

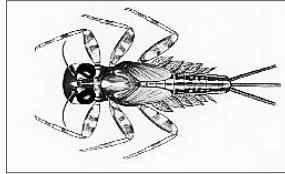
5.0 OUTLET STRUCTURES

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

Mayfly Nymphs

Flatheaded Mayfly Nymph

Order Ephemeroptera, Family Heptageniidae



- Measures up to 3/4 inch in length
- Nymphs are flattened with sprawling legs and a horizontally oriented head
- Platelike gills are present on abdominal segments
- Abdomen terminates in two or three tails
- Often colored yellow to dark brown, some with banding of yellow and brown on legs.
- Flatheaded mayfly nymphs are common in a variety of aquatic habitats. Stream species are often found clinging to rocks where they graze on algae and other organic material associated with the stream bottom.

Great Lakes Trivia Test (answers on back):

- 1) Which Great Lake is the only one entirely within the United States boundaries?
- 2) Approximately how many islands are in Lake Huron?
(a) 5,000 (b) 10,000 (c) 30,000
- 3) What Lake forms the headwaters (or source) of the Great Lakes?
- 4) When did the glaciers recede leaving the Great Lakes and Michigan shaped as they are today?

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 Michigan
- 2) (c) over 30,000
- 3) Lake Superior
- 4) 10,000 years ago

5.0 OUTLET STRUCTURES

5.1 Description

Outlet structures are used to discharge water from a ditch or culvert. There are a variety of types of outlet structures. Roadside water should not be discharged directly to surface waters.

5.2 Importance to Maintenance & Water Quality

Outlet structures reduce the velocity of water carried by road ditches and culverts, therefore helping to control sedimentation. Water should outlet to areas with moderate slopes and vegetative filter strips before entering surface waters. This type of outlet, often referred to as *daylighting*, will allow for most of the sediments and other pollutants to be removed before runoff enters surface waters.

5.3 Turnouts

Turnouts are extensions of ditches which direct water away from the road edge to filtering or detention/retention areas. They are usually geotextile-reinforced, vegetative chutes. Turnouts will not only protect water quality, but will also save gravel for reuse.

- Use only in areas where the water will flow to a filtering or detention/retention area, well away from the road and surface waters.

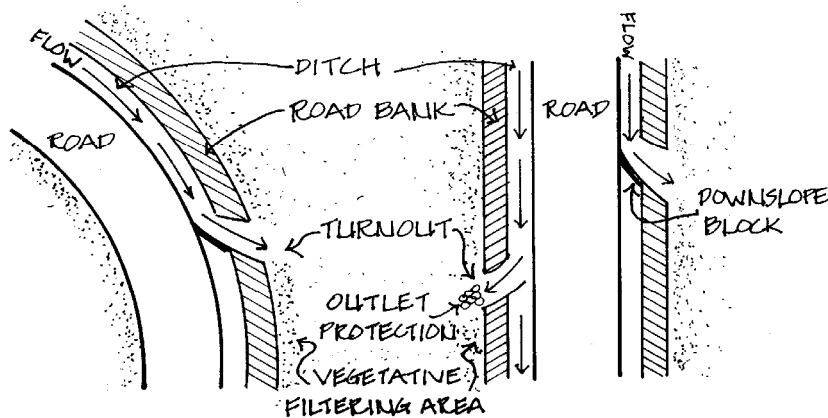


Figure 19—TURNOUTS

5.4 Rock Aprons

Rock aprons are areas lined with riprap used to discharge water from culverts to existing ground. Rock aprons provide culvert outlet protection by reducing water velocity and promoting sheet flow.

- Use only where there is a vegetative filter strip.
- Discharging of culvert to a fill slope will require a conveyance channel (see next section) before the water reaches the rock apron for discharge to existing ground.
- Size and placement of riprap in the apron is dependent on the diameter of the culvert as well as on expected water flow through it.

Table 5 - ROCK APRON SPECIFICATIONS					
Culvert Diameter (inches)	Riprap Size - R#	T (inches)	N (feet)	W (feet)	L (feet)
18	D50 - 6 inches	18	4.5	14.5	10.0
24	D50 - 6 inches	18	6.0	20.0	14.0

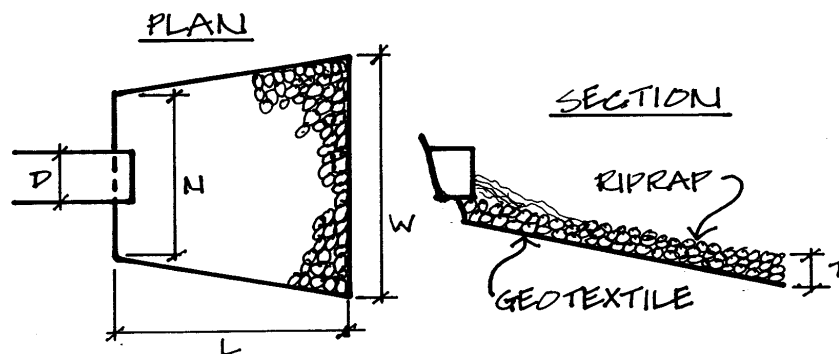


Figure 20—ROCK APRON

5.5 Riprap Conveyance Channel

A riprap channel is used to remove sediments and to keep the channel itself from eroding while carrying runoff from a culvert or ditch. It is used only in areas with steep fill slopes, where erosion would otherwise occur without adequate vegetative filter strips, and where an outlet must go directly into surface waters.

