

# How to Read Topography Maps and Delineate Watershed Boundaries

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EXTENSION



# Nonpoint Education for Municipal Officials

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**RI NEMO** provides training and technical tools to help local decision makers manage impacts of changing land use on water resources.

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*RI NEMO is part of the URI Cooperative Extension Water Quality Program and a member of the National NEMO network.*



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# Acknowledgments



RI NEMO is funded by the RI Department of Health, Office of Drinking Water to help build municipal capacity for source water protection.

*and*



URI College of the Environment and Life Sciences (CELS), Cooperative Extension.



# Topics

**Map Basics**

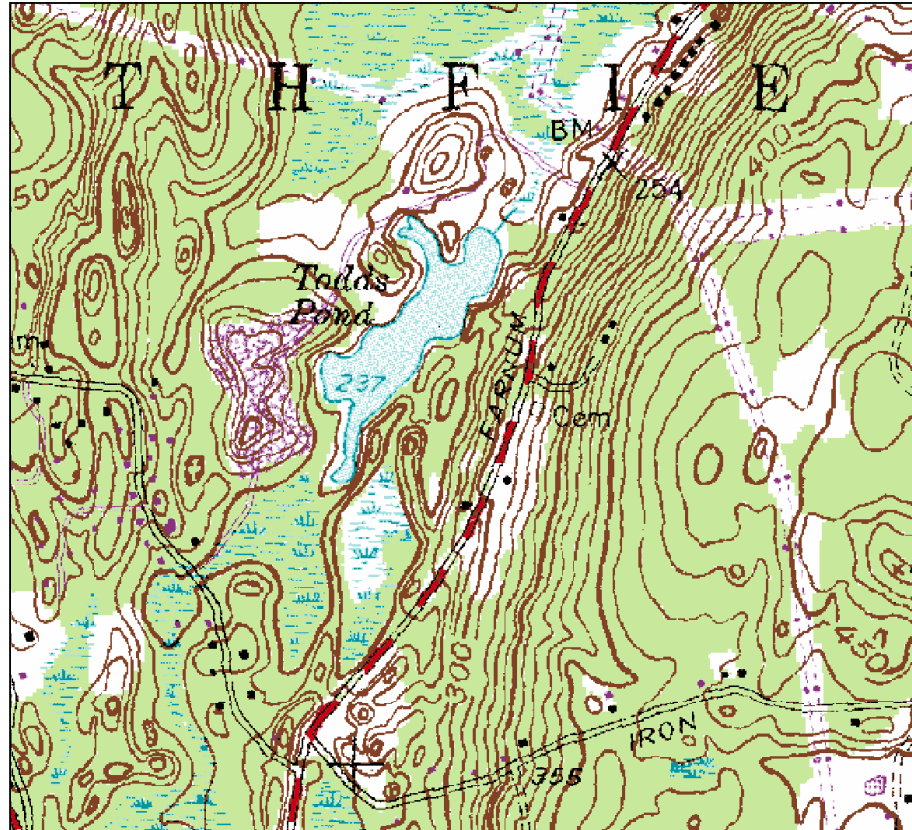
**Working with topography maps**

**Practice exercise**

# Map Basics

# Key Map Elements

- \* Title
- \* North arrow
- \* Scale
- \* Legend



# Key Map Elements

## North Arrow



# Scale

## Written Scale

Ratio scale

1:24,000

1 inch = 24,000 inches

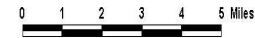
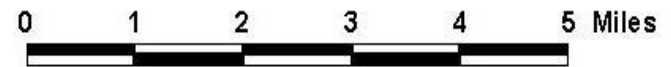
Equivalent scale

1" = 2000 ft.



Beware of Xerox Distortion

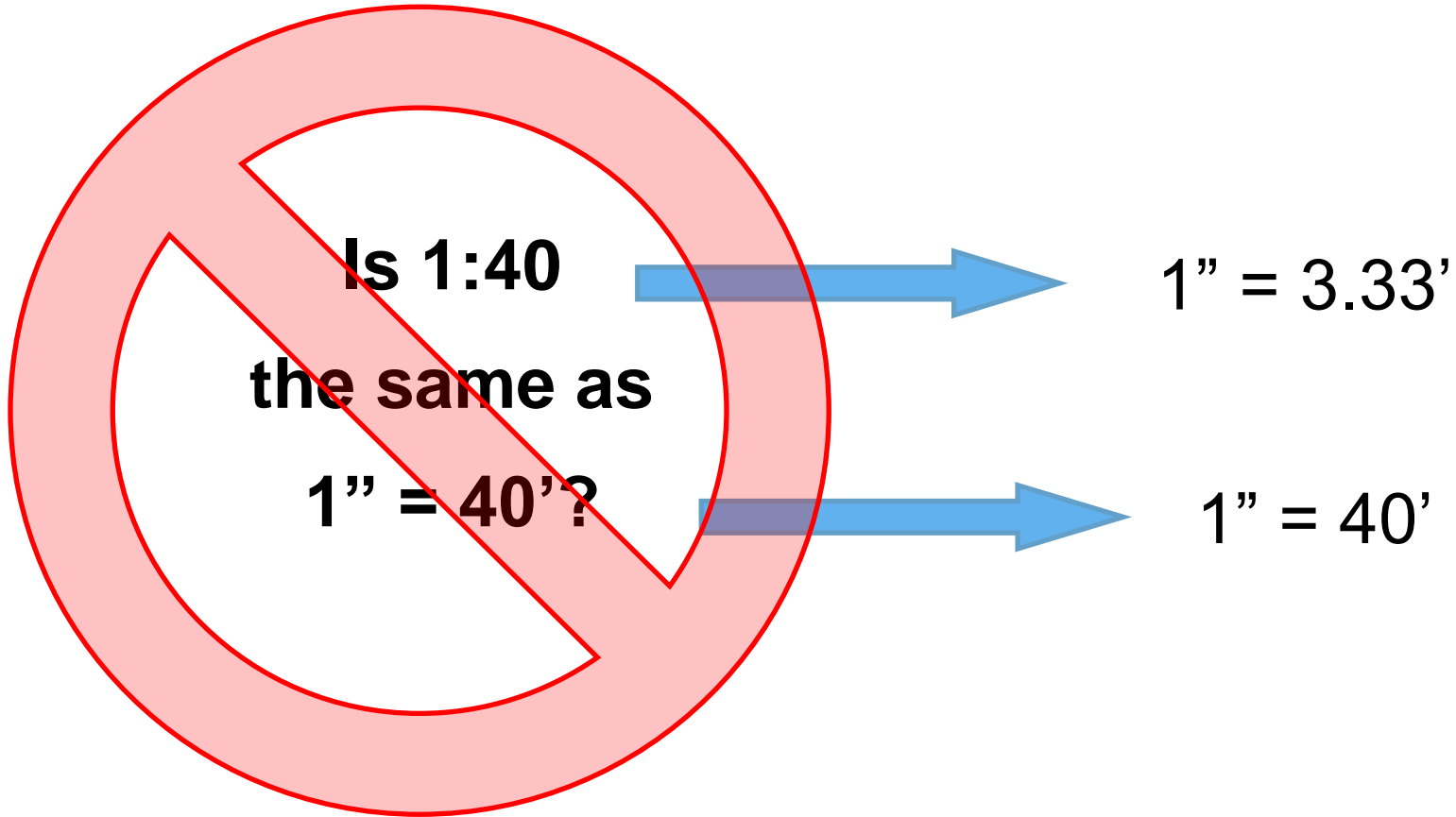
## Graphical (Bar) Scale



Graphic scales are the most reliable!



Question: Are Ratio and Equivalent scales different?



# Legends

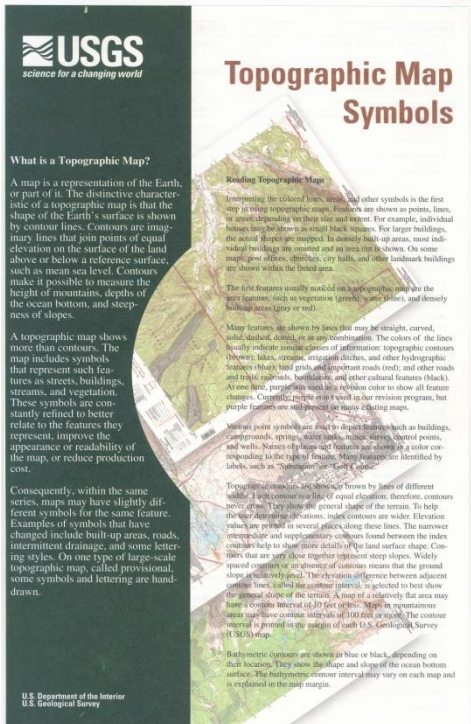
Provide a guide to the symbols used

<b>Watershed Basins</b>	Basins
<b>Town</b>	Town
<b>Migratory Fish Runs</b>	Fish Runs
<b>Tidal Wetlands</b>	Tidal Wetlands
<b>Eelgrass</b>	Eelgrass
<b>Water Features</b>	Streams     Lakes     Water Shore
<b>Urban Growth</b>	Developed before 1985 Turf and Grass before 1985 Water Undeveloped Developed 1985-1990 Turf and Grass 1985-1990 Developed 1990-1995 Turf and Grass 1990-1995 Developed 1995-2002 Turf and Grass 1995-2002

## LEGEND

	DTP LOCATION
	PERC TEST LOCATION
	WETLAND LINE PER FIELD INVESTIGATION
	BUILDING LOT SETBACK
	WETLAND FLAG NUMBER
	SOIL TYPE DESIGNATION
	APPROX. LIMIT OF SOIL TYPES
	SOIL EROSION CONTROL BARRIER
	EXISTING CONTOURS
	PROPOSED CONTOURS
	EXISTING SPOT ELEVATION
	PROPOSED SPOT ELEVATION
	100' REVIEW ZONE
	LIMIT OF VEGETATION
	EXISTING LEDGE OUTCROPPINGS
	EXISTING 20% SLOPE
	PROBE HOLE LOCATION NO LEDGE TO 24" OR MOTTLING/WATER TO 18" ENCOUNTERED IN PROBE HOLES

# USGS Topographic Map Symbols



## Topographic Map Symbols

### Introduction

What is a Topographic Map?  
Reading Topographic Maps  
Topographic Map Information

