Natural Resource Protection Act (NRPA) Identification Guide for Rivers, Streams, and Brooks

Babel Brook, Ebeemee TWP

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION
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http://www.maine.gov/dep/

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Contact Information for Assistance

Ask for the land resource person that is on-call

Central Maine Office (Augusta): 207-287-7688, 800-452-1942

Southern Maine Office (Portland): 207-822-6300, 888-769-1036

Eastern Maine (Bangor): 207-941-4570, 888-769-1137

Northern Maine (Presque Isle): 207-764-0477, 888-769-1053

DISCLAIMER:

This manual is intended to be a guidance document for the identification of rivers, streams and brooks. The manual is also intended to assist developers and the regulated community in complying with existing state laws and regulations. The information outlined in this guidance manual supplements the requirements stated in the Maine Natural Resources Protection Act and cannot overrule regulatory requirements.

This manual is not intended to be an all-inclusive source of information, as identification of rivers, streams and brooks is an evolving and developing science, and each site is unique. However, to provide satisfactory and consistent results, the regulated community should adhere to the basic principles and guidelines of the Maine Natural Resources Protection Act.

The Department reserves the right and discretion to vary from this guidance and approve, on a case-by-case basis, analyses that are warranted by site conditions or are based on new techniques or procedures if the proposed system or design meets the requirements of the Maine Natural Resources Protection Act.

Contents

Appendices

Introduction

Maine is fortunate to have many high-quality streams and rivers. Maine's streams and rivers support an amazing diversity of aquatic life. Popular game fish, such as brook trout, land-locked Atlantic salmon, and smallmouth bass may immediately come to mind; however, more than 40 species of fish can be found in Maine's streams and rivers. In addition to fish, the Department of Environmental Protection (DEP) has identified more than 800 different kinds of benthic macroinvertebrates in Maine's streams and rivers. Benthic macroinvertebrates are animals that live on the bottom of streams and rivers (benthic), can be seen without magnification (macro), and do not have back bones (invertebrates). Many other species of plants, algae, amphibians, reptiles, birds, and mammals live in or otherwise utilize Maine's streams and rivers. Many species of fish and other aquatic life are only found in small streams. Cumulatively, there is more aquatic life in Maine's small streams than in its rivers.

Although streams and brooks can be small, they serve as the life blood of larger waters. Ecological processes in small streams help maintain the quantity and quality of water to downstream waterbodies. Headwater streams help remove pollution, prevent floods, and recharge groundwater supplies. Some aquatic life in streams drift downstream and become an important source of food for other animals. One of the best ways to keep Maine's lakes, rivers, and estuaries healthy is to keep the streams healthy.

Maine's Natural Resource Protection Act (NRPA) requires the DEP to issue permits for activities that may alter river, stream or brooks. Streams and brooks are interchangeable terms with the same meaning. It is obvious to most people when an activity involves a river or trout stream, but there can be some confusion over some small streams and brooks. Figure 1 includes the NRPA definition of "River, stream or brook". It is important to note that this guidance documents applies only to identifying streams, rivers or brooks as defined in the NRPA, not the shoreland zoning law or other laws. To qualify as a river, stream, or brook, a water feature must have a defined channel. In addition, the water feature must have two or more characteristics that are described in the definition. Ditches and other drainage ways constructed to convey storm water are not considered rivers, streams, or brooks under NRPA.

Purpose

The purpose of this document is to provide the regulated community with guidance on identifying rivers, streams, and brooks as defined by the NRPA. Definitions can be found in corresponding Department rules or statutes. This is not intended to act as a rule or have any authority of enforcement; it is only a guide to assist the laymen in understanding the Department's methods of identification of a river, stream, or brook as defined by the NRPA.

Title 38: WATERS AND NAVIGATION

Chapter 3: PROTECTION AND IMPROVEMENT OF WATERS

Subchapter 1: ENVIRONMENTAL PROTECTION BOARD

Article 5-A: NATURAL RESOURCES PROTECTION ACT

§480-B Definitions

9. River, stream or brook. "River, stream or brook" means a channel between defined banks. A channel is created by the action of surface water and has 2 or more of the following characteristics.

A. It is depicted as a solid or broken blue line on the most recent edition of the U.S. Geological Survey 7.5-minute series topographic map or, if that is not available, a 15-minute series topographic map. [1995, c. 92, §2 (NEW).]

B. It contains or is known to contain flowing water continuously for a period of at least 6 months of the year in most years. [2001, c. 618, §1 (AMD).]

C. The channel bed is primarily composed of mineral material such as sand and gravel, parent material or bedrock that has been deposited or scoured by water. [1995, c. 92, §2 (NEW).]

D. The channel contains aquatic animals such as fish, aquatic insects or mollusks in the water or, if no surface water is present, within the stream bed. [1995, c. 92, §2 (NEW).]

E. The channel contains aquatic vegetation and is essentially devoid of upland vegetation. [1995, c. 92, §2 (NEW).]

"River, stream or brook" does not mean a ditch or other drainage way constructed, or constructed and maintained, solely for the purpose of draining storm water or a grassy swale. [2001, c. 618, §1 (AMD) .]

Figure 1. NRPA statutory definition of River, stream or brook.

(http://www.mainelegislature.org/legis/statutes/38/title38sec480-B.html)

River, Stream, and Brook Channels

River, stream, and brook channels are linear features with defined banks that contain flowing water at least part of the year. Stream channels may be dry during parts of the year. Small, headwater streams may have intermittent flow and dry up every summer. Larger streams may dry up only during droughts. Stream channels are created and reshaped by flowing water. Rivers, streams, and brooks are that that are altered or relocated by human activities are still rivers, streams, and brooks.

Stream channels come in many shapes and sizes depending on their location in the landscape. The transition from a stream bank to an adjacent upland is often clearly evident (Figure 2). Often, there is a change of slope where the more vertical stream bank meets the more horizontal upland. The change in slope is normally accompanied by a change of substrate material, topsoil, vegetation, and leaf litter. One exception is when large rock is part of the stream bank. In that case, instead of a change of slope, the water level varies up and down the rock. In these cases, water staining and lack of moss or lichens may be evident on the side of the rock where it is periodically submerged. In contrast, some streams in flat landscapes have less clearly defined stream banks (Figure 3). The transitions between stream channels and neighboring wetlands or floodplains may be less distinct. There still may be a change of substrate and/or vegetation, however. Some streams flowing through wetlands may only be apparent during low flow or if one wades into the wetland.

Figure 2. Stream channel showing a distinct change of slope where the stream bank transitions to the floodplain

Figure 3. Small stream channel showing a less distinct change of slope where the stream bank transitions to the wetland

Challenging Situations (see Case Studies in Appendix 4)

- *Altered or relocated streams* – Some streams have been intentionally or unintentionally modified or relocated by people. For example, some streams are diverted into drainage ways along roads or developed areas. Some stream channels have been straightened or armored with large rocks, called riprap. Also, soil disturbance can unintentionally modify or relocate streams. Altered or relocated channels qualify as streams or brooks for NRPA purposes if they have 2 or more of the 5 characteristics of a NRPA streams (e.g., case studies 10, 11, 14, and 15).
- *Streams that originate from a culvert* – Some streams originate from culverts because past development buried or piped headwater streams, seeps, or wetlands. A channel originating from a culvert would qualify as a stream or brook for NRPA purposes if there is enough flowing water to maintain a channel further downstream away from the culvert opening or it has a downstream connection to another waterbody. They also must have 2 or more of the 5 characteristics of a NRPA stream (e.g., case studies 10 and 17. These channels would be considered altered or relocated streams. In contrast, a channel originating from a culvert would not qualify as a stream or brook for NRPA purposes if the channel dissipates quickly into uplands (e.g., case study 18). Also, a channel downstream of a culvert would not qualify as a stream or brook for NRPA purposes if there was documentation showing that the channel was made by people and was not an alteration of a stream or brook. Some created channels naturalize, are reshaped over time by flowing water, and would qualify as NRPA streams and brooks.
- *Braided channel* – Instead of having a single channel, some streams and rivers flow through more than one interconnected channel, called braided channels. Some streams and rivers flowing through flat landscapes may naturally form braided channels. In other

cases, braided channels may be a sign of degradation caused by altered stream flow, especially during floods. Braided channels are still considered rivers, streams, or brooks for NRPA purposes if they have 2 or more of the 5 characteristics (e.g., case study 21H).

- *Dry channels* – As mentioned earlier, streams do not need continuously flowing water to be considered a stream or brook for NRPA purposes. Dry channels would be streams or brooks if they have 2 or more of the 5 characteristics (e.g., case study 9).
- *Underground streams* – Some streams may switch back and forth between flowing above ground and flowing underground. Stream segments that flow underground do not have defined channels as defined by NRPA. The above ground segments do qualify as stream or brooks (e.g., case study 5). When a stream flows underground, it is important to look upstream and/or downstream for other above ground stream segments.
- *Tiny streams* – Some headwater streams may be very small; too small to have fish in them. They may be shallow and only several inches wide. Despite their small size, they are ecologically important as they can be homes to many species of macroinvertebrates. Instead of fish, salamanders occupy the role of top predators in tiny streams. Tiny stream channels are still considered streams or brooks under NRPA if they have 2 or more of the 5 characteristics (e.g., case studies 2 and 4).
- *Channels within wetlands* – Some streams spread out when they cross a flat area and form wetlands. If a wetland has an inlet or outlet stream, then a channel may pass through the wetland. Sometimes channels are more easily seen with aerial photography than when standing on the edge of the wetland. The channel may not be obvious, especially when water levels are high or when obscured by plants. There is no substitute for putting on a pair of boots or waders and searching for a channel. Channels within wetlands qualify as NRPA streams if they have 2 or more of the 5 characteristics (e.g., case study 8).
- *Impounded streams* – Stream segments that are impounded by beavers or people retain protection afforded to the original stream segment under NRPA, including inlets, outlets, and impoundments less than 30 acres in size (e.g., case studies 19 and 20).

Characteristic A. Blue line on 7.5-minute topographic map

This is one of the five criteria under NRPA and only two are needed to identify a stream.

A 7.5-minute map is the standard topographic map with a 1:24,000 scale made by the U. S. Geological Survey. These maps are provided on *The National Map Viewer* (https://viewer.nationalmap.gov/viewer/). Also, maps can be downloaded or purchased (https://www.usgs.gov/faqs/how-can-i-purchase-a-topographic-map). Digital copies of historic maps dating back to 1892 are available from the University of New Hampshire (http://docs.unh.edu/nhtopos/nhtopos.htm). Historic maps tend to show more streams than recent maps. To meet this criterion, the stream or river must appear on a map as a solid or

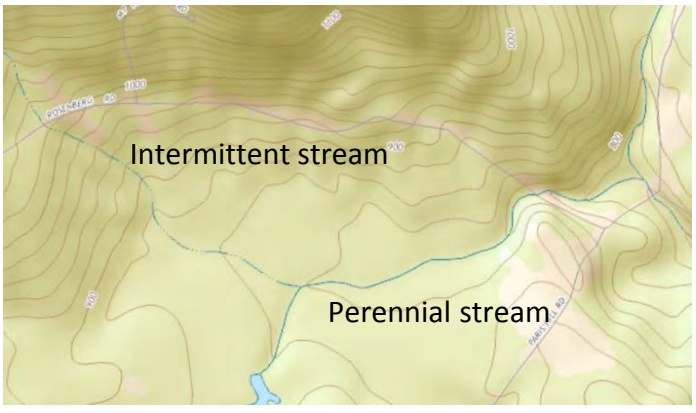

Figure 4. Solid and broken lines on 7.5-minute USGS topographic map representing perennial and intermittent streams, respectively

broken line (Figure 4). Solid lines represent perennial streams. Broken lines represent intermittent streams that may dry up. It is worth noting that many headwater streams do not appear on topographic maps, but the location of their channels may appear as U-shapes in elevation contours, which point uphill (Figure 4 – Intermittent Channel). Rarely, some channels that are mapped as streams do not meet two or more other criteria and therefore are not considered streams or brooks under the NRPA.

Characteristic B. Continuous flow for at least 6 months in most years

This is one of the five criteria of which two are needed to identify a stream.

To meet this criterion, one must document that a stream has continual flow for at least six months. Maine's streams and rivers have a range of flow duration. Larger streams and rivers flow continuously, even under winter ice. Some streams may dry up during the summer, but flow in the fall, winter, and spring. Some headwater streams may freeze solid in the winter and may only flow from late winter to early summer. One way to identify that a stream meets this criterion is to periodically visit the stream and document flowing water. Beneficial evidence may include date stamped images. Alternatively, one could use data loggers or remote cameras to periodically collect supporting evidence. Although this is a straight forward criterion, it may take the longest to investigate.

