NAACC Stream Crossing Instruction Guide for Terrestrial Passage Assessments

Developed by the:

North Atlantic Aquatic Connectivity Collaborative &
The Staying Connected Initiative

Version 1.0 – July 17, 2019
(for Data Form dated 4/20/2019)

For more information, go to: **www.streamcontinuity.org/naacc**

LEAD AUTHORS
Alissa Fadden, The Nature Conservancy, Adirondacks
Laura Marx, The Nature Conservancy, Massachusetts

CONTACTS
Jessie Levine
Nature United / Staying Connected Initiative Coordinator
jlevine@tnc.org

Scott Jackson
Department of Environmental Conservation
Holdsworth Hall
University of Massachusetts
Amherst, MA 01003
(413) 545-4743; sjackson@umass.edu

For more information about the North Atlantic Aquatic Connectivity Collaborative (NAACC), go to: **www.streamcontinuity.org/NAACC**

ACKNOWLEDGEMENTS
The development of this instruction guide and the survey protocol it explains is thanks to the effort of many people involved with the NAACC. Participants in protocol development included: Jessie Levine (Nature United), Scott Jackson (University of Massachusetts), Alex Abbott (U.S. Fish and Wildlife Service's Gulf of Maine Coastal Program), Josh Thiel (New York State Department of Environmental Conservation), Andrew Milliken (U.S. Fish and Wildlife Service), Gretchen Fowles (New Jersey Department of Environmental Protection), Bridget Donaldson (Virginia Department of Transportation), David Paulson (Massachusetts Department of Transportation), John Magee (New Hampshire Fish and Game), Elia del Molino (Berkshire Environmental Action Team), Paul J. Marangelo (The Nature Conservancy in Vermont), and Barbara Charry (formerly of Maine Audubon).

In addition, the following people helped develop the terrestrial passage metrics and associated scoring system: Jessie Levine, Scott Jackson, Jed Merrow (McFarland Johnson), Andrew Wood (University of Vermont), and Paul J. Marangelo. Since the terrestrial passage protocol uses some of the same metrics as the NAACC's aquatic passage assessment protocol, some of the content from that instruction guide, titled, "NAACC Stream Crossing Instruction Manual for Aquatic Passability Assessments in Non-tidal Stream and Rivers," is reused here. Thanks to the authors of the aquatic passage guide, Alex Abbott and Scott Jackson, for their earlier work and permission to use relevant content from that document. Finally, partners from Massachusetts Department of Fish and Wildlife and The Nature Conservancy in Massachusetts, with the help of Andrew Wood, were instrumental in piloting early versions of protocol and adapting it based on their experiences.

Suggested Citation

Fadden, A. and L. Marx. 2019. NAACC Stream Crossing Instruction Guide for Terrestrial Passage Assessments. North Atlantic Aquatic Connectivity Collaborative (NAACC), University of Massachusetts Amherst. June 25, 2019. 21 pp.

TABLE OF CONTENTS

OVERVIEW

This document provides guidance for completing the North Atlantic Aquatic Connectivity (NAACC) Terrestrial Passage Assessment Survey.

The North Atlantic Aquatic Connectivity Collaborative (NAACC) is a network of individuals from universities, conservation organizations, and state and federal natural resource and transportation departments focused on improving ecological connectivity across a thirteen-state region, from Maine to Virginia. The NAACC formed in 2014 with an initial focus on developing common protocols for assessing road-stream crossings (culverts and bridges) and a regional database to identify improvements for aquatic connectivity, available at https://naacc.org. The addition of the terrestrial passage assessment, which this guide describes, will allow for expanded recommendations based on improvements to enhance passage for terrestrial wildlife. The assessment aims to answer the following question—to what extent are terrestrial wildlife likely to pass through the road-stream crossing?

RELATION TO AQUATIC STREAM CROSSING SURVEY

This terrestrial passage assessment may be used alone, or in conjunction with the aquatic stream crossing survey depending on the priorities of the surveyors. If you are surveying a passage that has already been surveyed for aquatic connectivity in the NAACC database, it is very important to match the crossing codes so that it is clear the terrestrial passage survey being filled out refers to an existing crossing with a known aquatic connectivity score (more details on "crossing code" in the next section). Finally, if you are surveying a passage for terrestrial connectivity that has previously been surveyed for aquatic connectivity, but the structure looks new or recently replaced, it is recommended you re-do the full aquatic stream crossing survey.

DATA COLLECTION

The survey data form is to be used for an entire road-stream crossing, which may include single or multiple culverts or multiple cell bridges. On the first page, the top of the form contains general information about the crossing, and the bottom half of that page is for data on the first (or only) structure at the crossing. Subsequent pages are used to add data where there are additional culverts or bridge cells.

Multiple culvert/cell crossings could provide more than one way for wildlife to cross, and may be quite different in terms of substrate. Accordingly, it is essential to gather all of the data required for each structure (pipe or bridge cell) for an accurate assessment of the entire crossing.

Stream crossing survey data can be collected digitally on a variety of devices, including tablet computers and smart phones. At the time of this writing, terrestrial passage assessment data cannot be entered into the NAACC database, but can in the interim be uploaded to a Massachusetts Department of Fish and Wildlife site. Please reach out to Jessie Levine for further instructions while the NAACC online database is in the process of being updated.

Please be sure to complete every possible element of the field data form.

SURVEY PLANNING

SAFETY

Streams can be hazardous places, so take care to sensibly evaluate risks before you begin a survey at each stream crossing. While these efforts to record data about crossings are important, they are not nearly as important as your safety and well-being. Working around roads can be dangerous, so be sure to wear highly visible clothing, preferably safety vests in bright colors with reflective material; some vests have the additional bonus of containing many pockets to hold gear. Take care when parking and exiting your vehicle, and when crossing busy roads.

These surveys are best undertaken by teams of two people. This will facilitate taking measurements, making decisions in challenging situations, and recording data.

Take measurements seriously and carefully, but make estimates if necessary for your safety. Avoid wading into streams – even small ones – at high flows and entering pools of unknown depths, and take care scaling steep and rocky embankments. There are usually ways to effectively estimate some dimensions without risk. For example, an accurate laser rangefinder is a safe way to measure longer distances when conditions are unsafe, such as measuring culvert lengths through them instead of across busy roads.

