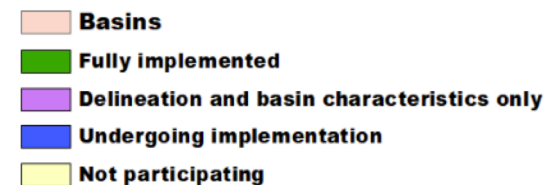
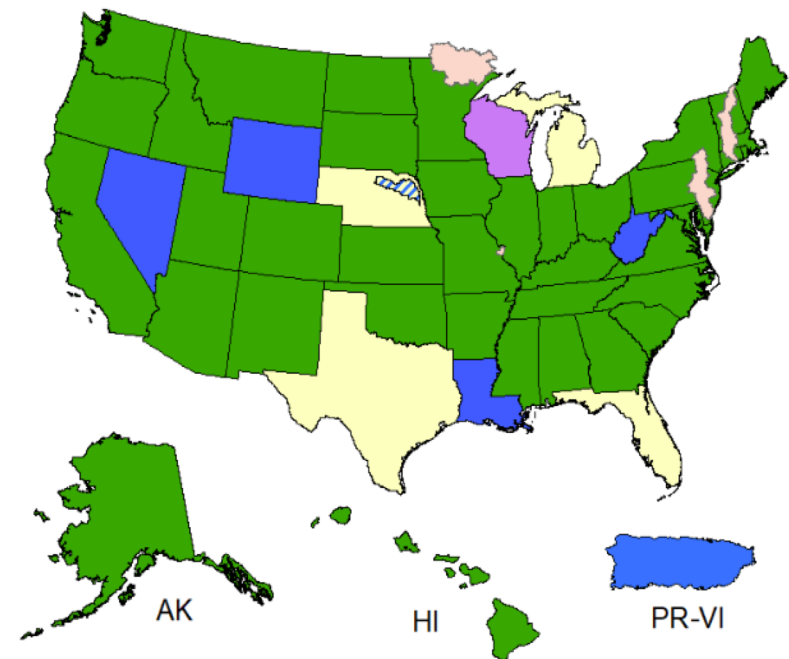
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# WATERSHED DELINEATION USING STREAM STATS

➔ Available coverages – Texas is excluded.

- To the right is a map that depicts the status of the StreamStats toolkit.
- Most of the United States is fully implemented, the exceptions are Texas, Florida, Nevada, Nebraska, and Michigan.
- In these states, the stated reason for exclusion is insufficient funding to implement the tool (the data exist and are safely archived at the USGS).



U.S. Geological Survey, 2019, The National Map—New data delivery homepage, advanced viewer, lidar visualization: US. Geological Survey Fact Sheet 2019-3032, 2 p., <https://doi.org/10.3133/fs20193032>.

Ries, K.G., III, Newson J.K., Smith, M.J., Guthrie, J.D., Steeves, P.A., Haluska, T.L., Kolb, K.R., Thompson, R.F., Santoro, R.D., and Vraga, H.W., 2017, StreamStats, version 4: U.S. Geological Survey Fact 2017-3046, 4 p., <https://doi.org/10.3133/fs20173046>. [Supersedes USGS Fact Sheet 2008-3067.]

