Statewide Asset Data Exchange System (SADES)

New Hampshire Stream Crossing Initiative

Field Manual

In Partnership with:

New Hampshire Department of Environmental Services
New Hampshire Geological Survey
New Hampshire Department of Transportation
New Hampshire Fish and Game Department
New Hampshire Department of Safety – Division of Homeland Security and Emergency Management
Association of New Hampshire Regional Planning Commissions
UNH Technology Transfer Center

Version: 8 (2019)

The New Hampshire Stream Crossing Initiative— A multiagency effort

The State of New Hampshire has formed an interagency workgroup to collaboratively manage the state's stream crossing assessment efforts, comprised of representatives from the New Hampshire Departments of Environmental Services (NHDES; New Hampshire Geological Survey and Wetlands Bureau) and Transportation (NHDOT), Fish and Game Department (NHFG), and The Division of Homeland Security and Emergency Management. This initiative has become possible due to the expertise of many people who have contributed their time and effort to develop and refine the stream crossing survey protocols, data management and methods for scoring stream crossings for their compatibility with local stream processes, as well as Aquatic Organism Passage. The multiagency approach of the New Hampshire Stream Crossing Initiative enables towns and agencies to more efficiently address the problem of undersized stream crossings, infrastructure safety, and flood risk management by working collaboratively.

New Hampshire DOT Department of Transportation

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

NEW HAMPSHIRE 1839 2001 GEOLOGICAL SURVEY

STATE OF NEW HAMPSHIRE LIVE FREE OR DIE FISH AND GAME

New Hampshire Technology Transfer Center

HSEM NEW HAMPSHIRE DEPARTMENT OF SAFETY

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Project Background

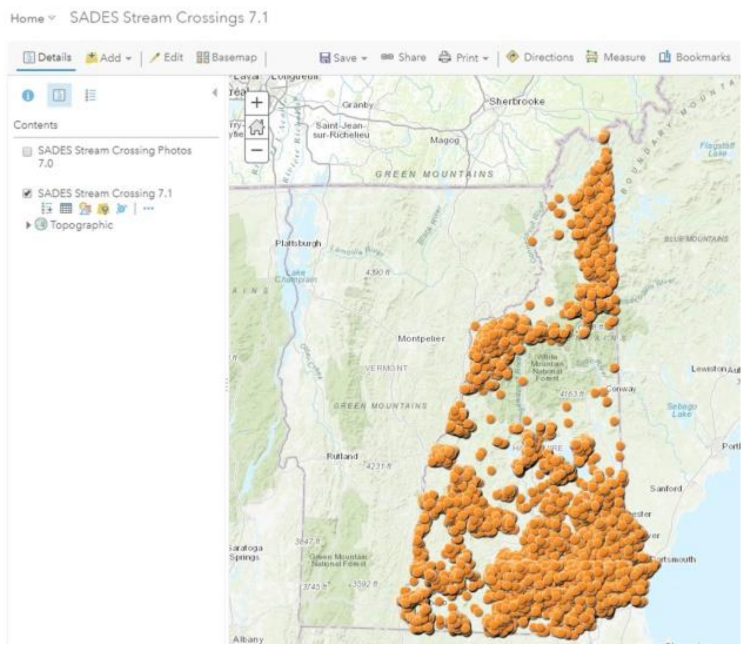
Stream crossings are structures (i.e., culverts, bridges, arches) that carry a road over a river, lake, wetland or small stream. As a state that has a vast diversity of waterbodies, stream crossings are a critical component of New Hampshire's road network and infrastructure. Undersized culverts and bridges may restrict streamflow moving through the crossing, thereby increasing water velocity through the culvert. The force of this fast-moving water exiting the culvert can cause downstream bank erosion and streambed scour, bank destabilization, and a perched culvert condition. During floods, fast moving water entering the pipe can overwhelm the roadway fill and banks, and lead to a road washout. In addition, small culverts are prone to obstructions, which can cause water to pond upstream, and which can act as a wall of water washed downstream, eroding stream banks and damaging infrastructure in its path. Improperly designed crossings can also be a barrier to fish and other aquatic animal passage, prohibiting upstream movements to important spawning areas and fragmenting the stream network. Learning from past experiences, NHDES, working with partners, is striving to address flood risks and make our infrastructure more resilient through a proactive approach by identifying problem culverts for replacement before they can fail and cause damage.

The purpose of stream crossing surveys is to collect coarse-screening level information to support data-driven decisions on prioritizing stream crossing replacement projects within a town, watershed or region. The data collected in this protocol will be sufficient to rank culverts according to their risk of overtopping and failure, degree of aquatic organism passage, and impacts to stream geomorphology and general river environment. Once data collection for a crossing assessment is complete and has undergone quality assurance and quality control (QA/QC), it is screened for: 1) **Geomorphic Compatibility** (GC; structure fit with river form and processes), 2) **Aquatic Organism Passage** (AOP; ranking of whether the structure is a barrier to animal passage), 3) **Condition** (New Hampshire Department of Transportation (NHDOT) asset condition score), and 4) **Hydraulic Capacity** of the structure to transport predicted flows under storm events. For these screening tools to produce accurate results, accurate data collection and following the instructions outlined in this manual is *essential*. Stream crossing data collected through this protocol **must** be QA/QC'd by the NHDES New Hampshire Geological Survey (NHGS) **before** it can be run through the scoring models and distributed to the public. It is critical that data collectors participate in the QA/QC process to ensure high-quality data that accurately represent the conditions of the stream crossing and river environment. Contact Kyle Hacker, in NHGS (kyle.hacker@des.nh.gov), for questions regarding the QA/QC process.

This protocol is designed for surveys on freshwater stream crossings and is **NOT** applicable for tidally-influenced crossings. For information on tidal crossings, contact Kevin Lucey from the NHDES Coastal Program at (603) 559-0026.

The Statewide Asset Data Exchange System (SADES)

The Statewide Asset Data Exchange System (SADES) is an online geodatabase that stores stream crossing data and is displayed on a web mapping service. The online database and map is hosted by Arc GIS Online, and managed by The University of New Hampshire Technology Transfer Center (T^2) as part of the NHDOT's asset management program. Data are collected using the ESRI Collector Application for ARCGIS and uploaded to ArcGIS online. UNH T^2 has an equipment loan program available to agencies to collect these data. This equipment is available on a first-come-first-served basis and an outline of the loan program is distributed by T^2 to all stakeholding parties.



Because these data are collected by multiple agencies, they are subject to a rigorous QA/QC process at several levels before they are ready for use and distribution by agencies, towns and other groups working on stream crossing efforts. The initial data compilation and management onto the webserver is done by T^2 and QA/QC is performed by NHGS scientists. The QA/QC process ensures consistency across agencies performing the data collection and reduces incorrect scoring of stream crossings due to errors made in the field.

Questions regarding the ESRI Collector app, SADES geodatabase and equipment loan program:

UNH Technology Transfer Center
Chris Dowd
SADES Manager
chris@nhsades.com
Office: (603) 862-5489
Cell: (603) 397-7745

Questions about survey coordination, field training and Data Quality Control contact:

New Hampshire Geological Survey, Department of Environmental Services
Shane Csiki (Survey Coordination/Field Training) – Shane.Csiki@des.nh.gov
Office: (603) 271-2876
Kyle Hacker (Data Quality Control) – Kyle.Hacker@des.nh.gov
Office: (603) 271-0587

Equipment

Rangefinder	To measure bankfull widths, crossing dimensions and length, and pool length. This is an essential piece of equipment!
Measuring Tape	To measure in cases where the rangefinder will not work.
Depth Rod	To measure water and pool depth, and roadway and culvert elevations in tenths of a foot.
Electronic Field Tablet	Equipped with the Arc Collector app; Cellular capacity for ArcGIS geographic positioning.
GPS Receiver	To use if the data collection device is not GPS equipped
Safety Vests	Brightly colored, reflective vests so data collectors are visible on the road.
Waders or Hip Boots	These allow observers to survey tailwater pools and deeper portions of the stream and also protect data collector's legs from abrasions and poison ivy.
Sun Protection	Hat, sunglasses, and sunscreen.
Insect Repellant	To protect from mosquitoes and ticks.
First Aid Kit	To deal with any minor injuries, cuts, scrapes, etc.
Cell Phone	In case of emergency, to coordinate surveys, or to contact your coordinator
Flashlight	To inspect the inside condition and substrate of the crossing.
Hard ruler	To measure sediment within structure for embedded culverts.

Safety

These surveys must be done by at least two people for safety reasons. Because these surveys take place around roads, it is recommended that each person wears highly visible clothing and a safety vest in bright colors with reflective material. Surveyors should avoid wading into areas of high flows, pools of unknown depths, or scaling steep and rocky embankments. Using an accurate laser rangefinder is one way to measure long distances without having to wade across the stream or climb up the banks. People should never enter or cross-through a culvert as part of this protocol.

There may be situations when a parameter cannot be collected due to safety and land access issues, in these cases leave the field blank and explain in the comments. Each collector should also follow their own agency safety protocols.

Training

Training is required of any individuals, agencies or organizations that plan to assess stream crossings using the New Hampshire Stream Crossing Assessment Protocol. Instructions on electronic data collection and uploading data and accessing SADES are provide by Chris Dowd at UNH [T2] and is available at (603) 862-5489. The field manual training includes a classroom session, followed by a field portion on Punch Brook in Franklin, NH. Please contact NHGS to find out the dates of planned training at (603) 271-2876. During the course of field assessments, NHGS and NHDOT staff are available to answer questions and provide technical guidance at any time.

Identifying Possible Assessment Locations

Data collectors must identify and plan what stream crossings your team will assess. To identify survey locations using spatial data:

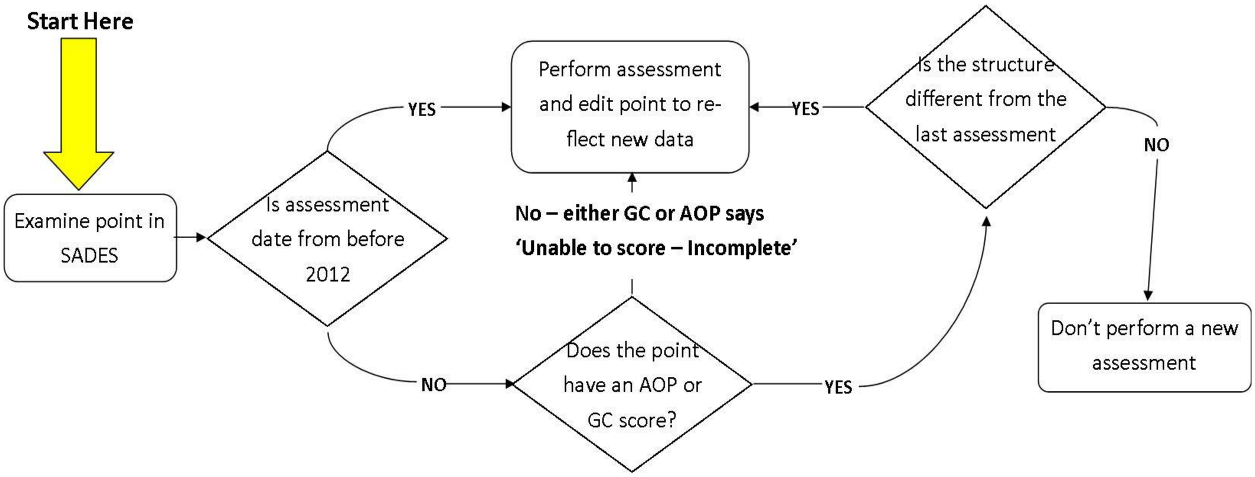
1. Identify ***possible*** crossing locations.
    a. NHDES conducts an intersection analysis of NHDOT's road layer and the National Hydrography Dataset flowline.

2. Compare the list of ***possible*** crossing locations versus ***completed*** assessments.
    a. Check the SADES layer to determine which ***possible*** crossing locations have already been assessed.
    b. If a ***possible*** crossing location has already been assessed, it can be further categorized into one of two categories:
        i. **Re-assess** – Locations with an AOP/GC score of "Unable to Score-Incomplete" or assessment date earlier than 2012 must be surveyed again.
        ii. **DO NOT re-assess** – Locations with an AOP/GC score.

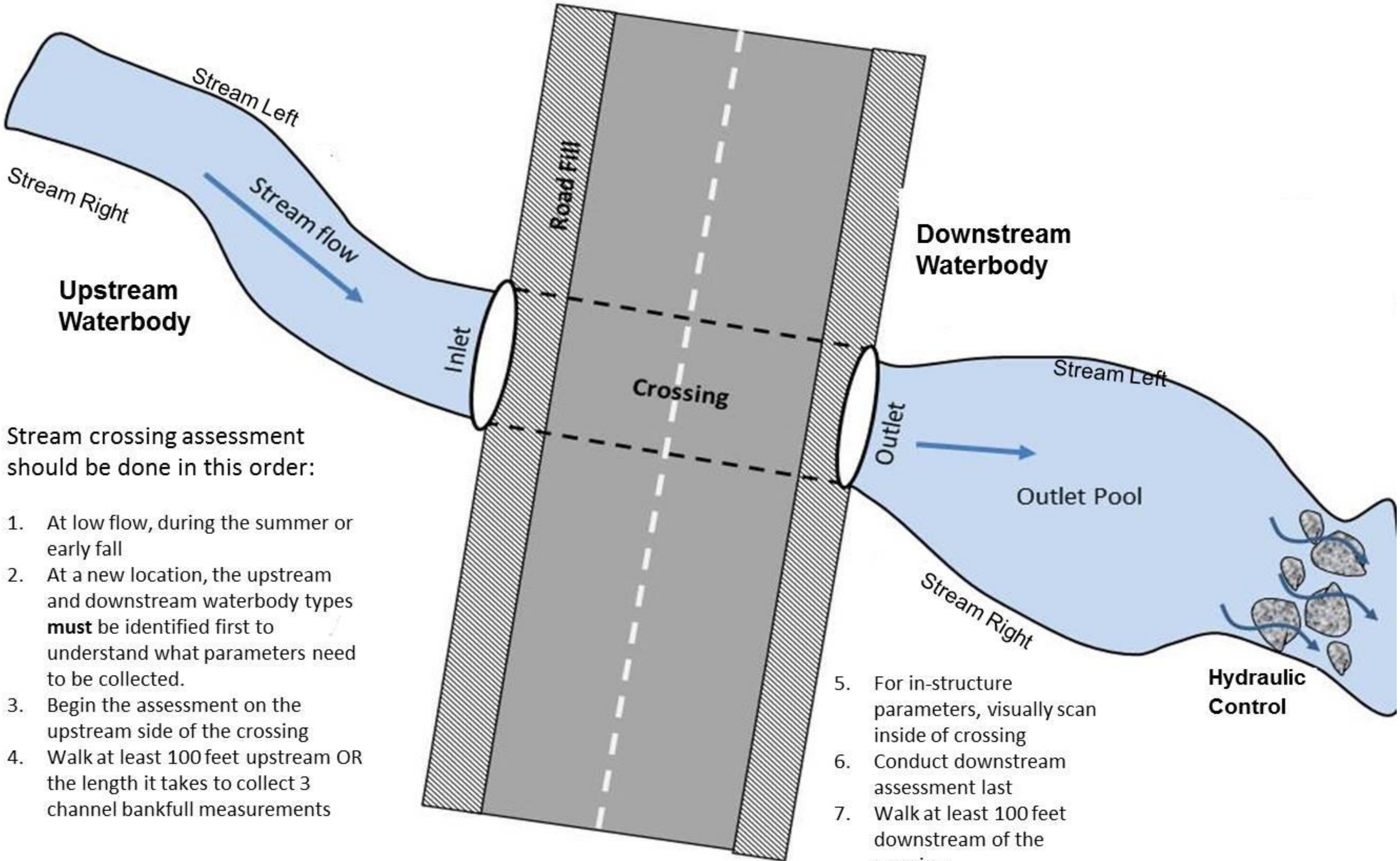
3. Coordinate with NHGS staff for ***confirmation*** on survey plans.
    a. NHGS can assist with survey planning by confirming the locations you plan to assess, because the agency is informed on the survey plans of all other groups and has access to current layer updates.
    b. If you plan on surveying on private property, you ***MUST*** contact NHGS first.

Protocol for Re-assessing Stream Crossing Locations

What if another team has already assessed a stream crossing? Follow the flow chart below to determine whether your team needs to redo the assessment.