AVOIDING THE SPREAD OF INVASIVE SPECIES

Stream crossing inventory work may place NAACC observers in situations where they inadvertently contribute to the spread of aquatic invasive species (AIS), particularly when they cross watershed boundaries. AIS are harmful non-native plants, animals, and microorganisms living in some aquatic habitats that damage ecosystems or threaten commercial, agricultural, and recreational activities. The following best management practices are recommended for NAACC observers to prevent the spread of AIS between drainage basins.

<u>Survey planning:</u>

- Complete surveys of HUC12 watersheds one at a time. Staying within a HUC12 rather than changing sub-basins can help stop the spread of invasive species.
- Whenever possible, start surveying stream crossing sites at the upstream end of a HUC12 watershed and progress downstream over the course of the day. Invasive species are naturally moved downstream by streamflow but do not easily move upstream on their own. By progressing from upstream to downstream in surveys, observers can avoid helping move invasive species to upstream locations.
- Do not use waders with felt soles.
- In waters known to contain invasive species, try to avoid entering the stream to take measurements. This may not be possible at many sites but could be at some.

<u>Between site surveys</u>:

- Before leaving a survey site, clean, drain, and dry (or treat) equipment. Clean equipment by inspecting it for attached mud, plants, and debris. Remove and dispose of anything found. Scrub equipment with a stiff brush and rinse with water. Drain any standing water in waders and other equipment.
- Keep a plastic drum filled with bleach or quaternary ammonia solution (which is less harmful on gear than bleach) in the back of the vehicle and put the wading boots in the drum while driving to the next site.

- When survey schedules or logistics prevent cleaning and drying/treating of equipment, a set of duplicate wading boots are recommended when observers change watershed boundaries during a single day. Observers should change into dry boots before surveying crossings in new watersheds and cycle the previous pair to be clean and dry for the following day.

At the end of the day, or when moving between HUC12 watersheds, use one of these options:

- Dry equipment completely for at least 48 hours. Preferable ways to dry equipment include direct sunlight, a heated garage, or a boot drying device such as a PEET Dryer device.
- Soak or spray equipment with a mild bleach solution (1 Tbsp bleach per gallon of water) for 10 minutes. The bleach solution must be mixed daily to maintain its effectiveness after 24 hours.
- Visit a "wader wash" station, if available.
- Freeze equipment for 6-8 hours.

EQUIPMENT

To collect data on stream crossing structures, you will need several essential pieces of equipment for measuring and recording, and some other items to keep you healthy and safe:

- ✓ **Instruction Guide for the NAACC Terrestrial Passage Assessment Survey Data Form** (this document)
- ✓ **Measuring Implements** in feet and tenths (decimal feet rather than inches)
  - **Reel Tape:** For measuring structure lengths and channel widths; 100 feet.
  - **Pocket Tape:** Best in 6 foot "Pocket Rod" version with no spring to rust.
  - **Stadia Rod:** Telescoping, 13 feet long to measure structure dimensions such as height above terrestrial passage.
- ✓ **Safety Vests:** Brightly colored, reflective vests, preferably with lots of pockets to hold equipment, but most importantly to be seen on the road.
- ✓ **Waders or Hip Boots:** To stay dry, insulate from cold water, minimize abrasions, and allow access to tailwater pools and deeper streams**.**
- ✓ **Flashlight:** To be able to see features inside long dark structures.
- ✓ **Rangefinder** (optional): To safely take measurements without crossing structures, busy roadways or streams; should be accurate to within one foot for adequate data accuracy.
- ✓ **Sun Protection:** Hat, sunglasses, and sunscreen as needed.
- ✓ **Insect Repellent:** To protect from annoying or dangerous bites.
- ✓ **First Aid Kit:** To deal with any minor injuries, cuts, scrapes, etc.
- ✓ **Cell Phone:** In case of emergency, to coordinate surveys, or to ask questions of coordinators.
- ✓ **Tracking and Scat Guides (optional):** to identify tracks and scat. Suggestions include:
  - Mammal Tracks and Scat Life-Size Pocket Guide Lynn Levine & Martha Mitchell. Heartwood Press. www.heartwoodpress.com (Pocket guide)
  - Local Tracks of North America: "Quick Guide" to Commonly Seen Animal Tracks and Scats. Local Birds Inc., 2010. www.Localbirds.com (Pocket guide)
  - Mammal Tracks & Sign: A Guide to North American Species. 2003. Mark Elbroch. Stackpole Books, Mechanicsburg, PA. (Large field guide)

For Paper Surveys:

- ✓ **Terrestrial Passage Assessment Survey Forms**: Best printed on waterproof paper. Bring along more than you expect to use. Even digital surveys should include these in case a digital device becomes inoperable.
- ✓ **Clipboard**, **Pencils & Erasers**
- ✓ **Stream Crossing Maps**: For planning sites to survey, and for recording sites assessed, a *DeLorme Atlas and*

Gazeteer or similarly accurate and updated set of maps with topography is helpful for navigation.

- ✓ **GPS Receiver**: Set GPS to collect data in WGS84 datum, with Latitude and Longitude in decimal degrees.
- ✓ **Digital Camera**: Best if waterproof and shockproof, with sufficient battery power for a full day of surveying, and capable of storing approximately 100 low to moderate resolution images (approximately 100 - 500 kilobyte stored size, generally less than 1 million pixels–1 megapixel). Include batteries or battery charger, and download cable. A backup memory chip can be very useful to have on hand.

For Digital Surveys:

- ✓ **Tablet Computer or smartphone:** Should be waterproof, and preferably shockproof, to be able to survive wet and rugged field conditions. Various mapping applications can be run to allow navigation to planned survey sites, replacing paper maps. For more information on this method of survey, refer to the NAACC Digital Data Collection User's Guide available at https://www.streamcontinuity.org/resources/naacc_documents.htm *(Note: As of 2018 digital data entry of terrestrial passage surveys is not yet available.)*
- ✓ **GPS Receiver:** If not integral to the tablet computer or smartphone, an external GPS device will be needed either to connect to the tablet via Bluetooth or wire, or at the least, to be able to provide correct coordinates for entering to the tablet manually.
- ✓ **Terrestrial Passage Assessment Survey Forms**: As a backup in case digital devices fail.

