4.0 STREAM CROSSINGS

Insects that are indicators of excellent water quality and provide nutrition for stream trout

Mayfly Nymphs
Brush-legged Mayfly Nymph
Order Ephemeroptera, Family Oligoneuridae

- ❑ Mature larvae measure up to 3/4 inch in length (excluding tails)
- ❑ Two rows of long hairs present on inside of front legs
- ❑ 2 or 3 tails
- ❑ Slender antennae
- ❑ The conspicuous hairs growing on the inner front legs are used for filtering food particles from the water.
- ❑ Brush-legged mayflies may be minnowlike with a vertically oriented head and three tails (as pictured) or may be more flattened with a horizontally oriented head and tow tails.

Great Lakes Trivia Test (answers on back):

1) Which is the shallowest Great Lake?

2) Which is the largest Great Lake?

3) Which is the smallest Great Lake (by surface area)?

4) There are many Great Lakes in the world. What is the official name of our Great Lakes?

5) How many gallons of water do the Great Lake hold?
(a) 400 trillion gallons (b) 6 quadrillion gallons
(c) 100 quadrillion gallons

GUIDING PRINCIPLES

1. Plan projects. (All projects should be planned!)
2. Move water off road surfaces as soon as possible.
3. Direct runoff into vegetated filter areas or rock-lined turnouts.
4. **Address road runoff from the top of both approaches.**
5. **Avoid directing runoff into surface waters.**
6. Stabilize bare areas.
7. Keep runoff velocities low and avoid concentrating runoff.
8. Minimize areas of disturbance.
9. Revegetate disturbed areas ASAP.
10. Maintain and monitor all practices.

Answers:

1) Lake Erie
2) Lake Superior (which is also the largest lake in the world by surface area)
3) Lake Ontario
4) the Laurentian Great Lakes
5) (b) 6 quadrillion gallons

4.0 STREAM CROSSINGS

Because fisheries, recreational, aesthetic, and water quality values all can be seriously impacted by poorly designed stream crossings, much careful thought must go into determining what type of crossing would be most appropriate for each situation.

Some general guidelines taken from a position statement prepared by the Michigan Department of Natural Resources, Fisheries Division, are as follows (words in parentheses are ours):

1. **Bridges (<u>and bottomless culverts</u>) with adequate span and underclearance are normally preferred over all (other) types of culvert crossings.**

2. **Where bridges are not feasible and where crossings require 36-inch diameter pipe or smaller, culverts may be an acceptable alternative if carefully installed. (Boating and recreational wading are not major factors on these streams. Fish passage and water quality are of greatest concern on these streams.)**

3. **Culverts will not normally be an acceptable alternative to bridges where crossings require pipe of 72-inch diameter or larger (or the equivalent in multiple pipes). Such streams usually require provision for navigation by wading anglers and boats.**

4. **A careful environmental analysis is necessary where crossings call for pipe diameters between 36 and 72 inches.**

In order to minimize adverse impacts of stream crossings on aquatic and riparian stream habitat and navigability, the following criteria should be satisfied:

- *The structure should not encroach upon the stream channel. Encroachment onto the flood plain should be minimized.*

- *Dredging, filling and channel straightening or relocation should be avoided. Where no alternatives exist, changes should be held to a minimum.*

- *The natural downcutting process of rivers and streams should not be interfered with. A jump or leap at the downstream end of the sill or floor could interfere with fish passage. Navigation could also be jeopardized by elevation difference.*

- *The greatest possible end opening is desired to maximize passage of flood flows and to minimize blockage of light which is important to navigation and aquatic productivity.*

- *There must be no interference with navigation where recreational uses presently exist or may be significant in the future. Consideration should be given to animal passage down stream valleys. Stream valleys are important animal migration routes.*

- *Velocities at all flood flows should be such that all migrating fish are capable of swimming upstream against the flow.*

4.1 General Considerations for All Above-Ground Crossings

- A flood flow analysis should be done for all types of above-ground crossings and is required by various state statutes.
- Consider using existing (old) crossings and existing (old) grades instead of creating new crossings.
- Roadway approach fills should be minimized in temporary crossings and must be removed after use.
- Consider installing devices along the roadway itself to control runoff from the roadway. These devices can include Grade Stabilization Structure, Section 7.1 and Water Turnouts, Section 5.3
- Adequate vegetative cover must be established on all disturbed areas upon completion of finish grading.
- Determine permit requirements of state agencies for bridge and culvert replacements.

