It is more economical and effective to prevent or minimize the impacts of an activity at the design stage, rather than trying to control or mitigate the harmful effects of a poorly planned watercourse, wetland or buffer zone activity. Public and private funds are spent each year to repair improperly installed structures, restore aquatic habitat or rehabilitate watercourses and wetlands severely impacted by sedimentation or erosion. Taking the time to plan the activity in advance will minimize the disturbance to the watercourse, wetland or buffer zone and improve the viability of the project.

When planning watercourse, wetland or buffer zone activities applicants should carefully consider:

1. The protection of aquatic habitat and the provision of fish passage (Section 2.2);

2. The appropriate methods and equipment required to successfully complete the project (Section 2.3);

3. The provision of buffer zones as required under the Environmental Protection Act, Watercourse and Wetland Protection Regulations (Section 2.4) ; and

4. Potential environmental impacts (e.g., flooding, sedimentation, destruction of existing habitat) associated with the proposed project (Section 2.5).

What are we protecting?

The aims of the Watercourse, Wetland and Buffer Zone Activity Program are to preserve Prince Edward Island's watercourses, wetlands and buffer zones, protect aquatic habitat, with mandates to prevent sedimentation and property damage, and ensure public safety**.** Conserving and protecting our watercourses, wetlands and buffer zones means:

- maintaining and enhancing aquatic and wildlife habitat,

- maintaining or improving water quality,

- maintaining stable banks and buffer zone vegetation, and

- maintaining or providing fish passage.

What is a watercourse?

As defined within the Environmental Protection Act of Prince Edward Island, Watercourse and Wetland Protection Regulations, a watercourse is "an area which has a sediment bed and may or may not contain water, and without limiting the generality of the foregoing, includes the full length and width of the sediment bed, bank and shore of any stream, spring, creek, brook, river, lake, pond, bay, estuary or coastal body, any water therein, and any part thereof, up to and including the watercourse boundary."

A watercourse does not include a grassed waterway or a tap drain unless a sediment bed has been formed in it by flowing water. Generally, this would also require an absence of terrestrial vegetation in the sediment bed.

What is a wetland?

A wetland is "an area which contains hydric soil, aquatic or water-tolerant vegetation, and may or may not contain water, and includes any water therein and everything up to and including the wetland boundary".

Hydric soil is soil is soil that has been sufficiently saturated or flooded (during the growing season) to develop anerobic (oxygen deficient) conditions in the upper layer.

Water-tolerant vegetation refers to plants that are adapted to growing in saturated or flooded conditions.

Wetland types recognized in the PEI Wetland Inventory include: open water, deep marsh, shallow marsh, seasonally flooded flat, meadow, shrub swamp, wooded swamp, bog, salt marsh, and brackish marsh.

What is a buffer zone?

A buffer zone is the 15 metre area surrounding all watercourses and wetlands on PEI.

What is an activity?

A watercourse, wetland or buffer zone activity is any temporary or permanent change made at or to a watercourse, wetland or buffer zone or to water flow in a watercourse, wetland or buffer zone.

In accordance with the Environmental Protection Act of Prince Edward Island, Watercourse and Wetland Protection Regulations, "No person shall, without a license or Watercourse or Wetland Activity Permit, and other than in accordance with the terms and conditions thereof, alter a watercourse or a wetland, or any part thereof, or water flow therein, in any manner, or engage in any of the following activities in or on a watercourse or wetland:

1. drain, pump, dredge, excavate or remove soil, water, mud, sand, gravel, stones, rubbish, rocks, aggregate or material or objects of any kind;

2. dump or infill, or deposit soil, water, mud, sand, stones, gravel, rubbish, litter, rocks, aggregate or material or objects of any kind;

3. construct or place, repair or replace, demolish or remove, buildings or structures or obstructions of any kind, including, but not limited to bridges, culverts, breakwaters, dams, wharves, docks, slipways, decks or flood or erosion protection works;

4. operate heavy equipment or a motor vehicle on the sediment bed, beach or bank of a watercourse, with the exception of the operation of a motor vehicle on a beach for the conduct of activities related to the legal harvesting of a fishery resource or the legal removal of beach material, and the exception of the launching of a boat;

5. operate heavy equipment or a motor vehicle on a wetland, except a boat on the water of a wetland;

6. disturb, remove, alter, disrupt or destroy the ground in any manner;

7. disturb, remove, alter, disrupt or destroy vegetation in any manner, including but not limited to the cutting of live trees and shrubs; or

8. carry out any type of watercourse or wetland enhancement activity, including but not limited to debris removal, habitat development or placement of structures."

Also In accordance with the Environmental Protection Act of Prince Edward Island, Watercourse and Wetland Protection Regulations, "No person shall, without a license or a Buffer Zone Activity Permit, and other than in accordance with the conditions thereof, engage in or cause or permit the engaging in of any of the following activities within 15 metres of a watercourse boundary or wetland boundary:

1. drain, pump, dredge, excavate or remove soil, water, mud, sand, gravel, stones, rocks or aggregate

2. dump or infill, or deposit soil, water, mud, sand, gravel, stones, rubbish, litter, rocks, aggregate or material or objects of any kind;

3. construct or place, repair or replace, demolish or remove, buildings or structures or obstructions of any kind, including, but not limited to bridges, culverts, breakwaters, dams, wharves, docks, slipways, decks or flood or erosion protection works;

4. operate heavy equipment or a motor vehicle, other than

(a) upon a highway,

(b) upon a private road, right-of-way, or driveway which was approved prior

to the enactment of these regulations by the provincial government or a municipal government in a building permit or a subdivision plan, or

(c) for the conduct of activities directly related to the legal harvesting of a fishery resource, the legal removal of beach material, or the cultivating of an agricultural crop;

5. disturb, remove, alter, disrupt or destroy the ground in any manner;

6. cut down live trees or live shrubs;

7. cultivate an agricultural crop;

8. spray or apply pesticides in any manner.