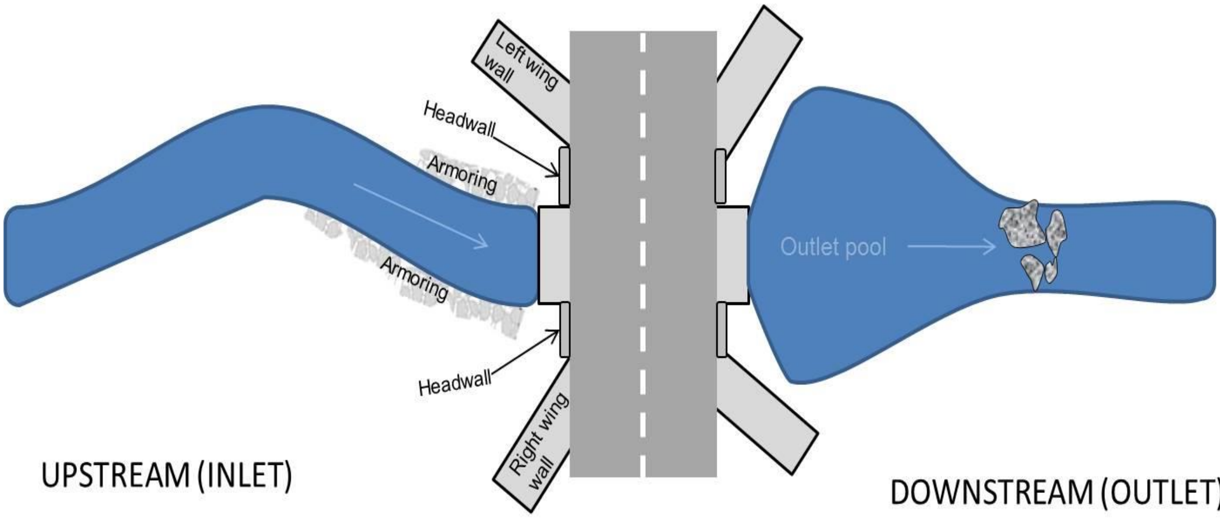
ASSESSMENT OVERVIEW



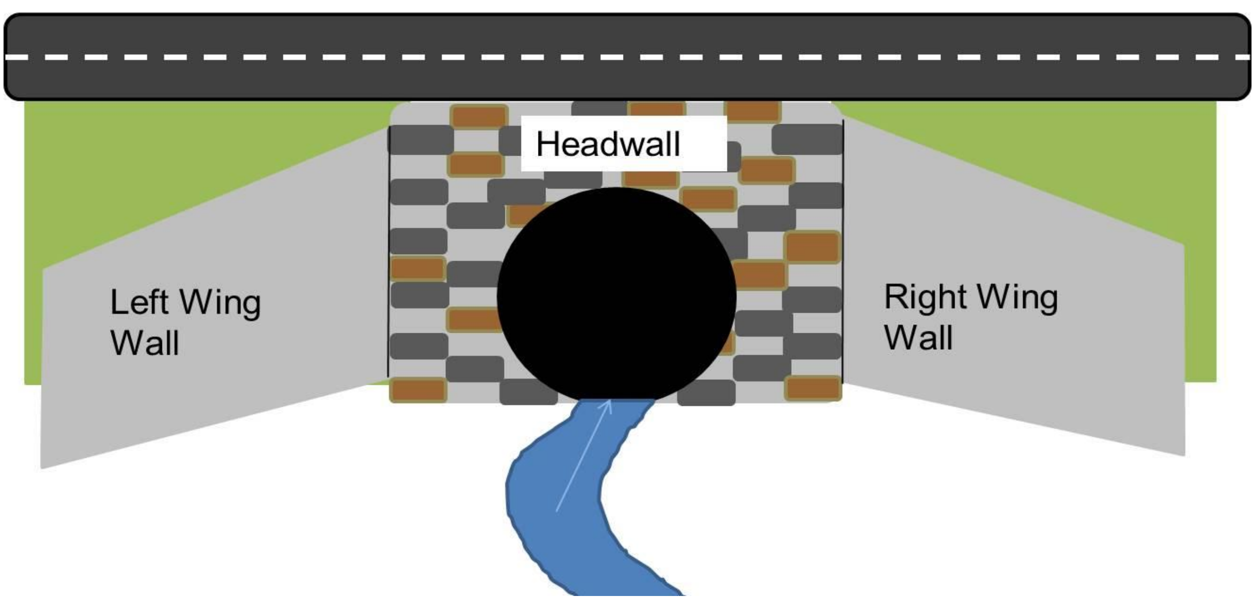
Stream crossing assessment should be done in this order:

1. At low flow, during the summer or early fall
2. At a new location, the upstream and downstream waterbody types **must** be identified first to understand what parameters need to be collected.
3. Begin the assessment on the upstream side of the crossing
4. Walk at least 100 feet upstream OR the length it takes to collect 3 channel bankfull measurements
5. For in-structure parameters, visually scan inside of crossing
6. Conduct downstream assessment last
7. Walk at least 100 feet downstream of the crossing
8. **Do not enter the enclosed area of the structure**

STRUCTURAL COMPONENTS OF A CROSSING



Headwall	Solid structure surrounding the inlet anchoring the pipe and preventing erosion of material. Can be constructed from a variety of materials such as concrete, stone, metal or even plastic.
Wing Wall	Intentionally installed on either side of the inlet to direct water into the crossing and hold back the road embankment, and that is in direct contact with the inlet face. Usually made of concrete or stone with masonry.
Armoring	Material such as rocks or vegetation *installed* to protect stream banks from erosion
Culvert (Structure or Conduit)	The main structure at the crossing that allows water to pass through. Often a pipe but can also be a box or bridge



Parameter	Waterbody Type		
	Stream	Wetland or Pond	Drainage
03) Upstream Waterbody	X	X	X
04) Crossing Type	X	X	X
05) Assessment Date	X	X	X
06) User ID	X	X	X
07) Observers	X	X	X
08) Organization	X	X	X
09) Project Name	X	X	X
12) Road Name – Field	X	X	X
14) Structure Skewed to Roadway	X	X	
15) If Channel Avulses Stream Will	X	X	
16) Angle of Stream Flow Approach	X	X	
17) Number of Structures at Crossing	X	X	X
18) Overflow Structures Present	X	X	
19) Structure Type	X	X	X
20) Structure Material	X	X	X
22) Inlet Type	X	X	X
23) Inlet Wingwall Material	X		
24) Inlet Wingwall Angle – Stream Left	X		
25) Inlet Wingwall Angle – Stream Right	X		
26) Upstream – Width (A) (ft)	X	X	X
27) Upstream – Open Height (B) (ft)	X	X	X
28) Upstream – Wetted Width-Wall Rise (C) (ft)	X	X	X
29) Upstream – Total Height (D) (ft)	X	X	X
30) Structure Opening Partially Obstructed	X	X	
31) Screening at Structure	X	X	
32) Inlet Headwall – Materials	X	X	X
33) Inlet Condition	X	X	X
34) Scour Undermining Structure – Upstream	X	X	
35) Bank Armoring – Upstream	X		
36) Water Depth – Upstream channel (ft)	X		
37) Upstream – Bankfull Width 1 (ft)	X		
38) Upstream – Bankfull Width 2 (ft)	X		
39) Upstream – Bankfull Width 3 (ft)	X		

Parameter	Waterbody Type		
	Stream	Wetland or Pond	Drainage
40) Dominant Substrate – Upstream	X		
41) Upstream Deposit Type	X		
42) US Deposit Taller than 0.5 Bankfull Height	X		
43) Bank Erosion – Upstream	X		
44) Channel – Bankfull Width 1 (ft)	X		
45) Channel – Bankfull Width 2 (ft)	X		
46) Channel – Bankfull Width 3 (ft)	X		
47) Dominant Substrate – Channel	X		
48) Steeper Segment within 1/3 mile Upstream	X		
49) Beaver Dam Near Structure – Upstream	X	X	
51) Structure Slope Compared to Channel Slope	X		
52) Inlet Invert Elevation (ft)	X		
53) Reference Elevation (ft)	X		

Your particular crossing may have a combination of waterbody types between the upstream and downstream environment. Be sure to follow this key and the icons next to each parameter to understand what data needs to be collected at each waterbody type.

55) Outlet Invert Elevation (ft)	X		
56) Waterbody – Downstream	X	X	X
57) Water Depth – Structure Outlet (ft)	X	X	
58) Structure Length (ft)	X	X	X
60) Downstream – Width (A) (ft)	X	X	X
61) Downstream – Open Height (B) (ft)	X	X	X
62) Downstream – Wetted Width-Wall Rise (C) (ft)	X	X	X
63) Downstream – Total Height (D) (ft)	X	X	X
65) Structure Condition	X	X	X
66) Dominant Substrate Throughout Structure	X	X	
67) Structure Filled with Sediment	X	X	X
68) Outlet Wingwall – Material			
69) Outlet Headwall – Materials	X	X	X
70) Outlet Condition	X	X	X
71) Scour Undermining Structure – Downstream	X	X	
72) Outlet Grade	X	X	

Parameter	Waterbody Type		
	Stream	Wetland or Pond	Drainage
73) Outlet Invert Drop (ft)	X	X	
74) Outlet Invert Height	X	X	X
75) Outfall Treatment	X	X	
76) Scour of Streambed at the Outlet	X	X	
77) Bank Armoring – Downstream	X	X	
78) Downstream Pool Present	X	X	
79) Downstream Pool Depth at Entrance (ft)	X	X	
80) Downstream pool – Maximum Depth (ft)	X	X	
81) Water Depth – Downstream Channel (ft)	X	X	
82) Downstream – Bankfull Width 1 (ft)	X		
83) Downstream – Bankfull Width 2 (ft)	X		
84) Downstream – Bankfull Width 3 (ft)	X		
85) Dominant Substrate – Downstream	X		
86) Bank Erosion – Downstream	X		
87) DS Bank Heights Taller than US Banks	X		
88) Bedrock Present – Downstream	X		
89) Downstream Hydraulic Control – Type	X		
90) Downstream Hydraulic Control Distance from Structure (ft)	X		
91) Beaver Dam Near Structure – Downstream	X	X	
92) Wildlife observed – US, DS, Structure	X	X	
93) Comments	X	X	X
NA) Minimum 6 photos	X	X	X

3.) Upstream Waterbody	S	W	D
Identify the inflow waterbody type form the viewpoint of the road.			

WETLAND – A waterbody that does not have defined channel banks and is in an area where the water table is at or above the land surface throughout the year. The soil is saturated with water and vegetation and there is often standing or flowing water. If there is flowing water moving downstream through the crossing, but it is surrounded by wetland and you are unable to collect *at least* three (3) bankfull widths due to lack of defined channel, then classify as a wetland.




STREAM – A channelized depression in the landscape that has *defined channel banks* and transports water either intermittently or perennially to lower elevations. If the stream is dry during the time of survey, use the presence of bankfull indicators to determine whether the waterbody is a stream.



SURFACE – A crossing at a depression in the land surface that stores water, such as a lake or pond, and does not have defined channel banks. An impounded water body, as created by a large dam downstream for example, could also meet this category, particularly if channel bank indicators are sufficiently submerged.

DRAINAGE – A crossing at a depression or indentation in the landscape that holds water only during or directly following precipitation events. Engineered landforms such as storm water retention ponds and roadside ditches should be classified as drainages. A key indicator that a crossing is only for stormwater drainage is the **absence** of bankfull indicators. If you are unsure whether the water body only transports water for roadside drainage use a topographic map or LiDAR to determine if the crossing is on a stream line. Even if an identified crossing is <u>not</u> on a mapped stream line, walk upstream to assess whether bankfull indicators are present.

Parameter Name	**S**	**W**	**D**
Icons next to each parameter indicate the waterbody types where it is collected.			

S - parameter is collected at stream crossings.
W - parameter is collected at wetland or surface (pond, lake, impounded) crossings.
D - parameter is collected at drainage structures.

4.) Crossing Type	**S**	**W**	**D**
Select the crossing type based upon the upstream waterbody. Refer to the table on pages 11-13, and the white boxes next to each parameter, to ensure adequate data is collected for each crossing.			

- **WETLAND**: the upstream waterbody has been identified as a wetland.
- **STREAM:** the upstream water body has been identified as a stream.
- **SURFACE:** the upstream water body has been identified as a pond or lake.
- **DRAINAGE:** the upstream water body has been identified as a drainage.
- **NOT SURVEYABLE:** a crossing that cannot be surveyed due to safety or access issues, such as a crossing on a busy street or highway, or a culvert on private land. Write in the comments why the crossing is unsurveyable. Include pictures if possible.
- **NO CROSSING PRESENT:** No structure was present where one was predicted to occur. It is important to document these locations to avoid repetitive sampling. Create a data point in SADES and include in the comments what is observed at the location and include pictures.

5.) Assessment Date	S	W	D
Record survey date.			

6.) User ID	S	W	D
User specific ID's may have been generated by the organization(s) performing the assessments. This ID could be based on an area (political or watershed), a specific project or the collecting organization.			

7.) Observers	S	W	D
Initials in all CAPS of the observer(s) collecting the field data, separated by a single space. For example: "JH EM".			

8.) Organization	S	W	D
Select the standard organization abbreviation.			

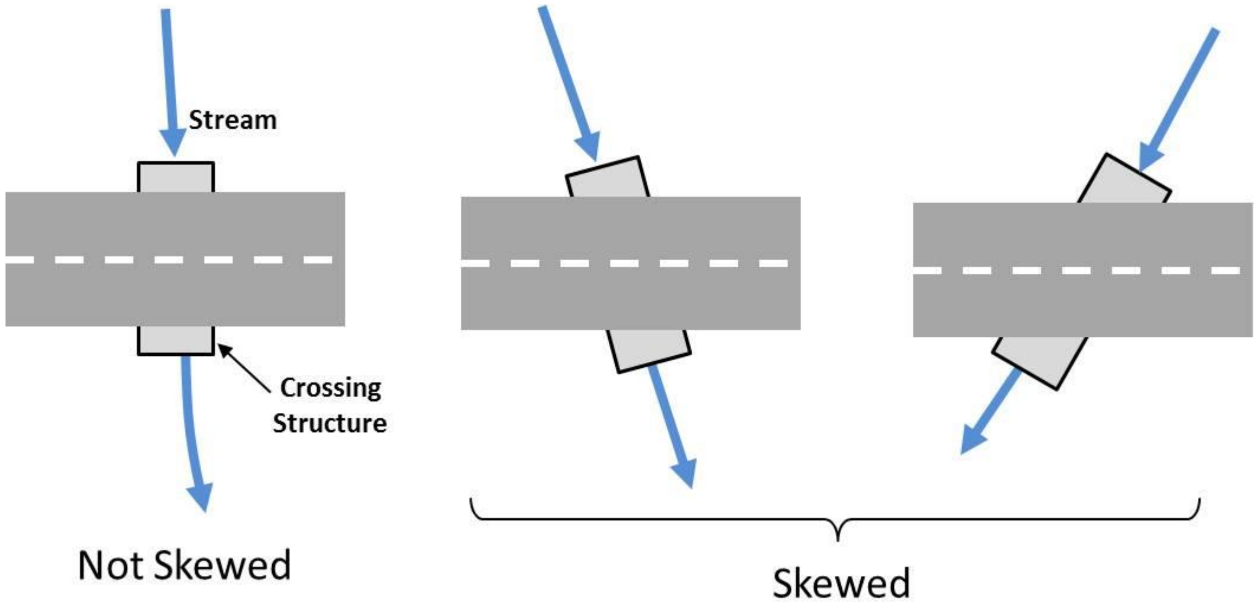
NHGS- NH Geological Survey
NHDES- all other units within the NH Department of Environmental Services
NHDOT- NH Department of Transportation
NHFG- Fish and Game Department
NCC- North Country Council
LRPC- Lakes Region Planning Commission
UVLSRPC- Upper Valley-Lake Sunapee Region Planning Commission
SWRPC- Southwest Region Planning Commission
CNHRPC- Central NH Region Planning Commission
SNHPC- Southern NH Region Planning Commission
NRPC- Nashua Regional Planning Commission
RPC- Rockingham Planning Commission
SRPC- Strafford Regional Planning Commission
TU- Trout Unlimited
TNC- The Nature Conservancy
SW – Streamworks
FEA- Fitzgerald Environmental Associates
MCCD- Merrimack County Conservation District
OTHER- A group that is not listed above, include name in the comments section.

9.) Project Name	S	W	D
Name that has been agreed upon with your project collaborators to identify this work.			

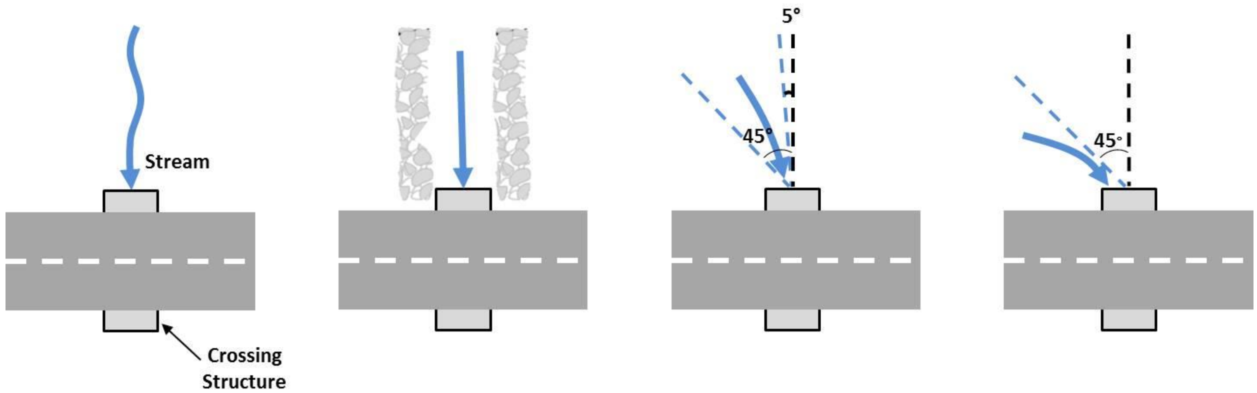
12.) Road Name – Field	S	W	D
Type in the road that the structure is on using maps or street signs.			

