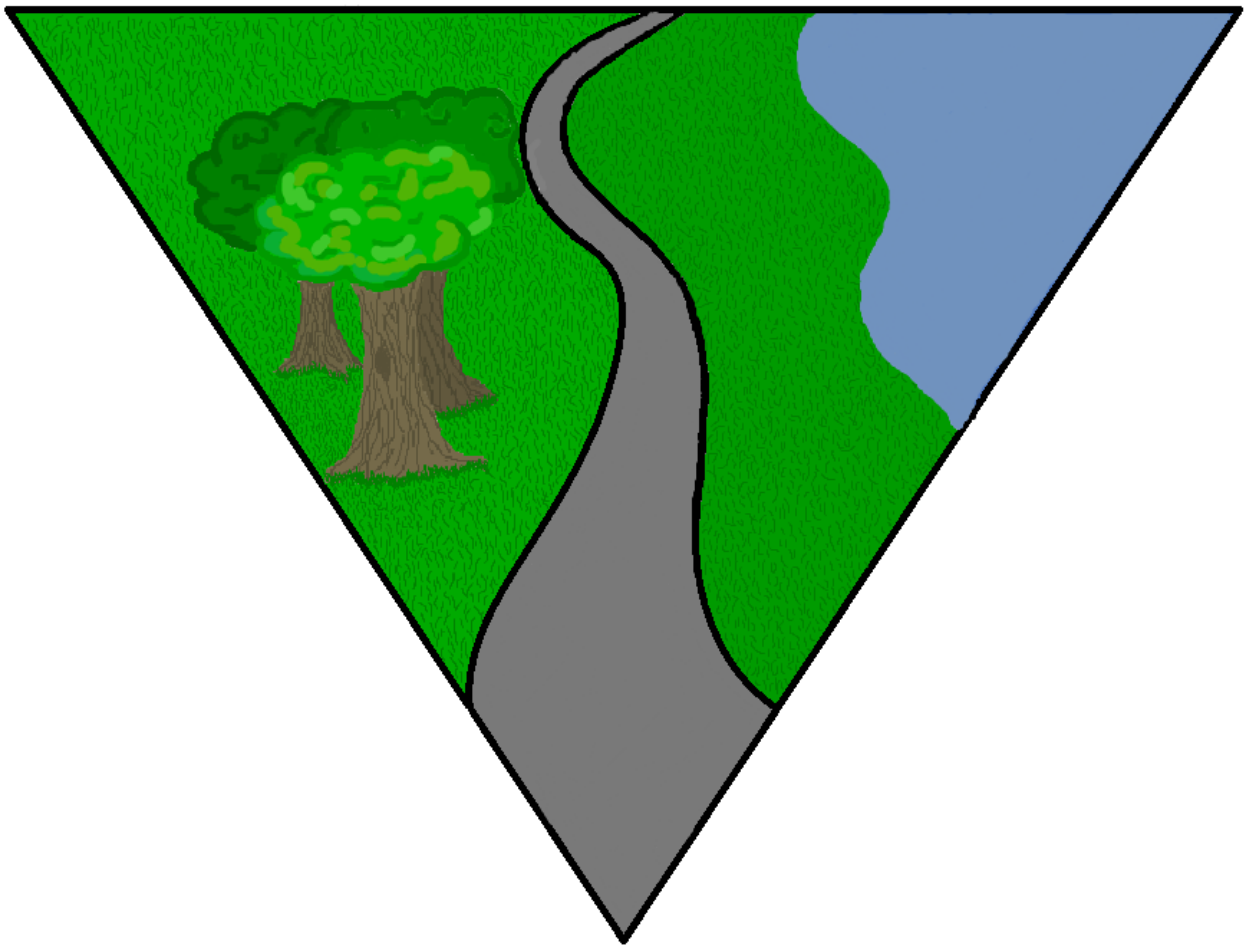
Vermont Better Roads Manual

Clean Water You Can Afford



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VTrans Working to Get You There
Vermont Agency of Transportation

Principles of Better Roads

1. **Get water off the road quickly and avoid having water run lengthwise down the road.**

2. **Stabilize and revegetate disturbed areas in and/or near ditches, culverts, banks, inlets and outlets immediately**

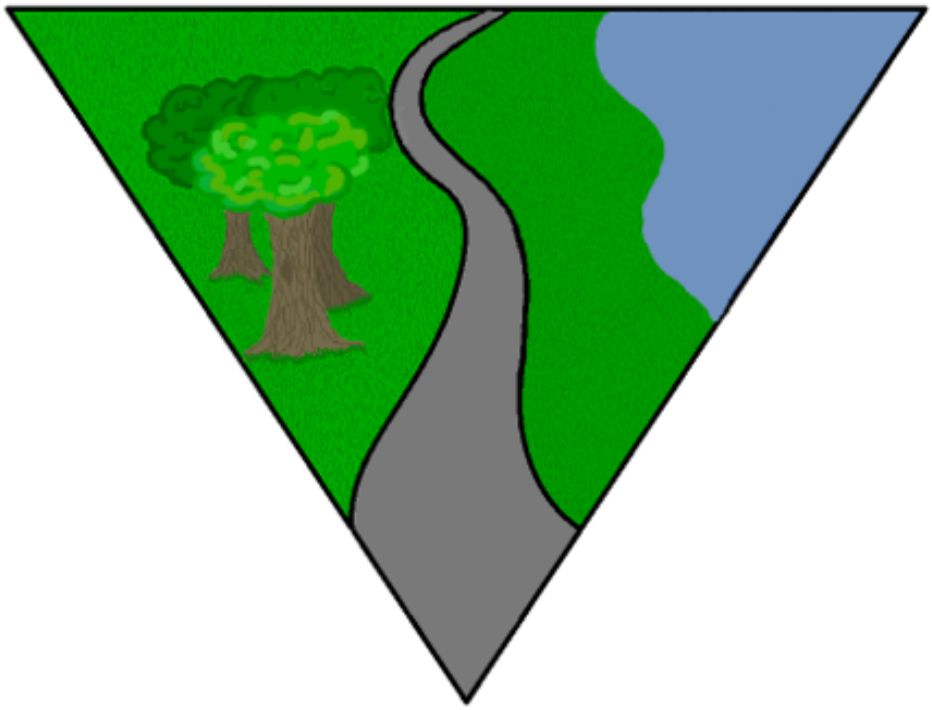
3. **Divert as much runoff as possible away from surface waters into vegetated areas**

4. **Good maintenance saves $$$ by decreasing road problems and preventing untimely repairs**

5. **Good maintenance and infrastructure reduce susceptibility to flash flood damage**

Better Roads

Clean Water You Can Afford



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Introduction

History

The Better Roads program (formerly known as the Better Backroads Program) was founded in 1997 to provide funding and technical assistance to municipalities to promote the use of erosion control and maintenance techniques that save money while protecting and enhancing water quality. From 1997-2013, program administration was provided on behalf of the Vermont Agency of Transportation (VTrans) by the (now defunct) Northern Vermont Resource Conservation & Development Council. In 2013, the program administration was moved in to VTrans. ACT 64 of 2015, often referred to as the Clean Water Bill, directed the Agency of Natural Resources (ANR) to develop a municipal roads general permit. VTrans has been working collaboratively with ANR and other partners to educate municipalities on the permit requirements and to ensure our program and guidance materials support municipalities in their compliance efforts.

Purpose

The purpose of this manual is to provide guidance to Vermont municipalities and road maintenance decision makers on cost effective techniques and actions that can be used to enhance the resilience of municipal roads while protecting water quality in Vermont. This manual was revised to assist municipalities with implementation of appropriate Best Management Practices (BMPs) required by the ANR Municipal Roads General Permit (MRGP). These BMPs are highlighted in the appropriate sections of the manual to inform municipalities of their permit obligations under the MRGP.

Better Roads Best Practices Checklist

- Crown roads to allow water to move quickly from the surface into the ditches (approximately ½ to ¾ inch per linear foot of lane width or 4%-6%).
- Stabilize all exposed soil with seed and mulch, erosion control blankets or hydroseeding as soon as possible.
- Line ditches with slopes less than 5% with vegetation (seed and mulch).
- Line ditches with slopes equal to 5% and less than 8% with vegetation and disconnection practices.
- Line ditches with slopes greater than or equal to 8% with stone.
- Direct runoff into vegetated areas, where possible.
- Avoid concentrating runoff and keep runoff velocities as low as practicable.
- Install culverts with a minimum diameter of 18 inches.
- Install stone aprons at culvert outlets where erosion is occurring or on any new construction with slopes greater than 5%.
- Install headers and/or wingwalls on culverts where erosion is occurring.
- Where erosion persists, upgrade culvert size and correct gradient (slope).
- Schedule and perform regular inspection and maintenance on culverts, ditches, and roads (remove all berms from shoulders and make sure culverts and ditches aren't blocked by debris).
- Stabilize eroding banks with vegetation or stone and only disturb an area that can be stabilized (temporary or permanent) the same day.
- After September 15th, stabilize soils by hydroseeding or covering with erosion control blankets, not just seed and mulch.

Municipal Roads General Permit

Municipal Roads General Permit (MRGP) Background – The MRGP is one of several new water quality permits contained within Act 64, the Vermont Clean Water Act, to address state water quality issues. Act 64 was signed into legislation in 2015 and required the Vermont Department of Environmental Conservation (DEC) to develop a new municipal roads stormwater general permit to cover all municipal roads (Classes 1 – 4) and the stormwater infrastructure associated with those roads. The major components of the MRGP include the road erosion inventory and implementation table, and upgrade of roads to new MRGP standards before December 2036, with the exception of Very High Priority road segments which will have to brought up to standards by December 2025 and Class 4 Very High Priority segments by December 2028. A full schedule of implementation deadlines can be found in the Appendix on page 52.

For more information of all aspects of the MRGP, please see the MRGP website.

http://dec.vermont.gov/watershed/stormwater/permit-information-applications-fees/municipal-roads-program

Hydrologically-connected segments – Segments that are in close proximity to water resources such as, perennial and intermittent streams, wetlands, lakes and ponds. The Agency of Natural Resources Atlas allows you to see the "connected" roads in your town under the Municipal Roads Theme layer (link found in appendix). MRGP Best Management Practices are only required to be installed on "connected" segments, a hydrologically-connected segment is defined as:

a. A municipal road segment that is within 100 feet of a water of the State or wetland;
b. A municipal road segment that bisects any water of the State or wetland, or a defined channel;
c. A municipal road segment that is uphill from, and drains to, a municipal road that bisects a water of the State or wetland.
d. Paved roads with catch basins- If the catch basin outlet is within 500' of a water (defined above), it is considered connected.

Road Erosion Inventories (REIs) and Implementation Table – One of the main requirements of the MRGP is that towns complete a REI of their hydrologically-connected roads. There are separate REI evaluations for different road types including: paved roads with curbs and catch basins, paved and gravel roads with drainage ditches not Class 4, and Class 4. All municipal roads are divided into 328-foot road segments. The REIs evaluate whether each road segment meets MRGP standards. Each segment is scored as Fully Meeting, Partially Meeting or Not Meeting standards. DEC, VTrans and the Agency of Digital Services has developed a REI App to ease in the collection of assessment data. The REI results are summarized in an Implementation Table that towns will use to update progress in bringing their roads up to MRGP requirements.

Temporary Erosion Prevention and Sediment Control Measures

Temporary erosion prevention and sediment control measures reduce surface water pollution during the installation of a project, or for a short period after the project is completed and final stabilization measures have not been fully established. It is recommended that all areas of disturbance have permanent stabilization measures installed within 48 hours of reaching final grade.

Municipal Roads General Permit Policy

In accordance with the Municipal Roads General Permit (MRGP), following any construction or soil disturbances, all bare or unvegetated areas shall be protected with erosion matting, revegetated with seed and mulch, hydroseeded, or stone lined within 5 days of disturbance of soil. If precipitation is forecasted before the 5 day limit, this must be done sooner. The MRGP requires this only of hydrologically-connected road segments but is a recommended practice for all roads.

Silt Fence

A temporary control measure that can last up to roughly one year, constructed of geotextile fabric and steel or wood posts that is lightweight, portable, and often reusable. Used to remove sediment from distributed flows and reduce runoff velocities. NOT recommended for use across ditches as flowing water can easily overwhelm the fence.

- Install at the base of a slope to intercept overland flow and hold sediment.
- Should be placed along the contour of the slope (not diagonally or up and down the slope).
- Anchor in a minimum of 4” but, recommended 10” where practicable. Backfill the base of the silt fence to prevent water from running underneath.
- Periodic removal of trapped sediment is necessary for optimum performance.
  - Recommended removal when sediment reaches half the height of the silt fence.
- When working on a lake bank or streambank, install a turbidity curtain. Be sure to anchor the turbidity curtain tightly to the lake or stream bottom.

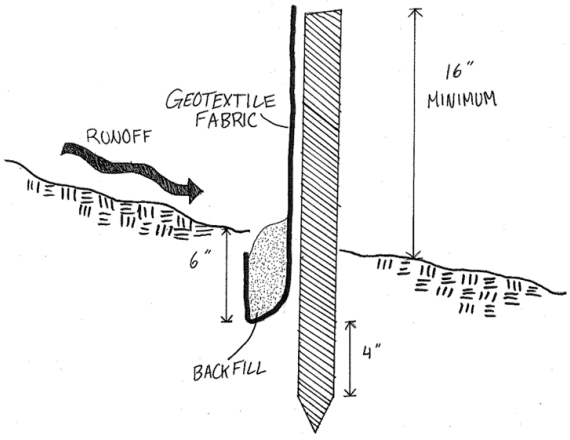


Figure 1: Silt Fence

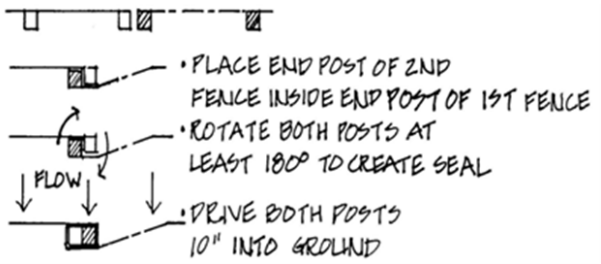


Figure 2: Attaching two silt fences

Stone Check Dam

A single check dam constructed of stone, used to slow velocity of concentrated flows and remove sediment. Especially useful for when flows that would overwhelm a silt fence are present, and when flow is concentrated in a conveyance channel. Also recommended to use in grass lined ditches while vegetation is still being established.

- Rock/stone must extend across the entire width of the channel with a lower elevation in the middle for flowing water to spill over.
- Require periodic maintenance to remove accumulated sediment to prevent clogging.
- Refer to page 16 for design details of check dams.

Fiber Roll/Coir Log

A coconut fiber, straw, or excelsior woven roll encased in netting of jute, nylon, or burlap, used to remove sediment from flowing water. Also, can be used to dissipate energy along bodies of water and protect sediment from entering a water body.

- Can range from 8” to 18” in diameter.
- Excavate a small, roughly 4”, trench along contour of slope and place roll in trench.
- Fiber roll should be anchored with 2” x 2” posts, ideally pounded in 10”, placed on both sides of the roll and trimmed to height of the roll.
- Place excavated soil behind roll and hand tamp to help secure.
- Built up sediment should be removed once it has reached half the height of the roll.
- Is best used in areas that drain 10 acres or less.

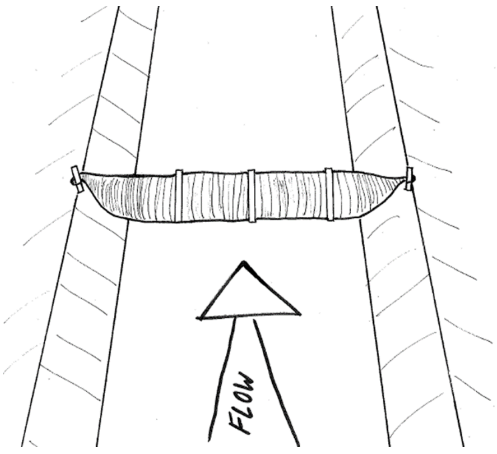


Figure 3: Fiber Roll
Section View

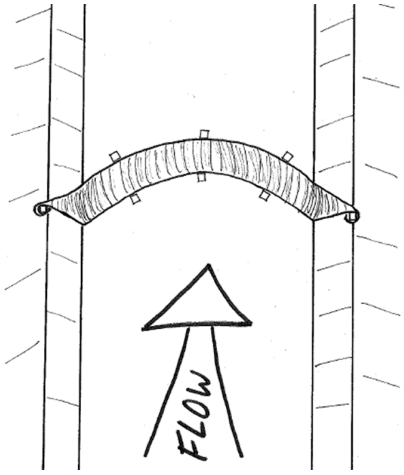


Figure 4: Fiber Roll
Plan View

Sediment Trap

Sediment filter made of stone that can handle the largest flows. Useful to install when there is a constant flow of water.

- Small temporary excavation or embankment designed to intercept, trap, and retain sediment.
- Able to handle flows larger than other control methods can.
- Should be at least twice as long, as it is wide.
- Recommended to use 8” minus stone on roads with a slope of 5% - 8%; 12” minus stone recommended for roads with a slope greater than 8%.

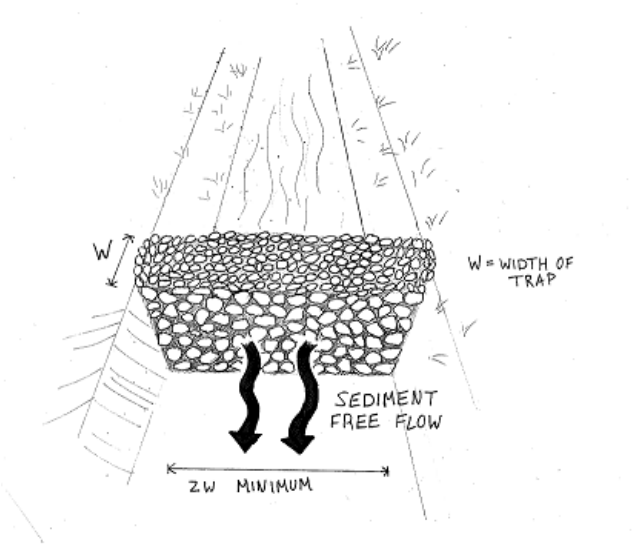


Figure 5: Sediment Trap

Excess Material

Improper disposal of excess material can increase the amount of sediment that enters streams and damages sensitive areas, particularly wetlands. Material that is being saved for future road construction or maintenance must be kept in a designate storage or borrow area, such as a salt/sand shed or sand pit.