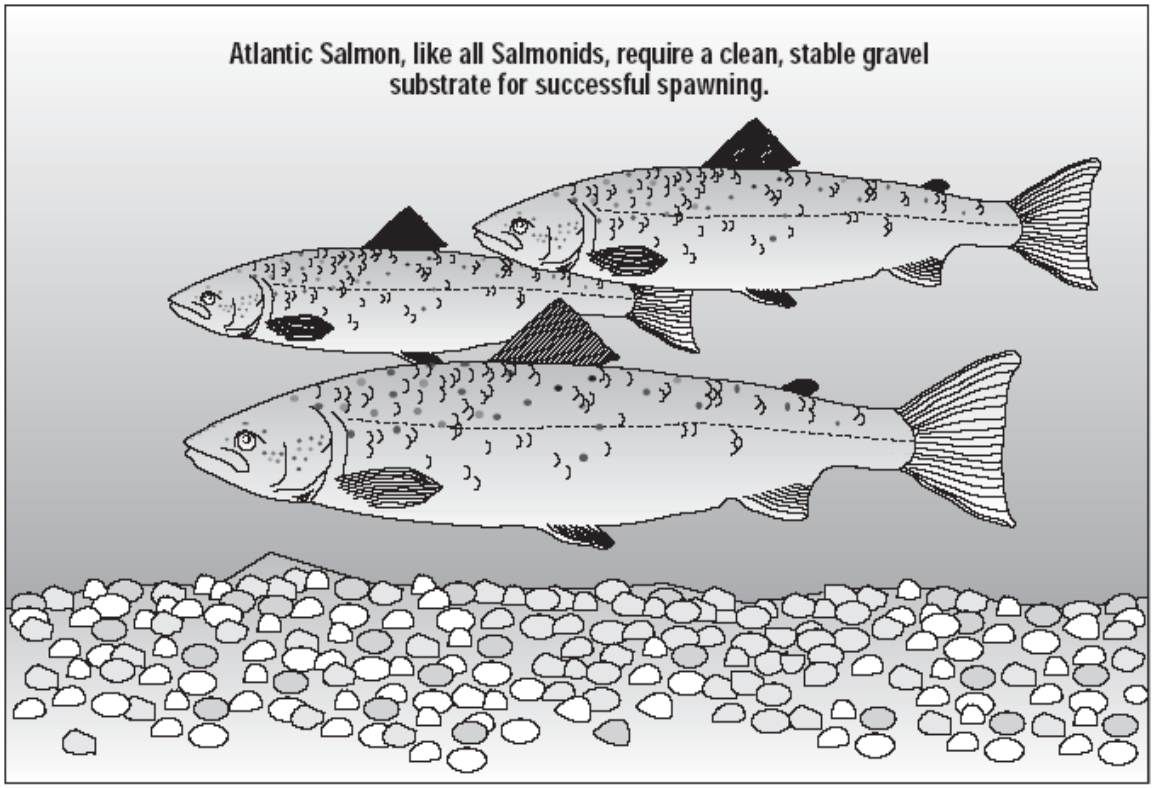
Prince Edward Island contains a diverse range of aquatic habitat in its many watercourses, wetlands and coastal waters. This habitat supports a large variety of aquatic species, terrestrial wildlife, and plants. When planning watercourse or wetland alteration activities, applicants should carefully consider the protection of aquatic habitat and provision of fish passage.

Wetlands are a vital element of Prince Edward Island's ecosystems and serve many important ecological functions. They maintain biodiversity by providing habitat for a wide range of waterfowl, furbearers, fish, reptiles and flora and provide natural purification and storage of freshwater for humans, fish and wildlife. They are a refuge for rare and endangered species.

Despite the biological and socioeconomic value of wetlands, there has been steady incremental loss and degradation of this habitat over the past 200 years. For example, many of our coastal salt marshes have been reduced or lost to other functions. This loss has been a cumulative process, remaining virtually undetected over decades until it has now reached an advanced state. The "Prince Edward Island Wetland Conservation Policy" (Appendix H) requires that existing wetlands management and protection mechanisms are used to control development in and adjacent to wetlands. This is to ensure no net loss of wetlands and wetland function.

The Fisheries Act (Appendix C) defines fish habitat as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes".

Many species of fish are hatched and reared in fresh water and migrate to the ocean to grow, returning to fresh water to reproduce. These include the salmonids (e.g. Atlantic salmon, sea trout), gaspereau, and smelts. Conversely, the American eel is hatched in salt water and migrates to rearing areas in fresh water, returning to saltwater to spawn.



Shellfish, including clams, oysters and mussels inhabit estuarine and coastal waters throughout their lifecycle and contribute to important aquaculture and shellfish harvesting activities.

Habitat requirements vary with each stage in the fish's life cycle. Basic requirements of most species include:

- Clean, clear water – Water should be clean and free of deleterious substances with minimal suspended particulate matter. Most suspended sediment is made up of soil particles released due to erosion of the banks and bed of a watercourse or disturbed upland areas. The suspended sediment in highly turbid water can interfere with the feeding habits of fish as well as breathing processes and migration patterns.

- Suitable water temperatures and dissolved oxygen levels - Temperatures of 24°C or more are considered lethal for some species such as the salmonids and extremes in temperature can affect fish migrations. Well oxygenated water is especially critical during egg incubation, hatching and the first few weeks of life. The levels of dissolved oxygen in water are decreased by increases in temperature.

- Clean bottom substrates - Substrates include the materials such as rock, boulder, gravel, sand and sediment on the bottom of our watercourses and coastal waters. Many species of shellfish, such as clams, oysters, mussels and many of the organisms upon which fish feed, dwell on or within bottom substrates. Some fish species, particularly in early life stages, utilize this substrate for protection from predators and high water flows and currents. Bottom substrates are also important spawning and nursery areas for many species. Salmonids, for example, bury their eggs in clean gravel during the fall, where they remain until they hatch into the larval form called alevins. Alevins are highly sensitive to habitat disturbance and will remain in the gravel until they emerge the following spring.

  Substrates, therefore, should be free from contaminants, deposits of suspended sediment, and construction debris including plastics which can smother habitats or impair the respiration and general health of aquatic life.

Fish Passage - Adult fish migrate to spawn, to find food, to escape predation, or to reside in deeper pools before the winter freeze-up occurs. Juvenile fish may migrate to rearing areas in small creeks and channels. Unobstructed migration routes and water characteristics conducive to the swimming ability of fish are necessary for migrations to occur. Adult salmonids must reach spawning grounds at the proper times and with enough energy to complete the life cycle. The swimming ability of fry and juvenile fish is limited by body length, making it more difficult to swim if confronted with an obstruction.