### Map Symbols

Elevation  
Boundaries  
Land Surface Features  
Water Features  
Buildings and Related Features  
Roads, Railroads, and Other

### Water Features

**MARINE SHORELINE**  
Topographic maps  
Approximate mean high water  
Indefinite or unsurveyed  
Topographic-bathymetric maps  
Mean high water  
Apparent (edge of vegetation)

**COASTAL FEATURES**  
Foreshore flat  
Rock or coral reef  
Rock bare or awash  
Group of rocks bare or awash  
Exposed wreck  
Depth curve, sounding  
Breakwater, pier, jetty, or wharf  
Seawall

**BATHYMETRIC FEATURES**  
Area exposed at mean low tide; sounding datum  
Channel  
Offshore oil or gas well; platform  
Sunken rock

**RIVERS, LAKES, AND CANALS**  
Intermittent stream  
Intermittent river  
Disappearing stream  
Perennial river  
Small falls, small rapids  
Large falls, large rapids  
Masonry dam  
Dam with lock  
Dam carrying road

Perennial lake, intermittent lake or pond  
Dry lake  
Narrow wash  
Wide wash  
Canal, flume, or aqueduct with lock  
Elevated aqueduct, flume, or conduit  
Aqueduct tunnel  
Well or spring; spring or seep

**SUBMERGED AREAS AND BOGS**  
Marsh or swamp  
Submerged marsh or swamp  
Wooded marsh or swamp  
Submerged wooded marsh or swamp  
Canal, flume, or aqueduct with lock  
Elevated aqueduct, flume, or conduit  
Aqueduct tunnel  
Well or spring; spring or seep

**SUBMERGED AREAS AND BOGS**  
Marsh or swamp  
Submerged marsh or swamp  
Wooded marsh or swamp  
Submerged wooded marsh or swamp  
Rice field  
Land subject to inundation

[Top]

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Roads, Railroads, and Other

### Buildings and Related Features

**BUILDINGS AND RELATED FEATURES**  
Building  
School, church  
Built-up Area  
Race track  
Airport  
Landing strip  
Well (other than water); windmill  
Tank  
Covered reservoir  
Water Features  
Gaging station  
Landmark object (feature as labeled)  
Campground, picnic area  
Cemetery, small, large

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### Roads, Railroads, and Other Features

**ROADS AND RELATED FEATURES**  
Roads on Provisional edition maps are not classified as primary, secondary, or light duty. They are all symbolized as light duty roads.  
Primary highway  
Secondary highway  
Light duty road  
Unimproved road  
Trail  
Dual highway  
Dual highway with median strip  
Road under construction  
Underpass, overpass  
Bridge  
Drawbridge  
Tunnel

**RAILROADS AND RELATED FEATURES**  
Standard gauge single track; station  
Standard gauge multiple track  
Abandoned  
Under construction  
Narrow gauge single track  
Narrow gauge multiple track  
Railroad in street  
Junction  
Roundhouse and turntable

**TRANSMISSION LINES AND PIPELINES**  
Power transmission line: pole, tower  
Telephone line  
Aboveground oil or gas pipeline  
Underground oil or gas pipeline

[Top]

# USGS

## Topographic Map Symbols

### Use of Color

Blue – used for all water features.

Red – major roads & highways.

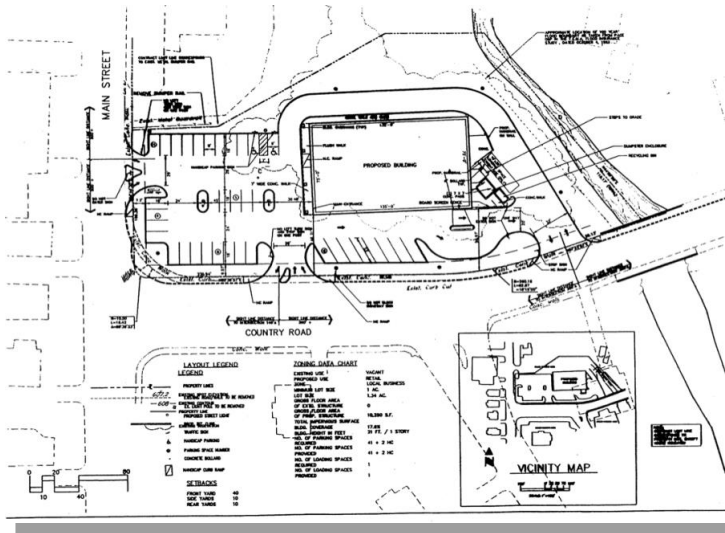
Green – identifies vegetation such as forest cover, orchards, etc.

Brown – used to depict contour lines as well as some landform features.

Black – man-made features & all labeling & lettering.

Purple – revisions & new map data.

# Large or Small Scale?



1 : 480

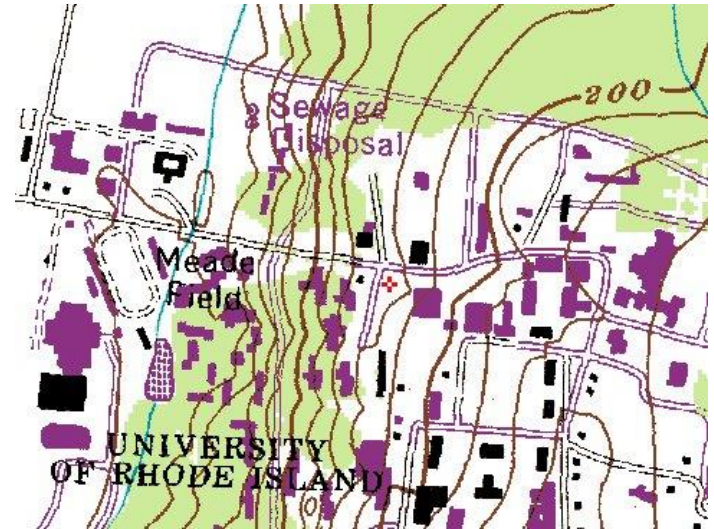
1" = 40 ft.

## Large Scale

High detail

Small Area

Map features are large



1 : 24,000

1" = 2,000 ft.