4.2 Bridge Spans

Bridges are desirable as crossing devices because they can be constructed in the dry except for any required support piers. Minimal encroachment into the floodplain will occur if abutments and wing walls are set back from the stream bank. Less environmental disturbance will result and free movement of wild animals and wading anglers will be permitted with these provisions. Sufficient structure height would allow for suitable watercraft and wading passage.

4.3 Planning Considerations for Bridges

- Obtain hydraulic clearances from appropriate regulatory agencies.
    - Locate the structure at the narrowest point in the floodplain/ wetland.
    - Indicate any alterations or reconstruction that is needed in the channel to accommodate the proposed structure.
    - For bridges which will be used as part of a roadway, indicate how stormwater runoff from the roadway will be managed to prevent erosive velocities. Alternatives are discussed below in Section 4.4 in Design Considerations.
- A cofferdam may be used to create a dry work site, or water may be flumed or pumped around the work site.
- In extreme situations, consider installing a sediment trap downstream of the road crossing if filter fences, floatation curtains, cofferdams and other practices will not be able to keep soil from moving downstream. These are temporary instream basins which will only be used to trap excess sediment from a particular project. Once a project is completed, the sediment basin will be removed and the channel bottom restored. You will need a permit from the appropriate state agency for any instream sediment basin.
- Disruption of the natural vegetation should be kept to a minimum.
- Follow Best Management Practices for treating timber when used in bridge construction or adjacent structures.

4.4 Design Consideration

- Bridge crossings (including bridges and roadways) must be designed to pass the 100-year flood flow without causing a harmful interference, as determined by the appropriate state agency.
- Bridge abutments should be parallel to the direction of flow. Exceptions may occur during the engineering review as a result of flood flow direction.
- The bridge should span the entire width of the stream, leaving the streambed beneath the structure undisturbed.
- If cofferdams are used, locate them to isolate the construction work site from the stream flow. Alternatives include:
    - Constructing a temporary run around the channel
    - Pumping water around the site to provide a dry work site (follow proper dewatering operations)
- Riprap should be installed beneath bridges on all fill slopes or exposed banks.

- Stormwater runoff from roadways should be directed away from the crossing using one of the following methods:
    - Turnouts, Section 5.3
    - Grade Stabilization Structures, Section 7.1
- Concentrated runoff can be directed to a detention or retention basin and either released slowly to the watercourse or allowed to infiltrate the soil.
- Provide stabilization of bridge abutments and all fill slopes using riprap and other critical area stabilization practices.

4.5 Construction Considerations

The construction of a bridge should be done with the least amount of impact on the natural resources. To do this, the operation must be done in steps which will decrease the amount of water crossings that occur. Follow the guidelines below.

- Where depth allows, place filter fences in the water adjacent to the bridge abutment which will be removed first. If filter fences will not work in water because of water depth, consider using floatation curtains. These are suspended in the water and help settle out larger particles so that they are not carried downstream.
- If flows or banks are such that filter fences cannot be used, consider using cofferdams alongside the channel.
- Where applicable, install the approved sediment trap.
- Where applicable, remove the first bridge abutment and replace with a new one.
- Stabilize the first side with vegetation and riprap following the methods found in Section 6.0 Bank Stabilization.
- Install riprap alongside the new abutment and on either side of the new abutment.
- Place filter fences and/or floatation curtains on the opposite side and repeat the sequence above for the second side.
- Complete the rest of the bridge using as few crossings with equipment as possible.
- Clean out the sediment trap upon completion. Restore the natural channel bottom.
- During construction, keep loose boards, nails, and other debris on site and in a way that will not result in them entering the waterway. Wash buckets, wheel barrows and shovels upland away from the water course.

