SC Envirothon Training Trunk Log

Check out date	Coach Name	School/Organization Name	Phone Number	Return date

SC Envirothon Training Trunk Inventory

Large Tote Contents				
ITEM	CHECK		ITEM	CHECK
Training Trunk Binder			Describing & Sampling Soils Book	
Small totes (3)			Soil Survey Book	
Topo map set (3 maps, legend, booklet)			Soil Horizon Poster	
Nets (2)			Indicators of Hydric Soils in U.S.	
Sorting trays (2)			Keys to Soil Taxonomy	

Forestry/Wildlife Tote Contents				
ITEM	CHECK		ITEM	CHECK
Waterford Guides (7)			Clinometer (pouch, instructions)	
Forest Trees of South Carolina			Binoculars (pouch, strap) (2)	
DBH tape			Angle Gauge	

Aquatics Tote Contents				
ITEM	CHECK		ITEM	CHECK
Freshwater Fish of the Carolinas			Phosphate test tabs	
Macroinvertebrate card set			pH test tabs	
Water parameter testing cards			Thermometer with case	
Plastic vials (2)			Forceps (2 curved, 2 straight)	
Glass vials (1)			Pipettors (6 small, 1 large)	
Nitrate test tabs			Pocket microscope (2)	
DO/BOD test tabs			Petri dishes (5)	

Soils Tote Contents				
ITEM	CHECK		ITEM	CHECK
Munsell Soil Color Book			Spray bottle	
Soil texture sample jars (sand, silt, clay)			Jar test (jar, marker, ruler)	

By signing this inventory check-in sheet – both the district representative and the SC Envirothon Coach returning the SC Envirothon Training Trunk certify that all trunk contents are being returned clean, dry, and in working order.

Date of check-in:_____

_____ _____

Signature of SC Envirothon Coach Signature of District Representative

SC Envirothon Training Trunk Contents

Large Tote Contents	
ITEM	ITEM
Training Trunk Binder	Field Book for Describing & Sampling Soils
Small totes (3)	Soil Survey Book
Topo map set (3 maps, legend, booklet)	Soil Horizon Poster
Nets (2)	Soil-Field Indicators of Hydric Soils in U.S.
Sorting trays (2)	Keys to Soil Taxonomy

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Soils Tote Contents	
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All trunk contents must be returned clean, dry, and in working condition to the local Soil and Water Conservation District. Missing or broken parts must be reported. If damage is due to neglect or misuse - borrower will be expected to replace missing or broken items.

TABLE OF CONTENTS

Teacher Tips

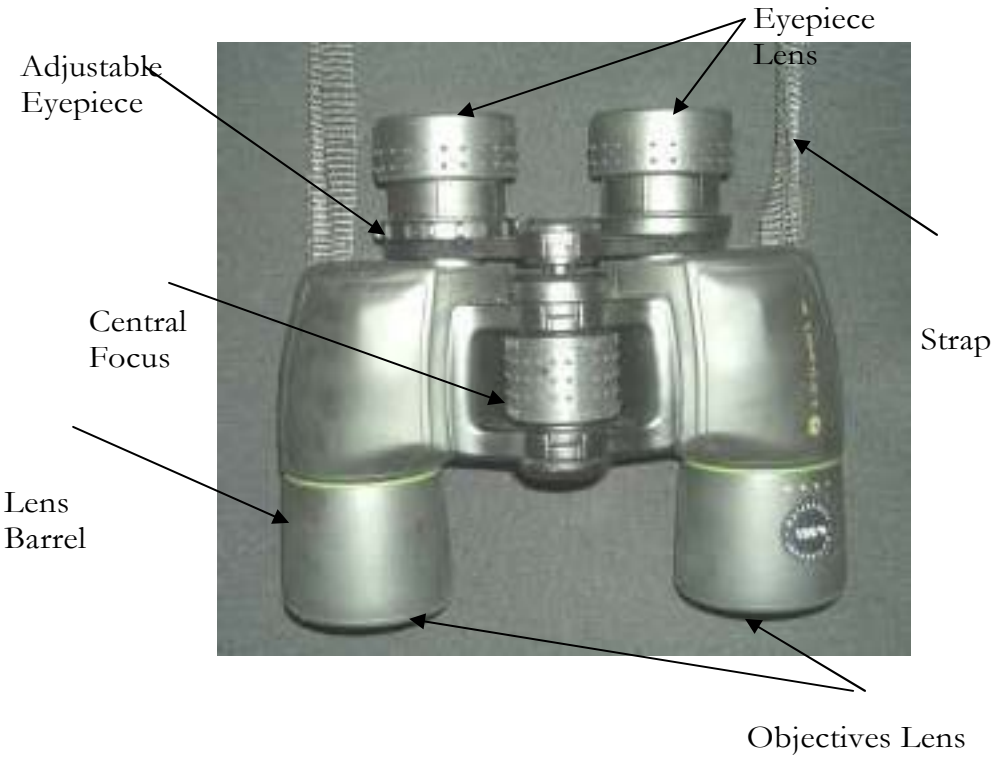
What are Binoculars?

Structure

Binoculars are essentially two identical telescopes mounted side by side and aligned to point in the same direction. At the front of each telescope is an objective lens where light enters, is magnified, and formed into a visual image. The image produced is upside down and backwards. With the help of prisms (blocks of glass functioning as mirrors without reflecting back), the visual images are turned right side up and viewed properly left to right.

Magnification

Binoculars are described by a pair of numbers such as 7x35 or 8x40. The first number represents the magnification, or "power," of the binoculars. This means the 7 in a pair of 7x35 binoculars makes an object appear seven times closer than when viewed by the naked eye. The second number represents the aperture, or the diameter of each objective lens. Aperture is especially important because it determines the amount of light entering the binoculars. The larger aperture, the brighter the image.



Safe Use of Binoculars

- Keep the strap around the neck at all times.
- Stand still when using binoculars.
- Never look at the sun with binoculars.
- Do not rattle, shake, or bump binoculars.
- Never touch binocular lenses with fingers or dirty cloth.

Cleaning & Protecting Binoculars

1. Clean lenses with soft cloth. Make sure to blow off any dirt particles first so the lenses don't scratch.
2. Thoroughly wipe off metal parts.
3. Never try to open up binoculars (leave internal cleaning to professionals).
4. If there is a dirty film on the lenses, put a drop of lens cleaner on a tissue and wipe in a circular fashion.
5. Keep binoculars clean, dry, and off the ground.

Teacher Tips

How to Focus Binoculars

Have students stand about 30 feet away from an object or enlarged bird photo before beginning the lesson. Explain the following 10 steps of how to focus binoculars to students.

Step 1: Put binoculars strap around the neck.

Step 2: If you wear eye glasses, fold eyecups (extra rubber protecting eye from contacting eyepiece lens of binoculars) back.

Step 3: Locate the adjustable eyepiece (most are located on the right eyepiece lens and read " - 0 + " (see right panel). Set adjustable eyepiece to "0", or in the middle of the scale.

Step 4: Locate stationary object (or enlarged bird photo) first with the naked eye.

Step 5: Hold binoculars with two hands and bring binoculars up to your eyes, which are still looking at the stationary object.

Step 6: Move the two halves of the binoculars (connected by a hinge) until one field of view is seen. If you see a dark patch or crescents in the center or on the sides, the binoculars are too close together. If you see through two circles or see two images, the binoculars are too far apart. Adjust binoculars to your eye width.

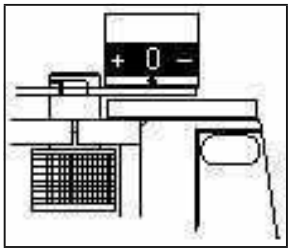
Step 7: Open both eyes and use a finger or two to locate the center focus wheel. Turn the wheel back and forth until the object becomes clearest. Close right eye (left eye open) and turn wheel again until image is clearest in the left eye.

Step 8: Continue looking at the object and close the left eye (keep right eye open). Use a finger on your right hand to locate the adjustable eyepiece. Adjust the eyepiece back and forth until the image becomes the clearest in the right eye. For some, the eyepiece will be closer to the "-", for some it will be closer to the "+" or the "0".

Step 9: Use the central focus for further adjustments during birding, but try not to touch the adjustable eyepiece once focused.

Step 10: Now you are ready for birding. Have fun!

Step 3: Adjustable Eyepiece



Student learning how to correctly focus binoculars.

Students using binoculars while watching birds.

Teacher Tips

Bird Identification Tips!

Use the following information for activity and extension located on right panel.

Bird Field Marks — What did the bird look like?

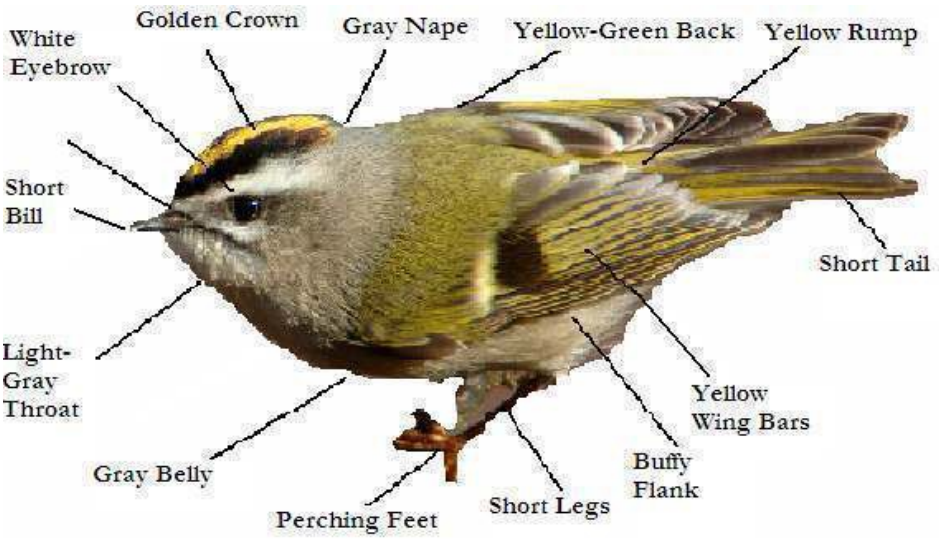
1. *Silhouette*: Body and tail shape, length of bill, etc.
2. *Plumage*: Feather coloration, wing bars or patches.
3. *Posture:* Was the bird sitting upright or perching horizontally?
4. *Size:* Was the bird small like a finch or large like a hawk?

Bird Behavior- What was the bird doing?

1. *Foraging:* Another word for feeding. Describe what it is feeding on.
2. *Flocking:* More than three birds together in a group.
3. *Preening:* Cleaning its feathers with its bill.
4. *Flying:* Describe soaring, hovering, flapping, or gliding.
5. *Singing:* Long, complex musical notes sung only by male birds.
6. *Calling:* Short, simple notes made by both males and female birds.

Bird Habitat- Where was the bird located?

1. Pine forest
2. Urban area
3. Hard woods
4. Swamp



Take a Hike

After the lesson, take students on a hike or walk to use their new bird expertise. Have them help other students identify their focus bird in the field by pointing out its field marks.

Outdoor Extension!

Ask students if they can think of other ways to identify birds in the field. Direct students to two other commonly used identification methods: bird behavior and habitat. Then take students outside on a hike or schoolyard walk to identify birds using the three methods: field marks, behavior, and habitat. Have students use the Student Journal to check-off information about one bird seen (they can try to locate their focus bird). Discuss journals and field marks at the end of the walk.

Using Adjectives!

Adjectives are important when identifying field marks. Some examples of "field marks" for the Golden-crowned Kinglet include:

- golden crown
- short bill
- white wing bars
- buffy flanks

Teacher Tips

What are bird songs?

Bird songs are long, complex, melodic, and almost exclusively produced by male birds during breeding season.

Function of Song:

- Attracting a Mate
- Strengthen Pair Bond
- Establish Territory
- Defend Nest

What are bird calls?

Bird calls are relatively shorter, simpler, and produced by both sexes throughout the year.

Function of Call:

- Threaten others of the same species.
- Alarm or warn others there is a presence of danger.
- Contact family members.

How do birds sing?

Birds have a similar sound-producing device to the human larynx called the syrinx. Unlike the larynx which is located at the top of the trachea, syrinx is located directly below. As air from the lungs move over the syrinx, special membranes called tympaniform membranes vibrate generating sound waves. For this reason, birds are able to produce a variety of sounds.

Why do birds sing?

Birds communicate to each other through the production of sound in the form of songs and calls.

Photo by Jim Livaudais

During breeding season, the song of the American Robin is one of the first heard in the morning.

What is a mnemonic device?

A device used to remember bird songs or calls. This system translates songs into word phrases so they are easier to remember.

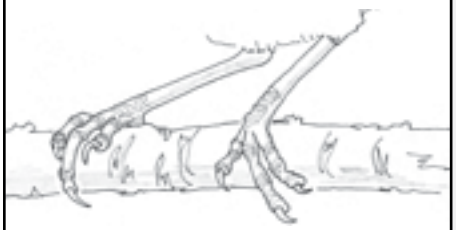
Beaks and Feet

A bird's beak or bill has the primary function of gathering and eating food. A bird's beak is designed to help it eat the foods it needs including tearing, crushing, picking, probing and breaking the shells of food items. Birds also use their beaks to preen or clean and oil their feathers. Preening keeps their feathers healthy and in the right position. Birds use their beaks like humans use their hands when they are building their nests and feeding their young. By looking at a bird's beak we get clues about the bird's lifestyle, where it lives and what it eats.

TYPES OF BEAKS		
	**Cone shaped beaks**	Strong, short beaks that are used for cracking seeds
	**Chisel or drilling beak**	Long tapered bill used for drilling holes in trees
	**Tubular shaped beak**	A long bill used for sipping nectar from flowers
	**Sharp hooked beak**	A bill used for ripping and tearing meat
	**Straining beak**	A flat-shaped bill with fringed edges to filter plants and small animals from water
	**Probing beak**	A long, slender beak used for probing the ground

Beaks and Feet

Bird's feet come in different sizes and shapes. A bird's foot is designed to help it navigate its environment and find the food it needs.

TYPES OF FEET	
	Hawks, eagles and owls have strong feet with long claws or talons to help them capture, grasp and kill their prey.
	Woodpeckers have four toes, two pointed forward and two pointed backward. This arrangement helps them grasp tree bark and climb.
	Song birds use their feet for perching and walking or hopping. Three toes pointing forward with one opposing toe helps them grasp their perch.
	Wading birds such as cranes and herons have long toes to help them walk through soft bottoms in wetlands in search of food.
	Swimming birds, such as ducks and geese, have webbing between their toes to help them paddle in water.

Identify Raptors in Flight

Test and hone your ID skills with this raptor puzzle.

Seeing the birds on the wing is thrilling—particularly when there are large numbers of them—but it can also be frustrating to try and identify them at various angles and distances. **The challenge**: Identify and age these common raptors. Some species appear more than once. Scroll down for a list of all of the species shown, and keep going for the answers.

Below is a list of all species pictured.

American Kestrel	Merlin	Red-shouldered Hawk
Bald Eagle	Northern Harrier	Red-tailed Hawk
Broad-winged Hawk	Osprey	Sharp-shinned Hawk
Cooper's Hawk	Peregrine Falcon	Turkey Vulture

"Identify Raptors in Flight" Quiz was adopted from the National Audubon Society
https://www.audubon.org/news/identify-raptors-flight

ANSWERS

1. Sharp-shinned Hawk, immature: Note short, stocky wings and body, long slim tail that is short for an accipiter, and small head. Plumage is difficult to see on distant birds, but 1st-years lack a rufous tone underneath.

2. Bald Eagle: Very distinct white heads and tails and dark overall. Very large with long, broad wings and yellow legs and bill.

3. American Kestrel: Note pale underside with orangey chest, black spots on belly two black "sideburns" on head, and blue upperwing coverts, orange tail with black tip.

4. Northern Harrier: Very distinct brilliant white underside with a black border on flight feathers. Note long, slim wings and tail, and small head.

5. American Kestrel: Note pale underside with orangey chest, black spots on belly two black "sideburns" on head, and blue upperwing coverts, orange tail with black tip.

6. Turkey Vulture: Blackish overall; reddish head can be difficult to see at a distance but white bill usually glows. Note long, broad, squared-off wings, broad tail, and modified dihedral when gliding.

7. Sharp-shinned Hawk, adult: Note short, stocky wings and body, long slim tail that is short for an accipiter, and small head.

8. Broad-winged Hawk, immature: Stocky pointed wings, large head, and short, narrow tail. Pale underside with dark streaking on sides of breast, and indistinct tail pattern with darker tip denote 1st-year. Some (like this bird) have streaks on belly similar to red-tailed.

9. Red-shouldered Hawk, adult: Note somewhat stocky squared-off wings with translucent "commas" along the primaries. Adults have bold black and white bands on wings and tail and a warm reddish underside.

10. Red-shouldered Hawk, immature: Note somewhat stocky squared-off wings with translucent "commas" along the primaries. Pale underside with buffy underwing coverts, and dark, evenly spaced streaking on body denote 1st-year.

11. Northern Harrier: Very distinct brilliant white underside with a black border on flight feathers. Note long, slim wings and tail, and small head.

12. Merlin, adult: Merlin has stockier, more sharply pointed wings, broader, shorter tail, and is "chesty" compared with kestrel. Juvenile and adult female are pale below with heavy, dark streaking, heavily "checkered" underwings, and distinct tail bands.

13. Northern Harrier, immature: Pale underneath mostly brown flight feathers. Note long, narrow wings and tail (showing bands when spread). Head is small with owl-like facial disc.

14. Red-tailed Hawk: Quintessential broad-winged, short-tailed buteo shape. Plumage is pale underneath with dark patagial bars and bellyband.

15. Cooper's Hawk, immature: Pale underneath with dark streaks throughout underbody, and brown head denote 1st-year. Note long wings for an accipiter, large head, and long tail with white tip.

16. Cooper's Hawk, immature: Pale underneath with dark streaks throughout underbody, and brown head denote 1st-year. Note long wings for an accipiter, large head, and long tail with white tip.

"Identify Raptors in Flight" Quiz was adopted from the National Audubon Society
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17. Peregrine Falcon, adult: Pale underneath with heavily streaked body, heavily “checkered” underwings, and dark head. Note very long, pointed wings, heavy body, and broad tail and head. Wingtips are less sharply pointed in a full soar.

18. Osprey: Note the dark stripe through the eye, long, dark brown wings, white underside, and a black bill with sharp hook.

19. Sharp-shinned Hawk, adult: Note short, stocky wings and body, long slim tail that is short for an accipiter, and small head.

“Identify Raptors in Flight” Quiz was adopted from the National Audubon Society
https://www.audubon.org/news/identify-raptors-flight


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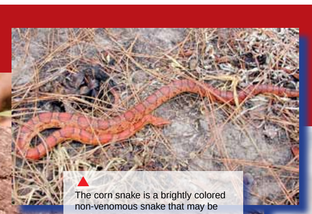
◀ ***Copperheads*** and their relative the cottonmouth have bright yellow tail-tips as juveniles that they use to lure prey such as small lizards and frogs.

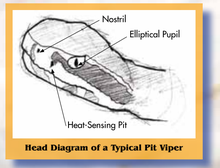


The corn snake is a brightly colored non-venomous snake that may be confused with the ***copperhead.***

Copperhead

The copperhead is South Carolina's most common venomous snake. Found throughout our state, the copperhead can reach a length of 4 feet; however, the average adult length is between 2 and 3 feet. Background color varies from pink to coppery-tan with dark brown hourglass-shaped cross-bands overlying. The head is typically a uniform copper color.

Copperheads occur in a wide range of habitat types including mountain coves, piedmont and coastal plain hardwood forests, longleaf pine forests and swamp forests. Copperheads feed on a variety of prey including small rodents, frogs, lizards and insects.



Head Diagram of a Typical Pit Viper

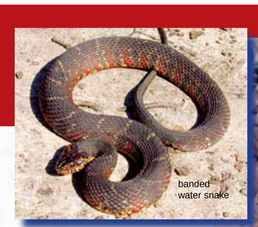
The non-venomous scarlet kingsnake and scarlet snake both possess patterns similar to the ***coral snake.*** Both non-venomous species have red heads, and their red and yellow (white) bands never touch.

Coral Snake

The coral snake is South Carolina's only representative of a group of snakes known as elapids. This family of snakes contains some of the world's deadliest snakes including cobras, mambas and the Australian snakes such as the taipan and tiger snake. Coral snakes are not pit vipers, as are our other venomous snakes, and are quite different both in appearance and behavior from these snakes.

Adult coral snakes can reach a length of 2 feet. The bright red, yellow and black bands alternate down the length of the body. Two species of non-venomous snakes are similar in appearance to the coral snake. The banding patterns for the harmless scarlet snake and scarlet kingsnake differ from those of the coral snake ... on the coral snake the red and black bands never touch and the nose of the coral snake is always black.

Coral snakes can occur in a wide range of habitats; however, they are never found commonly anywhere. The species is very secretive, spending much of its time underground, and loose, sandy soil typifies most of the habitats frequented by the coral snake. The coral snake feeds primarily on lizards and other snakes.



The banded water snake and brown water snake are large-bodied, non-venomous water snakes that are commonly mistaken for the ***cottonmouth.***

brown
water snake ▼

Cottonmouth

The cottonmouth, also known as the water moccasin, is a large snake of wetlands and swamps. Adult cottonmouths are typically 3 to 4 feet in length but can reach lengths in excess of 5 feet. The cottonmouth is variable in coloration ranging from dark brown and black to olive drab and yellow-tan. Dark cross-bands occur irregularly down the length of the body. Juvenile cottonmouths resemble copperheads with their brighter, well-defined pattern.

Cottonmouths are almost always associated with some type of wetland. They occur in riverine swamps and floodplains, lake edges, Carolina bays, and small stream forests. Cottonmouths eat a variety of prey including rodents, amphibians, fish and other snakes.

Unlike other venomous snakes that generally attempt to escape from humans, the cottonmouth will stand its ground. They typically coil tightly, with the head centered in the coil and the mouth held open showing the white "cotton" lining. Researchers believe this threat display is a warning, and research results indicate that cottonmouths are reluctant to bite humans who approach them.

Venomous Snakes of South Carolina

Venomous Snakes

There are thirty-eight species of snakes found in South Carolina and, only six of these - the coral snake, eastern diamondback rattlesnake, timber (or canebrake) rattlesnake, pigmy rattlesnake, copperhead and cottonmouth - are venomous. All of South Carolina's venomous snakes are pit vipers, with the exception of the coral snake. Pit vipers get their name from the infrared heat-sensing organs (pits) found on their faces between their eyes and nostrils. These pits can detect minute changes in infrared radiation (heat) given off by warm-blooded prey. Pit vipers tend to be ambush predators that sit and wait for prey to come to them. The heat-sensing pits aid these animals in detecting prey as it approaches them. All of South Carolina's pit vipers have vertically elliptical (cat's eye) pupils ... the coral snake and all of our non-venomous snake species have round pupils.

Of the six venomous snake species in South Carolina, two - the eastern diamondback rattlesnake and the coral snake - are considered rare to very uncommon. The mountain form of the timber rattlesnake is also considered rare in our state. The pigmy rattlesnake, while not rare, is considered to be uncommon in South Carolina. Only the copperhead and cottonmouth are common to abundant in our state.
Venomous snakes are a component of South Carolina's environment and play a vital role in controlling rodent populations in many habitats. Their venom apparatus, including fangs and venom glands, developed as a means to obtain food and is typically only used in defense as a last resort. The best protection against snakebite is to remain aware and alert while in the woods.

Try to stay on trails that offer good visibility of the ground. Snake chaps (leggings) can provide adequate protection for legs if you are working or hiking in areas where venomous snakes are common. It is best to leave all snakes alone, if you don't know how to identify them, and to avoid trying to kill venomous snakes. Many people are bitten or harmed when trying to approach too close to a venomous snake.

The likelihood of snakebite in South Carolina is extremely low. You are more likely to die choking on food or falling down stairs than from the bite of a venomous snake. In the unlikely event of a venomous snakebite it is best not to try and treat the bite yourself. Keep the victim calm and get him or her to medical attention as quickly as possible.

For more information on venomous snakes and snakes in general you can order the booklet "Snakes of Georgia and South Carolina" for $5.00 from the S.C. Wildlife Shop. To order, call toll free, **1-888-644-9453 (wild).**

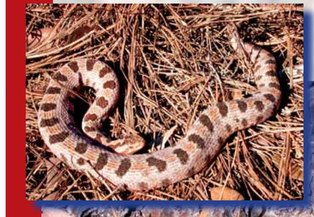
ENDANGERED WILDLIFE FUND

SOUTH CAROLINA WILDLIFE

Pigmy Rattlesnake

The pigmy rattlesnake is the miniature of the rattlesnake world, with adults seldom reaching over a foot in length. Background color can vary from dark, charcoal gray to light gray and pink. Dark blotches occur down the back of this rattlesnake and often a faint red stripe runs down the spine. The pigmy has a tiny set of rattles that may be difficult to see without close inspection and often cannot be heard.

Pigmy rattlesnakes are found throughout South Carolina, with the exception of the mountains. They occur in a variety of habitats but are seldom found far from fresh water, such as marshes, swamps and ponds. Pigmies feed on a variety of prey including lizards, frogs and small rodents.



◀ Pink to pinkish red ***pigmy rattlesnakes*** are not uncommon, especially in the sandhills region of South Carolina.

Eastern Diamondback Rattlesnake

The eastern diamondback rattlesnake is South Carolina's largest venomous snake. Adults of this species range from 3 to 5 feet in length and occasionally reach lengths in excess of 6 feet. The diamondback gets its name from the series of dark-brown to black "diamonds" running down the rattlesnake's back. Each dark diamond is outlined in yellow to cream-white and sits on a background varying from light brown to olive. The diamondback has a black mask across its eyes, thought to hide its eyes from potential prey.

The eastern diamondback rattlesnake is found in longleaf pine flatwoods, rolling pine-hills and in maritime grasslands of the lower coast. Diamondbacks typically spend winter months in a stump-hole but spend most of their time above ground during the warmer months of the year. Diamondbacks, like other pit vipers, are ambush predators. They sit and wait, in cover, for prey to come to them. The infrared, heat-sensing pits on their faces help them detect warm-blooded prey. They feed primarily on rabbits, squirrels, cotton rats and other large rodents.

Both the eastern diamondback rattlesnake, and its relative the timber rattlesnake, mate and give birth during late summer and early fall. Gravid females, which will give birth in a given year, do not mate. This unusual life history results in biennial (every other year) reproduction for these species.

The pine snake is a large, blotched non-venomous snake that can be mistaken for a ***rattlesnake.*** This species will shake its tail rapidly when disturbed but does not have a rattle. ▼

Timber Rattlesnake

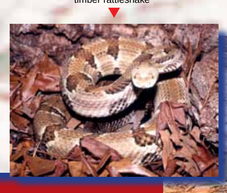
The timber rattlesnake is a large, 3- to 5 foot rattlesnake that is found throughout South Carolina. This species has two different "forms" in our state: the mountain form, often referred to as the timber rattlesnake, and the piedmont-coastal form, referred to as the canebrake rattlesnake. These two forms of this species are different in their appearance and their life history.

The timber, or mountain form, can vary from a background color of yellow to black, both with dark cross-bands across the back. The canebrake, or coastal form typically has a background color of light tan but can be pink to light orange, with dark cross-bands. The canebrake form typically has a red-brown stripe running down its back. This stripe is missing in the mountain form.