Disposal of Excess Material

- Excess materials should not be disposed of in wetlands, drainage ditches and swales, streambanks, areas within 50 feet or drain into waterways, slopes that are more than 2:1 horizontal to vertical or other locations that may potentially cause pollution.
- Be sure that the area downhill of the disposal area has an adequate vegetated filter strip to trap sediment.
- Seed or vegetate any fill areas as soon as possible.
- Plan possible disposal areas ahead of time, giving the opportunity to utilize excess materials if possible.

Storage & Borrow Areas

- Excavated materials should not be stored in floodplain, surface waters, river corridor or wetland areas
- Locate storage areas on the uphill side of a disturbed area so they can act as a diversion for runoff.
- Develop an erosion prevention and sediment control plan specific for the site.
- Vegetate all areas immediately that are not in current use.

Temporary Traffic Control

The Manual on Uniform Traffic Control Devices (MUTCD) contains the national standards governing all traffic control devices. All public agencies and owners of private roads open to public travel across the nation rely on the MUTCD to bring uniformity to the roadway. The MUTCD plays a critical role in improving safety and mobility of all road users. The MUTCD is law governing all traffic control devices. Non-compliance with the MUTCD ultimately can result in the loss of federal-aid funds as well as in a significant increase in tort liability. Chapter 6 of the manual is dedicated to temporary traffic control (TTC) and a link to the complete document can be found on page 51.

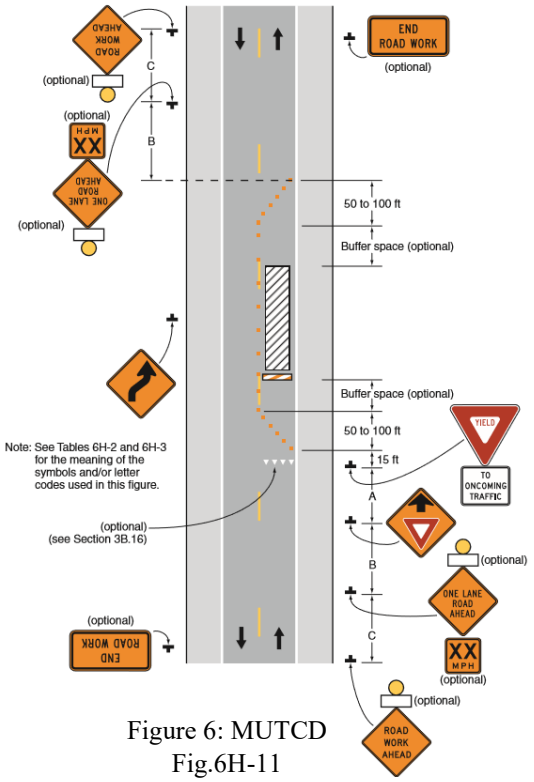


Figure 6: MUTCD Fig.6H-11

Lane Closure on a Two-Lane Road with Low Traffic Volumes

- Shown in Figure 6, this TTC application is appropriate when traffic volume is low enough that sufficient gaps exist in traffic from the yielding lane.
- Road users from both directions must be able to see approaching traffic through and beyond the worksite.

One-Lane, Two-Way Traffic Taper

- When traffic volume is not low enough to have one lane simply yield to the other, or if there is any obstruction of view from one side of the work zone to the other, this method of TTC, shown in Figure 7, should be used.
- Traffic is controlled by a flagger at each end of a constricted section of roadway.
- One flagger is designated as the coordinator and both flaggers must be in constant communication with each other either orally, electronically, or with hand signals.

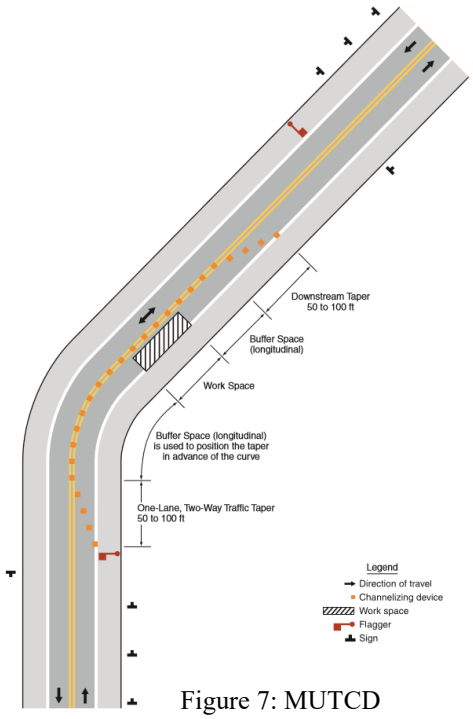


Figure 7: MUTCD Fig.6H-10

Road Closure

- This TTC application is appropriate for situations where a road closure is necessary but will not exceed 20 minutes.
- The use of a flagger is necessary for this application, and flagger shall follow standard procedures. (Procedures can be found in sections 6E.07 and 6E.08 of the MUTCD).

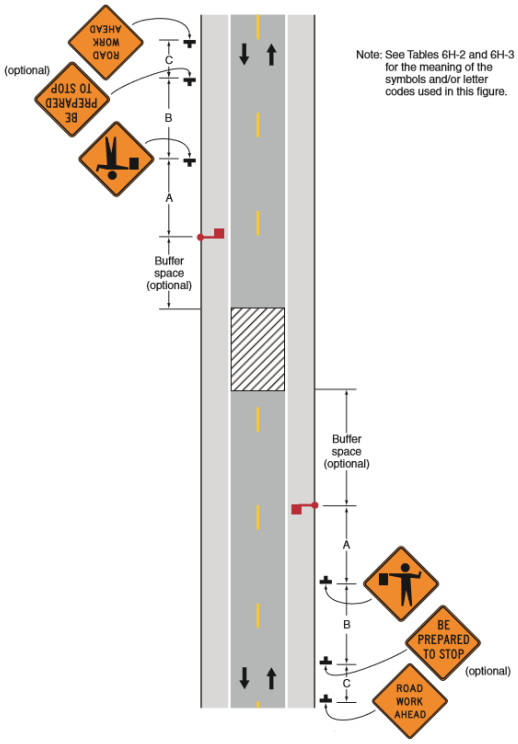


Figure 8: MUTCD Fig.6H-13

Road Surface

Unpaved roads carry local traffic between rural lands and provide connecting links between paved collector roads. In Vermont, more than 75% of the local town roads have an unpaved/gravel surface. The top layer of gravel on these roads needs to be shaped, compacted, and smoothed so that surface water runoff will move quickly from the road surface into established ditches.

Failure to direct surface water from the road surface to a drainage channel can result in deterioration of the road surface, safety problems (ice), and assorted erosion problems. Immediate removal of runoff will prevent these issues and lessen the frequency and cost of maintenance, thus lengthening the life of the road surface and decreasing the amount of sediment carried into surface waters.

Travel Lane

A proper cross-section of the road surface is essential for efficient water drainage from the travel lane to established stormwater infrastructure. If a road is not in or out-sloped it must have an established crown that will shed water to either the roadside ditches or create distributed flow along the road.

Surface Profile

- Construct the surface layer with 4”-6” of well-graded aggregate and crushed rock.
- 12” minimum of processed gravel is recommended under the surface material.
- Towns should be aware of the gradation of the gravel they use and be conscious of what size aggregate to incorporate when re-grading to ensure a well-graded and effective road surface.
- Gravel roads should be crowned with a slope of at least 1/2” – 3/4” for each foot of lane width or 4% - 6%.
- Paved roads should be crowned with a minimum of 1/8” – 1/4” per foot or 1% - 2% but is recommended that the road has a 2% - 3% slope for best drainage conditions.
- Be sure to remove any berm left on the road from winter sanding so that stormwater can flow into the ditches and not erode the road surface.

Municipal Roads General Permit Policy

The MRGP has established crown requirements for all hydrologically-connected road segments regardless if erosion is present or not. All gravel roads shall be crowned, or in or out-sloped, with a slope of 1/4” per foot of lane width or 2%. All paved/ditched roads shall be properly crowned in new construction to a minimum slope of 1/8” per foot of lane width, or 1%.

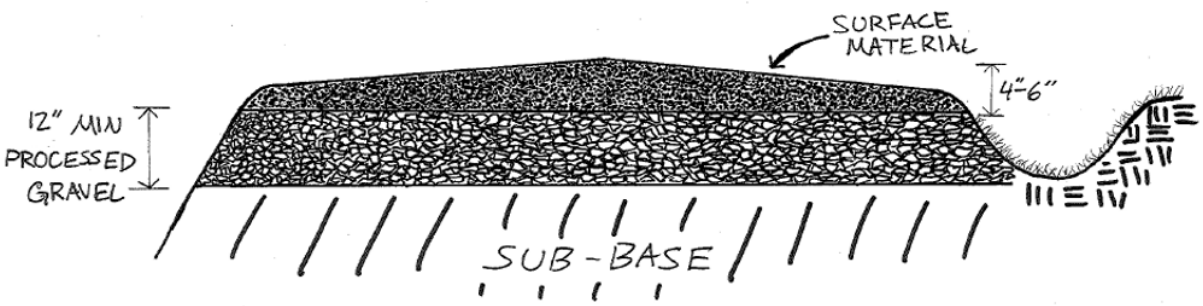


Figure 9: Properly shaped road surface

Equipment

- Proper equipment for surface maintenance includes but is not limited to: grader (shaping and restoring), rake (smoothing before compaction), steel wheel roller (compaction), and slope board (slope confirmation).
- It is recommended to use an 8-10-ton vibratory steel drum roller for all road surface compaction.

Grading

- Roads should be graded in the spring as soon as the frost leaves the ground.
- Do not grade roads if rain is forecasted, it is best to do this *after* rainfall. Always avoid grading during dry periods to minimize material loss as dust.
- Add new material by running a truck down the center of the roadway and dumping. Approximately 2 to 3 inches of new material should be added whenever regraveling.
- Regravel roads every 4 to 5 years.
- The road should be scraped prior to adding new material to remove any deformities and establish ideal shape. Scarifying also helps blend old material with new material and improves compaction.
- Perform grading operations with the moldboard tilted backward and with sufficient downward pressure on the blade to produce a cutting action.
    - The angle of the moldboard should be between 30 and 45 degrees.
    - For most cases tilt the front wheels slightly (10 to 15 degrees) toward the direction the aggregate should roll.
- The outer edge of the moldboard should reach the road surface's edge.
- Keep a minimum of one-foot distance from the ditch line so that vegetation or rock stabilization is not disturbed.
- When possible, the entire width of the roadway disturbed by grading should be compacted by the end of the day.
- Regravel roads every 4 to 5 years.

Compaction

Proper compaction of the road surface is vital for the longevity of the road and improving the impermeability of the surface. If the travel surface is tight it is less likely to ravel resulting in washboards, potholes, dust, and rutting which would then require more frequent grading.

- Roadway compaction is only possible with adequate moisture, whether natural or added.
- The presence of moisture in the road surface is critical for the effectiveness of road stabilization materials such as magnesium or calcium chloride.
    - Refer to manufacturer for application rates of magnesium or chloride-based compounds.
- A vibratory roller is the optimal piece of equipment for proper compaction. Renting a vibratory roller should be considered for larger projects.
- Static drum or rubber tire rollers that can be fitted to the back of the grader are also effective equipment and are gaining popularity.
- At the very least the road should be compacted with the grader or truck tires before and after chloride or water application.

Distress Conditions

Surface Deteriorations

Common types of surface deteriorations refer to wear and tear the road surface will experience over the years and include dust, raveling, and slipperiness.

Dust – The loss of fine, binder aggregates from the road surface into the air.

- Dust can lead to other types of road distress.
- Sprinkling water on the road surface helps but is only a very short-term solution.
- Dust can be minimized by applying chloride-based compounds, which draws moisture from the air to improve fine aggregate cohesion. It is most effective if applied before roads become too dry and dusty and after any grading actions.
- Refer to product manufacturer for necessary application rates.

* Chloride compounds should be used in moderation adjacent to surface waters as its long term, extensive use can cause water quality problems.

Raveling – Loss of coarse aggregate.

- Correct by grading or blading when moisture is available and consider the addition of material with more fines in it to improve surface composition.
- Always compact the surface again once treatment is completed.

Slipperiness – Excess amounts of fine aggregates or soil on the road surface can cause the road to become slippery during wet weather.

- To correct, incorporate more coarse aggregate by grading, blading, and compacting.
- Slipperiness is often caused by excess fines in sands used to treat roads during winter months. To avoid, use winter sands largely made up of coarse material.

Surface Deformations

Surface deformation problems include rutting, corrugations/washboards, depressions, potholes, and soft spots but, are reduced with proper road surface drainage.

Rutting – Longitudinal depressions in the wheel paths caused by high moisture content in the subsurface soil, inadequate surface course thickness, and/or heavy traffic loads.

- To correct ruts: grade, add suitable material, and roll road surface.
- It is NOT recommended to add stone as a temporary solution; draining the ruts and filling them with roadbed material is preferred.
    - During times of especially bad road conditions, such as "mud season", road foreman should use their judgement to address the current issue in the most efficient manner.
- For severe ruts, a layer of geotextile material, under at least 6 inches of crushed gravel, may be required.

Corrugations/Washboard – A series of ridges and depressions across the road surface caused by a lack of surface cohesion and excessive vehicle speeds.

- Improve cohesive qualities of the road surface by remixing with fines.
- Scarify the road surface while damp, regrade, recrown, and roll the surface.

Depressions – Localized low areas, at least 1 inch below the surrounding road surfaces caused by settlement, excessive moisture content, and improper drainage.

- Correct depressions by filling with well graded aggregate that will improve drainage, followed by grading, and compacting.

Potholes – Depressions or "holes" in the road surface caused by excessive moisture content, poor drainage, inadequate crown, and poorly graded aggregates.

- Spot grading or patching with crushed aggregate will repair potholes.

Soft Spots – Caused by lack of proper drainage; part of "mud season".

- To correct, replace soft spot area with a suitable material such as well graded stone or gravel.
- Deepening the ditches along the road may alleviate soft spots by helping drain the subsurface.
- Placing a layer of geotextile under at least 6 inches of crushed gravel may also help solve this problem.
- Chronic and severe locations may need to be excavated and have densely graded material, or road material, right down to the bed to allow for proper drainage.

Road Shoulder

The road shoulder is an integral part of road design. Following the VT State Design Standards, it is recommended that roads have a minimum of a 9' travel lane and a 2' shoulder, where possible. The State Design Standards can be found in the Links section on page 51.

- For gravel roads where the average crown is being maintained at 4%, the shoulder grade should increase to 6-8% to ensure quick runoff and visual break between travel lane and shoulder.
- The shoulder needs to be adequately compacted to support commercial and agricultural vehicles
- The Vermont Standard Specifications for Construction manual calls for an 8-10-ton static roller to be applied when shoulders are constructed. This may be difficult for some municipalities to perform, but compaction of some form is a must to ensure shoulder integrity.

Distributed or Sheet Flow

It is best for roadway runoff to flow in a distributed manner or shed to grassed or forested area. This can be achieved by lowering the elevation of the road shoulders or by raising the elevation of the travel lane. If distributed flow is not possible a grass or stone-lined drainage ditch system shall be installed to convey road runoff. (See drainage section for practices based on road slope).

Armored Shoulder

This technique is applicable when distributed flow is present or there is shedding of road stormwater to vegetated areas down the front slope of a road. By stabilizing with stone, the road shoulder is protected and will not erode during heavy rain events.

- Especially effective in the presence of distributed flow down steep slopes.
- The road sub-base is reinforced immediately below the road surface.
- 8" minus stone is installed under the road surface to a depth of 2 to 3 feet and extends up the road shoulder.
- This technique can be used with a mid-crown road surface, or an out-sloped road surface.

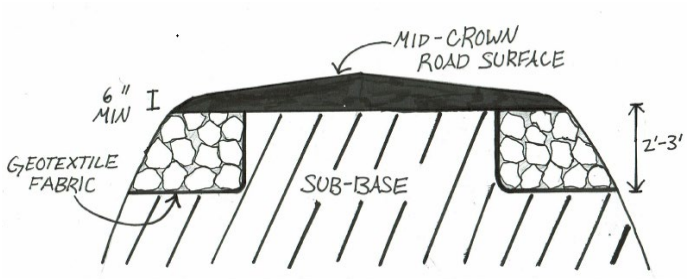


Figure 10: Armored shoulder on crowned road surface

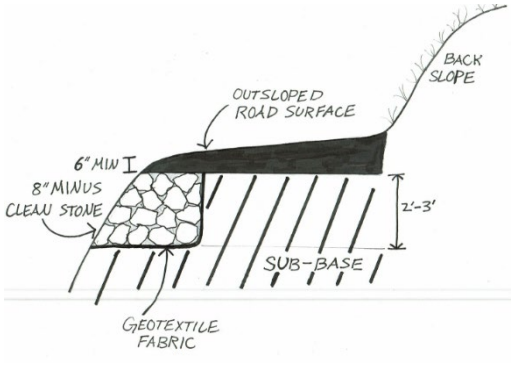


Figure 11: Armored shoulder on outsloped road surface

Berm Removal

A grader berm is typically material that has been lost off the moldboard on a previous pass and should be brought back into the road on a subsequent pass.

- Precipitation should be able to shed from the travel lane in a distributed manner to drainage system or infiltration area.
- A shoulder berm is only able to remain on a road if the road is in-sloped or out-sloped and the berm is located on the uphill side.

Municipal Roads General Permit Policy

All shoulder berms are to be removed and compacted on gravel roads with drainage ditches to restore proper drainage.

Shoulder Maintenance and Equipment

The transition from road surface to road shoulder should be a break to a slightly steeper slope unobstructed by a grader berm, cut edge, or high shoulder. There are times where these conditions are very difficult to achieve but is crucial for proper road drainage.