Dams without fishways, blocked culverts, or debris jams present physical obstructions to fish passage. Other barriers, such as increased flow velocities, may not be immediately apparent. Barriers created by improperly designed or installed culverts are common. These barriers are created by conditions which impede fish swimming ability and include the following:

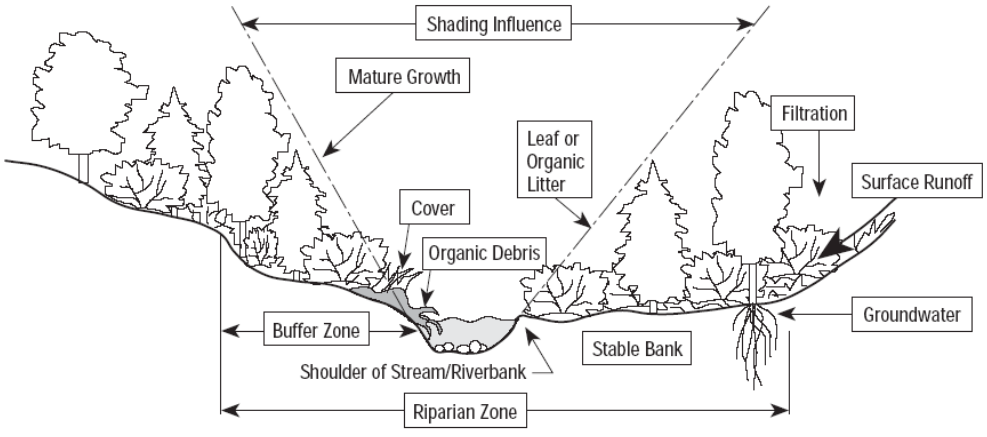
- culvert slope greater than 0.5%, or variable slope
- perched outlet
- channelization of flow leading to increased velocity
- inadequate water depth caused by an oversized culvert
- culvert length

Other impediments to fish passage resulting from improperly planned, or performed, alterations include:

- reduced concentrations of dissolved oxygen;
- high turbidity;
- excessively high or low temperatures
- chemical barriers resulting from spills or leaks of deleterious substances
- a lack of water due to water withdrawals or stream diversions.

Riparian Vegetation - The vegetation in riparian zones is crucial for maintaining and nurturing fish habitat by providing the following:

- Shade - The vegetation along the banks of the watercourse scatters the sunlight and shades the water, protecting it from the heating effects of the direct sun.
- Food - Riparian vegetation contributes insects and detritus such as leaf litter into the watercourse which act as food sources for the fish.
- Shelter - Riparian vegetation, in the form of tall grasses, shrubs and trees, protects fish from predators.
- Erosion Control - The root system of vegetation contributes to bank stability and intercepts runoff which limits erosion and sedimentation, protecting fish habitat from the harmful effects of sedimentation.
- Filter - Vegetation and root systems act to filter out pollutants such as pesticides, bacteria, fertilizers, heavy metals, sediment, and hydrocarbons.



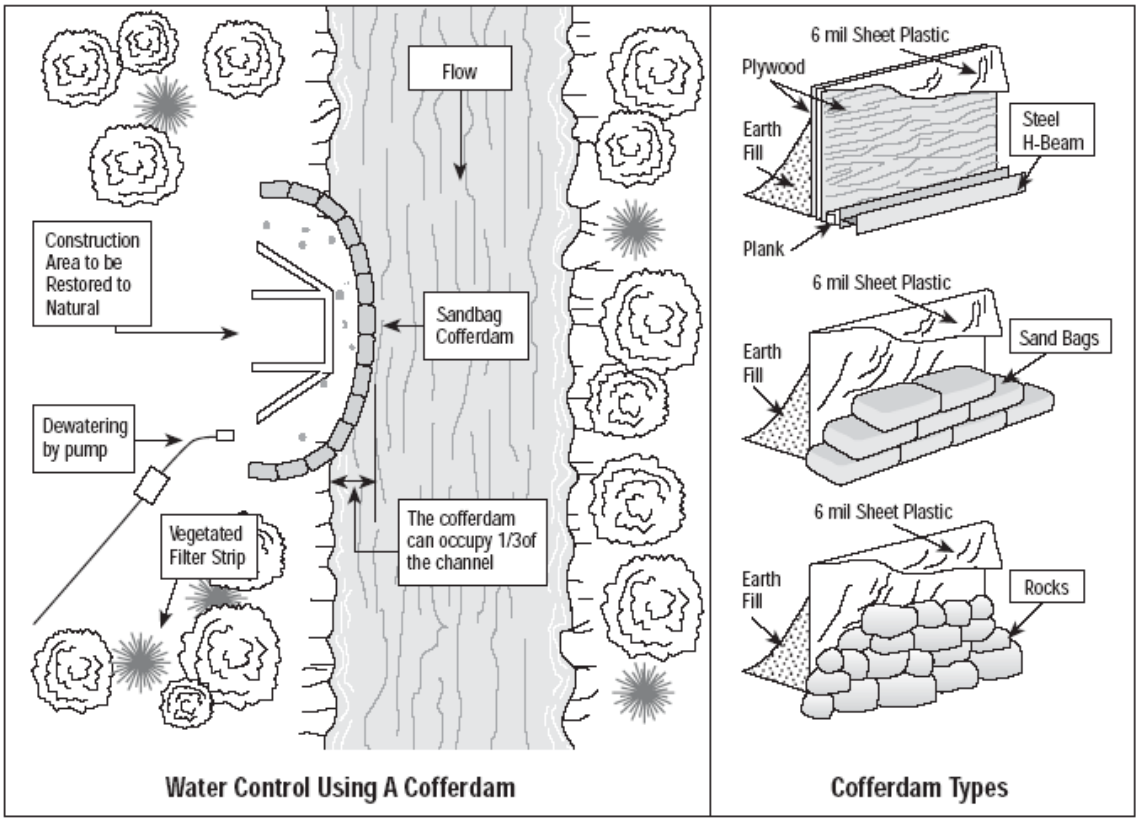
Importance of the Riparian Zone to Aquatic Habitat

General Planning Considerations and Guidelines for Site and Water Management

Construction sites and activities are constantly dealing with water management. This management may be due to groundwater or surface water, along with wet weather conditions. Understanding a construction site prior to initiating ground disturbance is essential in order to be prepared for water control measures, erosion control and sediment control.

Effective mitigation measures can improve site management and reduce the potential of watercourse, wetland or buffer zone impacts. A ***site risk assessment*** should be undertaken for all sites to determine the potential for problems and identify solutions which can include best management practices. Once completed, the design must incorporate these issues in order to have them addressed. All stages of construction should include effective water control measures, erosion control measures and sediment control measures.

Where possible, ***surface water*** should be diverted around the site and the site isolated so that clean water does not become contaminated with sediment or affect the construction site. **Construction activities adjacent to or within the watercourse must be isolated from the water.** This can be done by the construction of cofferdams, temporary diversions and pump-arounds.

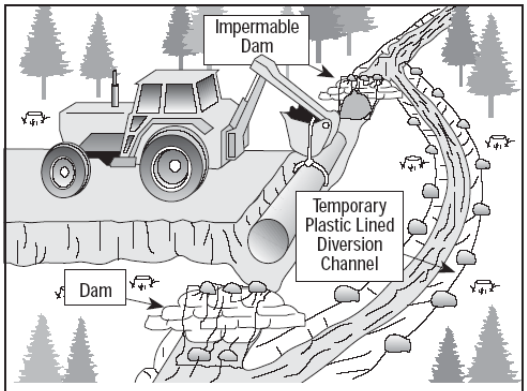


Cofferdams can be constructed to isolate the work area from flowing water. At least two-thirds of the cross-sectional area of the channel must be open at all times. Cofferdams may consist of: sheet piling or a layer of 6 mil plastic sandwiched between an inner wall of in situ earth fill and an outer wall of either rocks, sandbags, or a steel H-beam attached to the bottom of a sheet of plywood. If piers are constructed in open water where it is not possible to build a cofferdam, a floating silt curtain anchored to the bottom should be placed around the work area.