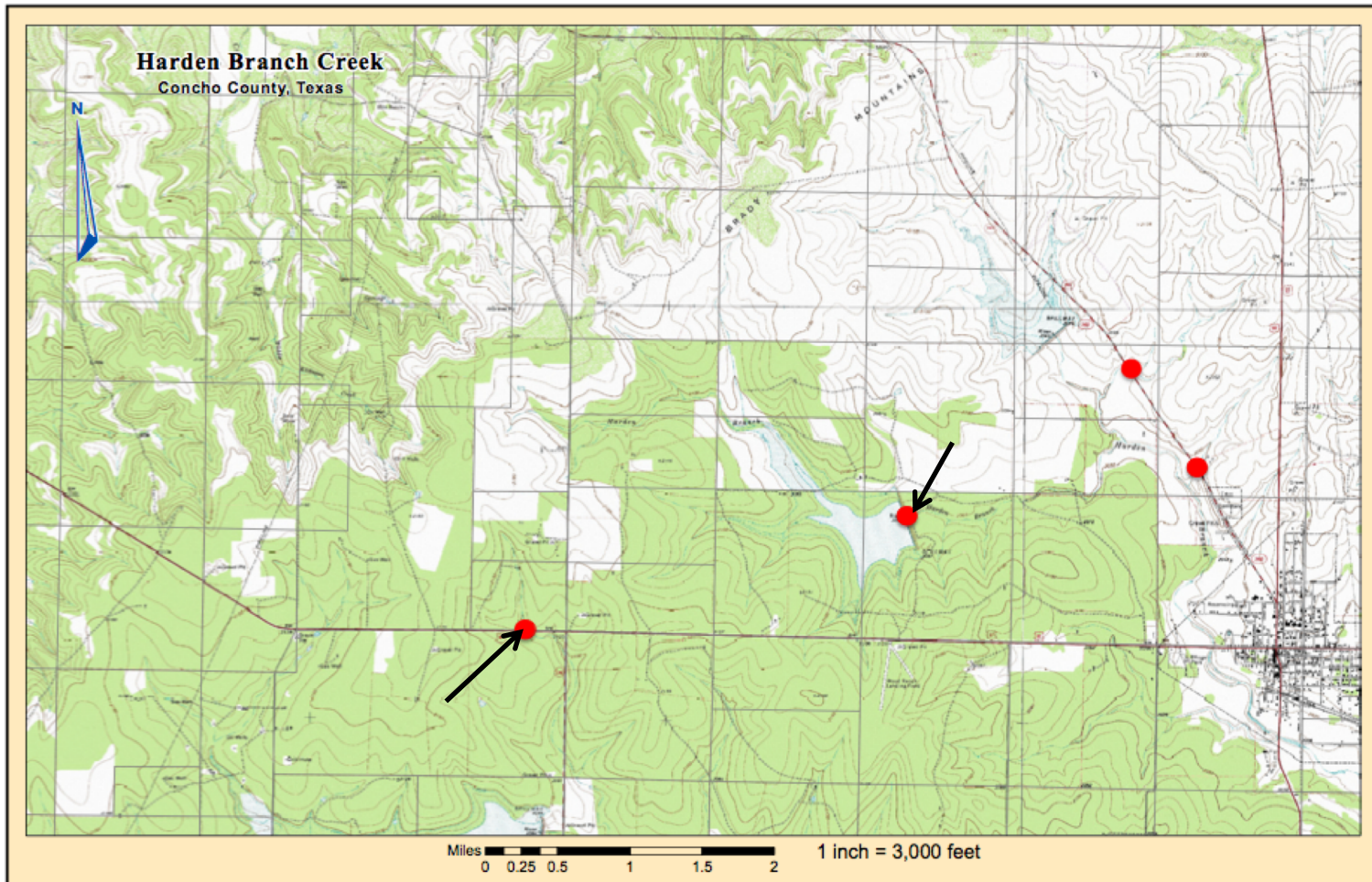
# WATERSHED METRICS

- The fundamental unit in surface water hydrology is the watershed.
- A watershed is defined as the area on the surface of the earth that drains to a specific location.
- Watershed properties include:
  - Area
  - Main channel length
  - Slope (requires the specification of path),
  - Soil moisture/permeability