- A cut edge is where the moldboard went below grade at the edge of the shoulder.
- If a cut edge is not brought up to grade during finishing passes, it creates a secondary false ditch. In some situations, adding gravel may be an option worth considering versus reclaiming the shoulder.
- A high shoulder often is the result of the road sinking in its entirety, thus lifting the shoulders above the grade of the road surface or may be from years of debris build up and neglect.
- To fix a high shoulder, typically the material simply needs to be removed.
- An effective option for reclaiming shoulders is some form of offset disk harrows that can be adjusted to reclaim gravel and reshape the shoulder.
    - Offset disk harrows are not suitable for all locations.

Mowing

It's very important for all municipalities to have a regular roadside mowing program. Roadside mowing is a major safety concern that poses challenges when considering invasive plant species. A link to the Invasive Plant Atlas of New England and VT Invasive can be found on page 51.

- It is not always recommended to mow every species found on our roadsides.
- Avoid mowing invasive plants that can regenerate roots from a small amount of stem and root fragments as mowing will simply help the invasive plant spread.
    - Purple Loosestrife, Phragmites, and Japanese Knotweed are examples of species that should be avoided when mowing.
- It is suggested to delineate and mark growth areas with these types of invasive with "Do Not Mow" signs until an herbicide program can be implemented.
- When dealing with invasive species it is necessary to mow prior to seed maturation to limit the spread of the plant.
- It is important to educate municipal staff on dangerous invasive plants, such as Wild Parsnips, as simple contact with such plants can lead to severe injuries and need for immediate medical attention.
- Mowing directly adjacent to streams or lakes should be minimized as it often results in excess sediment entering the waterway.
- Mid to late-June and early to mid-August are the two times during the warm months that mowing needs to be a focus.
- Mowing equipment should be thoroughly cleaned prior to being transported, especially if mowing occurred after seed maturation times to limit the spread of invasive plants.

Road Drainage

Ditches

Ditches are constructed to divert storm water away from roads to an adequate outlet without causing erosion or sedimentation. Ditches also allow the sub-base to drain which helps maintain the structural integrity of the road. A stable ditch needs to be shaped and lined with appropriate vegetative or structural material and should collect and disperse storm water in a controlled manner.

Efficient removal of storm water helps preserve the road bed and banks. Ditches also provide an opportunity for sediments and other pollutants to be removed from runoff before entering surface waters by controlling, slowing, and filtering water through vegetation. A stable ditch should not become an erosion problem itself.

Ditch Profile and Grading

A proper ditch profile and grading technique will redirect water efficiently, decrease erosion, and increase longevity of the ditch, thus decreasing maintenance costs.

- Ditches should be located so that water draining from uphill does not flow across the road surface before entering the drainage ditch.
- The preferred equipment for creating the ditch is an excavator with an articulated bucket.
- Size ditch so that it is large enough to handle runoff from the drainage area.
- Excavate the ditch deep enough to drain the road base and handle an expected runoff depth of 1.5-2 feet deep.
- The ditch bank side slopes should be at a maximum 2:1 horizontal to vertical ratio.
- The ditch should be at least 2 feet wide forming a slightly rounded (parabolic) shape to help slow and disperse water.
    - Ditches with a V shape will channelize the flowing water, thus increasing its velocity and power and are not recommended.
- Ditches should be lined as soon as possible to prevent erosion and to maintain ditch profile.
- Outlet ditches into vegetated areas whenever possible.
- The Better Roads program suggests following the Municipal Roads General Permit (MRGP) ditch requirements on all roads, whether hydrologically-connected or not. Refer to page 14 for table of requirements.

MRGP Ditch Requirements		
Slope Range	**Lining**	**Required Infrastructure**
0% > 5%	Grass	None
5% ≥ 8%	Grass	Check Dams
		Cross Culvert and/or Turnouts*
	Stone	None
>8%	Stone	None

*When installing a cross culvert and/or turnouts the MRGP requires a minimum of 2 installations every road segment, or every 328 feet.

Grass Lined Ditch

Ditches with a slope less than 5% may be lined with vegetation to prevent erosion, collect sediment, and dissipate velocity of runoff. Grass lined ditches may also be used in conjunction with disconnection practices such as cross culverts, turnouts, or stone check dams.

- All bare soil in the ditch should be seeded, a hydroseeder can be used to efficiently stabilize soil.
- Biodegradable temporary erosion matting that is non-welded, should be used with seed when site conditions require side slopes steeper than 1:2.
- Vegetated ditches installed after September 15th should be stabilized with either erosion control blankets or hydroseeding to provide adequate protection for winter.

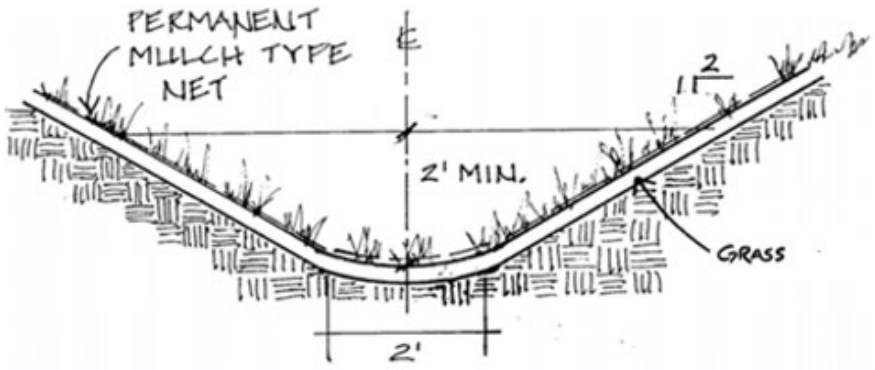


Figure 12: Grass lined ditch

Stone Lined Ditch

Ditches with a slope greater than 5% may need to be stone lined to provide adequate protection against erosion and to collect sediment from higher velocity stormwater runoff.

- It is recommended to use 12" minus stone, also referred to as Type 1 stone for ditch lining.
- Stone should be placed below the height of the shoulder so that grading and other maintenance operations don't negatively impact the stone lining.
- Recommended 2-foot minimum depth from stone in base of ditch, to road shoulder.
- Where ditches are installed adjacent to a steep back slope, stabilize the disturbed soil with methods detailed in the prior section, Temporary Erosion Prevention and Sediment Control.

Municipal Roads General Permit Policy

When a road slope is between 8% - 10% the stone-lined ditches shall use a minimum 6" – 8" minus stone or the equivalent for new practice construction. For ditches on a slope greater than 10% a minimum 6"- 8" minus stone is required but it is recommended to use 12" minus stone or the equivalent.

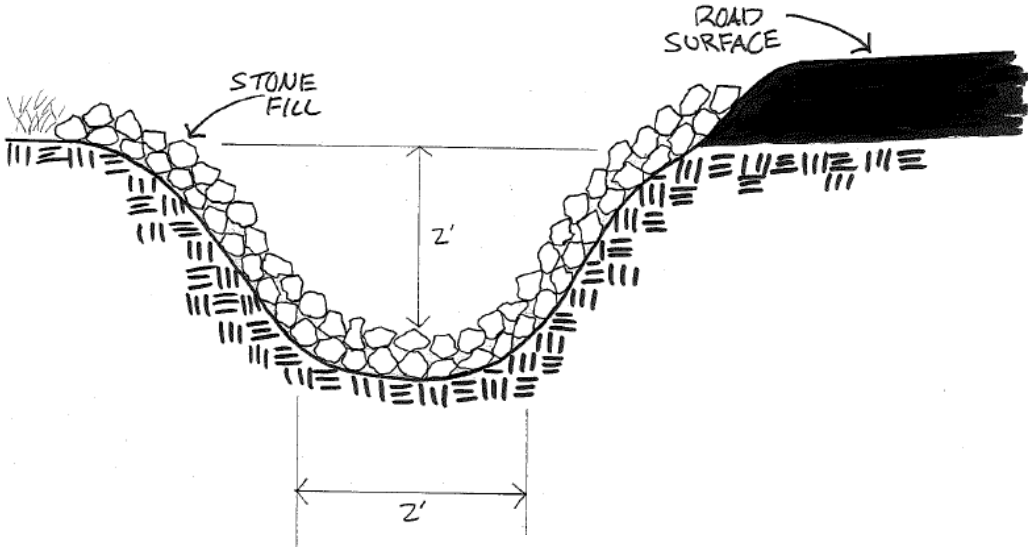


Figure 13: Stone lined ditch

Ditch Cleaning & Maintenance

- Clean ditches when they become clogged with sediments or debris to prevent overflows and washouts.
- Check ditches after major storm events as they may have obstructions, erosion, or collapsed banks.
- Regrade ditches only when absolutely necessary and line with vegetation or stone as soon as possible.
- Preventing erosion from uphill or on backslopes can lengthen the time needed between ditch cleanings.

Stone Check Dams

The Municipal Roads General Permit has set specifications for the installation and design of a stone check dam. These standards are encouraged to be used in all cases.

- A check dam should be constructed with side slopes 2:1 or flatter.
- A mixture of stones 2 to 9 inches shall be used to adequately remove sediment from runoff.
- Dams should span the width of the channel and extend up the sides of the banks.
- The height of the dam should not exceed 2 feet and the center of the dam should be 9 inches lower than the side elevation.
- Space the dams so that the bottom (toe) of the upstream dam is at the same elevation of the top (crest) of the downstream dam. This spacing is equal to the height of the check dam divided by the slope of the channel.
- Sediment that has accumulated behind the dam should be removed as needed to allow water to drain through the stone. This will also prevent large flows from carrying sediment over the dam.
- If significant erosion is occurring between check dams a stone lining should be installed.

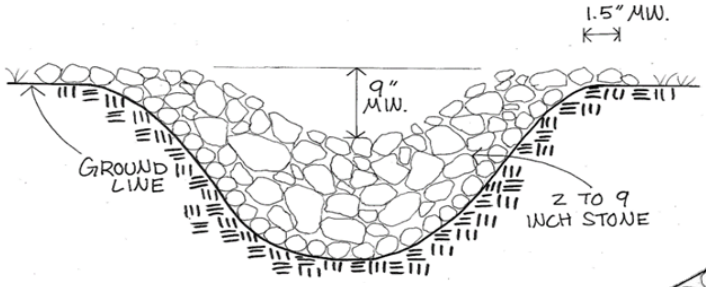


Figure 14: Section view perpendicular to channel

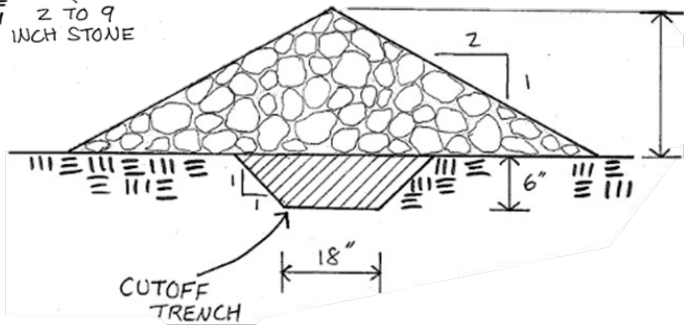


Figure 15: Section view parallel to channel

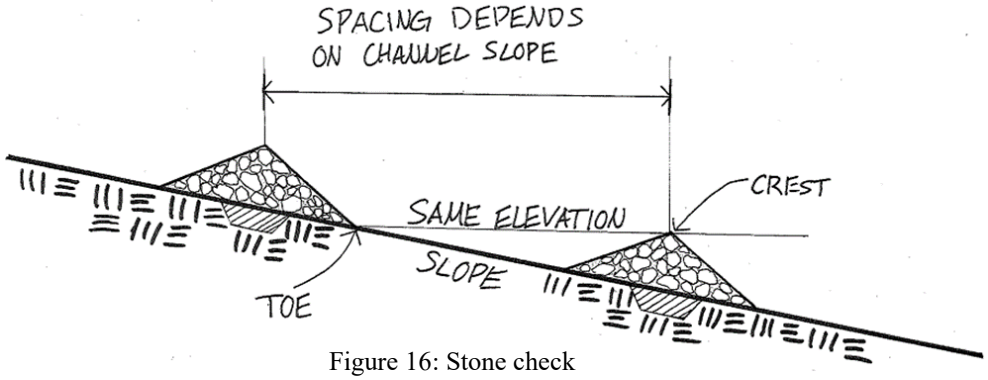


Figure 16: Stone check dam spacing

Stormwater Infrastructure

Closed drainage systems play a vital role in the control of stormwater on a continuous grade, paved surface. It is important to consider the peak discharge of stormwater when placing inlets to capture the runoff and work to reduce the velocity, spread, and depth of surface runoff. This should be done by a professional engineer, experienced in discerning these variables.

Drop Inlets and Catch Basins

- Inlet structures should be placed no more than 300' apart to reduce velocity within the system.
- There should be an inlet structure whenever the pipe size within the system changes, the alignment of the run changes, or when there is a slope change.
- There should be a 2"- 6" elevation change between the inverts of the inlets and the outlet pipes within the structures (the outlet being lower).
- It should be a goal to maintain a minimum 12" sump at the base, inside the inlet structure.
- Pipes within the closed system should not be sized smaller than 15", as per Vermont standard design and practices.
- Downstream pipes should never be smaller than upstream pipes to help eliminate "choke points".
- Whenever possible it is beneficial to keep internal velocities below 20 ft/sec, this may require the help of an engineer to calculate flows and placement of inlet structures to mitigate demand.

Municipal Roads General Permit Policy

The MRGP standard for paved roads with curbs and catch basins is that there can be no rill or gully erosion at the catch basin outlet, if it is hydrologically-connected. If the volume of erosion (length x width x depth in feet/27) is equal to or greater than 3 cubic yards, it is considered to be a Very High Priority site and must be brought up to MRGP standards before 12/31/25.

Maintenance

- During winter months, grates need to be kept clear of snow and ice to enable them to adequately capture snow and ice melt, keeping the roadway safe for all users.
- During warm weather months, grates and inlets need to be cleaned periodically to maintain proper functionality.
- After storm events, the first charge of runoff will likely gather leaves and debris around the grates. This needs to be cleared to reduce pooling of runoff which increases the possibility of hydroplaning.
- Inlets need to be periodically cleared of sediment gathered in the "sump" portion of the inlet structure using a vac truck. The "sump" allows sediment to be trapped in the structure and runoff velocities to slow before discharge into rivers and streams.

Green Infrastructure

Green infrastructure is a natural and/or semi-natural structure of any size, incorporated into the landscape between developed areas. Green infrastructure can be used to help mitigate and store stormwater, thus reducing the volume of water on the roads. There are a variety of types of green infrastructure that can be functional in multiple situations.

Rain Garden

Rain gardens are vegetated, shallow depressions constructed with highly permeable soil, used to capture and slow down stormwater by allowing it to infiltrate. Rain gardens are only appropriate for use in treating road stormwater from paved roads in village centers, and urban or highly developed areas.

- To determine if the soil in a certain area is well drained enough for a rain garden, dig a 6" – 8" deep and wide hole and fill it with water. If the water does not drain within 12 hours this is not an ideal location.
- Rain gardens should be designed to be sized roughly 20% – 30% of the contributing drainage area.
- It is very important that the soil present is highly permeable for optimal performance of the garden.
    - If soil is mainly composed of sandy soils 2% – 30% compost should be added.
    - If clay soils are present, replace with a mixture of 50% – 65% sand, 15% – 30% top soil, and 2% – 30% compost to ensure for optimal performance.
- A proper rain garden should resemble a soft sloping bowl, with the lowest point being no more than 6" below the surrounding land. It can be beneficial to install a rain garden in a pre-existing natural depression within the land if available.
- Rain gardens should be placed at 10' away from all structures to ensure they do not lead to flooding.
- Runoff should be clearly directed towards the rain garden through grassy swales, gutter extensions, or other devices.
- The plants used to vegetate the rain garden need to be wet tolerant species, especially towards the center as they will often experience flooding at the center of the garden.
- Once construction is complete the area should be mulched to stabilize. It is also important to maintain and water vegetation as it takes hold. Once vegetation is established, a rain garden does not need any routine maintenance.

Constructed Wetland

A constructed wetland is an aesthetically pleasing alternative method to removing sediment from stormwater, thus improving water quality while also providing additional storage for stormwater runoff.

- A constructed wetland can be single standing basin or part of a series of constructed wetlands. Incorporating multiple wetlands leads to greater pollution reduction and more stormwater storage.
- The basin should be sized according to the drainage area and expected flow, the length to width ratio should be no more than 2:1.
- Wetlands can be constructed by either excavating a basin or by constructing embankments (dikes) made of soil with a lot of fines to create an impermeable barrier.
    - Dikes need to be high enough to achieve desired depth of basing and be sloped no greater than 2:1 horizontal to vertical.
- The material making up the basin needs to be comprised of fines so that when compacted a near impervious surface is created. The bed slope of the wetland should also be between 1% – 3% to ensure constant flow.
- Determine the number of inlets necessary for the flow the wetland is expected to receive. There are a variety of different types of inlets that could be selected including an open-end pipe, channel, or gated pipe.
- Line the basin with geotextile fabric for sediment control and top with 3” – 4” of top soil to hold the vegetation roots.
- A variety of different vegetation should be incorporated into the wetland including but not limited to cattails, iris, and reeds.
- It is necessary to also incorporate a spill way for water to flow out of the wetland. The spillway should consist of a wide cut made in the ground or dike with side slopes no steeper than 2:1. Line with geotextile fabric to prevent erosion of spillway.
- Constructed wetlands should not require any routine maintenance if functioning properly.

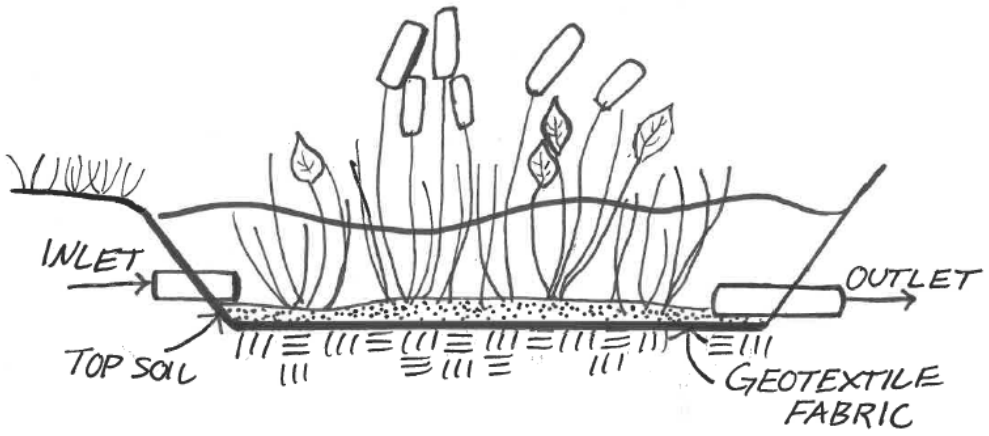


Figure 17: Constructed wetland

Infiltration Trench

A trench that can be used to catch runoff and quickly allow the water to infiltrate before getting a chance to travel across the road surface. These trenches are so functional due to the highly permeable material that is used.