No excavation may be carried out inside the cofferdam until the cofferdam is completely closed.

Silt-laden water pumped from inside the cofferdam should be pumped into a settling pond, behind a filter fabric dam, or onto an adjacent vegetated area where it can be filtered so that suspended sediments entering the watercourse are minimized.

The cofferdam material must be removed immediately upon completion of the alteration.



Temporary Diversion

Water diversion activities can be undertaken by one of the following methods:

- constructing a temporary plastic lined diversion. The diversion channel must be parallel to the existing channel and excavated from the downstream end.
- stemming the flow upstream of the structure and pumping the flow around the site to a point immediately downstream of the work area. An impermeable cofferdam must be constructed to block the flow upstream of the construction site and a system must be established that ensures the water is constantly pumped around the site until the installation is completed.
- other techniques as approved by the Regulatory and Advisory agencies.

General Planning Considerations and Guidelines for the Use of Appropriate Equipment

Choosing the appropriate tool for the proposed activity, while considering site characteristics is critical. Instream work with heavy machinery can never be regarded as harmless. Some of the more significant adverse effects of projects carried out within a watercourse or wetland using heavy machinery are:

- obstruction of the watercourse during the spawning migration of fish species (e.g., salmon, trout, gaspereau, smelts);
- impairment of wetland function as a result of sedimentation and compaction;
- destruction of the banks of a watercourse resulting in increased erosion;
- sedimentation of shellfish beds leading to the smothering of larval (spat) and mature shellfish**;**
- sedimentation of fish spawning beds after egg deposition leading to smothering of the eggs; negative effects of excessive sediment on trout and Atlantic salmon; and the destruction of aquatic invertebrates which fish and wildlife species require for food.

If any equipment is to be used in the watercourse or wetland it must be mechanically sound, having no leaking fuel tanks or hydraulic systems, and be steam cleaned free of petroleum products and dirt.

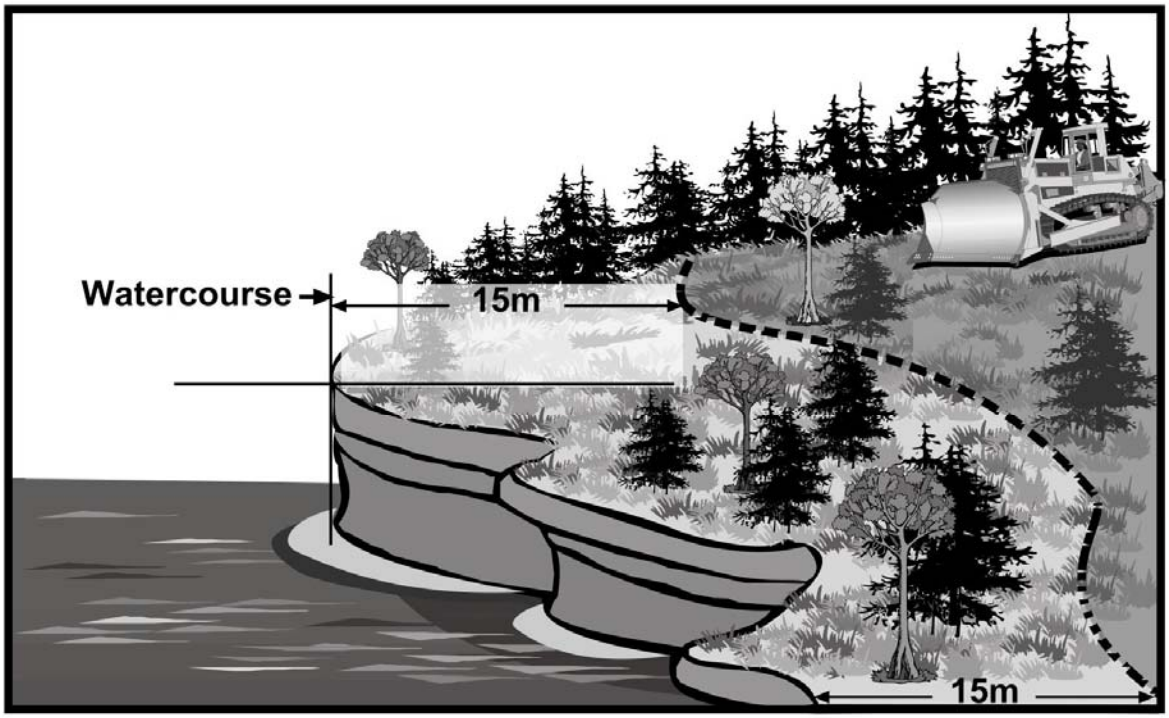
No washing of tools, forms or machinery may occur in, or adjacent to, a watercourse or wetland.

Machinery and potential pollutants (e.g., fuel, oil) must be contained and stored so as not to pose a hazard to the watercourse or wetland.