The timber rattlesnake of the mountains is typically associated with south-facing rock outcrops, where snakes den communally for the winter. The warm months find this form hunting along the streams and valleys near the over-wintering site. The canebrake of the piedmont and coastal plain is a species of forested woodlands, wooded bluffs near rivers, river swamps and wet thickets. Canebrake rattlesnakes, like their relative the diamondback, tend to over-winter singly in stump-holes and other subterranean structures.

Ambush predators, both forms feed primarily on rodents including mice, rats, chipmunks and squirrels. Timber rattlesnakes in some parts of their range display an interesting hunting technique, sitting at the base of a tree with their head leaning against the trunk and pointing upward, waiting on a squirrel to descend.

timber rattlesnake



The ***timber rattlesnake*** is variable in color and can range from normal tan to pink-orange in the coastal plain and from yellow to black in the mountains.

pink-orange
variation
of canebreak

SCDNR 03CE4028 3/03

Cut

Fold

American Kestrel

Characteristics

Two black stripes on face, reddish-brown back and tail, hooked beak, sharp talons

Cut

American Robin

Characteristics

Brick-red breast and belly, yellow beak, grayish back with darker head and tail

Cut

American Woodcock

Characteristics

Reddish-brown breast and belly, long beak, horizontal dark bars on head

Cut

Cut

Fold

Blue-winged Teal

Characteristics

Blue forewing, crescent-shaped white patch on face, small for a duck

Cut

Broad-winged Hawk

Characteristics

Broad black and white bands on tail, last white band broader than others; hooked beak; sharp talons

Cut

Brown Thrasher

Characteristics

Reddish-brown on head, back, and tail; heavily streaked belly; long tail

Cut

Cut

Fold

Canada Goose

Characteristics

Black head and neck,
white “chin strap”

Cut

Common Nighthawk

Characteristics

White bar across wings,
white throat, small beak

Cut

Eastern Bluebird

Characteristics

Deep blue along head, back, and tail;
reddish-brown along throat and breast;
white belly

Cut

Cut

Fold

Cut

Cut

Cut

European Starling

Characteristics

Iridescent black feathers;
body feathers tipped with white;
short, square tail

Grasshopper Sparrow

Characteristics

Breast plain and dull brown (buff-colored);
dark head with light, buff-colored median stripe

Great Horned Owl

Characteristics

Large ear tufts, white throat,
hooked beak, sharp talons

Cut

Fold

Hairy Woodpecker

Characteristics

Back black except for white center stripe,
outer tail feathers white,
red patch on back of neck

Cut

House Finch

Characteristics

Front of head, throat, and breast reddish-purple;
reddish-purple spot on rump;
streaks on sides of belly

Cut

House Sparrow

Characteristics

Black throat, rusty-brown neck,
gray on top of head and belly

Cut

Cut

Fold

House Wren

Characteristics

Black barring on tail,
small size, brownish overall

Cut

Mallard

Characteristics

Metallic-green head, white neck ring,
reddish-brown breast

Cut

Mourning Dove

Characteristics

Long, pointed tail; small head;
gray body; rosy-colored breast

Cut

Cut

Fold

Northern Bobwhite

Characteristics

White throat and eye stripe,
sides striped reddish-brown,
chunky body

Cut

Northern Flicker

Characteristics

Black bib, black spots on belly,
shafts of feathers yellow, black barring on back,
red patch on back of neck

Cut

Northern Harrier

Characteristics

Large white spot at base of tail;
long, banded tail; brownish overall;
hooked beak; sharp talons

Cut

Cut

Fold

Ovenbird

Characteristics

Orange head stripe bordered by black,
breast with reddish-brown streaks or spots

Cut

Red-eyed Vireo

Characteristics

Gray head with white eye stripe,
small hook on beak,
olive body with gray belly

Cut

Red-tailed Hawk

Characteristics

Tail red on upper surface,
reddish-brown spots across belly,
hooked beak and sharp talons

Cut

Cut

Fold

Red-winged Blackbird

Characteristics

Body black, red and yellow patches on forewing,
beak straight and pointed

Cut

Ring-necked Pheasant

Characteristics

Long, pointed tail with black barring;
white neck ring; iridescent coloring on head

Cut

Rock Dove (Pigeon)

Characteristics

Multicolored feathers,
neck darker than back,
small head

Cut

Cut

Fold

Ruby-throated Hummingbird

Characteristics

Small body;
long, slender beak;
iridescent throat

Cut

Ruffed Grouse

Characteristics

Tail banded with wide terminal band,
black ruffs on sides of neck,
chicken-like in appearance

Cut

Rufous-sided Towhee

Characteristics

Sides reddish-brown,
black head and throat,
white outer tail feathers

Cut

Cut

Fold

Song Sparrow

Characteristics

Large spot on center of breast,
spotting or streaking along side of breast,
belly whitish, back brownish

Cut

Wild Turkey

Characteristics

Large size, naked head,
modified feathers (beard) on breast,
iridescent body feathers

Cut

Wood Duck

Characteristics

Glossy iridescent body,
head with large crest,
reddish-brown breast

Cut

Cut

Fold

Yellow-rumped Warbler

Characteristics

Yellow rump, yellow throat,
yellow crown, black breast

Cut

Beaver

Characteristics

Large, broad, and flattened tail;
fur brown and thick; hind feet webbed

Cut

Big Brown Bat

Characteristics

Black wings, brown fur,
tail membrane without fur

Cut

Cut

Fold

Bobcat

Characteristics

Tail short and black only at tip,
ear tufts short,
white spot behind each ear

Cut

Coyote

Characteristics

Resembles medium-sized dog,
body grizzled-gray or reddish-gray,
tail often with black tip

Cut

Eastern Cottontail

Characteristics

Large white hind feet; long narrow ears;
cotton-ball shaped tail, white below;
neck rusty-reddish color;
body fur speckled brownish and grayish

Cut

Cut

Fold

Eastern Fox Squirrel

Characteristics

Body fur rusty orange mixed with gray,
long tail with orange-tipped fur,
belly orange

Cut

Eastern Gray Squirrel

Characteristics

Body fur grayish,
long tail with white-tipped fur,
belly whitish

Cut

Eastern Mole

Characteristics

Huge front feet and claws;
short, naked tail;
soft, “reversible” body fur;
no external ears; eyes inconspicuous

Cut

Cut

Fold

Mink

Characteristics

Tail long and slightly bushy;
rich, dark-brown fur;
patch of white fur on chin

Cut

Muskrat

Characteristics

Body fur rich, dark brown;
tail long, naked, and compressed from side to side

Cut

Raccoon

Characteristics

Tail with alternating rings of yellowish-white and black,
body fur “salt and peppered,”
black mask over eyes

Cut

Cut

Fold

Red Squirrel

Characteristics

Belly white with black lines along sides,
tail rusty-red tipped in black

Cut

Short-tailed Shrew

Characteristics

Short, furred tail;
small eyes, ears, and feet;
small size; pointed snout

Cut

Southern Flying Squirrel

Characteristics

Tail broad and smoothly furred;
folded layer of loose skin between front and hind legs;
soft and silky fur—grayish above; white belly

Cut

Cut

Fold

Virginia Opossum

Characteristics

Long, naked, round tail;
white face with black, leathery ears

Cut

White-tailed Deer

Characteristics

Fawns reddish-brown with white spots,
white undersides, feet with hooves

Cut

Woodchuck

Characteristics

Body fur grizzled, yellowish-brown, and frosted at tips;
legs and feet dark brown or black; heavy-bodied

Cut

Cut

Fold

Meadow Vole

Characteristics

Body fur dark brown, belly silvery-gray

Cut

American Toad

Characteristics

Large warts,
1–2 warts per dark spot,
black pigmentation on belly

Cut

Black Rat Snake

Characteristics

Body mostly dark with lighter spaces between scales,
some blotches visible on back,
belly marked with light and dark squares

Cut

Cut

Fold

Bluegill

Characteristics

Black ear flap;
long, pointed pectoral fin;
small mouth

Cut

Box Turtle

Characteristics

High, dome-like shell;
black and yellow streaking on shell

Cut

Bullfrog

Characteristics

Large size,
no dorso-lateral ridge,
ridge around eardrum

Cut

Cut

Fold

Channel Catfish

Characteristics

Barbels (whiskers) on face,
spots on sides, forked tail

Cut

Copperhead

Characteristics

Dark bands form hour-glass shape,
reddish-brown body,
triangular-shaped head,
deep facial pits beneath nostril

Cut

Crappie

Characteristics

Deep, compressed body;
white body with dark spots on side and on fins

Cut

Cut

Fold

Creek Chub

Characteristics

Dark spot at base of dorsal fin,
smooth scales

Cut

Eastern Newt

Characteristics

Rough skin;
numerous small, black spots on back and sides;
no scales or claws; laterally compressed tail

Cut

Fence Lizard

Characteristics

Spiny scales,
long toes with small claws, long tail

Cut

Cut

Fold

Five-lined Skink

Characteristics

Smooth, shiny scales;
long toes with small claws; long tail

Cut

Garter Snake

Characteristics

Three longitudinal stripes along body,
small head, plain belly

Cut

Largemouth Bass

Characteristics

Large mouth; whitish body with
broad, dark stripe along side

Cut

Cut

Fold

Northern Leopard Frog

Characteristics

Large spots along head and back,
prominent dorso-lateral ridge

Cut

Painted Turtle

Characteristics

Smooth, flattened shell;
greenish-yellow spot on each side of head; short tail

Cut

Red-backed Salamander

Characteristics

Reddish-yellow stripe down back and tail,
small size, no scales or claws

Cut

Soil Survey Data

Soil survey data are a product of the National Cooperative Soil Survey, a joint effort of the USDA Natural Resources Conservation Service and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants.

Web Soil Survey (WSS)

The Web Soil Survey provides agricultural producers, agencies, Technical Service Providers, and others electronic access to relevant soil and related information needed to make land-use and management decisions. The WSS:

- Provides an alternative to traditional hardcopy publication,
- Provides the means for quicker delivery of information,
- Provides electronic access to full soil survey report content,
- Provides access to the most current data,
- Allows customers to get just the information they want, and
- Provides customers with the ability to download spatial, tabular, and thematic soils data for use in GIS.
- Additional help is available at "Contact Us" or by emailing soilshotline@lin.usda.gov.

Current, Custom
Soil Maps & Reports:
Fast.
Free.
Friendly.

Print a Hydric Soil Map

- Complete Steps 1, 2, and 3.
- From the **Soil Data Explorer** tab, click the **Suitabilities and Limitations for Use** tab.
- Click **Land Classifications**.
- Click **Hydric Rating by Map Unit**.
- Click the **View Rating** button.
- Click the **Legend** tab to open or close the map symbol legend.
- Click the **Printable Version** button.
- Click the **View** button.
- On the browser menu bar, select **File** and **Print**; or click the print icon.

Print a Soil Chemical Properties Report

- Complete Steps 1, 2, and 3.
- From the **Soil Data Explorer** tab, click the **Soil Reports** tab.
- Click **Soil Chemical Properties**.
- Click **Chemical Soil Properties**.
- Click the **View Soil Report** button.
- Click the **Printable Version** button.
- Click the **View** button.
- On the browser menu bar, select **File** and **Print**; or click the print icon.

Natural Resources Conservation Service
National Cooperative Soil Survey

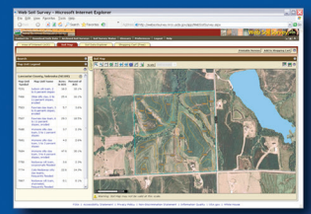
August 2016

USDA
United States Department of Agriculture

Web Soil Survey

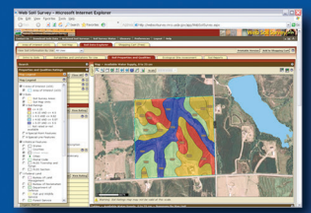
http://websoilsurvey.nrcs.usda.gov

Define.



Search / Locate

Collect.



Analyze Data

Develop.

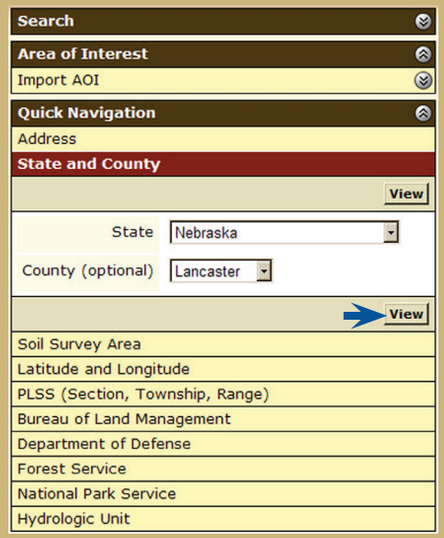
Custom Reports & Maps

"Helping People Help the Land"

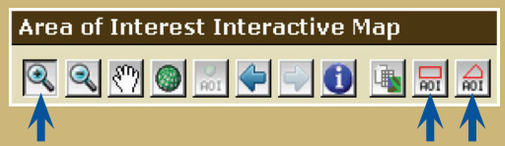
Accessing Web Soil Survey

- Open the Web Soil Survey (WSS) site at: http://websoilsurvey.nrcs.usda.gov and click the **Start WSS** button.

Step 1. Define Your Area of Interest (AOI)

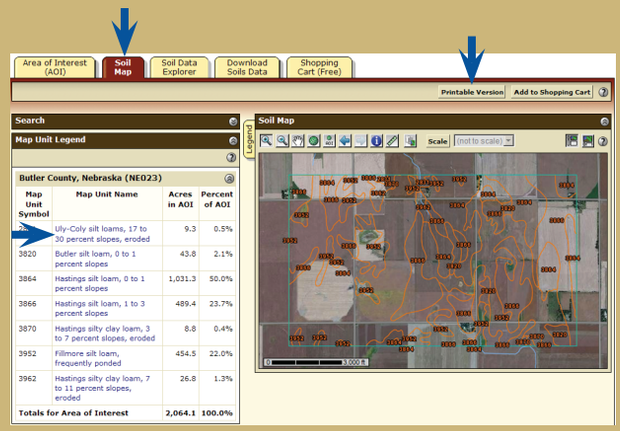


- Several methods are available to zoom into a geographic area of interest. You can enter an address; select a state and county; enter section, township, and range information; or import a boundary file from your local computer to set the AOI.
- Click the **View** button to see the area.



- Use the **Zoom In** tool (plus sign) to click and drag a rectangular box around a specific area. Repeat, as necessary, to zoom further.
- Select an **AOI** tool to draw a rectangular box or irregular polygon that defines the AOI and allows selection of associated soil data. Once the AOI has been defined, you can save it for use at a later date.

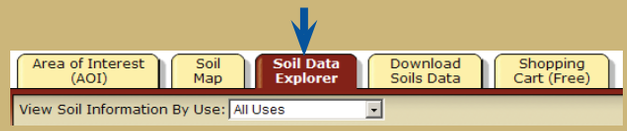
Step 2. View and Print Your Soil Map



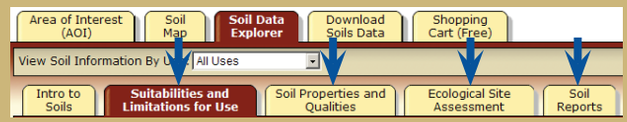
- Click the **Soil Map** tab.
- Click a map unit name to view a map unit description. Click the **X** to close the narrative.
- Print your soil map by clicking the **Printable Version** button; then click the **View** button. On the browser menu bar, select **File** and **Print**; or click the print icon. Close the window.

Step 3. Explore Your Soil Information

WSS generates thematic maps of soil interpretations, ecological sites, and chemical or physical properties. Tabular data reports are also available.



- Click the **Soil Data Explorer** tab.

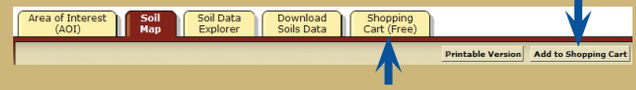


- Click the tabs below **Soil Data Explorer** and explore available information (the default tab is **Suitabilities and Limitations for Use**).

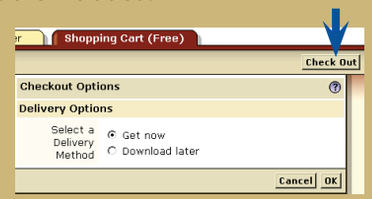
Step 4. Add Items to the Free Shopping Cart and Check Out

WSS allows you to collect a variety of thematic maps and reports in the Shopping Cart, then print or download the content into one file or document.

- Soil map, map unit legend, and map unit descriptions are automatically added.

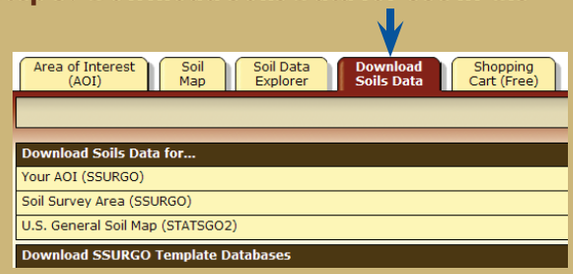


- Items viewed in Step 3 can be added by clicking the **Add to Shopping Cart** button.
- View your cart contents by clicking the **Shopping Cart (Free)** tab. Items checked on the Table of Contents are included.



- Get your Custom Soil Resource report.
  - -- Click the **Check Out** button.
  - -- Select a delivery option and click **OK**.

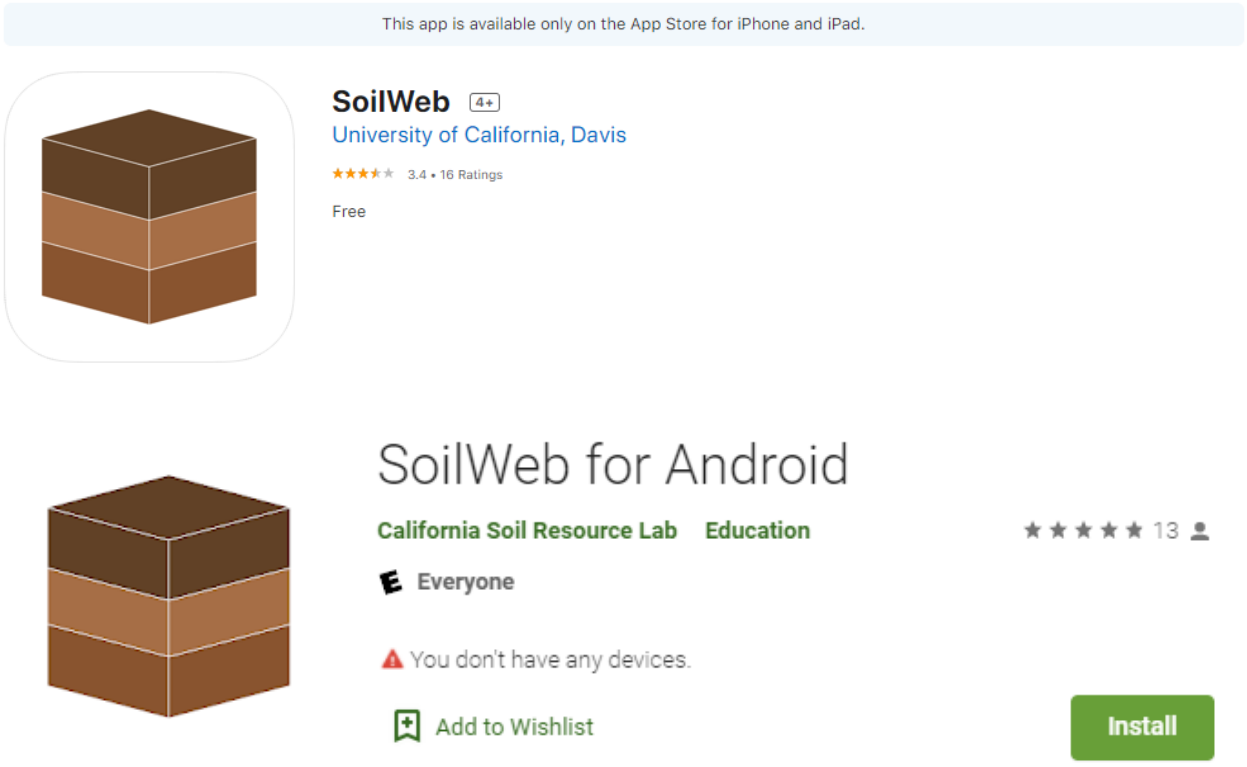
Step 5. Download Soils Data for Use in GIS



WSS allows you to download spatial and tabular SSURGO and STATSGO2 soils data for use in your local GIS. SSURGO data can be downloaded for your defined AOI or for a soil survey area. STATSGO2 data can be downloaded for individual states or for the whole United States.

NOTE: At any time during Steps 2, 3, 4, or 5, you can redefine the soil map location by clicking the **Area of Interest** tab and clicking the **Clear AOI** button. Repeat Step 1.

Soil Web Application



The SoilWeb application accesses soil survey information (the SSURGO dataset, published by the USDA Natural Resources Conservation Service) at your current location. This app was designed to be a lightweight version of the SoilWeb GMap web application. SoilWeb GMap features an interactive map for viewing and querying individual map units, while this app does not. However, SoilWeb for iOS conveniently provides a link to the SoilWeb GMap web app.

Features of SoilWeb application include:

- Soil profile sketches, estimated proportions, and geomorphic position of soil components associated with the SSURGO "map unit" identified at your current location.
- Map unit aggregate data such as estimated water holding capacity.
- Soil survey area scale and publication date.
- Component details: soil taxonomy, soil property depth profiles, land classification ratings, hydraulic and erosion ratings, forest productivity, soil suitability ratings.
- Links to Official Series Descriptions (OSDs) generated automatically.
- Component links to related web apps: Series Extent Explorer (SEE) and Soil Data Explorer (SDE).
- Link to the SoilWeb GMap web application at your current location.
- Location accuracy setting allows you to select between standard accuracy (less accurate, uses less battery power) and high accuracy (more accurate, but may use more battery power).
- Location auto-refresh feature allows you to continually look up soil data at a specified time interval.

More information about SSURGO is available at:
https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/survey/geo/?cid=nrcs142p2_053627

Clemson Cooperative Extension
Home & Garden Information Center
https://hgic.clemson.edu/

SOIL TEXTURE ANALYSIS “THE JAR TEST”

Factsheet | HGIC 1656 | **Updated:** Feb 11, 2019

Soil is a medium comprised of soil particles, organic matter, water, air and living organisms, all of which are important to the overall health of the soil and the plants that grow in it. The three primary soil particles are sand, silt, and clay. The relative percentages of these components present make up the soil’s texture. Texture is important to overall soil and plant health as it relates to soil porosity, which refers to the pore spaces where air and water reside.

The ideal soil texture is a mix of sand, silt, and clay particles, known as a loam. In most cases the particles will not be balanced, and the soil will need to be altered by adding organic amendments. To evaluate soil texture, use a simple jar test to determine the percentages of sand silt, and clay. Once the percentages are calculated, the soil textural triangle can be used to determine the soil type.

Soil Texture Analysis “The Jar Test” Procedure

Materials:

- Straight edged, clear jar
- Permanent marker
- Ruler
- Watch or stop watch
- 1 tablespoon of powdered dishwashing detergent
- Mesh sieve or old colander

Procedure:

Jar filled a ⅓ of the way full with soil.
Andrew Jeffers, ©2018, Clemson Extension

1. Using a mesh sieve or old colander, sift the soil to remove any debris, rocks, and large organic matter (leaves, sticks, roots, etc.).

2. Fill the jar ⅓ full of the soil to be tested

Jar filled with water, leaving space at top.
Andrew “Drew” Jeffers, ©2018, Clemson Extension

3. Fill the remainder of the jar with clean water, but leave some space at the top.

Jar showing the coarse sand layer settled at the bottom of the jar.
Andrew “Drew” Jeffers, ©2018, Clemson Extension

4. Add 1 tablespoon of powdered dishwashing detergent

5. Cap the jar and shake vigorously until the soil turns into a uniform slurry.

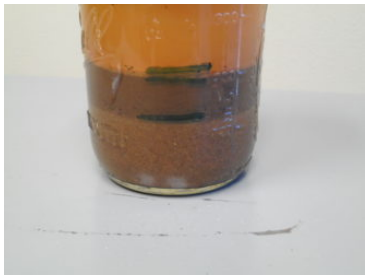
6. Set on a level surface and time for one minute.

7. Place a mark the outside of the jar, showing the coarse sand layer settled at the bottom of the jar.

Jar showing the silt layer.
Andrew “Drew” Jeffers, ©2018, Clemson Extension

8. Leave the jar in a level spot for 2 hours.

9. Mark the top of the next settled layer with the permanent marker. This is the silt layer.



Jar showing the clay layer.
Andrew “Drew” Jeffers, ©2018, Clemson Extension

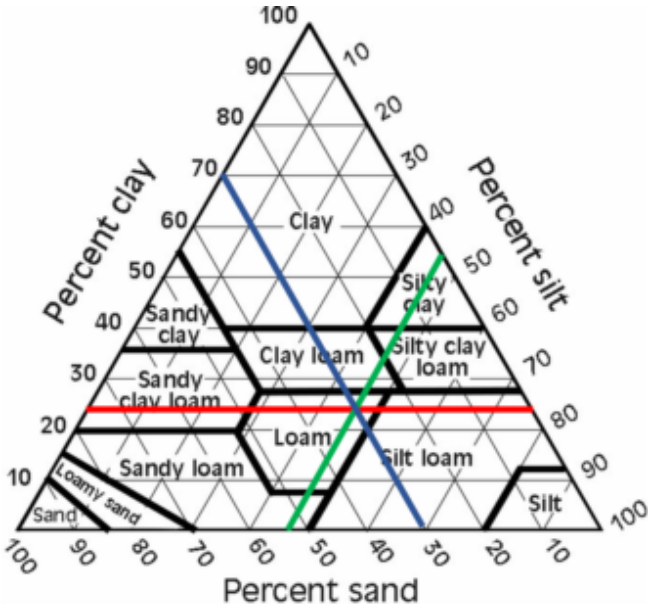
10. Leave the jar on a level spot for 48 hours.

11. Mark the top of the next settled layer with the permanent marker. This is the clay layer that has settled on top of the silt layer.

Using a ruler, measure and record the height of each layer, and the total height of all three layers. Andrew “Drew” Jeffers, ©2018, Clemson Extension

12. Using a ruler, measure and record the height of each layer, and the total height of all three layers. Use the soil texture analysis worksheet below to record results.

1. Use the soil texture triangle to estimate the soil type for the site.
2. The clay percentages are listed on the left side of the triangle. Lines corresponding to clay percentages extend from the percentages reading left to right (see red line).
3. The silt percentage is on the right side, with lines extending downwardly, diagonally right to left (see green line).
4. The sand percentage is on the right side, with lines extending upwardly, diagonally right to left (see blue line).
5. Track the lines with the percentages measured and find the spot on the triangle where all three lines intersect. The region where these lines intersect indicates the soil type present. The example shown represents a loam soil texture.



Soil texture triangle to estimate the soil type for the site

Most soils in South Carolina will require some form of organic amendments. Adding organic matter to clay and sandy soil can help with:

- Nutrient holding capacity
- Improved drainage
- Reducing compaction

For more information on amending soils, see **HGIC 1655, *Soil Conditioning – Establishing a Successful Gardening Foundation***.