- Can be installed along the roadway or in any area subject to excess overland flow, to reduce the volume of runoff present.
- Infiltration trenches should be installed with a vegetative filter strip acting as a buffer around the perimeter to remove sediment from incoming flow and prevent pollutants from clogging the trench.
- Excavate a trench that is a minimum of 18" wide and 8" deep. Can be constructed to any length desired.
- It is recommended to line the trench with geotextile fabric, as this is found to lengthen the lifespan of the trench.
- Fill the trench with ½" – 1 ½" clean crushed stone, until 3" within the surface level.
- Wrap clean stone with geotextile fabric, if being used, and fill remaining space of trench with stone.
- Accumulated sediment needs to be periodically cleaned out to allow the trench to function properly. The incorporation of non-woven geotextile fabric will decrease the frequency at which the trench needs to be cleaned.

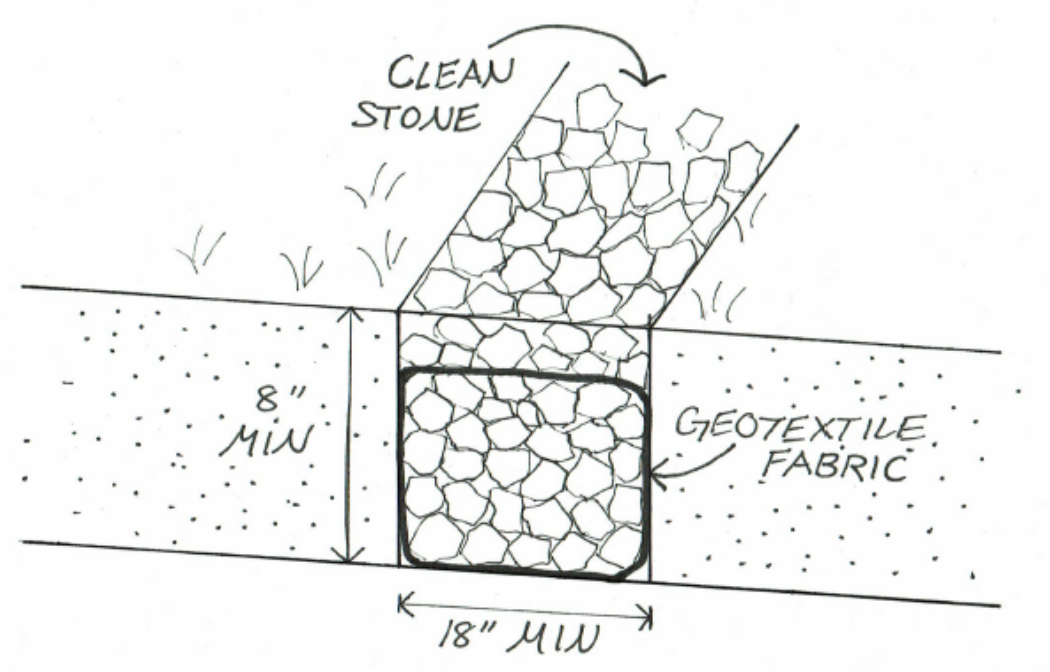


Figure 18: Infiltration Trench

Sub-Surface Drainage

French Mattress

A structure installed under a road, consisting of clean course rock wrapped in geotextile fabric through which water can pass freely, sometimes referred to as a rock sandwich. Useful in extremely wet areas, such as wetlands, to support roadbed while allowing unrestricted water movement. Further details on sub-surface drainage practices can be found in the US Department of Agriculture's Environmentally Sensitive Road Maintenance Practices for Dirt and Gravel Roads manual, a link is provided in the reference section on page 51.

- French mattress can be used in areas where concentrated outlet flow through a pipe is undesired, wetlands where installing cross drains would be impractical, and areas with a high water table.
- Use of a French mattress maintains dispersed flows and prevents gully erosion above or below the structure.
- A French mattress should NOT be used for concentrated overland flow, such as small stream channels or storm water from ditches.
- Install to match the slope of the land. In flat areas, a 1 to 2 percent slope should be used to aid drainage.
- Excavate material to desired depth and place geotextile fabric in trench, ensure there is enough fabric to wrap around the sides.
- Place porous stone on top of the fabric spread out in a uniform bed. Cover top of structure with fabric, be sure to overlap all joints by at least 12 inches.
- Compact at least 8 inches of fill over top of finished mattress.
- Requires no maintenance and has a long service life.

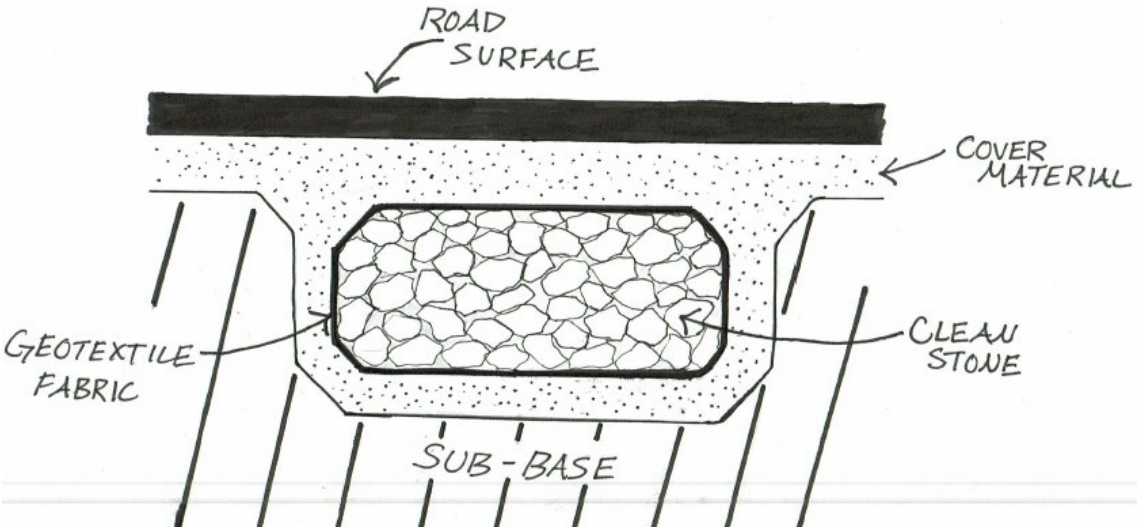


Figure 19: French Mattress

Underdrain

An underdrain is a drainage system installed under a road or road ditch to collect and transport subsurface water. These buried conduits come in a variety of shapes and sizes and are usually wrapped in geotextile fabric which allows water to enter the conduit while keeping sediment out.

- Underdrains can help dry out road base, ditches, and banks. Also prevent subsurface water from mixing with sediment-laden surface runoff during storm events.
- All underdrains should be installed with at least at 1% slope.
- Excavate a trench for the underdrain and line with geotextile fabric.
- Geotextile fabric allows water to pass through while blocking fine silt and clay which otherwise would eventually clog the underdrain.
- "Clean" stone is used for underdrains, the stone is relatively uniform in size, usually 1"-2" diameter, and has no fine material.
- Lay a bed of clean stone, place perforated pipe on top of it, and cover pipe with clean stone.
- Perforated pipe typically available in 4"- 6" diameter.
- Wrap the fabric around the stone to fully encase the drain.
- Place at least 12" of fill over the pipe, this prevents road surface runoff from entering the underdrain and protects the pipe from the weight of traffic.
- Water from underdrains should be outletted separately from road drainage, particularly if the underdrain is carrying spring water.

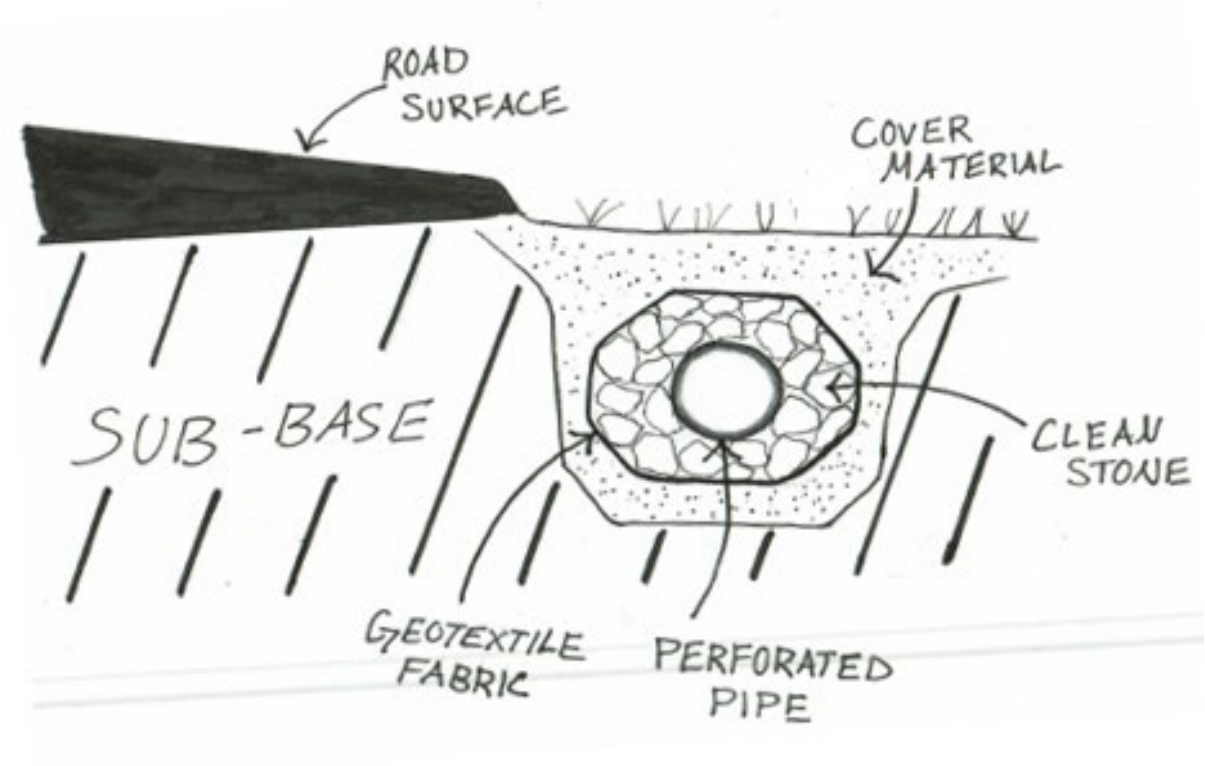


Figure 20: Underdrain

Culverts

Properly placed culverts will help alleviate ditch maintenance problems. When a smooth transition at the inlet/outlet is made and by being placed at the correct elevation. 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 the volume and velocity of discharges and reduce the amount of sediment entering the surface waters. Culverts preserve the road base by draining water from ditches along the road, keeping the sub-base dry.

Perennial Stream Crossings

Culverts, bottomless arches and other structures are used to allow roads to cross over perennial streams. Proper consideration of alignment, sediment control, and aquatic organism passage (mentioned in preceding section) is important to maintain the health and stability of a perennial stream.

Culvert Sizing

- Aquatic organism passage should be incorporated into design. Contact the regional River Management Engineer for engineering assistance and permitting.
- The culvert pipe length needs to be equivalent to the width of the road, plus the shoulder's width, plus 4 times the summation of the fill cover and diameter length.
    - In some cases, headwalls allow for shorter culvert length.
- Consider protecting culvert outlets from erosion and undermining by use of rock aprons, headwalls and wingwalls, and even plunge pools in certain scenarios.

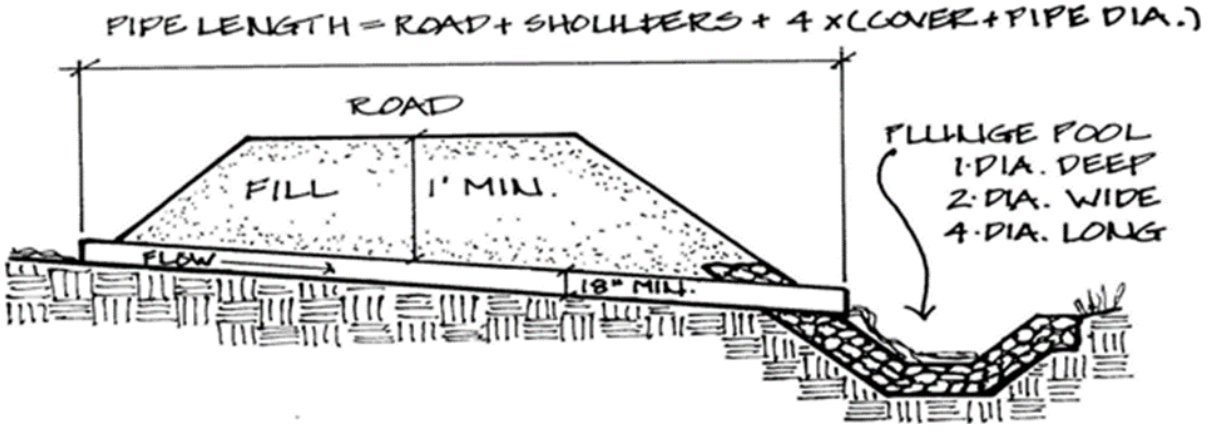


Figure 21: Required Culvert Length

Installation/Replacement

Culvert installation should occur during periods of low stream flow (Note: it is best to divert the flows while culvert is being installed to avoid sedimentation of the stream, otherwise known as a stream bypass). Stream alteration permit is required for work in perennial streams if culvert installation requires excavation or fill of more than 10 cubic yards.

- Minimize disturbance to the natural system and surrounding land.
- Install sandbag dams in the stream and use a pump, with riprap placed at the discharge, to convey the water around the excavation.
- Excavate the culvert area; remove the old culvert if doing a replacement.
- The bottom width of the culvert trench should be twice the width of the culvert, with sidewalls no steeper than 1:1.
- Excavate 10 feet downstream of the culvert discharge to a depth of 18" for riprap. Use erosion control precautions; permit may be required.
- Lay pipe up slope, starting at outlet end.
- The longitudinal profile should be set at the same slope as the natural stream gradient.
- Where possible, a minimum of 18"-24" of fill over a culvert is recommended.
- Place 12 inch minus riprap in the excavated outlet area tamping it level with the stream bottom.
- Place silt fence at the base of the bank slope and remove sandbag dam upon completion of installation.
- Seed and mulch all disturbed areas.

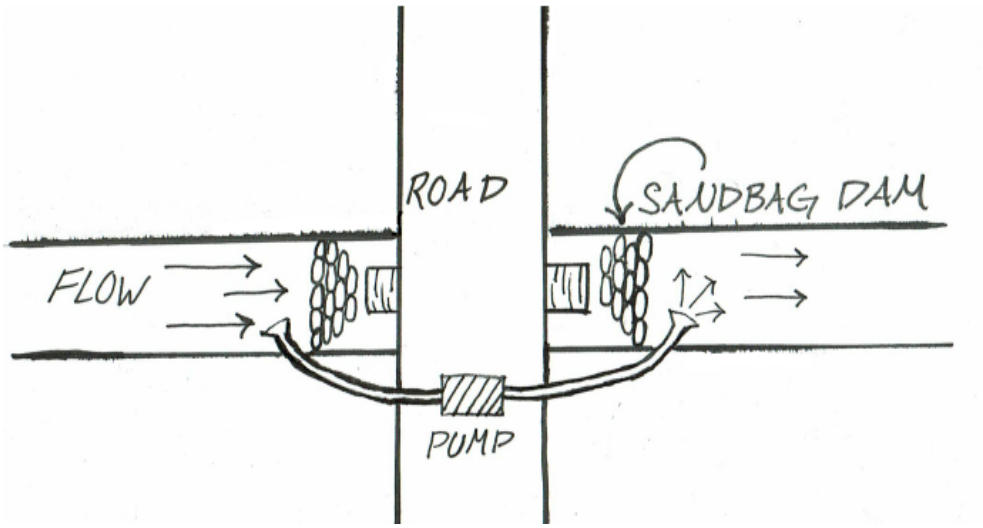


Figure 22: Culvert Installation

Aquatic Organism Passage (AOP)

A culvert installation should not change the conditions in the stream that existed prior to the installation. Any time a culvert is being installed in a stream, a regional River Management Engineer at the Agency of Natural Resources must be contacted to determine any requirements for a permit.

- Trout and other species move upstream or downstream, to spawn and meet other habitat needs.
- Culverts can impede fish passage by the following conditions:
  - Vertical barrier – if culvert is perched, fish won't be able to jump high enough to pass.
  - Water velocity is too fast over the given length of the culvert in relation to fish capabilities.
  - Inadequate water depth in culvert.
  - Icing and debris problems.
  - Culvert design does not accommodate for the size and species of fish passing through the structure.

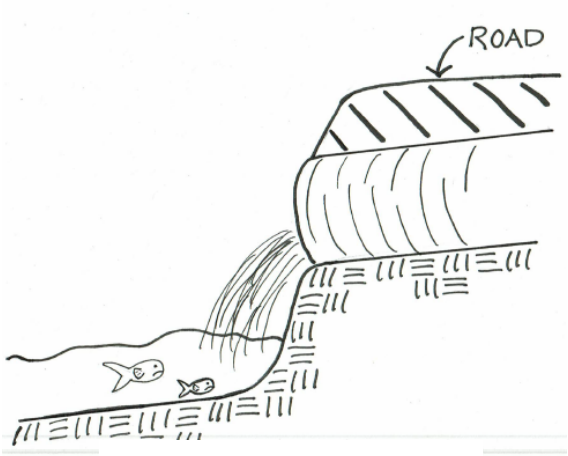


Figure 23: Impassible Barrier

- When selecting a new stream crossing site to install a culvert, the site should have no sudden increase or decrease in gradient and cannot be located near a bend in the stream. This will minimize the potential for frequent or difficult maintenance.
- Use bridges, bottomless arches or partially buried culverts in areas where fish passage is an important consideration.
- Corrugated culverts decrease water velocities and supply resting areas for migrating fish.
- Make sure culvert diameters are adequate to pass maximum expected design flows.
- Design culverts so that water velocities passing through the pipe are equal to water velocities in the stream.
- Provide resting pools at culvert inlet and outlet for culverts installed across streams with high gradients.
- Place riprap at upstream culvert end securely to avoid dislodging that may result in lower culvert capacity, high velocity flows, and reduced inlet efficiency.
- Minimize disturbances of soil and vegetation.
- Complete all work on culvert installation before diverting the stream back to the stream channel and through the culvert.
- Contact the regional River Management Engineer with sizing, design assistance and permitting. The River Management Engineer will coordinate projects with Vermont Fish & Wildlife.