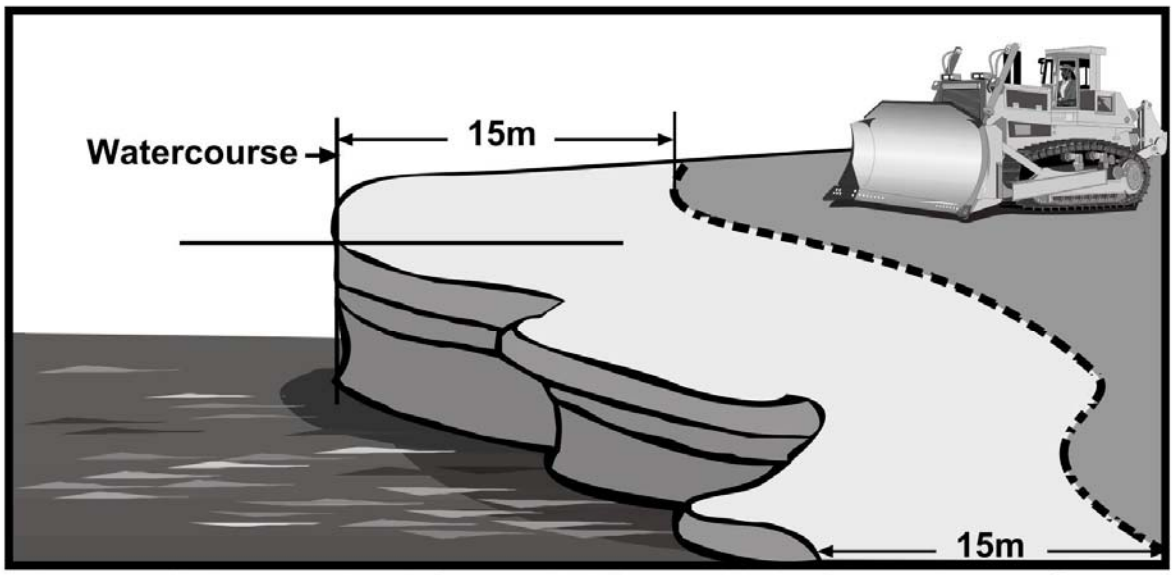
Buffer zones (strips of land area adjacent to a watercourse or wetland) are an important tool in helping protect Prince Edward Island's watercourses and wetlands from erosion and sedimentation. Vegetated buffer zones help to trap silt and other contaminants (i.e., nutrients, pesticides, bacteria) that may be found in run-off water prior to their entering Island streams, wetlands and estuaries. In addition to protecting the aquatic environment, buffer zones also provide excellent habitat and travel corridors for a variety of wildlife species. The riparian zone, which may include all or a portion of the 15 metre buffer zone, is among the most productive of wildlife habitats. Riparian zones are areas of transition between watercourses/wetlands and uplands and are often characterized by a greater diversity of wildlife species compared to the adjacent upland area.

All watercourses and wetlands require a buffer zone of 15 metres (49.5 feet). For freshwater streams they are measured from the edge of the sediment bed; for tidal areas they are measured from the top of the bank; and for wetlands they are measured from the edge of the water tolerant vegetation. In addition, some agricultural crop activities are affected up to 200 metres (656 feet) from the watercourse or wetland.

There are some exceptions to the restrictions on carrying out activities in the buffer zone adjacent certain types of wetlands. For example, a permit is not required to grow an agricultural crop or cut down a live tree or shrub in the buffer zone of a wetland classed as solely or a combination of seasonally flooded flats, shrub swamp, wooded swamp, bog or meadow.



A 15 metre buffer zone surrounds all watercourses and wetlands. No disturbance of the soil/treecutting/addition of fill material,etc. is allowed within a buffer zone without a permit.



A permit is required for activities within 15 metres of a watercourse or wetland.

Crop Production

- Planting of agricultural crops within 15 metres of a watercourse or wetland is not permitted.

If row crops are to be grown within 200 metres of a watercourse or wetland, individual rows must drain onto a grassed headland which is at least 10-metres in width and which was established in the calendar year prior to the year in which the row crop was planted.

If the 15-metre buffer zone is in grass, it can be used as the headland. If it is in trees, an adequate grassed headland must be left upslope of the trees if row crops are grown within 200 metres of a watercourse or wetland.

Livestock Operations

Buffer zones must be maintained at sites with intensive livestock operations (i.e., animals are kept in a confined area, the animal density is greater than seven per acre and feed/water are delivered).

Livestock waste or contaminated runoff from intensive livestock operations cannot be discharged into any watercourse or natural wetland.

Forage crops may be grown under Permit within the buffer zone and can be renewed once every five years using spring tillage and under-seeded cereal crop.

New intensive livestock operations (buildings, manure storage, exercise yards, concentrated feeding areas) cannot be constructed within 90 metres of a watercourse or wetland. Existing operations within 90 metres need prior approval in order to expand.

Impacts to Water Levels or Flow

Improperly designed or constructed structures (e.g., dams, bridges, culverts) or changes made to the bed or banks of a watercourse may cause unstable channel conditions causing erosion, meandering and increased potential for flooding. These impacts could result in property and watercourse or wetland damages downstream or, in the case of failed dams, even the loss of life.

Activities may also cause substantial changes in the availability of water suitable for domestic and industrial consumption as well as for a number of other uses including agriculture, forestry, fishing, aquaculture, mineral development, tourism, outdoor recreation, and power production.

Erosion & Sedimentation

In a pristine environment a natural balance exists between erosion and deposition in a watercourse; a section of land erodes, the eroded particles are deposited downstream or deposition occurs during a low flow period followed by erosion at the same location the next time high flows occur.

On Prince Edward Island this natural balance has been upset due in part to the highly erodible qualities of the soil in conjunction with present land use practices. As a result, excessive soil erosion has long been identified (by a number of studies and public forums) as the largest environmental issue in the province. Most, if not all, of this sediment eventually comes to rest in our watercourse and wetlands, causing severe degradation of water quality and diminished aquatic/wildlife habitat.

Land use practices, including agriculture, highway construction and maintenance, and forest harvesting have improved in recent years, yet most of our watercourses and wetlands suffer from years of accumulated sedimentation. Some of the most common and serious consequences of an improperly planned watercourse or wetland activity are caused by erosion and sedimentation. Managing this sediment must be a primary consideration in the undertaking of any watercourse, wetland or buffer zone activity in Prince Edward Island.

Erosion reduces the stability of the banks of a watercourse which could lead to slope failure and loss of adjacent property. Erosion of the banks of a watercourse and adjacent areas may destroy the riparian vegetation. Eroded soil particles may be washed into the watercourse. These particles, particularly if they originate from agricultural land, contain nitrogen, phosphorous and other nutrients which can lead to development of thick algal blooms, reducing oxygen content and water clarity for the fish population.

Sediment can vary in size between fine clay to small pebbles. The amount that remains suspended in water depends on the particle size and flow velocities in the watercourse. The deposition of suspended sediment occurs when the velocity of water can no longer transport the sediment. (See Table 1.)

Table 1: Transport velocities for various sizes of bed materials.

	Transport Velocity Material (cm)	Size (mm)
Clay	> 15	< 0.002
Silt	15 – 30	0.002 – 0.02
Sand	30 – 65	0.02 – 2.0
Gravel	80 – 120	5.0 – 15
Pebble	140 – 240	25 – 75
Cobble	270 – 390	100 – 200

Most of the sedimentation problems are caused by fine sand size (.25mm) to silt size (.002mm) particles. Fine clay particles can stay in suspension for a very long time and up to 200 days.

Sedimentation of watercourses is destructive to fish habitat whether the sediment remains suspended in the water or settles out. The following conditions are the result of excess sediment entering the watercourse:

- Suspended solids entering the watercourse may coat and abrade the body surfaces of fish, including their

sensitive gill areas. It may cause them to overproduce mucous, blocking the absorption of dissolved oxygen, or accumulate on the gill surfaces, causing them to hyperventilate or smother.