Soil Texture Analysis “The Jar Test” Worksheet

Measurements

Height of sand layer _____inches / cm

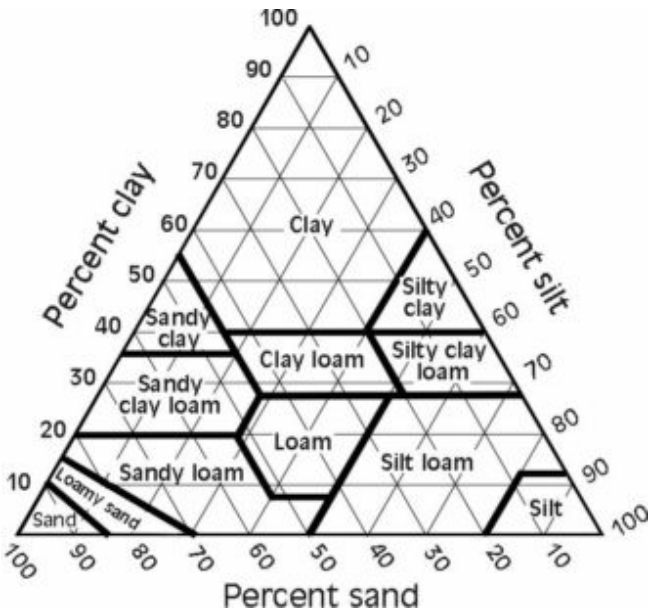
Height of silt layer _____inches / cm

Height of clay layer _____inches / cm

TOTAL HEIGHT OF LAYERS _____inches / cm

% SAND=(sand height)/(total height) x 100
=_____ % SAND

% SILT=(silt height)/(total height) x 100
=_____ % SILT



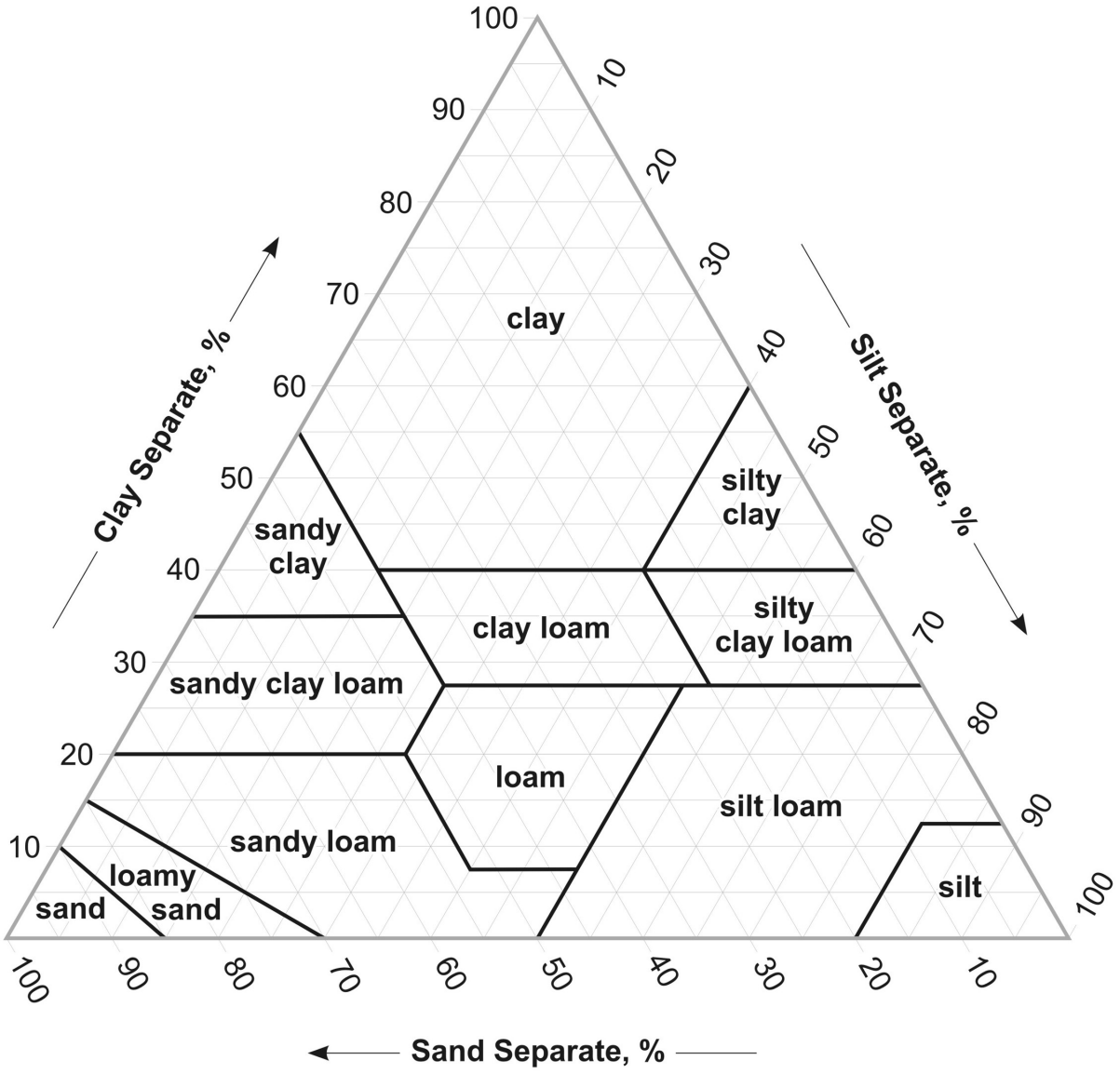
Soil texture triangle to estimate the soil type for the site

If this document didn’t answer your questions, please contact HGIC at **hgic@clemson.edu** or 1-888-656-9988.

Author(s)

Andrew "Drew" Jeffers, Spartanburg Cooperative Extension, Horticulture and Natural Resource Agent, Clemson University

Soil Textural Triangle



1-2015

Determining Soil Texture by Feel

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David Gehring
Natural Resources Conservation Services

COOPERATIVE EXTENSION SERVICE
UNIVERSITY OF KENTUCKY COLLEGE OF AGRICULTURE, FOOD AND ENVIRONMENT, LEXINGTON, KY, 40546

AGR-217

Determining Soil Texture by Feel

Edwin Ritchey and Josh McGrath, Plant and Soil Sciences; and David Gehring, Natural Resource Conservation Services

What is soil texture?

Soil texture refers to the proportion of sand, silt, and clay in a soil. Texture influences almost every aspect of soil use, both in agricultural and engineering applications, and even how natural ecosystems function. Many scientists consider soil texture the most important soil property as it can influence soil/water relationships, gas exchange, and plant nutrition. Accurately determining soil texture in a lab requires time and money; therefore, it is often necessary to estimate soil texture in the field by feel, which can be very accurate if done correctly.

What gives soil its texture?

The three building blocks of soil—sand, silt, and clay—feel very different and lend different properties to a soil. Although the three types of soil particles are differentiated by their size (Table 1), which is a physical property, the relative amount of each of these components has a large influence on the physical, chemical, and biological properties of a soil. The pore spaces between soil particles are largely responsible for the amount of water a soil can hold. Finer soil textures have greater surface area, smaller soil pores, and slower water infiltration into the soil profile.

- **Sand** is the largest soil particle, measuring 0.05 to 2 mm in diameter, and can be seen by the naked eye. Sand feels gritty to the touch and holds very little water.
- **Silt** is the medium-sized component of soil, measuring 0.002 to 0.05 mm in diameter. Dry silt particles feel like flour or baby powder. When wet, silt will feel smooth. Silt only holds a moderate amount of water.
- **Clay** is the smallest particle in the soil, measuring less than 0.002 mm in diameter, and can only be seen with powerful microscopes. The largest clay particle is 25 times smaller than the largest silt particle and a thousand times smaller than the largest sand particle. Clay will feel sticky when wet and hard and brittle when dry. Clay can hold much more water than sand or silt. In most soils, clay content increases with depth.

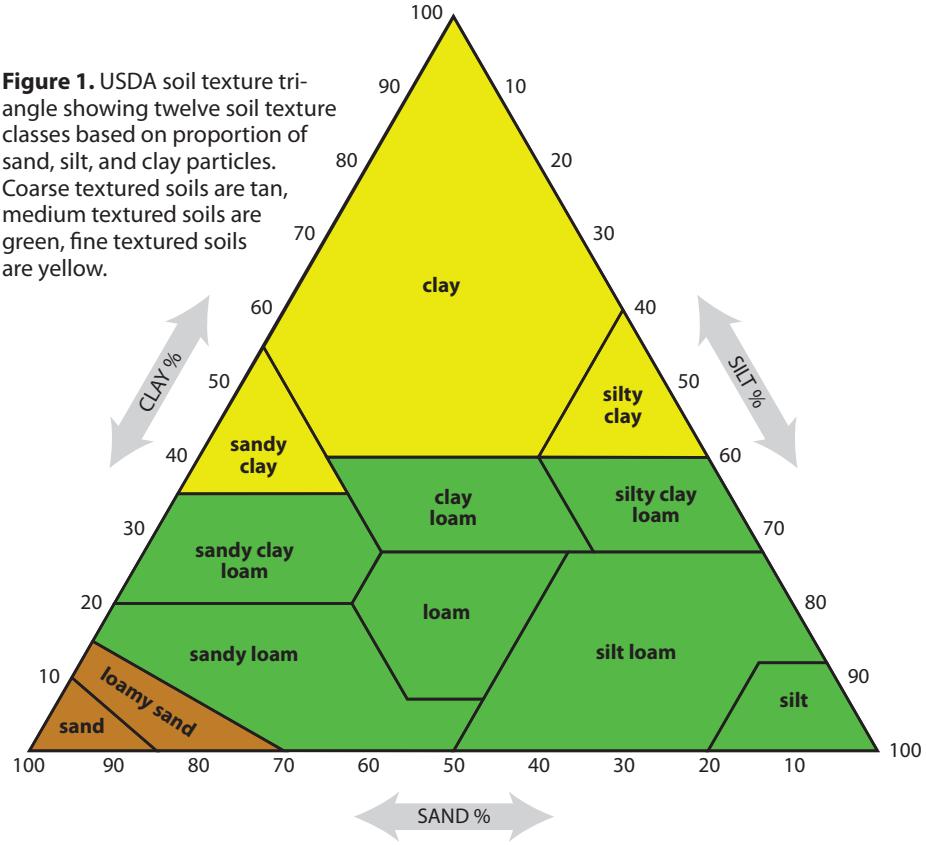


Figure 1. USDA soil texture triangle showing twelve soil texture classes based on proportion of sand, silt, and clay particles. Coarse textured soils are tan, medium textured soils are green, fine textured soils are yellow.

Table 1. Particle sizes for soil separates

Soil Separate	Diameter (mm)
Clay	<0.002
Silt	0.002 to 0.05
Sand	0.05 to 2.0
Very fine sand	0.05 to 0.10
Fine sand	0.10 to 0.25
Medium sand	0.25 to 0.5
Coarse sand	0.5 to 1.0
Very coarse sand	1.0 to 2.0

How are soil textures classified?

Soils are divided into three broad texture groups—coarse-textured soils, medium-textured soils, and fine-textured soils (Figure 1). A **coarse-textured** or sandy soil has 70 to 100 percent sand-sized particles. Because of the strong properties clay exhibits, a soil only needs to have 35 to 40 percent clay-sized particles to be considered **fine-textured** or clayey. Finally, the **medium-textured** soils or loams have a more even distribution between clay and sand particles.

The United States Department of Agriculture (USDA) soil texture triangle (Figure 1) is used to divide soils into 12 distinct classes based on their particle size distribution, or the relative amount of sand, silt, and clay in the soil. In the laboratory, we would first determine the

relative amount of sand, silt, and clay particles in a soil sample as a percent of the sample's weight, follow the arrows from each side to where they intersect, and identify what texture class the soil belongs to. For example, if we determined that a soil had 30 percent sand, 40 percent silt, and 30 percent clay, it would be called a *clay loam.* However, we can also estimate soil texture by feel fairly accurately with practice.

Using soil texture in the field

Once the soil texture is determined in the field, general characteristics of a soil can be predicted with reasonable accuracy, which helps identify proper management practices to use. A coarse-textured soil would have low water holding capacity, high water infiltration rates, high potential for leaching, low nutrient retention, and should respond well to supplemental irrigation. In contrast, fine-textured soils will remain wet longer than medium- or coarse-textured soils, have slow water infiltration rates, high potential for denitrification, and high nutrient retention. The medium-texture soils, such as loams, silt loams, or clay loams, have a good balance of sand silt, and clay. Medium-textured soils generally are very productive soils that allow for sufficient water infiltration without excessive drainage and have good water holding capacity and nutrient retention. Most soils can be used to produce crops or forage, if managed properly. Accurate determination of the soil texture allows for proper management practices to be used to maximize the potential soil productivity.

References

Thien, S.J. 1979. A flow diagram for teaching texture by feel analysis. Journal of Agronomic Education. 8:54-55.

Photos by Edwin Ritchey

How do I estimate texture by feel?

Three simple steps along with the flow chart in Figure 2 will help you to determine soil texture by feel.

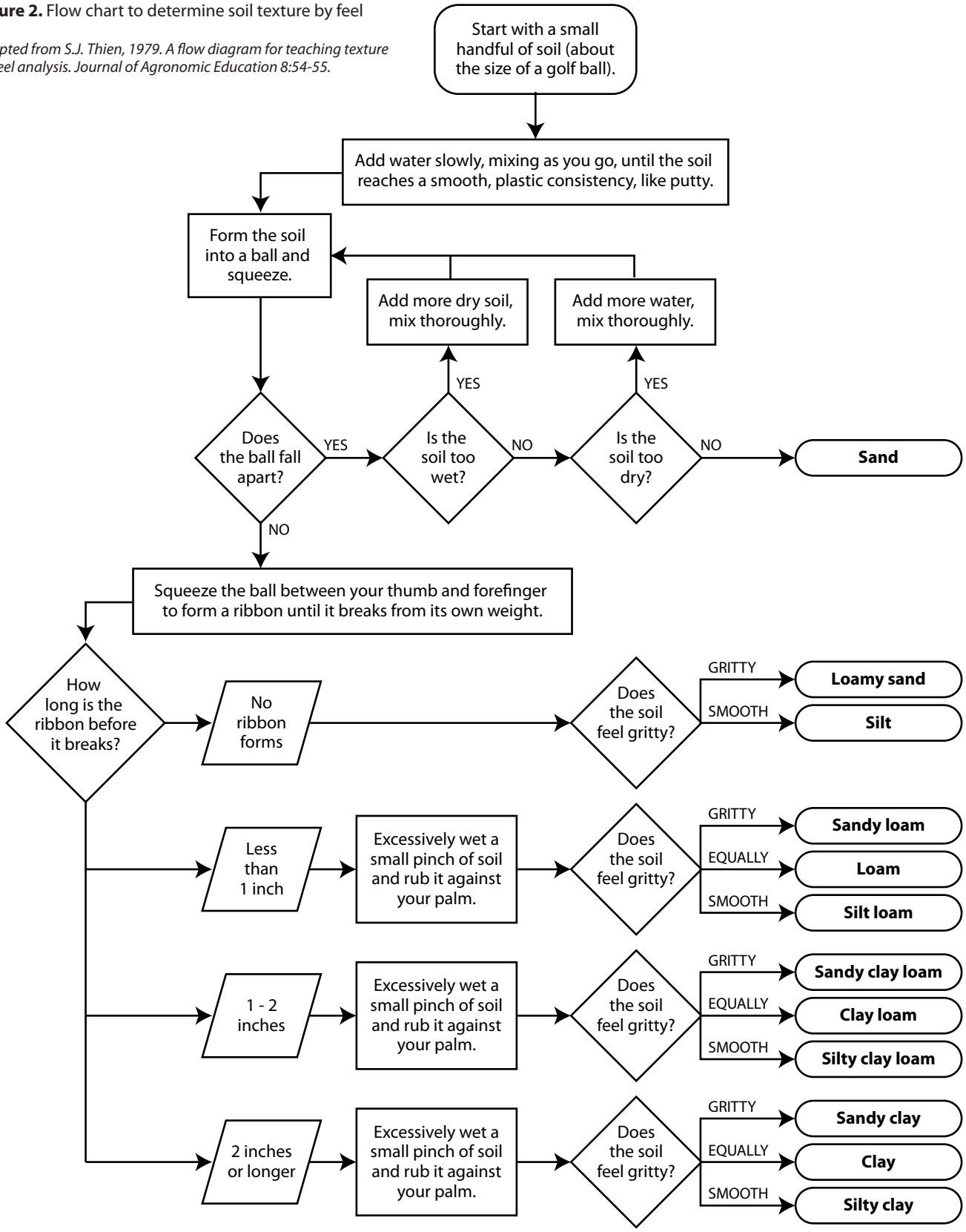
Step 1: Start with a small handful of soil, about the size of a golf ball, and slowly add water a drop at a time, mixing as you go, until you have a ball of soil that has the consistency of putty. Gently squeeze the ball to determine if it will stay together in a ball or fall apart.

Step 2: If the ball of soil stays intact, gently press the ball between your thumb and index finger, trying to work it out to form a ribbon. If you can form a ribbon, measure how long the ribbon is before it falls apart.

Step 3: After completing the ribbon test, add water to a pinch of soil in the palm of your hand until you have a muddy puddle. Rub the mud puddle against your palm and determine if it feels gritty, smooth, or equally gritty and smooth.

Figure 2. Flow chart to determine soil texture by feel

Adapted from S.J. Thien, 1979. A flow diagram for teaching texture by feel analysis. Journal of Agronomic Education 8:54-55.



Issued 1-2015

Using the MSU Basal Area Angle Gauge

Basal area (BA) is commonly used by foresters as a simple and easily measured estimate of the density of a stand of trees. BA is simply a measure of the cross-sectional area of a stand of trees at 4.5 feet aboveground and is expressed in square feet per acre (ft^2/ac). In other words, think of BA in the context of slicing all trees on a given acre at 4.5 feet above the ground, then adding the cumulative area of diameters at the point where all trees were cut.

This is the procedure for calculating BA for an individual tree:

Basal area (BA) = $0.005454 \times DBH^2$

(DBH = diameter at breast height, or 4.5 feet above the ground)

To determine basal area on a per-acre basis, you can use an angle gauge of a known basal area factor (BAF). Using a known BAF, each tree measuring "in" on the angle gauge counts as one multiple of a predetermined BA. For example, using a BAF 10 angle gauge results in each "in" tree representing one multiple of 10 ft^2/ac of BA. This provides a fast and simple method of BA estimation for foresters and other land managers.

BA estimation on a per-acre basis follows this simple method:

Basal area/acre (BA_{acre}) = (number of "in" trees) × (BAF)

The measured BA can be used as a "trigger" by forest managers in making the decision for thinning a stand of trees. For example, when BA of a pine plantation reaches 120 ft^2/ac, foresters know that it is time for a thinning. Mangers can also use target BA as a guide for how many residual trees to leave in thinning operations. For example, many foresters desire to leave a residual post-thinning BA of 70–90 ft^2/ac. The angle gauge is the simplest of several tools available to measure BA. If used properly, the instrument can give relatively precise estimates of BA.

Using the MSU Basal Area Angle Gauge

The MSU Basal Area Angle Gauge can be used to obtain BA estimates quickly. Be sure to extend the angle gauge the correct distance, and evaluate trees carefully to avoid incorrect estimations of BA. This is the correct procedure for using the MSU Basal Area Angle Gauge:

1. Extend the angle gauge 25 inches from your eye. To maintain the correct distance from your eye, measure string or twine and tie it to the angle gauge (**Figure 1**). Keep your eye at a central point and extend the angle gauge from that point. One commonly used technique is to place a staff or stick at the center point of your measurement plot, and extend the angle gauge from that point.

Figure 1. Using the MSU Basal Area Angle Gauge at 25 inches from eye. (Photo by Stephen Dicke)

2. Mark your first tree and pivot in a clockwise direction, evaluating each tree individually. Look at each tree at 4.5 feet above ground level and assess the "in" status using the angle gauge. Decide whether each tree is "in," "out," or "borderline" (**Figure 2**). Each "in" tree counts as 1 unit of the BAF of your angle gauge (BAF of 10 using the MSU Basal Area Angle Gauge), and each "borderline" tree counts as ½ unit.
    - **"in" tree** = diameter of tree at 4.5 feet appears larger than the box width on the angle gauge
    - **"out" tree** = diameter of tree at 4.5 feet appears smaller than the box width on the angle gauge
    - **"borderline" tree** = diameter of tree at 4.5 feet appears exactly the same width as the box on the angle gauge
3. Once you have pivoted back to your initial measurement tree (take care not to overlap), multiply your "in" and "borderline" tree count by 10 (the BAF of the angle gauge). For example, if 11.5 trees were counted, you would multiply 11.5 by 10 for a BA of 115 ft^2/ac. Multiple BA counts should be averaged throughout a timber stand to obtain a good estimate of stand BA. At this point, the BA estimate can be used in management decision-making processes.

If you would like an MSU Basal Area Angle Gauge, please contact your local MSU Extension Forestry specialist or the Extension agent in your county.

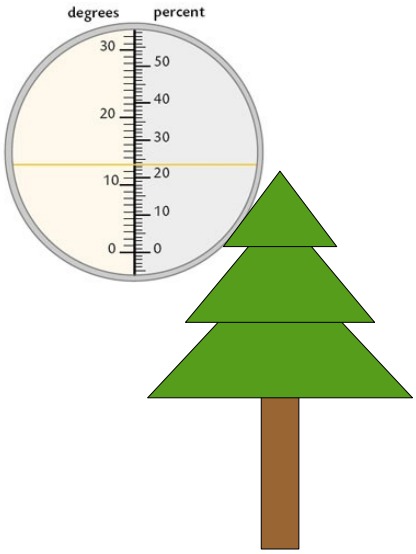
Figure 2. Counting trees using the MSU Basal Area Angle Gauge. (Photo by James Floyd)

Information Sheet 1995 (POD-12-17)

By **A. Brady Self**, PhD, Assistant Extension Professor, Forestry, and **James Floyd**, Forestry Instructor, Holmes Community College.

How tall is this tree?

Using a clinometer to measure tree height



1) Find a place to stand where you can see the top of the tree. The distance away from the tree should be at least equal to the height of the tree.

2) Measure the distance to the tree and the height that the clinometer will be from the ground.

3) Look through the clinometer with one eye and at the tree with the other eye (this takes a bit of getting used to). Line up the crosshair in the clinometer with the top of the tree.

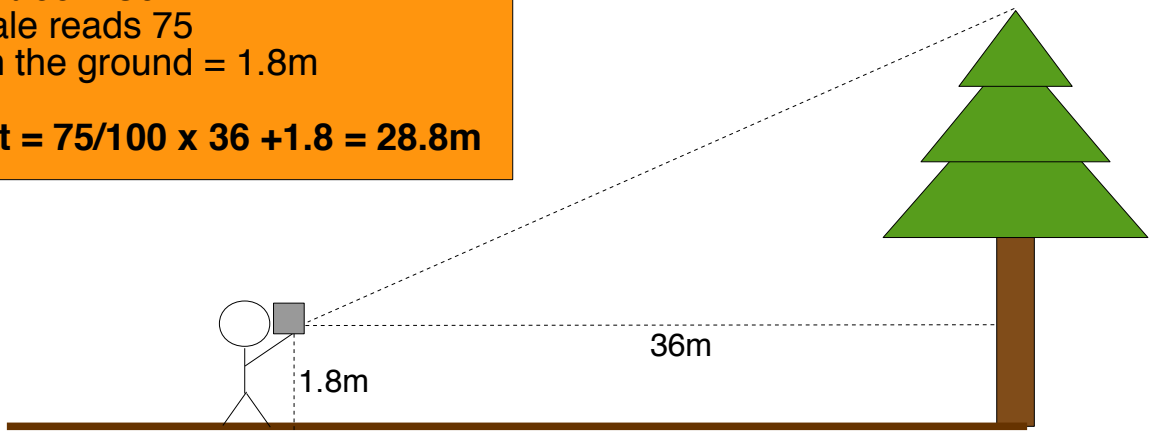
4) Read the number on the percent scale. This gives you the tree's height as a percentage of the distance from the tree. Eg. If it reads 50% the height of the tree is half the distance you are from the tree.

5) Calculate the height of the tree using the equation:
Tree height = clinometer reading/100 x distance to tree + distance of clinometer from the ground

Example:

Distance to tree = 36m
Percent scale reads 75
Height from the ground = 1.8m

Tree height = 75/100 x 36 +1.8 = 28.8m



Estimating the Volume of a Standing Tree Using a Scale (Biltmore) Stick

NC STATE EXTENSION

Woodland Owner Notes

The volume of wood in a tree and the type of product made from the wood are based primarily on the tree's height and diameter. One of the basic tools for estimating the height and diameter of standing trees is a calibrated 25-inch scale stick, often referred to as a Biltmore stick or a cruiser's stick. With practice, this instrument can be used to provide a reliable estimate of tree height and diameter, which then can be used to determine tree volume. This publication is for those interested in learning how to estimate tree volume and the type of product the tree may provide. For instructions on how to make your own scale stick, see "How to Make a Scale Stick" below.

If you want to estimate tree volume in order to sell timber, it is highly recommended that you consult a forester for advice. Volume alone does not determine value or the products that could be produced; tree quality is also very important. Forestry consultants can advise you on the types of wood products that could come from your timber as well as the quality of your timber. They also can provide you with estimates of the volume and value of the timber. In most cases the consulting forester's experience with timber sales and knowledge of current markets can increase your revenues far in excess of the forester's fees. For more information on consulting foresters, visit a N.C. Cooperative Extension county center or North Carolina Forest Service county office.

Product Types and Measurement Units

Major products that can be produced from pine trees include pulpwood, chip-n-saw, sawlogs, veneer logs (also known as plylogs), and pilings or poles. Major products produced from hardwood trees include pulpwood, sawlogs, and veneer logs (also known as grade or export logs). Each of these products must meet certain minimum size requirements (Table 1), and each varies in value based on the product, tree quality, and markets. For example, a tree 14 inches in diameter (measured 4½ feet above the ground) and with 50 feet of merchantable height can produce any one of three products that will vary in value based on the product (Table 2).

Table 1. Minimum tree size characteristics, volume units, and relative value by timber product.

Minimum Tree Size Characteristics			Volume Unit	Relative Value
Product	**Pine**	**Hardwood**		
Pulpwood	>– 6” DBH to a minimum 3” top diameter	–> 6” DBH to a minimum 3” top diameter	cord	very low
Chip-n-saw	9-14” DBH to a minimum 6” top diameter	not applicable	cord	low
Sawtimber	–> 14” DBH to a minimum 8” top diameter	>– 16” DBH to a minimum 10” top diameter	board foot	high
Veneer log	>– 16” DBH, clear/straight first log	>– 18” DBH, clear/straight first log	board foot	high
Pilings	various specifications based on local markets	not applicable	board foot	high

Table 2. Relative value of a tree 14 inches in diameter DBH and 50 feet in merchantable height, based on various products that could come from it.