4.6 Bridge Types

4.6.1 Concrete/Steel spans

- Usually for major highway crossings
- Expensive alternative
- Long lasting

4.6.2 Wood or timber

- Aesthetically pleasing
- Suitable for smaller spans
- Less expensive
- Native (local) materials can be used
- Long lasting
- Easy and quick to assemble

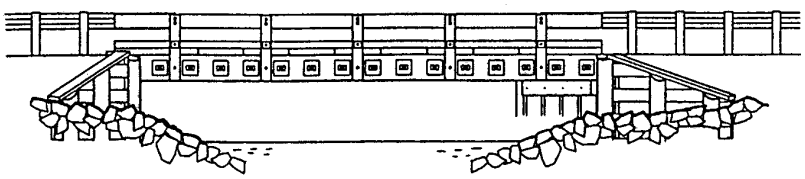

Figure 12—TIMBER BRIDGE

4.6.3 Temporary Portable Bridges

- Can be used for temporary crossing needs such as logging operations where a permanent bridge is unnecessary.
- Can be used in an interim bridge plan in high traffic backroads when a permanent bridge is being delayed.
- Easy installation and removal or relocation.
- Must be removed when completion of the needed work is finished.
- The crossing must be restored to its original condition when finished.
- Streambanks must be left in a stable condition.
- Sediment control measures may be needed downstream.

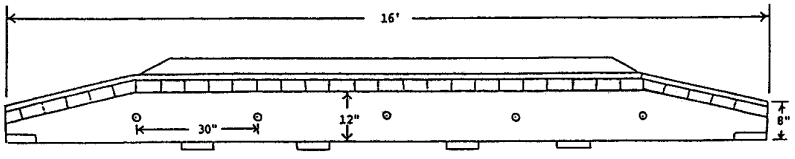

Figure 13—TEMPORARY PORTABLE BRIDGE

4.6.4 Other Possible Temporary Crossings

The following may be used upon approval:

- Temporary culverts
- Flatbed railroad car with wheels removed

4.7 Culverts

A culvert is a conduit used to convey water from one area to another, usually from one side of a road to the other side. Culverts can be used for stream crossings or ditches (roadside water conveyances).

Types of culverts:

4.7.1 Box Culverts-concrete, wood, steel, aluminum or plastic

- More fish friendly than cylindrical culverts
- More bridge-like in appearance
- Can be more expensive
- Natural stream bottom

4.7.2 Cylindrical Culverts - concrete, metal or plastic

- Round
- Elliptical

4.7.3 Bottomless Culverts - metal or concrete

- Box
- Corrugated metal pipe
- Natural stream bottom

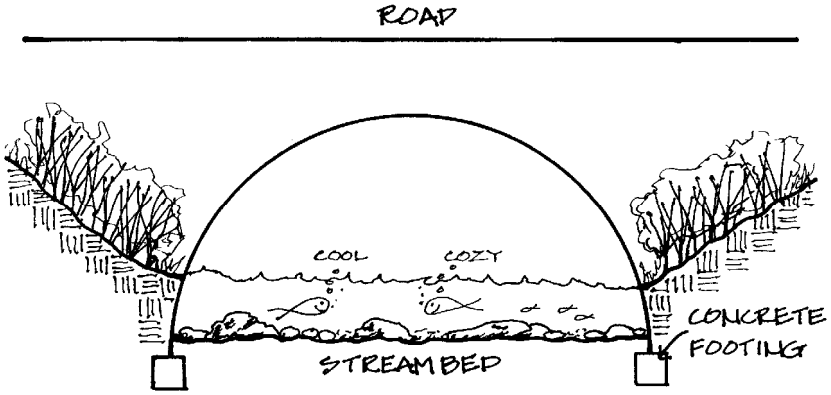

Figure 14—BOTTOMLESS ARCH CULVERT

4.8 Stream Culverts

Culvert installation should occur during periods of low stream flow. This will minimize disturbance to the natural land and water system. Note: It is best to divert or dewater the stream while culvert is being installed to avoid sedimentation of the stream.