UNMAPPED SITES AND NONEXISTENT CROSSINGS

Survey teams may encounter unmapped crossings, or it may be unclear whether a crossing they have found in the field is on their map because its location does not match the map. In most cases, the surveyed crossing should be within 100-200 feet of the planned crossing. Survey teams also may encounter unmapped crossings because either the road was not mapped, as in the case of a road built to serve a new housing development, or because of an error in the road or stream data.

If there is no planned crossing near the site you are assessing, you need to assign a temporary *Crossing Code* to that crossing. A *Crossing Code* is composed of the prefix "xy" followed by the latitude and longitude of the site, with decimal degree latitude and longitude values as seven-digit numbers. For instance, a crossing located at 42.32914 degrees north and -72.67522 degrees west, will have the resulting *xy code* = "xy42329147267522," followed by the notation: "NEW XY" to indicate that this crossing site must be added to the map.

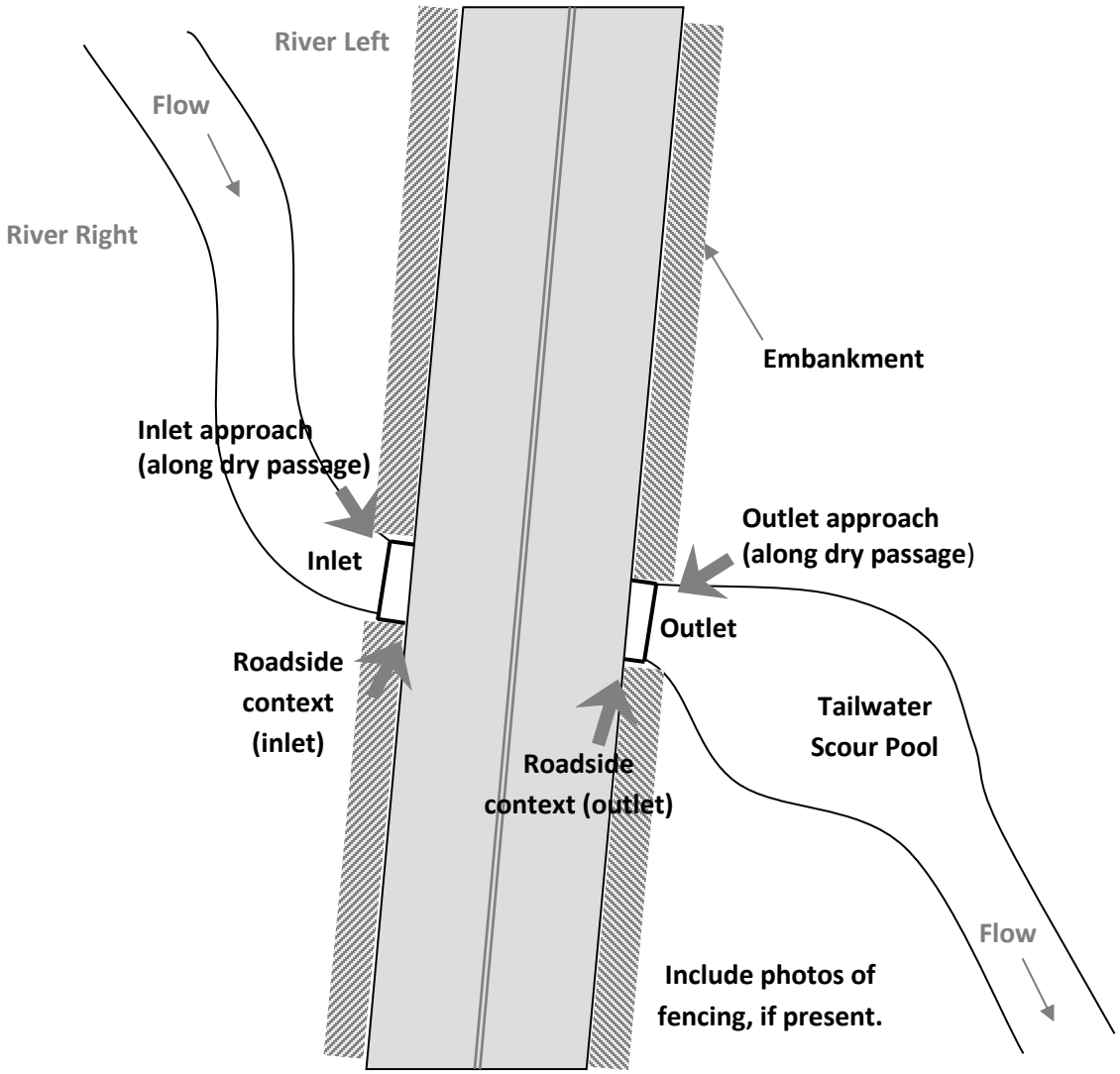
Conversely, a crossing may exist on the map but not in the field. If you try to navigate to a site and are certain that there is no crossing in the vicinity, you should select the "No Crossing" option for *Crossing Type* on the field data form. Some crossings may not actually exist due to errors in generating the crossing points. Another possibility is that there may have been a road crossing there at one time, but the crossing has been removed, but may still need to be surveyed to note passage problems. For these sites, you will select the "Removed Crossing" option. Similarly, sometimes an entire stream reach has been moved, particularly underground, in which case you will select the "Buried Stream" *Crossing Type*.

In all cases where a survey crew either cannot locate a mapped crossing or intends to add a new unmapped crossing, it is essential to check the location carefully to minimize navigation and data collection errors.

COMPLETING THE SURVEY DATA FORM

SITE IDENTIFICATION

While each crossing will be different from others in its details, many common features will be assessed, measured, or otherwise observed during all surveys. The diagram below contains the basic terminology for key stream crossing features in a simplified overhead view. Refer to page 8 and 9 for examples of the required photos.