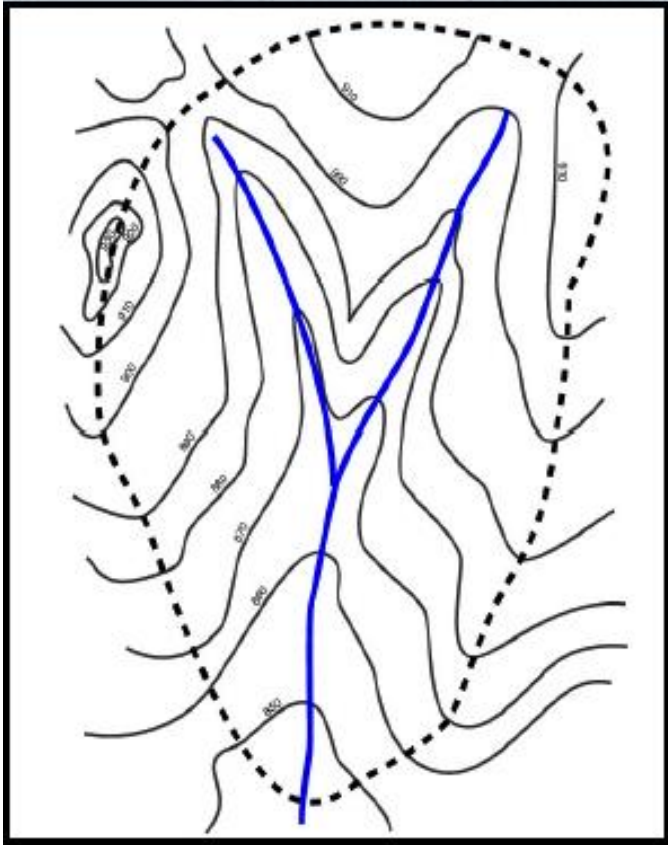
## Small Scale

Low detail

Large Area

Map features are small

# What is a Watershed ?

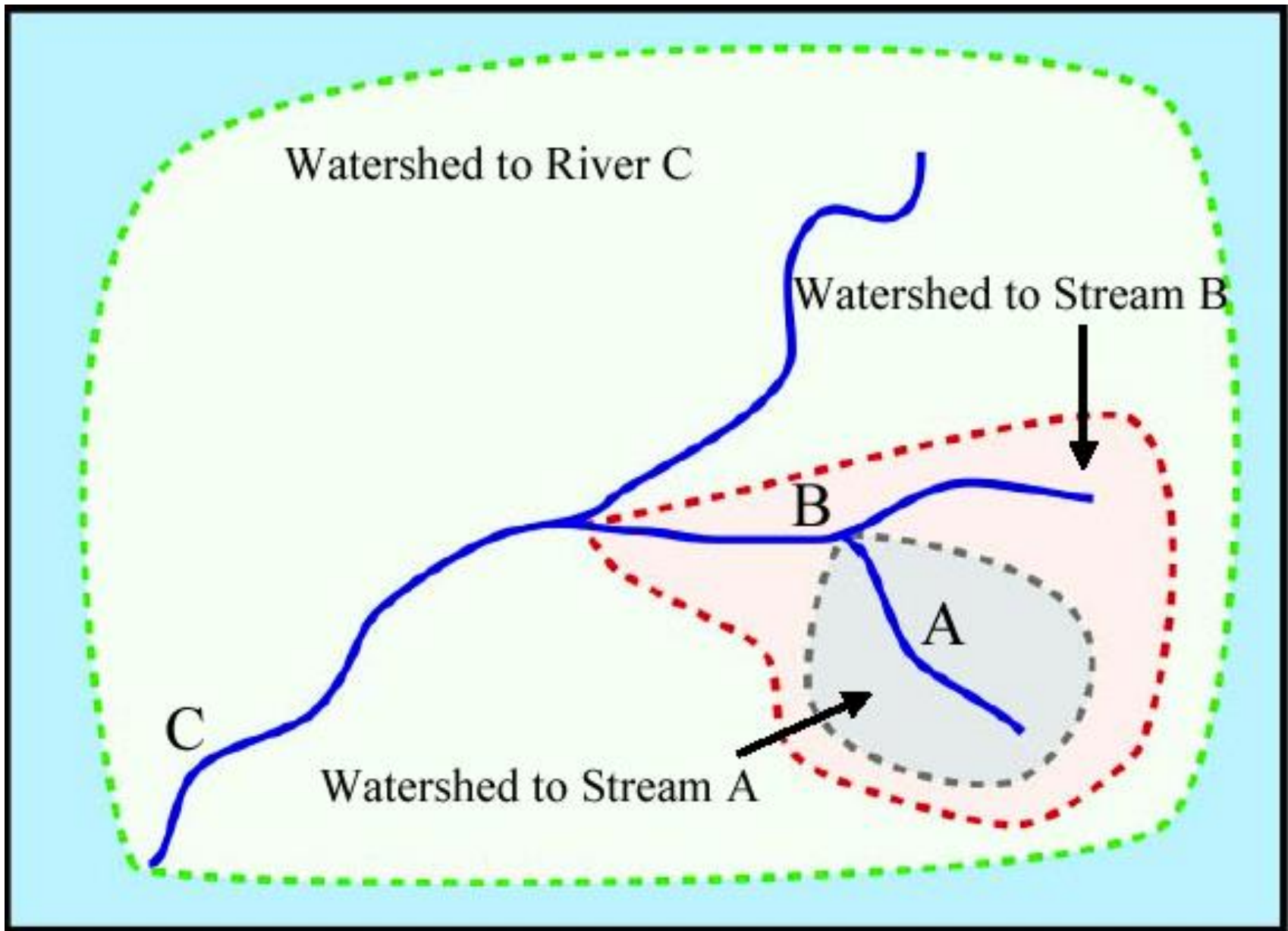


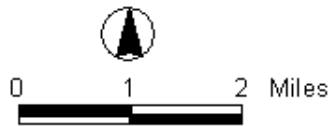
The area of land that drains to a common outlet - such as a lake, stream segment or bay.

Watershed boundaries are based on topography.

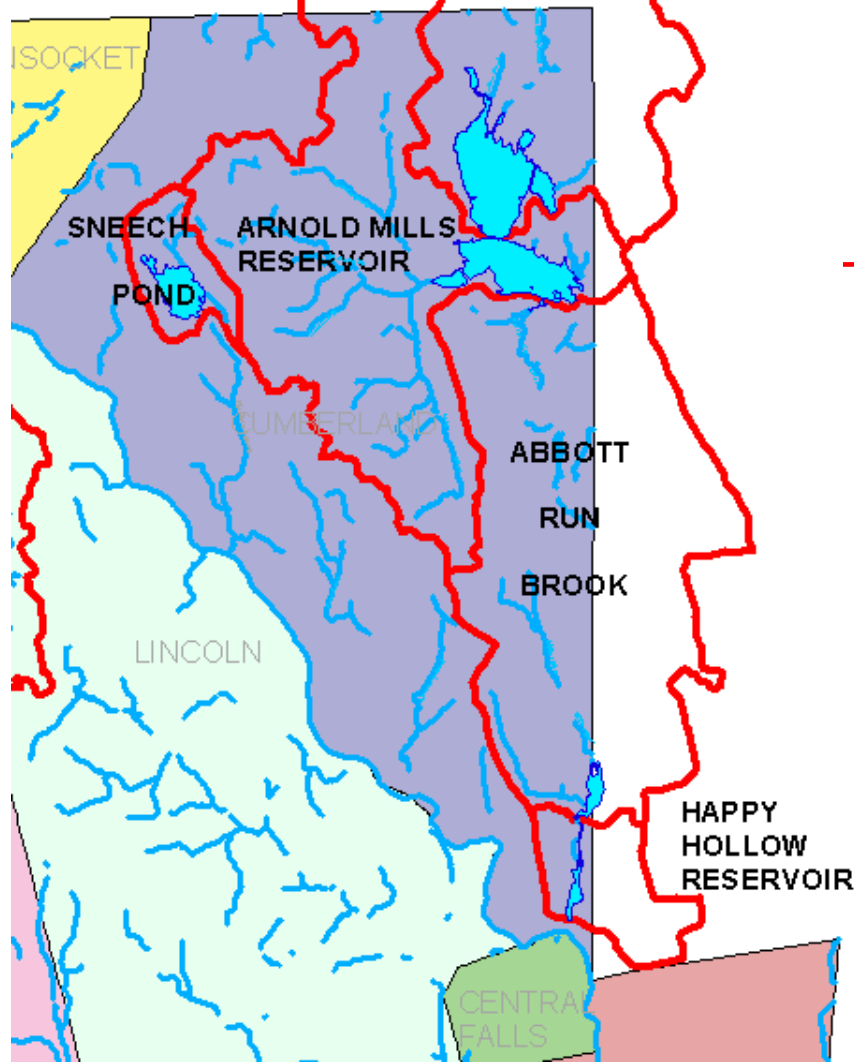


All land is in one watershed or another





# Watersheds don't follow town or state borders



— The watershed boundaries of the Pawtucket water supply reservoirs

■ Town of Cumberland

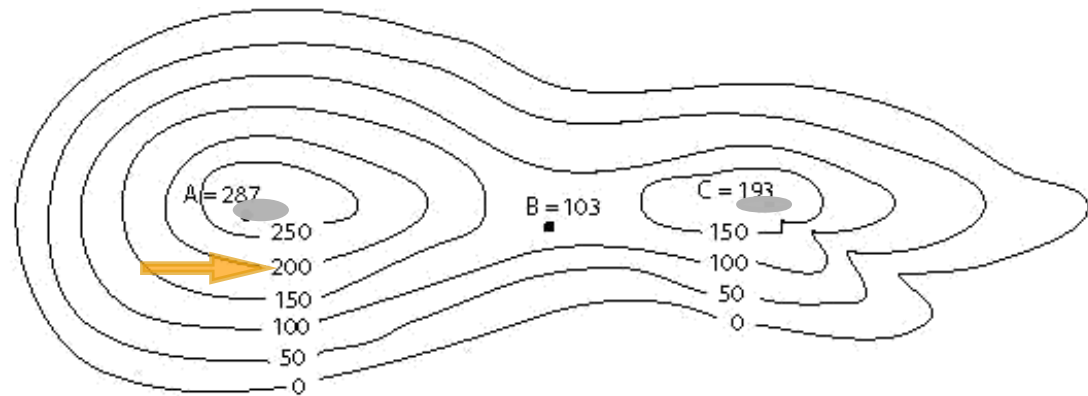


# **Working with Topography Maps**

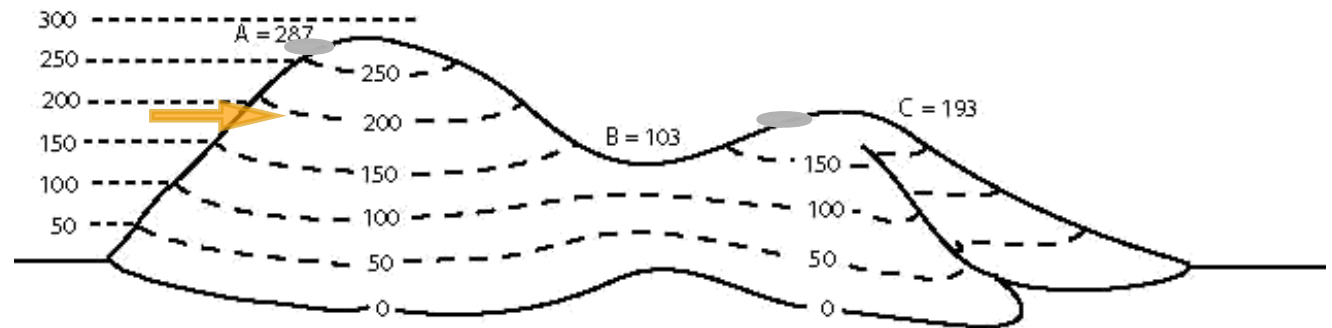
# Topography

Contours: an imaginary line that connects points of equal elevation

Plan View

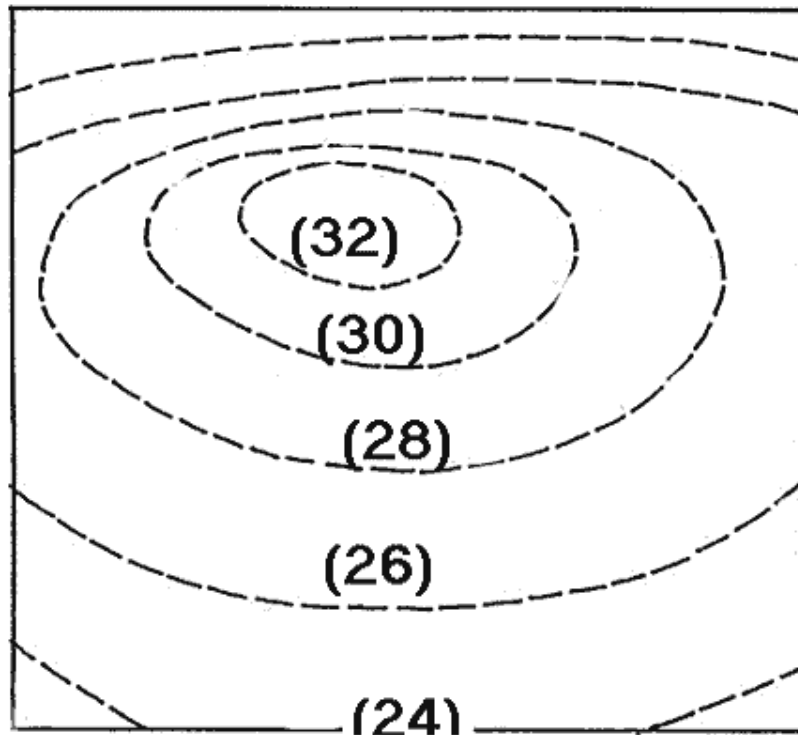


Terrain relief



# Topography

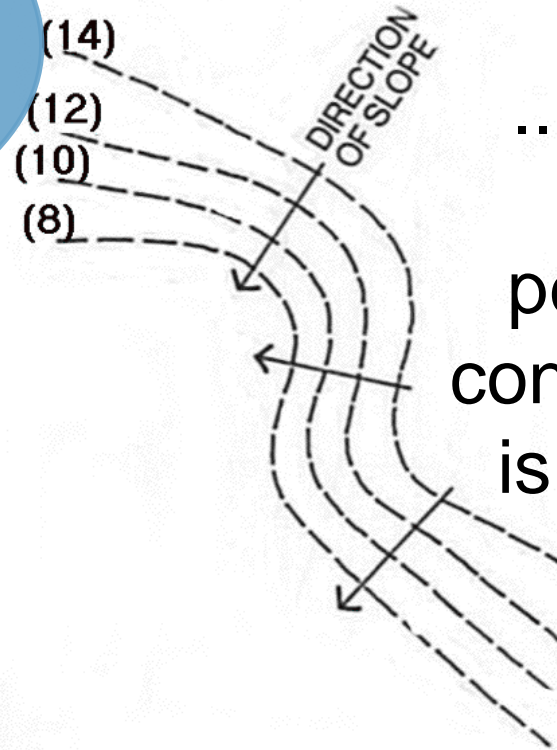
Contours always connect, but not always within the map boundaries...