14.) Structure Skewed to Roadway	S	W	D
Indicate whether the structure is skewed (or angled) in comparison to the roadway.			

- **YES**: the structure is **not** perpendicular to the road (~90º angle).
- **NO:** the structure is positioned perpendicular (~90º angle).



16.) Angle of Streamflow Approach	S	W	D
Stand directly above the inlet and record the angle that the stream enters the crossing structure.			



Naturally Straight θ < 5°

Channelized Straight θ < 5°

Mild Bend 5° < θ < 45°

Sharp Bend θ > 45°

SHARP BEND – Stream enters the structure at a severe angle; 45° to 90° bend.

MILD BEND – The stream enters the structure at a gentle angle; 5° to 45° bend.

NATURALLY STRAIGHT – Stream enters structure straight-on with no channelization.

CHANNELIZED STRAIGHT – Stream enters the inlet straight on due to alteration and straightening of the channel or banks. Indicators include landscaped banks (left), concrete banks (center), armored banks (right), or the channel just upstream of the straightened section is naturally sinuous.

The aerial images show examples of channelized straight streams, including a reach that has been straightened compared to the natural channel form, based on the meander scars on the surrounding landscape (below left), or a clearly straightened stream in a field (below right).

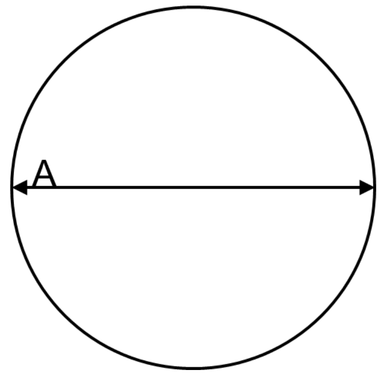
17.) Number of Structures at Crossing	S	W
Count all of the culverts that are at or below the bankfull elevation. Do not count overflow pipes. If multiple structures are identical in size, shape, material and slope, collect data on one of the structures and enter the number of crossings (top photos). If the structures are not identical, collect data on the structure carrying most of the water flow and include data for the other structure(s) in the comments (bottom photos).		

18.) Overflow Structures Present	S	W
Overflow pipes are *usually* smaller than the primary crossing, and are installed at a higher elevation than the main structure.		

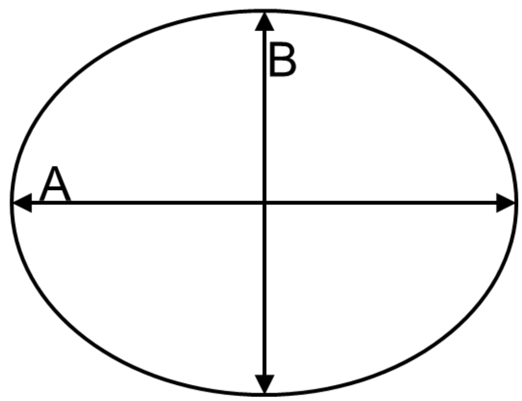
YES – there are overflow pipes.
NO – there are no overflow pipes present.

19.) Structure Type	S	W	D
Select the type that describes the shape and dimensions of the main structure.			

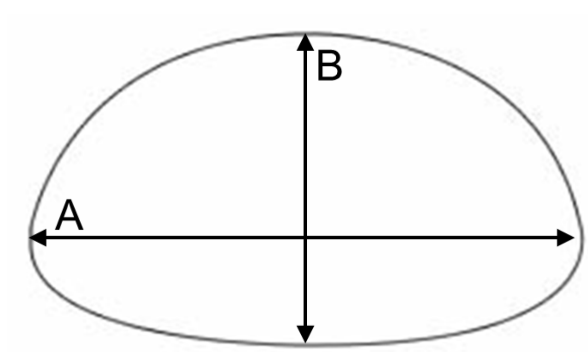
ROUND CULVERT – a circular structure with a closed bottom such as metal, concrete and plastic pipes.



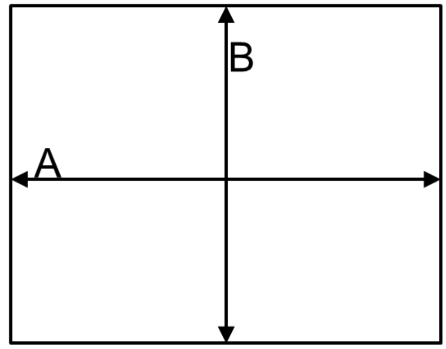
ELLIPTICAL CULVERT – an oval structure that has a closed, constructed bottom and is longer along one of its axes, so it appears to be flattened.



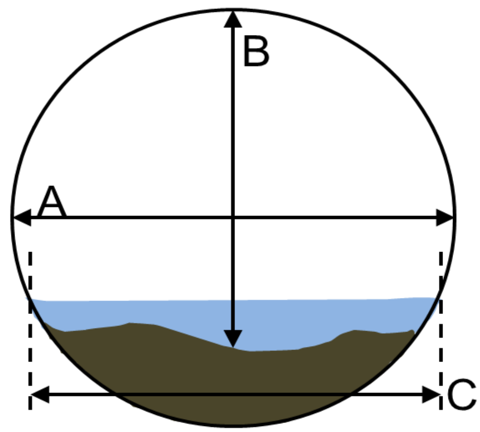
PIPE ARCH CULVERT – an oval structure that has a closed, constructed bottom and is shaped somewhat like an egg (vertically), in that the bottom is wider and more rounded compared to the top.



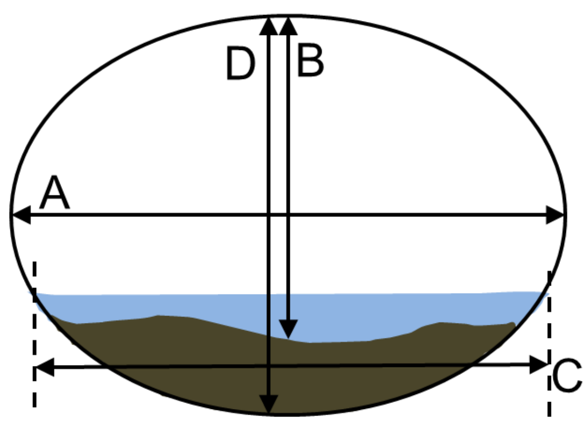
BOX CULVERT – a square or rectangular-shaped culvert with a constructed bottom.



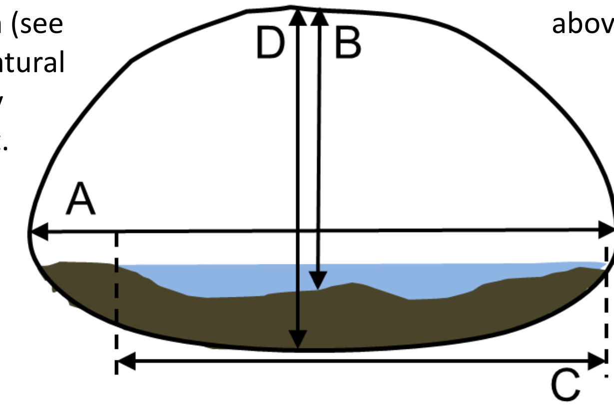
EMBEDDED ROUND CULVERT – a circular pipe that is partially buried below the stream bed so that natural sediment continues throughout the bottom of the structure.



EMBEDDED ELLIPTICAL CULVERT – an elliptical pipe that has been intentionally installed so that natural sediment continues throughout the bottom of the structure.



EMBEDDED PIPE ARCH CULVERT – a pipe arch (see above) that has been intentionally installed so that natural sediment continues throughout; you generally won't see the bottom of an embedded culvert.



***EMBEDDED OR SEDIMENT BUILD-UP? ***

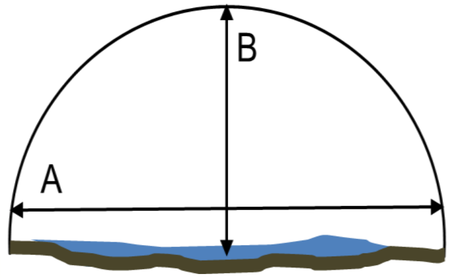
Embedded

- Has sediment throughout the bottom.
- Sediment throughout bottom matches the character of the sediment upstream and downstream.
- Substrate is usually at grade with the upstream inlet.

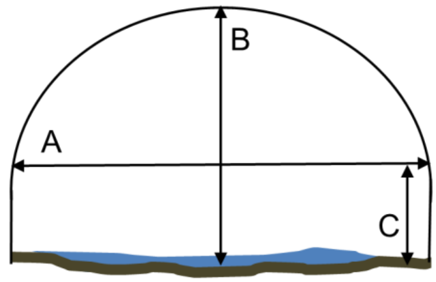
Clogged

- Buildup of sediment and/or material caused by culvert being undersized.
- Sediment and/or material depth is a significant percentage of the structure's opening height.

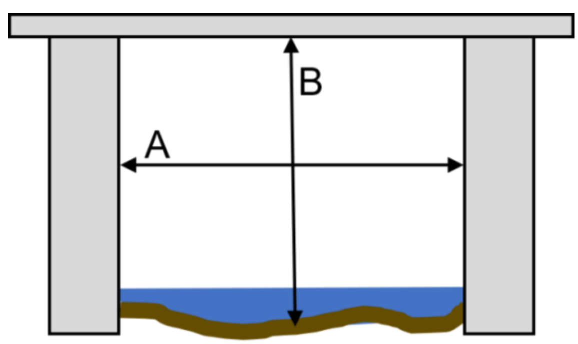
OPEN BOTTOM ARCH – an arc-shaped structure that does not have a bottom half, so the natural sediment continues throughout the crossing.



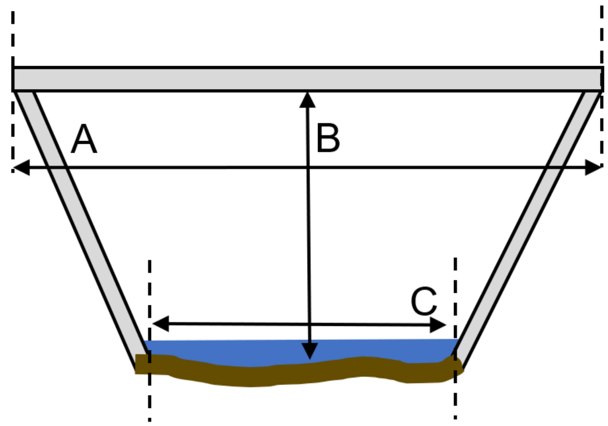
ARCH-BRIDGE – structure with a curved top under the road deck and sits on vertical abutments.



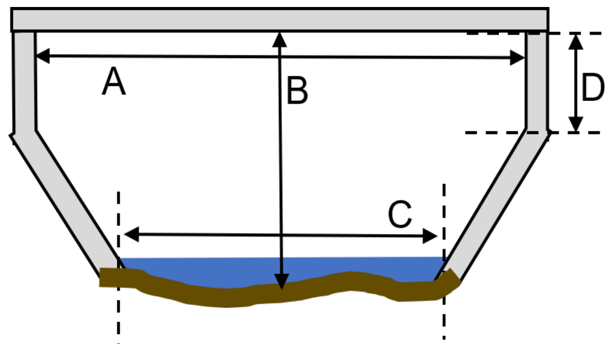
BRIDGE WITH ABUTMENTS – a structure where the road deck bottom is consistent with the top of the structure and the sides are at right angles, and has an open bottom.



BRIDGE WITH SIDE SLOPES – a structure where the road deck bottom is consistent with the top of the structure with angled sides, and an open bottom.



BRIDGE WITH SIDE SLOPES AND ABUTMENTS – a structure where the road deck bottom is consistent with the top of the structure having both sloping sides and sides at right angles to give the bridge height over the stream.



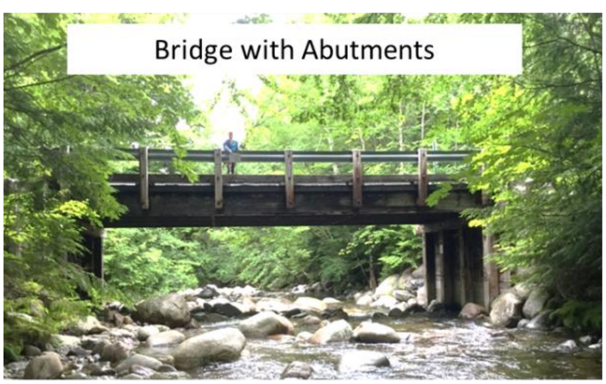
CATCH BASIN INLET – a structure designed to collect and transport roadside and storm water drainage. These structures can be varying shapes and sizes but are usually small round culverts or concrete box culverts.

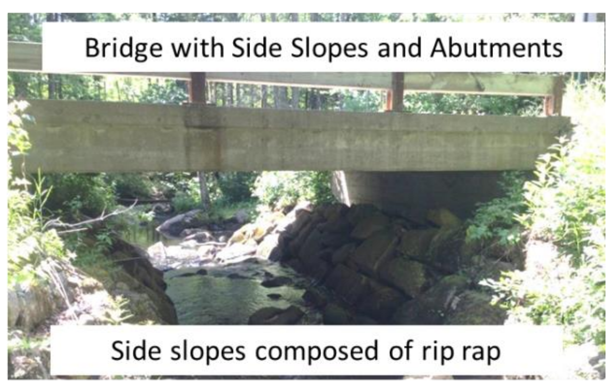
FORD – road crosses the river over material such as logs, stone or gravel laid on the streambed to stabilize the bottom. These are mostly found on dirt or gravel roads.

Notes about Identifying Box Culverts versus Bridge with Abutments:

Culvert – structure that supports a road over a water body by means of a complete pipe or box embedded in road fill, or constructed within a masonry or concrete headwall, that usually has a constructed bottom and does not have abutments or piers.

Bridge – structure that supports the roadway and *typically* spans the width of the channel, encompassing both banks, and the road deck bottom typically is the top of the structure. Some structures that look like a bridge may actually be an embedded box culvert or an open bottom arch (culvert).





Characteristics to consider when evaluating whether a structure is a culvert or a bridge:

- A structure where the top of the inlet opening is the road deck is typically classified as a bridge, whereas a culvert has a headwall made of concrete, fill, or earthen material between the top of the inlet and the road surface.
- Culverts are usually enclosed structures, whereas bridges have an open bottom (natural sediment). Embedded culverts, arch culverts, and box culverts made of dry fit stone, will have or appear to have an open bottom and are an exception to this.
- Bridges usually span the width of the channel and encompass both channel banks.

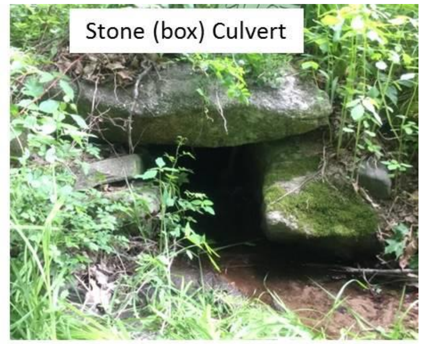
The definition for a bridge in this protocol is for stream crossing surveys only and differs from that used by NH Department of Transportation that classifies all structures >10-foot width as a bridge. Please adhere to the definitions in this protocol for all stream crossing surveys!

20.) Structure Material	S	W	D
Identify the material that describes the dominant construct of the crossing. If structure material varies between the inlet and outlet, use the inlet material type and describe the outlet material in the comments. Bridges are often composed of several material types (e.g. a steel deck with concrete abutments); the primary (dominant) material of the overall structure should be selected.			

- **CONCRETE:** structure is made of pre-cast or cast-in-place concrete.
- **PLASTIC-CORRUGATED:** both the outside **and inside** of the pipe has ridges.
- **PLASTIC-SMOOTH:** the **inside** surface of the plastic pipe is smooth and has no texture, regardless of whether the outside of the pipe has grooves.
- **STONE:** structure is made of rocks that are either bound together with mortar (masonry) or stacked tightly without mortar (dry fit stone).
- **STEEL-CORRUGATED:** both the outside and inside of the metal pipe have ridges and grooves. A steel pipe will often have a dull metallic appearance and evidence of rusting.
- **STEEL-SMOOTH:** the inside surface of the metal pipe is smooth and has no texture, regardless of whether the outside of the pipe has grooves and ridges. A steel pipe will often have a dull metallic appearance and may have evidence of rusting.
- **ALUMINUM-CORRUGATED:** both the outside and inside of the metal pipe have ridges and grooves. An aluminum pipe will have a shiny-metallic appearance and will not have any rust, though can have water stains.
- **WOOD:** the structure is made of wood, not a common material for crossings.
- **OTHER:** please note in the comments what material the crossing is made of.