Professionally trained engineers or hydrologists should determine the sizing and design of the culvert. Culverts should be designed to handle a 100-year flood flow and to maintain velocities that allow resident fish easy passage through the culvert.

The bottom width of the culvert trench should be twice the width of the culvert with sidewalls no steeper than 1:1. The grade of a culvert should be set by the existing channel. The minimum slope should be 0.05% to allow for positive drainage flow, and should be used in all culvert designs except equalizers. The up slope or inlet end must always be higher in elevation than the down slope or outlet end.

To determine proper pipe length with 4:1 embankment slope, take the road and shoulder width at the angle across the road plus 4x (cover plus pipe diameter); extra length will need to be added to accommodate for headwalls if they are needed.

Whenever possible, align culvert with the existing stream channel. Compact the soil around the lower one-third of culvert. A minimum of one foot of compacted fill over a culvert is recommended. Culvert outlets should be protected from erosion and undermining by use of rock aprons or slope drain/sediment basins.

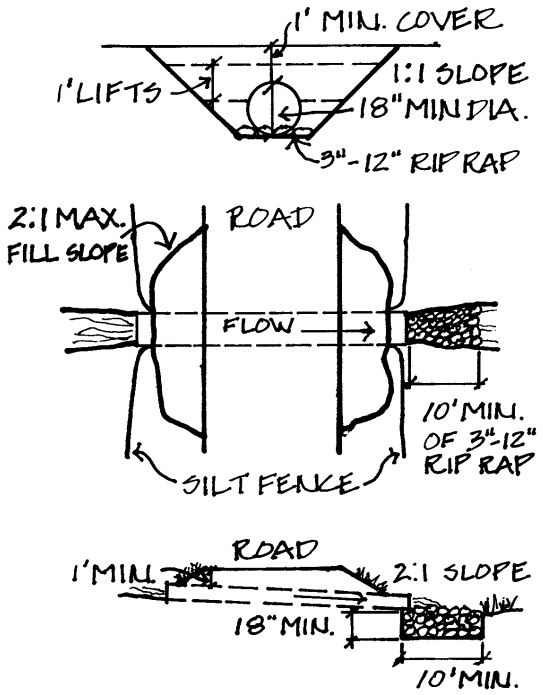

Figure 15—PROPER CULVERT PLACEMENT

FISH FRIENDLY CULVERTS

A culvert installation should not change the conditions in the stream that existed prior to the installation. Trout and other species move upstream and downstream to spawn and meet other habitat needs.

Culverts can impede fish passage by creating the following conditions:

- Excessive water velocities
- Vertical barrier - fish must jump too high
- Inadequate water depth
- Icing and debris problems
- Insufficient or excessive design flows in relation to the range of flows encountered during the seasons of fish passage
- Culvert design does not accommodate the size and species of fish passing through the structure

- When crossing a stream, select the culvert site so there is no sudden increase or decrease in gradient.
- Align the culvert with the natural stream channel.
- Use bridges, bottomless arches or partially buried culverts in areas where fish passage is an important consideration.
- Design culverts so that water velocities passing through the pipe are equal to water velocities in the stream.
- Provide resting pools using riprap at culvert inlet and outlet for culverts installed across streams with high gradients.
- Place riprap securely at upstream culvert end to avoid dislodging that may result in lower culvert capacity, higher velocity flows and reduced inlet efficiency.
- Contact the local state fisheries biologist or state bridge transportation specialist for assistance with stream crossings.