# Topography

**Slope** direction is calculated perpendicular to the contour lines.

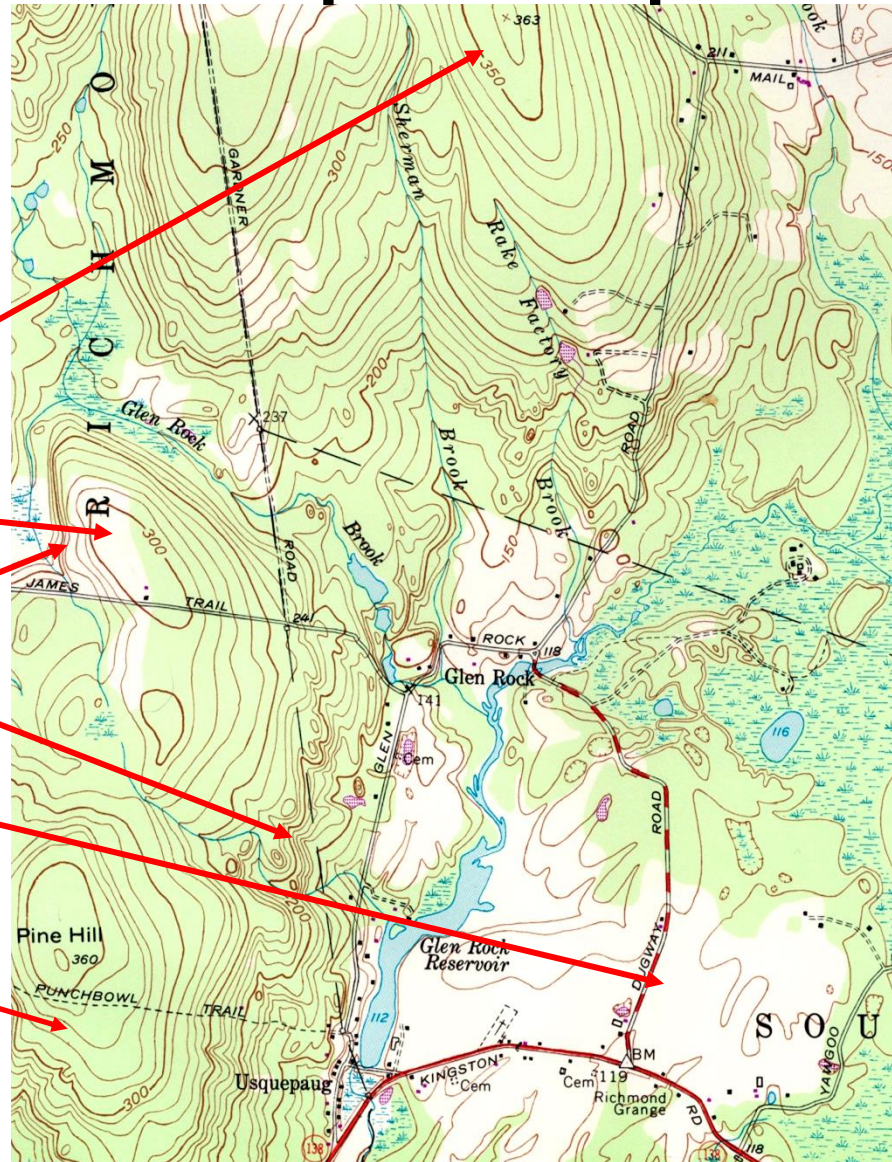
Water flows downhill...



...so the direction of flow is always perpendicular to the contour lines, since this is the steepest slope

# How to read a topo map...

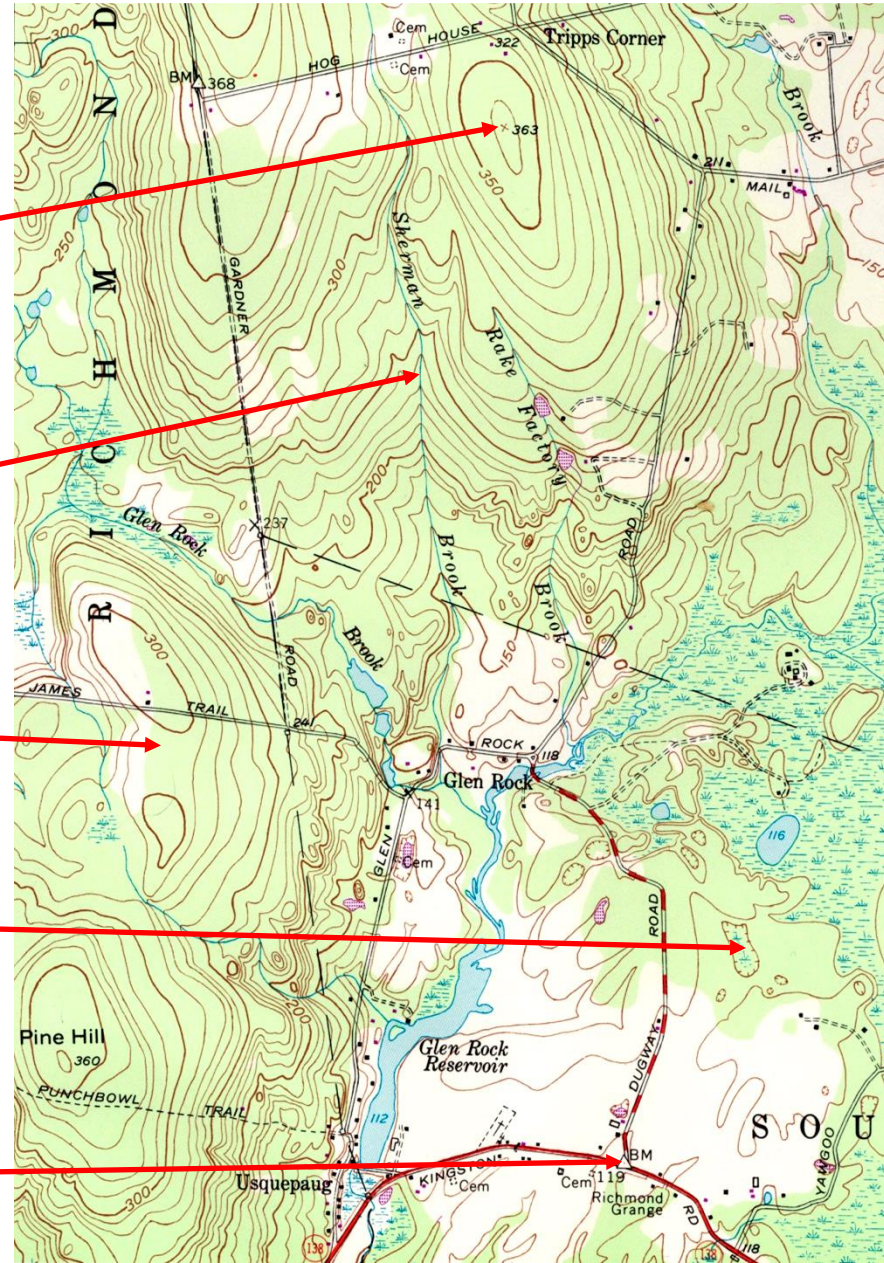
- The **contour interval** is the vertical distance between contours, generally 10ft. on topo maps. **Contour lines** never cross each other.
- Every fifth contour line is an **index contour** and is usually labeled.
- **Hilltops** are indicated by progressively smaller, closed contours.
- Contours close together indicate a **steep slope**.
- Contours far apart indicate a **gentle slope**.
- **Forest Cover** is green





# How to read a topo map...

- A **spot elevation** is a point with a known elevation.
- When contour lines cross a stream, they form a “V” that always points **uphill**.
- A **saddle** is a lower area, often on a ridge, between two areas of higher elevation.
- **Depressions** are indicated by closed contours with inward-pointing ticks.
- A **benchmark (BM)** is a point of known position & elevation used as a point of reference for surveys



# Review of Topo Map Basics

- **Contour lines** never cross each other.
- USGS 1:24,000 topos typically use 10' contour intervals.
- Every fifth contour line is an **index contour** (dk brown) and is usually labeled
- Contours close together indicate a **steep slope**.
- Contours far apart indicate a **gentle slope**.
- **Hilltops** are indicated by progressively smaller, closed contours.
- **Depressions** are indicated by closed contours with inward-pointing ticks.
- A **spot elevation** is a point with a known elevation.
- A **saddle** is an area, often on a ridge, between two areas of higher elevation. There is high ground in two opposite directions and lower ground in the other two directions.
- When contour lines cross a stream, they form a “**V**” that always points **uphill**.
- As a general rule, **water flows** downhill **perpendicular** to contour lines.