CROSSING DATA

Complete this section for the entire crossing. Choose only one option for the fields with checkboxes in the crossing data section (except for the last field "Conditions that may Inhibit Wildlife from Crossing Over the Road", where you may select all that apply).

Crossing Code: This is the 18-character "xy code" assigned to each planned survey crossing on survey maps. Be very careful to record the correct numbers, as they represent the precise latitude and longitude of the planned crossing, which can be compared with the actual location you record as GPS Coordinates below. If a structure has been assessed for aquatic passage using another NAACC protocol and is in the NAACC database, it is very important to match the crossing codes so that it is clear the terrestrial passage survey being filled out refers to an existing crossing with a known aquatic connectivity score.

Local ID: Optional field for a program's own coding systems. Does NOT replace the Crossing Code.

Date Observed: Date that the crossing was evaluated, following the form *M/D/Y*.

Lead Observer: The name of the survey team leader responsible for the quality of the data collected.

Town/County: The town or county in which the assessed crossing is located according to the map.

Stream/River: The name of the stream or river taken from the map, or if not named on the map, the name as known locally, or otherwise list as *Unnamed*.

Road: The name of the road taken from the map or from a road sign. Numbered roads should be listed as "Route #", where # is the route number, with multiple numbers separated by "/" when routes overlap at the crossing (e.g., "Route 1/95"). For driveways, trails, or railroads lacking known names, enter *Unnamed*.

Road Type: Choose only one option:

Multilane: > 2 lanes, including divided highways (assumed paved)

Paved: public or private roads

Unpaved: public or private roads

Driveway: serving only one or two houses or businesses (paved or unpaved)

Trail: primarily unpaved, or for all-terrain vehicles only, but includes paved recreational paths

Railroad: with tracks, whether or not currently used

GPS Coordinates: Latitude and Longitude in decimal degrees to 5 decimal places. Use of a GPS (Global Positioning System) receiver is required, but your smart phone or tablet computer may include this capability.

Map Datum: It is best to use *WGS84* datum.

Location Format: Use Latitude-Longitude decimal-degrees (often in GPS menu as "hddd.ddddd").

You should stand above the stream centerline, and ideally on the road centerline, when taking the GPS point, but use your judgment and beware of traffic.

Location Description: If there is any doubt about whether someone could find this crossing again, provide enough information about the exact location of the crossing so that others with your data sheet would be confident that they are at the same crossing that you evaluated. For example, the description might include "between houses at 162 and 164 Smith Road," "across from the Depot Restaurant," or "driveway north of Smith Road off Route 193." This information could also include additional location information, such as a site identification number used by road owners or managers.

Crossing Type: If a crossing is found at the planned location, choose the one most appropriate option.

Bridge: A bridge has a deck supported by abutments (or stream banks). It may have more than one cell or section separated by one or more piers.

Culvert: A culvert consists of a structure buried under some amount of fill.

Multiple Culvert: If there is more than one culvert that is part of a single crossing structure, for example two pipes next to each other that together pass water from a single stream under the road.

Ford: A ford is a shallow, open stream crossing, in which vehicles pass through the water. Fords may be armored to decrease erosion, and may include pipes to allow flow through the ford (*vented ford*).

If a planned crossing cannot be found or surveyed, the site will fit one of the following types:

No Crossing: There is no crossing where anticipated, usually because of incorrect road or stream location on maps. No further data is required. (Be sure you are in the correct location.)

Removed Crossing: A crossing apparently existed previously at the site but has been removed, so the stream now flows through the site with no provision for vehicles to cross over it. Continue to complete the survey form to the extent possible. Include information in Crossing Comments to explain your observations. For instance, indicate if an old culvert pipe is seen at the site, or if removal of the previous crossing structure left the stream with problems for aquatic organism passage.

Buried Stream: The planned crossing site does not include an inlet and/or outlet, likely because a stream previously in this location has been rerouted, probably underground. In this case, survey is not possible, and no further data is required.

Inaccessible: Survey is not possible because roads or trails to the crossing are not accessible. This may be due to private property posting, gates, poor condition, or other factors. Record in Crossing Comments why the site is inaccessible. No further data is required.

Partially Inaccessible: Use this option when you can access a crossing well enough to collect some but not all required data. This is most likely to occur when you cannot access either the inlet or outlet side of a crossing and cannot reasonably estimate the dimensions or assess things like inlet grade, outlet grade, scour pool or tailwater armoring.

Adequate Terrestrial Passage: Much like “bridge adequate” for aquatic passage surveys, observers have the option of using this classification for large bridges or large open-bottomed culverts where it is obvious that the culvert or bridge presents no barrier for any of the wildlife listed in the table at the bottom of the datasheet, from small mammals, snakes and lizards, up through moose. Observers should still take at least two photos to provide context (and create a complete database record), but do not need to fill out any other portions of the data sheet. Structures that would be appropriately classified as “Adequate Terrestrial Passage” are rare.

Number of Culverts/Bridge Cells: For all bridges with multiple sections or cells, and for all multiple culverts, you must enter the number of those cells or culvert structures here.

Photo IDs: All surveys should include the following photos:

Inlet Context: 1 photo of roadside situation (inlet side) to show landscape context (view of road and road shoulder, standing in the shoulder parallel to the road). Example photos below:



Inlet Approach: Photo of inlet approach of dry passage facing structure (close up). Photo should show where an animal would walk to enter the inlet across dry passage. Example photos below:



Outlet Context: 1 photo of roadside situation (outlet side) to show landscape context (view of road and road shoulder, standing in the shoulder parallel to the road). See examples for inlet context.

Outlet Approach: Photo of outlet approach of dry passage facing structure (close up). Photo should show where an animal would walk to enter the inlet across dry passage. See examples for inlet approach.

Other: Anything else about the site that is important to document. Ex: photos of right-of-way or guide fencing if present, steep embankments, etc.

It is essential that all photos be associated with the correct crossing. If you take photos with a digital camera (and sometimes when using a smart phone or tablet computer), you should record the photo numbers assigned by the camera on the survey form in the space for each photo perspective. To record the correct photo numbers from any camera, each person taking photos must be familiar with the numbering system of the camera used. Record the ID number of each photo in the blanks on the data form. It is highly recommended that you rename photos and either upload them to the temporary database or otherwise store them with a particular crossing shortly after returning from the field. It can be surprisingly easy to lose track of which photos came from which crossing, especially on iPads or other devices that re-use photo numbers or associate them with a time of day taken.