Potential Product	Volume	Relative Tree Value
Pulpwood	0.23 cord	$3.00
Chip-n-saw	0.23 cord	$13.00
Sawtimber	145 board feet	$35.00

Standing trees or portions of trees sold for pulpwood or chip-n-saw are measured in cord volume. A cord is a stack of 4-foot long pieces of wood that is 4 feet high and 8 feet long; it includes 128 cubic feet of wood, bark, and air space.

Standing trees sold for sawlogs or veneer logs are measured in board-foot volume. A board foot is 1 inch thick, 12 inches wide, and 1 foot long. To determine the cord or board-foot volume of a tree, first measure the diameter and height using a scale stick. Check the diameter at a point 4½ feet above the ground (diameter breast height or DBH) on the uphill side of the tree and the merchantable height in increments of 16-foot and additional 8-foot logs. With these two measurements, you can determine the volume of the tree from various tree volume tables. Most scale sticks have the International ¼-inch, board-foot volume tables imprinted on them.

In North Carolina, pine sawtimber volume is often estimated using the Scribner log rule, and hardwood sawtimber volume is often estimated using the Doyle log rule. Tree volume estimates will differ based on which log rule is used because of differences in the way the estimates were formulated. Using the International ¼-inch rule as the basis for the volume, the Doyle log rule provides the lowest estimates for for trees up to 30 inches DBH, and Scribner provides intermediate estimates across all tree diameters (Figure 1). No matter which log rule is used to estimate volume, it is important to understand that timber prices also vary with log rules.

How to Make a Scale Stick

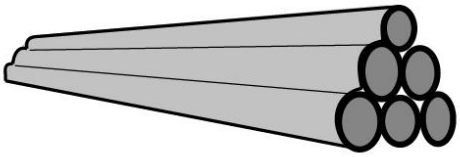
Materials

- a yardstick, $1\frac{1}{8}$ inches wide
- scissors
- paintbrush
- sandpaper

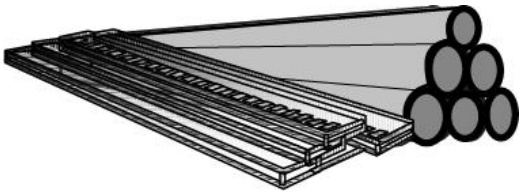
- rubber cement or a waterproof, clear household cement that adheres well
- varnish

Steps

1. Download the NC State Extension Tree Estimate Stick template. Cut out the three paper forms.
2. Glue Form 1 to the left edge of the yardstick, making sure that the left edge of Form 1 is even with the left end of the stick. The glue should be placed on the stick.
3. Glue Form 2 to the stick. Make sure the left edge of Form 2 butts against the right edge of Form 1, which is marked by two arrows. The glue should be placed on the stick.
4. Glue Form 3 to the stick by aligning the left edge of Form 3 with the right edge of Form 2, which is marked by two arrows. The glue should be placed on the stick.
5. After gluing the three forms to the stick, trim and sand the corners of the stick so that the edges are smooth. Then cover the stick with clear water repellent (such as a clear varnish) to protect the stick during use.



Pulpwood.



Chip-n-saw

Sawtimber.

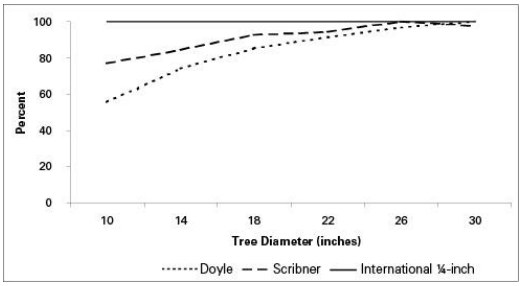


Figure 1. Relationships among three log rules in boardfoot volume estimates for trees using the International ¼-inch rule as a standard for comparison.

Measuring Diameter

Tree diameter is the most important measurement of standing trees. Trees are measured 4½ feet above ground-level, a point referred to as *diameter breast height* or DBH. Diameter breast height is usually measured to the nearest inch; but where large numbers of trees are to be measured, 2-inch diameter classes are used.

To measure DBH, stand squarely in front of the tree and hold the scale stick 25 inches from your eye in a horizontal position against the tree at 4½ feet above the ground. Shift the stick right or left until the zero end of the stick coincides with the left edge of the tree trunk. Without moving your head, read the measurement that coincides with the right edge of the tree trunk. This measurement is the tree's DBH, including the tree's bark (Figure 2). On sloping ground, measure from the uphill side. Two measurements at right angles to each other and averaged will give a more accurate reading since many trees are not perfect cylinders.

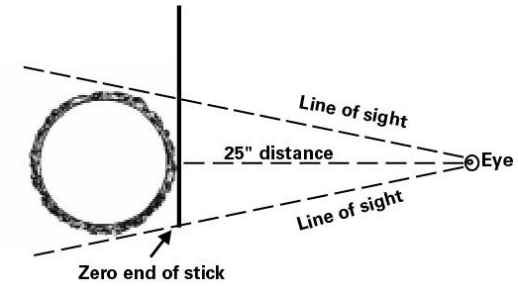


Figure 2. Measuring diameter with a scale stick.

Measuring Merchantable Height

Merchantable height refers to the length of usable tree and is measured from stump height (1 foot above ground) to a cutoff point in the top of the tree. The cutoff height will vary with markets, with the product being produced, and with the presence of excessive limbs. The scale stick has been calibrated so that if you stand 66 feet from the tree being measured and hold the stick 25 inches from your eye in a vertical position, you can read the number of merchantable logs from the stick. It is important not to move the stick when taking a measurement; tilt your head back slightly so that you do not have to move your head when reading from stump point to cutoff height (Figure 3A and Figure 3B).

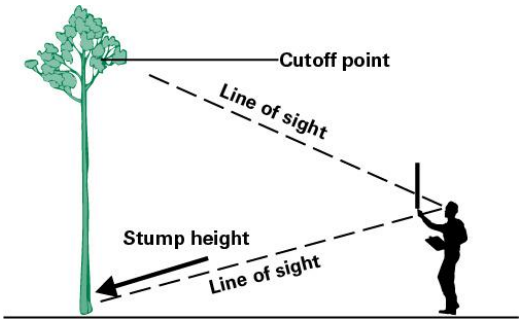


Figure 3A. To measure merchantable height with a scale stick, stand 66 feet from the tree and hold the scale stick vertically, 25 inches from your eye.

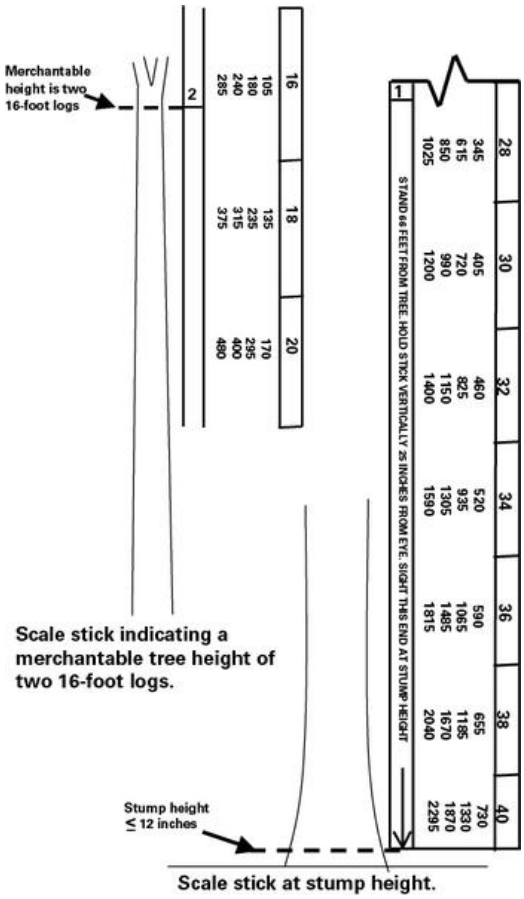


Figure 3B. Reading merchantable height from a scale stick measuring from a 12-inch stump height and indicating a merchantable tree height of two 16-foot logs.

Estimating Volume

To estimate the board-foot volume of a tree using the volume table (International ¼-inch rule) imprinted on the scale stick, you need an estimate of the tree's DBH and merchantable height. With these two measurements, the board-foot volume of the tree is estimated by reading first the tree's DBH and then the number of 16-foot logs (Figure 4). For example, a tree that is 10 inches DBH with a merchantable height of two 16-foot logs would have a volume of 60 board feet, International ¼-inch rule. See the box below for instructions on converting to Doyle or Scribner.

Which Price Do You Use?

Timber prices per board foot vary, based on which log rule is used to estimate timber volume. Here are converstion factors for the various log rules:

Log Rule Converstions (Dollar Values)

Doyle to Scribner Scribner to Doyle	26% difference	0.75 Doyle to Scribner 1.33 Scribner to Doyle
Doyle to International ¼-inch International ¼-inch to Doyle	39% difference	0.62 Doyle to International ¼-inch 1.60 International ¼-inch to Doyle
Scribner to International ¼-inch International ¼-inch to Scribner	20% difference	0.83 Scribner to International ¼-inch 1.20 International ¼-inch to Scrib

For example: You know that pine sawtimber is selling for $300 per 1,000 board feet (Scribner log rule). What is the price equivalent for the International ¼-inch log rule?

$300 per 1,000 board feet (Scribner log rule) x 0.83 = $249 per 1,000 board feet (International ¼-inch log rule)

Things to Remember

- Seek professional forestry advice before selling your timber.
- The products that could be made from a tree vary based on minimum size requirements and tree quality.
- In general, product value increases with tree size.
- Timber prices differ, based on which log rule is used.
- Tree volume estimates vary, based on which log rule is used.
- When reviewing tree volume and prices, be sure that the price used to estimate value is for the log rule used to estimate volume.
- To ensure accuracy, hold the stick 25 inches from your eye when measuring.
- To measure tree height correctly, stand 66 feet from the tree.

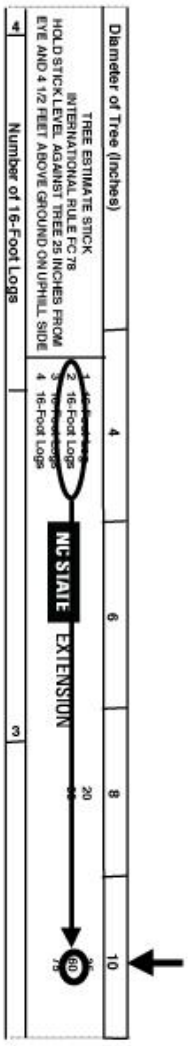


Figure 4. Estimating volume using the volume table imprinted on the scale stick.

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WON-05

This publication printed on: July 29, 2020
URL of this page

Safety Data Sheets (SDS)

Safety First Card

Obtain and read SDS for all reagents and apparatus before use. Reagents marked with an* in test kit instructions are considered to be potential health hazards. To view or print a Safety Data Sheet (SDS) for these reagents go to www.lamotte.com. Search the four digit reagent code number listed on the reagent label, in the contents list or in the test procedures. Omit any letter that follows or precedes the four digit code number. For example if code is 4450WT-H. search 4450. To obtain a printed copy, contact LaMotte by e-mail phone or fax.

Emergency information for all LaMotte reagents is available from Chem-Tel: (US. l-800-255-3924] (International, call collect, 813-248-0585).

First Aid Information
In the event of an accident or suspected poisoning, immediately call the National Poison Control Center [l-800-222-1222) or call your physician. Emergency information for all LaMotte reagents is available from Chem-Tel: (US. 1-800-255-3924] (International, call collect, 813-248-0585].

Safety
1. Read this card in its entirety!
2. Wear protective eye wear and gloves when handling reagents.
3. Avoid contact between reagents and skin, eyes, nose, and mouth.
4. Read instructions and reagent labels before using reagents or apparatus.
5. Keep all reagents and equipment out of the reach of small children.
6. Children should only use kits with adult supervision.
7. Wipe up spills as soon as they occur.
8. Cap reagents after use. Do not interchange caps between reagents.
9. Store reagents and equipment in a cool. dry place. Protect from freezing. Avoid prolonged exposure to direct sunlight or extreme temperatures.
10. As a general rule, replace reagents annually.

CARSON®

MM-300

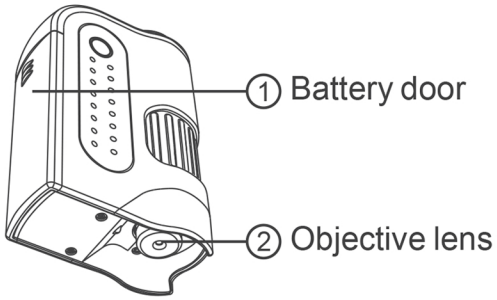
MICROBRITE™ PLUS

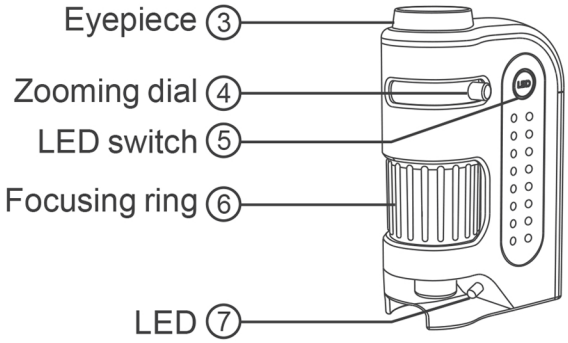
60 - 120x LED Lighted Pocket Microscope

PDF : www.carson.com/MM300guide

English / Français / Español / Deutsch / 日本語

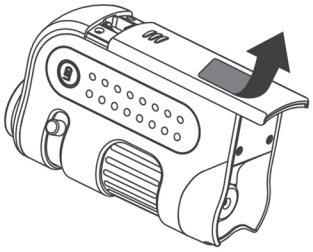
1) Product overview



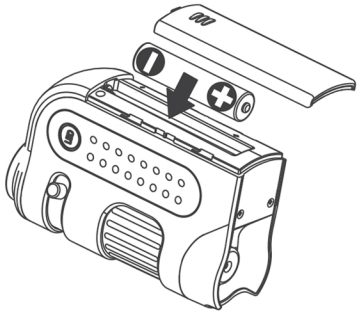


2) Installing the battery

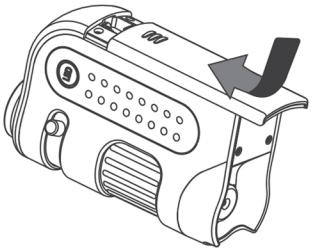
1. Slide open the battery door ① as shown below.



2. Install 1 AA battery with the correct polarity.

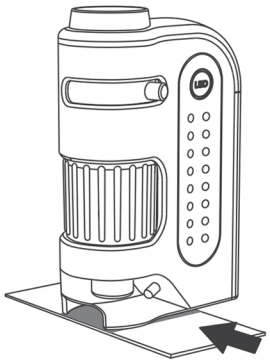


3. Attach the battery door ① as shown below.

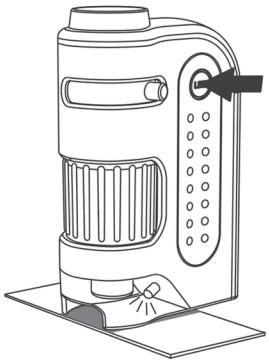


3) Using the microscope

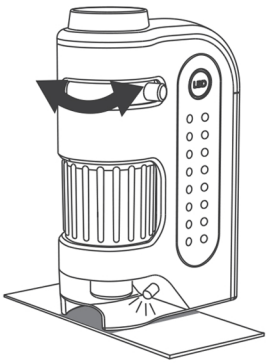
1. Place the viewing object directly below the objective lens ②.



2. Press the LED switch ⑤ to turn on the LED.

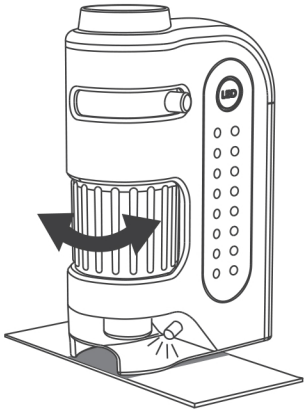


3. Adjust the zooming dial ④ to the desired level of magnification.

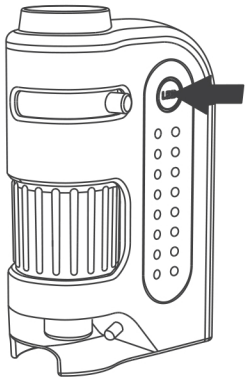


Carson Optical • 2070 5th Avenue, Ronkonkoma, New York 11779 • U.S.A.

4. Rotate the focusing ring ⑥ until the image is sharp and clear.



5. Turn off the LED at the end of the observation by pressing the LED switch ⑤.



4) Product specification

Magnification:	60x - 120x	Illumination:	LED
Exit pupil diameter:	10mm - 14mm	Size:	59mm x 30mm x 92mm
Optical zoom:	2x	Weight:	Approx. 50 grams (excluding batteries)
Power:	1 x AA battery (not included)		

5) Warning

1. To avoid possible permanent eye damage, do not look at the sun or bright objects with the microscope.

2. To avoid possible permanent eye damage, do not place the lighted microscope directly upon human eye.

3. Remove the battery before storing the microscope for an extended period.

4. The device may get warm after extended period of use. This is normal and should not be considered as a defect.

5. Inspect all batteries for signs of corrosion or leakage. Do not expose to fire or excessive heat. Use alkaline batteries only, rechargeable batteries not recommended. Insert battery in the direction indicated.

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Macroinvertebrate Identification Card Suggested Activities

Allow students to model sampling the diversity of macroinvertebrates in stream while in the classroom. This is a great way to bring macroinvertebrate sampling to students who might not get the opportunity to sample firsthand or to preview macroinvertebrate sampling before going in the field. Each illustrated card is printed with a biotic index value and a pollution tolerance value which can be used to determine the health of the stream. You can either pre-select the sample size to control the results or allow students to randomly select cards to simulate a stream. You can also explore concepts like how the sample size collected or number of sampling events affects results.

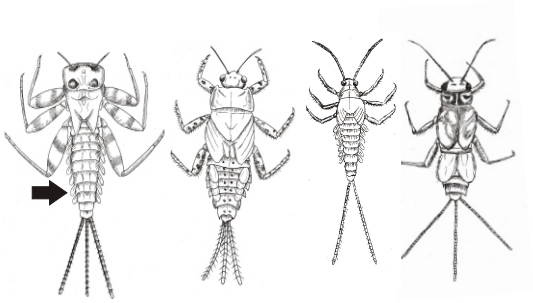
Stream Macroinvertebrates

Maryland Department of Natural Resources

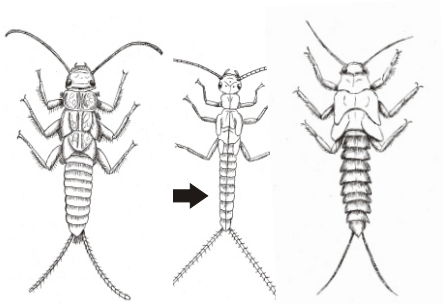
Relative abundances in Maryland are indicated by "rare", "common", or "abundant". The number of families in Maryland for higher taxonomic levels are also listed (if applicable). Sizes are for "full grown" animals. To learn more about these fascinating creatures, go to http://www.dnr2.maryland.gov/streams/Pages/streamLife.aspx. To learn about DNR's volunteer stream monitoring program, Maryland Stream Waders, send an inquiry to streamwaders.dnr@maryland.gov.

SENSITIVE ORGANISMS

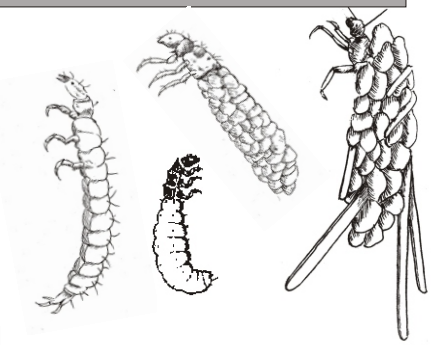
POLLUTION-SENSITIVE ORGANISMS TYPICALLY FOUND IN HEALTHY STREAMS



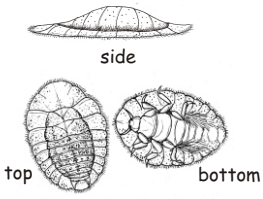
Mayfly: Order Ephemeroptera- Plate-like or feathery gills on sides of lower body (arrow); three (sometimes 2) long, hair-like tails; 1"; abundant; 11 families.



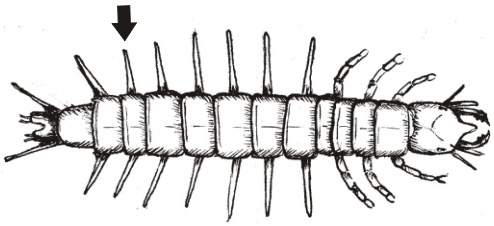
Stonefly: Order Plecoptera-Two hair-like tails; six jointed legs with two hooked tips each; big antennae; no gills on lower half of body (arrow); 1½"; abundant; 9 families.



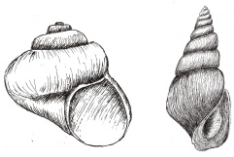
Caddisfly: Order Trichoptera- Six jointed, hooked legs just behind head; 2 hooks at back end; may be in a case made of stones, leaves or sticks; non-netspinning caddisflies have no bushy gills along bottom; 1"; abundant; 20 families.



Water Penny: Order Coleoptera- shaped like a tiny, grey, oblong frisbee; 6 tiny legs on bottom; slow crawler; ½"; common.



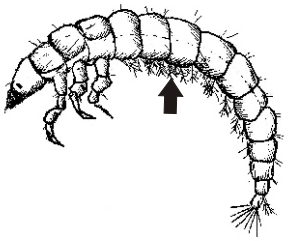
Hellgrammite and Fishfly: Order Megaloptera- dark body; six jointed legs; large, pinching jaws; many pointed feelers along edge of body (arrow); two small hooks at back end; hellgrammites have feathery tufts of gills along side of body; 4"; rare.



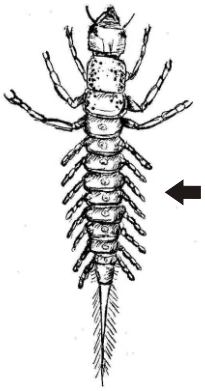
Gilled Snail: Class Gastropoda- shell opens on the right and is covered by a hard shield-like operculum; 1"; rare; 4 families.

MODERATELY-SENSITIVE ORGANISMS

MODERATELY POLLUTION-SENSITIVE ORGANISMS FOUND IN HEALTHY OR FAIR QUALITY STREAMS



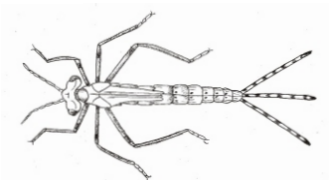
Net-spinning Caddisfly: Order Trichoptera- six jointed, hooked legs just behind head; 2 hooks at back end; bushy gills along lower half (arrow); 1"; abundant.



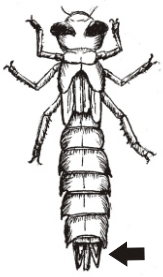
Alderfly: Order Megaloptera- six jointed legs; pinching jaws; many pointed feelers along edge of body (arrow); long tail at the end; 1"; rare.

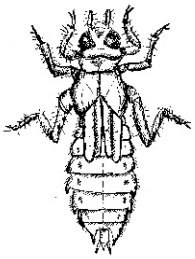
Crane Fly: Order Diptera- worm-like; no jointed legs; head hidden inside the light brown body; 4 finger-like lobes at back end (arrow); 2"; abundant.

MODERATELY-SENSITIVE ORGANISMS (continuted)

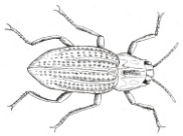


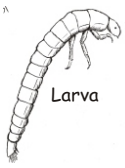
Damselfly: Order Odonata- 6 long, thin legs; 3 broad oval tails at end (arrow); may have wing pads; no gills along sides of body; 2"; common; 3 families.





Dragonfly: Order Odonata- large eyes; bullet-shaped, round or leaf-like body; 6 long legs; 3 short-spike-like tails (arrow); may have wing pads; 2"; common; 6 families.

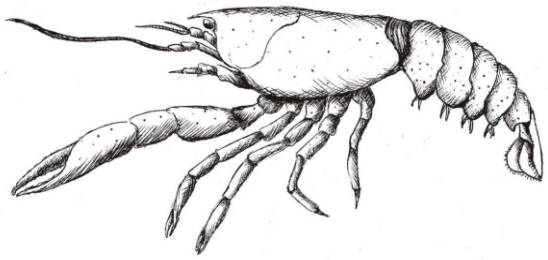




Riffle Beetle: Order Coleoptera- 6 jointed legs; brown or black; adults have hard covering over the wings, body with fairly hard covering; 3/8"; abundant.

Scud: Order Amphipoda- white to gray; more than six legs; swims on its side; looks like a small shrimp; 1/4"; abundant; 3 families.

Crayfish: Order Decapoda- 8 walking legs and 2 pinching claws; 6"; abundant.



Clams and mussels: Class Bivalvia- two hinged hard shells; 5"; rare; 2 families.

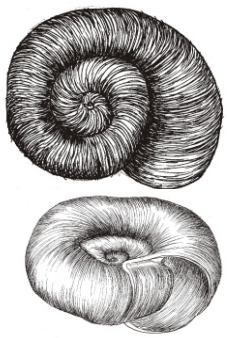
TOLERANT ORGANISMS

POLLUTION-TOLERANT ORGANISMS FOUND IN HEALTHY, FAIR OR POOR QUALITY STREAMS

Black Fly: Order Diptera- shaped like a little bowling pin; black head with tiny bristles for filtering food (arrow); suction pad on end; no jointed legs; ½"; abundant.

Non-biting Midge: Order Diptera- dark head; body white, gray or reddish; worm-like segmented body; 2 tiny unjointed legs on both ends (arrow); ½"; abundant.

Leech: Order Hirudinea- brown or grey, slimy, suction pads on both ends (arrow); 2"; rare; 3 families.



Ramshorn Snails: Class Gastropoda- No hard cover over opening; shell coiled in one plane; ½"; common.

Aquatic worm: Class Oligochaeta- thin and hairlike or thicker like an earthworm; 2 ½"; common; 8 families.

Pouch Snail: Class Gastropoda- shell opens on the left; no hard covering over shell opening; 3/4"; common.