- Fine particles blanket the bed of the watercourse, filling in and eliminating the interstitial spaces in the gravel beds where eggs are incubating, or where the alevins are resting and feeding, eventually smothering and killing them.

- The turbidity caused by suspended sediments prevents sunlight from reaching the bottom of the watercourse reducing photosynthesis in algae and rooted aquatic plants, leading to a reduced food supply for all aquatic animals.

- Deposition of sediment in the watercourse on existing clean gravel bottoms renders them unsuitable for spawning or resting grounds. Accumulation of suspended sediment can lead to a decrease in water depth, causing overheating of the water, resulting in temperatures above the acceptable ranges for fish and shellfish habitat.

- Increased turbidity levels can cause changes in fish feeding behaviour, since salmonids feed by sight and prey is less visible. It could result in starvation of fish in the affected area.

- Bottom dwelling organisms, upon which fish depend for food, such as aquatic insect larvae or other aquatic invertebrates, may be smothered and killed or their habitats destroyed.

- Sediment may scour invertebrates and aquatic plants from their substrates in the watercourse.

- Deposition of sediment in the watercourse may interfere with the spawning and feeding habits of aquatic animals (fish, shellfish, crustaceans).

- Shellfish resources (commercial, recreational and aquaculture) may be smothered and killed or their habitats destroyed.

- Deposition of sediment resulting in unstable watercourse substrate.

- Culverts may become plugged with sediment or other material resulting from slope failure, leading to flooding, road washouts and introduction of debris into the watercourse.

- Introducing sediment into a watercourse may diminish drinking water quality. If the flow capacity is lowered by a reduction of channel capacity, the potential for flooding is increased.

All surface erosion and sedimentation control undertakings may not fall under the definition of a watercourse or wetland activity although almost all activities have the potential to introduce sediment into the water body. One of the mandates of the Watercourse, Wetland and Buffer Zone Activity Program is to avoid sedimentation of watercourses by requiring that preventative measures be taken during the construction phases of the project. It is worthwhile, therefore, to devote a discussion of the general practices and some specific measures used to prevent and control these processes.

Design Principles

If basic principles for prevention of surface erosion and sedimentation are considered at the design stage of the project, potential problems will be minimized. These principles are as follows:

- Limit the size of the disturbed area.

- Limit the time the disturbed area is exposed.

- Plan construction to coincide with the low flow period from June 1st to September 30th of every year.

- Retain existing vegetation wherever feasible. Erosion is minimized on a surface covered with natural vegetation.

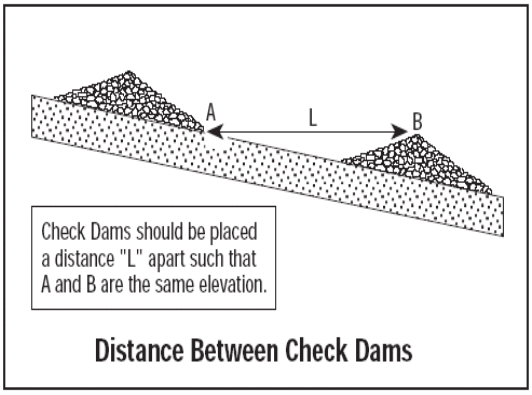
- Stabilize or re-vegetate exposed areas.

- Divert upland surface runoff away from exposed areas. Berms, dykes and swales may be used to divert runoff.

- Minimize the velocity of surface runoff by limiting the slope and gradient of disturbed areas, covering erodible soils with mulch, vegetation or rip-rap and constructing check dams or similar devices in swales and ditches.

Construction Techniques
It is essential to place sediment control devices before the construction phase of an activity begins in order to intercept and trap sediment before it reaches the watercourse or wetland. These devices must remain in place until permanent vegetation has been established or the site is otherwise stabilized. Specific sediment control measures are listed below.

Check Dams
Ditches or man-made swales are used to concentrate flow beside a road, adjacent to a disturbed or newly seeded area, or towards a sediment pond or vegetated area. This concentrated flow may erode the ditch.



Distance Between Check Dams

Check dams are *temporary structures* made from stones, straw bales, sandbags, or logs constructed across a ditch to reduce the velocity of the concentrated flow and thereby the potential for erosion until permanent stabilization of the disturbed area has been established.

The following criteria apply to the use of check dams:

1. The check dams should be installed before runoff is allowed to flow through the ditch.

2. The dams should be constructed so that the centre of the dam is at least 15 centimetres lower than the elevation at which the ends of the dam tie into the existing ground. This may be accomplished with a notch in the centre of the dam.

3. The dams must be embedded into the bottom and banks of the ditch to prevent undercutting and runaround.

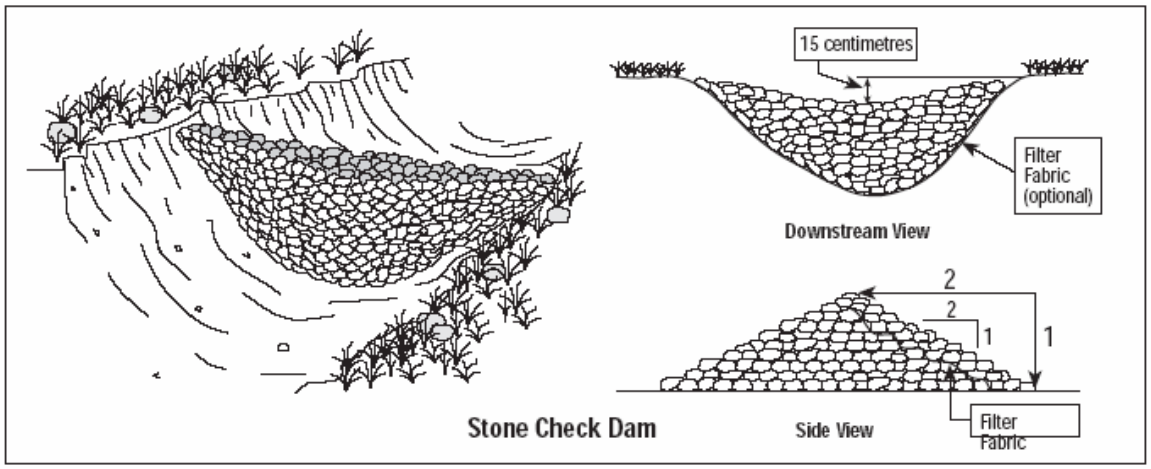
4. Check dams spacing depends on the slope of the ditch and erodibility of the soil.

5. Regular inspections are necessary to ensure that sediment does not accumulate to an elevation of more than half of the height of the dam at which point the accumulated sediment should be removed.

6. Before removal of the check dam, all accumulated sediment must be removed and disposed of in an area such that it cannot re-enter any watercourse.