One approach for keeping track of photos is to make the first photo at each site an image of the field data sheet with the xycode and location information. All other photos of that crossing should immediately follow the photo of data form (with the xycode). It is important to remember to photograph the data form first, before you take any other photos for each crossing. Otherwise, you risk mixing up photos from different crossings.

While you may take multiple photos at a site, in order to choose the best ones later, you must record on the data form the ID numbers of all photos taken at the site. It can be very helpful to have one or more additional photos, especially when important characteristics are not captured on the four required photos. For instance, if there are steep embankments at the site, or if other aspects of the crossing make it a likely barrier to connectivity, it is useful to capture these with one or two additional photos.

Here are several additional tips for taking useful photos:

- Always include more than just the structure or stream area you are photographing; it is better to capture more context. Remember that with digital photos, we can zoom in to see detail.
- Including a stadia rod or other reference in photos of the inlet and outlet can be valuable to verify some measurements, and as a general reference for scale.
- When available, use a date/time stamp to code each photo.
- Set your camera to record in low to medium resolution so that the photos do not take up too much space on the memory card and when downloaded for storage. To minimize storage space but still allow a reasonable quality image, each photo should be between 100 and 500 kilobytes in size when downloaded. This often equates to a camera resolution setting of “1 Megapixel.”
- Review photos at the site to discard bad photos and to be sure all perspectives are well represented.
- If you haven’t used the camera before, practice to be sure you know how to take photos in dark or mixed light situations, as these often exist when surveying stream crossings.

Flow Condition: Check the appropriate box to indicate how much water is flowing in the stream. Normally, the value selected for the first perennial crossing of the day will hold for all perennial sites in the area during that day, unless a rainfall event changes the situation. Choose only one option.

> *No Flow*: No water is flowing in the natural stream channel; this option is typical of extreme droughts for perennial streams, or frequent conditions for intermittent or ephemeral streams.
>
> *Typical-Low*: This is the most commonly used and expected value for surveys conducted during summer low flows, particularly on perennial streams. Water level in the stream will typically be below the level of non-aquatic vegetation, exposing portions of stream banks and bottom.
>
> *Moderate*: This value is selected when recent rains have raised water levels at or above the level of herbaceous (non-woody) stream bank vegetation.
>
> *High*: This value is selected only rarely, when flows are very high relative to stream banks, making

crossing surveys very difficult or impossible, normally due to very recent, or ongoing major rain events. Avoid surveying crossings under high flows as data will not reflect more frequent flow conditions.

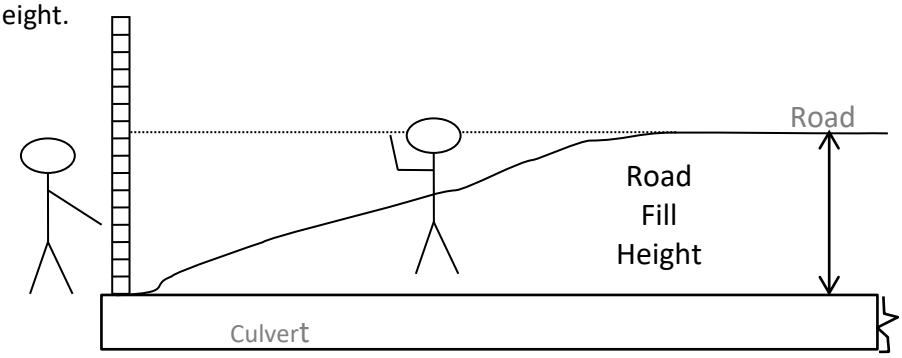
Tidal Site: Sites in tidal areas will often require additional survey to fully assess aquatic organism passage. This element is primarily meant to identify sites in a tidal zone. Choose only one option. Survey of tidal crossings is best done within one hour of low tide to improve access and provide the most useful data. Freshwater streams influenced by tides, often at great distances from the ocean, are more difficult to identify. Coordinators working in such areas should provide Lead Observers with guidance on survey of such sites.

Yes: Evidence shows that tidal waters regularly reach the crossing site. Evidence includes a clear wrack line (line of debris) marking the limit of recent tides. Other indications include observation of salt marsh plants (*spartina spp.*, not upland vegetation or freshwater wetland plants like cattails and common reed (*phragmites*), though both of these wetland plants *can* exist on the fringes of salt marshes) in the vicinity.

No: Sites are not tidal if downstream banks obviously contain plants that could not survive salt water inundation, such as alders, maples, ferns, etc., normally seen on stream banks in upland areas.

Unknown: Select when unsure of whether a crossing is in a tidal zone.

Road Fill Height: Within 1 foot, measure the height of fill material between the top of the crossing structure(s) and the road surface. This is best measured with two people when the road surface or fill height is above a surveyor's height, with one person holding a stadia rod, and the other sighting the elevation of the road surface from the side (see diagram below). For multiple culverts with differing amounts of fill over them, provide an average fill height.



Human Activity at/Through Crossing: There are varying examples of human activity and it may be hard to distinguish how frequently it occurs. Use your best judgement to select from the three options below based on some of the examples provided.

Frequent (daily): Presence of fresh footprints, tire marks or garbage around or through the crossing.

Infrequent: Presence of old garbage, graffiti, or other signs of human activity that appear to have been around for a while.

None: No evidence whatsoever of human activity.

Unknown: Select this option if you think people might be using the crossing, but are not sure.

Scour Pool Barrier: This is a pool created downstream of a crossing as a result of high flows exiting the crossing. Use as a reference natural pools in a portion of the stream that is outside the influence of the crossing structure. A scour pool is considered to exist when its size (a combination of length, width, and depth) is larger than pools found in the natural stream.

None: There is no tailwater scour pool.