Characteristic C. Channel bed composed of mineral material

This is one of the five criteria of which two are needed to identify a stream.

To meet this criterion, a stream must have a channel bed primarily composed of mineral material. The mineral material may be scoured and exposed by flowing water. In other cases, flowing water may deposit mineral material that was carried from upstream. Mineral materials range in size from bedrock to boulder, cobble, sand, silt, and clay (Figure 5). Substrates primarily composed of thick layers of leaves, decaying plant parts, or peat moss would not qualify as mineral material for NRPA purposes.

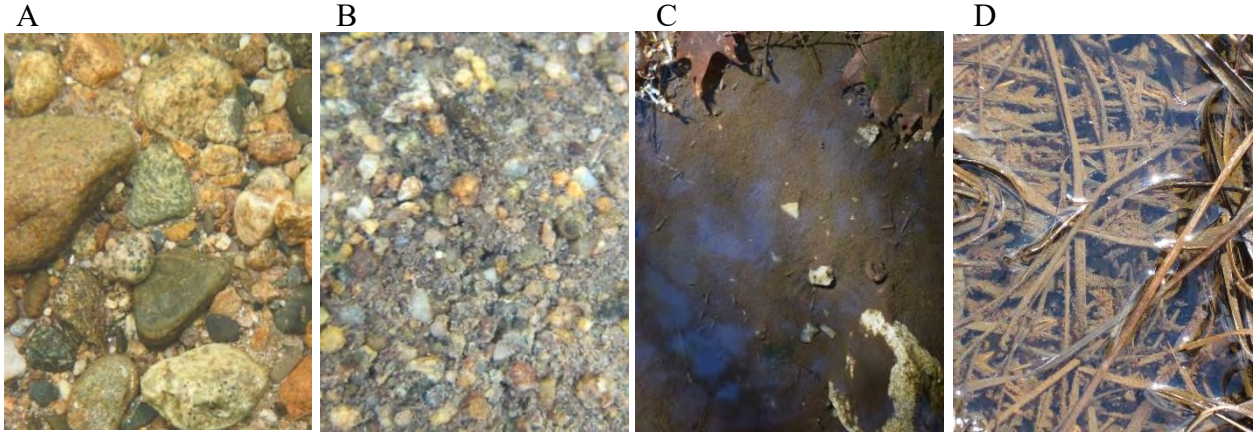

Figure 5. Examples of mineral substrate including (A) cobble and gravel, (B) coarse sand, and (C) mud, composed of sand and silt with some organic matter. Example of an organic substrate composed of a thick layer of decomposing plants (D).

Challenging Situations

- *Mud substrates* – The bottoms of some streams located in flat areas are muddy. These qualify as channel beds made of mineral material because mud is primarily composed of sand, silt, and/or clay. For muddy areas without defined channels, it is important to search up and down gradient for channels.
- *Bedrock substrate* – Stream channels that have eroded down to bedrock qualify as channel beds made of mineral material.
- *Thin layers of leaves or plants*– In the autumn, leaves may fall into small streams and stay in place until a large storm removes them. In this case, it is important to identify what is under the leaves or plants to see the channel substrate. If the substrate underneath looks like the substrate in neighboring uplands, then it may not be a channel bed formed by the stream. If the substrate shows signs of erosion or deposited mineral particles, then it would meet the criterion of a channel bed composed of mineral material.

Characteristic D. Aquatic animals

This is one of the five criteria of which two are needed to identify a stream.

The most common aquatic animals in streams and rivers are fish (Appendix 1), salamanders (Appendix 2), and macroinvertebrates (Appendix 3). The presence of any kind of aquatic animals meets this criterion.

Fish

In small streams, the most common fish are likely to be brook trout and blacknose dace (Appendix 1). These species sometimes swim upstream into headwaters and then return downstream later in the year. As a result, fish may be present in streams that are less than a foot wide. Other fish, such as creek chub, white sucker, or the four stickleback species (brook, fourspine, threespine, ninespine) may be present, depending on where the stream is located. Observing fish satisfies this criterion as does the use of a minnow trap to catch and identify fish. **Before collecting any fish, contact Inland Fisheries & Wildlife to determine if a permit is necessary.**

Salamanders

Three species of salamanders could be found in Maine's streams (Appendix 2). The most common salamander is the northern two-lined salamander. The two-lined salamander has a golden stomach, yellowish-brown back, and two dark stripes that run down the back. They are slender and have long tails. In contrast, the northern dusky salamander has a light grey stomach and darker grey or brown back, sometimes with lighter flecks of color. The northern dusky salamander is stouter and has a shorter tail than the two-lined salamander. Both species are referred to as "brook salamanders" because they live in streams. They often hide under rocks and logs during the day. They may forage along the edge of the stream at night. The two-lined salamander can be found statewide and the northern dusky salamander can be found in all but the northern tip of Maine. The third species is the spring salamander. It has a large, stout, orange body with black flecks on the back. It inhabits springs, seeps, and streams with cold water. The spring salamander is found in the hills and mountains of southwest Maine. To search for salamanders, flip over rocks in the stream and along the stream edge. It is important to put rocks back in the same places. All three of these salamanders have no lungs and "breath" through their

skin. Always keep your hands clean and wet when handling salamanders to protect their sensitive skin.

Macroinvertebrates

Searching for macroinvertebrates requires patience and attention to detail. Macroinvertebrates are a diverse group of animals, such as crayfish, snails, mussels, worms, leaches, mayflies, stoneflies, caddisflies, blackflies, beetles, and water bugs (Appendix 3). Many species are quite small and some are camouflaged. Also, some macroinvertebrates live in "homes" and won't look like insects. Some make portable cases and others make silken tubes to dwell in. Some small streams naturally have low abundances of macroinvertebrates because of low amounts of nutrients in the water. This is a timely process that could take 20 minutes or longer.

Before looking for macroinvertebrates, it can be helpful to assemble a tool kit including the following items:

- camera for documenting the site and macroinvertebrates
- small aquarium net
- magnifying lens
- small white tray
- forceps or tweezers for picking up organisms
- plastic spoon for scooping up organisms
- plastic pipette for sucking up organisms
- pad for kneeling
- vial for saving organisms
- rubbing alcohol for preserving organisms
- non-chlorinated water (for dry streams)
- sift with fine mesh (for dry streams)
- small shovel or trowel (for dry streams)

Many aquatic insects have adult forms that can fly, such as dragonflies, mayflies, stoneflies, caddisflies, and true flies (Dipterans). The adult flying insects may be found near water, but are considered terrestrial and would not count toward meeting the Aquatic Animals criterion. There are some beetles and true bugs that have both aquatic larvae and aquatic adults (even though they can fly too). For example, water striders, water boatmen, backswimmers, water scavenger beetles, and predaceous water beetles all have aquatic larvae and adults. The adult macroinvertebrates that are adapted for life in or on the water would count toward meeting the Aquatic Animals criterion.

Some aquatic macroinvertebrates are more commonly found in streams with rocky substrate. Other aquatic macroinvertebrates are more commonly found in wetlands or low gradient streams with sandy or mucky bottoms. In either case, any aquatic macroinvertebrates count toward meeting the Aquatic Animals criterion.

Some aquatic macroinvertebrates are adapted for life in streams that dry up. Some live underground where there is still water. Others wait out the dry summer period in the form of an egg or pupa and colonize the stream again in the fall or spring when the water returns.

Rocks

One way to search for macroinvertebrates is inspect rocks that lay on the bottom of the stream, especially rocks resting on other rocks so there are spaces between them. Macroinvertebrates can be found on the top, sides, or underneath rocks. Some will crawl and some may stay in one place. Place the aquarium net downstream of the rock. Pick up the rock and place it in the white tray with some water while catching any disturbed debris or organisms with the net. Place material from the net into the tray. Examine all sides of the rock for moving organisms and ones that may live in a case or tube. Wash the rock in the stream water and look for organisms moving in the water.

Leaf packs

Leaf packs are a great place to look for macroinvertebrates. Some kinds of macroinvertebrates eat the thin layer of bacteria and algae that grow on decaying leaves. Pick up a few leaves from the stream and transfer them to the tray with a little water. It is easier to work with a few leaves at a time than a handful of leaves. Remove one leaf at a time from the tray, inspect the leaf, and rinse it with water. Look for movement on the leaves and in the water in the tray.

Sand and mud

Searching for macroinvertebrates in sand, silt, or mud can be more difficult. Before disturbing the substrate, spend a little time watching the surface and looking for movement. Sometimes organisms are visible crawling or swimming over the surface. After searching, gently disturb the surface of the substrate while holding the net downstream. Place the contents of the net into the tray with some water and look for moving or camouflaged organisms. If no organisms are observed at this point, take a small scoop or pinch of the substrate and add it to a white tray with some clean water. Agitate the contents of the tray and look for organisms swimming in the opposite direction of the moving water. Let the contents of the tray settle and then look for moving or camouflaged organisms. Only take small amounts of the substrate at a time to prevent the water in the tray from getting too cloudy and to prevent having too many places for organisms to hide.

Dry channel

Searching for macroinvertebrates can be challenging when there is no water in a potential stream. Many headwater streams dry up in the summer or during droughts. Evidence of macroinvertebrates in a dry channel satisfies the Aquatic Animals criterion. Look for caddisfly cases that might be attached to rocks and look for snail or fingernail clam shells on the substrate. Walk up and downstream focusing efforts on remnant pools or wet patches. Dig up small amounts of damp sediment and put it in a tray with some clean bottled water (not chlorinated). Look for movement and camouflaged organisms. If no organisms are observed at this point, try sifting dry sediment looking for cases and shells. This is a timely process that could take 20 minutes or longer.

Characteristic E. Aquatic Vegetation

This is one of the five criteria under NRPA and only two are needed to identify a stream.

To meet this criterion, a stream channel would have some aquatic plants and would be essentially devoid of upland vegetation. For purposes of NRPA, DEP defines aquatic vegetation as plants

that usually grow on or below the surface of the water for most of the growing season in most years. Aquatic plants may have submerged, floating, floating-leaved, or emergent growth forms. Pondweeds and milfoils are examples of submerged plants and duckweed is a floating plant. Yellow water lily is an example of floating-leaved plants. Pickerelweed is an example of aquatic plants with emergent leaves. Water moss (*Fontinalis sp.*) is an example of an aquatic moss. For help with species identification, visit the Go Botany website maintained by the New England Wild Flower Society (https://gobotany.newenglandwild.org/).

Constructed Drainage Ditch or Grassy Swale

The definition of NRPA rivers, streams, and brooks excludes ditches, grassy swales, and other channels that are created solely for the purpose of draining stormwater. Figure 5 shows examples of constructed channels that are not NRPA streams, including a roadside ditch and a grassy swale. If the bottom of the constructed drainage way has minimal erosion and is primarily covered by upland vegetation, then it is not a NRPA stream (e.g., case study 16). Similarly, a channel with defined banks and a mineral bottom would not be a NRPA stream if the channel was created solely for conveying stormwater and was not an altered or relocated stream or brook (e.g., case studies 12 and 13).

In contrast, some drainage ways that may look like ditches are NRPA streams if they convey more than stormwater. To determine if a ditch/swale/drainage way is part of a NRPA stream, one needs to walk upstream and find the source of the water. A drainage way would be considered an altered stream segment if it connects to an upstream waterbody, such as a stream, spring, wetland, or pond. Stream segments that have been altered or relocated by human activities remain NRPA streams or brooks (e.g., case studies 10 and 11), therefore stream segments that have been diverted into roadside drainage features are still NRPA streams (e.g., case studies 14 and 15). Also, some drainage ways originating from culverts are NRPA streams if they are altered streams or brooks. This sometimes occurs where the headwaters of a stream were buried or piped (e.g., case study 17). In contrast, a drainage originating from a culvert would not be a NRPA stream if the only source of water is stormwater (e.g., case study 18).