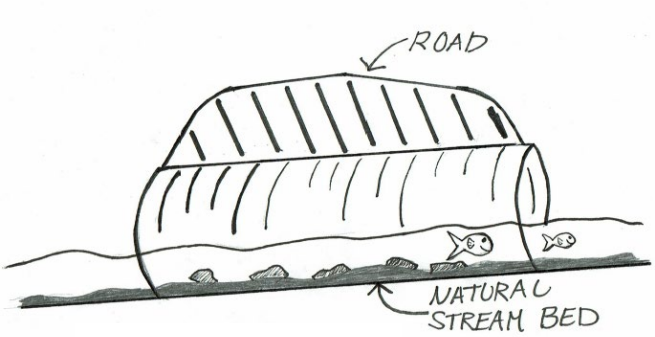


Figure 24: Proper AOP

Intermittent Streams, Drainage, and Driveway Crossings

This section pertains to crossings of channels that only have flow present for part of the year, not continuously flowing year-round. Therefore, all design sizing needs to be based on active channel measurements.

Culvert Sizing

- Culvert should be designed to handle at least a ten-year flood.
- Intermittent stream culverts should be sized to cover a width of at least the active channel width (i.e. 75% of bankfull width).
- A diameter of 18" is the minimum requirement for any intermittent stream or drainage culvert.
- A diameter of 15" is the minimum requirement for all driveway culverts.
- If field measurements of active channel width are not available, drainage area can be used to determine proper sizing. The Vermont Rivers & Roads Field Manual has a table of drainage areas and bankfull width and depth, a link to the manual can be found on page 51.
- Consider protecting culvert outlets/inlets from erosion and undermining by use of rock aprons, headwalls and wingwalls, and/or plunge pools.

Municipal Roads General Permit Policy

The MRGP requires that for driveway and drainage culverts, if any erosion is noted during the REI assessment, due to improperly installed, maintained, failing or undersized culvert; the culvert must either be retrofitted or replaced. If a new culvert is required, it must have a minimum 15" diameter for driveway culverts within the right-of-way, and 18" minimum for drainage culverts. Drive and drainage culverts located on roads slopes 5% or greater also require headers/headwalls and outlet stabilization. In many cases drive and drainage culverts are actually intermittent streams and require diameters larger than the minimum requirement. It is recommended sizing new intermittent stream culverts based on the "active channel" shown in Figure 25.

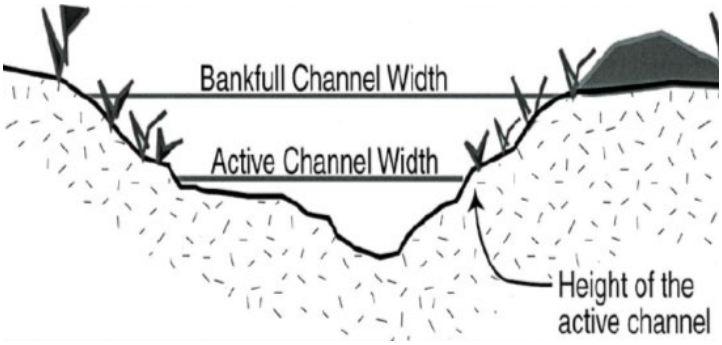


Figure 25: Channel Width Dimensions

Installation/Replacement

- Minimize disturbance to the natural system and surrounding land.
- If any flow is present, install sandbag dams in the stream and use a pump with riprap placed at the discharge to convey the water around the excavation.
- Excavate the culvert area; remove the old culvert if doing a replacement.
- The bottom width of the culvert trench should be twice the width of the culvert, with sidewalls no steeper than 1:1.
- Excavate 10 feet downstream of the culvert discharge to a depth of 18" for riprap; a stream alteration permit may be required.
- A 0.5% slope is the minimum to allow for positive drainage flow and should be used in all culvert designs except equalizers.
- Set grade to where the outlet can discharge to the existing ground; if this is not possible, use a flexible slope drain and a sediment basin.
- Outlet culvert to a vegetated area if possible – never directly into a stream.
- A minimum of 18"- 24" of fill over a culvert is recommended.
- Place 12 inch minus riprap in the excavated outlet area tamping it level with the stream bottom.
- If flow is present, place silt fence at the base of the bank slope and remove sandbag dam.
- Seed and mulch all disturbed areas.

Municipal Roads General Permit Policy

Intermittent streams and their related infrastructure are covered under the MRGP unlike perennial stream structures. All new construction on intermittent stream culverts need to be at least 18" in diameter and recommends that it matches active channel width. New driveway culverts require a minimum of 15" diameter and recommend 18".

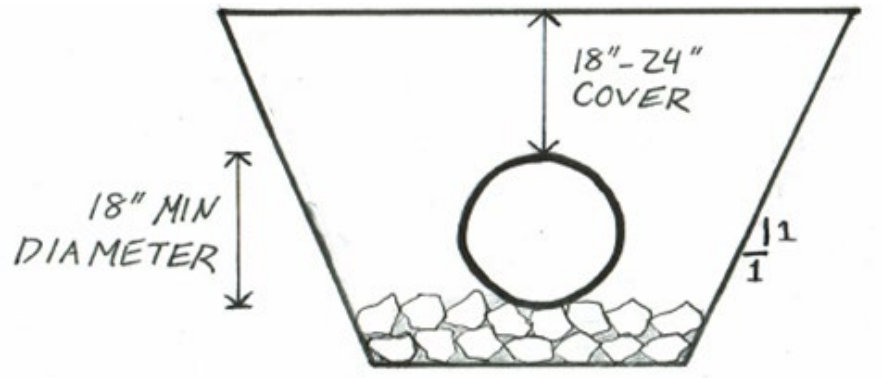


Figure 26: Culvert Installation

Cleaning and Maintenance

Avoid clogging, collapsing, washouts, and settlement by practicing preventative maintenance.

- Mark or keep inventory of culverts, so they do not get missed during inspections.
- Check culverts during freezing weather and act if the culverts start to freeze.
    - Thaw frozen culverts by using steam, high-pressure water, ice augers, and/or calcium chloride.
- A high-pressure hose can be used to flush most plugged culverts (with water).
- Flush culverts from outlet end.
- Clean the outlet ditch after flushing.
- 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 the bedding and the culvert will fail (e.g. piping).
- Replace culverts with the same size pipes if it already meets the sizing requirements.
- Increase culvert size as development along a road increases or if the culvert is more than half full during high flows.

Culvert Inspection

Road foremen continuously need to fix or replace culverts to ensure their town's roadside stormwater systems is performing properly. It is important to know the cause of a failing culvert, so the culvert can be repaired or replaced appropriately. Use the *Culvert Maintenance & Inspection Chart* on page 30 to help you recognize the signs that indicate maintenance or replacement of a culvert is required and to prioritize your culvert projects.

- Inspect culverts as often as possible, but at least in the spring, fall, and after major storms.
- Inspect underdrains and keep outlets of underdrains clear.
- When considering an in-stream culvert replacement or upgrade, check with River Management Section at the Agency of Natural Resources to see if geomorphic assessment data is available for that particular stream.

Culvert Inspection & Maintenance Chart

What You Observe…	What May Be The Reason	How To Fix It…
Scouring/erosion at the inlet	- ditch too steeply graded - poor location/alignment - culvert is plugged - culvert is too small	- line the inlet with stone - properly align the culvert - clean/flush the culvert - replace with larger culvert - install headwalls
Scouring/erosion at the outlet	- culvert is sloped too much - culvert is too small - culvert is too high above ground (perched)	- decrease slope of culvert - check size and replace with larger pipe if necessary -build a stone splash pad
Ponded/puddled water	- inlet is too high - ditch grade is too flat - culvert is too small	- reset culvert to match the inlet to the channel bottom - regrade ditch to maintain correct flow - install larger culvert
Dented/crushed ends	- traffic/snow plows are hitting the ends	- fix culvert ends and mark them - install stone header to protect from damage - add extension to lengthen culvert
Heavy corrosion	- water flowing through the culvert is acidic	- install a sleeve of PVC in the existing culvert or replace the steel culvert with a non-corrosive material (PVC, aluminum, concrete)
Water piping around the culvert	- culvert is incorrectly installed, resulting in water flowing outside the culvert	-reinstall pipe with proper bedding and compaction - install a headwall
Sediment build up in culvert	- not enough slope -an erosion source exists uphill from culvert	- reinstall culvert with a slope of at least ¼” per foot -locate a stabilize uphill erosion site
Sediment build up above culvert inlet	- culvert is too small - an erosion source exists uphill from culvert	- replace existing culvert with a larger one - locate and stabilize uphill erosion site
Objects blocking the culvert	- debris traveling from the ditch to culvert	-remove blockage - install check dams uphill of culvert
Sagging bottom	- foundation material has settled or has low bearing capacity - bottom of culvert has rotted out	- reinstall culvert with suitable and properly compacted foundation material -replace culvert

Crushed top	- not enough cover - soil around the walls not compacted -traffic loads are too heavy	- add cover - reinstall culvert deeper and/or with suitable and properly compacted bedding material - replace with stronger culvert
Eroding side banks at culvert inlet and outlet	- culvert improperly aligned with water flow - culvert is too small	- realign culvert to match flow of water - replace existing culvert with a larger one -install headers and wing walls
Water backed up at culvert inlet	- culvert is too small	- replace existing culvert with a larger one
Culvert is narrower than “bank full” width of live stream	- culvert is too small	- measure the “bank full” width or channel width about 50 feet upstream of the culvert and install a new culvert at least as wide in diameter
Culvert has washed out	- culvert is too small, at the wrong angle to the road, has unstable or nonexistent headers	- replace existing culvert with a larger one - install headers on new culvert - do not reinstall the same culvert or a new one that is the same size as the one that was washed out

Conveyance Zones

A conveyance zone is an area where the outlet of a drainage ditch or the turnout of a drainage ditch, meets with a waterway (the graphic below highlights the areas that would be defined as conveyance zones). Road drainage should be disconnected from waterbodies whenever possible and flow in a distributed manner to a grass or forested filter area.

Municipal Roads General Permit Policy

The MRGP requires a turnout, that is approaching a waterway (creating a conveyance zone), to be stabilized according to slope. Road embankment slopes less than 5% are to be grass-lined, where the slope is 5% or greater, stone-lining is necessary

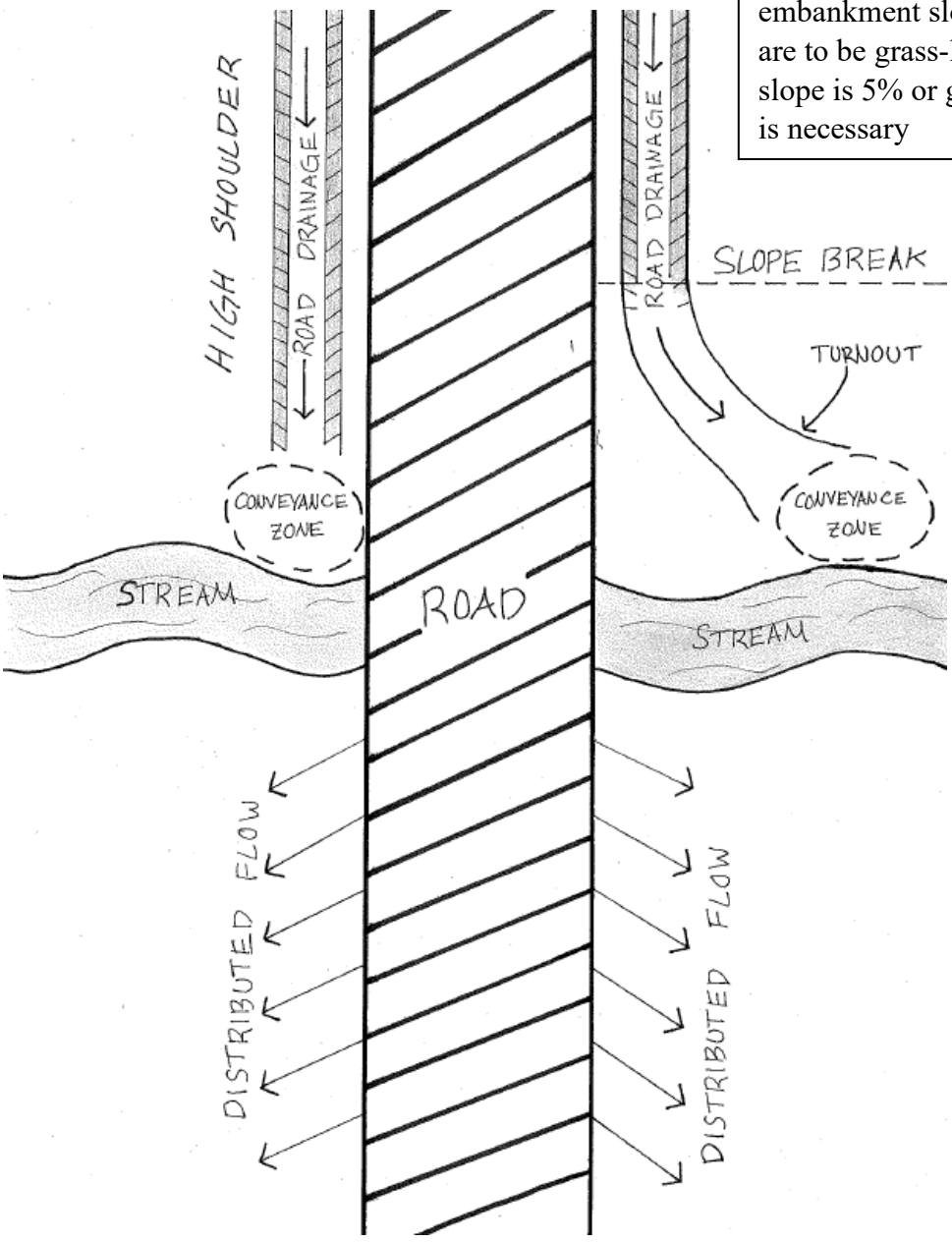


Figure 27: Conveyance Zones

Outlet Structures

Outlet structures are used to discharge water from a ditch or culvert. There are a variety of types of outlet structures.

Outlet structures reduce the velocity of water carried by road ditches and culverts, therefore helping to control sedimentation. Water should outlet to some vegetative filter zone and/or outlet structure with a moderate slope before entering surface waters. This type of outlet, often referred to as ***daylighting,*** will allow for pollutants to be removed before runoff enters surface waters

Municipal Roads General Permit Policy

The installation of a culvert outlet structure is required for drainage and intermittent stream crossing culverts if any erosion is present. Outlet treatment is also required on any new construction on road slopes 5% or greater.

Turnouts

Extensions of ditches which direct water away from the road edges to filtering areas whenever possible. Use of turnouts will not only protect water quality but, will also collect gravel for reuse.

- Turnouts should be stabilized as to not create additional soil erosion.
- Use only in areas where the water will flow to a filtering area well away from the road and surface waters.
- The MRGP has specifications on adequate outlet protection of the turnout depending on the slope and should be followed on all road segments.
- Turnouts are similar to but, separate than a *cut out.* A cut out entails the cutting of a high shoulder to divert water out of the ROW.
    - Should only be used as a last resort, such as between large trees, stone walls, or other shoulder obstructions.

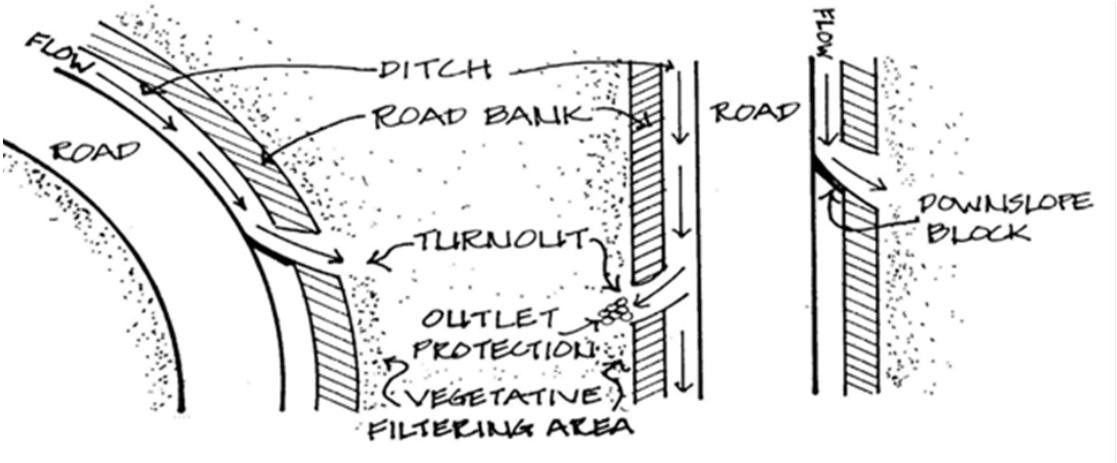


Figure 28: Turnout

Rock Apron

An area lined with riprap used to transition discharging water from culverts to existing ground.

- Provides outlet protection by reducing water velocity and promoting sheet flow.
- Use only where there is adequate vegetative filter strip.
- Discharging of a culvert to a slope will require a conveyance channel before the water reaches the rock apron.
- Size and placement of riprap in the apron is dependent upon the diameter of the culvert and expected water flow traveling through it.