## Concepts for delineating watershed boundaries.

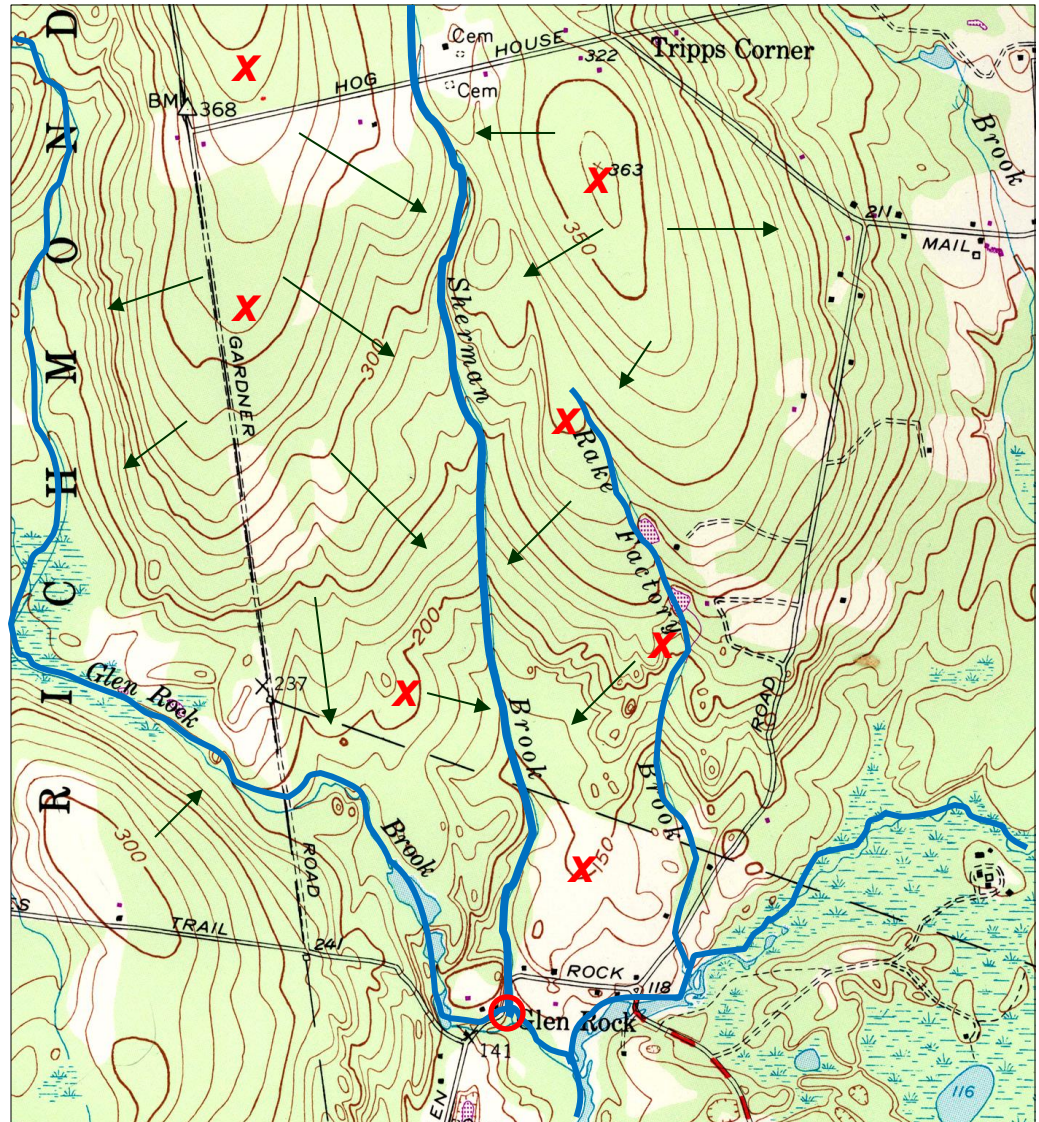
- A watershed is a land area draining to a common outlet.
- All land is in a watershed.
- Watershed boundaries can be drawn to show smaller parts of larger watersheds. The terms basin, watershed, subwatershed, drainage area, hydrologic unit, catchment, subcatchment, are used interchangeably to describe a watershed. There are no size rules but in general, the terms “basin” and “watershed” are used to describe larger drainage areas.
- Watersheds can be drawn for any area. The point chosen as the watershed outlet determines the boundaries.. For example, the mouth of the Pawtuxet River as it flows into Narragansett Bay is the outlet for the entire Pawtuxet River watershed, including the Scituate Reservoir and its watershed. At a project scale, a developer must identify the point(s) where a stream or wetland leaves the property, then identify areas that drain to that outlet, either on or upgradient of the property.
- Natural drainage patterns may be altered by man made features. For example, roads are often built to follow ridges and other high points, so drainage divides often follow roads. Stormwater drainage systems may redirect water flow away from naturally occurring patterns. In urban areas, field checking is needed to verify water flow direction based on locations of stormdrain inlets and outlets.



# Watershed Delineation Example

## Sherman Brook Watershed

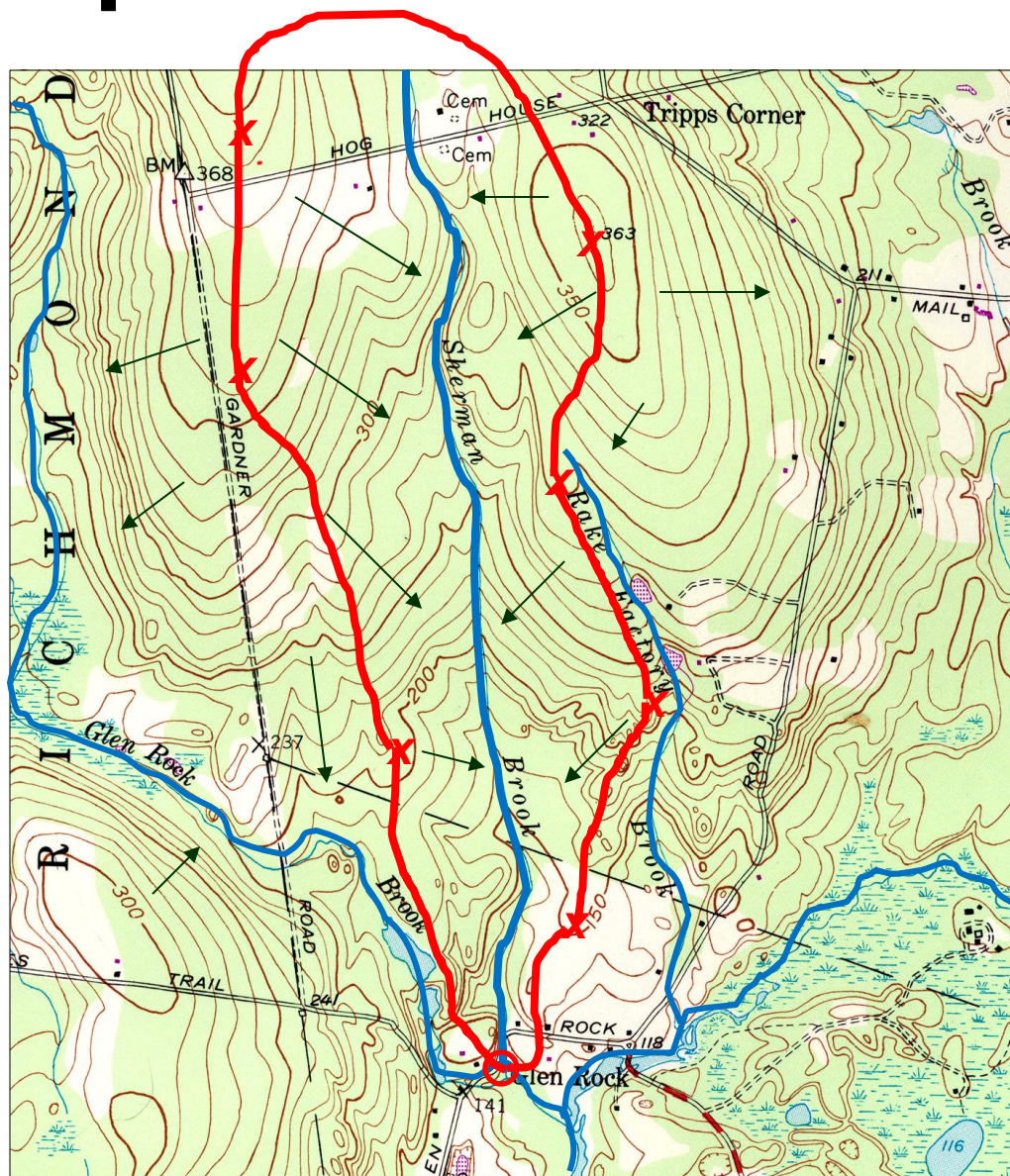
1. Identify the watershed outlet. Mark with ○.
2. Highlight Sherman Brook & other nearby watercourses and flow direction.
3. Look for ridge lines & saddles. Mark high points with X.
4. Visualize surface flow direction from high points. Draw arrows to indicate direction of flow.
5. Trace outline of watershed beginning at outlet, connecting high points. Cross contours at right angles. Form a closed and continuous boundary.