Figure 5. Examples of a drainage ditch and a grassy swale

Appendix 1. Fish found in small streams

Blacknose dace

Creek chub

Brook trout

Ninespine stickleback

Threespine stickleback

Brook stickleback

Fourspine stickleback

Appendix 2. Salamanders found in small streams

ADULTS LARVAE

Northern two-lined salamander

© Jason Poston, paherps.com

© Carl Brune, Ohio University

Northern dusky salamander (range in color from brown to almost black)

© Jason Poston, paherps.com

© Carl Brune, Ohio University

Northern spring salamander (range in color from orange to grey)

© Carl Brune, Ohio University

© Carl Brune, Ohio University

Appendix 3. Examples of some aquatic macroinvertebrates found in small streams

Section 1: Macroinvertebrates without legs

Section 2: Macroinvertebrates with 10 legs

Section 3: Macroinvertebrates with 8 legs

Section 4: Aquatic insect larvae with 6 legs and aquatic adults with wings

Section 5: Aquatic insect larvae with 6 legs (terrestrial adults)

Section 6: Aquatic insect larvae without legs (terrestrial adults)

IMPORTANT NOTES

1. This provides examples of the major groups of aquatic macroinvertebrates. There are **many** different kinds in a variety of shapes and sizes that are not represented in this appendix.

2. Some aquatic macroinvertebrates build "homes" in the form of tubes or cases. Look for these as well as free living macroinvertebrates.

3. Aquatic macroinvertebrates are quite small when they hatch from eggs. They will increase in size as they grow. Some remain quite small. Be prepared to look for tiny creatures.

4. Most of the images used in this appendix are from Bug Guide (http://bugguide.net) and used with permission of the photographers. Do not reproduce the images without their permission. The images in this appendix are not shown to scale.

ADDITIONAL RESOURCES

Voshell Jr., J. R. 2002. *Guide to Common Freshwater Invertebrates of North America.* The McDonald & Woodward Publishing Company, Blacksburg, VA.

Stroud Water Research Center (http://www.stroudcenter.org/education/MacroKeyPage1.shtm)

Website with various links… (http://www.dep.wv.gov/wwe/getinvolved/sos/pages/macros.aspx)

SECTION 1: MACROINVERTEBRATES WITHOUT LEGS

SNAILS

© Great Lakes Environmental Research Laboratory

LIMPETS

© Freshwater Gastropods of North America

MUSSELS

© Kurt Stepnitz

FINGERNAIL CLAMS

© G & Ph Poppe

AQUATIC WORMS

© ANEBO

LEECHES

© Aphotofauna

PLANARIA

© Eduard Solà

SECTION 2: MACROINVERTEBRATES WITH 10 LEGS

CRAYFISH, ISOPODS, AND AMPHIPODS

© Kerry Yurewicz

© Thomas Palmer

© Biodiversity Institute of Ontario

SECTION 3: MACROINVERTEBRATES WITH 8 LEGS

MITES

© Stephen Luk

© Stephen Luk

© Stephen Luk

SECTION 3: AQUATIC INSECT LARVAE WITH 6 LEGS AND AQUATIC ADULTS WITH WINGS

PREDACEOUS DIVING BEETLE (ADULTS & LARVA)

© Tom Murray

© Brandon Woo

© Brandon Woo

WHIRLIGIG BEETLE (ADULT & LARVA)

© Joyce Gross

© Tom Murray

RIFFLE BEETLE (ADULT & LARVA)

© MJ Hatfield

© Tom Murray

CREEPING WATER BEETLE (ADULT & LARVA)

© Mike Quinn

© Salvador Vintanza

WATER CRAWLING BEETLE

© Stephen Luk

SECTION 3: ADULT INSECTS WITH 6 LEGS AND WINGS (continued)

MICRO WATER STRIDERS

© Jennifer Forman Orth

WATER STRIDER

© Richard Wolfert

CRAWLING WATER BUGS

© Tom Murray

GIANT WATER BUGS

© Brandon Woo

WATER BOATMEN

© Brandon Woo

WATER SCORPIONS

© Drew Fulton

BACKSWIMMERS

© Tom Murray

© Tom Murray

SECTION 4: AQUATIC INSECT LARVAE WITH 6 LEGS (TERRESTRIAL ADULTS)

MAYFLIES (usually 3 thin tails (rarely 2) and gills on abdomen)

© Tom Murray

© Tom Murray

© Tom Murray

STONEFLIES (2 tails and usually no gills on abdomen)

© Tom Murray

© Tom Murray

© Tom Murray

DRAGONFLIES

© Tom Murra

© Tom Murray

© Tom Murray

DAMSELFLIES (3 leaf-like gills that look like tails)

© Robert Kotzer © Jason Neuswanger

SECTION 4: AQUATIC INSECT LARVAE WITH 6 LEGS (TERRESTRIAL ADULTS) (continued)

CADDISFLIES (Grub-like with 6 legs, some make portable homes called cases)

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© Tom Murray

© Mark Melton

© Don Chandler

© Robert Henricks

© Robert Henricks

DOBSONFLY and FISHFLY

© Stephen Luk

© Tom Murray

SECTION 5: AQUATIC INSECT LARVAE WITHOUT LEGS (TERRESTRIAL ADULTS)

MIDGES (CHIRONOMIDS)

© Tom Murray

© Robert Henricks

silken tube of a species of midge

© Stephen Luk

CRANEFLY

© Stephen Luk

HORSEFLY

© Jim Moore

BLACKFLY

© Tom Murray

BITING MIDGE

© Stephen Luk

Appendix 4. Case studies

1. Perennial stream
2. Intermittent drainage #1
3. Intermittent drainage #2
4. Intermittent drainage #3
5. Stream that goes above and below ground
6. Stream that changes to a wetland and then back
7. A marsh without a channel
8. A marsh with a channel
9. Dry channel
10. Relocated stream that originates from a culvert
11. Relocated stream alongside a road
12. Roadside drainage #1
13. Roadside drainage #2
14. Roadside drainage #3
15. Roadside drainage #4
16. Grassy swale
17. Channel originating from a culvert #1
18. Channel originating from a culvert #2
19. Impounded stream #1
20. Impounded stream #2
21. Complex site in a natural landscape
22. Complex site in a modified landscape

Yellow lines are added to some images to show the location of channel banks.

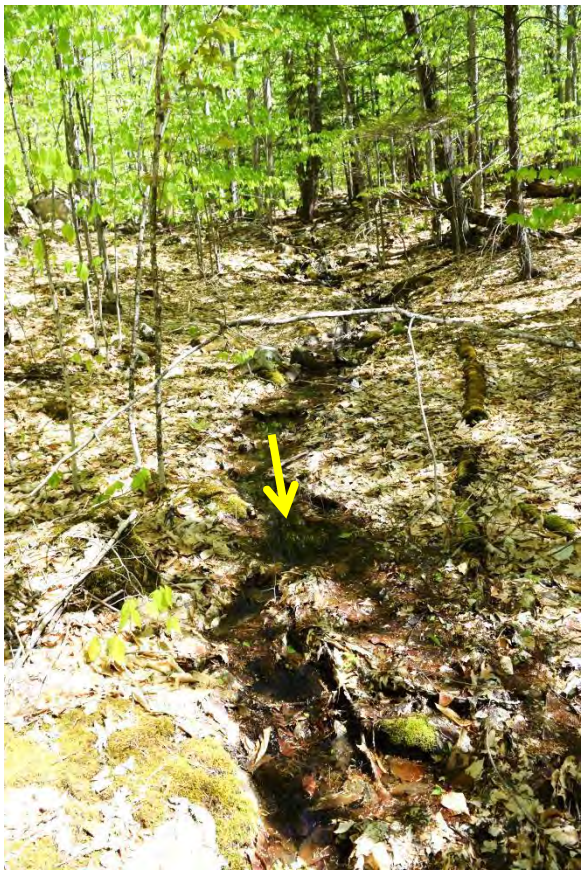
Yellow arrows are added to some images to show the direction of water flow.

Case Study 1 – Perennial stream

Criteria		Evidence
Channel	✓	Clearly defined channel and banks (2-3 feet wide)
A. Mineral channel bed	✓	Composed of rocks and sand
B. Blue line on topographic map	✓	Solid line
C. Continuous flow for 6 months	✓	Only stops flowing during droughts
D. Aquatic life	✓	Many different kinds of aquatic macroinvertebrates and a two-lined salamander were observed
E. Aquatic vegetation	×	None
Conclusion	✓	It has a defined channel and meets 4 of the 5 other criteria. It is a NRPA stream.

Case Study 2 – Intermittent drainage #1

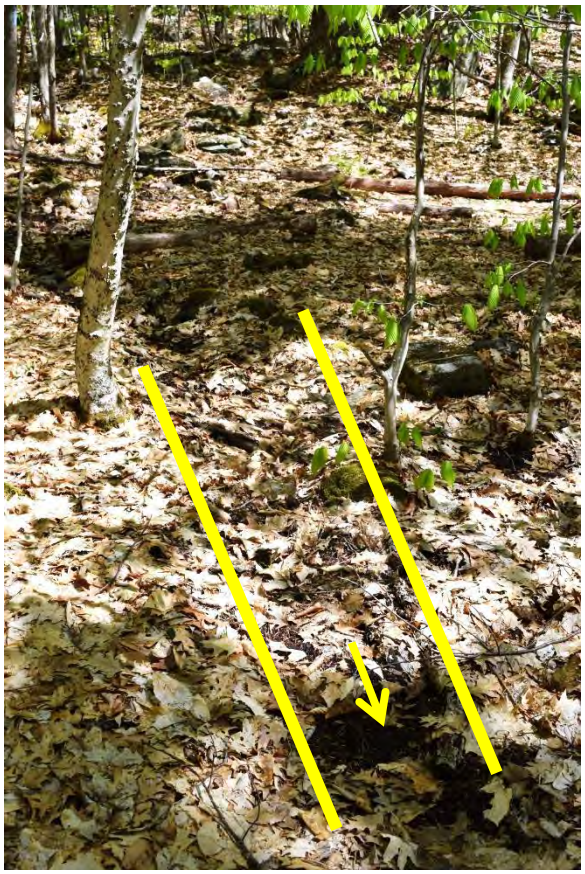
A



B

Criteria		Evidence
Channel	✓	Narrow channel with defined banks (3-8” wide, <1” deep in most places) (A)
A. Mineral channel bed	✓	Composed of sand, silt, and rocks (B)
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	--	Not evaluated
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates and a two-lined salamander were observed
E. Aquatic vegetation	×	None
Conclusion	✓	It has a defined channel and meets 2 of the 5 other criteria. It is a NRPA stream.

Case Study 3 – Intermittent drainage #2



Criteria		Evidence
Channel	×	Water flowing through leaves, but there is no defined channel (yellow lines added to show area with flowing water)
A. Mineral channel bed	×	Water movement did not create a channel bed that is different from the surface layer of surrounding upland soils
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	Dries up
D. Aquatic life	×	None found in a 15-minute search
E. Aquatic vegetation	×	None
Conclusion	**×**	Without a defined channel, it is not a NRPA stream

Case Study 4 – Intermittent drainage #3 (high gradient)

Segment A

Segment B

Criteria		Evidence
Channel	✓	Upstream segment (A) is on a hill side and has a step-pool channel that is common to steep streams. The downstream segment has a standard channel with rock substrate (B).
A. Mineral channel bed	✓	There is exposed mineral substrate caused by flowing water
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	Dries up
D. Aquatic life	✓	Both segments A and B have a variety of macroinvertebrates.
E. Aquatic vegetation	×	None
Conclusion	✓	Both segments A and B have a channel with defined banks and 2 of the 5 other criteria. Despite drying up in the summer, both segments would qualify as NRPA streams.

Case Study 5 – Stream that goes above and below ground (2 pages)

Segment A

Segment B

Segment A – Flows underground

Criteria		Evidence
Channel	×	There is a channel with defined banks upstream, but then the water goes underground in Segment A. One can hear the water flowing underground.
A. Mineral channel bed	×	The underground segment does not have a channel with mineral bed
B. Blue line on topographic map	×	No
C. Continuous flow for 6 months	×	No
D. Aquatic life	?	
E. Aquatic vegetation	×	None
Conclusion	✘	Segment A does not have a defined channel

Segment B

Criteria		**Evidence**
Channel	✓	Water flows from a hole and forms a channel with defined banks
A. Mineral channel bed	✓	Gravel, and sand
B. Blue line on topographic map	×	No
C. Continuous flow for 6 months	×	No
D. Aquatic life	✓	Yes
E. Aquatic vegetation	×	None
Conclusion	✓	Segment B is a NRPA stream because it has a defined channel and 2 of 5 other criteria

Case Study 6 – Stream that changes to a wetland and then back (2 pages)

Segment A - Upstream

Segment B - Downstream

Segment A

Criteria		Evidence
Channel	×	Flat, wet area without a defined channel (yellow lines added to show area with flowing water)
A. Mineral channel bed	×	Thick layer of leaves without an eroded mineral bed
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	Not evaluated, but most likely dried up most years
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✘	Segment A does not have a channel, therefore it is not a NRPA stream. It is a NRPA stream both upstream and downstream, however.