Plastic-smooth


Concrete


Stone (box) Culvert

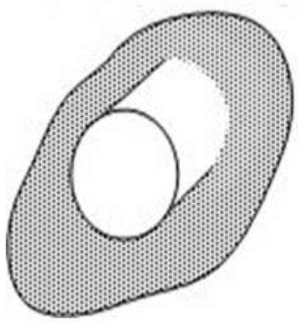

Steel-corrugated


Concrete Box

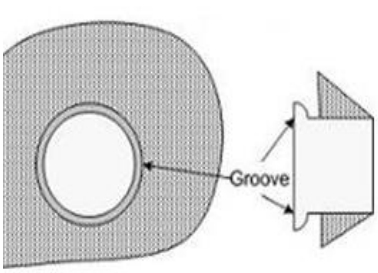

Aluminum- Corrugated

22.) Inlet Type	S
Select the option that best describes the shape and structure of the crossing inlet.	

THIN PROJECTING – the end of the pipe extends outward from the headwall.




GROOVED CONCRETE PROJECTING – the end edge of the concrete pipe has a lip and extends from the headwall.




GROOVED CONCRETE W/ HEADWALL– the end edge of the concrete pipe has a lip and is flush with the headwall.

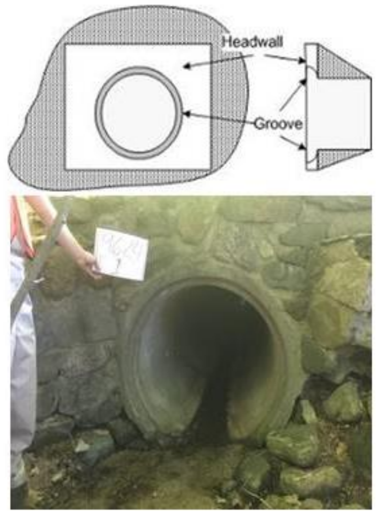
SQUARE EDGE W/ HEADWALL – the end edge of the concrete pipe is not grooved and is flush with the headwall.

1.5:1 BEVELED HEADWALL – a 33º angle inclined surface at the inlet crown between the headwall and culvert top.

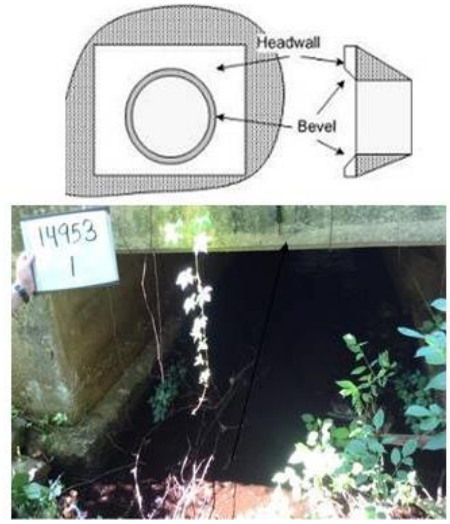
1:1 BEVELED HEADWALL – a 45º angle inclined surface at the inlet crown between the headwall and culvert top.

Square edge with headwall

Grooved pipe with headwalls



Beveled edge with headwall



STANDARD END SECTION – the culvert inlet pipe and tapered wingwalls are flush with the embankment, and both are connected with a structural floor that extends upstream from the pipe inlet to a point flush with the upstream extent of the flared wingwalls.

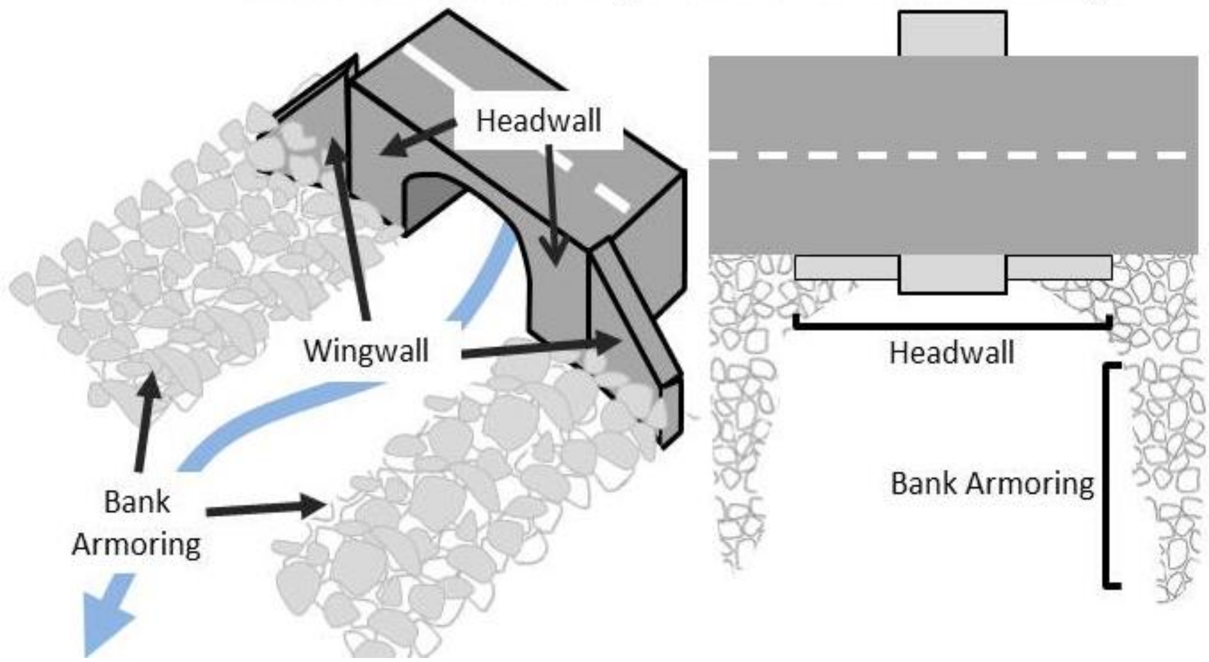
MITERED – the end edge of the pipe has been cut at an angle that matches the slope of the road fill material.

ANY BEVEL WITH WINGWALLS – the end edge of the inlet entrance is not perpendicular, but is angled.

NO BEVEL WITH WINGWALLS – the end edge of the inlet entrance is perpendicular, and there are flared out walls.

NONE OF THESE – the inlet type cannot be categorized into any of the types above.

Headwall versus Wingwall versus Bank Armoring



23.) Inlet Wingwall – Material	S	W
Wingwalls are structures installed on either side of the inlet to direct water into the crossing and hold back the road embankment. Structures should only be considered wingwalls if there is continuous material intentionally installed to be in direct contact with the with the inlet face. Wing Walls are solid structures lacking any large gaps and spaces within the structure material.		

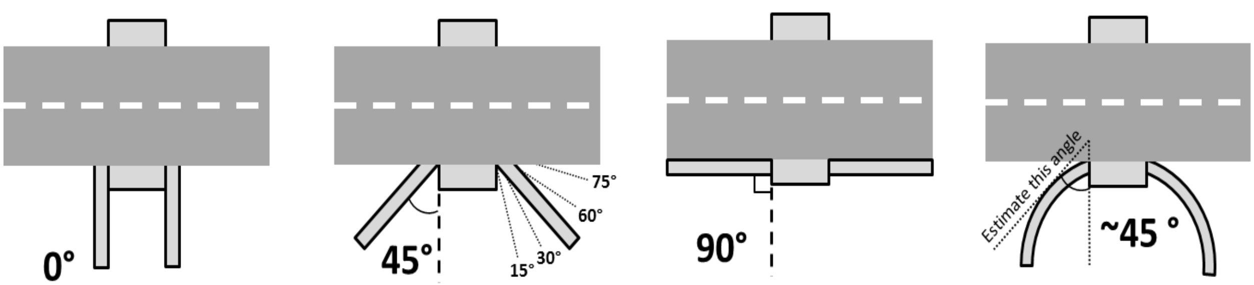
- **METAL:** continuous metal walls, whether smooth or corrugated.
- **CONCRETE:** preformed or cast in place concrete walls.
- **MASONRY:** brick or stone structure bonded by mortar.
- **DRY FIT STONE**: stone structure without mortar to bind the stones together.
- **PLASTIC**: continuous plastic walls, whether smooth or corrugated.
- **GABION**: wire cages filled with small stones that stack on one another to form a wall.
- **OTHER:** a material not listed above.
- **NONE**: no wingwall present.

24.) Inlet Wingwall Angle – Stream Left	S
Stand in the middle of the channel facing the inlet and visually estimate the angle at which the wing walls project out from the structure opening, based on the diagram below. If no wingwalls are present, leave this field blank.	

ANGLE VALUE- 90, 75, 60, 45, 30, 15, 0

25.) Inlet Wingwall Angle – Stream Right	S
Stand in the middle of the channel facing the inlet and visually estimate the angle at which the wing walls project out from the structure opening, based on the diagram below. If no wingwalls are present, leave this field blank.	

ANGLE VALUE- 90, 75, 60, 45, 30, 15, 0

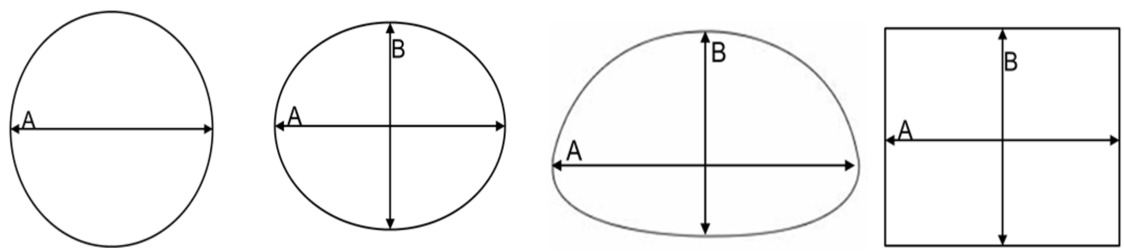


26.) Upstream – Width (A) (ft)	S	W	D
Measure interior width of crossing in decimal feet to the nearest tenth. Reference the structure diagrams for guidance.			

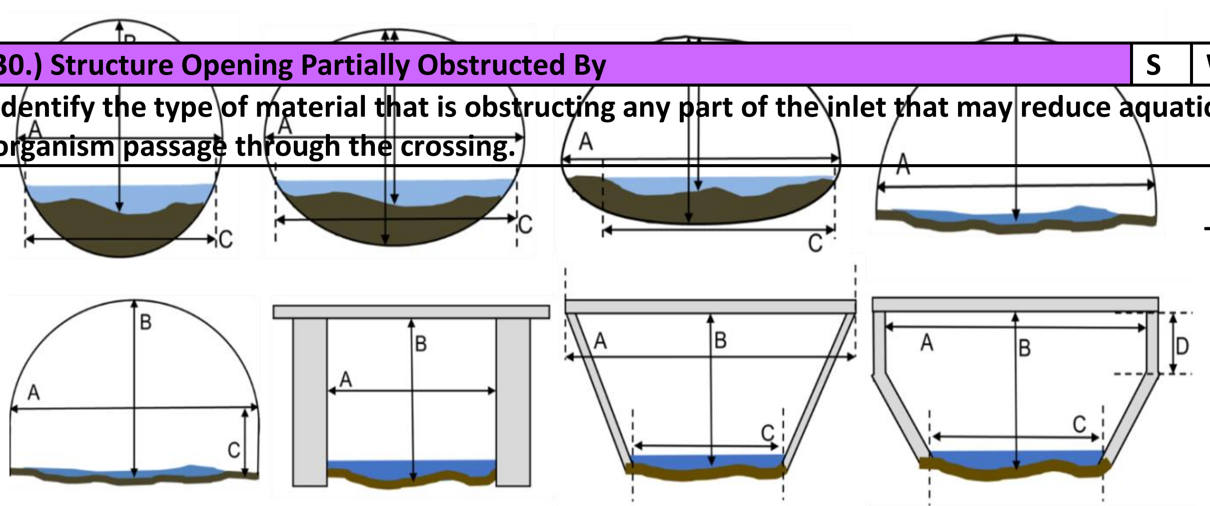
27.) Upstream – Open Height (B) (ft)	S	W	D
Measure the height from the interior side of the top of the structure to the bottom of the structure of the top extent of sediment or substrate. For *open* structures, i.e. structures that are not embedded or clogged with sediment, the bottom point on this measurement should be located at the bottom of the structure itself. For *embedded or clogged* structures, this measurement should be located equal to the highest elevation of accumulated or embedded			

28.) Upstream – Wetted Width / Wall Rise (C) (ft)	**S**	**W**	**D**
If the structure is an *embedded or clogged* culvert, measure width of actual stream channel (wetted width) through crossing structure. If the structure is an *Arch Bridge*, measure the wall rise as shown in the Arch Bridge diagram.			

29.) Upstream – Total Height (D) (ft)	**S**	**W**	**D**
For *embedded or clogged* structures, measure the height from the interior side of the top of the structure to the bottom of the structure.			



30.) Structure Opening Partially Obstructed By	**S**	**W**
Identify the type of material that is obstructing any part of the inlet that may reduce aquatic organism passage through the crossing.		



WOOD: wood material such as logs, branches, and trees.

- **SEDIMENT:** sand and rocks transported and deposited by the stream in front of the inlet. Sediment is only considered an obstruction if it is blocking some of the inlet or water drops **down** into the culvert. If the entire culvert bottom is filled with sediment at an equal elevation to the natural streambed, this is not considered an obstruction.
- **STRUCTURAL DEBRIS**: part of the headwall, wingwall, armoring, or pieces of the crossing itself have detached and are blocking the inlet.
- **WOOD AND SEDIMENT:** both wood and sediment are blocking the inlet.
- **DEFORMATION (CULVERT ONLY):** culvert pipe inlet is crushed, bent, or broken.
- **BEAVER DAM:** logs and sticks from a beaver dam are blocking the inlet.
- **NONE:** no part of structure opening is covered.

- **OTHER:** none of the options apply and record the type of blockage in comments.


wood


Deformation of pipe


Wood material


Sediment with vegetation

31.) Screening at Structure	**S**	**W**
Screens made of metal, plastic, wood, or any another material may be installed across or around the inlet and outlet to prevent debris or wildlife from entering the pipe.		

- **INLET:** screening is present at the inlet.
- **OUTLET:** screening is present at the outlet.
- **NONE:** there is no screening present at this crossing.

32.) Inlet Headwall – Material	**S**	**W**
A headwall provides anchoring support for the conduit and prevents surrounding soil and fill washing away. Select the option that best describes the overall material surrounding the face of the inlet.		

- **METAL:** continuous metal walls, whether smooth or corrugated.
- **CONCRETE:** preformed or cast in place concrete walls.
- **MASONRY:** brick or stone structure bonded by mortar.
- **GABION**: wire cages filled with small stones that stack on one another to form a wall.
- **DRY FIT STONE**: stone structure without mortar to bind the stones together.
- **PLASTIC**: continuous plastic walls, whether smooth or corrugated.
- **OTHER:** a material not listed above.
- **NONE**: no headwall present.

33.) Inlet Condition	S	W
Describe the condition of the structural features (both the headwall and wingwalls) at the crossing inlet. This parameter is assessing the structural features on the exterior of the inlet.		

- **GOOD:** spalling of up to ¼-inch thickness is present, joints between headwall and wingwalls are broken, or some mortar is missing from joints. Metal: Pitting or superficial rust is present.
- **FAIR:** spalling of more than ¼-inch thickness is present, but no reinforcement is present, joints between headwall and wingwalls are beginning to separate, or joints between some stones are broken. Metal: flaking rust is present and some loss of wall thickness is present, or a hole can be poked through the wall with a sharp point.
- **POOR:** reinforcement is visible, stones are loose, or large cracks run through the headwall. Metal: holes due to corrosion are present, full length cracks or tears are present, joints are separated, or severe deformation is present.
- **N/A:** the headwall is not evaluated or there is no headwall at the inlet.

34.) Scour Undermining Structure – Upstream	S
Identify the part of the crossing that is affected by scour. Scour is the erosive action of running water in streams, which excavates and carries away material from the bed and banks. Indicators of scour are: exposed areas of structure that are typically covered by stream bed material (e.g., bridge footings), leaning or hanging structures, water visibly flowing under or to the side of the inlet of a culvert, and deep water along one or both sides of a bridge or arch when the bed feature through the structure is a riffle.	