# Delineation Steps

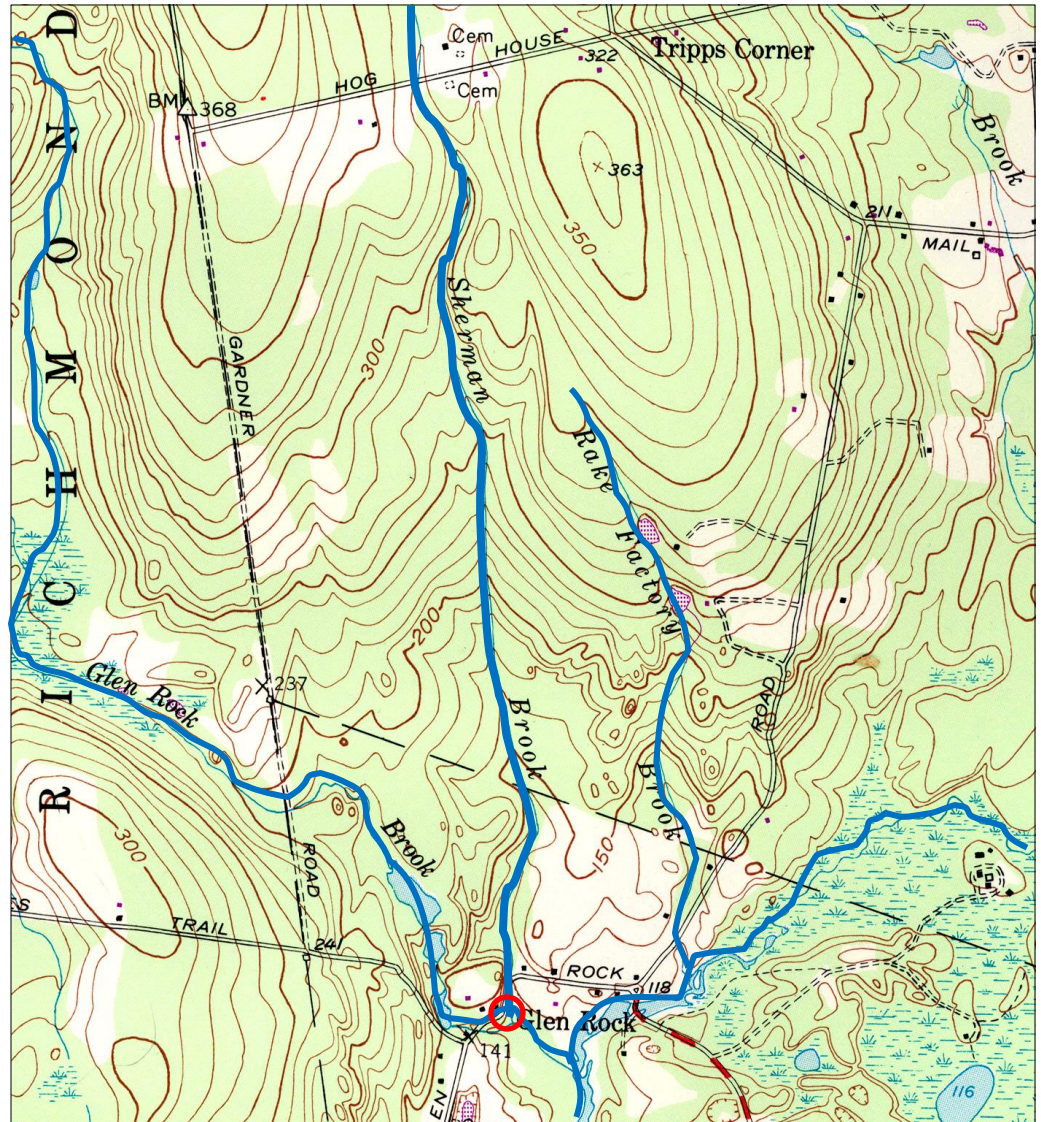
- *Begin to connect high points, following ridges when present.*
- *The watershed boundary should cross each contour line at a right angle.*
- *If you are unsure as to the placement of your delineation, try drawing direction of flow arrows on either side (staying perpendicular to the contour lines). Flow within your boundary should drain into Sherman Brook, while flow outside your boundary should drain elsewhere.*
- *The boundary should be closed and continuous.*





# Now try it on your own

- *Begin to connect high points, following ridges when present.*
- *The watershed boundary should cross each contour line at a right angle.*
- *If you are unsure as to the placement of your delineation, try drawing direction of flow arrows on either side (staying perpendicular to the contour lines). Flow within your boundary should drain into Sherman Brook, while flow outside your boundary should drain elsewhere.*
- *The boundary should be closed and continuous.*



# Your Turn

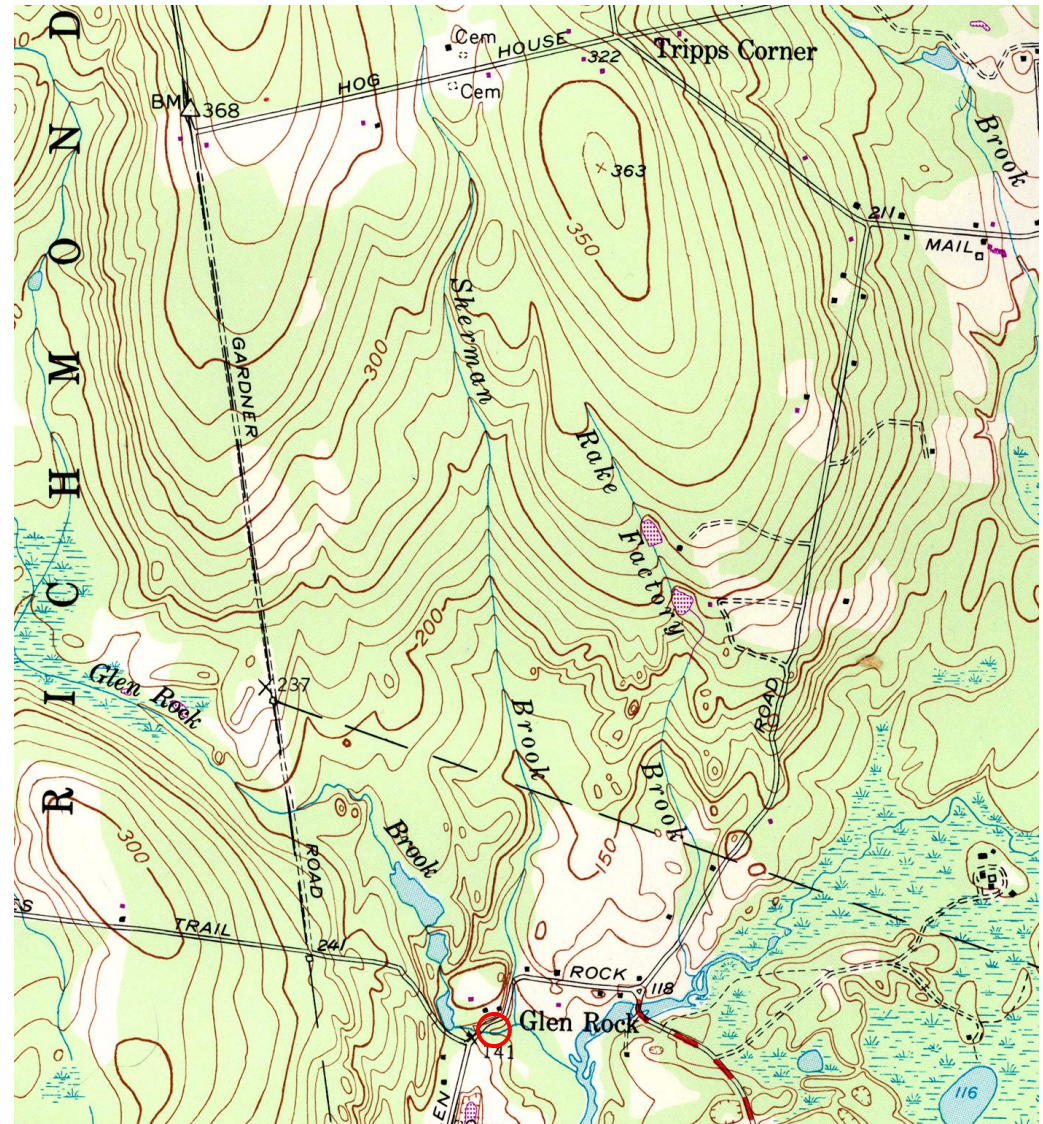




# Watershed Delineation Example

## Sherman Brook Watershed

1. Identify the watershed outlet. Mark with **O**.
2. Highlight Sherman Brook & other nearby watercourses and flow direction.
3. Look for ridge lines & saddles. Mark high points with **X**.
4. Visualize surface flow direction from high points. Draw arrows to indicate direction of flow.
5. Trace outline of watershed beginning at outlet, connecting high points. Cross contours at right angles. Form a closed and continuous boundary.

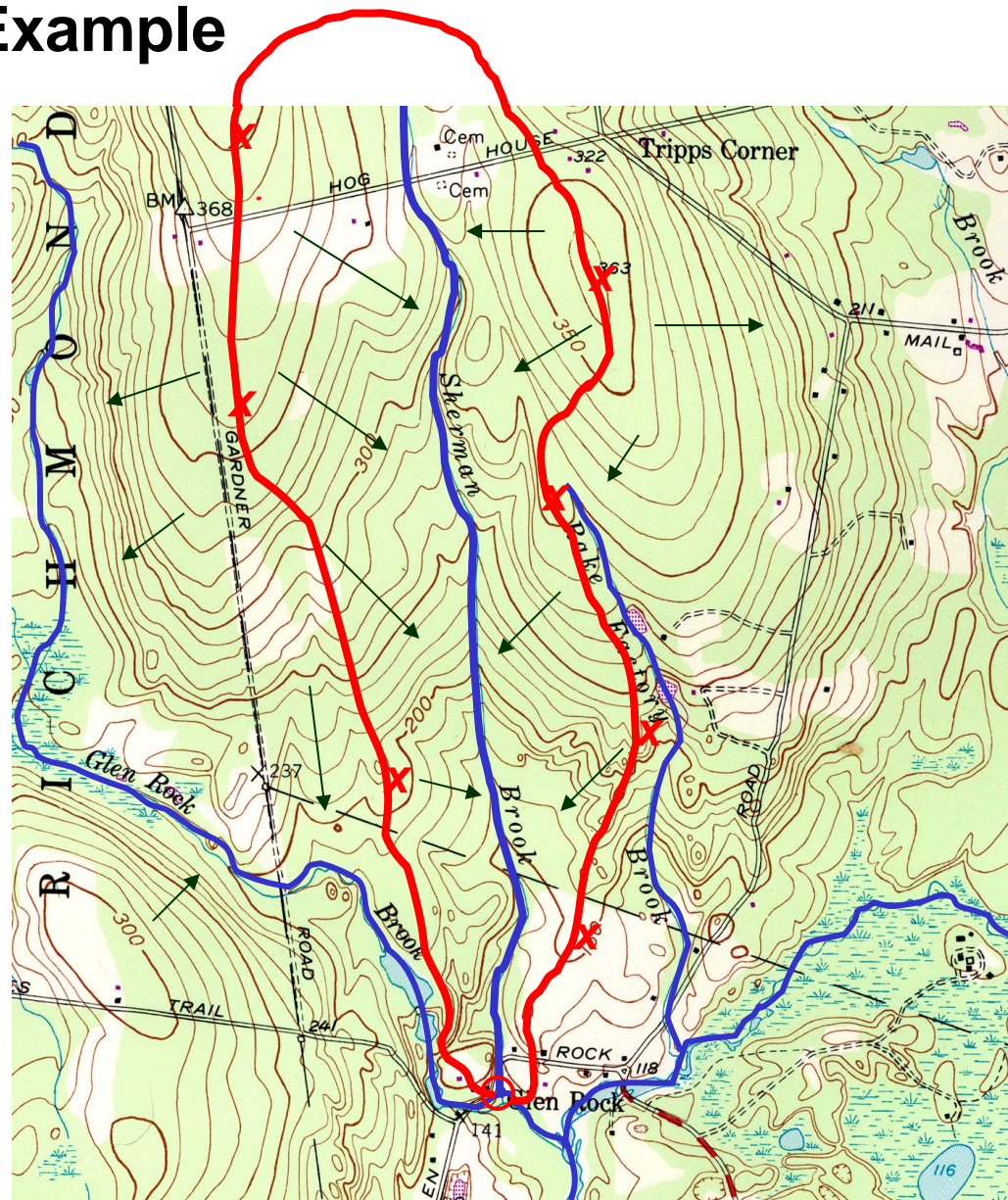




# Watershed Delineation Example

## Sherman Brook Watershed

1. Identify the watershed outlet. Mark with ○.
2. Highlight Sherman Brook & other nearby watercourses and flow direction.
3. Look for ridge lines & saddles. Mark high points with X.
4. Visualize surface flow direction from high points. Draw arrows to indicate direction of flow.
5. Trace outline of watershed beginning at outlet, connecting high points. Cross contours at right angles. Form a closed and continuous boundary.