# AFTER DELINEATION

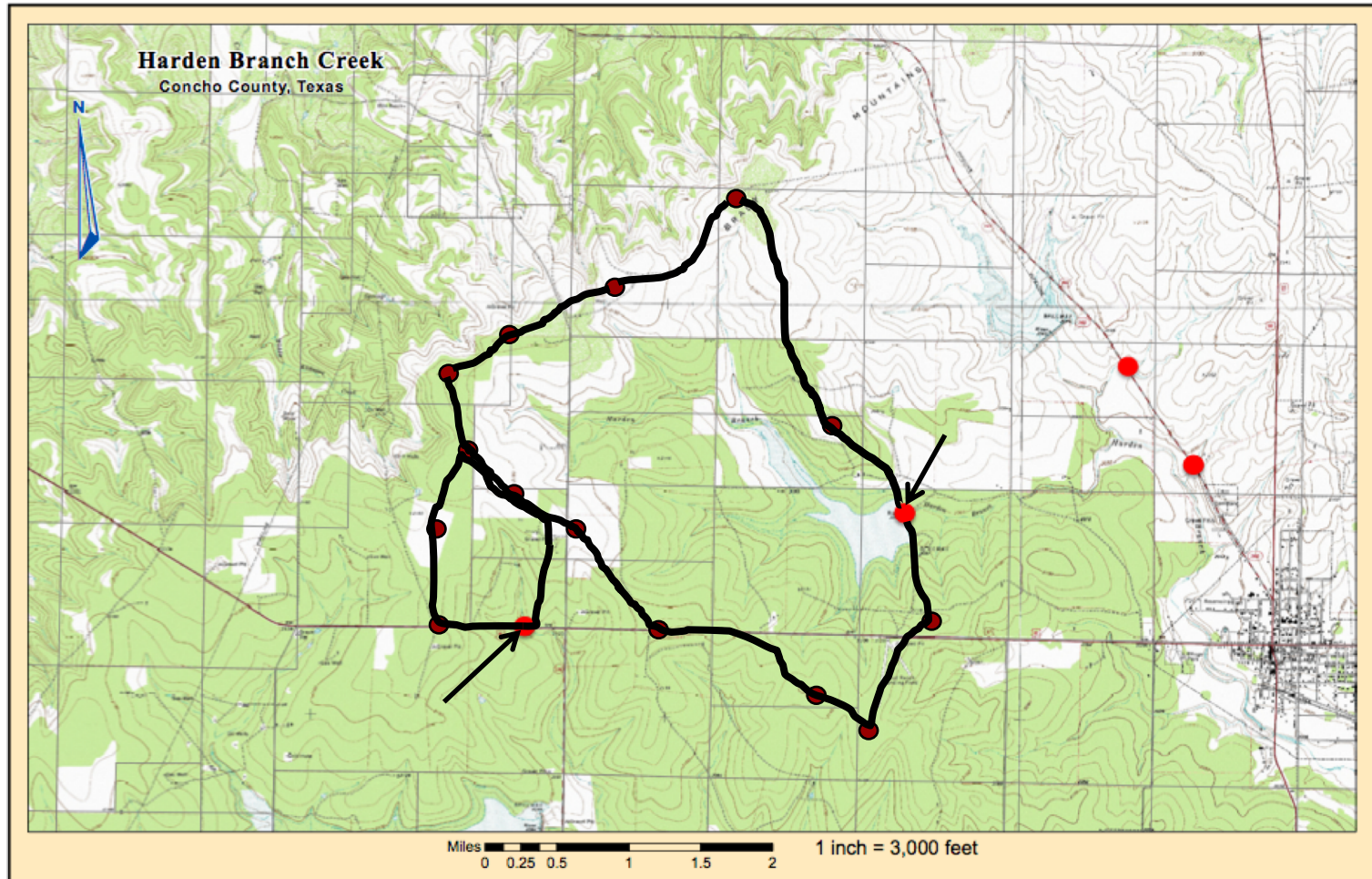
- Watershed physical and descriptive characteristics determined after delineation include:
  - Areas
  - Lengths
  - Slopes (along defined paths)
  - Cover type
  - Soil properties

# HARDEN BRANCH WATERSHED





# HARDEN BRANCH WATERSHED



# WATERSHED METRICS

## ➤ How to measure area

### ➤ Numerical Planimetry

➤ Arc GIS

➤ AutoCad  
(Polygon Area)

➤ Acrobat Pro  
(Measuring Tools)