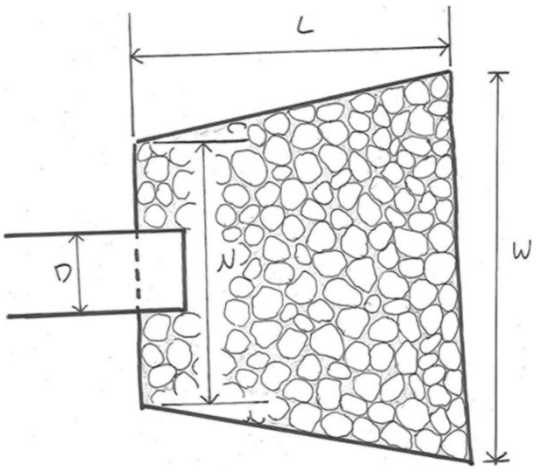


Figure 29: Rock Apron – Plan View

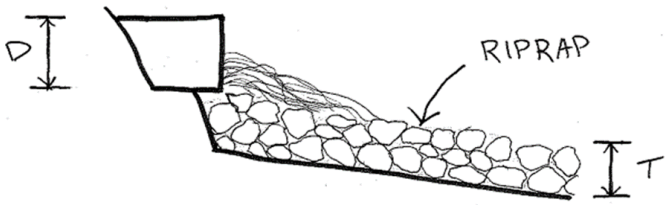


Figure 30: Rock Apron – Section View

D = diameter of culvert
N = width of apron
W = width at downhill end of apron
L = length of apron
T = depth of stone in apron

Splash/Plunge Pool

Riprap basin located at outlet of a culvert pipe.

- Used to remove sediment by absorbing energy from flowing water and allowing sediment to settle out. Useful in area without adequate vegetative filter strips.
- Limited to areas with less than a 10% slope.
- Consolidates sediment for easier removal.
- Reduces energy and velocity of flows by providing storage for runoff.
- Can allow for ground water recharge.
- Clean when pool is 1/3 filled with sediment.
- Locate the pool so that mechanized cleaning is possible.
- See pool capacity requirements chart for sizing on page 35.

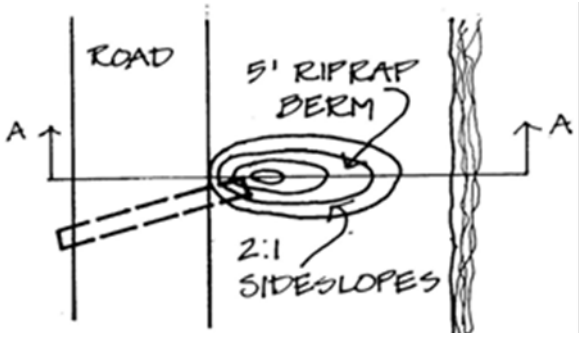


Figure 31: Plunge Pool

Figure 32: Plunge Pool – Section A-A View

Splash/Plunge Pool Capacity Requirements				
Distance Between Culverts (ft.)	**Pool Capacity (ft^3)**			
	Crowned Road		**Banked Road**	
	Depth (ft)	**Diameter (ft)**	**Depth (ft)**	**Diameter (ft)**
500	4.75	9.5	6	12
400	4.5	9	5.5	11
350	4.5	9	5	10
300	4	8	5	10
250	4	8	4.75	9.5
200	3.5	7	4.5	9

Headers

Headers or headwalls prevent erosion around the culvert inlet, mark the location of a culvert, and protect the culvert from damage. Headers will also increase hydraulic efficiency by helping direct the flow of runoff into the culvert.

Municipal Roads General Permit Policy

The installation of a header or headwall is required if rill or gully erosion is present in that area. A header/headwall is also required when installing new culverts with road slopes of 5% or greater.

- Headers can be used when hydraulic efficiency needs to be improved by 10% or less and installing a header would be easier than replacing the culvert.
- Headers should be flush with the end of the culvert.
- Dry laid field stone is recommended for headers. It has historically been used in many areas for over 100 years, align with Vermont's character, and are aesthetically pleasing.
    - Ditch stone or poured concrete may also be used.

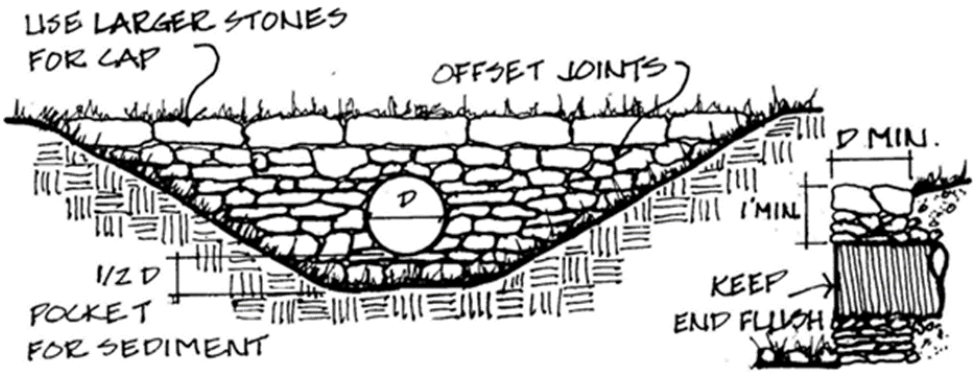


Figure 33: Culvert Header

Bank Stabilization

Bank stabilization is the vegetative or structural means used to prevent erosion or failure of any slope. These terms have different definitions as well as different causes. Erosion occurs when soil particles are carried away, directly caused by any of the following: wind, water, ice, and gravity. It is indirectly caused by such things as: obstacles in a stream, overbank drainage, heavy rainfall on exposed soil, freeze-thaw and dry cycles, seepage, and changes in land use. Failure of a bank occurs when a section of the bank slides. Bank failure is caused by: increase of load on top of the bank, swelling of clays due to absorption of water, pressure of ground water from within the bank, minor movements of the soil or creep, and changes in stream channel shape.

Figure 34: Hydroseeder attached to truck

Stabilization of banks along roads and streams will prevent bank erosion and failure, both of which may contribute considerable amounts of sediment to surface waters. Also, erosion and bank failure often lead to the need for expensive road repair, thus preventing these events will save money.

Vegetation - Seeding

Seeding is the most efficient and inexpensive method to stabilize a bank and should be used wherever possible.

- Grass will slow the movement of water, allowing more water to seep into the ground and minimizing the impact of runoff to surface waters.
- Seed areas immediately after disturbances, even if the project is not yet completed, especially if rain is forecasted within the next 5 days.
- Place sod in areas with unstable soil immediately.
- Areas that are to be seeded should have maximum 2:1 horizontal to vertical slope.
- Erosion control blankets (rolls of degradable netting embedded with hay or straw) can be used on steep slopes to better hold seed and soil in place.
- Final grading should be done after topsoil is spread.
- Fertilize and lime the area as needed according to the soil conditions.
- Harrow or rake fertilizer and lime into soil to a depth of at least 2 inches.
- The surface should be left rough to reduce water velocity and to help hold seed and mulch.
- Select a seed mixture appropriate for site soil and drainage conditions, “conservation mix” is suitable for most areas.
- Broadcast seed evenly over the prepared area either by hand broadcasting or hydroseeding.

- Hydroseeding is done using a truck with a mounted sprayer that broadcasts a mixture of seed, mulch, and tackifier.
- Mulch after seeding with hay or straw to a depth of 3 inches. This can be done by blowing it on from a truck or by hand spreading. If no mulch is to be applied, roll, rake, or brush to lightly cover the seed.

Grading Techniques

Proper grading or regrading of slopes can often stabilize banks without the use of structures. There are a variety of techniques that can be used depicted in Figure 35.

Terracing

Benches can be constructed on slopes that are excessively steep and long to provide near level areas that intercept and divert water.

- Backslope terraces inwards toward the slope to intercept water and prevent erosion.

Counterweight

A one level bench and slope that can be added next to a steep failing bank to hold the bank up and prevent continued sliding.

Cut and/or Fill

The removal or addition of soil to the bank to create the desired 2:1 or flatter slope, often removing less stable soils and replacing them in the process of regrading the slope.

Notching or Keying

A "V" or trapezoid shaped cut made in the existing ground to help further stabilize the slope.

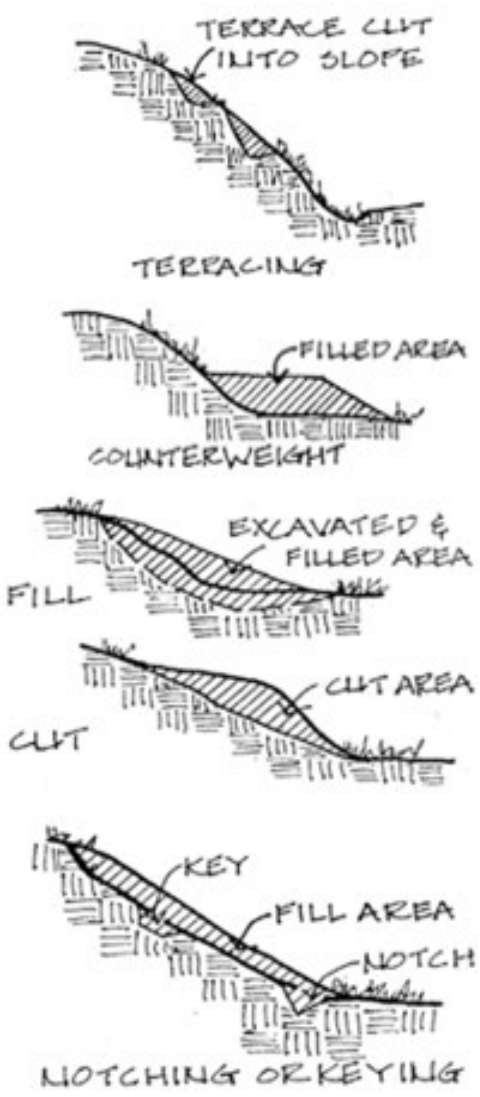


Figure 35: Grading Techniques

Log or Timber Cribs and Live Cribs

A structure made of logs or treated timber and filled with soil to be used as a retaining wall. Incorporate live branches in the crib as used in brush layering to make a live crib.

- Use at the base of a slope where a low wall (no higher than 6 feet) is required.
- May also be constructed in a step fashion, creating additional planting areas.
- Branch cuttings should be long enough to reach the undisturbed soil at the back of the crib.
- Place logs or timbers in an alternating manner, leaving space for live branch cuttings.
- Cover each layer of branches with a layer of compacted soil.
- Timber provides structural support while plants take root.
- Uses half the amount of wood compared to log or timber cribs, making it less expensive.

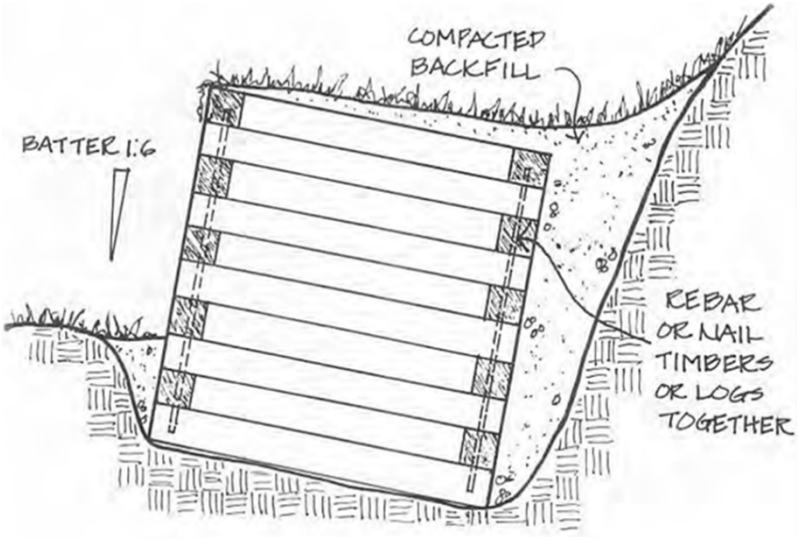


Figure 36: Log or Timber Crib

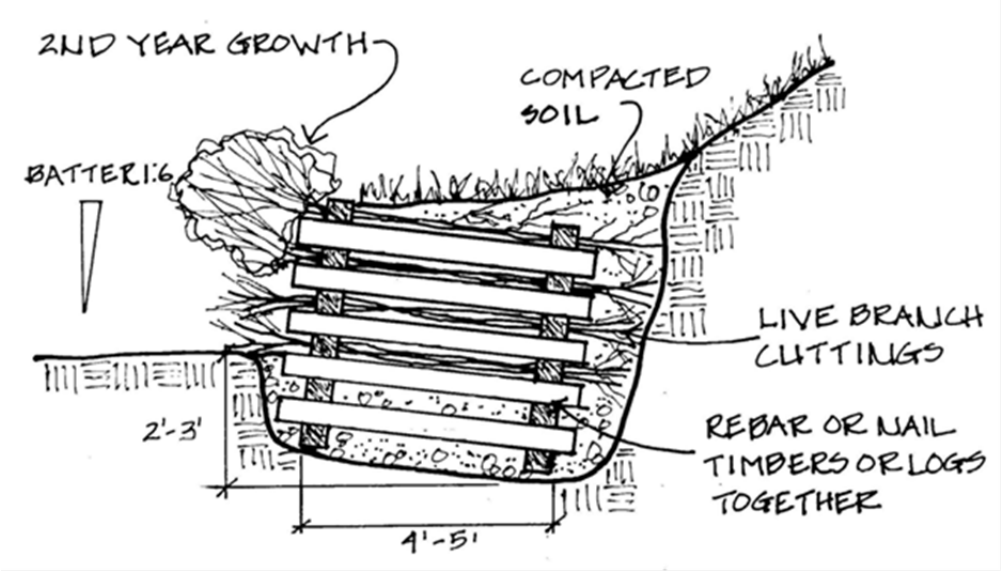


Figure 37: Live Crib

Erosion Control Mats and Blankets

Erosion control mats and blankets are used to prevent erosion on steep slopes, in ditches with high water velocities, and other areas prone to erosion. Types of mats and blankets include jute matting and mulch blankets.

Jute Matting

Undyed jute yarn, woven into an open 1-inch square weave mesh.

- Spread over seeded and mulched areas to hold in place. Only use matting with non-fixed net joints near water so animals can't become trapped in the matting.
- Burry the up-slope end of each section in a 6-inch vertical slot, backfill, and tamp.
- Overlap each up-slope section with 12 inches of mat.
- Overlap side-by-side sections by 4 inches.
- Securely anchor mat with stakes and/or stables.

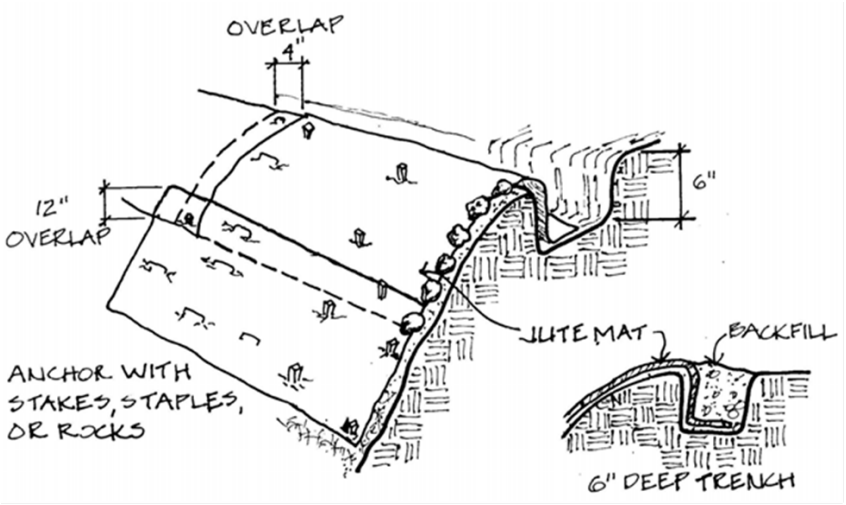


Figure 38: Jute Matting Installation

Mulch Blankets

Straw, coconut, or wood fibers sandwiched between biodegradable natural fiber.

- Use in areas where it is difficult to hold mulch in place and there is potential for erosion until vegetation is established.
- Place after area has been seeded.
- Place lengthwise along direction of the slope and secure with staples.

Vegetation – Shrubs and Trees

Shrubs and trees can be used to stabilize steep slopes and stream banks and create a good vegetative filter strip.

- Deeply rooted woody species provide greater protection against bank erosion problems.
- Identify other plants in the area to determine the most suitable plants for stabilization.
- Commonly used stabilization plants include: willows, alders, and dogwoods.
- Techniques for stabilizing banks with woody plants include live fascines/wattles/bundles, live stakes, brush layering, and sprigs/plugs.

Live Fascines/Wattles/Bundles

Long bundles, 5 to 30 feet in length and 6 to 8 inches in diameter, of live branches tied together with growing tips oriented the same direction and tops evenly distributed through the length of bundle.

- Place in 12 to 18 inch deep trench dug along the contour of the slope, working from the base of the slope upwards.
- Secure with live stakes and dead stout stakes.
- Install bundles the same day as cut during dormant periods (spring, winter, or fall).
- Can be used on steep slopes (1:1) and can protect slopes from shallow slides.

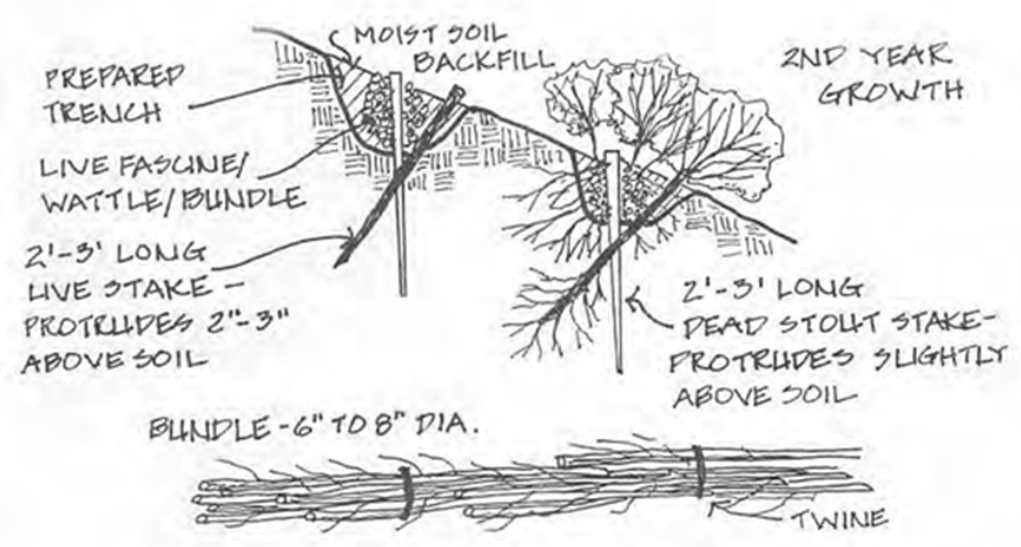


Figure 39: Live Fascine/Wattle/Bundle

Live Stakes

Cutting of live branches, usually ½ to 1-½ inches in diameter and 2 to 3 feet long.