Segment B

Criteria		**Evidence**
Channel	✓	Small channel with defined banks (3-8 inches wide)
A. Mineral channel bed	✓	Composed of sand, silt, and gravel
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	Not evaluated, but most likely dries up most years
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates, such as mayflies, stoneflies, caddisflies, and blackflies. A two-lined salamander was observed.
E. Aquatic vegetation	×	None
Conclusion	✓	It has a defined channel and meets 2 of the 5 other criteria. This segment is a NRPA stream.

Case Study 7 – A marsh without a channel

Criteria		Evidence
Channel	×	Water flowing through plants when water levels are high, but no channel
A. Mineral channel bed	×	There is some exposed mud, but not a channel
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	Dries up
D. Aquatic life	✓	Some macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✘	This is not a NRPA stream. It does not have a defined channel and is a wetland. Wetlands are protected resources under NRPA.

Case Study 8 – A marsh with a channel

View 1

View 2

Criteria		Evidence
Channel	✓	Although there appears to be no channel from View 1, there is clearly a channel with defined banks if one explores a little (View 2).
A. Mineral channel bed	✓	Composed of silt, sand, and gravel
B. Blue line on topographic map	✓	Solid line
C. Continuous flow for 6 months	✓	The central channel never dries up.
D. Aquatic life	✓	Many different kinds of aquatic macroinvertebrates, such as mayflies, stoneflies, and caddisflies. Fish were observed.
E. Aquatic vegetation	✓	Several kinds of aquatic plants
Conclusion	✓	It has a defined channel and meets all other criteria. It is a NRPA stream.

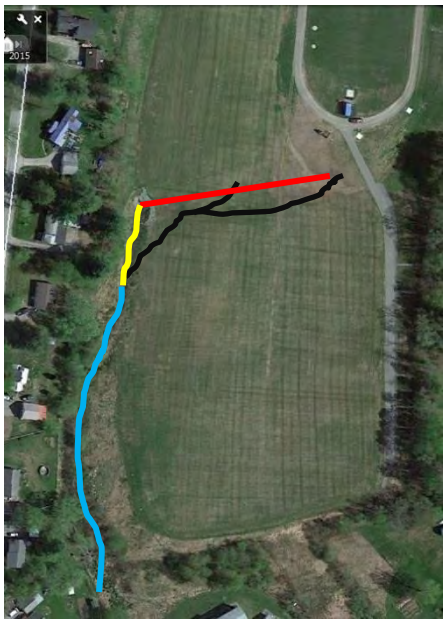
Case Study 9 – Dry channel

Criteria		Evidence
Channel	✓	Channel with defined banks (yellow lines added to show banks)
A. Mineral channel bed	✓	Composed of silt, sand, and rocks
B. Blue line on topographic map	×	It does not appear on a map
C. Continuous flow for 6 months	×	Dries up
D. Aquatic life	✓	Caddisfly cases were found on a rock and a few macroinvertebrates were found in the last remaining pool
E. Aquatic vegetation	×	None
Conclusion	✓	Despite being mostly dry, this is a NRPA stream because it has a channel and 2 of 5 criteria.

Case Study 10 – Relocated stream that originates from a culvert

A – Before construction of athletic field

B – After construction of athletic field



A stream (A & B – blue lines) was modified to accommodate the construction of an athletic field. The stream originated from 2 pipes before construction because of the original athletic fields. A section of stream was buried (B – black lines). A pipe was installed to convey water (B – red line). Part of the channel was relocated to minimize impacts of the project (B – yellow line).

Criteria		**Evidence**
Channel	✓	Channel with defined banks (A – blue lines) with a relocated segment after construction (B – yellow line)
A. Mineral channel bed	✓	Composed of cobble, gravel, and sand
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 06 months	--	Not assessed
D. Aquatic life	✓	Several kinds of macroinvertebrates observed
E. Aquatic vegetation	×	None
Conclusion	✓	The entire stream is a NRPA stream, including the relocated segment that now originates from a culvert (B – yellow line). It has a channel and has 2 of 5 of the other criteria.

Case Study 11 – Relocated stream alongside a road

A – Before construction of exit ramps

B – After construction of exit ramps

Parts of a stream were relocated to accommodate construction of highway ramps and to move a portion of the stream away from the highway. Blue lines show the stream channel prior to construction (A and B). Red lines show buried stream segments (B). Yellow lines show relocated stream segments (B).

Criteria		Evidence
Channel	✓	Channel with defined banks (A – blue lines) with relocated segments after construction (B – yellow lines)
A. Mineral channel bed	✓	Composed of gravel and sand
B. Blue line on topographic map	✓	It is shown as a blue line on the topographic map
C. Continuous flow for 6 months	✓	Yes
D. Aquatic life	✓	Fish and aquatic macroinvertebrates
E. Aquatic vegetation	✓	Aquatic plants
Conclusion	✓	The entire stream, including the relocated stream segments (B – yellow lines), is a NRPA stream. It has a channel and meets all other criteria. The stream segment that ran alongside the road (A) also was a NRPA stream.

Case Study 12 – Roadside Drainage #1

Criteria		Evidence
Channel	✓	Within the drainage feature, there is a narrow, meandering channel.
Ditch or Stream?	×	Channel gradually decreases in size and disappears upstream. It is not connected to an upstream waterbody, such as a stream, spring, or wetland. It is periodically dredged by road crews.
A. Mineral channel bed	✓	Sand and silt
B. Blue line on topographic map	×	It does not appear on a map
C. Continuous flow for 6 months	×	It is periodically wet after snow melt and rain storms
D. Aquatic life	✓	There were a few aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✗	Despite having a channel and meeting 2 of the 5 other criteria, this is not a NRPA stream. The source of water is runoff from precipitation. It was constructed and is maintained to drain stormwater.

Case Study 13 – Roadside Drainage #2

A

B

Criteria		Evidence
Channel	✓	Channel alongside of a road (A).
Ditch or Stream?	×	The channel disappears further up the hill. It is not connected to a stream, spring, or wetland upstream. The primary source of water is stormwater runoff. The channel joins a natural stream channel downstream (B).
A. Mineral channel bed	✓	Composed of sand, gravel, and cobble
B. Blue line on topographic map	×	It does not appear on a map
C. Continuous flow for 6 months	×	Dries up
D. Aquatic life	✓	Several kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✘	Despite having a defined channel and meeting 2 of the 5 other criteria, the drainage along the road is not a NRPA stream. The channel does not connect to an upstream source of water, such as a stream, spring, or wetland. It was created and is maintained for stormwater. A short segment of the channel where it joins the natural stream (B) has a natural channel and is a NRPA stream.

Case Study 14 – Roadside Drainage #3

A

B

Criteria		Evidence
Channel	✓	Channel with defined banks (A, looking upstream).
Ditch or Stream?	✓	Upstream, the channel connects to a natural stream (B, looking downstream). Further downstream of where the picture A was taken, the channel goes under the road and then returns to a natural channel.
A. Mineral channel bed	✓	Composed of sand, gravel, and cobble
B. Blue line on topographic map	×	It does not appear on a map
C. Continuous flow for 6 months	--	Not evaluated
D. Aquatic life	✓	Several kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	This is a modified segment of a NRPA stream. It has a channel and has 2 of 5 of the other criteria.

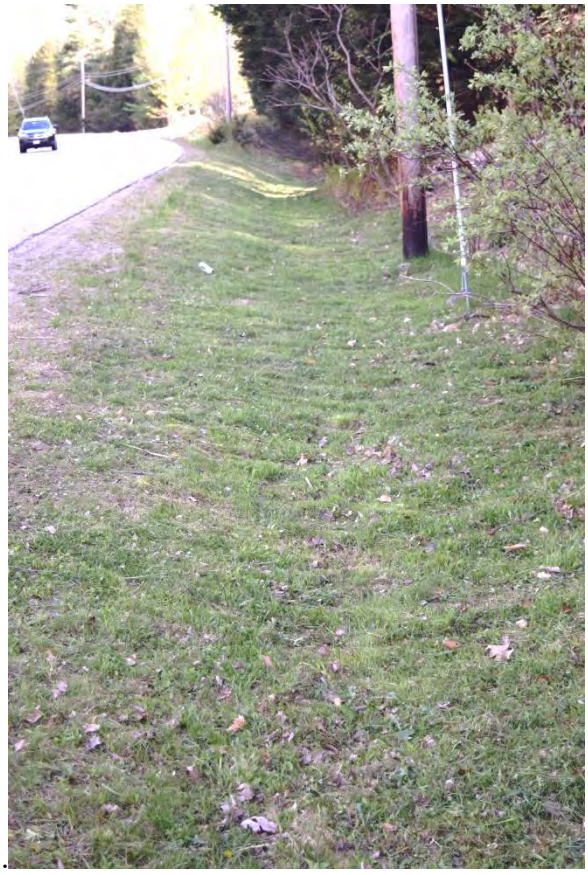
Case Study 15 – Roadside Drainage #4

A

B (top) & C (bottom)

Criteria		Evidence
Channel	✓	Channel with defined banks alongside of road (A)
Ditch or stream?	✓	The channel originates from a small wetland (B), flows through the forest, and then flows parallel to the road in a modified channel. Further downstream, water flows under the road through culvert and proceeds as a natural stream. This is not a ditch created solely for stormwater. It is a relocated stream.
A. Mineral channel bed	✓	Composed of sand, gravel, and rocks (C)
B. Blue line on topographic map	×	It does not appear on a map
C. Continuous flow for 6 months	--	Not evaluated
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	Some sedges and other wetland plants are in the flatter sections of the channel. No aquatic plants were seen in the channel.
Conclusion	✓	Despite being a straight channel alongside a road, this is a NRPA stream. The stream was altered in the past to run parallel to the road. It is connected to an upstream waterbody and it returns to a natural channel downstream. It has a defined channel and meets 2 of the 5 other criteria.

Case Study 16 – Grassy Swale



Criteria		Evidence
Channel	×	No channel with defined banks
A. Mineral channel bed	×	No exposed minerals caused by flowing water
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	Dry most of the year
D. Aquatic life	×	None
E. Aquatic vegetation	×	None
Conclusion	✘	This is not a NRPA stream because it does not have a defined channel. It also has none of the 5 characteristics of a NRPA stream.

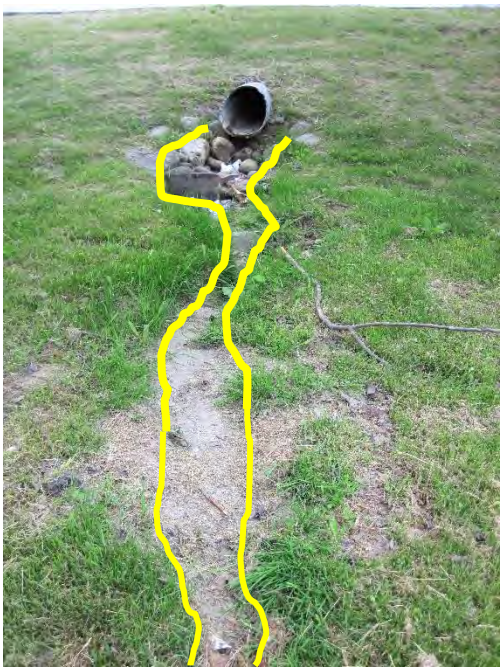
Case Study 17 – Channel originating from a culvert #1

A

B

Criteria		Evidence
Channel	✓	Channel with defined banks (A) that originates from a culvert (B)
A. Mineral channel bed	✓	Rocks
B. Blue line on topographic map	✓	Yes and historic topographic maps show that upstream segments have been buried or turned into ponds
C. Continuous flow for 6 months	✓	Yes
D. Aquatic life	✓	Fish and aquatic macroinvertebrates
E. Aquatic vegetation	×	No
Conclusion	✓	This is a NRPA stream. It has a channel with defined banks and 4 of 5 of the other criteria.