➤ Surfer

➤ ENGAUGE

➤ G3DATA+PolyArea.xls

### ➤ Mechanical Planimetry

➤ Count squares

## ➤ How to measure lengths

➤ ArcGIS

➤ AutoCad

➤ Acrobat Pro

➤ Surfer

➤ ENGAUGE

➤ G3DATA

➤ By-hand

# WATERSHED METRICS

## ➤ How to find soil properties

➤ Web Soil Survey

➤ Soil Maps

The screenshot shows the USDA Web Soil Survey website. At the top, there is a navigation bar with the USDA logo and the text "United States Department of Agriculture Natural Resources Conservation Service". Below this is a banner image featuring a ruler, soil samples, and a small plant, with the text "Web Soil Survey" overlaid. The main content area includes a search box with the text "Enter Keywords" and a "Go" button, and a "Browse by Subject" menu with options like "Soils Home", "National Cooperative Soil Survey (NCSS)", "Archived Soil Surveys", "Status Maps", "Official Soil Series Descriptions (OSD)", "Soil Series Extent Mapping Tool", and "Geospatial Data Gateway". A large green button labeled "START WSS" is prominently displayed. To the right, there is a section titled "I Want To..." with a list of links: "Start Web Soil Survey (WSS)", "Know the requirements for running Web Soil Survey — will Web Soil Survey work in my web browser?", "Know the Web Soil Survey hours of operation", "Find what areas of the U.S. have soil data", "Find information by topic", "Know how to hyperlink from other documents to Web Soil Survey", and "Know the SSURGO data structure". Below this, there is an "Announcements/Events" section with a link: "Web Soil Survey 3.1 has been released! View". The page also features a "Welcome to Web Soil Survey (WSS)" section with a photograph of people in a field and text describing the service: "Web Soil Survey (WSS) provides soil data and information produced by the National Cooperative Soil Survey. It is operated by the USDA Natural Resources Conservation Service (NRCS) and provides access to the largest natural resource information system in the world. NRCS has soil maps and data available online for more than 95 percent of the nation's counties and anticipates having 100 percent in the near future. The site is updated and maintained online as the single authoritative source of soil survey information."

# WATERSHED METRICS

## ➤ How to find soil properties

➤ Web Soil Survey

➤ Soil Maps

The screenshot shows the USDA Web Soil Survey homepage. At the top, there is a navigation bar with links for Home, About Soils, Help, and Contact Us. Below this is a search bar and a "Browse by Subject" menu. The main content area features a large banner with the text "Web Soil Survey" and a "START WSS" button. To the right of the banner is a "I Want To..." section with a list of links. Below the banner is a "Welcome to Web Soil Survey (WSS)" section with a photo of people in a field and a paragraph of text. At the bottom right, there is an "Announcements/Events" section with a link to "Web Soil Survey 3.1 has been released! View".

USDA United States Department of Agriculture  
Natural Resources Conservation Service

Web Soil Survey

Home About Soils Help Contact Us

You are here: Web Soil Survey Home

**Search**

Enter Keywords

All NRCS Sites

**Browse by Subject**

- ▶ Soils Home
- ▶ National Cooperative Soil Survey (NCSS)
- ▶ Archived Soil Surveys
- ▶ Status Maps
- ▶ Official Soil Series Descriptions (OSD)
- ▶ Soil Series Extent Mapping Tool
- ▶ Geospatial Data Gateway

The simple yet powerful way to access and use soil data.

**START WSS**

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**I Want To...**

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**Announcements/Events**

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# WATERSHED METRICS

- How to estimate %-impervious/developed
  - Google Earth
    - Find area of interest
    - Select a viewing height (needs to be same if have to scroll)
    - Put a grid on the screen (physical grid on see-thru plastic)
    - Count concrete vs not concrete – relative ratio is a useable estimate of the %-impervious

# MINIMAL WATERSHED DESCRIPTION

- Watershed boundary on a map
  - Area that drains to the outlet (AREA)
  - Main Channel Length (MCL)
  - Slope(s)
  - Soil Properties (Permeability)
  - %-Impervious