Partial: A scour pool exists but only partially obstructs the path into the crossing structures

Complete: A scour pool exists that completely obstructs the path into the crossing structures

Livestock at/Through Crossing: Select "yes" if any livestock tracks or scat are detected at or through the crossing. Otherwise, choose either "no" or "unknown." Select "unknown" if you think livestock might be using the crossing, but are not sure.

Right-of-Way-Fencing: This refers to fencing that is in the road right-of-way, such as chain link fencing to keep humans off the road, or decorative fencing installed by a homeowner that is in the right of way but not against the road. Choose the most appropriate option for both the inlet and outlet side of the road.

None
Chain link
Wire mesh
Barbed wire
Post and cable
Other (describe in the comments box)

Guide Fencing: This refers to fencing specifically designed to guide wildlife to a crossing structure. Examples include 6-foot deer fencing from the road to the edge of a culvert or bridge, or lower fencing to funnel turtles and salamanders to a crossing structure. Use the Comments box to describe the guide fencing.

None
Inlet side only
Outlet side only
Both sides

The photo below shows guide fencing, on the left, giving way to right-of-way fencing, on the right.

Conditions that May Inhibit Wildlife from Crossing Over the Road:
Indicate which, if any, of these conditions are present by checking the box that corresponds to the most severe inhibiting condition, and listing any additional conditions in the comment section:

Steep embankments: The slope between the roadside edge and the bottom of the structure is greater than 1:1 and the height of the embankment is greater than 15 feet.

Roadway Fencing: Whether designed as a roadway barrier or not, fencing that could prevent animals from crossing the road near the structure.

Retaining Walls: Human-made walls of concrete, stone or other material used to either support the edge of the roadway or a nearby steep bank.

Noise Barriers: Human-made walls along the roadside edge designed to block roadway noise from nearby areas. (These are most common on major highways bordering neighborhoods).

Jersey Barriers: Modular concrete or plastic barriers used to separate lanes of traffic. These are common as a temporary solution to reroute traffic or protect workers in areas with road work. (Comment in the box below if it appears to be temporary.)

Vertical Faces of Road Cut: A vertical or nearly vertical rock face, much steeper than an embankment.

High Traffic Volume (describe below): High traffic volume is considered over 5,000 vehicles per day. Note that traffic volume at night will be significantly lower than during the daytime.

Other: Choose this option if there are other conditions that would inhibit wildlife from crossing over the road and describe these conditions in the Crossing Comments section.

None: Choose this option if there are no conditions that would inhibit wildlife from crossing over the road surface.

Crossing Comments: Use this box to note any unusual characteristics of the crossing. Use this space also to provide detail when you check high traffic volume for "Conditions that may Inhibit Wildlife from Crossing Over the Road" and when selecting "other" for any metric.

STRUCTURE DATA

Choose only one option for structure data fields **except** when identifying "Dry Passage Substrate."

When there are multiple culverts and/or bridge cells, number them from left to right, while looking downstream toward the culvert inlet. The left-most structure is Structure 1, and structure numbers increase to the right. See examples below. When entering data via the ODM or data entry screen make sure that you enter the structures in the same order in which they are numbered.

For each structure, you will complete the following information.

Outlet Shape: Record here the structure number that best matches the shape of the structure at its outlet. This is usually simple, but when a shape seems unusual, you should carefully choose the most reasonable option from among the seven available. We collect this information to be able to find the "open area" inside the structure above any water or substrate, so the shape is vital to accurately calculate area. Choose only one

option. Diagrams are on the last page of the field data form, and descriptions and example photos are below.

1 - Round Culvert: This is a circular pipe. It may or may not have substrate inside, even though the diagram on the field form shows a layer of substrate. It may be compressed slightly in one dimension, and should be considered round unless it is truly squashed so that it reflects a type 2 shape below.




2 - Pipe Arch/Elliptical Culvert: This is essentially a squashed round culvert, where the lower portion is flatter, and the upper portion is a semicircular arch, or as on the right below, more of a pure ellipse. It may or may not have substrate inside (the diagram on the field form shows a layer of substrate).




3 - Open Bottom Arch Bridge/Culvert: This structure will often look like a round culvert on the top half, but it will not have a bottom. There will be some sort of footings to stabilize it, either buried metal or concrete footings, or concrete footings that rise some height above the channel bottom. There will be natural substrate throughout the structure. To distinguish between an embedded Pipe Arch Culvert and an Open Bottom Arch, note that the sides of the Pipe Arch curve inward in their lower section, while the sides of the Open Bottom Arch will run straight downward into the streambed substrate or to a vertical footing. Beware of confusion between an Open Bottom Arch and an embedded Round Culvert; Open Bottom Arches tend to be larger than most Round Culverts. This shape could also be selected for certain bridges that have a similar arched shape and are not well represented by other bridge types (Types 5, 6, 7, below).




4 - Box Culvert: These structures are usually made of concrete or stone, but sometimes of corrugated metal with a slightly arched top. Typically, they have a top, two sides, and a bottom.

A box culvert <u>without</u> a bottom, called a bottomless box culvert, should be classified as a *Box/Bridge with Abutments* (#6, below). If you cannot tell if the structure has a bottom, classify it as a *Box/Bridge with Abutments* (#6). The images below show *Box Culverts* (#4).




5 - Bridge with Side Slopes: This is a bridge with angled banks up to the bottom of the road deck. This type will have no obvious abutments, though they may be buried in the road fill.




6 - Box/Bridge with Abutments: This is a bridge or bottomless box culvert with vertical sides.




7 - Bridge with Abutments and Side Slopes: This is a bridge with sloping banks and vertical abutments (typically short) that support the bridge deck. (Arrows below show the abutments.)

Ford: Select this option if the crossing is a ford.

Unknown: Select this option if the shape of the structure is unknown (ex: if the structure is submerged or completely blocked with debris).

Removed: Select this option if the structure has been removed.

Clogged/Collapsed/Submerged: The structure outlet is either full of debris, collapsed, or completely underwater (not usually all three), making outlet measurements impossible. This may be found in places where beavers or sediment have plugged or inundated a structure so completely that water has backed up and covered the outlet, or where a crossing has collapsed to the point that it cannot be measured at its outlet. **Chose this option only if you are unable to collect data on outlet dimensions.**

Outlet Dimensions: Four measurements should be taken at the outlet and inside all structures, and a fifth measurement is needed for bridges with side slopes and abutments. These measurements are shown on the diagrams on the last page of the field data form.