7. Check dams should be removed when they are no longer needed or when the ditch becomes permanently stabilized with vegetation or a non erodible lining.

Stone Check Dams are usually constructed with stones having a minimum dimension of approximately 50 millimetres. A geotextile filter should be placed under the stones to provide a stable foundation and to facilitate removal of the stones with minimal disturbance to the original ground. This filter should be keyed into the base of the dam to prevent flow beneath the fabric and sandwiched between the stones on the vertical section of the dam. Stone check dams vary in height up to 1.0 metres, depending on the size and drainage area of the ditch and should be placed such that the



elevation of the toe of the upstream dam is the same elevation as the top of the downstream dam.

Straw Bale check dams must be keyed into the ditch and staked with two stakes angled towards the adjacent bale. Straw bales should be checked regularly and immediately after each rainfall for repair or replacement if necessary. Straw bales are recommended over hay bales because they do not deteriorate as rapidly.

Straw Bales and Silt Fences

Straw bale barriers and silt fences function as sediment barriers which are placed around the downslope perimeter of a disturbed area or along the bank of a watercourse in order to intercept and filter runoff, trapping the sediment before it reaches a watercourse.

The following criteria apply to the use of straw bale barriers and silt fences:

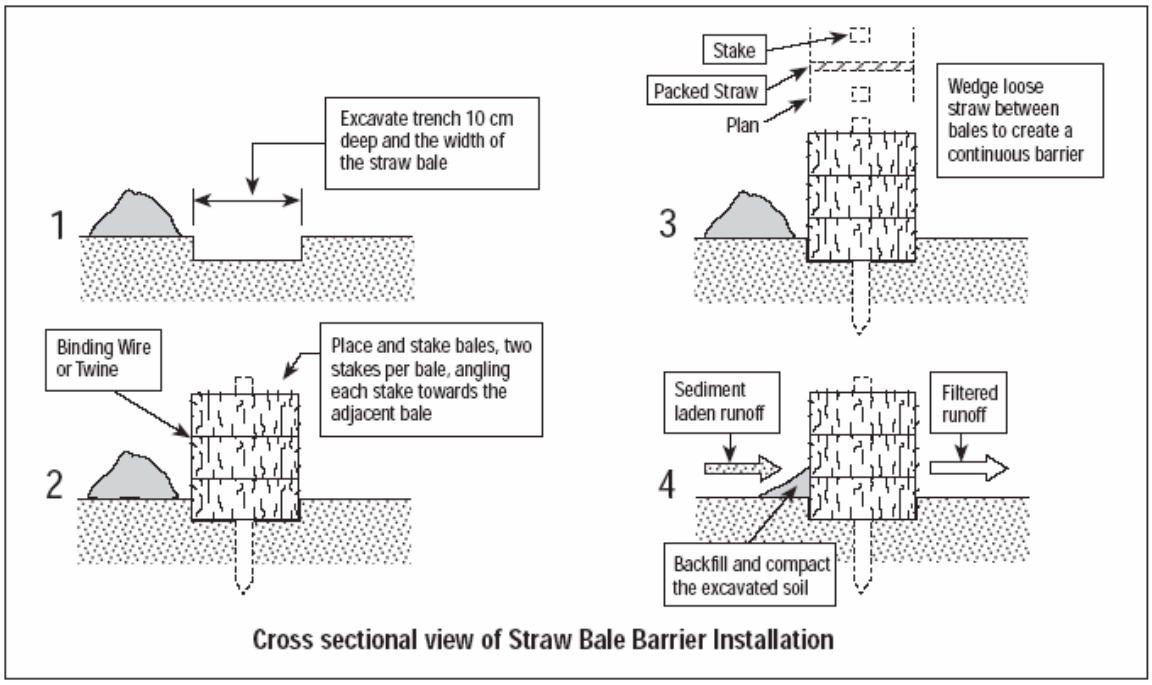
1. The slope behind the barrier should be no steeper than 2:1.

2. These sediment barriers should be erected prior to any soil disturbance of the upland area.

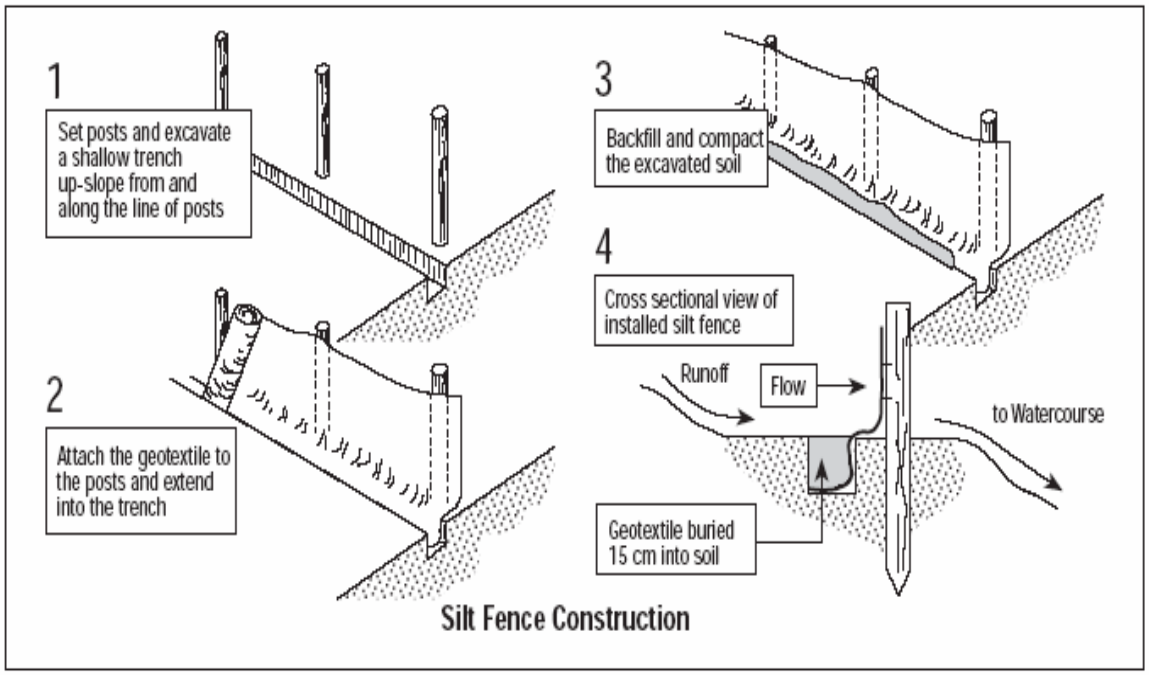
3. Sediment deposits should be removed when they reach one half the height of the filtering medium.