Case Study 18 – Channel originating from a culvert #2

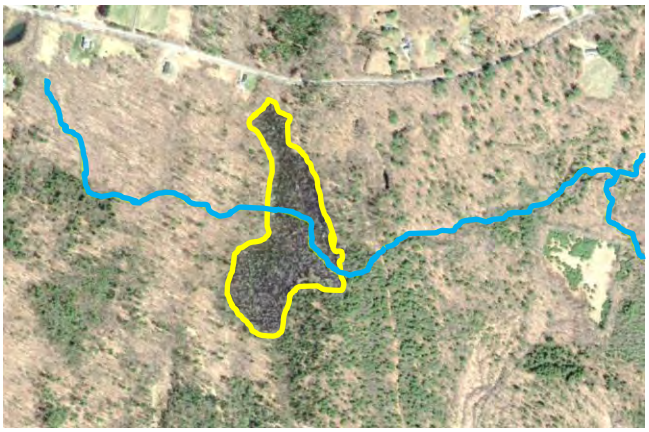


Criteria		Evidence
Channel	✓	Short channel with defined banks that originates from a culvert but dissipates into uplands
Ditch or stream	×	This was created only to drain stormwater from a road network, it does not connect to an upstream waterbody, and it does not drain groundwater
A. Mineral channel bed	✓	Exposed minerals caused by flowing water
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	Dry most of the year and does not have sustained flow from groundwater
D. Aquatic life	×	None
E. Aquatic vegetation	×	None
Conclusion	✘	This is not a NRPA stream because it was created solely for draining stormwater

.

Case Study 19 – Impounded stream #1

A – Before and after beaver dam



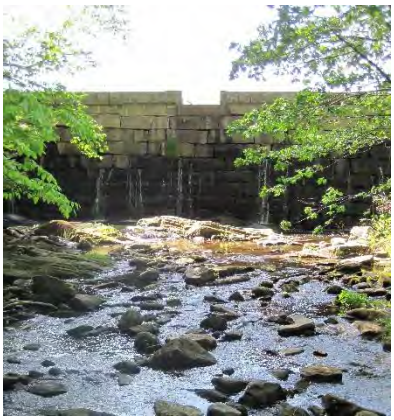
B – Beaver dam and pond

Blue lines show the stream channel and yellow line shows the outline of the beaver pond

Criteria		Evidence
Channel	✓	The inlet and outlet streams have channels with defined banks
A. Mineral channel bed	✓	Cobble, gravel, and sand
B. Blue line on topographic map	✓	Yes
C. Continuous flow for 6 months	✓	Yes
D. Aquatic life	✓	Aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	Beavers constructed a dam and flooded an existing stream channel. The impounded water retains the protection afforded to the original stream channel under NRPA.

Case Study 20 – Impounded stream #2

A – Dam



B – Pond with inlet stream on far side

C – Aerial imagery

Criteria		Evidence
Channel	✓	The inlet and outlet streams have channels with defined banks
A. Mineral channel bed	✓	Bedrock, boulders, and cobble
B. Blue line on topographic map	✓	Yes
C. Continuous flow for 6 months	✓	Yes
D. Aquatic life	✓	Aquatic macroinvertebrates and fish
E. Aquatic vegetation	×	None
Conclusion	✓	Construction of a dam flooded an existing stream channel. The new impoundment retains the protection afforded to the original stream channel under NRPA.

Case Study 21 – Complex site in a forested landscape (8 pages)

This case study presents a stream in forested landscape.

The following 8 segments are presented:

A. Origin of the stream

B. Segment of NRPA stream diverted into roadside drainage

C. NRPA stream segment

D. Segment in flat area without a defined channel

E. NRPA stream segment

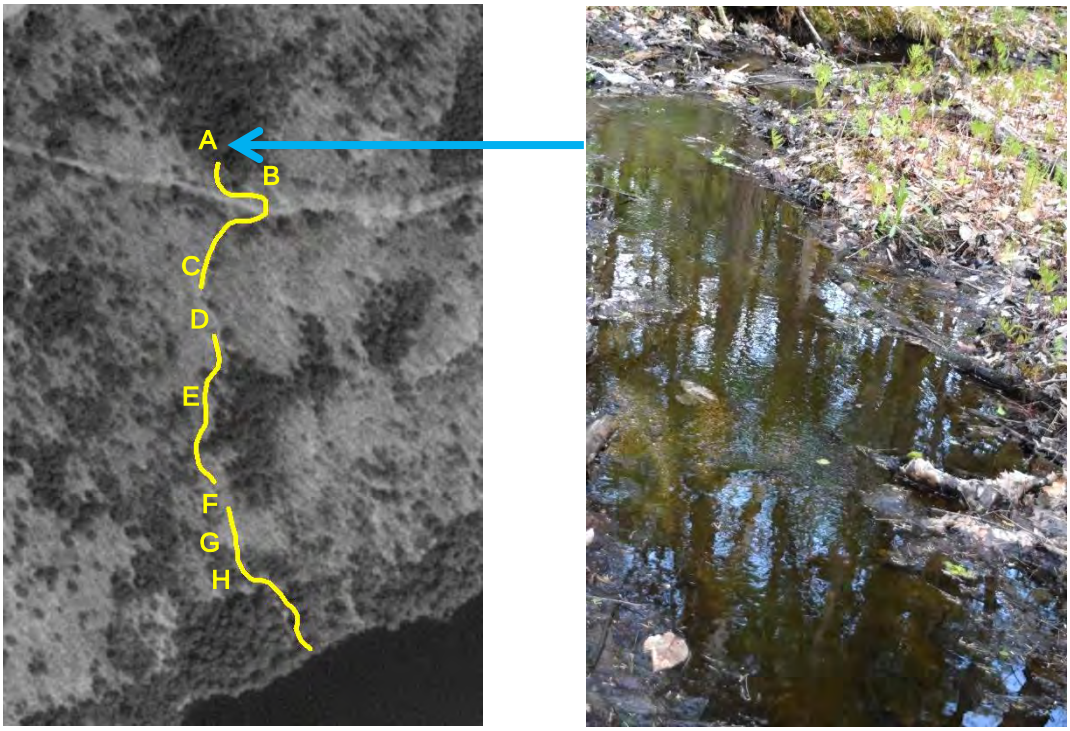
F. Segment of stream that flows underground

G. NRPA stream segment

H. NRPA stream segment with braided channel

A. Origin of the stream

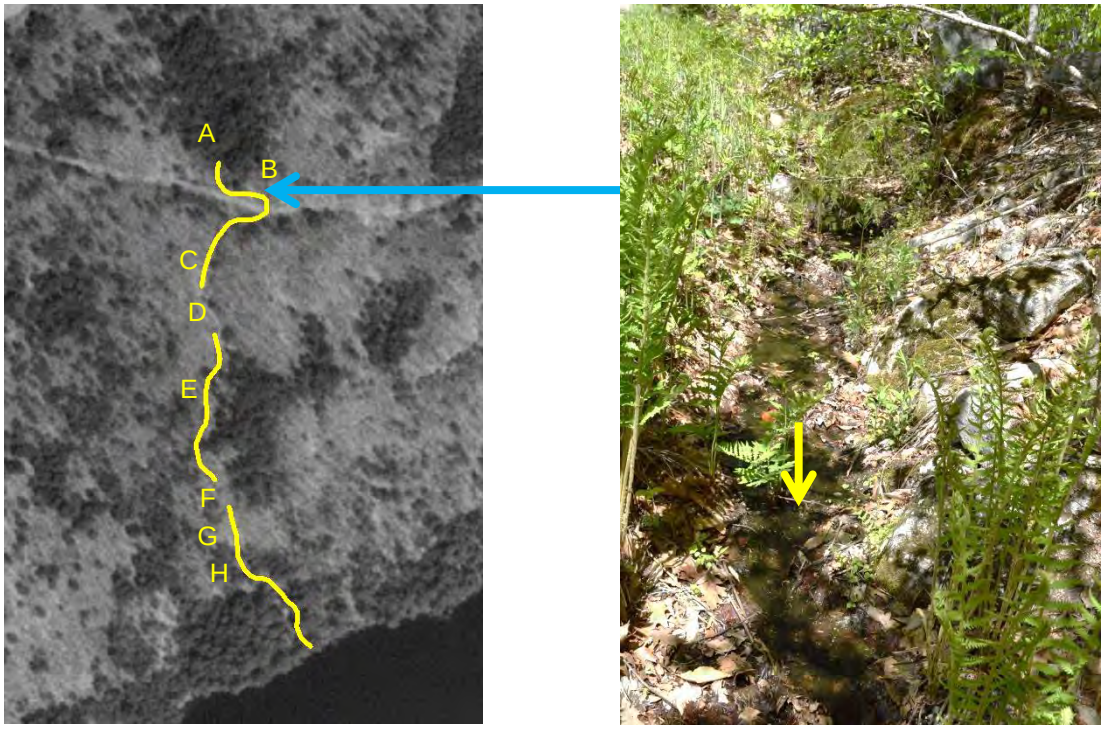
Yellow line on map shows NRPA stream segments



Criteria		**Evidence**
Channel	×	No channel
A. Mineral channel bed	×	No channel
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	Dries up
D. Aquatic life	✓	Some macroinvertebrates
E. Aquatic vegetation	✓	Some aquatic plants and mosses
Conclusion	✘	This is a wetland or vernal pool. It does not have a defined channel. Wetlands and vernal pools are protected resources under NRPA.

B. Segment of NRPA stream diverted into roadside drainage

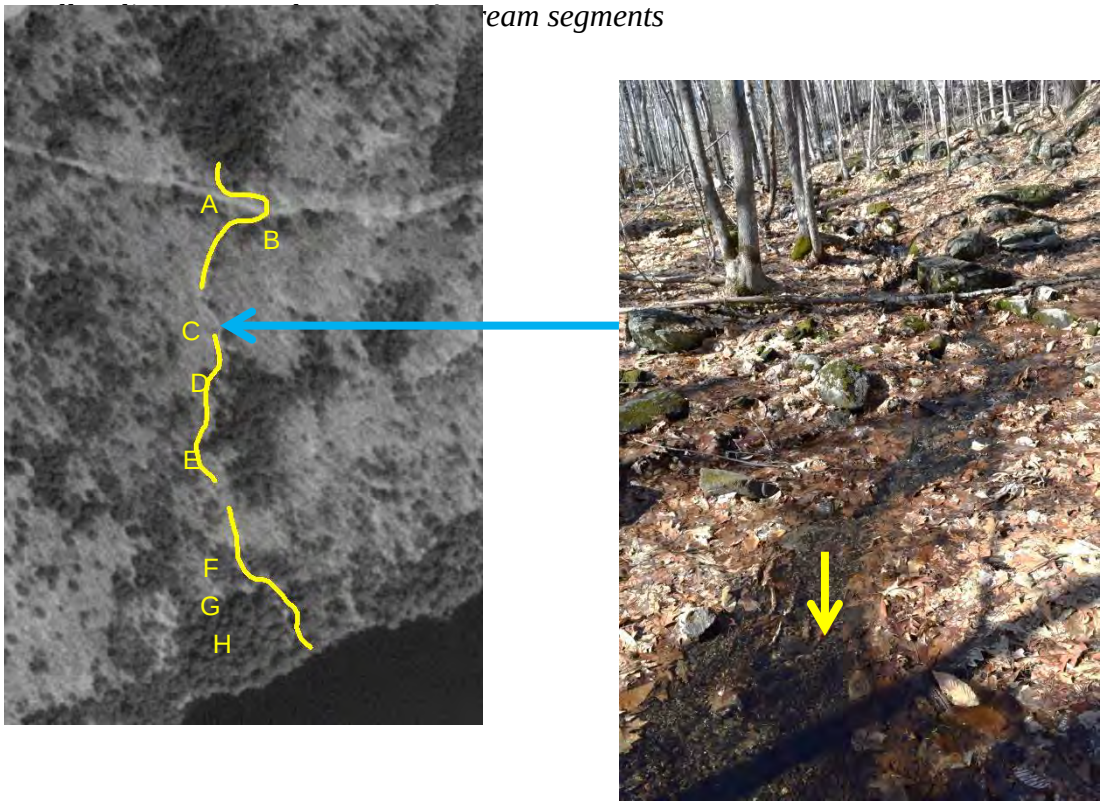
Yellow line on map shows NRPA stream segments



Criteria		**Evidence**
Channel	✓	Within a roadside drainage, there is a narrow meandering channel (3-5" wide)
Ditch or Stream?	✓	The channel originates from a wetland, flows a short distance as a natural channel, and then is captured by a roadside drainage
A. Mineral channel bed	✓	Composed of sand and gravel
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	No
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	Some wetland plants grow alongside the meandering channel, but there were no aquatic plants in the channel
Conclusion	✓	Despite being in a roadside drainage feature, the channel originates from a wetland and has 2 of 5 characteristics of a NRPA stream. The stream was altered in the past to run parallel to the road and then return to the original channel on the other side of the road.