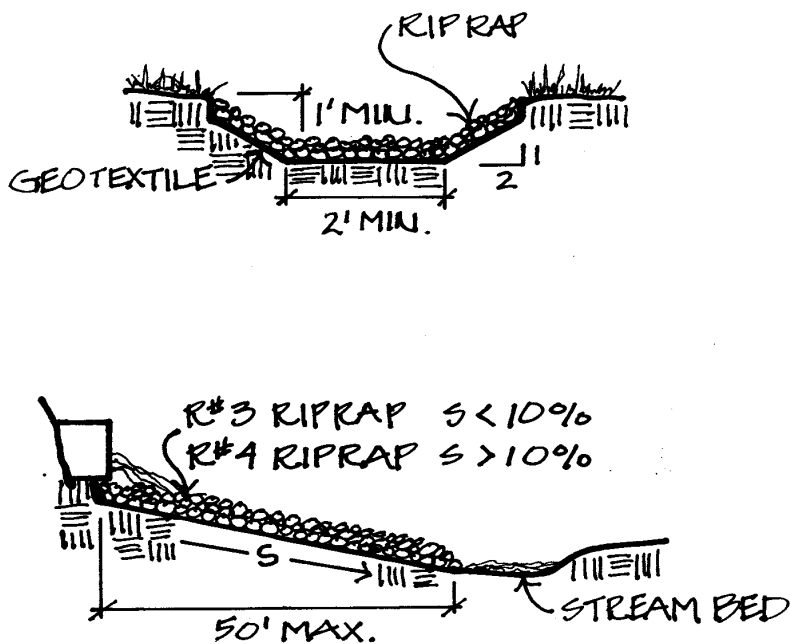


Figure 21—RIPRAP CONVEYANCE CHANNEL

5.6 Splash/Plunge Pools

Splash/plunge pools are riprap basins, located at the outlet of culvert pipes. They are used to remove sediments by absorbing energy from flowing water and allowing sediments to settle out from areas with concentrated flows and areas without adequate vegetative filter strips. They reduce energy and velocity flows by providing storage of runoff and consolidate the sediment for easier removal. They can also allow for ground water recharge.

- Limit to areas with less than 10% slope.
- Clean when pool area is one-third filled with sediment.
- Locate to facilitate mechanical cleaning.
- Not recommended for new culvert replacement.
- Useful to correct a perched culvert problem.



Figure 22—SPLASH/PLUNGE POOL

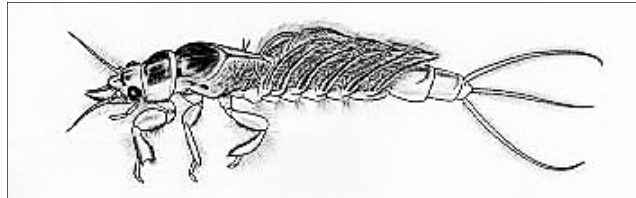
6.0 BANK STABILIZATION

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

Mayfly Nymphs

Burrowing Mayfly Nymph

Order Ephemeroptera, Family Ephemeridae



- Nymphs measure up to an inch in length
- Conspicuous dorsal gills on abdominal segments
- Three tails
- Possess curved tusks which project from the head
- Nymphs burrow in silt or sand in rivers, streams, lakes and ponds.
- Most species are thought to feed on organic particles associated with the substrate.

Great Lakes Trivia Test (answers on back):

- 1) Name one significant treaty or agreement concerning the Great Lakes.
- 2) The Great Lakes Charter is an agreement between the Great Lakes Governors for management of the quantity of Great Lakes waters. Under the agreement, a state must consult with the other Great Lakes states on any proposal to do what with Great Lakes water?
- 3) How many miles do the Great Lakes run from west to east?
(a) 750 miles (b) 1,000 miles (c) 3,000 miles
- 4) Name two Great Lakes ports starting with the letter "C".

GUIDING PRINCIPLES

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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) Boundary Waters Treaty of 1909, the Great Lakes Charter, the Canada-U.S. Great Lakes Water Quality Agreement, or the Great Lakes Toxic Substances Control Agreement
- 2) divert Great Lakes waters outside the Basin
- 3) (a) 750 miles
- 4) Chicago, Cleveland, Calumet