Maryland Department of Natural Resources; Resource Assessment Service; 580 Taylor Avenue; Annaoplis, Maryland 21401 **Published March 2004**
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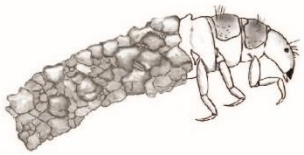
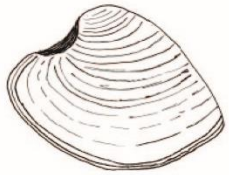
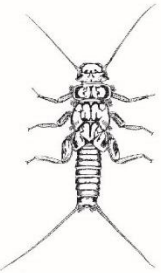
TTY users call via MD Relay

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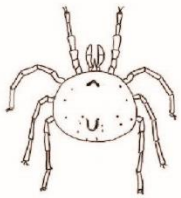
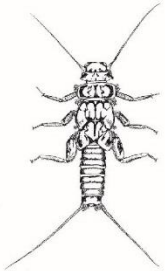
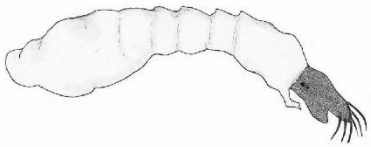
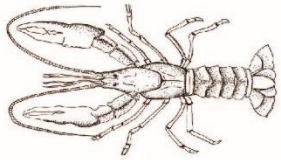
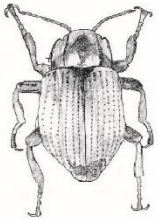
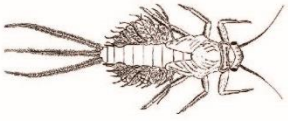
Identification Guide to Freshwater Macroinvertebrates








Major Characteristics of Aquatic Larvae

GLOSSARY

Abdomen: posterior body segment(s) of insect

Dorsal: the top surface, the back

Filaments (tail): hair-like structures

Jointed leg: true legs, legs capable of bending

Lateral: at the side

Portable case: structure made of leaves, twigs, or sand that some caddisfly and midge larvae carry with them

Posterior: tail end of the body

Prolegs: short leg-like structures (not jointed)

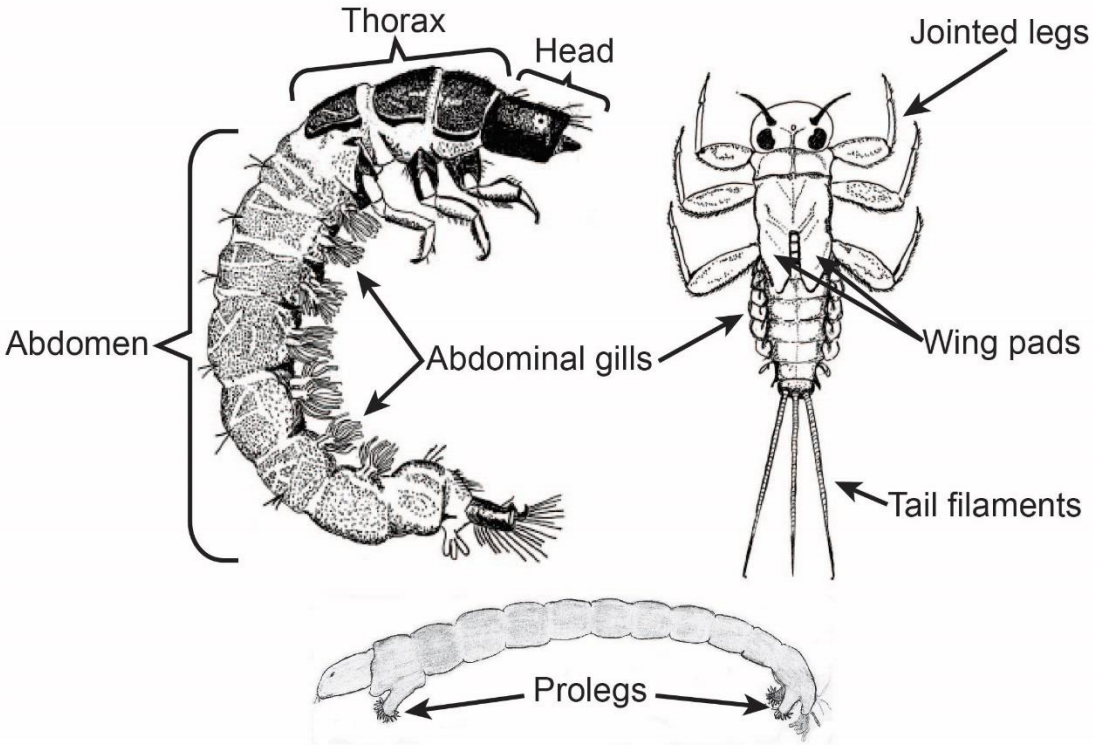
Protrusion: part of the body that sticks out

Segment: a section of body

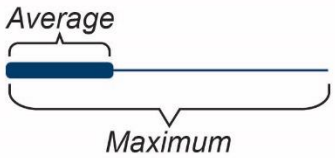
Thoracic: the middle region between the head and the abdomen

Ventral: underside

Wing pads: developing wings, often W in shape



Approximate Size Range



Pollution Tolerance

- Sensitive (S)
- Somewhat Sensitive (SS)
- Tolerant (T)

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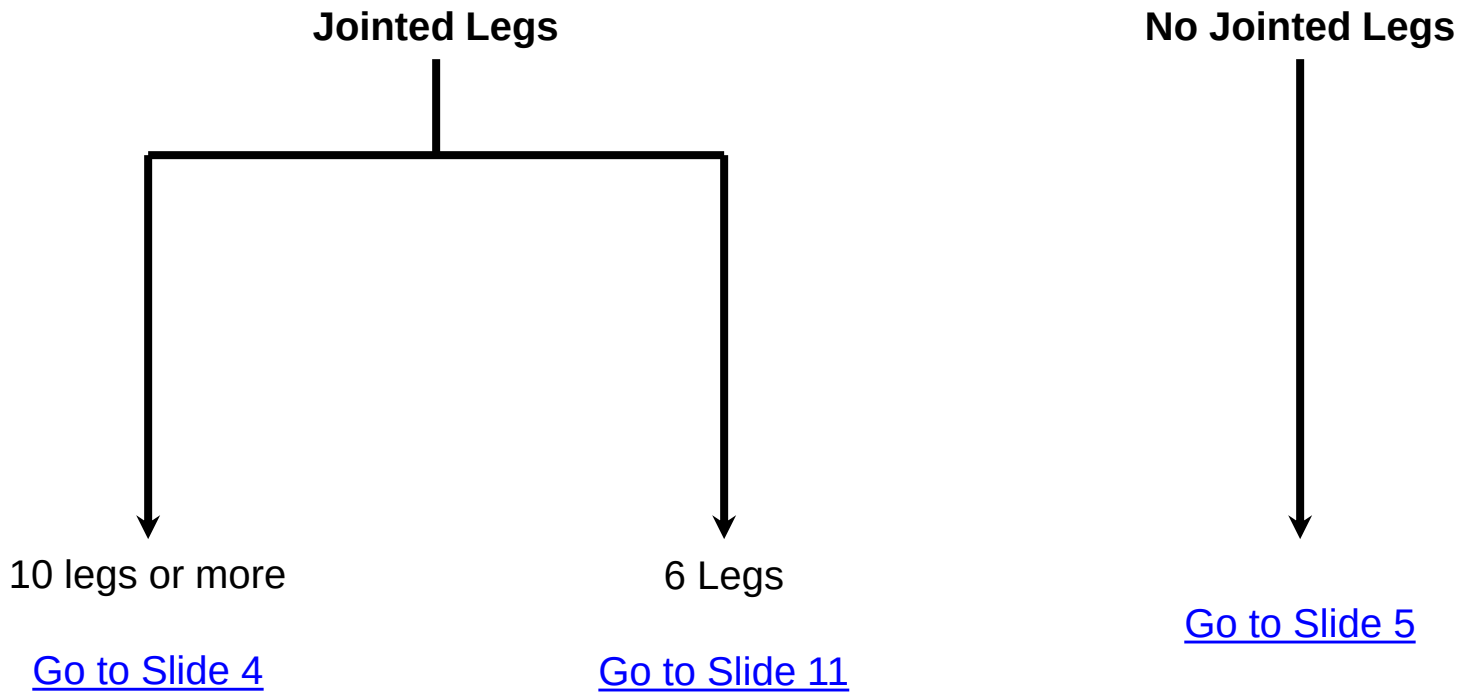

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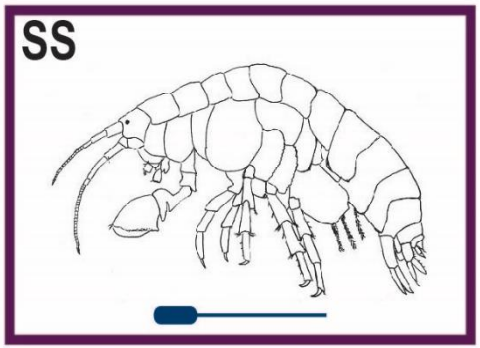
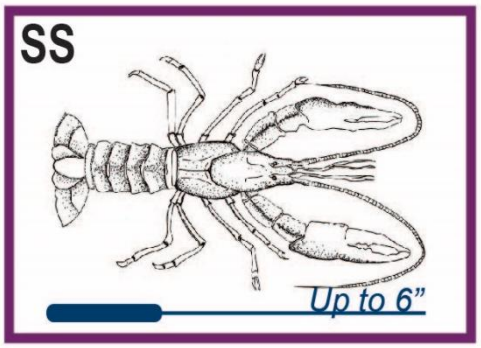
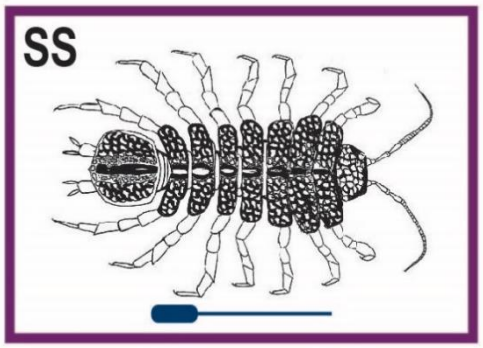
10 Legs or More



SCUDS
Amphipoda



CRAYFISH
Decapoda



SOWBUGS
Isopoda

Crustaceans

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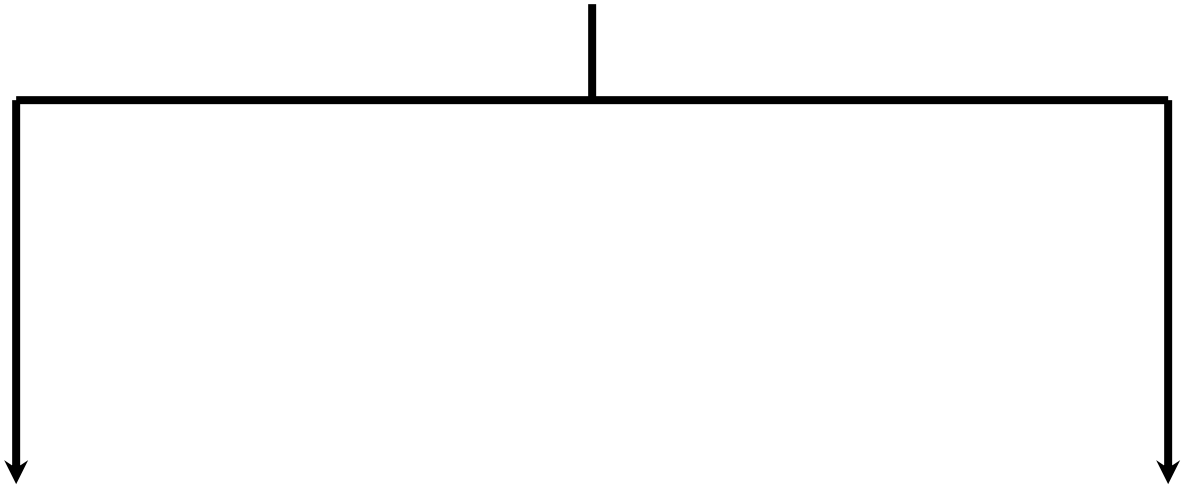
No Jointed Legs



Worm-like (no shell)

Go to Slide 6

Body encased in a hard shell

Go to Slide 7

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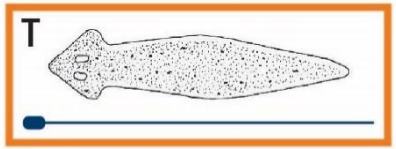
Worm-like (No Shell)

Segmented Worms

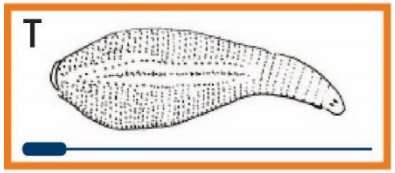
Head and/or fleshy protrusion

Non-segmented worms/flat-worm

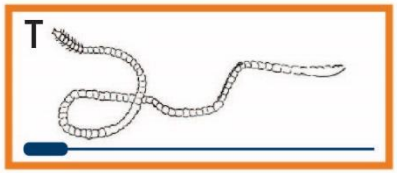
Go to Slide 8



PLANARIANS/FLATWORMS
Turbellaria



LEECHES
Hirudinea



AQUATIC WORMS
Oligochaeta

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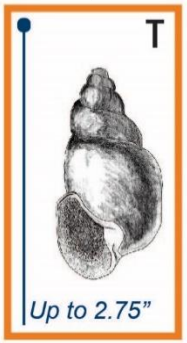
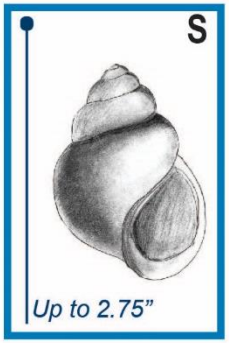
Body Encased in a Hard Shell

Single Shell
(snail or limpet-like)

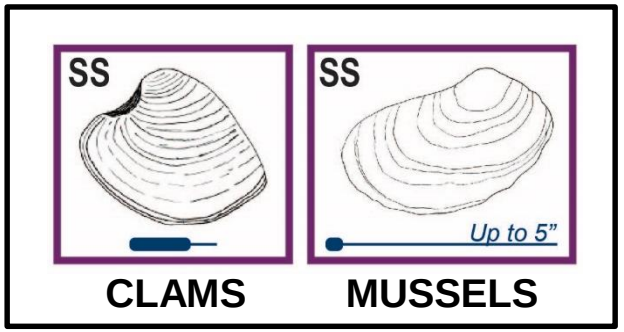
Double Shell
(Bivalve) – connected
with a single hinge



LEFT-HANDED/
LUNGED SNAILS
Gastropoda



RIGHT-HANDED/
GILLED SNAILS
Gastropoda



Mollusca

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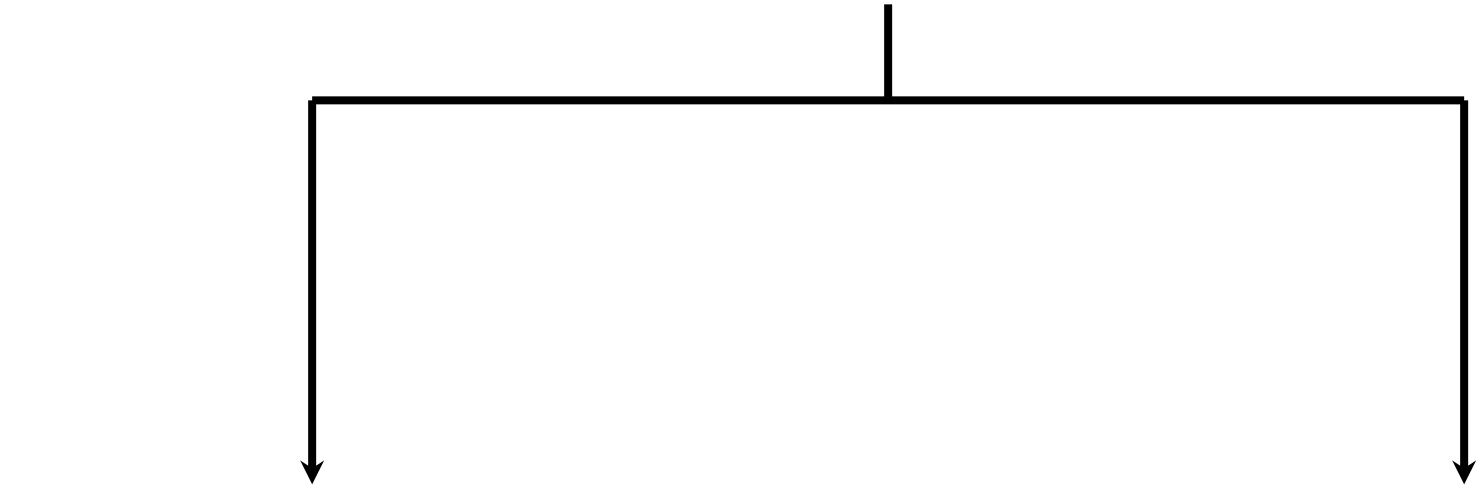
Worm-like with Distinct Head or Fleshy Protrusion

DIPTERA *True Flies*



Small head often hidden from view

Go to Slide 9

Distinct head

Go to Slide 10

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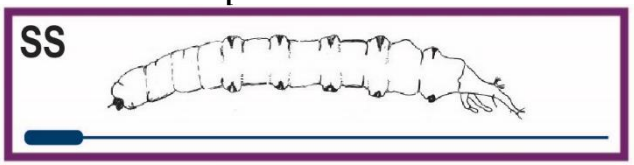
Small Head Often Hidden From View

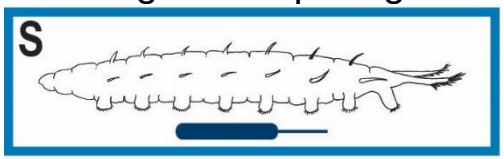
Fleshy protrusions at posterior end



CRANE FLIES
Tipulidae

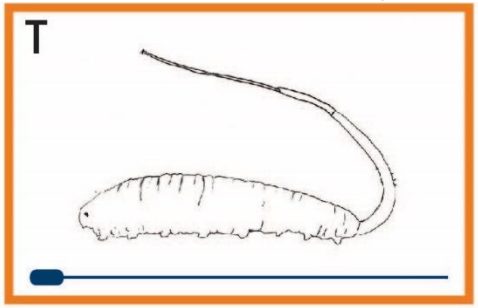
Other

Fleshy projections; posterior with 2 pointed protrusions longer than prolegs



AQUATIC SNIPE FLIES
Athericidae

Long tail; prolegs may be present on underside of body



RAT-TAILED MAGGOTS
Syrphidae

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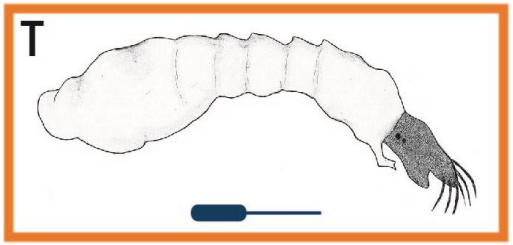
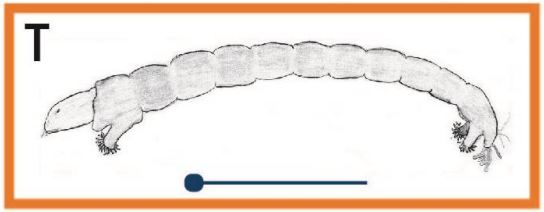
Distinct Head

One end wider than other;
no posterior prolegs

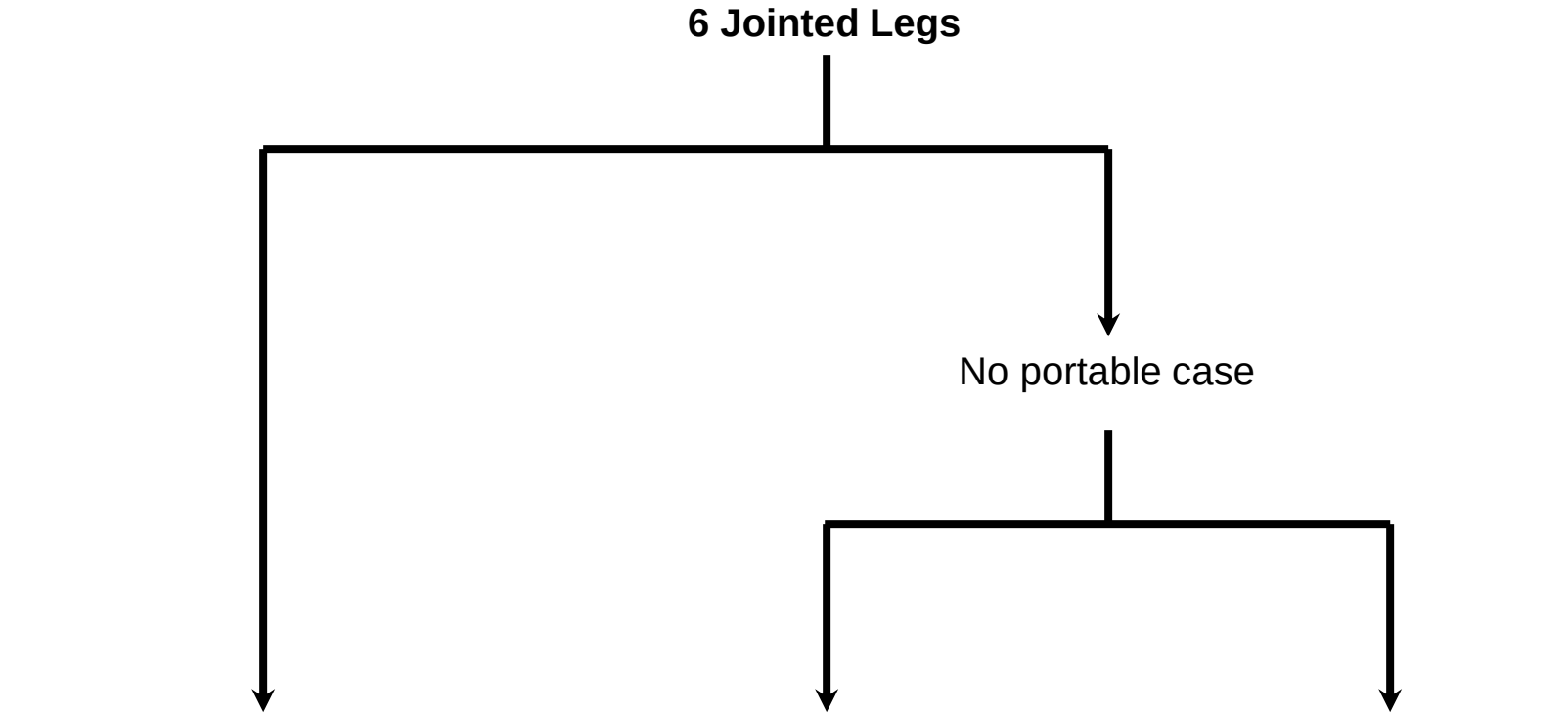


BLACK FLIES
Simuliidae

Both ends similar width; small
anterior and posterior prolegs



MIDGE FLIES
Chironomidae



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Portable Case

No Observable Wings or Wing Pads

Observable hooks at end of body

No observable hooks at end of body

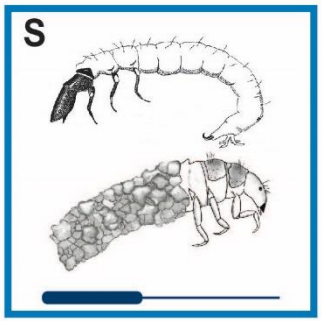
Go to Slide 13

Without lateral filaments

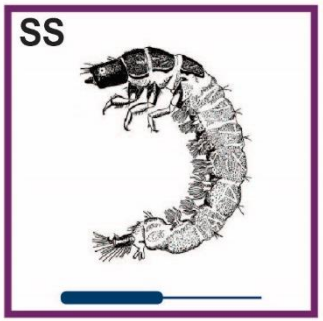
With lateral filaments

No branched gills

Branched gills on underside of abdomen; dorsal plates on all three thoracic segments

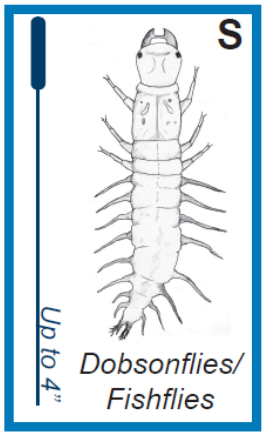


OTHER CADDISFLIES



NET-SPINNING CADDISFLIES

Trichoptera



DOBSONFLIES/FISHFLIES

Megaloptera

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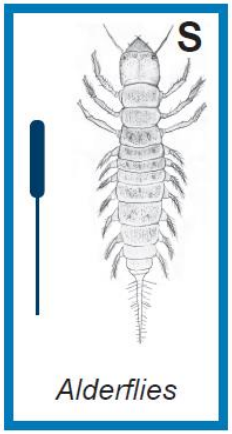
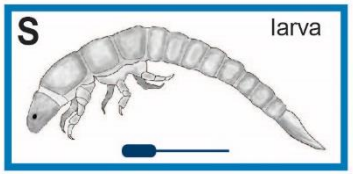
No Observable Hooks at End of Body

With lateral filaments; body ends in a single, long filament

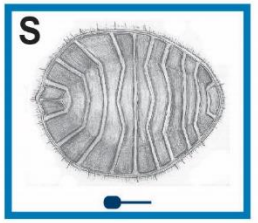


ALDERFLIES
Megaloptera

Without lateral filaments

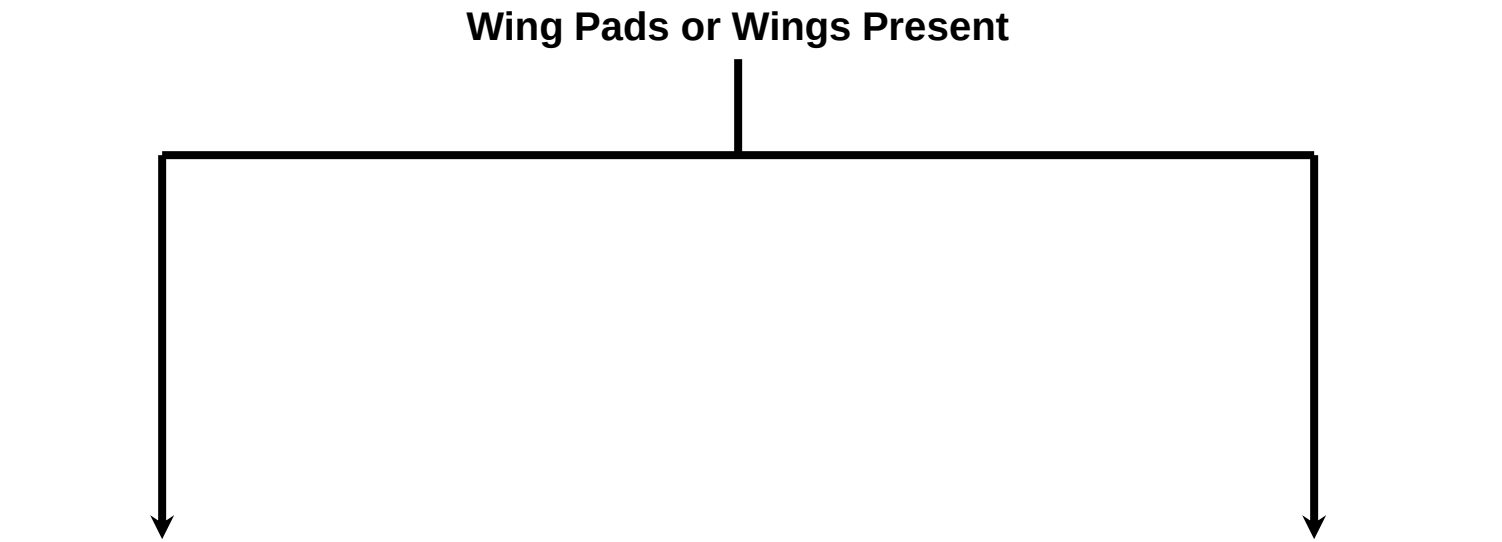


RIFFLE BEETLE LARVAE
Elmidae



WATER PENNIES
Psephenidae

Coleoptera



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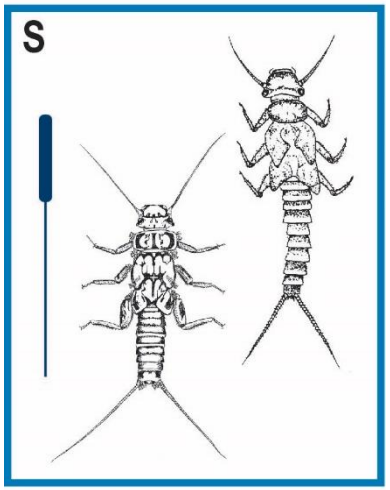
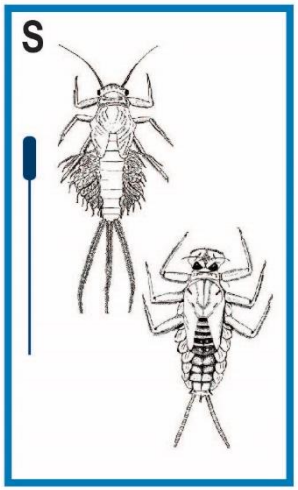
With Tail Filaments

Two tail filaments, without abdominal gills



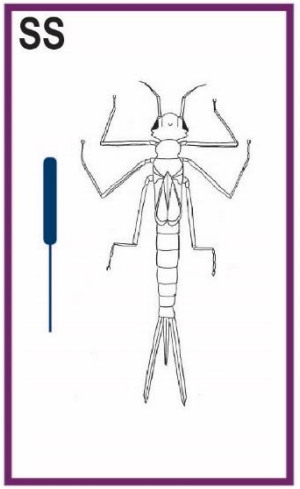
STONEFLIES
Plecoptera

Two or three tail filaments, with abdominal gills



MAYFLIES
Ephemeroptera

Three flat tail filaments, without abdominal gills; large hinged mouth



DAMSELFLIES
Odonata

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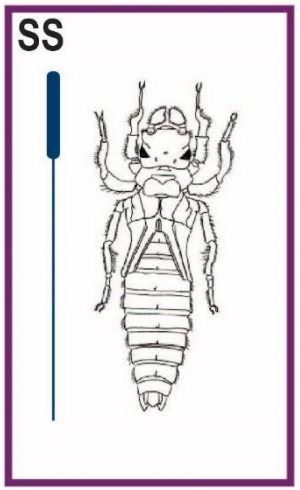
Without Tail Filaments

Wing pads

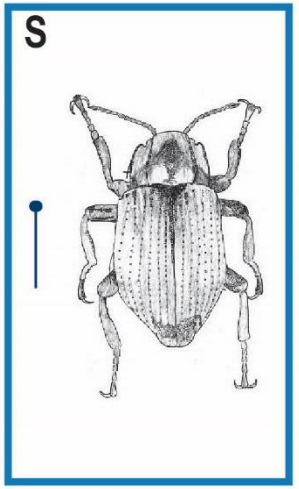
Large, hinged mouth



DRAGONFLIES
Odonata

Wings

Hard wing coverings with centerline



ADULT RIFFLE BEETLES
Elmidae

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United States Department of Agriculture
NRCS Natural Resources Conservation Service
Federal Building, 2 Madbury Road, Durham, NH 03824-2043 (603) 868-7581 Fax: (603) 868-5301 www.nh.nrcs.usda.gov

How to Read a Topographic Map and Delineate a Watershed

This fact sheet is an excerpt from Appendix E of the *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire*, 1991. Alan Ammann, PhD and Amanda Lindley Stone. This document and method is commonly called "The New Hampshire Method."