C. NRPA stream segment

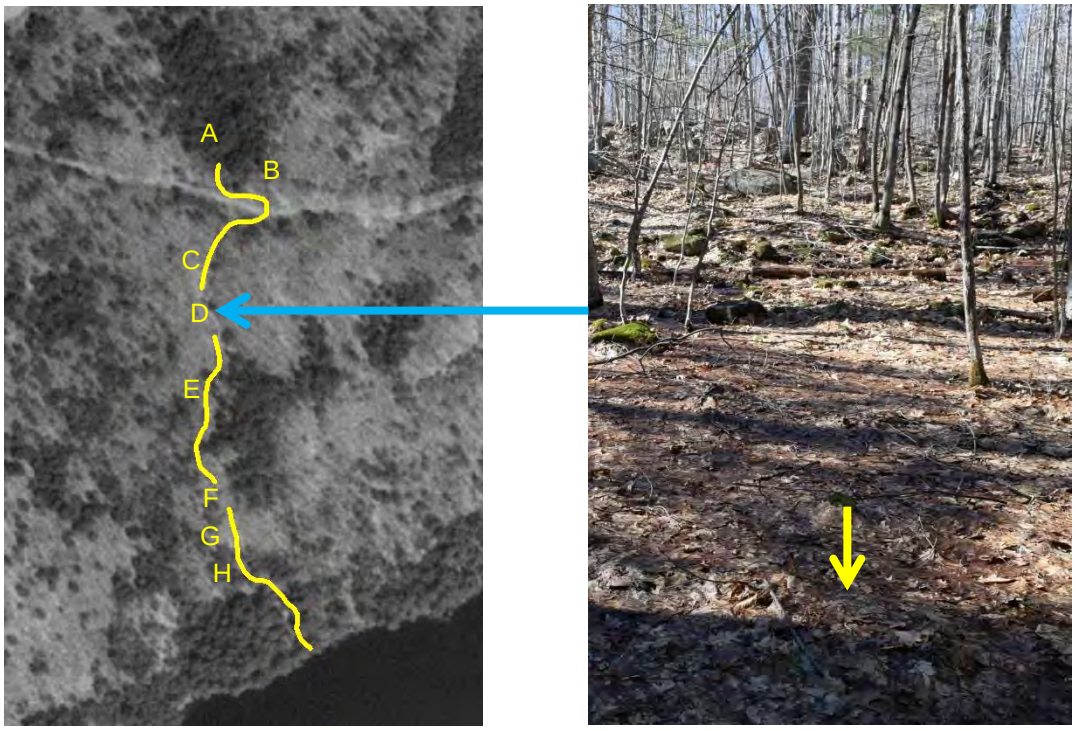
eam segments



Criteria		**Evidence**
Channel	✓	Channel with defined banks
A. Mineral channel bed	✓	Composed of sand and gravel
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	No
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	This is a NRPA stream because it has a defined channel and has 2 of 5 characteristics of a NRPA stream.

D. Segment in flat area without a defined channel

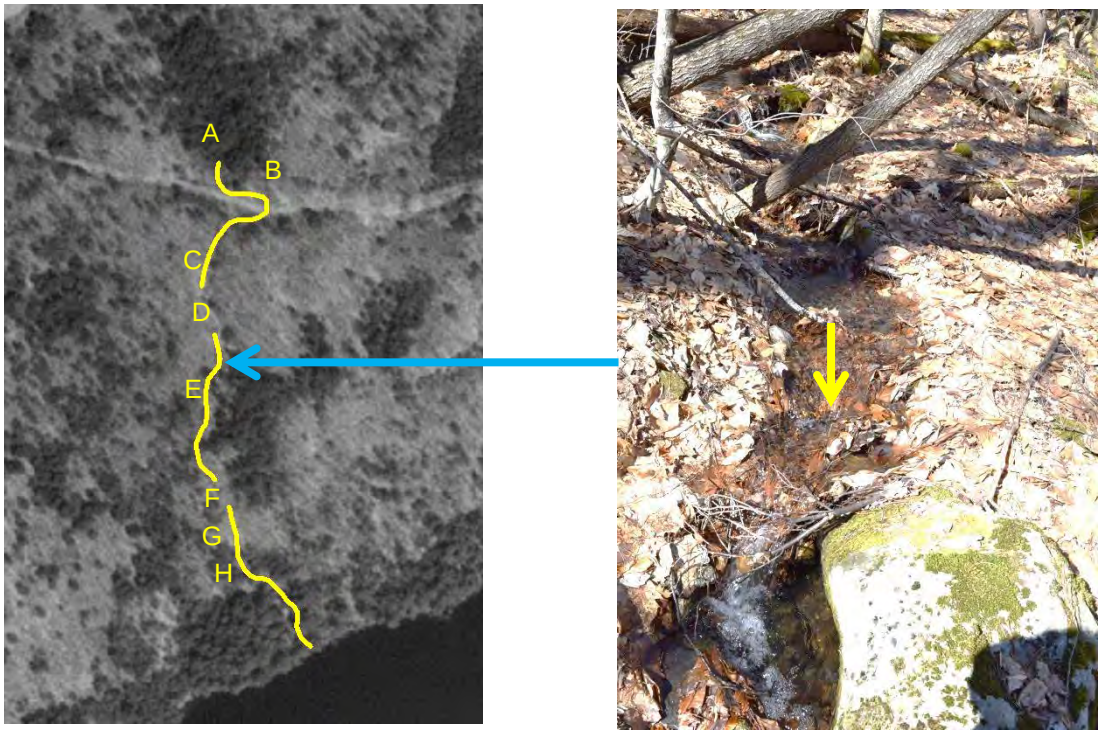
Yellow line on map shows NRPA stream segments



Criteria		**Evidence**
Channel	×	The stream enters a flat area, the water spreads out, and there no longer is a channel with defined banks
A. Mineral channel bed	×	There is no exposed mineral substrate caused by water movement
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	Dries up
D. Aquatic life	✓	Some macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✘	This segment is not a NRPA stream because it does not have a channel with defined banks

E. NRPA stream segment

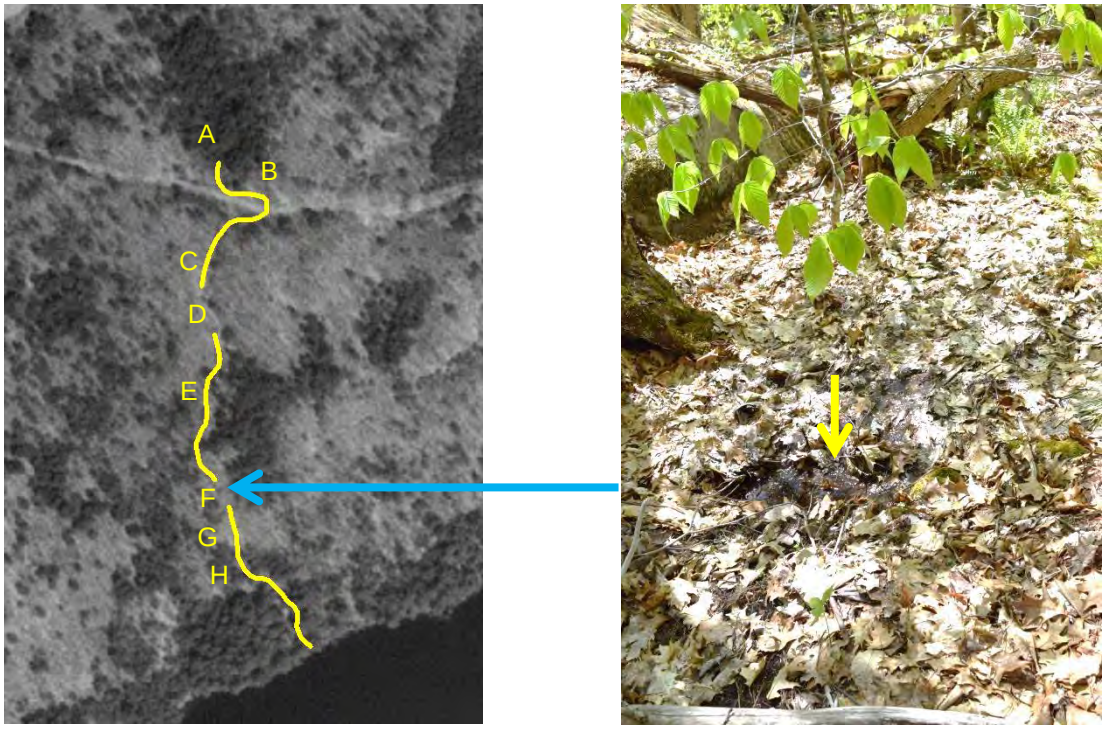
Yellow line on map shows NRPA stream segments



Criteria		**Evidence**
Channel	✓	Channel with defined banks
A. Mineral channel bed	✓	Composed of sand and gravel
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	No
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	This is a NRPA stream because it has a defined channel and 2 of 5 characteristics of a NRPA stream.

F. Segment of stream that flows underground

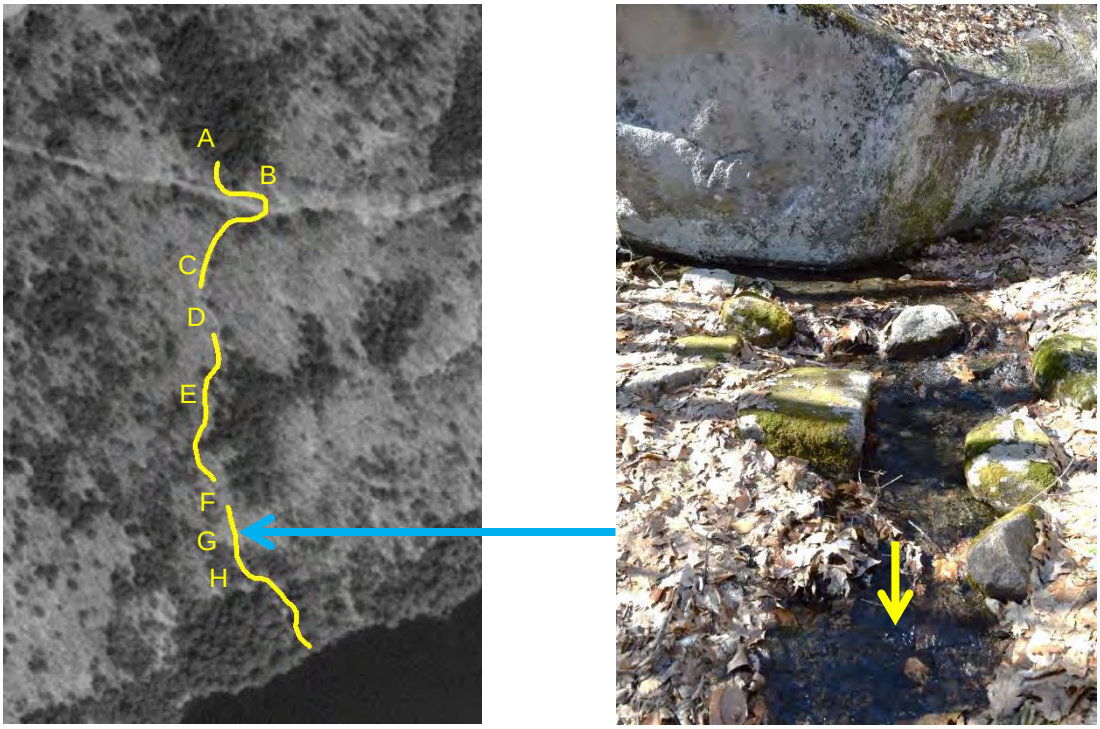
Yellow line on map shows NRPA stream segments



Criteria		**Evidence**
Channel	×	The water flows underground in this segment
A. Mineral channel bed	×	This segment does not have an exposed channel with mineral bed
B. Blue line on topographic map	×	No
C. Continuous flow for 6 months	×	No
D. Aquatic life	?	
E. Aquatic vegetation	×	None
Conclusion	✘	The underground segment does not have a defined channel