- Inexpensive method that can be used when time is limited, and the site is relatively uncomplicated.
- Branches should be cleanly removed from the stake and basal ends of stake cut at an angle for easy insertion into the soil.
- Stakes are tamped into ground at right angles to the slope along the contour with buds oriented up.
- Plant in an alternating grid with 2 to 4 stakes per square yard (shown in Figure 42).
- Plant stakes the same day as cut during dormant periods (spring, winter, or fall).

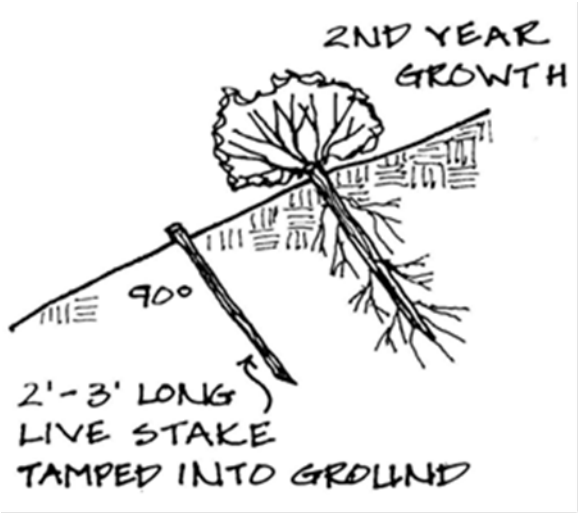


Figure 40: Live Stake

Brush Layering

Live branches, 1/2 to 2 inches in diameter and 3 to 4 feet long. Used to break up slopes into a series of shorter slopes.

- Small 2 to 3 feet wide benches, angled slightly higher at the outside, are excavated along the contour starting at the toe of the slope and working upward.
- Branch cuttings are placed perpendicular to the slope with the growing tips outward.
- Branch cuttings are placed on the bench in a crisscross or overlapping manner.
- Backfill on top of the branches and compact.
- Plant branches the same day as cut during dormant periods (spring, winter, or fall).

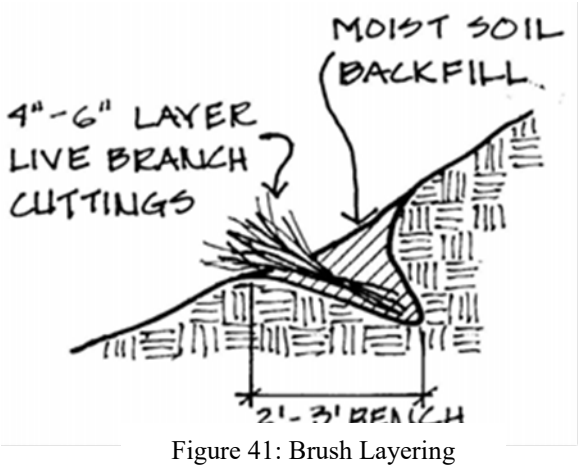


Figure 41: Brush Layering

Sprigs/Plugs

Individual plant stems with roots – can be seeding or rooted cuttings.

- Place in a hole that is dug large enough to accommodate the roots and tamp the soil down around the plant.
- Plant in alternating grid with plants ½ to 1 yard or meter apart.
- Often used on filled slopes in conjunction with special fiber rolls.
- Rooted shrubs from a nursery may also be planted and are more reliable, but more expensive.

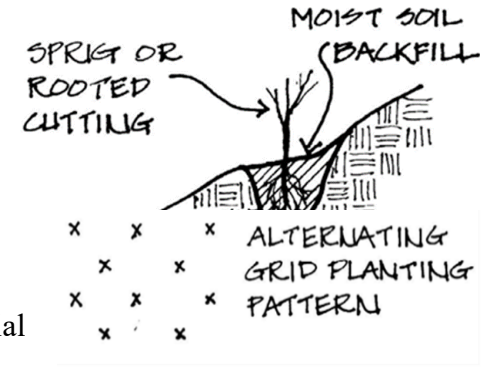


Figure 42: Sprigs/Plugs

Stacked Rock Wall

Placed riprap wall with steep slope at toe, allowing for full bankfull channel width to be maintained. A combination of rocks and live branches, as used in brush layering, can be used.

- Stone toe wall shall be constructed with stones with an immediate diameter no less than 3 feet.
- Wall shall be constructed with staggered joints between rocks on adjacent tiers.
- Footer rocks should be embedded below the channel at least 4".
- Place rocks with long axis slanting inward toward the slope.
- Can backfill between each layer of rocks and place live branch cuttings on backfill.
- Cover with soil and compact.

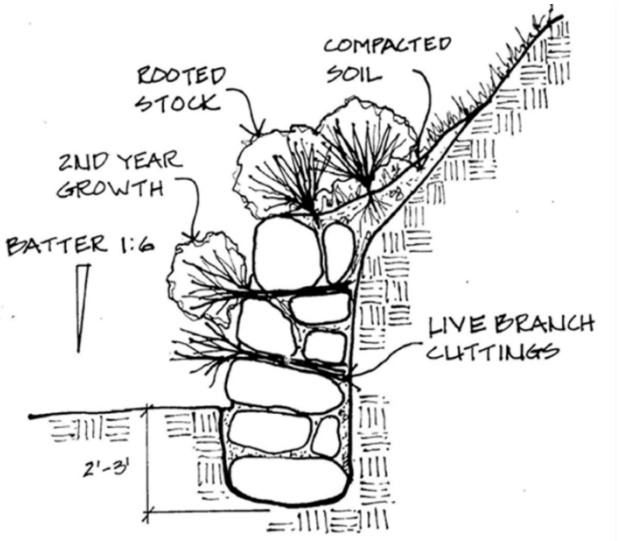


Figure 43: Stacked Rock Wall

Vegetated Riprap

Combines a riprap revetment with the tamping of live stakes between the joints or open spaces in the rocks.

- Live stakes must be long enough to extend well into the soil below rock surface.
- Roots improve drainage and create a mat that binds and reinforces the soil, preventing washouts and loss of fines between and below the rocks.

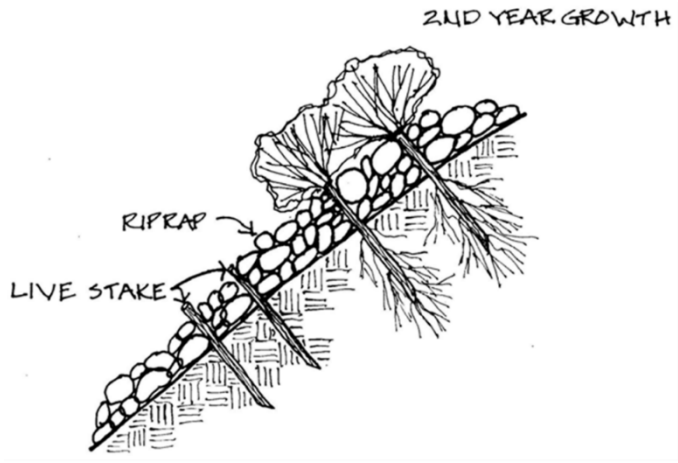


Figure 44: Vegetated Riprap

Riprap Revetment System

Riprap can be carefully placed on bank slopes and stream edges where vegetation does not adequately prevent soil loss leading to erosion and filter sediment out of water.

- Used on very steep slopes, at sharp turns in streams, and where a bridge or culvert restricts water flow.
- Size of riprap wall is dependent on quantity and velocity of water. Stones immediate dimensions shall not be less than 3 feet.
- Use angular riprap stone. Slate or round stone will slide too easily.
- Consider planting vegetation at the top of the bank, above the high water level, stabilizing with riprap at toe of the bank where moving water will flow.
- Always contact a Stream Alteration Engineer at the Agency of Natural Resources before installing riprap on a streambank.
- Recommend grubbing over stone fill areas above ordinary high water line.

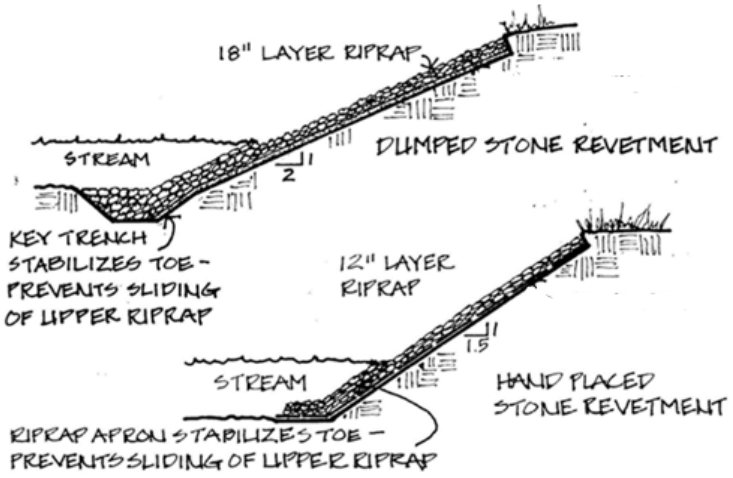


Figure 45: Riprap Revetment System

Encapsulated Soil Lifts

Involves the "encapsulation" of soil in biodegradable blankets that are then folded creating layers or lifts. Originally designed for lake shore stabilization projects but, can be used in a variety of scenarios.

- Use on heavily eroded or steeply sloped areas.
- Establish rock base using 6 to 8 inch rocks, sites with higher energy from water should use larger rocks.
- Geotextile should be placed from end to end of lifts to line shore and are then backfilled with soil to create levels 6 to 8 inches high.
- Tiers should stagger back roughly 12 inches creating soft slope.
- Seed and plant shrubs between each layer of soil lift.
- 12 to 15 inch rocks should be placed at base of lifts to stabilize until plant roots are established.
- All exposed soil should be seeded and covered with biodegradable erosion control fabric.

Buffer Zone

Undisturbed vegetated areas that separate roads, development, or construction sites from sensitive areas such as streams, wetlands, and lakes.

- The preferred method of slowing and filtering stormwater before it enters surface waters.
- Roughness of the vegetation slows stormwater flow and reduces its erosive power.
- Vegetation acts as a natural filter by intercepting sediments, nutrients, and other pollutants that may be in stormwater.
- Buffer zones are not intended and should not be used for treatment of channelized flow.
- Provides shade and habitat for birds and other wildlife.
- Can help stabilize banks and absorb floodwaters.
- Does not require any maintenance.

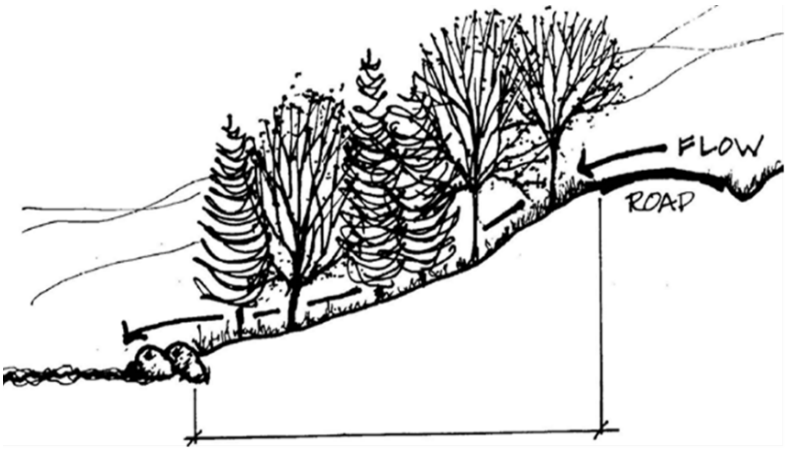


Figure 46: Buffer Zone

Vegetation Management

Roadside trees not only help hold soil and stabilize banks with their roots, but also offer different benefits throughout the seasons. Tree canopies provide cooling shade in the summer, act as living snow fences in the winter, and produce beautiful foliage in the fall. Roadside trees also encourage traffic calming, thus slowing motorists down and contribute to the community by instilling a sense of pride in the residents.

Trees growing alongside the road are exposed to many more stresses than forested trees. Root and trunk injuries are common during plowing, grading, and ditch work. Roadside trees are also exposed to an increased amount of salt due to winter road maintenance. The road crew has the important job of balancing the need for proper road maintenance and erosion control to protect surface waters, while still trying to maintain the aesthetic qualities of Vermont's backroads.

Municipal Roads General Permit Policy

There are certain instances and site conditions that might prohibit the full or partial installation of the required MRGP standards. These instances include: when the implementation of a standard requires the condemnation of private property (or formal easement); impacts to significant environmental and historic resources, including historic stone walls, historic structures, historic landscapes, or vegetation within 250 feet of a lakeshore; impacts to buried utilities; excessive hydraulic hammering of ledge and the acquisition of additional state or federal permits.

Roles and Responsibilities

Vermont Statutes Title 24 Chapter 67 V.S.A. 871 places all shade and ornamental trees within the limits of public ways under the control of the tree warden.

- Only the tree warden, deputy tree warden, or someone with his or her permission may cut a public shade tree. One may remove diseased, dying, or dead trees which create a hazard to public safety or threaten the effectiveness of disease or insect control programs at any time.
- Healthy public shade trees in the residential part of town shall not be felled without a public hearing by the tree warden.
- The tree warden may also plan and implement a town shade tree preservation program by planting new trees and shrubs and maintaining healthy ones.

Roadside Tree Best Management Practices

- Road crew should work with the tree warden to identify and remove hazard trees.
- Avoid grading near tree trunks and under the tree canopy, if possible, to prevent damaging root systems.
- Roots that are exposed during grading or excavating should be cut cleanly to promote quick wound closure and covered with soil, mulch or burlap as soon as possible.
- Prune trees during the dormant season when possible. When pruning limbs, cut limbs at a slight angle and do not leave a stub.
- Do not prune trees with a flail mower or boom arm mower.
- In heavily wooded areas, consider thinning the roadside trees by selecting the best trees to retain and cutting competing trees.
- Replant areas where trees are removed for construction purposes to provide for a new canopy and revegetation.
- For more information or questions regarding roadside trees, please contact the Vermont Urban and Community Forestry program.

Aesthetics

Road maintenance can sometimes appear messy and unsightly to the town residents. Performing maintenance and practicing good erosion control techniques during and after construction can help alleviate these concerns. Making the scenery more attractive, leads to the public being happier about the care their roads are receiving. This in turn makes the public more supportive of the needs of the road crew in maintaining town roads properly. Respect and attention to the historic and aesthetic characteristics of the road can also help keep town residents happy.

- Rebuild any stonewalls that must be removed for road construction or ditching.
- Using stone culvert headers is aesthetically pleasing and in keeping with the rural character of Vermont's road system.

Highway Access Policy

Vermont Statutes, Annotated, Title 19, section 1111 requires all individuals and corporations to obtain a permit to occupy or alter any part of a municipal highway right-of-way. Such permits are commonly referred to as "access," "curb cut," or "driveway" permits and are issued by the municipal legislative body (Selectboard, City Council, etc.) or its designee.

The Vermont League of Cities and Towns (VLCT) has developed a Model Access Policy and Model Access Forms to assist municipalities in carrying out the requirements of 19 V.S.A. § 1111, that is available on the VLCT website. Having a clear policy that spells out the process and standards in place ensures that all applicants for access permits understand what is required of them and that all applicants are treated fairly and consistently.

Nineteen V.S.A. § 1111 precludes municipalities from denying an access permit unless the legislative body, or its designee, finds the request "unreasonable." A permit application may be deemed unreasonable if it does not adequately: (1) protect the safety of the traveling public; (2) maintain reasonable levels of service on the existing highway system; (3) protect the public investment in the existing highway infrastructure; or (4) comply with the planning goals of 24 V.S.A. § 4302 and any regional, state, or approved municipal plan.

Driveways and private access roads can have a significant negative impact on municipal highways in the following ways:

- Water running down a driveway or private access road directly onto the public highway can erode the shoulder and road surface.
- Improperly installed driveways and private access road culverts that are too small, unstable, or improperly installed can impede the flow of water in a roadside ditch and can cause the road surface to wash out or driveway culvert to blowout, resulting in damage to the municipal highway.
- Poorly constructed driveways and private access roads can be a continual source of erosion, clogging municipal ditches and culverts and contributing to the sedimentation of surface waters.

To help municipalities establish minimum standards for the design, construction and maintenance of driveways and driveway structures, and comply with requirements of the VTDEC Municipal Roads General Permit, VLCT's Water Resources Assistance Program developed a guidance document containing sample drainage management standards for municipal highway access policies that is available on the VLCT website. Municipalities can use these standards to customize the VLCT Model Access Policy and Model Access Forms linked above, or their own existing access policy or ordinance.

Beavers

Beavers play an important role in Vermont's natural landscape by creating pond and wetland habitat. But, beavers can create problems for road crews by building dams that block culverts and by impounding water that can be released during a flood, releasing massive amounts of sediments and washing out roads and bridges. This becomes a recurring problem since beavers tend to rebuild dam after dam at the same location. Prior to addressing a beaver conflict, it is important to consider the following:

- Whether the beaver conflict threatens public safety/welfare and public or private property.
- What practice would be best applied to solve the problem.
- Solve the problem while doing the least amount of environmental damage.
    - In some cases, the best solution is to simply ignore the problem.
- Minimize potential conflicts with adjacent and downstream landowners.