Interpreting Topographic Maps

In order to successfully delineate a watershed boundary, the evaluator will need to visualize the landscape as represented by a topographic map. This is not difficult once the following basic concepts of the topographic maps are understood.

Each contour line on a topographic map represents a ground elevation or vertical distance above a reference point such as sea level. A contour line is level with respect to the earth's surface just like the top of a building foundation. All points along any one contour line are at the same elevation.

The difference in elevation between two adjacent contours is called the contour interval. This is typically given in the map legend. It represents the vertical distance you would need to climb or descend from one contour elevation to the next.

The horizontal distance between contours, on the other hand, is determined by the steepness of the landscape and can vary greatly on a given map. On relatively flat ground, two 20 foot contours can be far apart horizontally.

On a steep cliff face two 20 foot contours might be directly above and below each other. In each case the vertical distance between the contour lines would still be twenty feet.

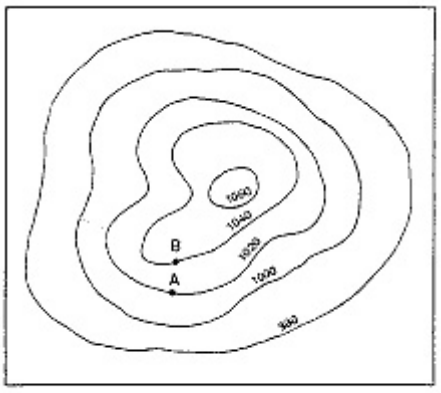


Figure E-1: Isolated Hill

One of the easiest landscapes to visualize on a topographic map is an isolated hill. If this hill is more or less circular the map will show it as a series of more or less concentric circles (Figure E-1). Imagine that a surveyor actually marks these contour lines onto the ground. If two people start walking in opposite directions on the same contour line, beginning at point A, they will eventually meet face to face.

If these same two people start out in opposite directions on different contours, beginning at points A and B respectively, they will pass each other somewhere on the hill and their vertical distance apart would remain 20 feet. Their horizontal distance apart could be great or small depending on the steepness of the hillside where they pass.

A rather more complicated situation is one where two hills are connected by a saddle (Figure E-2). Here each hill is circled by contours but at some point toward the base of the hills, contours begin to circle both hills.

How do contours relate to water flow? A general rule of thumb is that water flow is perpendicular to contour lines. In the case of the isolated hill, water flows down on all sides of the hill. Water flows from the top of the saddle or ridge, down each side in the same way water flows down each side of a garden wall (See arrow on Figure E-2).

As the water continues downhill it flows into progressively larger watercourses and ultimately into the ocean. Any point on a watercourse can be used to define a watershed. That is, the entire drainage area of a major river like the Merrimack can be considered a watershed, but the drainage areas of each of its tributaries are also watersheds.

Each tributary in turn has tributaries, and each one of these tributaries has a watershed. This process of subdivision can continue until very small, local watersheds are defined which might only drain a few acres, and might not contain a defined watercourse.

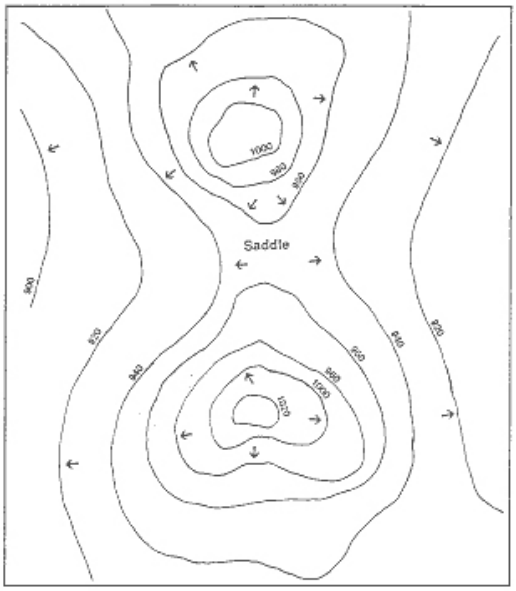


Figure E-2: Saddle

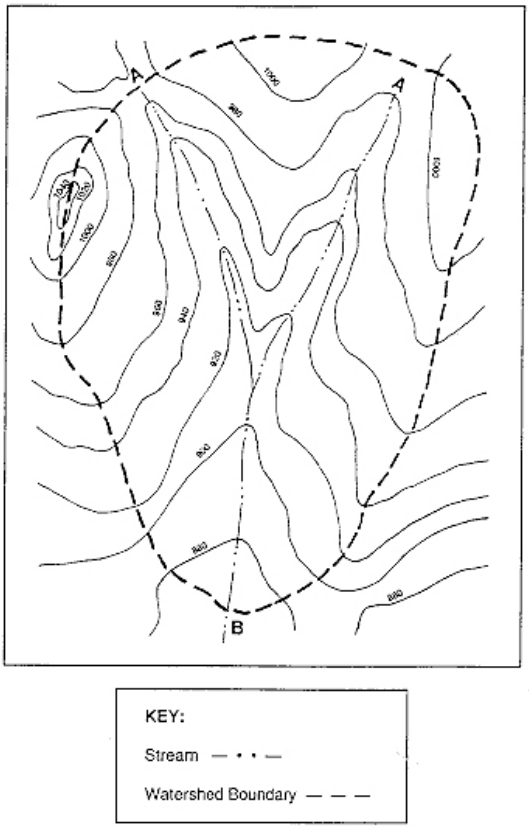


Figure E-3: Idealized Watershed Boundary

Figure E-3 shows an idealized watershed of a small stream. Water always flows downhill perpendicular to the contour lines. As one proceeds upstream, successively higher and higher contour lines first parallel then cross the stream. This is because the floor of a river valley rises as you go upstream. Likewise the valley slopes upward on each side of the stream. A general rule of thumb is that topographic lines always point upstream. With that in mind, it is not difficult to make out drainage patterns and the direction of flow on the landscape even when there is no stream depicted on the map. In Figure E-3, for example, the direction of streamflow is from point A to point B.

Ultimately, you must reach the highest point upstream. This is the head of the watershed, beyond which the land slopes away into another watershed. At each point on the stream the land slopes up on each side to some high point then down into another watershed. If you were to join all of these high points around the stream you would have the watershed boundary. (High points are generally hill tops, ridge lines, or saddles).

Delineating a Watershed

The following procedure and example will help you locate and connect all of the high points around a watershed on a topographic map shown in Figure F-4 below. Visualizing the landscape represented by the topographic map will make the process much easier than simply trying to follow a method by rote.

1. Draw a circle at the outlet or downstream point of the wetland in question (the wetland is the hatched area shown in Figure E-4 to the right)
2. Put small "X's" at the high points along both sides of the watercourse, working your way upstream towards the headwaters of the watershed.
3. Starting at the circle that was made in step one, draw a line connecting the "X's" along one side of the watercourse (Figure E-5, below left). This line should always cross the contours at right angles (i.e. it should be perpendicular to each contour line it crosses).
4. Continue the line until it passes around the head of the watershed and down the opposite side of the watercourse. Eventually it will connect with the circle from which you started.

At this point you have delineated the watershed of the wetland being evaluated.

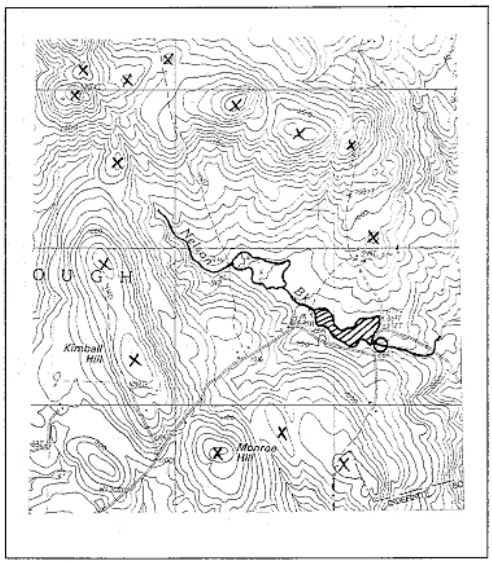


Figure E-4: Delineating a Watershed Boundary - Step 1

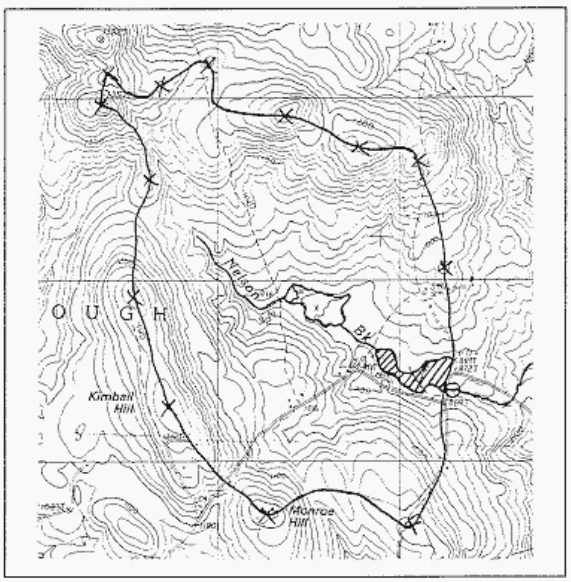


Figure E-5: Delineating a Watershed Boundary - Step 2

The delineation appears as a solid line around the watercourse. Generally, surface water runoff from rain falling anywhere in this area flows into and out of the wetland being evaluated. This means that the wetland has the potential to modify and attenuate sediment and nutrient loads from this watershed as well as to store runoff which might otherwise result in downstream flooding.

Measuring Watershed Areas

There are two widely available methods for measuring the area of a watershed: a) Dot Grid Method, and b) Planimeter. These methods can also be used to measure the area of the wetland itself as required by The New Hampshire Method.

a) The dot grid method is a simple technique which does not require any expensive equipment. In this method the user places a sheet of acetate or mylar, which has a series of dots about the size of the period at the end of this sentence printed on it, over the map area to be measured. The user counts the dots which fall within the area to be

measured and multiplies by a factor to determine the area. A hand held, mechanical counting device is available to speed up this procedure.

b) The second of these methods involves using a planimeter, which is a small device having a hinged mechanical arm. One end of the arm is fixed to a weighted base while the other end has an attached magnifying lens with a cross hair or other pointer. The user spreads the map with the delineated area on a flat surface. After placing the base of the planimeter in a convenient location the user traces around the area to be measured with the pointer. A dial or other readout registers the area being measured.

Planimeters can be costly depending on the degree sophistication. For the purposes of The New Hampshire Method, a basic model would be sufficient. Dot counting grids are significantly more affordable. Both planimeters and dot grids are available from engineering and forestry supply companies. Users of either of these methods should refer to the instructions packaged with the equipment they purchase.

For more information on The New Hampshire Method, wetlands restoration programs, conservation planning, ecosystem restoration, and other technical references, visit www.nh.nrcs.usda.gov or call (603) 868-7581.

Introduction

This presentation explains and illustrates how to identify and draw watershed boundaries on a topographic map. The process is explained step by step in the next 16 pages. You should review this presentation until you have a good understanding of the process and then test your watershed delineation skills using the two additional topographic maps provided in pages 18 and 19 of this presentation. The correct delineations (i.e., the answers) for those two watersheds are provided on the last two pages of this presentation (pages 20 and 21). Note that the delineation of the second test watershed is more difficult than that of the first because the landscape is flatter, which makes the features shown by the topographic lines less obvious.

Drawing Watershed Boundaries

When we talk about the hydrologic cycle and the water budget, we typically talk about these things in terms of watersheds. So first you should know what a watershed is.

Watersheds are topographically defined areas – something like bowls. What we mean by that is that a watershed is separated from neighboring watersheds by high points on the landscape. You can think of a watershed as an area that, if precipitation falling into it was not evaporated back to the atmosphere and did not infiltrate into the soil, all of the water in the watershed would run downhill to the same stream.

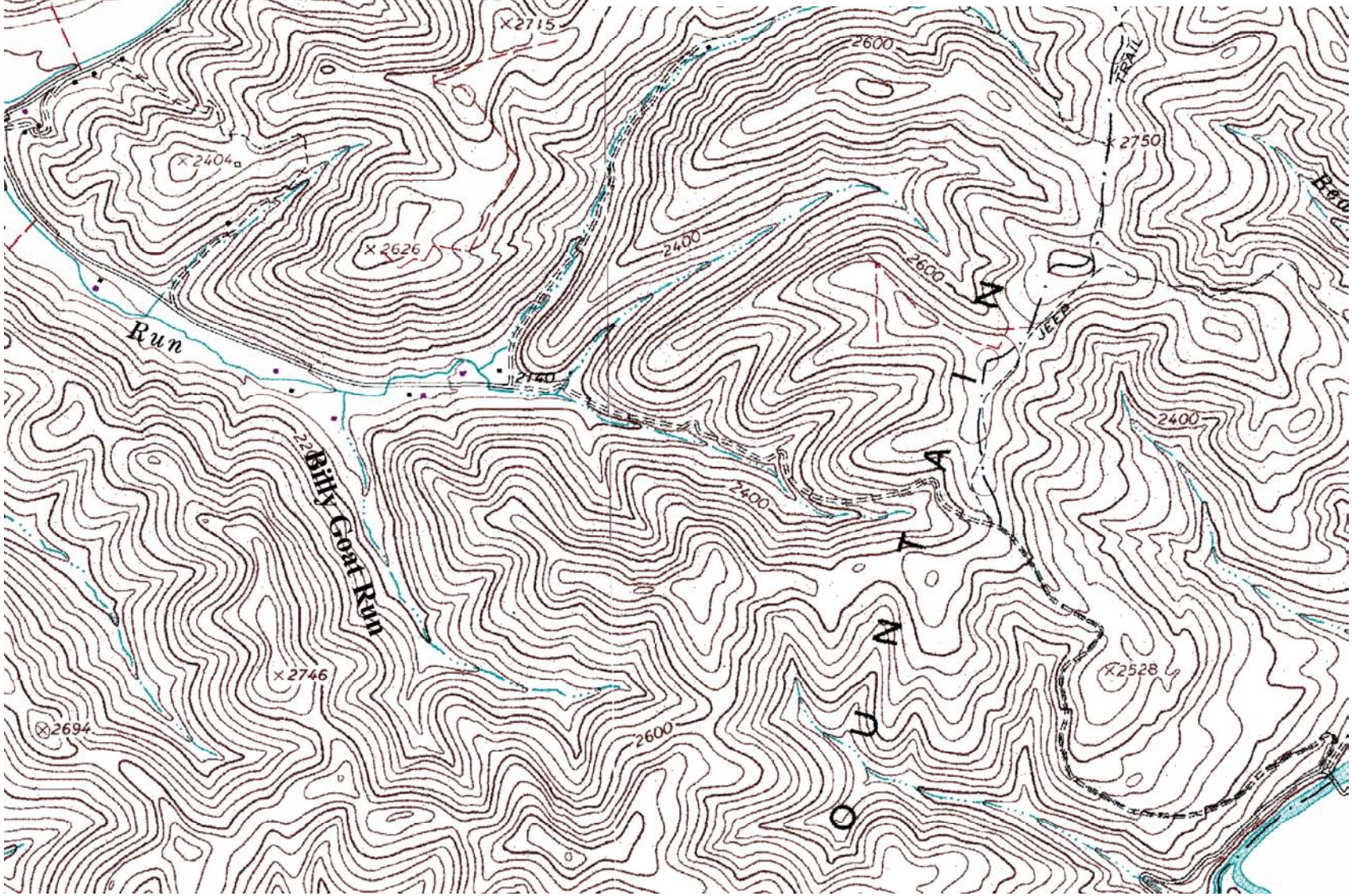
Delineating watershed boundaries. All watershed delineation means is that you're drawing lines on a map to identify a watershed's boundaries. These are typically drawn on topographic maps using information from contour lines. Contour lines are lines of equal elevation, so any point along a given contour line is the same elevation.

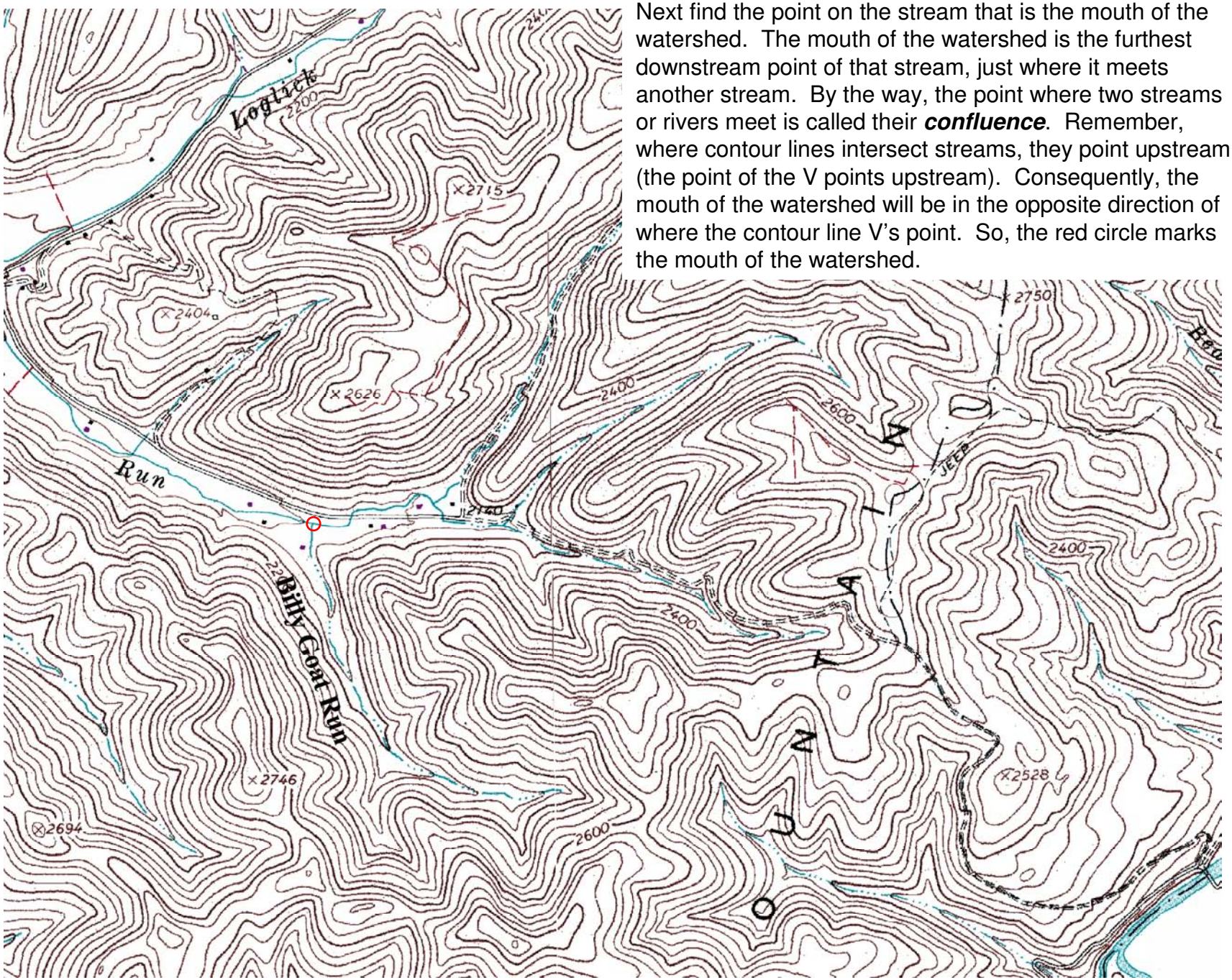
To delineate a watershed's boundaries on a topographic map it's easiest if you first understand some things about these maps. Rather than taking a lot of time to explain that here, there are several good web sites that describe this. I recommend that you Google "Read a topographic map" to access some of those sites. But here are a few highlights of topographic maps, and a bit more information will be given later in the presentation.

1) The primary lines on a topographic map are called contour lines, and as stated before, they represent points of equal elevations. Some of these lines are numbered, and those numbers are the elevations of those contour lines. In the U.S., those elevations are typically given in feet above sea level. You can move across contour lines and know if the elevation is increasing or decreasing, by whether the number is increasing or decreasing. 2) Streams and rivers are shown by blue lines. Solid blue lines show perennial streams, and the dashed blue lines show what are estimated to be intermittent streams. 3) Contour lines point upstream (they form kind of what looks like a V) as they cross over a stream or river. 4) The closer the contour lines are together the steeper the terrain; the further apart they are the flatter the terrain.

So let's go through the steps to delineate a watershed's boundaries.

First you need to identify the stream whose watershed boundaries you are going to identify. So let's say on this map we're going to delineate the watershed boundary for Billy Goat Run. So look for blue lines and find the one on this map with the name Billy Goat Run. It is in the lower left quadrant of this map.

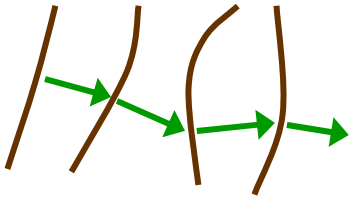




Next find the point on the stream that is the mouth of the watershed. The mouth of the watershed is the furthest downstream point of that stream, just where it meets another stream. By the way, the point where two streams or rivers meet is called their ***confluence***. Remember, where contour lines intersect streams, they point upstream (the point of the V points upstream). Consequently, the mouth of the watershed will be in the opposite direction of where the contour line V's point. So, the red circle marks the mouth of the watershed.