Straw Bales may be used if they are bound with wire or string. They should be placed lengthwise in a trench, staked, (at least two stakes per bale), and a small bank of fill placed against the downslope side. Straw bale barriers should be checked regularly and immediately after each rainfall for repair or replacement if necessary.

Silt Fences - Woven and non-woven synthetic fabrics are available for use as silt fences. The fabric is erected, to a height no greater than 0.9 metres above ground level, using wooden or steel posts. Reinforcement of the fabric may be necessary. The bottom of the fabric should be buried in a trench that's backfilled. Silt fences are more costly than straw bales but usually last longer (up to 6 months) and are more effective when checked regularly and immediately after each rainfall for repair or replacement if necessary.



Cross sectional view of Straw Bale Barrier Installation



Silt Fence Construction

Water Diversion

These temporary channels or dykes are constructed across the slope for the purpose of diverting surface runoff from upslope drainage areas away from disturbed areas to a stabilized outlet or a sediment trapping facility until permanent stabilization has occurred.

Diversion Channels are excavated channels with a supporting ridge on the lower side. The channels can be parabolic, V-shaped or trapezoidal. The dyke should be stabilized immediately with temporary or permanent vegetation. The channel may be stabilized with vegetation or rip rap. The diversion must have an outlet that conveys the outflow to a point where the discharge will not cause any erosion. The outlet may be a grassed waterway, a vegetated or paved swale or a stable ditch. Maintenance is necessary to maintain diversion capacity, storage, ridge height, vegetative cover, and the outlet. When constructed properly, these structures are durable, economical, effective, and require little maintenance.

Re-Vegetation General Guidelines

The above techniques are temporary measures aimed at preventing sedimentation of watercourses or wetlands resulting from erosion by surface runoff of a disturbed area. These techniques should only be maintained until permanent vegetation is established on the disturbed area. Re-vegetating disturbed areas for long term protection should be a part of erosion control plans for every project.

The following guidelines apply to re-vegetation:

1. Utilize erosion and sediment control techniques where needed. Grade the disturbed area to a stable uniform slope. Vegetative cover will never develop on an unstable slope until it has eroded back to a stable angle. This angle is generally accepted as 2 horizontal to 1 vertical. Remove stones or debris. Loosen the soil by hand raking. Fertilize where necessary.

2. Plant when the weather will permit suitable temperatures and moisture for plant growth. Spring plantings give the best results. Seeds should not be planted within 45 days of the first killing frost. Germination may occur but the seeds would not likely survive the winter.

3. Mulch increases the odds of successful re-vegetation by conserving moisture, modifying soil temperatures, and preventing soil compaction.

4. Choose a low maintenance seed mixture that is adapted to the local climate and soil conditions and which is fast growing.

5. Hydro-seeding is an acceptable process where a slurry of seed, fertilizer, wood fibre mulch and water is sprayed on the exposed area.

Mulching

Mulch is a layer of natural or manufactured material placed or sprayed onto exposed soil to control erosion, encourage germination and growth of vegetation, and/or discourage the growth of weeds. Mulch controls erosion by reducing both the impact of raindrops hitting the soil surface and the velocity of overland flow, permitting run-off more time to infiltrate the soil. It encourages vegetation growth by conserving moisture, maintaining humidity, reducing soil compaction, reducing soil surface freezing and thawing, and minimizing disturbance of the seed.

Straw and hay mulches are highly effective, readily available most years, and widely used for temporary erosion control and to aid in the establishment of permanent cover. Straw mulch has the advantage that its “true” mulch nature resulting from its greater thickness, provides a micro-environment conducive to germination. If straw is harvested for use as a mulch, bailing should take place after a light rain to ensure that bales have sufficient moisture content so they don’t fall apart when being handled during spreading. It is recommended that jute twine be used on bales as opposed to nylon. Jute will quickly biodegrade and will not become tangled in equipment causing damage and costly downtime in subsequent field operations.

Other types of mulches include foliage and branches, wood chips, jute cloth and a

variety of hydraulic mulches (sprayable mixes).

Applying seed with straw mulch is a two or three step process in which the seeding and mulching are carried out in sequence. Normally the seed and fertilizer are applied by hand or machine. Recent studies by the *Prince Edward Island Department of Agriculture* on residue management indicate that mulches get the best result if they are not compacted into the soil. A seed with crimped straw mulch may have to be used on sandy soils or areas of concentrated water flow where other mulches may be easily displaced. In this application, the seed is applied first and then the same day the straw or hay mulch is applied by hand or machine to an initial depth of between 35 to 50 mm. The straw is then crimped or indented into the ground 35 to 60 mm by discing, by driving over the newly applied straw with a steel tracked vehicle with deep cleats on the tracks, or by utilizing a hand tool such as an ice chipper.

Soil Stabilization Blankets

Soil stabilization blankets (such as jute mats, burlap or woven geotextiles) can be used to help establish vegetation on previously disturbed slopes, normally problem slopes of 3:1 or greater. These blankets are biodegradeable and therefore decompose over time. Jute mesh is a uniform, open, plain weave of undyed and unbleached single jute yarn. Jute mesh provides good coverage (large surface area of strands) and contains such small openings that it can be used alone as a blanket. Woven geotextiles are very useful in areas with slopes where other sediment control measures are not effective. They can be purchased with the seed already inserted in the geotextile allowing for a quick germination period.

Since these materials will decompose over time, they should be used in permanent conveyance channels with the realization that the system's resistance to erosion is based on the type of vegetation planted and the existing soil's characteristics.

When using jute or burlap, seed and mulch should be applied before laying the net. Start laying the protective covering from the top of the channel or top of the slope and unroll down. Allow it to lay loosely, do not stretch. Upslope ends of the protective covering should be buried in an anchor slot not less than 15 cm deep. Tamp the earth firmly over the material. Staple the material at a minimum of every 30 cm across the top end. Edges of the material should be stapled every one metre. As a final check one should be certain that:

- The jute, burlap or geotextile is in uniform contact with the soil;
- All lap joints are secure;
- All staples are driven flush with the ground; and
- All disturbed areas have been seeded.

Temporary Berm and Slope Drain

A temporary slope drain is defined as flexible tubing or conduit extending from the top to the bottom of a cut or fill slope. Concentrated run-off is temporarily and safely conducted down the face of a cut or fill slope without causing erosion on or below the slope. Temporary slope drains can provide valuable protection of exposed slopes until permanent drainage structures can be installed or vegetation can be established.

Temporary slope drains can be used in conjunction with diversion dykes to convey runoff from the entire drainage area above a slope to the base of the slope without erosion. It is very important that these temporary structures be installed properly since their failure will often result in severe gully erosion in the site and sedimentation below the slope. The entrance section must be securely entrenched, all connections must be watertight and the conduit must be staked securely.