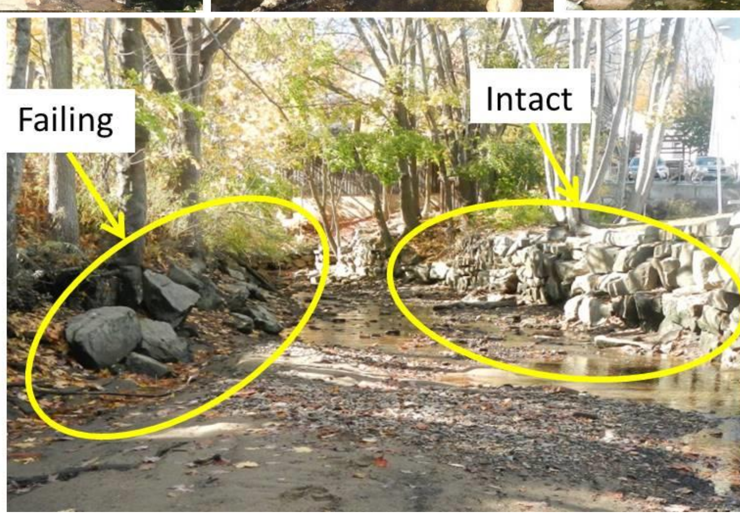
- **FOOTERS**
- **CULVERT**
- **WING WALL**
- **CULVERT AND FOOTERS**

- CULVERT AND WING WALL
- FOOTERS AND WING WALL
- CULVERT, FOOTERS AND WING WALL
- NONE
- UNKNOWN

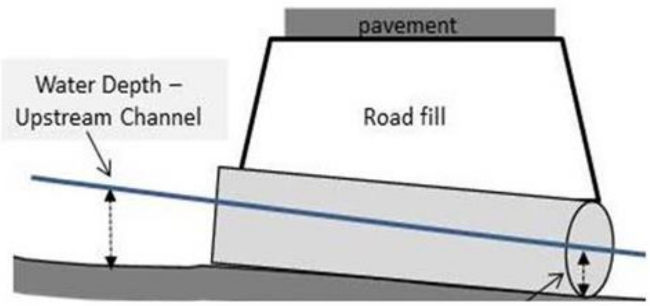
35.) Bank Armoring – Upstream	S	W
Protective covering, such as rocks, vegetation or engineering materials that is installed to protect stream banks, or fill or cut slopes from flowing water. Situations (such as in the photo below) where one condition exists on each bank, select the option for the worst condition, that could lead to future problems. In the case of the photo below, this would be "failing."		

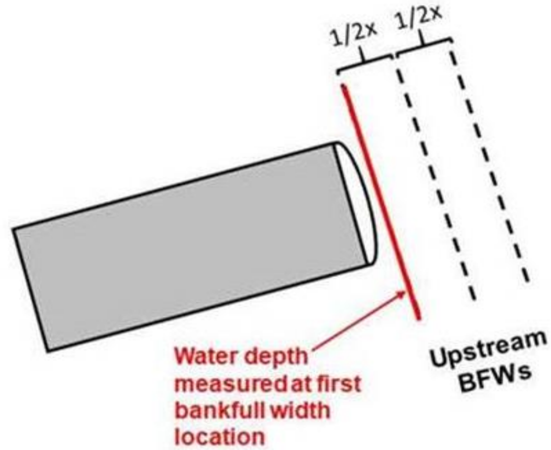
- **INTACT:** not falling into stream, no missing or out-of-place pieces of armoring material.
- **FAILING:** parts are falling into the stream, missing or out of place.
- **NONE:** no hard bank armoring present.
- **UNKNOWN:** unable to assess the condition or presence of hard bank armoring.

Natural Boulders | Intact Bank Armor | Failing Bank Armor



36.) Water Depth – Upstream Channel (ft)	S
Measure the water depth directly upstream of the inlet, where the 1st Upstream bankfull width, is collected. Record the water depth in the deepest part of the channel by measuring from the water surface to the streambed.	



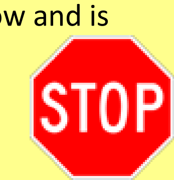


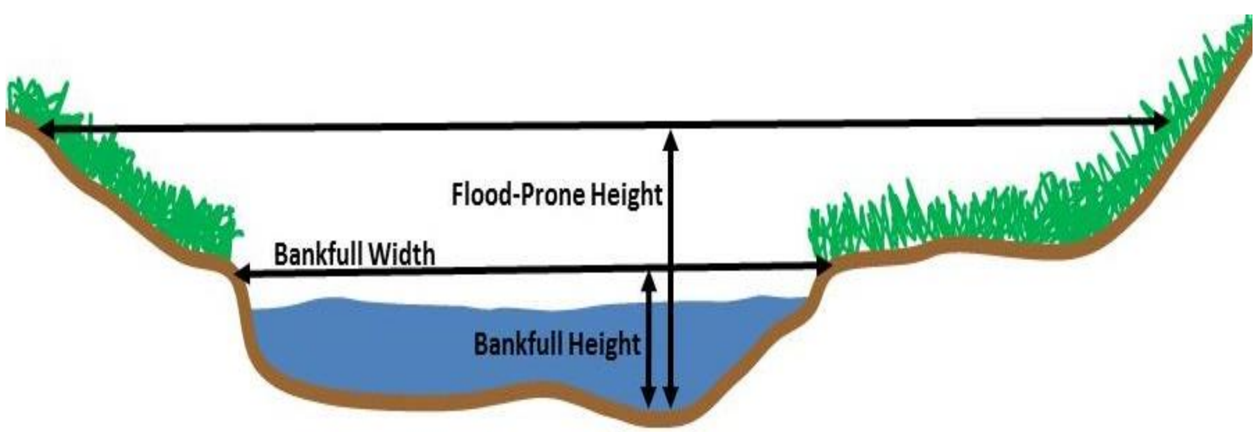
37.) Upstream – Bankfull Width 1 (ft)	S
Measure across the channel directly upstream of the crossing in the area that has the potential to be within the influence of the culvert.	

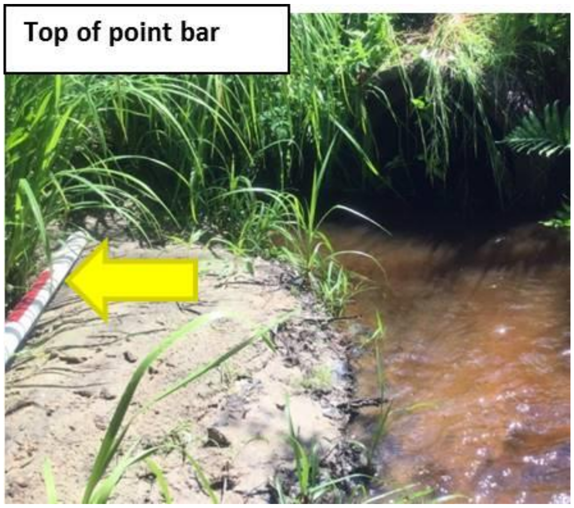
38.) Upstream – Bankfull Width 2 (ft)	S
Collected at ½ bankfull width upstream of the first bankfull width measurement.	

39.) Upstream – Bankfull Width 3 (ft)	S
Collected at ½ bankfull width upstream of the second bankfull width measurement	

Bankfull width is a measure of the wetted stream channel width at bankfull flow and is measured across the channel at the bankfull height. **Bankfull height** is the transitional point where water completely fills the stream channel and overflows onto the floodplain. First identify **bankfull indicators** and then measure the width from bank to bank at those locations.

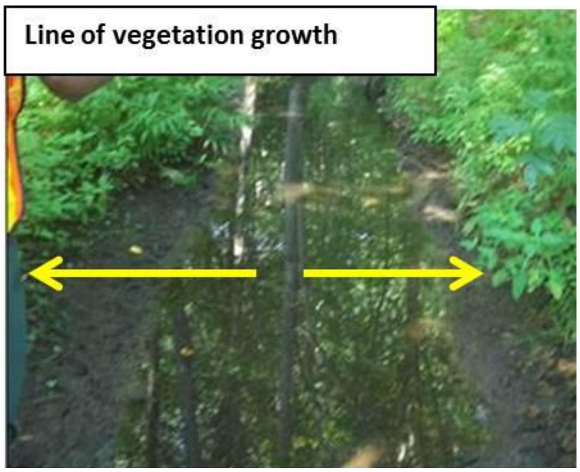


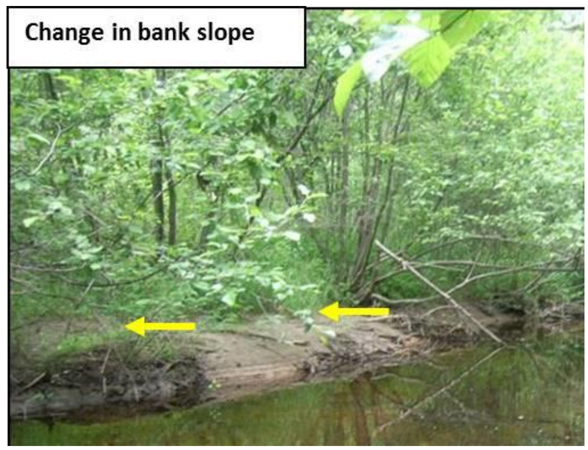




What are bankfull indicators?

- Abrupt change in bank slope.
- Line of vegetation growth.
- Mineral stain marks on rocks.
- Transition in sediment type.
- Top of depositional feature (bar).



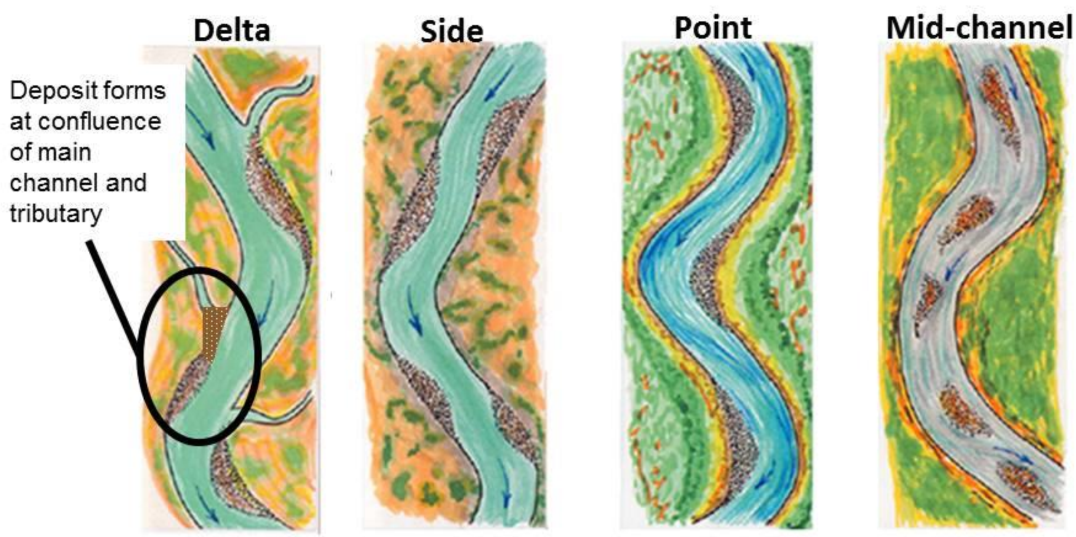


40.) Dominant Substrate- Upstream	S
In the area directly upstream from the crossing inlet, in the area where the 3 upstream bankfull widths were collected, visually determine the dominant substrate type based upon the grain size that takes up the greatest area.	

Type	Grain size(in.)	Relative size
BEDROCK		Immobile material anchored to the Earth's surface
BOULDER	>10.1	bigger than a basketball
COBBLE	2.51-10	about the size of a tennis ball to basketball
GRAVEL	0.08-2.5	about size of peppercorn to a tennis ball
SAND	<0.08	the size of silt to the size of a peppercorn
SILT/CLAY	<0.002	grains are extremely fine and smaller than sand
UNKNOWN	Cannot assess due to turbid water or limited visibility.	
NONE	There is no substrate.	

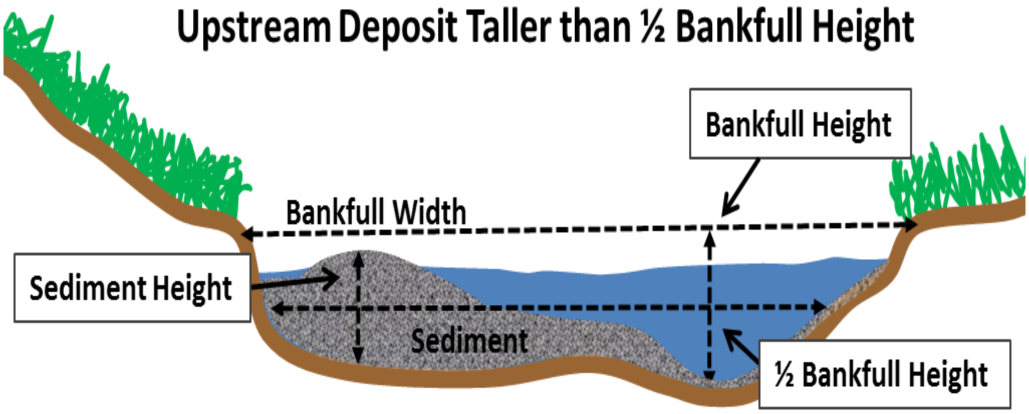
41.) Upstream Deposit Type	S
Indicate the type of sediment deposit in the channel directly upstream of structure.	

- **NONE:** no sediment deposits observed.
- **DELTA:** sediment deposits where a tributary enters a mainstem channel, often fan-shaped; these can be situated either at the mouth of the incoming tributary or directly downstream of a tributary (both diagrammed below)
- **SIDE:** sediment deposits located along the margins of the channel in locations other than the inside of channel meander bends (not point bars).
- **POINT BAR:** a sediment deposit that is adjacent to the bank and occurs on the inside edge of a meander bend.
- **MID-CHANNEL:** areas of sediment deposition (bars) built up above the streambed elevation of the nearby area, located in the channel away from the banks.



42.) Upstream Deposit Taller than 0.5 Bankfull Height	S
If a sediment deposit is present upstream of the structure, indicate whether the height of the deposit is equal to or higher than ½ bankfull elevation.	

- **YES:** upstream deposits fill the channel to an elevation greater than or equal to half of the bankfull elevation.
- **NO:** upstream deposits DO NOT fill the channel to an elevation greater than or equal to half of the bankfull elevation.



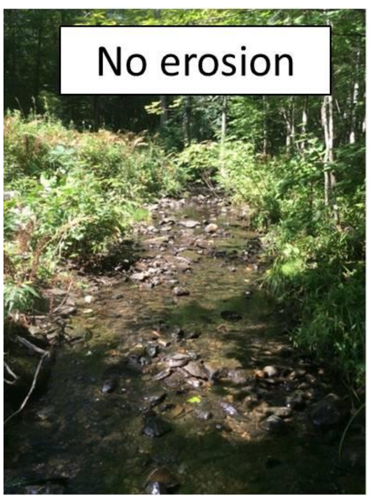
43.) Bank Erosion - Upstream	S
Identify the degree of bank erosion observed upstream of the structure. Indicators of bank erosion are areas of bank that are undercut and have exposed roots, are raw and barren of soil where the vegetation does not have the ability to hold the soil, and/or soil has slumped or fallen into the stream.	

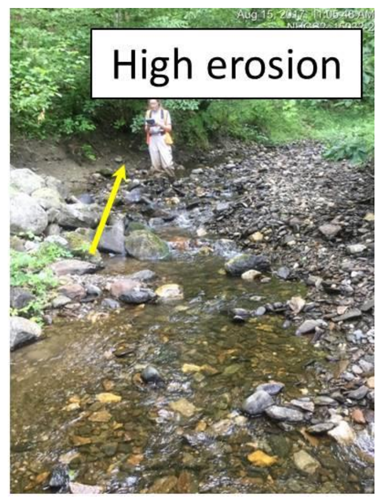
- **HIGH:** nearly continuous areas of erosion (raw and barren soil) along banks (left), especially on medium to steep banks (right).

LOW – discontinuous patches of erosion (raw and barren soil) along the bank (left) or occasional areas of undercut banks with root exposure (right).

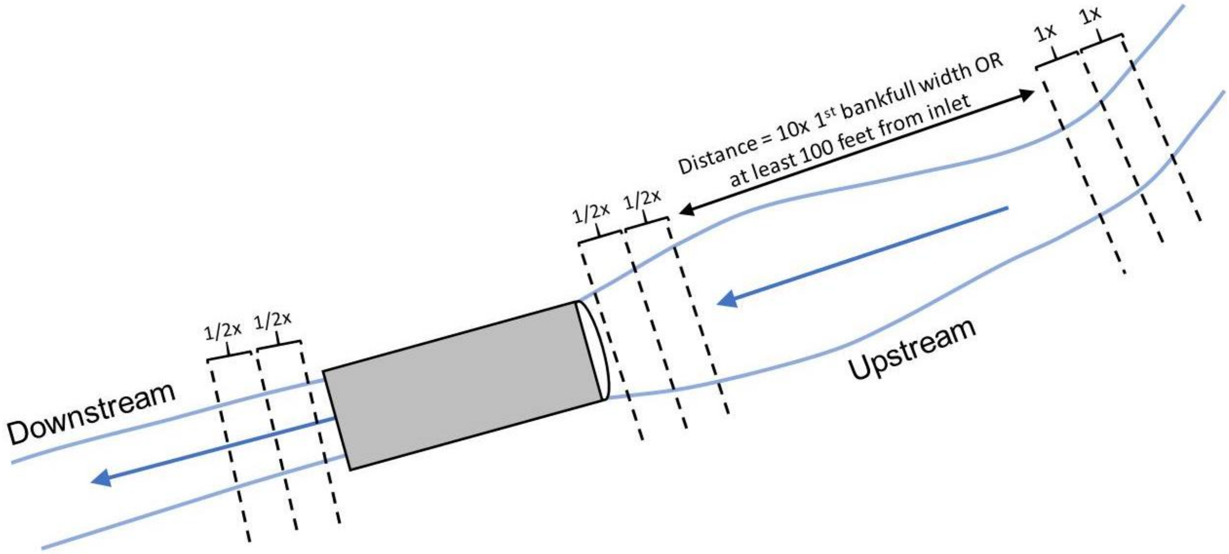

-

NONE – no bank erosion evident.