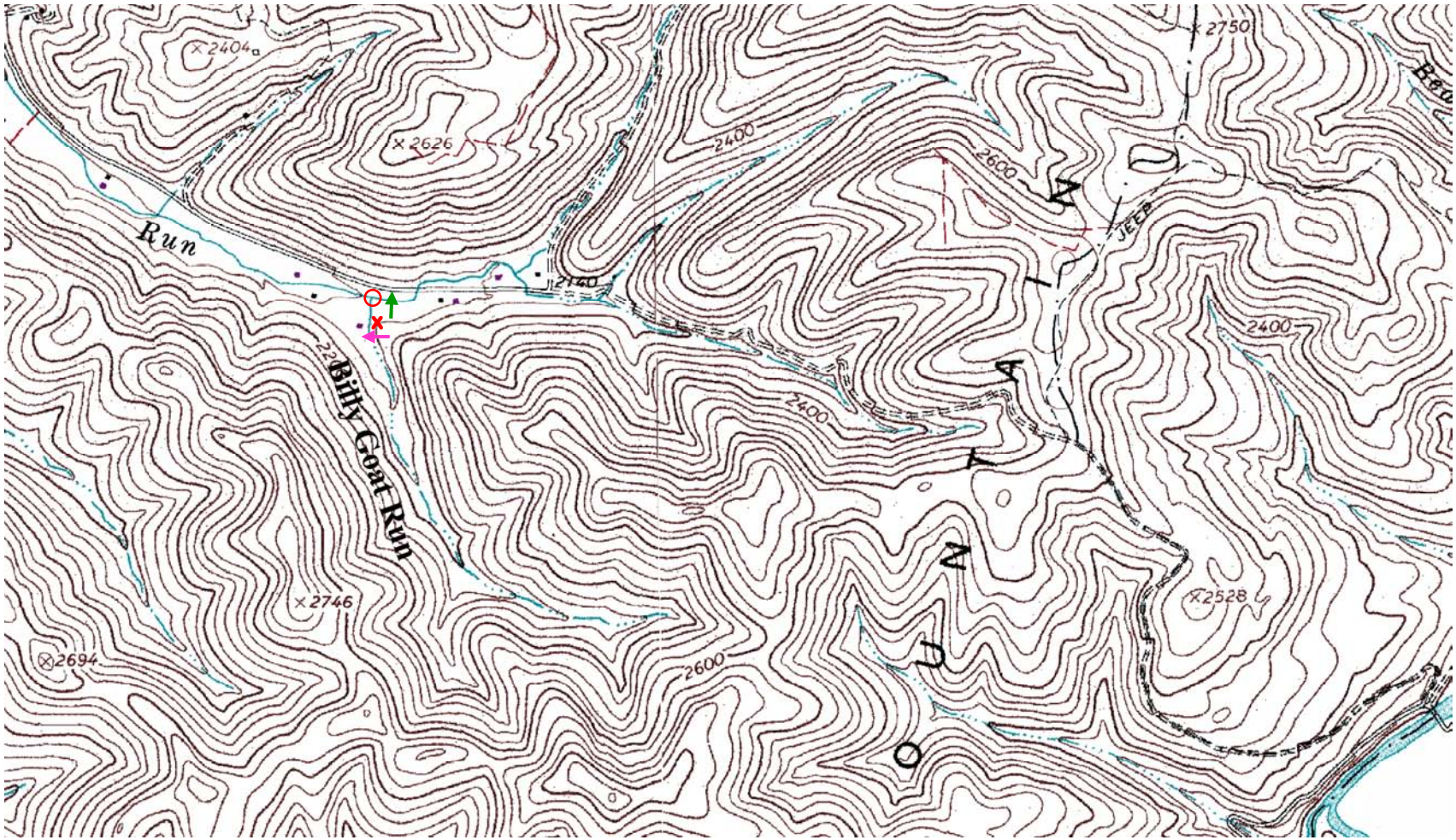
Now you're ready to start tracing the watershed boundary, or the highest elevations that surround your watershed. You always start at the mouth of the watershed, which is also the lowest elevation of the watershed. In order to identify these high points, we have to know just a little bit more about topographic maps and how water will flow. One indicator of the high points or ridge lines is a bulge in a contour line that looks something like this:

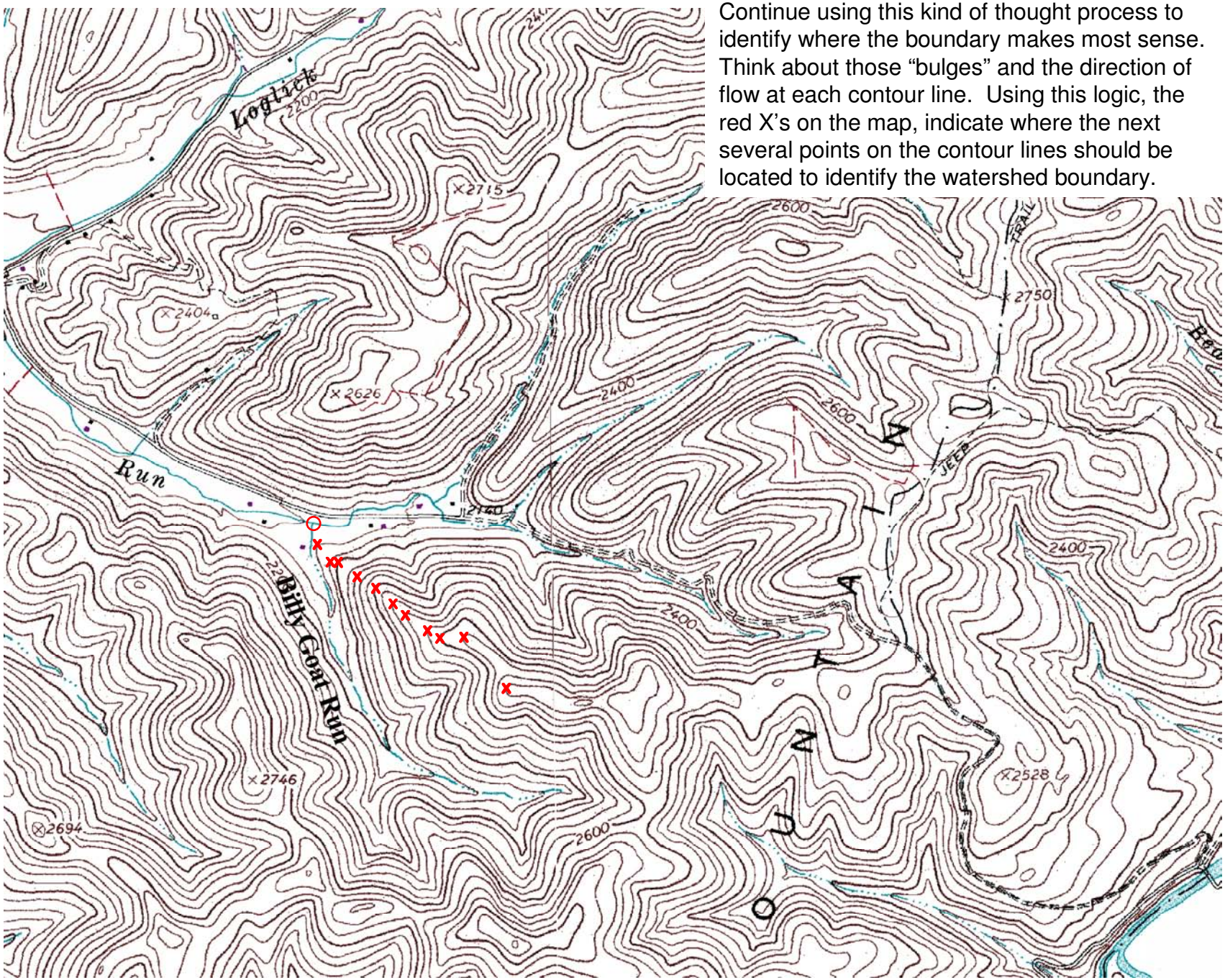
But how do you know exactly where on that bulge to draw the watershed boundary? To figure that out, you need to understand how a contour line indicates the direction of water flow. Water will flow perpendicular to each contour line. For example, if the brown lines below are contour lines, the green arrows show the direction water would flow on the ground.



So let's return to Billy Goat Run watershed, and try your hand at watershed delineation.

Go to the first contour line on the right side of the circle marking the confluence. The watershed boundary on that line would be where the red X is located. Here's why. If you put the point further to the right on that contour line, a line perpendicular to the contour line would point to the right of the confluence (see the green arrow) and water flowing that direction wouldn't flow into Billy Goat Run. Instead, it would flow into the larger stream that Billy Goat Run flows into. If you put your first point to the left of the X on that contour line, you can see the pink arrow indicates that water would move toward Bully Goat Run; which is what we want. HOWEVER, this point isn't the highest point, because flow at the red X would still be in the watershed and would flow approximately to the confluence. So this point is as far out on the contour line as you can go AND still have water flowing into the watershed. This X is the correct location for the start of the watershed boundary because the characteristics of that point make it the *highest* elevation on that contour line that would still allow water to drain into Billy Goat Run.



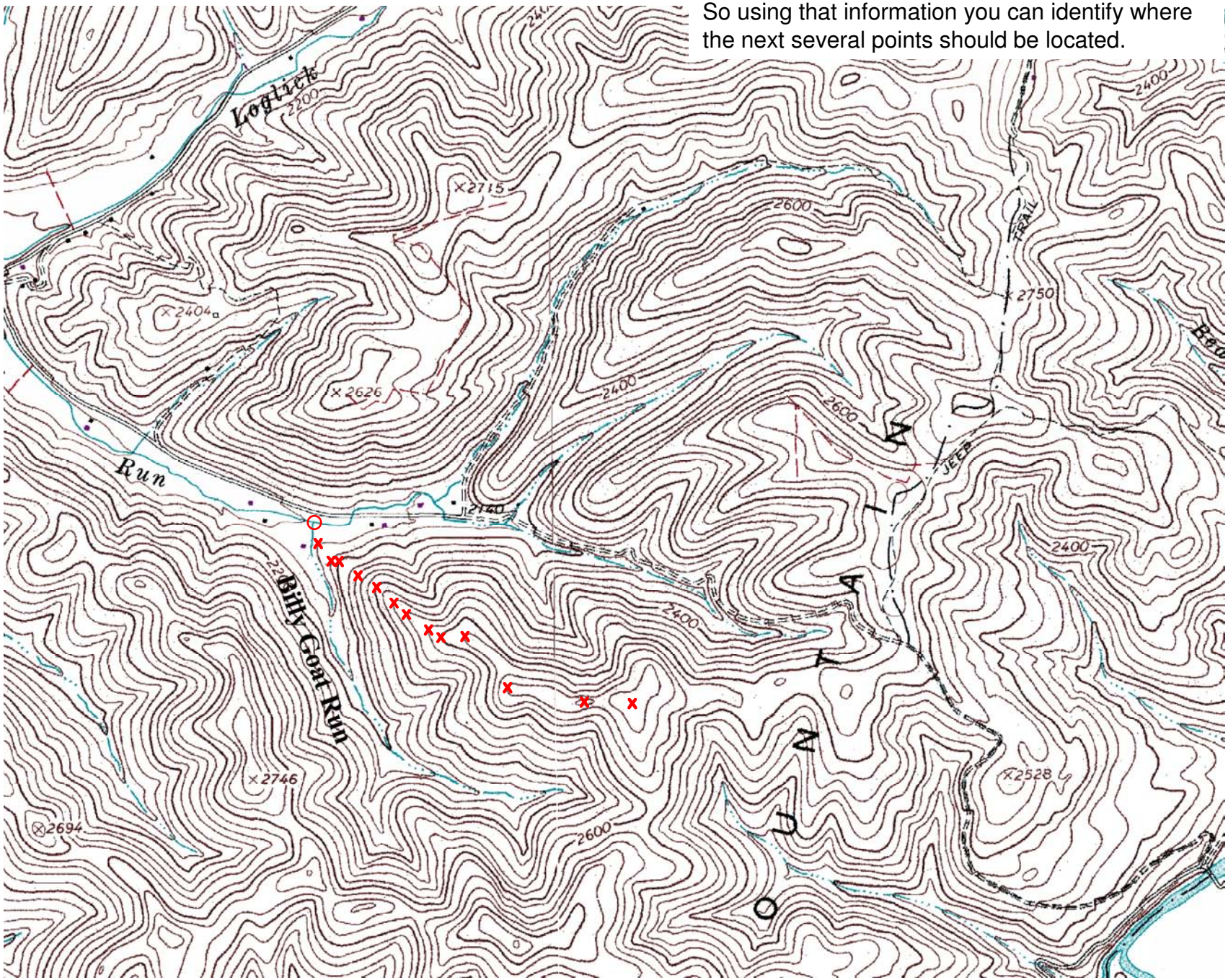


Continue using this kind of thought process to identify where the boundary makes most sense. Think about those “bulges” and the direction of flow at each contour line. Using this logic, the red X’s on the map, indicate where the next several points on the contour lines should be located to identify the watershed boundary.

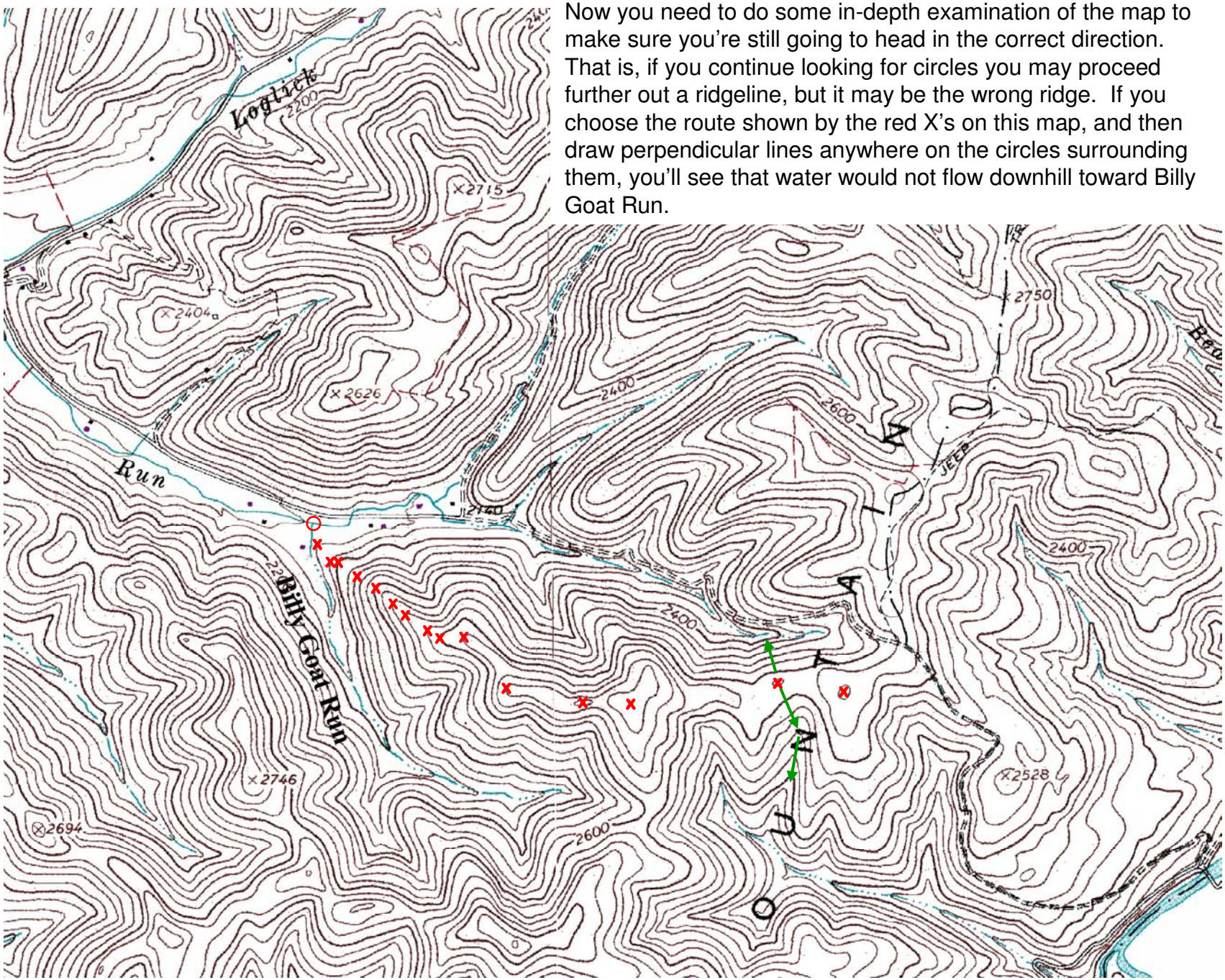
At this point on the map, we've kind of lost the presence of obvious bulges. That's because the ground is actually becoming flatter and wider along the ridge. You can tell this because the contour lines now have things that look like circles, ovals, or oddly shaped "circles" (that is if you pick a point on the contour line, and follow it around, it simply returns back to that original point). For simplicity, I'll refer to these as circles.

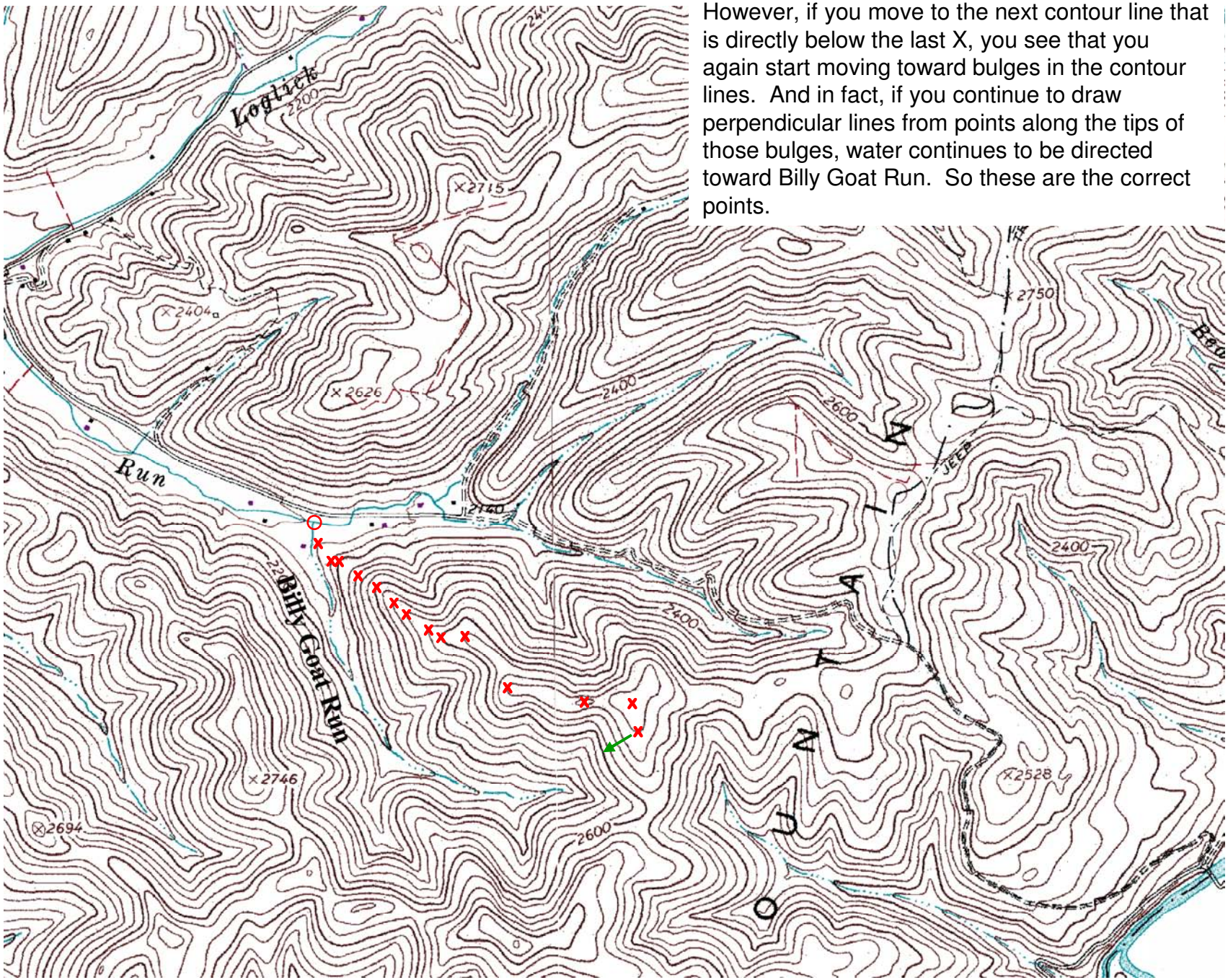
Single circles or circles within other circles identify high or low points on a topographic map. But since you've been going along the high point of the ridge, you know that these circles are high points. The approximate center of the most-inner circle is assumed to approximate the highest point on the ground in that area.

So using that information you can identify where the next several points should be located.

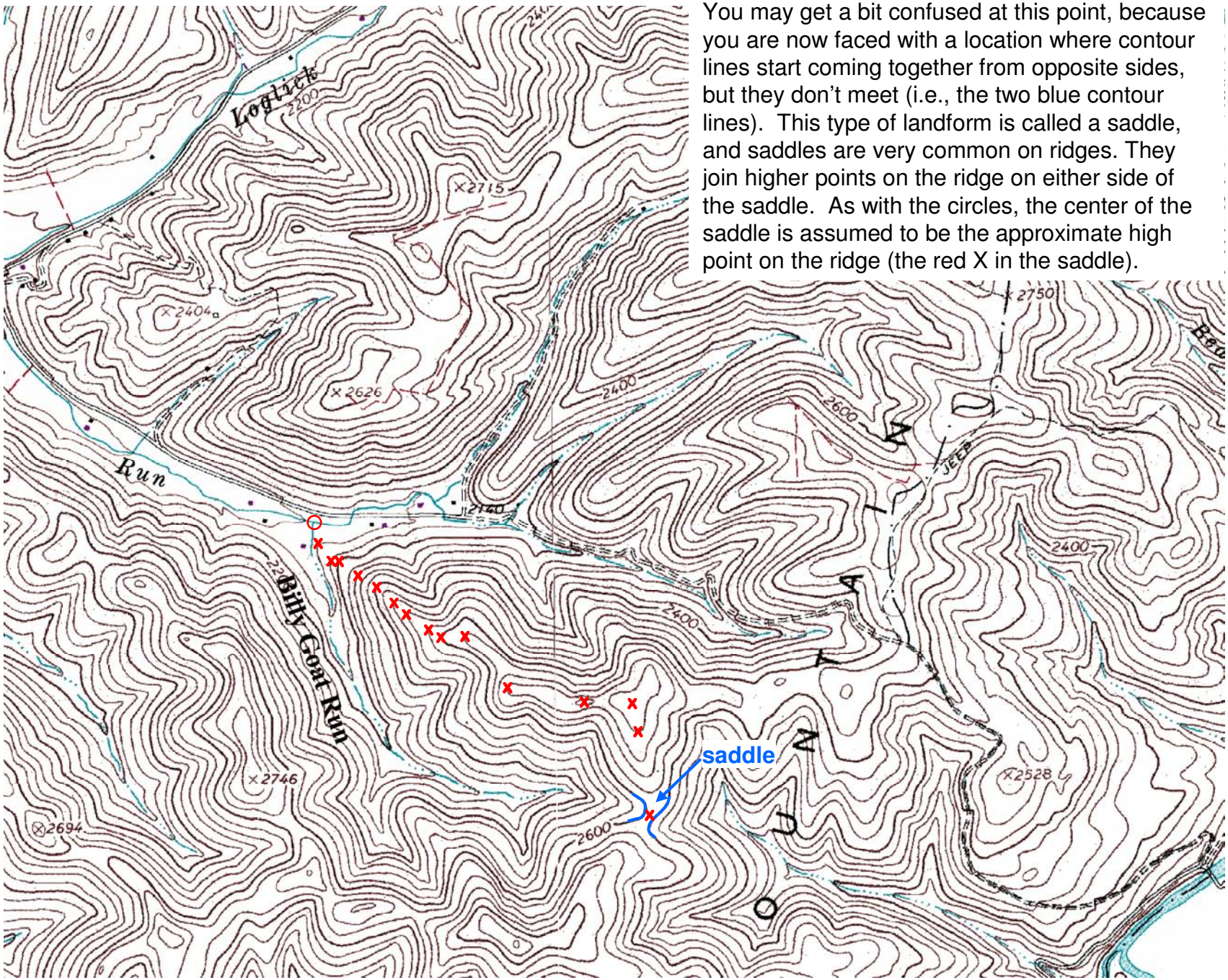


Now you need to do some in-depth examination of the map to make sure you're still going to head in the correct direction. That is, if you continue looking for circles you may proceed further out a ridgeline, but it may be the wrong ridge. If you choose the route shown by the red X's on this map, and then draw perpendicular lines anywhere on the circles surrounding them, you'll see that water would not flow downhill toward Billy Goat Run.



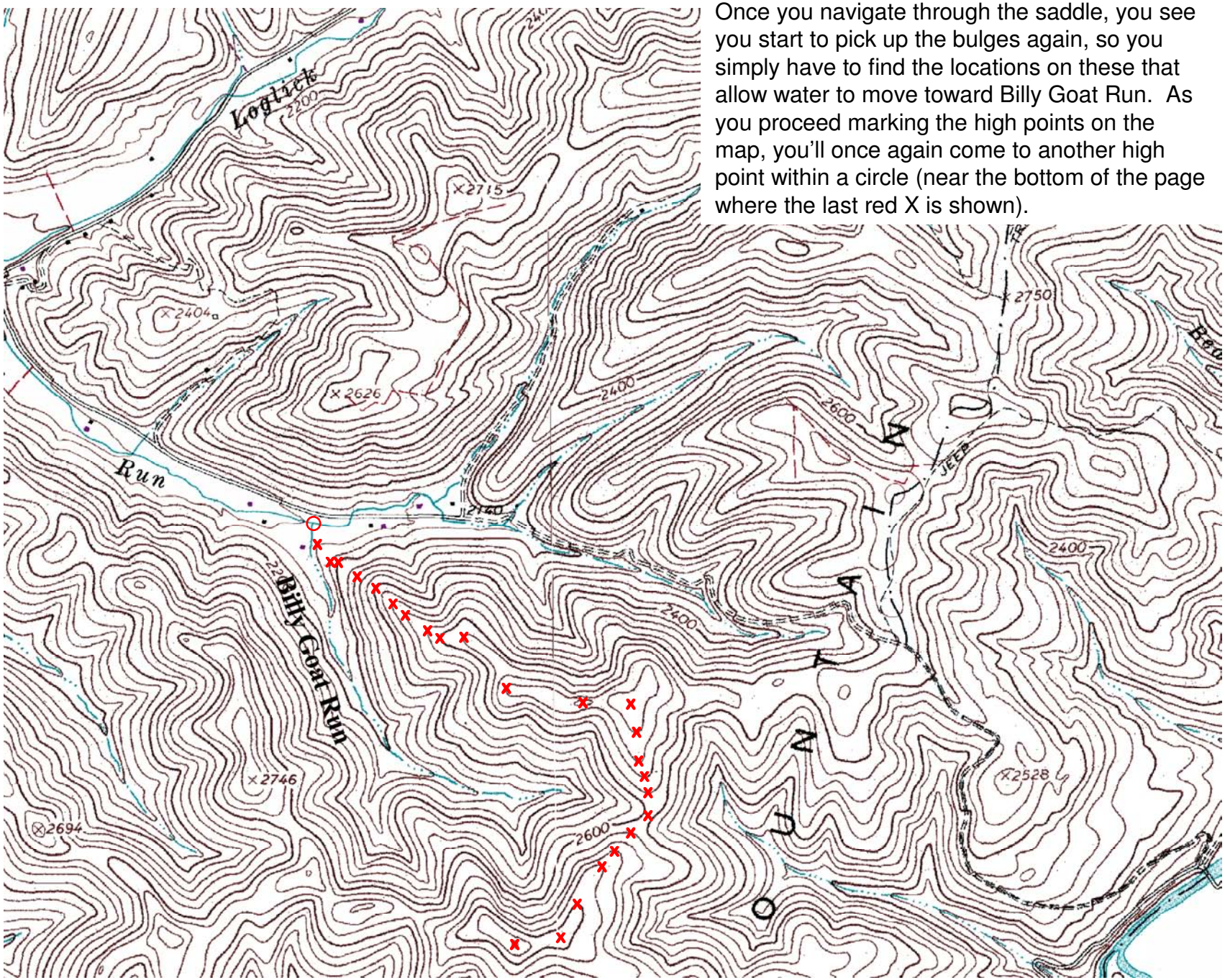


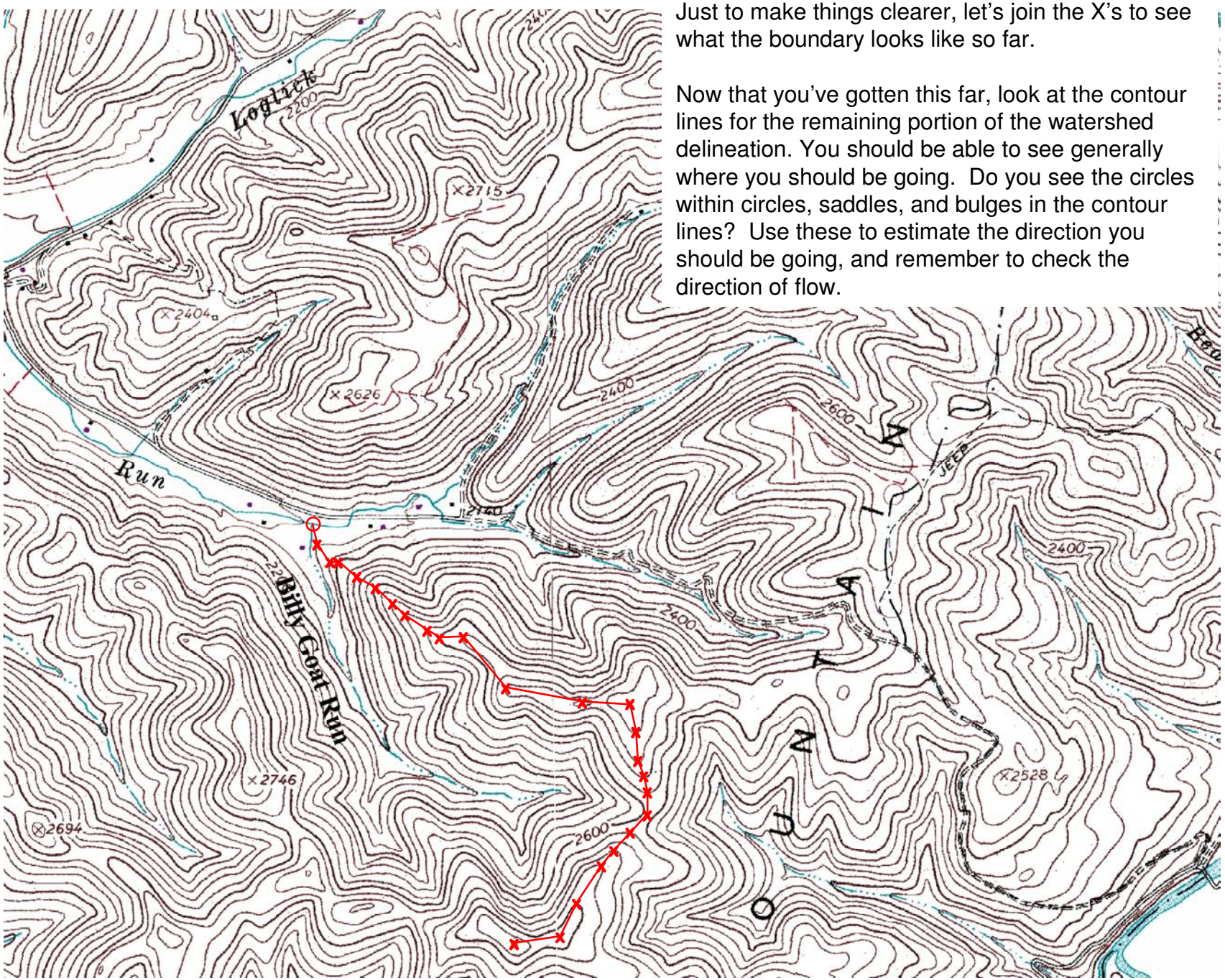
However, if you move to the next contour line that is directly below the last X, you see that you again start moving toward bulges in the contour lines. And in fact, if you continue to draw perpendicular lines from points along the tips of those bulges, water continues to be directed toward Billy Goat Run. So these are the correct points.