Beaver problems should first be brought to the attention of a Fish & Wildlife warden, an ANR regional office close to the problem site, Wetlands office, or Wildlife Services. If a problem cannot be fixed by a landowner conducting preventation or management techniques a warden or ANR representative will be necessary. Reference Vermont Fish & Wildlife Department for best management practices and further implementation descriptions on how to handle human-beaver conflicts. In recent years, methods have been developed to deal with the beavers other than dismantling dams or extermination.

Conflicts with Obstructed Culverts or Beaver Dams Less Than 2 Years Old

Exclusion Devices

- A fence around the opening of a culvert can be constructed as an exclusion device to block beaver access to culvert.
- Fencing should consist of galvanized farm panels that are 16' long, 48" tall, with 4x4 inch openings, and made of heavy duty steel.
- Prior to pounding in posts, test post locations to ensure no rocks or debris will get in the way. Metal T posts can be used in place of cedar posts if bottom is too rocky.
- Fencing should be attached to posts around the outside before being put in water and 4" spikes should be left at bottom of fence to be inserted into the ground.
- Spruce 2x4's should be used to brace the cedar posts. The fencing should then be attached to the 2x4's using 1 – ½ inch barbed galvanized fence staples.
- Refer to Vermont Fish & Wildlife Department for further BMP's on exclusion devices.

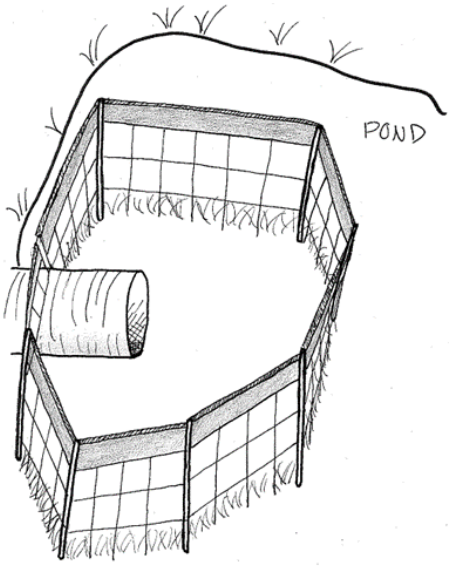


Figure 47: Beaver Exclusion Device

Obstruction Removal

- Dam alteration or removal has the potential for flooding adjacent and/or downstream properties, all parties whose land can be affected by alteration must be notified.
- First, the water level of the beaver impoundment must be lowered using a pump or siphon.
- Water level must be reduced gradually so that the impoundment is not lowered more than 1 foot per day.
- If no imminent hazard exists, dam removal shall take place only between June 1st and October 1st, for the protection of spawning trout or salmon and their eggs or fry.
- Immediately after dam removal, exclusion devices or water control devices should be installed.
- Refer to Vermont Agency of Natural Resources Fish & Wildlife Department "Best Management Practices for Human-Beaver Conflicts" for further instructions on proper installation and use of siphon or pump.

Conflicts with Established Beaver Dams (>2 Years Old)

- In most cases involving well-established beaver dams, a site visit by one or more representatives from the Agency of Natural Resources will be necessary.
- If dam poses a threat, obstruction removal may be necessary. One should refer to prior Obstruction Removal section for further instruction.
- If a beaver pond is no longer inhabited by an active colony, the unmaintained dam poses a likely threat and the retained water no longer serves the ecological function it once did.
    - An ANR representative may determine that the dam can be removed following the Vermont Agency of Natural Resources Fish & Wildlife best management practices.

Links

Websites

- Agency of Natural Resources
- Better Roads
- Department of Environmental Conservation
- Fish & Wildlife
- MRGP Website
- Vermont Local Roads
- VT Invasive

Documents/Resources

- ANR Natural Resources Atlas
- Best Management Practices for Resolving Human-Beaver Conflicts in Vermont
- Environmentally Sensitive Road Maintenance Practices for Dirt and Gravel Roads
- EPA Handbook on Constructed Wetlands
- Invasive Plant Atlas of New England
- Manual on Uniform Traffic Control Devices (chapter 6 – Temporary Traffic Control)
- Vermont Rivers & Roads Field Manual
- VT Culverts
- VT State Design Standards

Permits

- Aquatic Nuisance Control
- Lake Encroachment
- Municipal Roads General Permit (MRGP)
- Shoreland Protection Act
- Stream Alteration General Permit
- Vermont Army Corps of Engineers (ACOE) General Permit
- Vermont Wetland General Permit

Road Erosion Inventory

- Collector App FAQ
- Android App
  - Collector for ArcGIS
  - Survey 123
- iOS (Apple)
  - Collector for ArcGIS
  - Survey 123
- Inventory Template

Appendix

Right of Way Agreement – For a printable copy of the agreement click here.

TOWN OF _____

AGREEMENT FOR ENTRY; LIMITED RELEASE

THIS AGREEMENT, made and entered into this ____ day of _____, 20___

By and between the Town of _____, in the State of Vermont, (hereinafter "Town"), and _____ (Name), of the Town of _____, in the State of _____ (hereinafter "Owner").

WHEREAS, the Owner owns certain land and premises located at _____ (Address) in the Town of _____, which adjoin Town Highway No. _____ maintained by the Town (hereinafter "Owner's property"); and

WHEREAS, the Town desires, at its own expense, to perform certain work on or for the benefit of the highway (described more particularly below) (hereinafter "the Work"), which Work also will be of the benefit to the Owner's property, and

WHEREAS, performance of the Work may require the Town, with its own forces or those of contractors, to enter upon the Owner's property, in areas outside the existing highway right-of-way.

NOW, THEREFORE, the parties, intending to be legally bound, hereby agree as follows:

1. Description of the Work. The Work will consist of the following:

_____
_____
_____
_____

2. Right of Entry; Limited Release. The Owner hereby grants the Town, with its own forces or those of contractors, the right to enter upon the Owner's property, with workers and equipment, for the purpose of undertaking the Work, and hereby waives, releases and discharges any claims, whether styled as trespass or otherwise, that may arise from such entry.

3. Retention of Certain Other Rights. Not with standing paragraph 2 of this Agreement, the Owner retains the right to assert against the Town, its contractors or other parties any claims that may arise from negligent acts or omissions during performance of the Work.

4. Waiver: The Owner having been informed of its right to an appraisal to estimate the value of the right-of-entry herein granted and to receive just compensation based on that appraisal, hereby waives these rights.

5. This Agreement for Entry; Limited Release is not binding unless one of the parties signing below receives a Better Roads grant to perform the Work set forth above in Paragraph 1.

For The Town:

_____
Signature

_____
Printed Name

Owner:

_____
Signature

_____
Print Name (must be owner)

In Presence of:

_____
Signature

_____
Name of Witness (as to both)

Municipal Roads General Permit Implementation Schedule Table

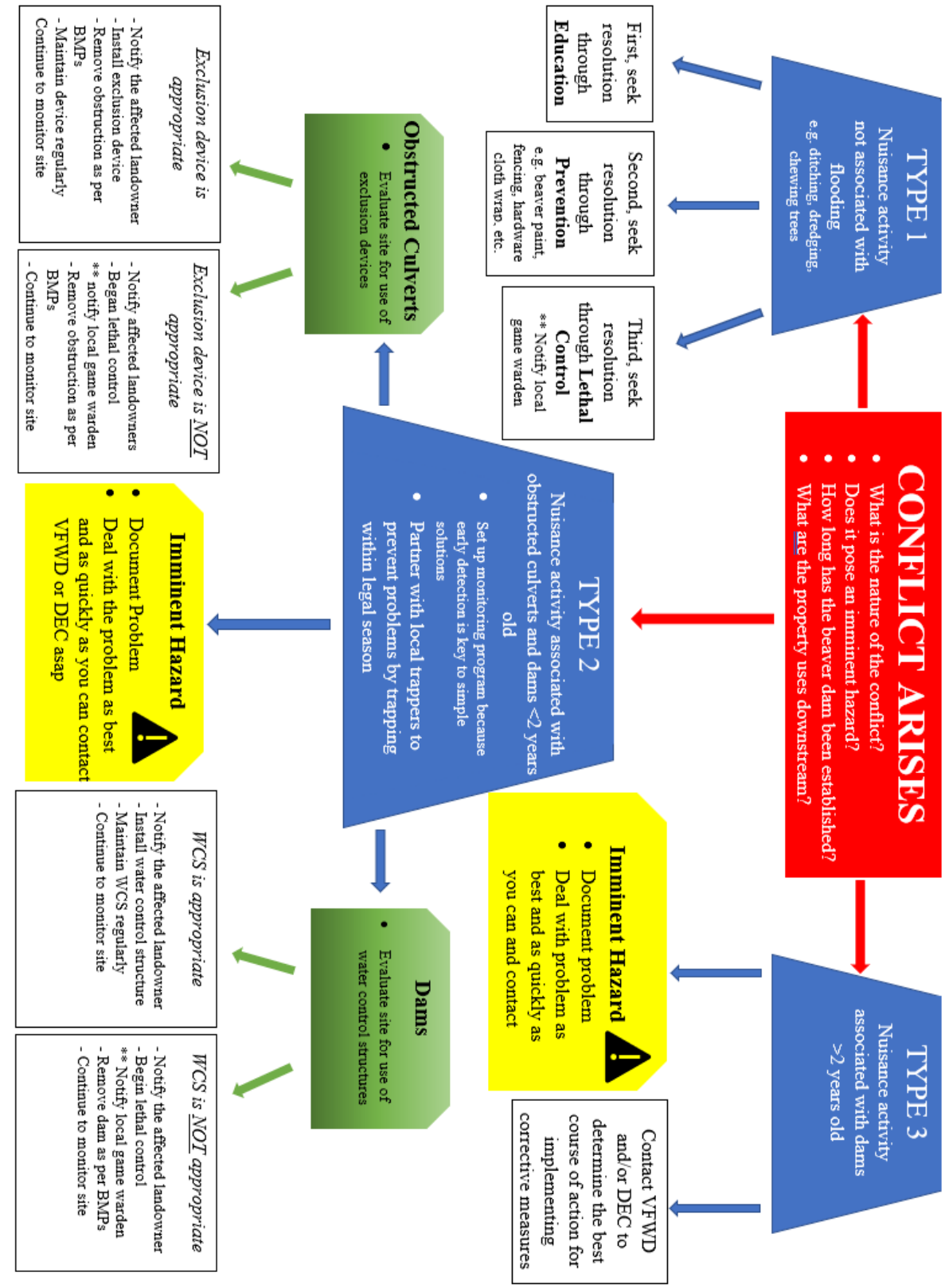
July 31, 2018	NOI must be filed with the Agency
April 1, 2019	Annual Report due (see Part 5.2.A)
April 1, 2020	Annual Report due (see Part 5.2.A)
December 31, 2020	RSWMP due: Consists of Implementation Table with REI results
April 1, 2022 and every April 1 thereafter	Annual Report due (see Part 5.2.B)
October 1, 2022[3]	Apply for authorization upon reissuance of the MRGP
No later December 31, 2036	Complete implementation; all hydrologically-connected municipal roads meet the standards listed in the MRGP General Permit

Rill/Gully Erosion Examples

Rill Erosion = depth of 1" < 12"

Gully Erosion = depth of 12" +

Beaver Conflict Solution Flow Chart



Glossary

Active Channel – The width of the active channel measured perpendicular to streamflow. The active-channel is narrower than the bankfull channel and is defined by a break in bank slope that also typically is the edge of permanent vegetation.

Aggregate – Various loose particulate materials such as sand, gravel or pebbles, added to a cementing agent to make concrete, plaster, etc.

Backhoe – A hydraulic excavating machine consisting of a tractor having an attached hinged boom, with a bucket with movable jaws on the end of the boom.

Backfill – The material used to refill a ditch or other excavation, or the process of doing so.

Bench – A horizontal surface or a step in a slope that breaks the continuity of the slope.

Berm – A linear mound of earth or other material.

Binder – A substance that holds loose material together.

Brush Layering – Live branch cuttings laid in a crisscross fashion on benches between successive lifts of soil.

Channel – A natural stream that conveys water or ditch excavated for the flow of water.

Class IV Road – A road that the town is responsible for but, is not required to maintain year-round.

Crib Structure – A hollow structure constructed of mutually perpendicular, interlocking beams or elements.

Culvert – Usually a factory assembled round-shaped conduit connected with couplers or bands; it differs from a bridge in that it is usually constructed entirely below the road.

Cutting – A branch or stem pruned from a living plant.

Dead Stout Stake – A 2x4 timber that has been cut into a specific shape and length.

Disk Harrow – An agricultural implement with spike like teeth or upright disks, drawn chiefly over plowed land to level it, break up clods, root up weeds, etc.

Drainage Culverts – Convey only road stormwater and generally will not have defined channels extending beyond the road ROW.

Driveway Culverts – A culvert under a driveway within municipal right-of-way.

Embankment – A structure of soil, aggregate, or rock material constructed above the natural ground surface.

Energy Dissipater – A device used to reduce the energy of flowing water.

Erosion – The wearing away of the land surface by running water, wind, ice or other geological agents, including such processes as gravitational creep; detachment and movement of soil or rock fragments by water, wind, ice or gravity.

Filter Strip – A long vegetated planting area used to retard or collect sediment for the protection of watercourses, diversions, drainage basins, or adjacent properties.

Fish Habitat – Resources and conditions essential to fish for survival, including sufficient water quality and quantity, spawning, nursery, rearing and food supply areas – all of which, fish depend on directly or indirectly for their processes.

Geomorphic – Referring to the form and adjustment of the landscape and other natural features on Earth.

Geotextile - Synthetic polyethylene fibers manufactured in a woven or loose non-woven pattern to form a blanket-like product.

Habitat – The environment in which the life needs of a plant or animal are supplied.

Header/Headwall – Structure built at the inlet or outlet of a culvert to protect the inlet/outlet from erosion.

Hydrologically Connected Road – A road segment, equal to 100 meters in length, where the Secretary has determined that road and drainage characteristics indicate a likelihood of discharge to surface waters or wetlands. This definition includes those road segments identified as hydrologically-connected on the ANR Atlas. The Secretary has developed a hydrologically-connected road segment layer using GIS analysis of several factors including roadway distance to waters.

Hydroseeding – Sowing of seed by distribution in a stream of water, mulch, and tackifier propelled through a hose.

Intermittent Stream – A stream that has flowing water at times throughout the year, typically during the wet season (winter and spring) and is dry during the hot summer months.

Invasive Species – A species not native to a specific location that most likely causes damage to the existing species and ecosystem.

Live Cribwall – A hollow, structural wall formed out of mutually perpendicular and interlocking members, usually timber, in which live branch cuttings are inserted through the front face of the wall into the crib fill and/or natural soil behind the wall.

Live Branch Cuttings – Living, freshly cut branches of woody shrub and tree species that propagate from cuttings embedded in the soil.

Live Fascine – Bound, elongated sausage-like bundles of live cut branches that are placed in shallow trenches, partly covered with soil, and staked in place to prevent erosion.

Live Stake – Cuttings from branches that are tamped or inserted into the earth.

MRGP – Municipal Roads General Permit

Mulch – A natural or artificial layer of plant residue or other materials covering the land surface which conserves moisture, holds soil in place, aids in establishing plant cover, and minimizes temperature fluctuations.

Perennial Stream – A stream that has at least some continuous flow all year-round during years of normal rainfall.

Permeability – The capacity of a porous rock or sediment to permit the flow of fluids through its pore spaces.

Plunge Pool – A depressed area used to dissipate the energy of flowing water that may be constructed or naturally created by flowing water. These pools may be protected by various lining materials.

Pollutant – Dredged soil, solid waste incinerator residue, sewage, garbage, sewage sludge, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water.

Retention Structure – A natural or artificial basin that functions like a detention structure except that it may maintain a permanent water supply.

Riprap Revetment – Broken rock, cobbles or boulders placed on earth surfaces, such as the face of a dam or the bank of a stream for protection against the action of water.

Rivulets – Very small streams.

Road Crown – Convex section or outline of the road surface

Rock Apron – Erosion protection placed in an area of high velocity flow such as a culvert outlet.

ROW – Right of way:

Runoff – The portion of the precipitation on a drainage area that does not infiltrate and is discharged from the area.

Scarify – To abrade, scratch, or modify the surface; for example, to break the surface of a road with a narrow-bladed implement.

Sediment – Solid material, both mineral and organic, that is in suspension, is being transported, or has been moved from its site of origin by air, water, gravity or ice and has come to rest on earth's surface either above or below sea level.

Sheet Flow – Water, usually storm runoff, flowing in a thin layer over the ground surface.

Silt – A very small particle no larger than 0.05 mm in diameter.

Slope – The degree of deviation of a surface from horizontal, measured in a numerical ratio, percent, or degrees; expressed as a ratio or percentage, the first number is the horizontal distance (run) and the second number is the vertical distance (rise) as 2:1, 50 percent, or 30 degrees.

Slope Board – A device, usually made of wood, created to confirm the cross slope of a road, ditch, or bank.

Soil Bioengineering – Use of live, woody vegetative cuttings to repair slope failures and increase slope stability, often combined with inert structures and materials.

Sub-base – The drainage layer of a road between the surface and the existing ground.

Surface Water – All water the surface of which is exposed to the atmosphere.

Swale – An elongated depression in the land surface that is at least seasonally wet, is usually vegetated, and is normally without flowing water. Swales conduct stormwater into primary drainage channels and provide some groundwater recharge.

Tamp – To force in or down by repeated, rather light, strokes.

Ten-year Frequency Storm – Maximum quantity of water flow per second expected at a particular water crossing, on a statistical average, once every ten years; it has a ten percent probability of occurring in any given year.

Terrace – An embankment or combination of an embankment and channel across a slope to control erosion by diverting or storing surface runoff instead of permitting it to flow uninterrupted down the slope.

Toe of the Slope – Base of the slope.

Turbidity Curtain – A flexible curtain barrier used to trap sediment while allowing water to pass. Usually weighed down and secured on bottom of water body.

Vegetated Structures – A retaining structure in which living plant materials, cuttings, or transplants have been integrated into the structure.

Water Quality – A term used to describe the chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Watershed – The area contained within a divide above a specified point on a stream contributing to the supply of a stream or lake. Often called drainage area, drainage basin or a catchment area.

Wetland – Land that is inundated by surface or ground water with a frequency sufficient to support plants and animals or seasonally saturated soil conditions for growth and reproduction. These areas are commonly known as bogs, fens, marshes, wet meadows, shrub swamps and wooded swamps.