Dimension A, ***Structure Width***: To the nearest tenth of a foot, measure the full width of the structure outlet according to the location of the horizontal arrows labeled ***A*** in the diagrams. Take this measurement **inside** the structure.

Dimension B, ***Structure Height***: To the nearest tenth of a foot, measure the height of the structure outlet according to the location of the vertical arrows labeled ***B*** in the diagrams. Take this measurement **inside** the structure. If there is no substrate inside, this will be the full height of a structure from bottom to top. If there is substrate inside, this will be the height from the top of the stream bottom substrate up to the inside top of the structure.

*Dimension C, **Substrate/Water Width***: To the nearest tenth of a foot, measure the width of the substrate layer or of the water surface in the bottom of the structure, according to the general location indicated by the arrows labeled ***C*** in the diagrams. This measurement must be taken **inside** the structure near the outlet. Some rules of thumb for Dimension C are below:

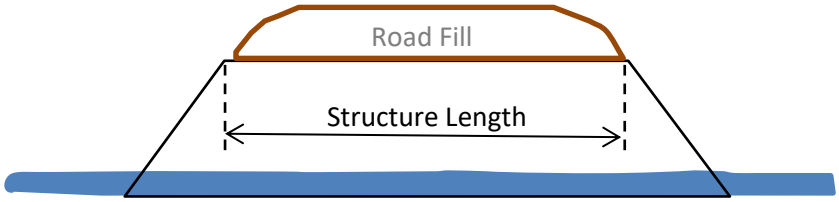
- When there is no substrate in a structure, measure only the width of the water surface.
- When there is no water in a structure, but there is substrate, measure the width of substrate.
- When there are both water and substrate in the structure, measure the width of water plus substrate.
- When there is no substrate or water in a structure, C = 0.

*Dimension D, **Water Depth***: To the nearest tenth of a foot (except when < 0.1 foot, to the nearest hundredth of a foot), measure the average depth of water in the structure at the outlet according to the location of the vertical arrows labeled ***D*** in the diagrams. This measurement must be taken **inside** the structure. When there are lots of different depths due to a very uneven bottom, take several measurements and record the average. For fords, measure the water depth at the downstream limit of the ford.

Dimension E, ***Abutment Height***: This fifth measurement is taken only when surveying a Bridge with Side Slopes and Abutments (#7 structure). To the nearest foot, measure the height of the vertical abutments from the top of the side slopes up to the bottom of the bridge deck structure.




Structure Length, *Dimension L*: To the nearest foot, measure the length of the largest structure at its top.



Inlet Shape: Refer to the diagrams on the last page of the field data form, and record here the number that best matches the shape of the structure at its inlet. Refer to the previous instructions for **Outlet Shape** for descriptions and example photos.

Clogged/Collapsed/Submerged: Choose this option if the structure inlet is either full of debris, collapsed, or completely underwater (not usually all three), making inlet measurements impossible. This may be found in places where beavers or debris have plugged a structure inlet so completely that water has backed up and covered the inlet, or where a crossing has collapsed to the point that it cannot be measured at its inlet. **Chose this option only if you are unable to collect data on inlet dimensions.**

Inlet Dimensions: There are four basic measurements to take at the inlet of each structure; these four measurements are to be made inside the structure. These are shown on the diagrams on the last page of the field data form. Refer to the previous instructions for **Outlet Dimensions** for further description.

Clear Line of Sight Through Structure: This is a measure of how well you can see through to the other end of the structure.

Yes: You can see all the way through the structure to the full opening on the other end. (Brighter lighting).

Partial: You can see partly through the structure. *S*omething is obstructing the view to see the full opening on the other end. (Dimmer lighting).

No: You cannot see the opening on the other end whatsoever. (Darker lighting).

Continuous Dry Passage Through Structure? Consider this question two different ways, depending on whether water is flowing through the structure. Choose only one option.

If there is water flowing in the structure: Is there a continuous dry pathway through at least one side of the

structure that allows the safe movement of terrestrial or semi-aquatic animals, and does this dry pathway connect to the stream banks upstream and downstream of the structure?

If there is no water flowing in the structure: then there is continuous dry passage through the structure.

Yes: A continuous bank connects upstream, through the structure, and downstream, or there is otherwise continuous dry passage through the structure.

Partial: There is partial dry passage through the structure. This could include passage that has shallow water running over the substrate that many animals could wade through, or dry passage through most of the structure but with short sections of water between sections of dry substrate.

No: There is no dry passage whatsoever through the structure.

Unknown: It is not possible to determine if continuous dry passage exists through this structure.

Minimum Width of Dry Passage: If there is dry passage through the structure, measure the width at the narrowest point, in feet and tenths of feet.

Minimum Height above Dry Passage: If there is dry passage through the structure, measure the height from top of dry passage to top of the structure where the clearance is highest, in feet and tenths of feet. Take this measurement at several points inside the structure if the height over dry passage varies through the structure. (See example photo below.) Record the lowest measurement on the data sheet. For example, if the height over dry passage at the inlet is 11 feet, and then in the middle of the culvert sediment is built up such that the height over dry passage is only 9 feet, record 9 feet as your measurement.

For this box culvert, the red arrow shows where to measure height above dry passage at the inlet – there is more clearance here than there is in the middle of the culvert immediately to the left, where rocks and sediment have mounded up. The yellow arrow shows where to measure height above dry passage at the

outlet – height of the yellow arrow is greater than that of the red arrow since there is no built up rock and sediment. On the datasheet, you would enter the height of the *red* arrow: the point along the dry passage where even an animal aiming for the highest clearance might have to duck its head to pass through.

If both stream banks are dry and connected, record the height on the side more suitable for terrestrial passage. The notes field can be essential here. If the structure has no water flow, use the dry stream as the dry passage surface for the measurement, as described above.