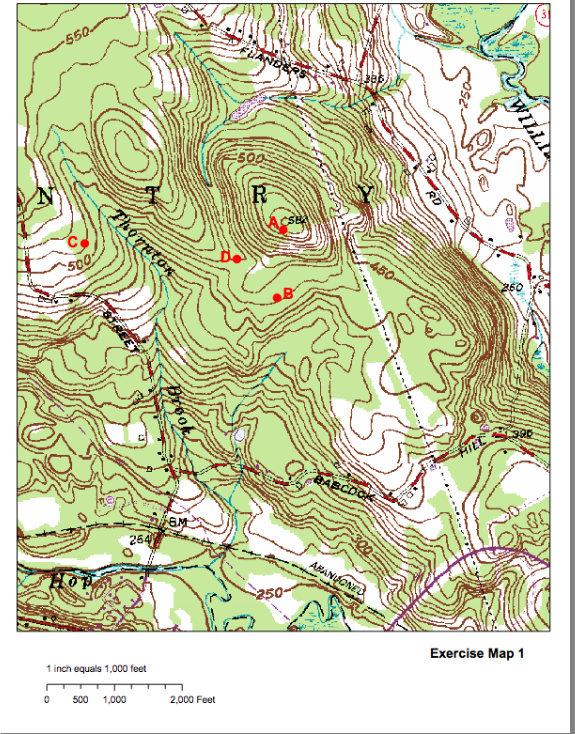
# **Extra Practice**

# Topography

Your turn!

Find or calculate the following:

- What's missing?
- highest elevation
- elevation of Pt. A
- the distance between Pts A & B
- the change in elevation between A & B
- the percent slope between A & B
- Which is higher C or D?
- Which direction would water flow from C? D?
- Where would that water leave the map edge?

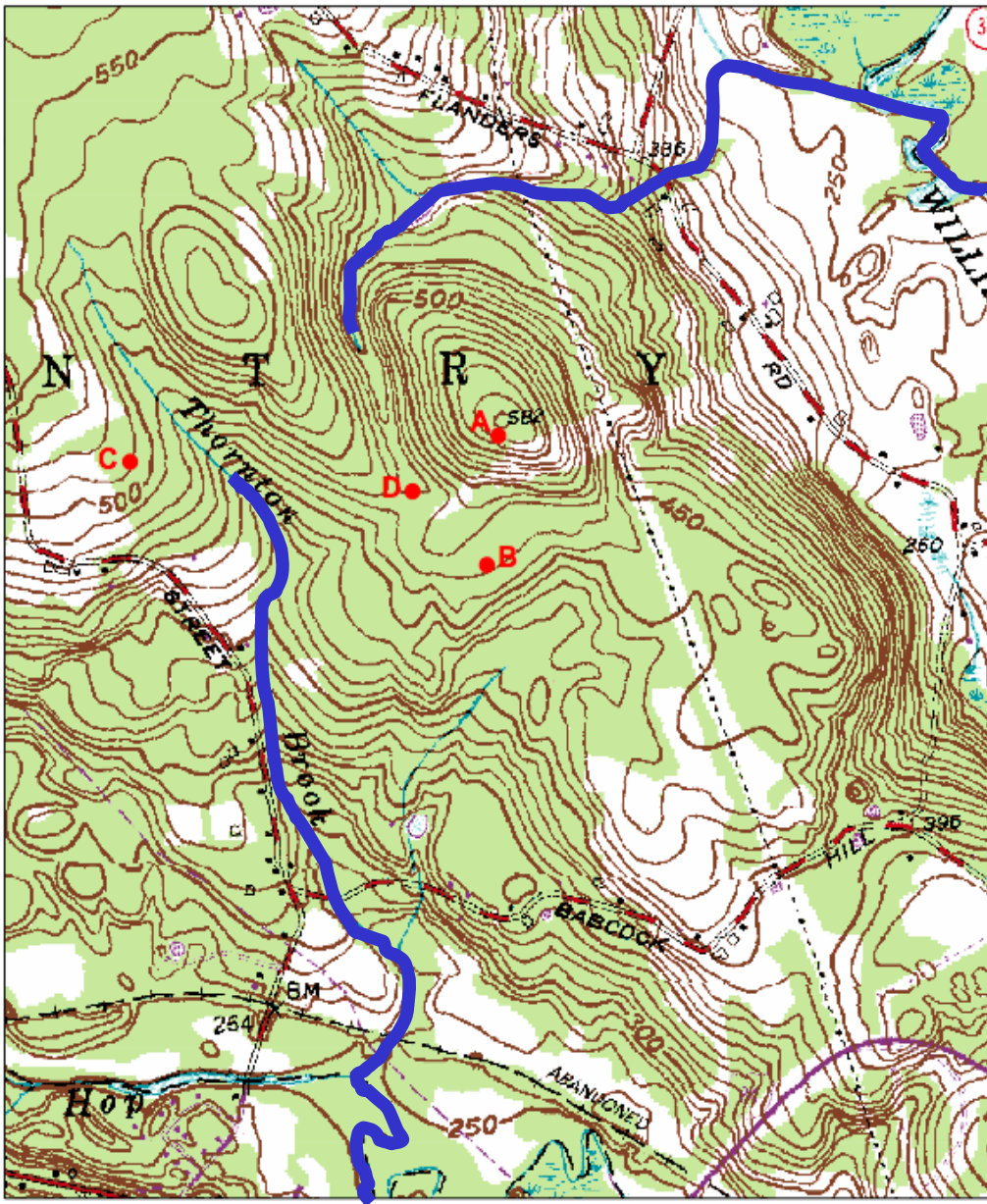






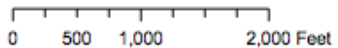
## Topography Exercise

1. What's missing?
2. Highest elevation?
3. Elevation of point A?
4. The distance between A & B?
5. The change in elevation between A & B?
6. The percent slope between A & B?
7. Which is higher C or D?
8. Which direction would water flow from C? D?
9. Where would that water leave the map edge?



Exercise Map 1

1 inch equals 1,000 feet



## Topography Exercise Answers

1.-What's missing?

North Arrow, Legend, Title

2.-highest elevation

582 ft

3.-elevation of Pt. A

570 ft

4.-the distance between Pts A & B

1,000 ft

5.-the change in elevation between A & B

100 ft

6.- the percent slope between A & B

10%

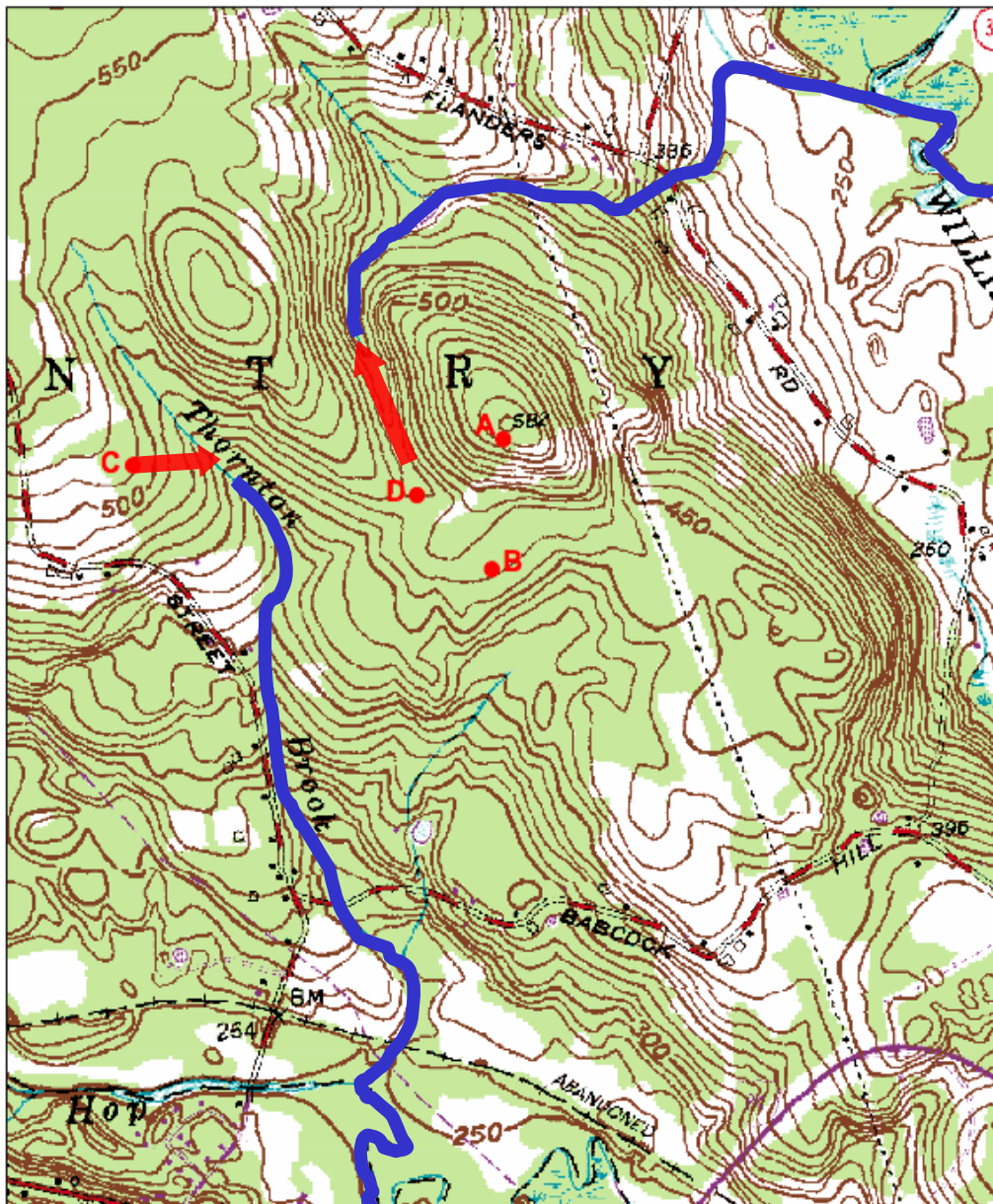
7.Which is higher C or D?