You may get a bit confused at this point, because you are now faced with a location where contour lines start coming together from opposite sides, but they don't meet (i.e., the two blue contour lines). This type of landform is called a saddle, and saddles are very common on ridges. They join higher points on the ridge on either side of the saddle. As with the circles, the center of the saddle is assumed to be the approximate high point on the ridge (the red X in the saddle).

Once you navigate through the saddle, you see you start to pick up the bulges again, so you simply have to find the locations on these that allow water to move toward Billy Goat Run. As you proceed marking the high points on the map, you'll once again come to another high point within a circle (near the bottom of the page where the last red X is shown).

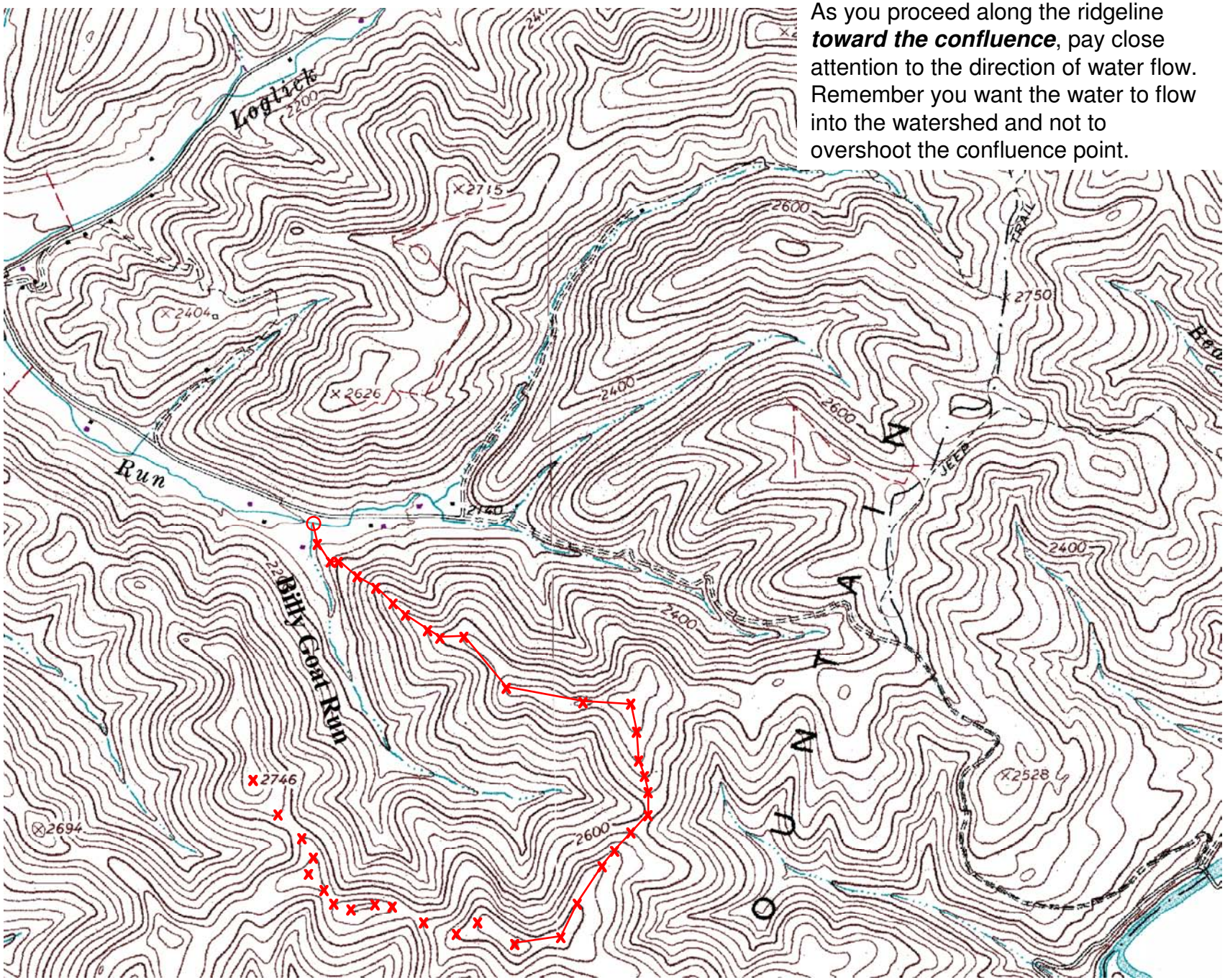


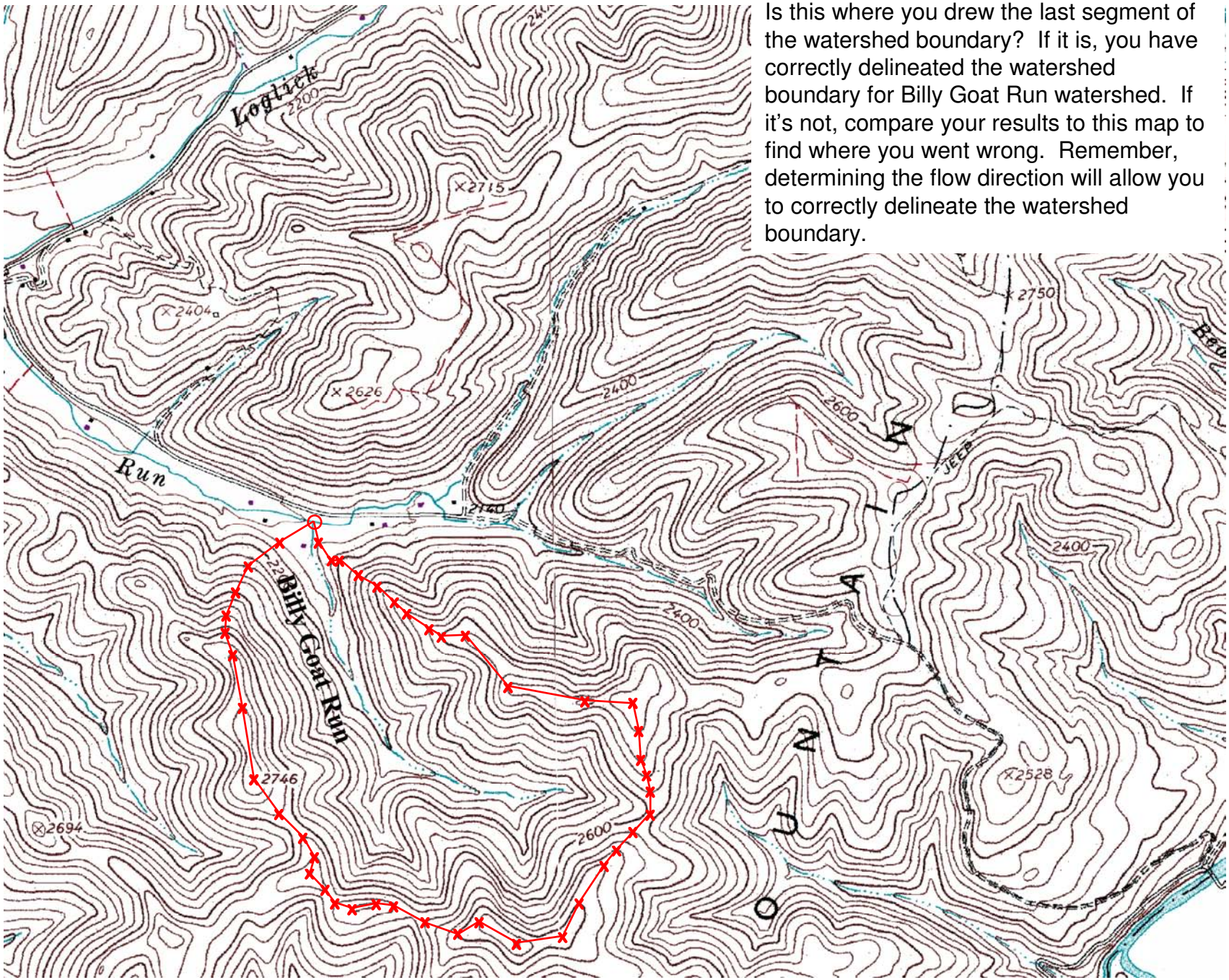


Just to make things clearer, let's join the X's to see what the boundary looks like so far.

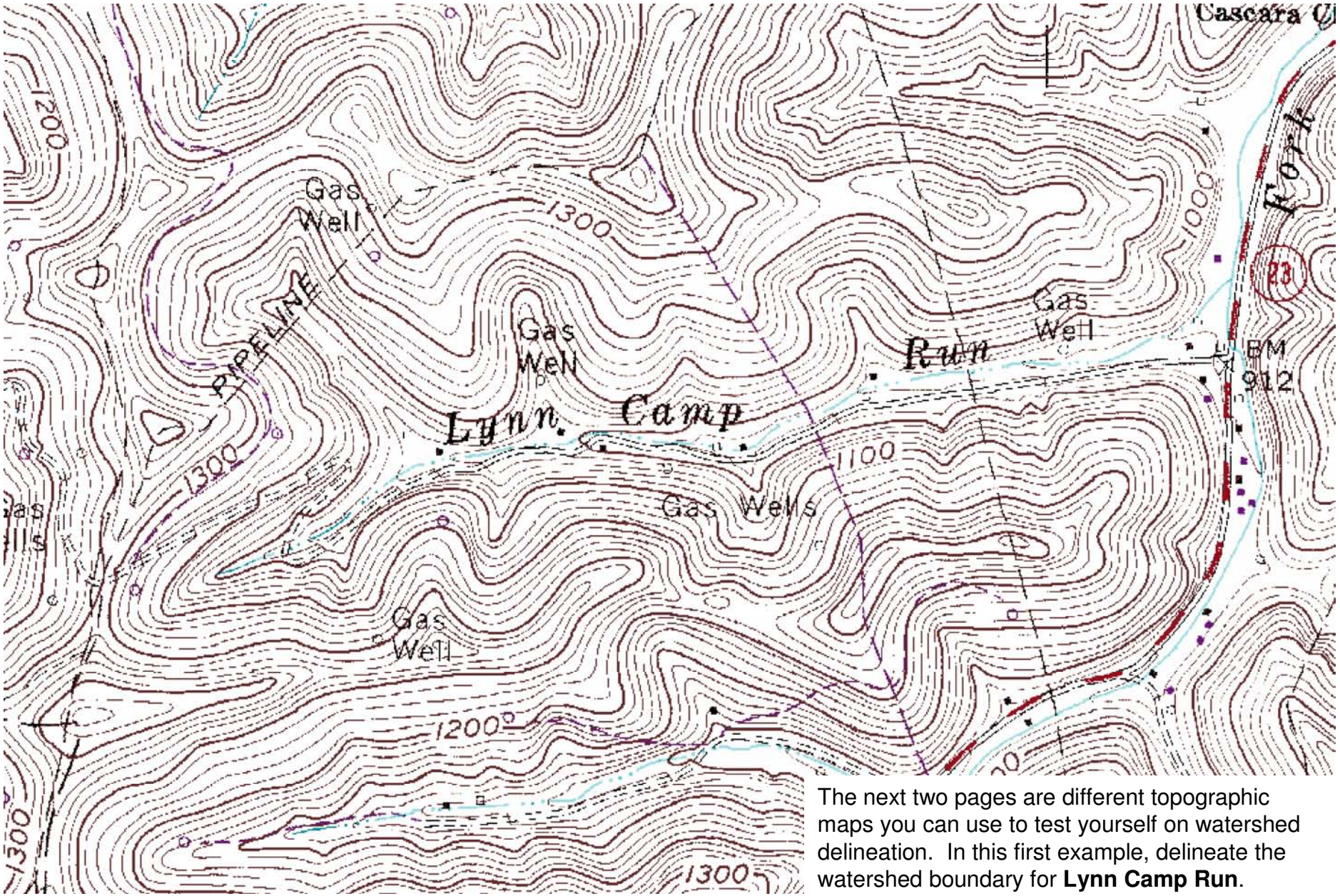
Now that you've gotten this far, look at the contour lines for the remaining portion of the watershed delineation. You should be able to see generally where you should be going. Do you see the circles within circles, saddles, and bulges in the contour lines? Use these to estimate the direction you should be going, and remember to check the direction of flow.

As you proceed along the ridgeline ***toward the confluence***, pay close attention to the direction of water flow. Remember you want the water to flow into the watershed and not to overshoot the confluence point.

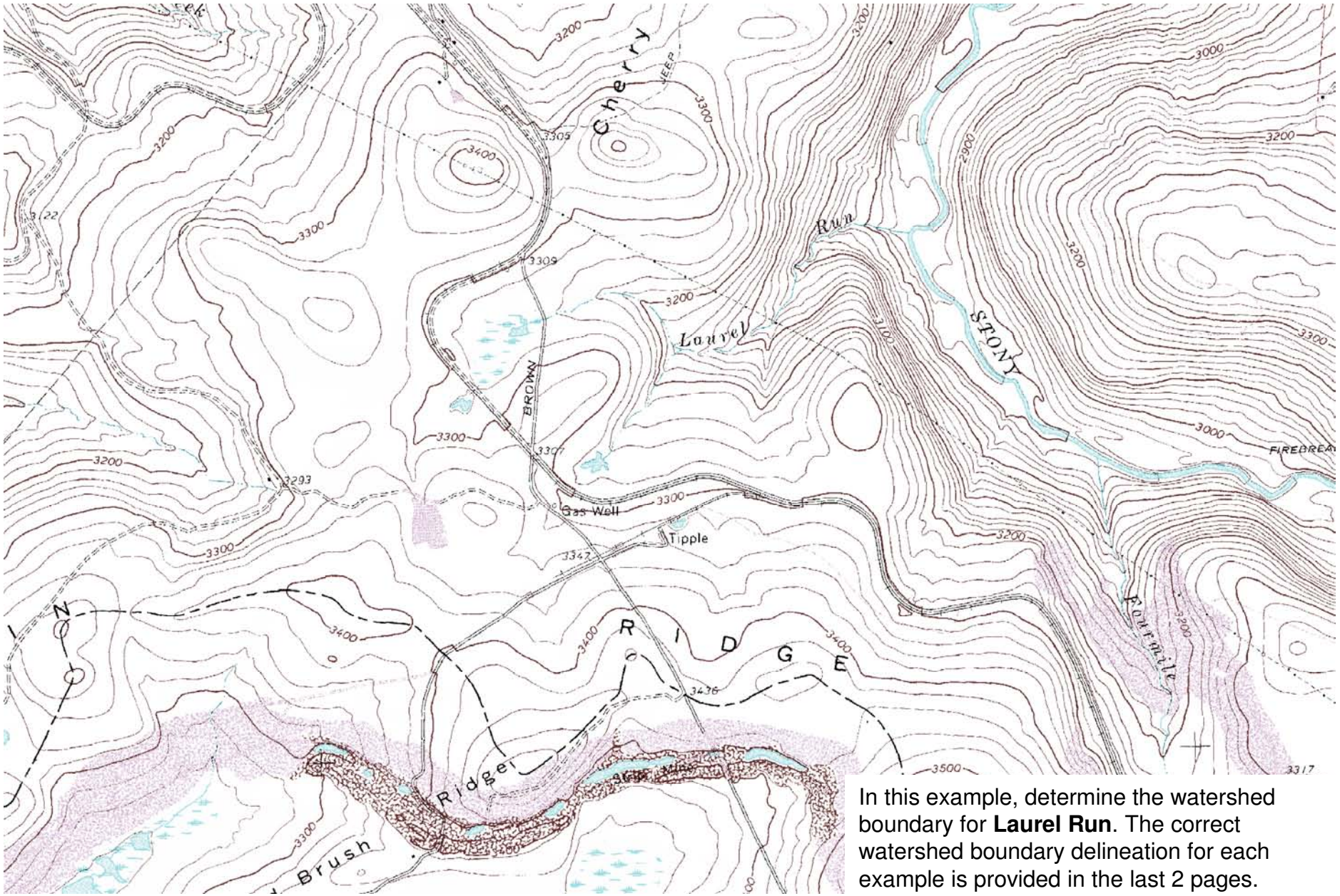




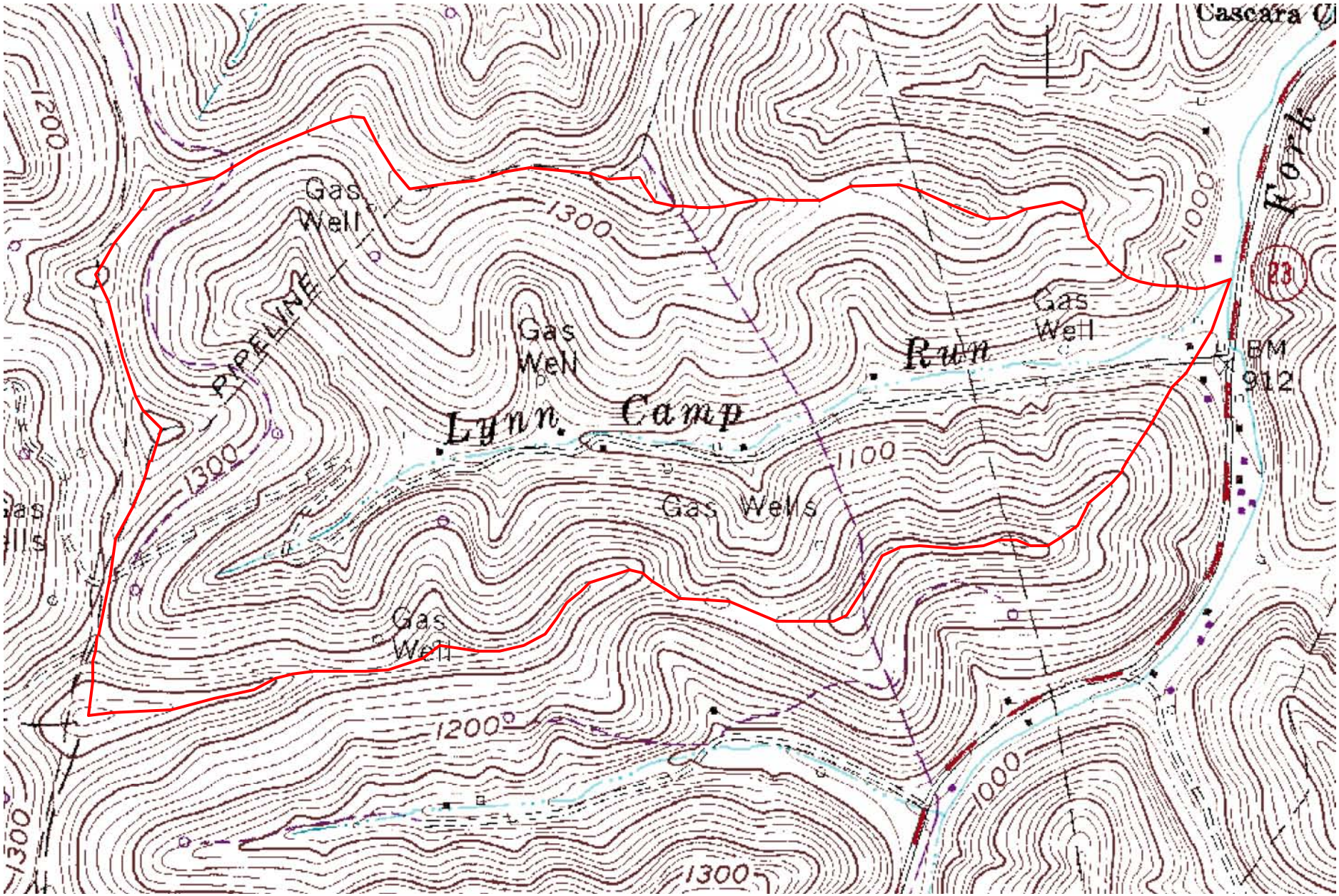
Is this where you drew the last segment of the watershed boundary? If it is, you have correctly delineated the watershed boundary for Billy Goat Run watershed. If it's not, compare your results to this map to find where you went wrong. Remember, determining the flow direction will allow you to correctly delineate the watershed boundary.

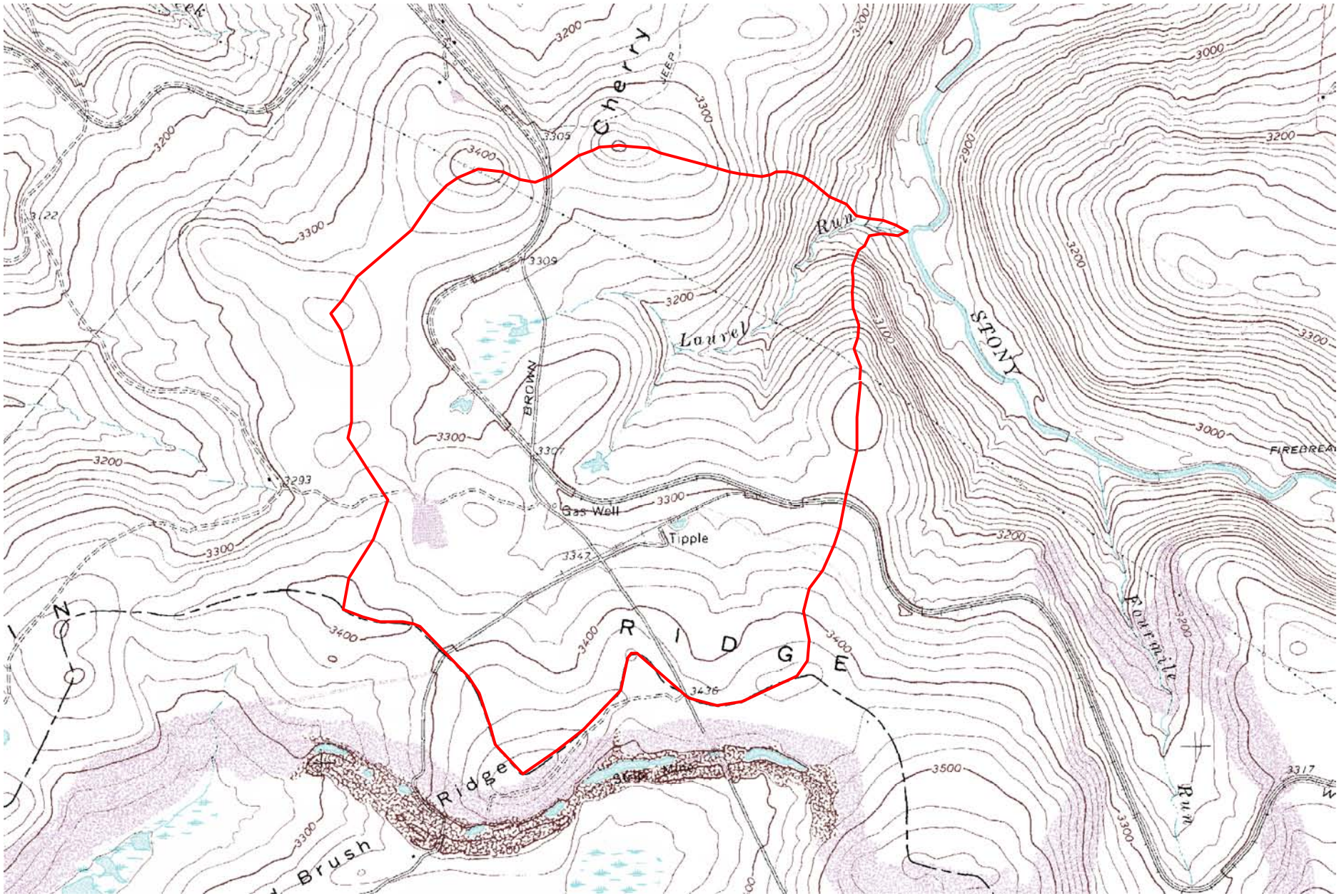


The next two pages are different topographic maps you can use to test yourself on watershed delineation. In this first example, delineate the watershed boundary for **Lynn Camp Run**.



In this example, determine the watershed boundary for **Laurel Run**. The correct watershed boundary delineation for each example is provided in the last 2 pages.


Cascara C
1200
1300
Gas Well
Gas Well
Gas Well
Gas Well
Pipeline
Lynn Camp Run
Gas Wells
1100
1000
BM 912
23
1200
1300
1000
1300
Gas Well


Cherry
Run
Laurel
STONY
BROWN
Gas Well
Tipple
RIDGE
Ridge
Brush
Run
3200
3300
3400
3000
3500
3305
3309
3293
3347
3436
3317