G. NRPA stream segment

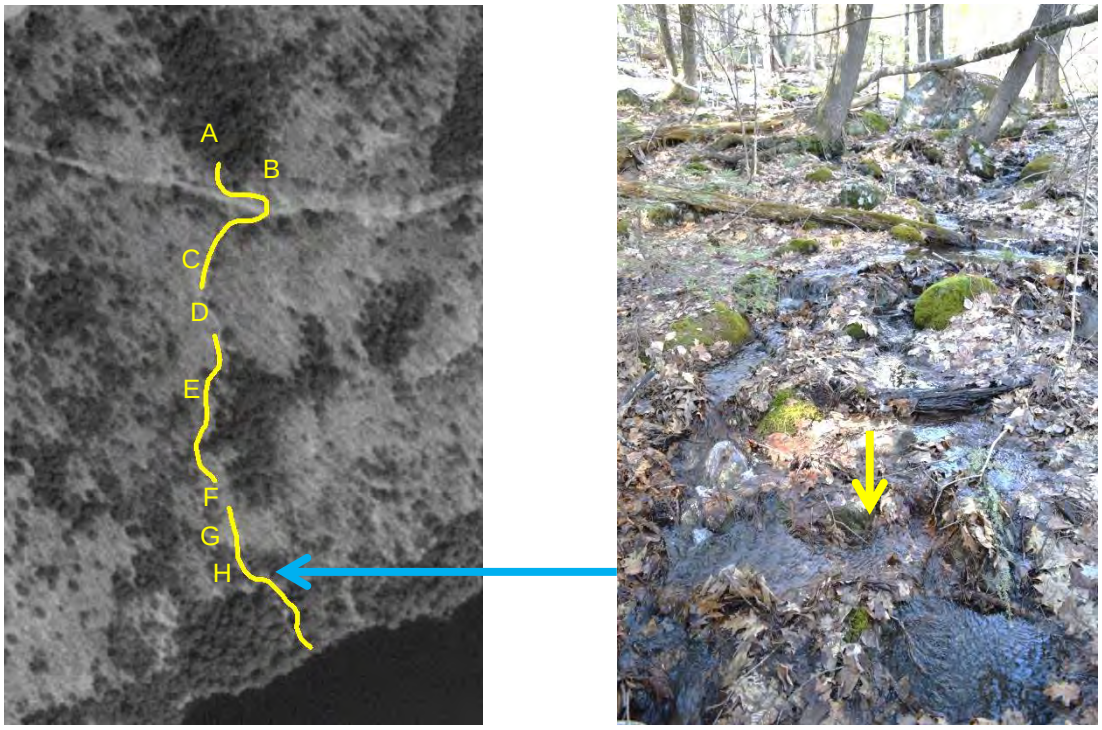
Yellow line on map shows NRPA stream segments



Criteria		**Evidence**
Channel	✓	The water returns to the surface next to the boulder and forms a channel with defined banks
A. Mineral channel bed	✓	Composed of sand and gravel
B. Blue line on topographic map	×	It is not show as a blue line on the topographic map
C. Continuous flow for 6 months	×	No
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	This is a NRPA stream because it has a defined channel and has 2 of 5 characteristics of a NRPA stream.

H. NRPA stream segment with braided channel

Yellow line on map shows NRPA stream segments



Criteria		**Evidence**
Channel	✓	This channel is braided because of large rocks and steeper slope
A. Mineral channel bed	✓	Yes
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	No
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	This is a NRPA stream because it has a defined channel and has 2 of 5 characteristics of a NRPA stream.

Case Study 22 – Complex site in an urban landscape (7 pages)

This is a case study of a stream network in an urban landscape.

The following 7 segments are presented:

A. Perennial stream segment

B. Perennial stream segment

C. Modified stream segment

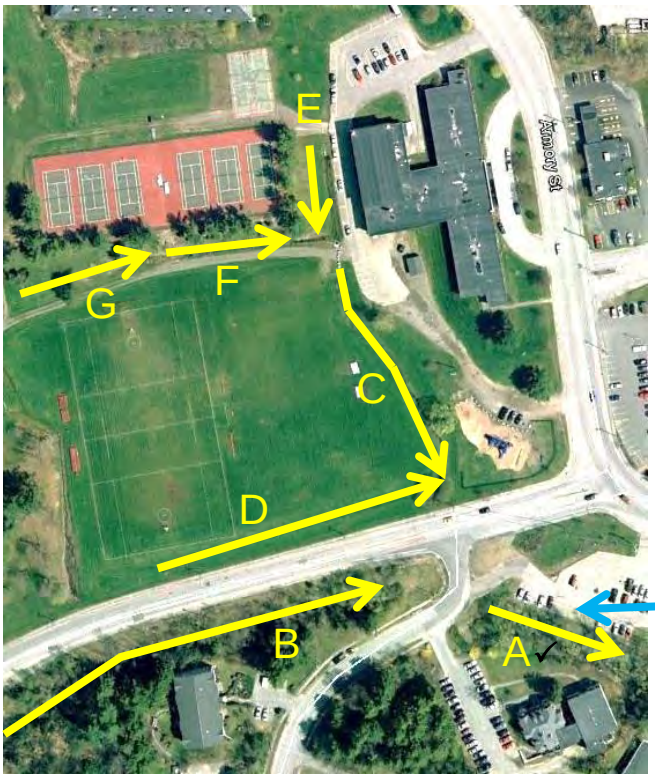
D. Grassy swale

E. Modified stream segment that originates from a pipe

F. Modified stream segment that originates from a pipe

G. Linear wetland

Segment A: Perennial Stream



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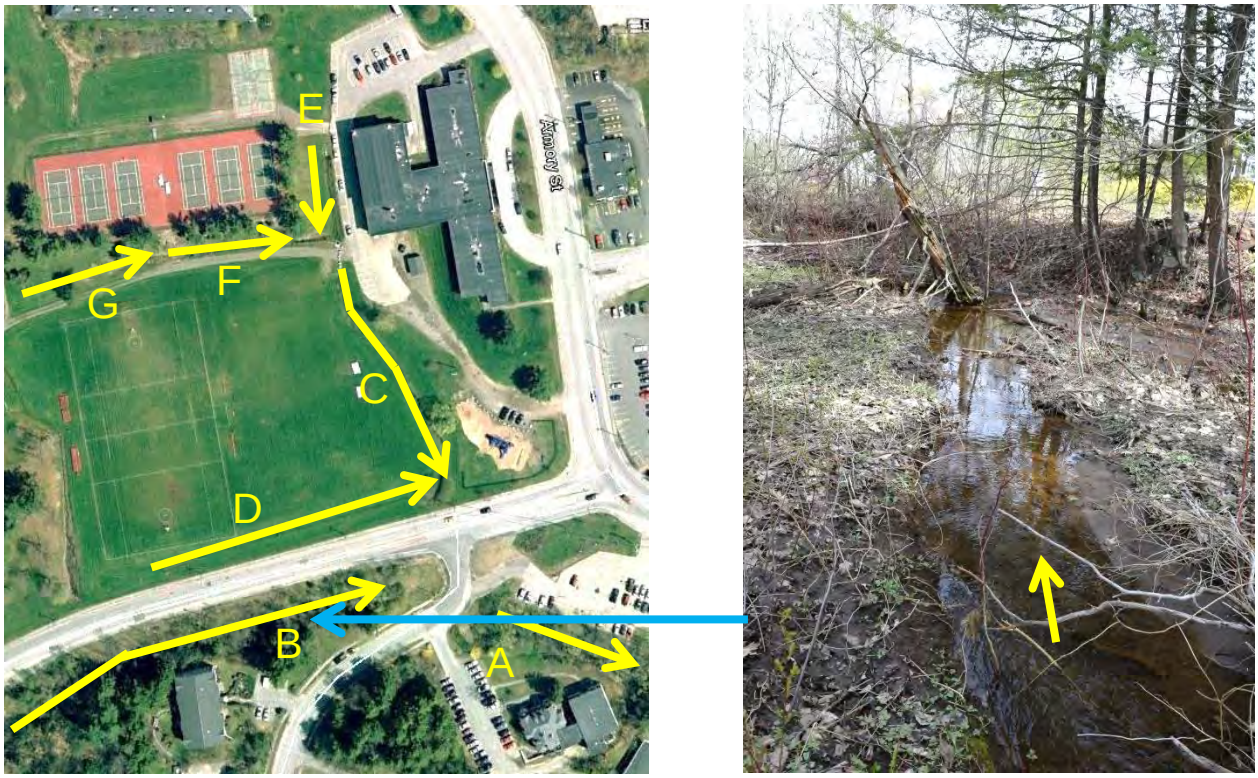
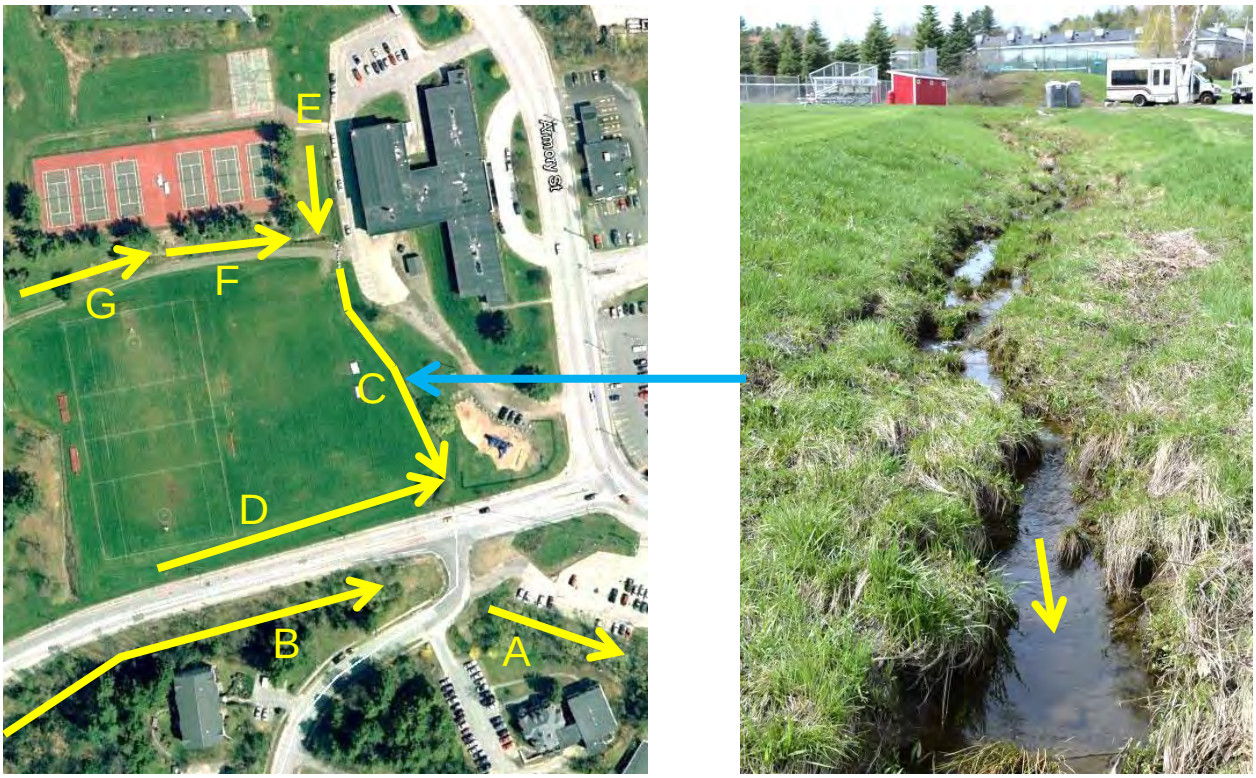
Criteria		Evidence
Channel	✓	Channel with defined banks
A. Mineral channel bed	✓	Composed of rocks and sand
B. Blue line on topographic map	×	Does not appear on a map
C. Continuous flow for 6 months	✓	Continuous flow in most years
D. Aquatic life	✓	Many different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	This is Kennedy Brook. It has a defined channel and meets 3 of the 5 other criteria. It is a NRPA stream.