C

8.Which direction would water flow from C? D?



9.Where would that water leave the map edge?



Exercise Map 1

1 inch equals 1,000 feet

0 500 1,000 2,000 Feet



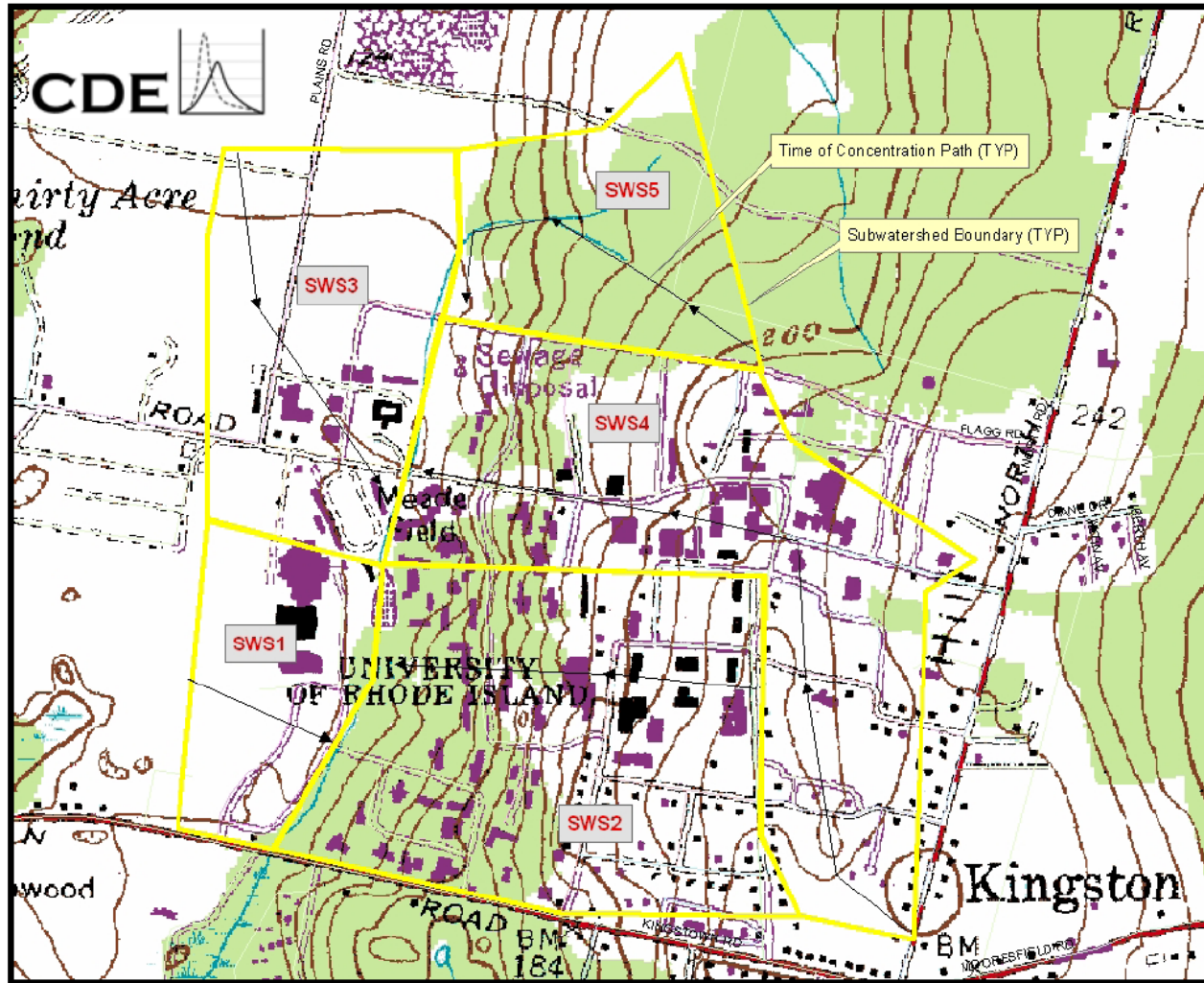


Figure 3 – White Horn Brook Subwatersheds (Source: RIGIS & USGS)

**Caution!** In areas with urban drainage systems, such as the URI Kingstown campus shown here, drainage boundaries may not follow topography.

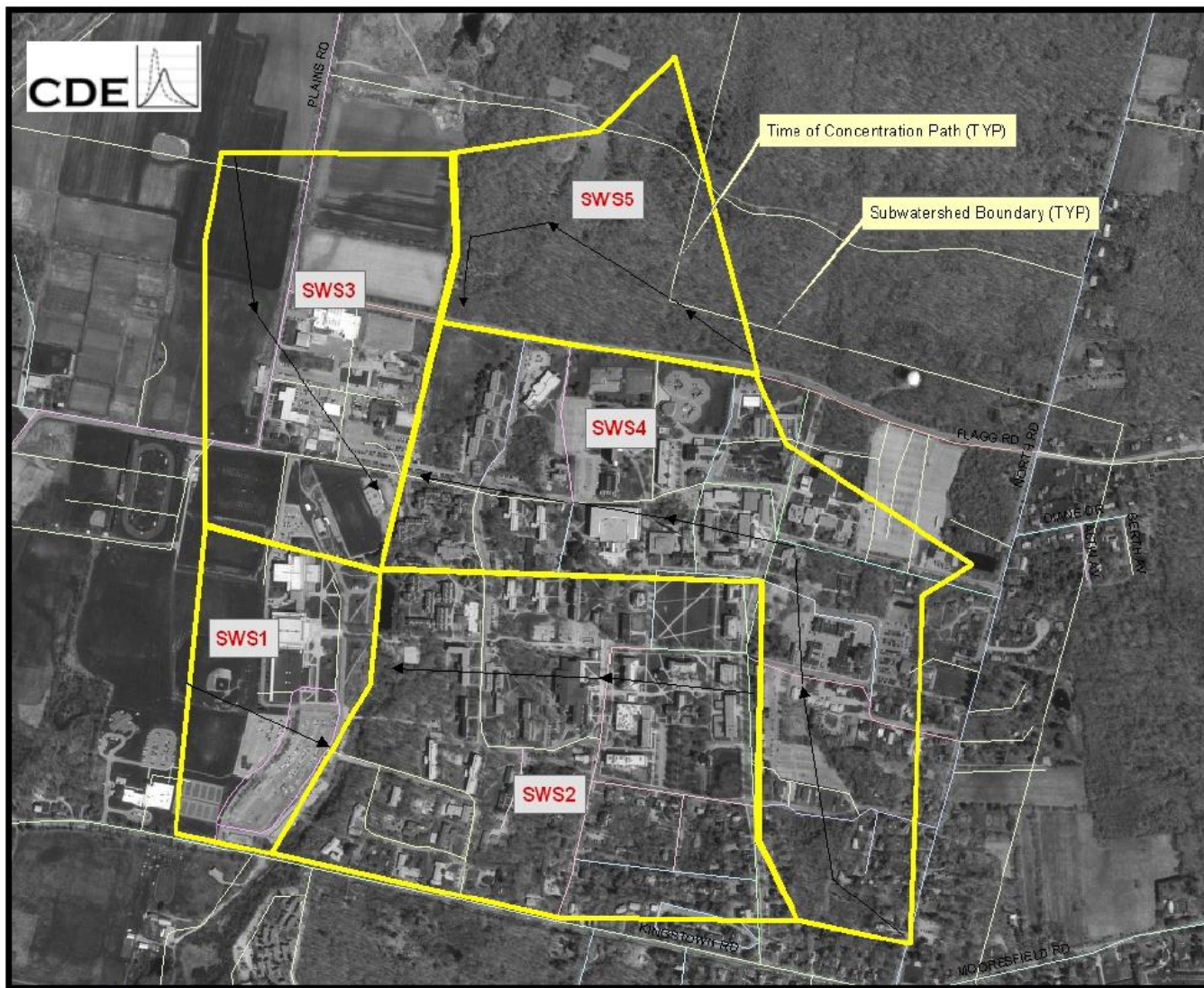


Figure 4 – White Horn Brook Subwatersheds (Source: RIGIS)

This aerial photo clearly shows the urban drainage boundaries in yellow.

## Sources

Watershed Delineation Tips: Christopher Mason, Adjunct Professor, URI Natural Resources Science Dept. and President, Mason & Associates, Inc.

Appendix D. Watershed Delineation: Maine Department of Environmental Protection. 2009/2010. Stream Survey Manual Vol 1 and 2, Appendix D. Augusta, Maine.

[http://www.maine.gov/dep/water/monitoring/rivers\\_and\\_streams/vrmp/stream-survey-manual/index.html](http://www.maine.gov/dep/water/monitoring/rivers_and_streams/vrmp/stream-survey-manual/index.html)

RI Community Resource Inventory Maps – links to online topography, watershed, other RI natural resources maps.



**Resources:** [www.uri.edu/ce/wq](http://www.uri.edu/ce/wq)  
[www.ristormwatersolutions.org](http://www.ristormwatersolutions.org)

**Contact:**

**Lorraine Joubert, URI NEMO, 401-874-2138**

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