How to Read Topography Maps and Delineate Watershed Boundaries

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THE UNIVERSITY OF RHODE ISLAND COOPERATIVE EXTENSION



Nonpoint Education for Municipal Officials

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

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



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and

THE UNIVERSITY OF RHODE ISLAND COLLEGE OF THE ENVIRONMENT AND LIFE SCIENCES

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





Key Map Elements

North Arrow









Scale

Written Scale

Ratio scale 1:24,000 1 inch = 24,000 inches

Equivalent scale 1" = 2000 ft.

Graphical (Bar) Scale



Graphic scales are the most reliable!

Beware of Xerox Distortion

Question: Are Ratio and Equivalent scales different?



Legends Provide a guide to the symbols used

Watershed Basins	Basins
Town	Town
Migratory Fish Runs	— Fish Runs
Tidal Wetlands	📺 Tidal Wetlands
Eelgrass	📒 Eelgrass
Water Features	— Water Streams 🔂 Lakes — Shore
Urban Growth	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

LEGEND



USGS

Topographic Map Symbols



What is a Topographic Map?

A map is a representation of the Earth for oper of the relationship characteristic of the operation of the operaphic map is that the shape of the Earth's surface is shown by contour lines. Contours are imaglevation on the surface of the land above or below a reference surface, above are below a reference surface, above are below a reference surface, begint of mountains, depths of the secan bottom, and steepness of slopes.

A topographic map shows more than contours. The map includes symbols that represent such features as streets, buildings, streams, and vegetation. These symbols are constantly refined to better relate to the features they represent, improve the appearance or readability of the map, or reduce produce

Consequently, within the same series, maps may have slightly different symbols for the same feature. Examples of symbols that have changed include built-up areas, roads intermittent drainage, and some letter ing styles. On one type of large-scale topographic map, called provisional, some symbols and lettering are handterers.

U.S. Department of the Interio U.S. Geological Survey

Topographic Map Symbols

Monitor longermotes Maps properties the colored lines, and with other symbols is the first or active depending with the state and result for example, harded not active depending with the state and result. For example, harded notes in a public two is stall back object. For larger balances the starts disposed in support in the observed two in operations more indisplayment of the state of the state start of the observed the start of the state of the state start of the start start of the observed memory not offices, therefore, typical, and the information building the shows with the themat access.

The first features usually noticed on a softeenable minute it area (causes, such as vegetation (green), water (blue), and d buildings areas (gray or red).

bis database, storagi, er an uny combination. The colors of the line and windows storage in the colors of affermation: topographic control by more than the colors of affermation to the color by the provide storage in the color of the color of the color of the database in the color of the color of the color of the color of the for applicable. Notifications and other coloration floatmers (black), the color more program used in a problem color to show all feature masses. Comparison to the color of the color of the color of the problem color of the formation of the color of the color of the color of the problem color of the color of the color of the color of the formation of the color of the color of the color of the color of the formation of the color of the color of the color of the color of the formation of the color of the color of the color of the color of the formation of the color of the color of the color of the color of the formation of the color of the color of the color of the color of the formation of the color of the color of the color of the color of the formation of the color of the color of the color of the color of the formation of the color of the color of the color of the color of the formation of the color of the colo

Mitroyic point symbolyaire may be deport features which as build carefuroands, springs, witter table, minus, survey, dontrol points and wells. Natures of places and frances are shown in a color corresponding to the type of features than frances are identified by linkels, such as "Submerging" or Cord Color."

They were required as a weak thread by an of different times are in the source of paral of daming the source one paral source of the source of the source of the source one of the source energy of the source of th

hymetric contours are shown in blue or black, depending on a location. They show the shape and slope of the ocean botton see. The bathymetric contour interval may vary on each map

≥USGS

Topographic Map Symbols

Water Features

MARINE SHORELIN

Introduction What is a Topographic Map2 Reading Topographic Maps Topographic Map Information

Map Symbols

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

	Topographic maps	
ion	Approximate mean high water	
IN II	Indefinite or unsurveyed	
	Topographic-bathymetric maps	
	Mean high water	_
	Apparent (edge of vegetation)	
	COASTAL FEATURES	
	Foreshore flat	(Par
	Rock or coral reef	and a state
	Rock bare or awash	
tures	Group of rocks bare or awash	···· (
er	Exposed wreck	d- de
	Depth curve; sounding	- 3
	Breakwater, pier, jetty, or wharf	[m
	Seawall	