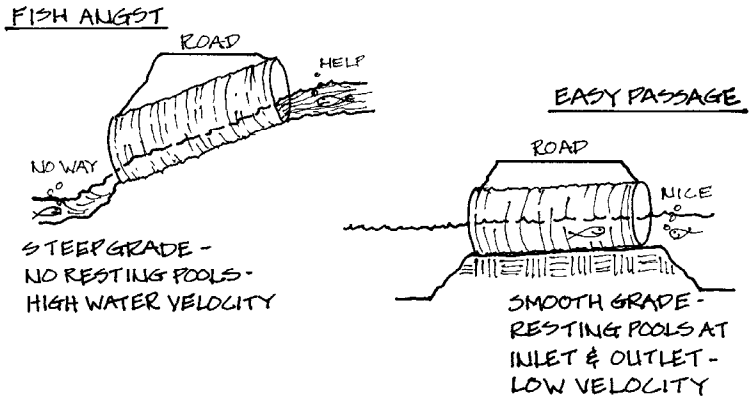

Figure 16—FISH ANGST vs. EASY PASSAGE

INSTALLATION/REPLACEMENT INSTRUCTIONS

1. Prepare the site by using diversion or dewatering techniques to allow for construction in the dry.
2. Excavate the culvert area, removing old culvert if this is a replacement.
3. Recess the pipe into the streambed to provide a natural stream substrate within the structure.
4. Lay pipe up slope, starting at outlet end.
5. Place culvert level with the streambed and backfill in one foot lifts, compacting the lower 1/3, then tamping the remaining fill in place.
6. Place 3 - 12 inch diameter riprap in the excavated outfall area tamping it level with the stream bottom.
7. Seed and mulch all disturbed areas.
8. Complete all work on culvert installation before diverting the stream back to the stream channel and through the culvert.

4.9 Ditch Culverts

Properly placed culverts will help alleviate ditch maintenance problems by outletting water in a timely manner. Culverts also preserve the road base by draining water from ditches along the road, keeping the sub-base dry. Sizing and maintaining culverts correctly will prevent flooding problems that can lead to erosion and repairs. Placing culverts and other outlets based upon road slope will control volume and velocity of discharges, reducing sedimentation from entering surface waters.

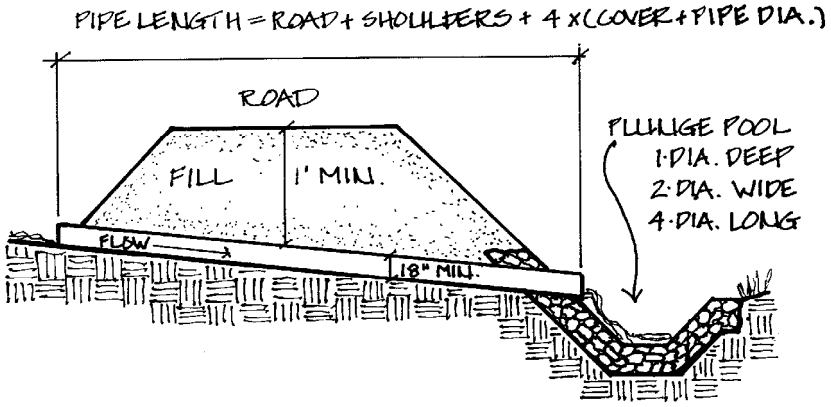

Figure 17—CULVERT PROFILE & CROSS SECTION

4.9.1 Ditch Culvert Profile

- Culverts for small watersheds (less than 20 acres) may be sized by adding the acreage of the water to “8”.
  Example: A 15-acre watershed would use a 24-inch culvert:
  15 + 8 = 23 inches,
  Then rounded to the nearest even inch = 24 inches
  (**Minimum** culvert diameter should be 12 inches.)
- Outlet the ditch culverts to a vegetated area - never directly into a stream, thereby diverting as much road runoff as possible away from the surface water.
- Ideally, culvert should be placed below frost depth to avoid problems caused by frost heaving.
- Culvert outlets should be protected from erosion and undermining by use of rock aprons, plunge pools, slope drain/sediment basins or vegetation.

4.9.2 Intersection of Public Roads with Private Roads/Drives

- To ensure the integrity of road ditch it may be necessary to provide culverts or a protective lining where private roads or drives intersect with public roads.
- Culverts on private roads/drives should follow the same criteria in placement and sizing as described for public roads.
- An open top culvert may be used when drainage is entering a public road by way of the private road surface - this open top culvert can be used to divert the drainage into the existing ditch.