44.) Channel – Bankfull Width 1 (ft)	S
Record the bankfull width of the channel far enough upstream of the crossing such that the measurements are taken outside of the influence of the structure and represent a stable area of stream channel. Once the upstream bankfull widths are collected, proceed upstream 10x the length of the first bankfull width OR AT LEAST 100 feet from the inlet. Space the remaining reference bankfull widths so that they are 1 bankfull width apart until a minimum of three have been collected.	



If the distance of 10x upstream from the 3rd bankfull measurement or 100 feet from the inlet brings you into the area of influence of another crossing, then **adjust** where you measure your channel bankfull widths and note the distance from the inlet in your comments.

45.) Channel – Bankfull Width 2 (ft)	S
Collected 1 bankfull width upstream of the first channel bankfull width measurement.	

46.) Channel – Bankfull Width 3 (ft)	S
Collected 1 bankfull width upstream of the second channel bankfull width measurement.	

47.) Dominant Substrate – Channel	S
In the area where the 3 channel bankfull widths were collected, visually determine the dominant substrate type based upon the grain size that takes up the greatest area.	

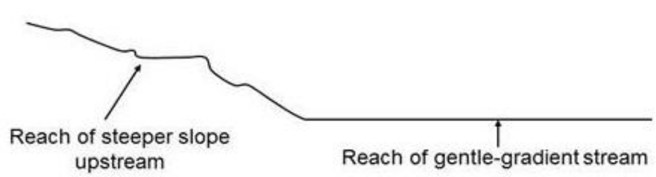
Type	Grain size(in.)	Relative size
BEDROCK		Immobile material anchored to the Earth's surface
BOULDER	>10.1	bigger than a basketball
COBBLE	2.51-10	about the size of a tennis ball to basketball
GRAVEL	0.08-2.5	about size of peppercorn to a tennis ball
SAND	<0.08	the size of silt to the size of a peppercorn
SILT/CLAY	<0.002	grains are extremely fine and smaller than sand
UNKNOWN	Cannot assess due to turbid water or limited visibility.	
NONE	There is no substrate.	

48.) Steeper Segment within 1/3 Mile Upstream	S
Walk upstream, use a topographic map or other digital elevation data, to determine if there is a break in the channel slope farther upstream.	

-YES: structure is located on a stream segment of relatively gentle-gradient that is within 1/3 mile downstream of a significantly steeper segment of stream.

- NO: there is no dramatic increase in stream gradient upstream.

- UNSURE: obscured view of upstream topography or topographic map not available.

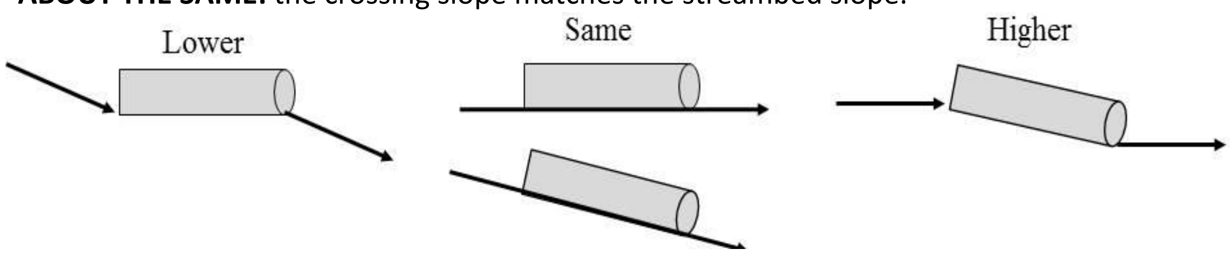


49.) Beaver Dam Near Structure – Upstream	S	
Record whether a beaver dam is within the survey area upstream from the structure. Beaver dams usually create a pond upstream. If unsure whether a dam was made by beavers, look at the ends of the branches to see if they have been gnawed.		

- **YES:** a beaver dam is located within the survey area upstream of the structure.
- **NO**: a beaver dam is NOT located within the survey area upstream of the structure.

51.) Structure Slope Compared to Channel Slope	S
This is a visual estimate to identify structures placed at a slope different than that of the channel.	

- **HIGHER:** the crossing slope is higher than the natural slope of the streambed.
- **LOWER:** the crossing slope is lower than the natural slope of the streambed.
- **ABOUT THE SAME:** the crossing slope matches the streambed slope.

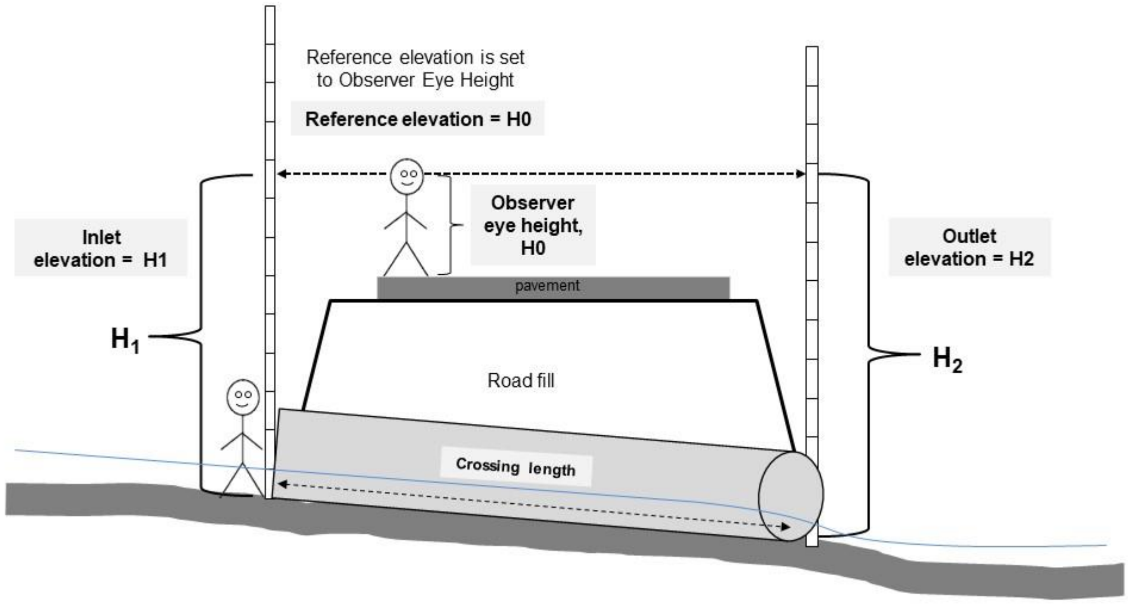


52.) Inlet Invert Elevation (ft)	S
Record the vertical distance between the inlet invert and the height of the roadway (which is set to the observers' eye height). One observer stands in the stream at the inlet and holds the base of the depth rod on the inside edge of the inlet invert. The depth rod is extended fully so that it surpasses the height of the road. A second observer stands on the road above the inlet, directly on top of the edge of the pavement. The second observer uses a pop level to measure the distance they are standing above the inlet and record this height (H_1).	

You do **NOT** need to collect inlet and outlet elevations at stream crossings with **>20 feet** width because these structures are too large to run through the Hydraulic Capacity model.

53.) Reference elevation (ft)	S
One observer stands on the pavement at the location where flooding water would first touch asphalt— this is the lowest point along the road profile on the *upstream* side of the culvert. This location is used as a reference point for all elevation measurements and should be set to the observer's eye height (measure the distance from the road surface to the observer's eye).	

55.) Outlet Invert Elevation (ft)	S
Record the vertical distance between the outlet invert and the reference height of the roadway (which is set to observer's eye height). One observer stands in the stream at the outlet and holds the base of the depth rod on the inside edge of the outlet invert. The depth rod is extended fully so that it surpasses the height of the road. A second observer stands on the road above the inlet, directly on top of the edge of the pavement and uses a pop level to measure their height above the inlet invert by shooting directly towards the extended depth rod. The second observer uses a pop level to measure the distance they are standing above the inlet and record this height (H_2).	



56.) Waterbody – Downstream	S	W
Select the waterbody that describes the downstream type. Refer to the definitions and diagrams of waterbody types listed in the Waterbody – Upstream parameter.		

- WETLAND
- STREAM
- SURFACE
- DRAINAGE

57.) Water Depth – Structure Outlet (ft)	S	W
Measure the depth of the water in the structure at the outlet.		

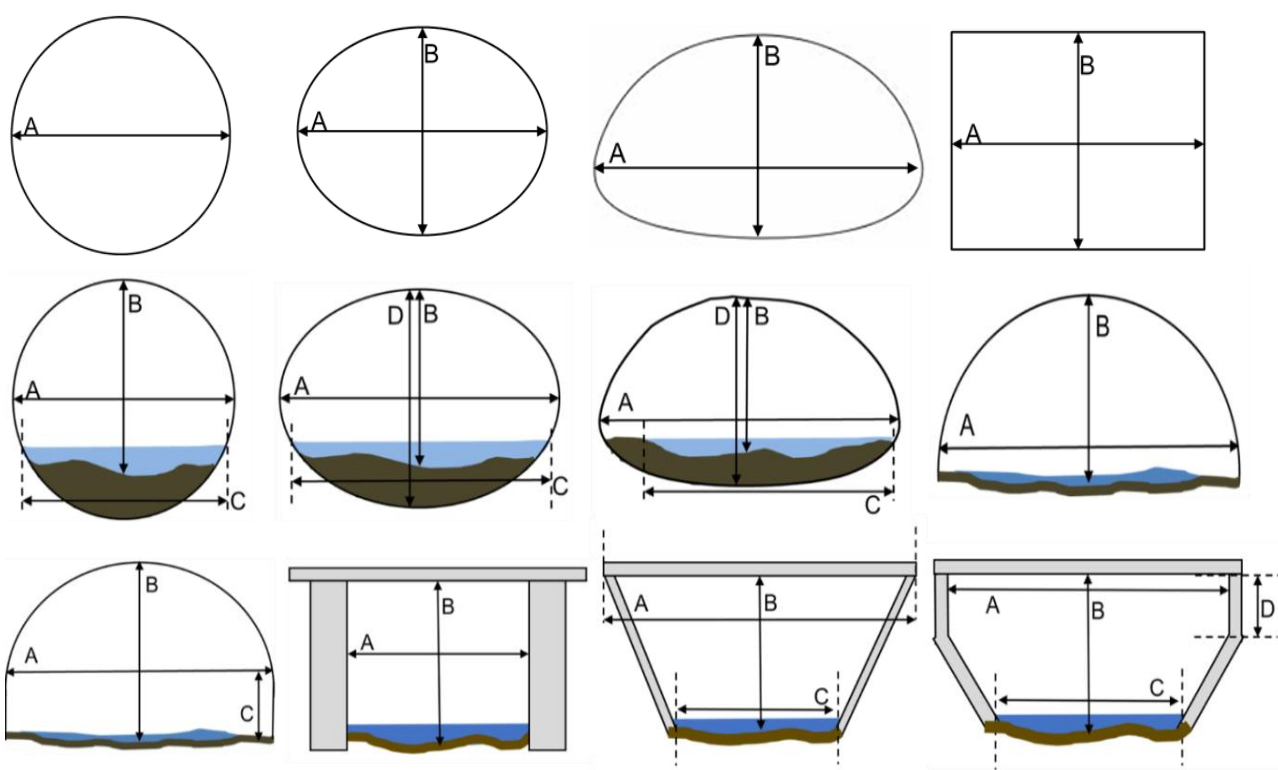
58.) Structure Length (ft)	S	W
Measure the crossing from inlet to outlet by using the rangefinder to shoot down the length of the crossing. If measurement through the crossing is not possible, is to stand on top of the inlet and measure over the road.		

60.) Downstream – Width (A) (ft)	S	W	D
Measure interior width of crossing in decimal feet to the nearest tenth. Reference the structure diagrams for guidance.			

61.) Downstream – Open Height (B) (ft)	S	W	D
Measure the height from the interior top of the structure to the bottom of the structure of the top extent of sediment or substrate. For open structures, i.e., structures that are not embedded or clogged with sediment, the bottom point on this measurement should be located at the bottom of the structure itself. For embedded or clogged structures, this measurement should be located equal to the highest elevation of accumulated or embedded material in the crossing.			

62.) Downstream - Wetted Width/Wall Rise (C) (ft)	S	W	D
Measure the height from the interior top of the structure to the bottom of the structure of the top extent of sediment or substrate. For *open* structures, i.e. structures that are not embedded or clogged with sediment, the bottom point on this measurement should be located at the bottom of the structure itself. For *embedded or clogged* structures, this measurement should be located equal to the highest elevation of accumulated or embedded material in the crossing.			

63.) Downstream – Total Height (D) (ft)	S	W	D
For *embedded or clogged* structures, measure the height from the underside of the top of the structure to the bottom of the structure.			



65.) Structure Condition	S	W	D
Identify the condition of the conduit, meaning the inside of the pipe or box (the part of the structure that carries the stream flow), based on the following rating criteria.			

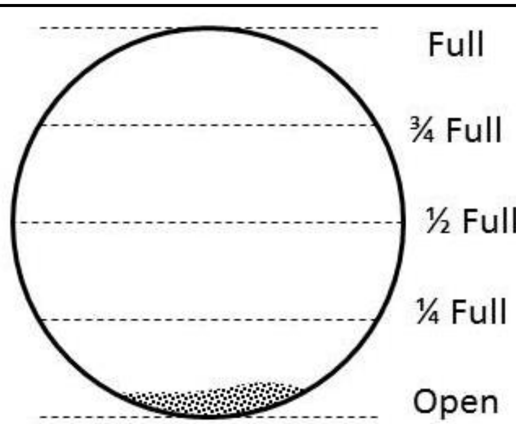
- **GOOD:** Like new, with little or no deterioration, consistent shape, minor joint misalignment, no movement, structurally sound and functionally adequate
- **FAIR:** Some deterioration or cracking, joint separation with minor infiltration but structurally sound, localized distortion in shape, functionally adequate
- **POOR:** Significant deterioration or extensive cracking and/or spalling, extreme deflection in shape, joint separation with potential to create voids, significant movement and/or functionally inadequate requiring maintenance or repair.

66.) Dominant Substrate Throughout Structure	S	W
Select the type of substrate that is *continuously* distributed throughout the crossing. This is a key parameter for AOP that identifies whether substrate is throughout the structure to assist in fish passage. If substrate is not present throughout then select "NONE."		

Type	Grain size(in.)	Relative size
BEDROCK		Immobile material anchored to the Earth's surface
BOULDER	>10.1	bigger than a basketball
COBBLE	2.51-10	about the size of a tennis ball to basketball
GRAVEL	0.08-2.5	about size of peppercorn to a tennis ball
SAND	<0.08	the size of silt to the size of a peppercorn
SILT/CLAY	<0.002	grains are extremely fine and smaller than sand
UNKNOWN	Cannot assess due to turbid water or limited visibility.	
NONE	There is no substrate.	

67.) Structure Filled With Sediment	S	W	D
Identify the amount of sediment buildup within the structure. This parameter should be evaluated for structures that are not considered 'embedded' but are filled (or plugged) with sediment.			

- **OPEN**
- **¼ FULL**
- **½ FULL**
- **¾ FULL**
- **ENTIRELY FULL**



68.) Outlet Wingwall – Material	S	W
Wingwalls are structures installed on either side of the outlet to hold back the road embankment. Structures should only be considered wingwalls if there is continuous material intentionally installed to be in direct contact with the with the outlet face.		

- **METAL:** continuous metal walls, whether smooth or corrugated.
- **CONCRETE:** preformed or cast in place concrete walls.
- **MASONRY-** brick or stone structure bonded by mortar.
- **DRY FIT STONE**: stone structure without mortar to bind the stones together.
- **PLASTIC**: continuous plastic walls, whether smooth or corrugated.
- **GABION**: wire cages filled with small stones that stack on one another to form a wall.
- **OTHER:** a material not listed above.
- **NONE**: no wingwall present.

69.) Outlet Headwall – Materials	S	W
A headwall provides anchoring support for the conduit and prevents surrounding soil and fill washing away. Select the option that best describes the overall material surrounding the face of the outlet.		

- **METAL:** continuous metal walls, whether smooth or corrugated.
- **CONCRETE:** preformed or cast in place concrete walls.
- **MASONRY:** brick or stone structure bonded by mortar.
- **GABION**: wire cages filled with small stones that stack on one another to form a wall.
- **DRY FIT STONE**: stone structure without mortar to bind the stones together.
- **PLASTIC**: continuous plastic walls, whether smooth or corrugated.
- **OTHER:** a material not listed above
- **NONE**: no headwall present

70.) Outlet Condition	S	W
Describe the condition of the structural features (both the headwall and wingwalls) at the crossing outlet. This parameter is assessing the structural features on the exterior of the outlet.		

- **GOOD:** headwall is concrete or stone: spalling of up to ¼" thickness is present, joints between headwall and wingwalls are broken, or some mortar is missing from joints. Metal: Pitting or superficial rust is present.
- **FAIR:** headwall is concrete or stone: spalling of more than ¼" thickness is present but no reinforcement is present, joints between headwall and wingwalls are beginning to separate, or joints between some stones are broken. Metal: flaking rust is present and some loss of wall thickness is present, or a hole can be poked through the wall with a sharp point.
- **POOR:** head wall is concrete or stone: reinforcement is visible, stones are loose, or large cracks run through the headwall. Metal: holes due to corrosion are present, full length cracks or tears are present, joints are separated, or severe deformation is present.