Substrate of Dry Passage: Dry passage as used here, means an area of exposed soil or other substrate that has the potential to be used to cross through a structure by wildlife that prefer to not to wade through standing or running water. Consider the predominant substrate of the dry passage. The passage may be mostly sand/silt, with a portion of cobble in the middle. Or, there may be no natural substrate, and the dry passage is corrugated metal or concrete. Choose the checkbox that refers to the predominant substrate, and use the comments field to describe additional substrate or substrates. Options include:

- *Sand/silt*
- *Gravel*
- *Cobble*
- *Boulder*
- *Bedrock*
- *Riprap*
- *Concrete*
- *Metal*
- *Plastic*
- *Other (describe in structure comment box)*
- *Unknown*

Comments: Use this area to briefly comment on any aspects of the structure, dry passage, fencing, or context of the roadway needing more information. This is a good place to capture recommendations that would maintain or enhance terrestrial passage, and conditions that might make it unlikely or unnecessary for wildlife to cross through the structure rather than over the road itself.

DRY PASSAGE SUITABILITY

For each class of animals, choose the descriptor that best describes the **suitability of dry passage** within the structure.

None: There is no dry passage whatsoever through the structure

Inadequate: There is some form of dry passage (some animals of the given class might pass through) but wildlife use is unlikely.

Moderately usable: Animals of the given class might be expected to pass through roughly half of the time, but there is a condition that discourages or prevents frequent passage.

Good: Dry passage exists, and most animals of the given class would pass through, but some (much less than half) would be discouraged or prevented from passing through.

Excellent: Dry passage exists and presents no barrier to animals of the given class.

Guidance on how to evaluate dry passage for various groups of animals is provided in the table below**.**

Dry Passage Suitability:

	Substrate type	**Dry passage width**	**Height over dry passage**	**Connection to banks**	**Other**
Small mammals and squamates	Prefer natural substrate but may use artificial substrate or ramps; uneven substrate such as all cobbles or boulders is a problem for many species	Minimum: dry passage ≥ 12 inches		Necessary for squamates and most small mammals though some can jump short distances	*Cover within or at least adjacent to structure would enhance passability
Medium mammals and turtles	Prefer natural substrate but may use artificial substrate or ramps; rock size is critical for turtles	Minimum: dry passage ≥ 18 inches	≥ 3 feet	Mammals can jump or wade up to 3’	
Bobcat, lynx	Doesn’t matter	Minimum: dry passage, ≥18 inches	≥ 4 feet	Can jump up to 4’	
Bear, coyote, cougar, wolf	Doesn’t matter	Minimum: dry passage, ≥ 2 feet	≥ 6 feet	Can jump or wade up to 6’	
Deer	Inappropriate: large boulders or riprap, gabion baskets, and steep side slopes	Minimum: dry or flat, wadeable (≤ 18 inches), area ≥ 6 feet wide	≥ 8 feet	Doesn’t matter	
Moose	Inappropriate: large boulders or riprap, gabion baskets, and steep side slopes	Minimum: dry or flat, wadeable (≤ 30 inches) area ≥ 10 feet wide	≥ 10 feet	Doesn’t matter	

PHYSICAL BARRIER SEVERITY

For each class of animals, choose the descriptor that best describes the **severity of physical barriers associated** with the structure. Guidance on how to evaluate barrier severity for various groups of animals is provided in the following table. Note that height over dry passage is considered in the ranking for dry passage suitability, and is purposely omitted here so as not to double-count height when developing a terrestrial passage score.

No passage: no passage whatsoever through the structure

Severe barrier: A physical barrier exists that makes it unlikely that wildlife will be able to cross through the structure.

Moderate barrier: Animals of the given class might be expected to pass through roughly half of the time, but there is a physical barrier that discourages or prevent frequent passage.

Minor barrier: A physical barrier exists but that might be inconvenient or discouraging enough to keep some (much less than half) of the animals of the given class from passing through.

No barrier: No barrier to animals of the given class.

Physical Barrier Severity:

	Inlet and outlet grade and free fall	**Debris/ sediment/ rock**	**Fencing**	**Scour pool (depth, width)**
Small mammals and squamates	OK: cascades, but not freefalls	Large debris or rocks can be a barrier	4x4 mesh or larger OK	Necessary: No scour pool that completely obstructs access or scour pool that can be jumped over
Medium mammals and turtles	Ideal: no inlet or outlet drop OK: drop < 12 inches (mammals)	Large rocks a barrier for turtles	Standard barbed wire fencing OK if bottom strand > 6" above ground; Other fencing OK if > 6" gaps underneath	Necessary: No scour pool that completely obstructs access or scour pool that can be jumped over
Bobcat, lynx	Ideal: no inlet or outlet drop OK: drop < 12 inches	Not important	Standard barbed wire fencing OK if bottom strand > 12" above ground; Other fencing OK if < 2 feet tall	Ideal: no scour pool OK: depth < 6 inches and distance < 4 feet
Bear, coyote, cougar, wolf	Ideal: no inlet or outlet drop OK: drop < 12 inches	Not important	Standard barbed wire fencing OK if bottom strand > 12" above ground; Other fencing OK if < 3 feet tall	Ideal: no scour pool OK: depth < 6 inches and distance < 6 feet
Deer	Ideal: no inlet or outlet drop OK: drop < 12 inches	Large rocks can impede movement	Standard barbed wire fencing OK if bottom strand > 12" above ground; Other fencing OK if < 3 ft tall; marginally OK if 3-6 ft tall	Ideal: no scour pool OK: depth < 18 inches
Moose	Ideal: no inlet or outlet drop OK: drop < 12 inches	Large rocks can impede movement	Fencing OK if < 3 feet tall; marginally OK between 3-6 feet tall	Ideal: no scour pool OK: depth < 30 inches

Structure Comments: Use this area to briefly comment on any unusual aspects of the structure. Use this space also to provide detail when selecting “Other” for “Dry Passage Substrate” or expand upon physical barrier and dry passage conditions. Finally, use this space when you have suggestions for ways to make the passage more suitable for wildlife. Are there any conditions that could be addressed during maintenance that would improve terrestrial passage? Are there any recommendations you would make for modifications to the structure that would improve terrestrial passage/remove barriers to passage?