4.10 Headers

- Headers can be used in both stream and ditch applications.
- Headers mark the location of a culvert, protect the culvert from damage during grading and ditch cleaning, increase the hydraulic efficiency, and prevent erosion around the culvert inlet.
- Use headers only when hydraulic capacity needs to be increased by 10% or less and if installing a header will be easier than replacing the culvert.
- Headers should be flush with the end of the culvert.
- Dry laid field stone, treated wood, concrete bags, or sand bags are typical materials used in header construction.
- Header extensions help direct the flow of runoff into the culvert, preventing water from flowing in undesirable directions.

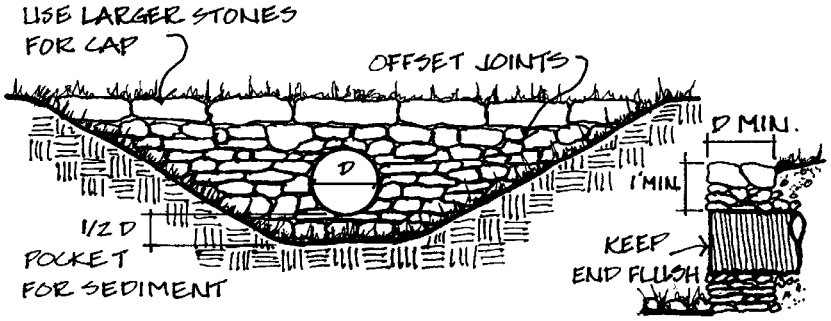

Figure 18—HEADER

4.11 Cleaning and Maintenance

Avoid clogging, collapsing, washouts, and settlement by practicing preventive maintenance. Inspect culverts as often as possible, but at least in the spring and fall, and after major storms.

- Mark or inventory culverts so they do not get missed during inspections.
- Inspect underdrain and keep outlet of underdrain clear.
- Use high pressure hose to flush (with water) plugged culverts.
- Flush culverts from the outlet end.
- Check culverts during freezing weather and take action if the culverts start to freeze.
- Thaw or open frozen culverts by using steam, high pressure water, or ice augers.
- Check culvert inlet for erosion and to ensure water is flowing in the pipe and not around it; if some water goes around the culvert it can undermine bedding and the culvert will fail (e.g. “piping”).
- Replace culverts with the same size pipe if it is handling the flow adequately.

Table 4 - CULVERT MAINTENANCE & INSPECTION CHART		
Problem	**Cause**	**Solution**
Scouring/ erosion at the inlet	Ditch graded too steeply Poor location or alignment Clogged pipe	Line the inlet with stone. Properly align the culvert. Clean/flush the culvert.
Scouring/ erosion at the outlet	Pipe sloped too much Pipe too small Improper alignment	Build a stone splash pad. Check size and replace with larger pipe if necessary. Properly align culvert.
Ponded/ puddled water	Invert too high Ditch grade too flat	Reset the pipe to match the invert to the channel bottom. Regrade ditch to maintain correct flow.
Dented/ crushed ends	Traffic/snow plows are hitting the ends	Fix pipe ends; use flared inlets and outlets; mark and protect.
Heavy corrosion	Water flowing through the culvert is acidic	Install a sleeve of PVC in the existing pipe or replace the steel pipe with a noncorrosive material (PVC, polyethylene, aluminum, concrete).
Piping around the outlet	Pipe incorrectly installed, resulting in water flowing outside the pipe	Reinstall pipe with proper bedding and compaction; install a headwall or anti-seep diaphragm.
Sediment build-up	Not enough slope	Reinstall pipe with a slope of at least 1/4 inch per foot.
Objects blocking the pipe	Debris traveling from the ditch to the culvert	Remove blockage; install check dams upstream of the culvert.
Sagging bottom	Foundation material has settled or has low bearing capacity	Reinstall pipe with suitable and properly compacted foundation material.
Crushed top	Not enough cover Soil around walls not compacted Traffic loads too heavy	Add cover. Reinstall pipe deeper and/or with suitable and properly compacted bedding material. Install multiple smaller pipes or pipe with different shape. Replace with stronger or elliptical pipe (“squashed tube”).