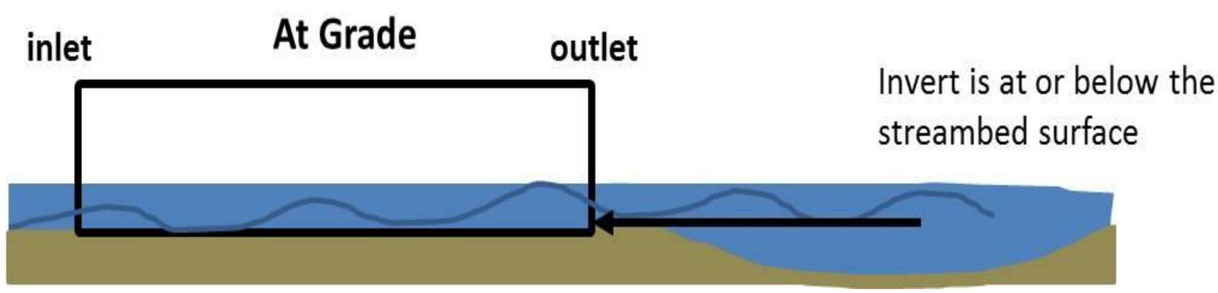
- **N/A (*default*)**: the headwall is not evaluated or there is no headwall at the outlet.

71.) Scour Undermining Structure – Downstream	**S**	**W**
Identify the part of structure that is affected by scour. Scour is the erosive action of running water, which erodes and carries away material from the bed and banks. Indicators of scour are: exposed areas of structure that are typically covered by stream bed material (e.g., bridge footings), leaning or hanging structures, water visibly flowing under or to the side of the outlet, and deep water along one or both sides of a bridge or arch when the bed feature through the structure is a riffle. If a culvert outlet is submerged and this parameter cannot be visually assessed, assessors can use their wading rod to sense for any scour that may exist under the crossing. Under no circumstances should assessors use their boot or hand to make this determination if submergence is seen.		

- **FOOTERS**
- **CULVERT**
- **WING WALL**
- **CULVERT AND FOOTERS**
- **CULVERT AND WING WALL**
- **FOOTERS AND WING WALL**
- **CULVERT, FOOTERS AND WING WALL**
- **NONE**
- **UNKNOWN**

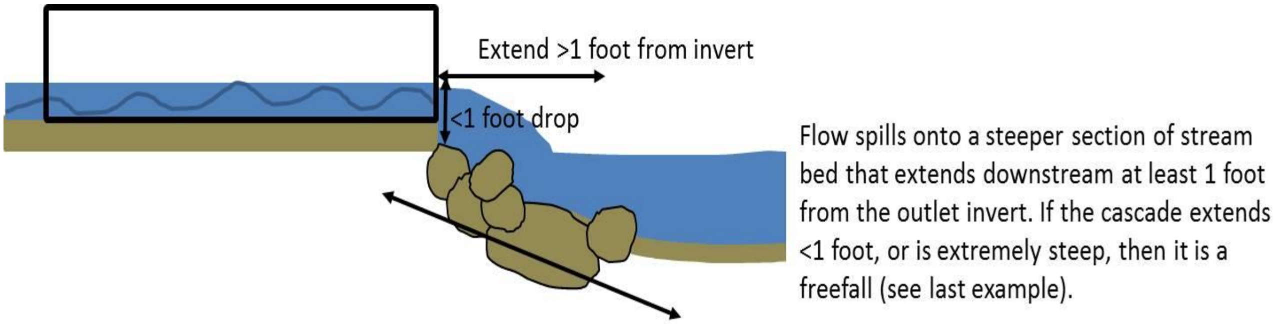
72.) Outlet Grade	S	W
Description of the water surface profile as it leaves the outlet of the structure. This parameter evaluates the vertical distance a fish, or other aquatic organism would have to travel to get from the stream into the pipe, it is a key variable in the AOP screen.		

- **AT GRADE:** The invert of the outlet is at or below the streambed surface, and the streambed directly downstream of the culvert outlet is of a gradient typical to the channel at the structure site. If the channel directly downstream of the structure outlet is much steeper than the typical channel gradient at the site, then the outlet condition should be described as a cascade.
- **BACKWATERED:** Directly downstream of the outlet the water direction has reversed and is re-entering the outlet. Measure the distance (in feet) that the crossing outlet is backwatered.

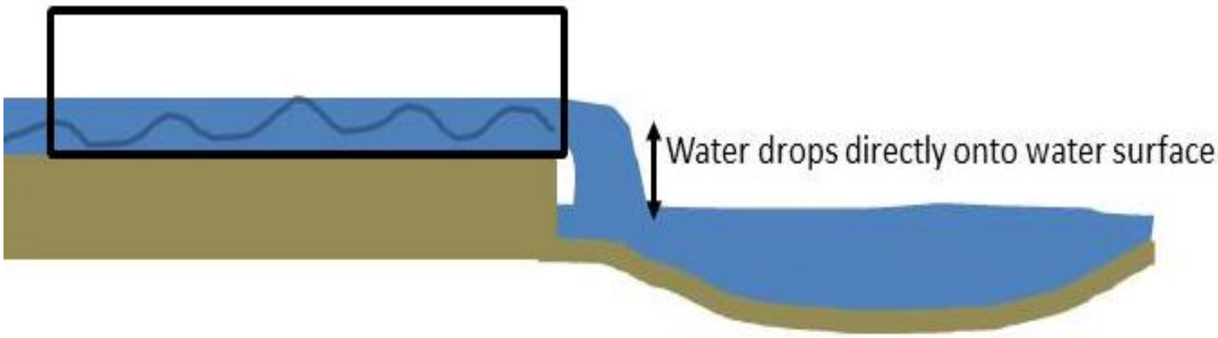


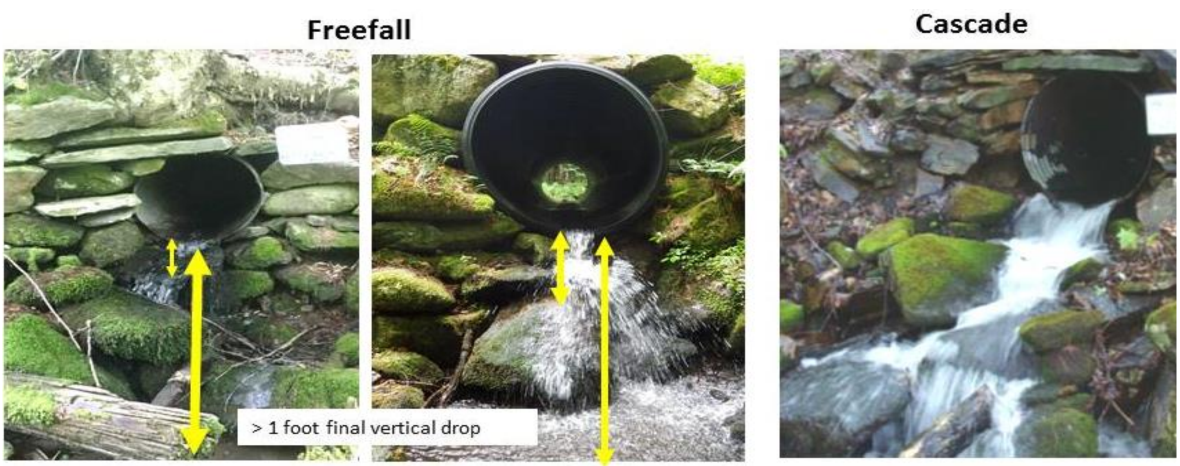
CASCADE – The outlet is above the water surface and the flow spills out of the culvert onto a steep section of stream bed (typically bedrock or large boulders). To be considered a cascade, the streambed directly downstream of the culvert outlet should be steeper than the general stream gradient. Stream flow over the cascade may be sheet flow (as in over bedrock) or disperse flow (as in splashing off riprap or large boulders). The following must also be true:

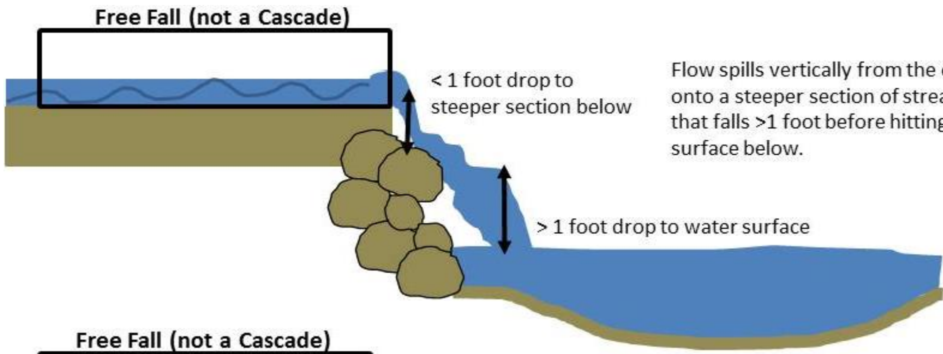
- Cascade must extend > 1 foot beyond the culvert measured longitudinally.
- Flow exiting the culvert must drop less than 1 foot before hitting the cascade below. Flows dropping greater than 1 ft. before hitting a cascade are considered “free fall.”

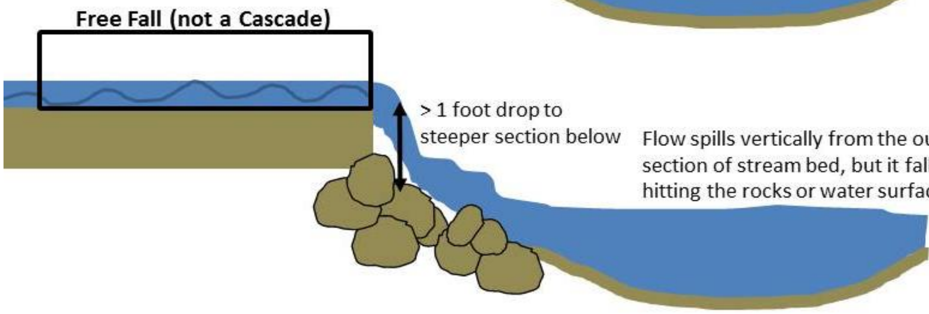


FREE FALL – The invert is above the stream bed surface and the flow spills vertically out of the culvert onto the water surface (e.g. "perched" culvert). If the flow falls vertically from the culvert outlet and then hits a cascade, it is still considered "free fall" If the vertical drop from the outlet invert to cascade below is greater than 1 foot.

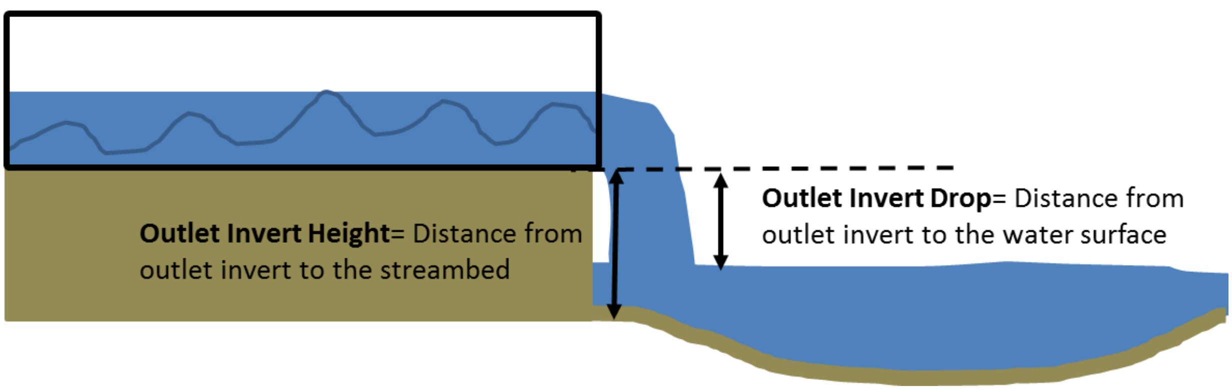


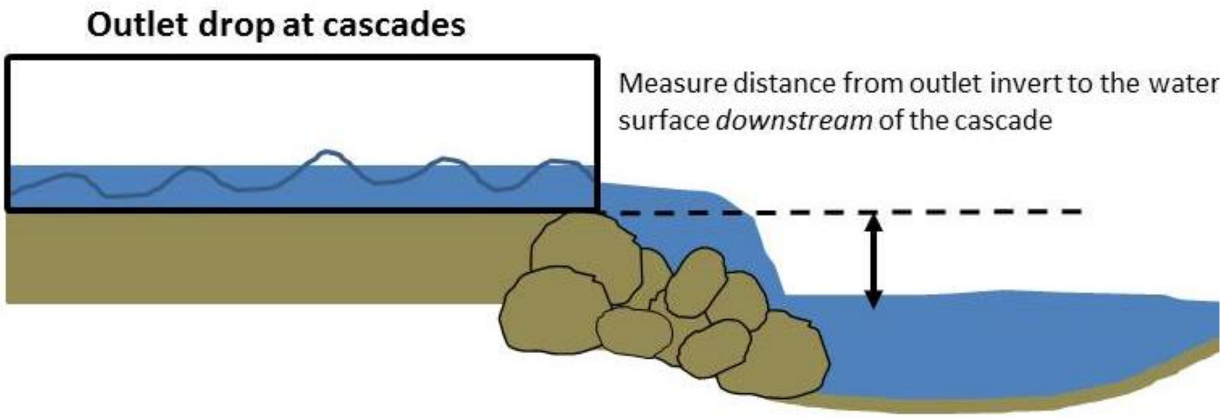






73.) Outlet Invert Drop (ft)	S	W
Measure the vertical distance (nearest tenth of a foot) from the outlet invert to the water surface. Take this measurement from the inside bottom surface of the structure (not the top of the water) down to the water surface below. If the culvert flow spills onto a cascade, or is a free fall onto a cascade, measure the vertical distance from the outlet invert to the water's surface directly downstream of the cascade. If the structure is at grade this measurement must be zero.		





74.) Outlet Invert Height	S	W
Measure with the wading rod, the vertical distance from the bottom of the structure outlet to the channel bottom. See diagram above.		

- **EMBEDDED:** the bottom of the structure is below the streambed
- **AT GRADE:** the bottom of the structure is approximately at the same grade as the streambed or is embedded.
- **< 1 FOOT ABOVE CHANNEL:** the bottom of the structure is above the streambed but less than 1 foot.
- **1-2 FEET ABOVE CHANNEL:** the bottom of the structure is between 1 and 2 feet above the stream bed.
- **> 2 FEET ABOVE CHANNEL:** the bottom of the structure is more than 2 feet higher than the streambed.

75.) Outfall Treatment	S
Identify the type of treatment at the outfall of the structure.	

- **PLUNGE POOL:** deep depression in the stream bed at the base of the outlet.
- **FLOW DISSIPATER**: a treatment at the outlet of the structure made of metal, concrete or plastic that reduces the energy of the water and guides / disperses the water from the outlet into the stream bed. The dissipater can look like an apron or fan attached to the outlet, a concrete pad, or granite blocks at the outfall of the outlet.
- **RIP RAP:** stone or rock bedding/ pad at base of the outlet.
- **OTHER:** any other treatment that does not fit any of the descriptions include a note in the comments.
- **NONE:** no treatment present.

76.) Scour of Streambed at the Outlet	S	W
Scour at Outlet of the crossing structure can cause visible erosion of the channel bed and can lead to the structure being perched above the channel.		

- **NONE:** no scour is observed at the outlet.
- **LOW:** finer material is no longer present after the outlet.
- **MEDIUM:** noticeable erosion is occurring at the outlet.
- **HIGH:** the outlet is perched due to erosion, high above the streambed.
- **UNKNOWN:** the scour cannot be observed due to turbid or turbulent water.

77.) Bank Armoring – Downstream	S	W
Protective covering, such as rocks, vegetation or engineering materials used to protect stream banks, or fill or cut slopes from flowing water.		

- **INTACT:** not falling into stream, no missing or out of place pieces of armoring material.
- **FAILING:** Parts are falling into the stream, missing, or out of place.
- **NONE:** No hard bank armoring present.
- **UNKNOWN:** Unable to assess the condition or presence of hard bank armoring.