BATHYMETRIC FEATURES Area exposed at mean low tide; sounding datum

	AND
Offshore oil or gas: well; platform	
Sunken rock	+
RIVERS, LAKES, AND CANALS	
Intermittent stream	
Intermittent river	10 mg 2 mma 198.5
Disappearing stream	
Perennial stream	
Perennial river	
Small falls; small rapids	

Large fulls, large rapids

Asseary dan

Dam with lock

Dam carrying road

Parensial lake; laramittant lake or particular

Parensial lake; laramittant lake or particular

Mide wash

Cana, fune, or equedect with lock

Evoxed equedect, fune, or equedect with lock

Evoxed equedect, fune, or equedect with lock

Well or spring; spring or seep

UBMERGED AREAS AND BUGS	
Marsh or swamp	· **
Submerged marsh or swamp	
Wooded marsh or swamp	
Submerged wooded marsh or swamp	100
Canal, flume, or aqueduct with lock	
Elevated aqueduct, flume, or conduit	
Aqueduct tunnel	*****
Well or spring; spring or seep	. 1

SUBMERGED AREAS AND BOGS

Submerged marsh or swamp	
Vooded marsh or swamp	
Submerged wooded marsh or swamp	10 - 11 - 11 - 11 - 11 - 11 - 11 - 11 -
Rice field	· · · (Rice)
Land subject to inundation	and the second

USGS

Introduction

Topographic Map Symbols

Buildings and Related Features

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	Ce

	BUILDINGS AND RELATED FEATURES	
	Building	
	School; church	
	Built-up Area	and the second
	Racetrack	0 0
	Airport	XX
	Landing strip	000000
	Well (other than water); windmill	• 1
	Tanks	• •
	Covered reservoir	0 000
	Gaging station	•
	Landmark object (feature as labeled)	0
	Campground; pionic area	1 .
_	Cemetery: small; large	(+3Cem)

USGS

Topographic Map Symbols

Introduction	Ro
What is a Topographic Map? Reading Topographic Maps Topographic Map Information	ROA Road light Pr
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Elevation Boundaries	
Land Surface Features Water Features	D
Buildings and Related Features Roads, Railroads, and Other ©	Ur Br
	Dr

ROADS AND RELATED FEATURES	
loads on Provisional adition maps are not ight duty. They are all symbolized as light	classified as primary, secondary, or duty roads.
Primary highway	
Secondary highway	
Light duty road	
Unimproved read	
Trail	
Dual highway	
Dual highway with median strip	And a second second
Road under construction	<u></u> - <u></u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u>-</u> - <u></u>
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	
Juxtaposition	Mag Branch
Roundhouse and turntable	-+-00

SMISSION LINES AND PIPELI

Power transmission line: pole; tower	AN
Telephone line	Telestere
Aboveground oil or gas pipeline	
Underground oil or gas pipeline	Pasting

|Iog|

http://erg.usgs.gov/isb/pubs/booklets/symbols

USGS

Topographic Map Symbols

Use of Color

- **Blue** used for all water features.
- Red major roads & highways.
- <u>Green</u> 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.
- **<u>Purple</u>** 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

Contours: an imaginary line that connects points of equal elevation



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



Slope direction is calculated perpendicular to the contour lines.



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 occuring 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 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.



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 you 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 you boundary should drain elsewhere.

•The boundary should be closed and continuous.

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CemHQUSE

Cem

.322 Tripps Corner

MAIL

Your Turn



Watershed Delineation Example

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Extra Practice

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?

1 inch equals 1,000 feet

0 500 1,000 2,000 Feet

Exercise Map 1



1 inch equals 1,000 feet

0 500 1,000 2,000 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?

С

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

9. Where would that water leave the map edge?



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. <u>http://www.maine.gov/dep/water/monitoring/rivers_and_</u> <u>streams/vrmp/stream-survey-manual/index.html</u>

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



Resources: www.uri.edu/ce/wq www.ristormwatersolutions.org

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