Segment B: Perennial Stream



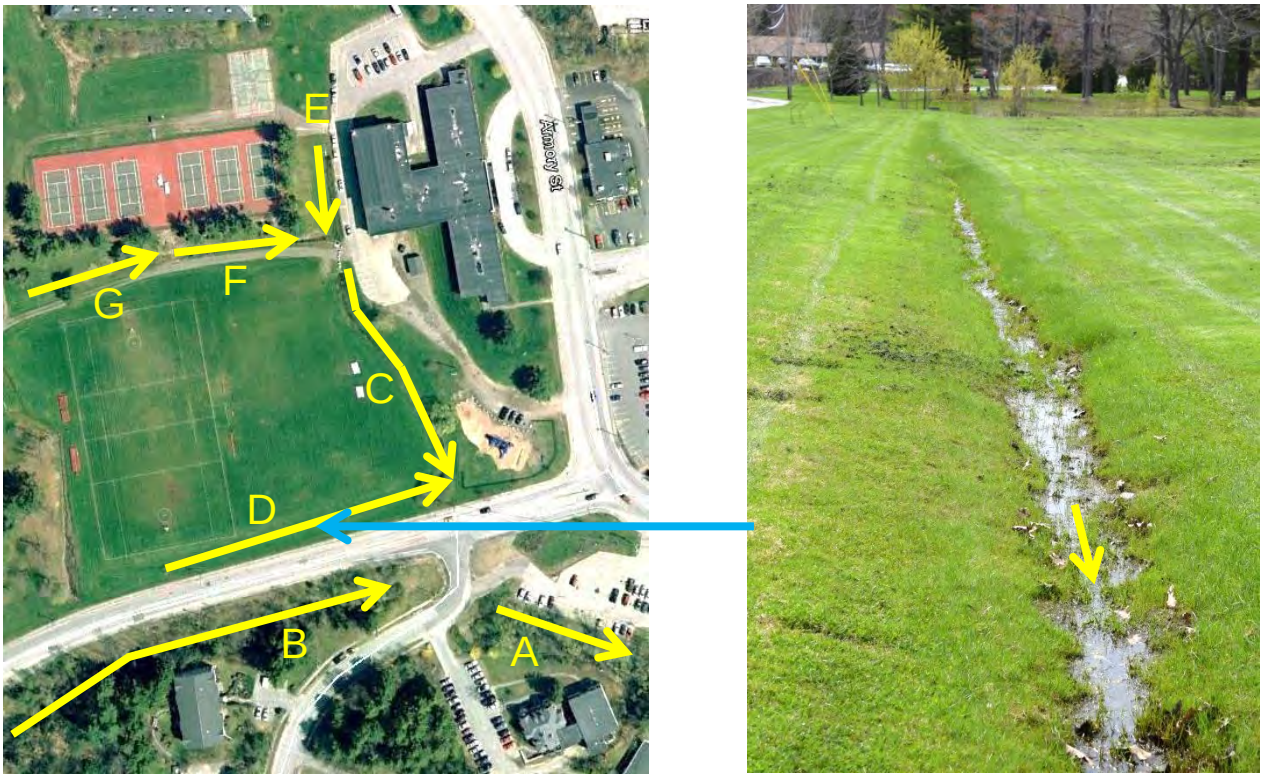
Channel	✓	Channel with defined banks
A. Mineral channel bed	✓	Composed of rocks and sand
B. Blue line on topographic map	×	Does not appear on a current map
C. Continuous flow for 6 months	✓	Continuous flow in most years
D. Aquatic life	✓	Many different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	This is Kennedy Brook. It has a defined channel and meets 3 of the 5 other criteria. It is a NRPA stream.

Segment C: Modified stream segment



Criteria		Evidence
Channel	✓	Channel with defined banks (some stream bank erosion and slumping)
A. Mineral channel bed	✓	Composed of rocks and sand
B. Blue line on topographic map	×	Does not appear on a current map, but a stream is shown in the vicinity on historic maps
C. Continuous flow for 6 months	✓	The channel has continuous water flow in most years
D. Aquatic life	✓	Several kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	This is an altered branch of Kennedy Brook. It has a defined channel and meets 3 of the 5 other criteria. It is a NRPA stream. Its riparian zone is greatly altered.

Segment D: Grassy swale



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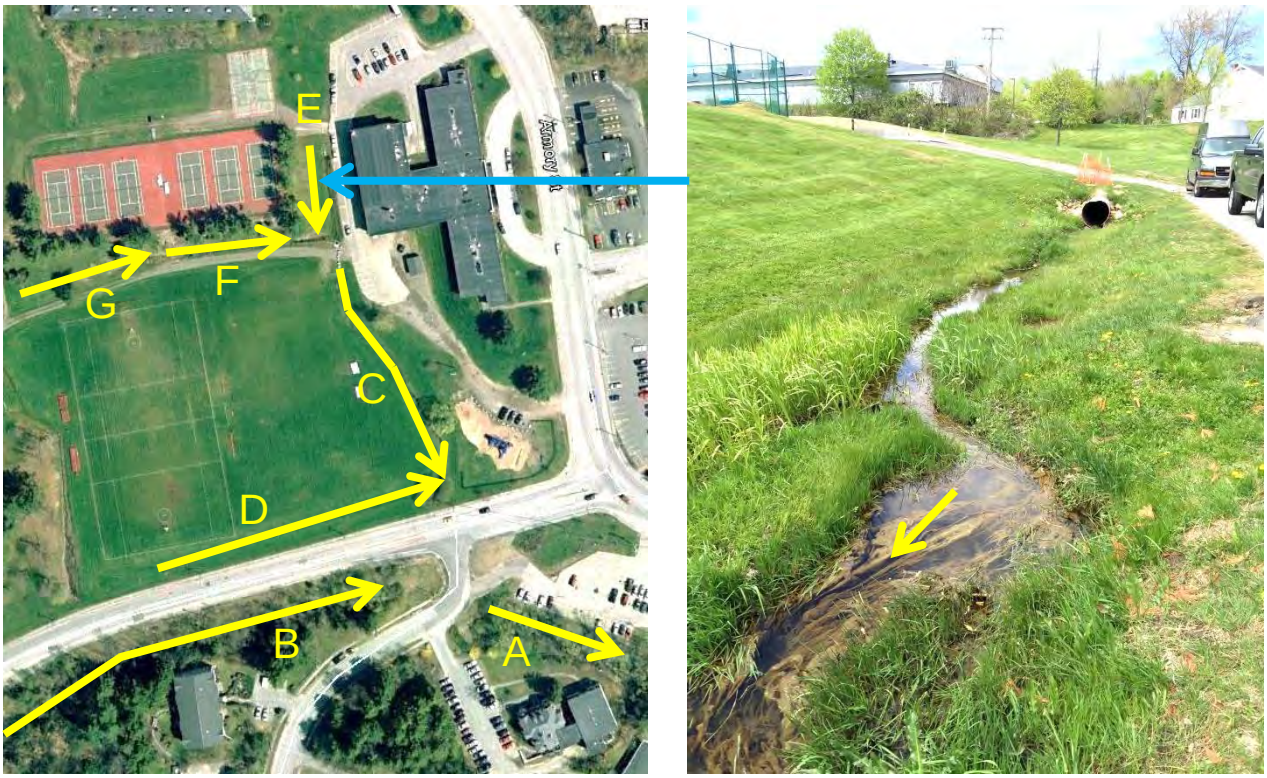
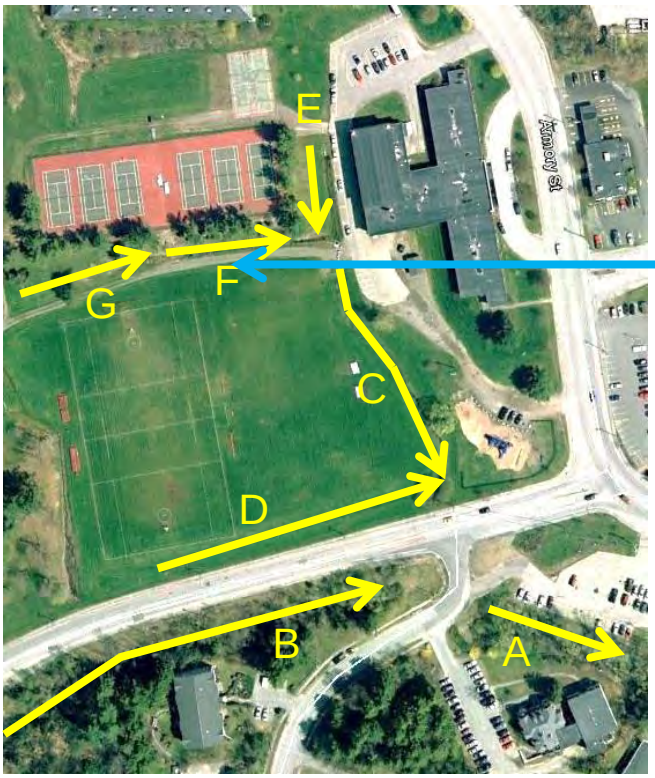
Criteria		**Evidence**
Channel	×	No channel with defined banks
A. Mineral channel bed	×	No channel
B. Blue line on topographic map	×	It does not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	Dry most of the year
D. Aquatic life	×	None
E. Aquatic vegetation	×	None
Conclusion	✘	This is not a NRPA stream because it does not have a defined channel. It also has none of the 5 characteristics of a NRPA stream.

Segment E: Modified stream segment that originates form a pipe



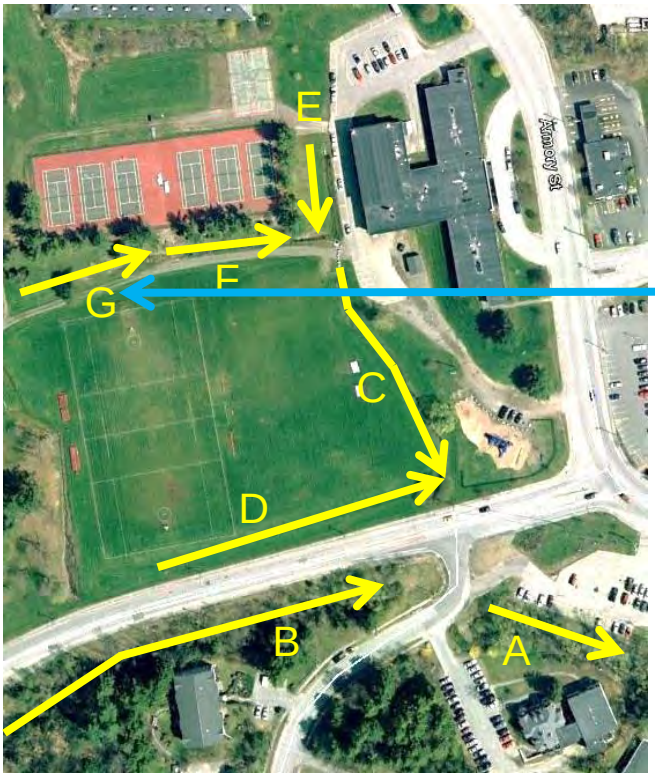
Criteria		**Evidence**
Channel	✓	It has a channel with defined banks, it has enough flowing water to maintain a channel away from the culvert opening, and it connects to a downstream waterbody
Ditch or Stream?	✓	The channel originates from a pipe, has continuous flow in most years, and is not only draining stormwater
A. Mineral channel bed	✓	Composed of sand and gravel
B. Blue line on topographic map	×	It is not shown as a blue line on the current topographic map, but historic topographic maps show the presence of a stream nearby
C. Continuous flow for 6 months	✓	The channel has continuous water flow in most years
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	This is an altered headwater of Kennedy Brook, it has a defined channel, meets 3 of the 5 other criteria, and is a NRPA stream

Segment F: Modified stream segment that originates form a pipe



Criteria		Evidence
Channel	✓	There is a straight drainage way containing a channel with defined banks. Flowing water originates from a pipe that drains groundwater from underneath the tennis courts. There is enough flowing water to maintain a channel away from the culvert opening and it connects to Kennedy Brook.
Ditch or Stream?	✓	Stream. The source of water is groundwater. The altered channel has naturalized and is forming meanders.
A. Mineral channel bed	✓	Composed of sand and gravel
B. Blue line on topographic map	×	It is not shown as a blue line on the current topographic map, but historic topographic maps show the presence of a stream nearby
C. Continuous flow for 6 months	--	Not sure but it remains wet for a long period of time and receives a lot of groundwater from the pipe that drains underneath the tennis courts. Groundwater sometimes comes to the surface of the tennis courts through cracks in the playing surface.
D. Aquatic life	✓	Several different kinds of aquatic macroinvertebrates
E. Aquatic vegetation	×	None
Conclusion	✓	This is an altered headwater of Kennedy Brook. It has a defined channel and has 2 of the 5 characteristics of a NRPA stream.

Segment G: Linear wetland



Criteria		Evidence
Channel	×	This is a straight drainage feature, but it does not have a channel with banks.
A. Mineral channel bed	×	There is no exposed mineral substrate caused by water movement
B. Blue line on topographic map	×	It is not shown as a blue line on the topographic map
C. Continuous flow for 6 months	×	This segment dries up
D. Aquatic life	×	None
E. Aquatic vegetation	×	None
Conclusion	✘	This segment does not have a defined channel. It is functioning more like a linear wetland