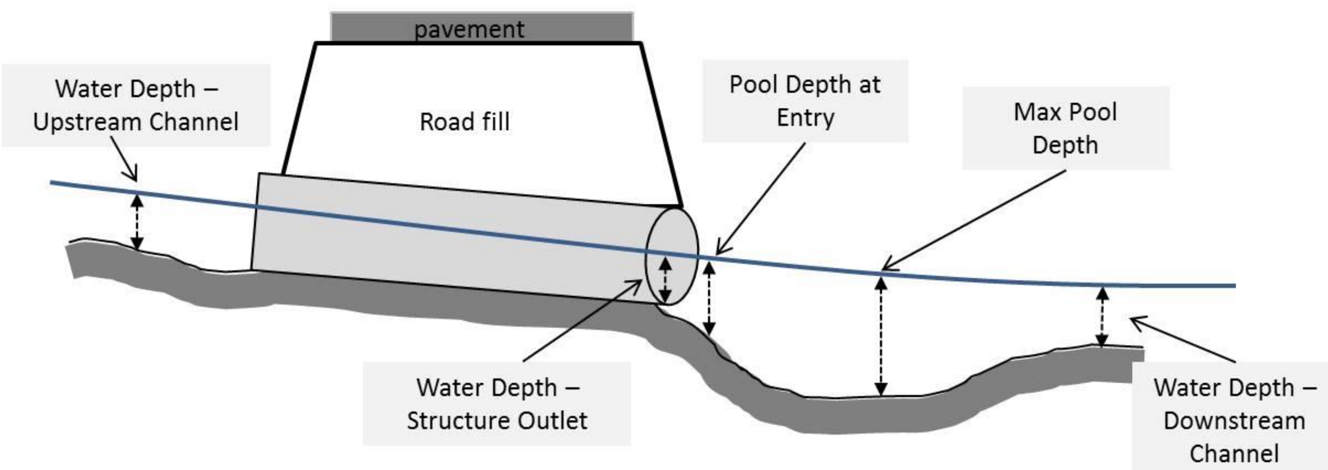
78.) Downstream Pool Present	S
Indicate if a pool is directly below the outlet of the structure. If the structure is a culvert that flows onto a cascade (as defined above) then answer "no" to this question.	

- **YES:** a pool is directly below the outlet of the structure.
- **NO:** there is no pool or the culvert flows onto a cascade.

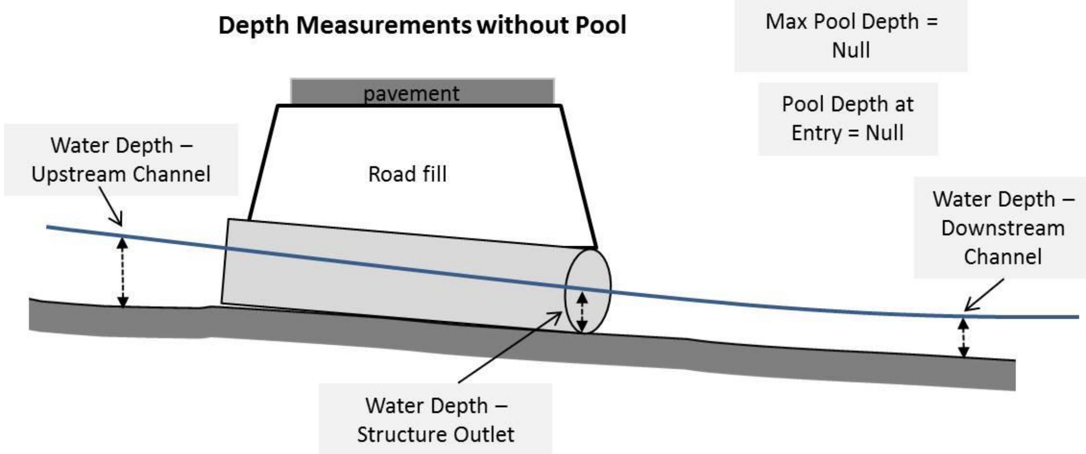
79.) Downstream Pool Depth at Entrance (ft)	S
Measure the depth from the water surface to the stream bed (nearest tenth of a foot) at the point where the streamflow enters the pool. Only applicable if there is a pool directly below the outlet. If there is no downstream pool, leave blank.	

80.) Downstream Pool Maximum Depth (ft)	S
At the point of maximum pool depth, estimate the pool depth. If the estimated depth is less than four feet measure the distance from the water surface to the stream bed to the nearest tenth of foot. If the estimated depth is greater than four feet, then record greater than four feet. This data should be collected when the pool is present, and only if a pool is present directly below the outlet. If there is no downstream pool, leave blank.	

Depth Measurements with Pool



81.) Water Depth - Downstream Channel (ft)	S
Where the 1st Downstream Bankfull width is measured, record the deepest part of the channel by measuring from the water surface to the streambed.	



82.) Downstream- Bankfull Width 1 (ft)	S
Measured directly downstream of the crossing in the area that has the potential to be within the influence of the culvert DS-1	

83.) Downstream- Bankfull Width 2 (ft)	S
Measured at ½ bankfull width upstream of the first bankfull width measurement.	

84.) Downstream – Bankfull Width 3 (ft)	S
Measured at ½ bankfull width upstream of the second bankfull width measurement.	

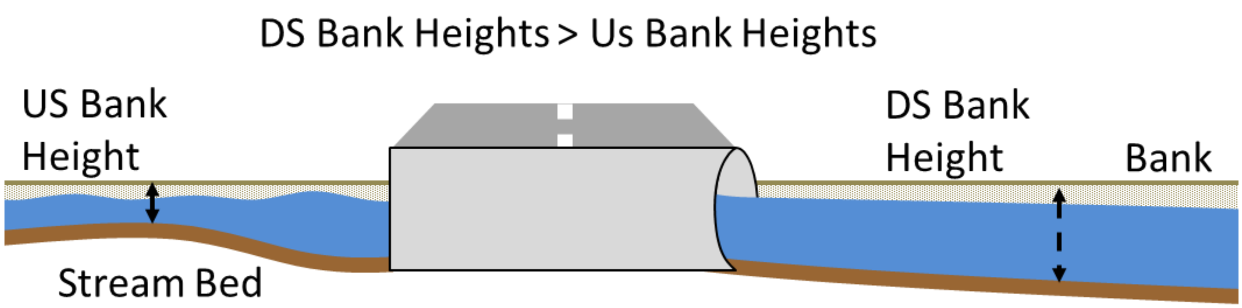
85.) Dominant Substrate – Downstream	S
In the area directly downstream from the crossing outlet, in the area where the 3 bankfull widths were collected, visually determine the dominant substrate type based on the grain size that takes up the greatest area.	

86.) Bank Erosion – Downstream	S
Identify the overall degree of bank erosion observed downstream from the structure outlet. Refer to photo examples provided for upstream erosion.	

- **HIGH:** nearly continuous erosion along banks, especially on medium to high banks.
- **LOW:** occasional erosion along banks, mostly found on low banks.
- **NONE:** no bank erosion evident

87.) DS Bank Heights Taller than US Banks	S
This parameter is designed to measure whether erosion has occurred downstream of the structure, and should be considered as relative to the streambed. If bank heights are higher downstream as compared to upstream, ensure that the form of the banks is similar to that observed upstream. For example, if a bank is high and comprised of a bedrock outcrop downstream that was not observed upstream, then it is possible that the difference in height may be caused by natural features as opposed to erosion caused by the culvert.	

- **YES:** bank heights downstream are substantially greater than bank heights upstream.
- **NO:** upstream and downstream bank heights are similar.



88.) Bedrock Present - Downstream	S
Indicate whether there is any bedrock visible in the channel downstream of the structure.	

- **YES**: bedrock is visible downstream of the structure and makes up part of the channel.
- **NO**: bedrock is NOT visible downstream of the structure; not present in channel.

89.) Hydraulic Control Type	S
If the water elevation directly downstream of the culvert outlet is being controlled by a geomorphic feature, indicate the material. Boulders, cobbles, sand, gravel, wood, or other materials can all act as a hydraulic control.	

Type	Grain size(in.)	Relative size
BEDROCK		Immobile material anchored to the Earth's surface
BOULDER	10.1-160	bigger than a basketball
COBBLE	2.51-10	about the size of a tennis ball to basketball
GRAVEL	0.08-2.5	about size of peppercorn to a tennis ball
SAND	<0.08	the size of silt to the size of a peppercorn
SILT/CLAY	<0.002	grains are extremely fine and smaller than sand
UNKNOWN	Cannot assess due to turbid water or limited visibility.	
NONE	There is no substrate throughout the structure.	

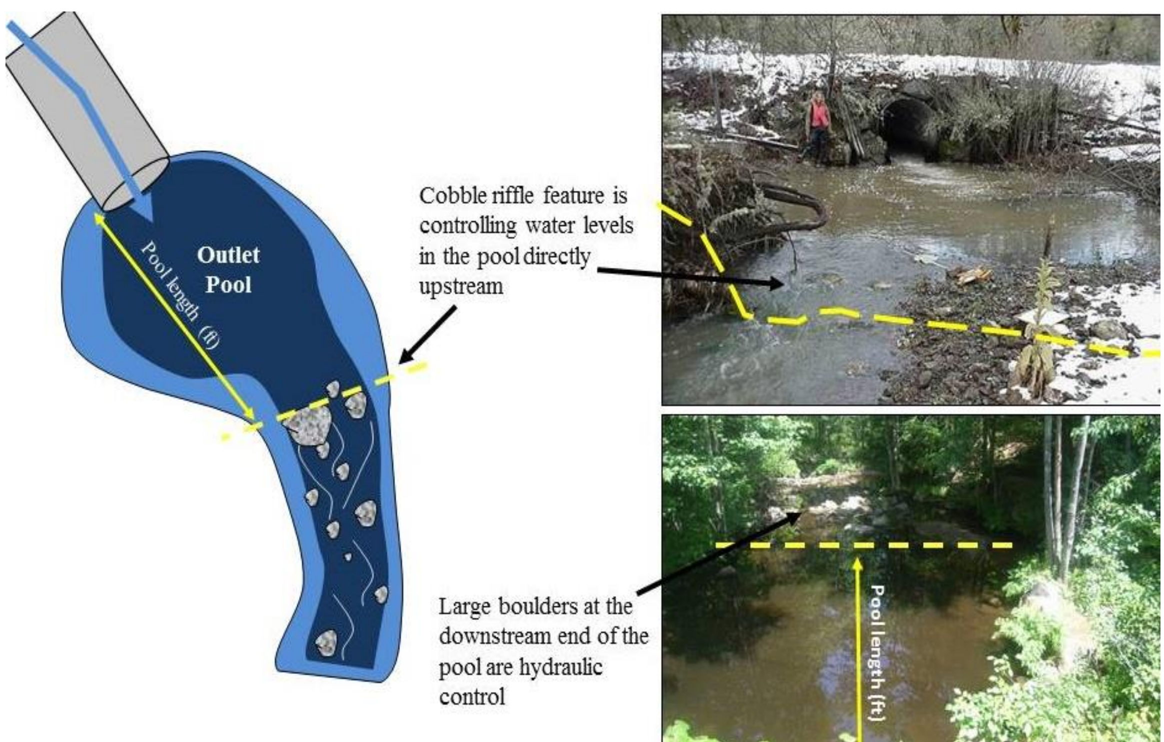


Diagram modified from Robert Gubernick R.G. (USFS) and Michael Love & Associates

90.) Downstream Hydraulic Control Distance From Structure (ft)	S
Measure the distance from the outlet to the hydraulic control at the downstream end of the outlet pool (to the nearest tenth of a foot). If there is no downstream hydraulic control, leave blank.	

91.) Beaver Dam Near Structure – Downstream	S	W
Record whether a beaver dam is within the survey area downstream from the structure. Beaver dams usually create a pond upstream. If unsure whether a dam was made by beavers, look at the ends of the branches to see if they have been gnawed.		

- **YES:** a beaver dam is located within the survey area downstream of the structure.
- **NO:** a beaver dam is NOT located within the survey area downstream of the structure.

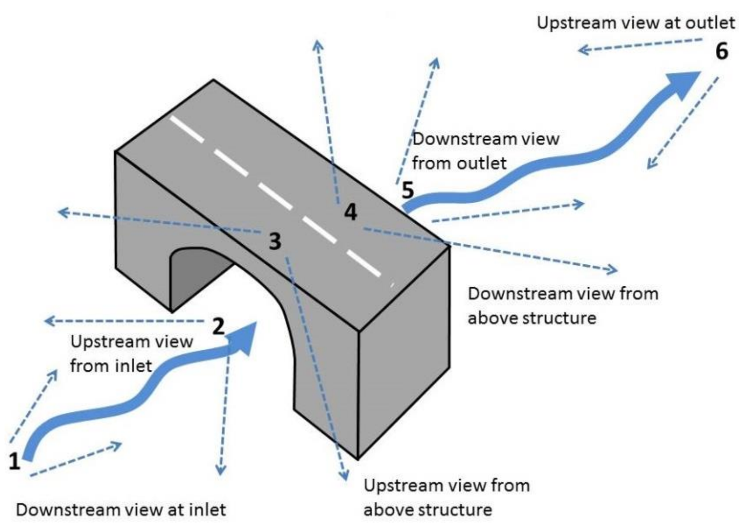
92.) Wildlife Observed - US, DS, Structure	S	W
Consider the entire area that was surveyed upstream, downstream, and within the structure, including the banks, water, and channel bed and indicate whether any wildlife was observed. Below is a list of examples of wildlife commonly seen around stream crossings, this is a text field (1,000 character limit) and multiple types may be entered.		

EXAMPLES OF POSSIBLE ANSWERS
- **AMPHIBIAN:** Frog or salamander
- **FISH**: if known indicate species
- **TURTLE:** if known indicate species
- **LARGE MAMMALS:** Moose, Bear, Coyote, Fisher, Deer, Beaver
- **SMALL MAMMALS:** Bobcat, Otter, mink, and any other small mammal
- **WATER FOWL:** ducks, geese, etc.

93.) Comments	S	W	D
Include notes on the structure not covered in the other fields. 1,000 character limit.			

Minimum 6 photos	S	W	D
Photographs are required and stream crossings cannot go through Quality Control without them. Photographs should be sufficient to enable identification of river bed material, bank condition, and views capturing the entirety of the culvert inlet and outside. All who collect culvert data need to collect photos of HIGH QUALITY. Photos are critical to the QA/QC process, so take extra care to collect sharp, clear images.			

- **PHOTO #1**: Downstream view toward structure inlet: This is meant to capture the structure inlet, roadway approaches, and if possible some of the land adjacent to the channel, armoring features (i.e., riprap, if present), and any other features of interest. This should be taken from a reasonable distance back from the structure with the widest angle setting so that the environment around the structure is captured.
- **PHOTO #2**: Upstream view from structure inlet: This is taken with the photographer standing in the streambed next to or in front of the structure. This picture is meant to focus on the bed and near-structure features. Bed substrate size and channel bars should be captured in this photograph.
- **PHOTO #3**: Upstream view of stream above structure: This picture should capture the river environment and land adjacent to the channel upstream of the crossing.
- **PHOTO #4**: Downstream view of stream above structure: This picture should capture the environment and land adjacent to the channel downstream of the crossing.
- **PHOTO #5**: Downstream view from structure outlet: The photographer should be standing in the streambed next to or in front of the structure. If dangerous conditions are present, take a photo standing as close as possible to the location where the downstream view will be maximized (please, take care not to fall into any scour pools).
- **PHOTO #6**: Upstream view toward structure outlet: This is meant to capture the structure inlet, roadway approaches, and if possible some of the land adjacent to the channel, armoring features (i.e., riprap, if present), and any other features of interest. This should be taken from a reasonable distance back from the structure with the widest angle setting so that the environment around the structure is captured.
- **ADDITIONAL PHOTOS**: Any features that may need clarification. If you are at a stream crossing where thick vegetation blocks portions of the normal views, additional photos beyond the six (6) required may be necessary and are encouraged.



Quality Assurance and Quality Control Review

All data that is uploaded to SADES **must** undergo Quality Control by trained personnel at the NHGS. For data to be reviewed, the six required photos must be included with the data submission. Data collectors will receive their comments and the Review Status field will change to "Comments Ready." It is the responsibility of the data collectors to make any changes to the raw data on SADES in order to address the concerns raised by NHGS during Quality Control. Once all of the QC comments have been addressed, NHGS will check whether appropriate edits are made, and change the Review Status to "Review Complete," at which time the data is ready to be run through the models and shared with the public. Once a crossing has been assigned its AOP and GC rank, the Review Status will be changed to "Input Scored" by NHGS.

94.) Current QAQC Review Status
Current state in the review process.

- **NEW**: default field setting; generated when a new record is uploaded onto SADES.
- **COMMENTS READY**: NHGS has provided QC comments to the data collectors and is waiting for their responses.
- **COMMENT ADDRESSED**: the data collectors have made their data edits on SADES in response to the NHGS QC comments and engaged in a QC dialog with the QC manager
- **REVIEW ONGOING**: There are unresolved issues regarding the NHGS comments that the data collector still must address. This may involve a field revisit or some further investigation into the data or site photos. The data collector and NHGS QC manager are still in communication regarding the QC issues for this record.
- **REVIEW COMPLETE**: NHGS has reviewed the response comments from the data collectors and ensured all issues have been addressed.
- **SCORED**: The data has undergone QC process and scored for GC and AOP.
- **MISSING PARAMETERS**: there are a long-term issues with this crossing that prevents it from being scored for AOP or GC
- **MISSING PHOTOS**: NHGS is unable to perform QA/QC review because there are no photos for the crossing and this is a long-standing issue with the record.

95.) NHDES Review Comments
These are written comments that NHGS provides on issues, questions and concerns, regarding environmental parameters, including those that are used specifically in the AOP, Geomorphic, Hydraulic Capacity and Condition scores.

96.) Assessment Team Response Comments
These are the responses that the data collectors have to the NHGS QC comments.