BEST MANAGEMENT PRACTICES TO REDUCE NON-POINT SOURCE POLLUTION IN THE TOWN OF PLAINFIELD, CONNECTICUT

(A Guidance Manual)

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USEPA Grant No. X981114-01-0

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December 2000

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Acknowledgements

This project was funded in part by a grant from the United States Environmental Protection Agency under the Source Water Protection Program [Grant X981114-01-0]. The Town of Plainfield and the American Ground Water Trust gratefully acknowledge this support. The Town and the Trust also thank the Connecticut Water Company, Connecticut Department of Environmental Protection, Connecticut Department of Public Health, NEMO (Non-point Source Education for Municipal Officials), and United States Department of Agriculture, Natural Resources Conservation Service (NRCS) for access to reports and information used in the compilation of this manual, and for reviewing various portions of the document.

The Plainfield Vision

The Town of Plainfield has a three hundred year history of land use blending the power and beauty of its water resources and rural character in the creation of a sustainable New England community.

The town leaders' vision of the future has two concurrent fundamental goals:

- To maintain the existing businesses and attract new, resilient enterprises that will thrive and benefit from the town's clean water resources and efficient transportation infrastructure.

- To preserve the town's water, forest, agricultural and historic resources to enhance the community's living environment and provide opportunities for recreation and healthy living.

A balanced and enlightened use of the Town's valuable and finite historic and natural resources will be required to fulfill this vision.

Introduction

Non-point source (NPS) pollution may occur in many settings and through various activities. The important distinction between NPS pollution verses point source pollution is that NPS pollution sources are difficult to identify and/ or the entry point of contamination to surface or ground water is diffuse and not limited to a single location. Frequently NPS pollution is related to an activity such as over-applied lawn or agricultural chemicals that leads to the accumulation of excess chemicals or nutrients in soil or storm runoff. These pollutants eventually enter down-gradient ground water or surface water resources.

The cumulative effects of adverse NPS pollution conditions lead to ecological stress and tohuman health issues when drinking water sources are affected. The health risks may go undetected for an extended period of time because no specific “incident” is apparent as a "red flag" for the community.

Aquifer protection regulations and zoning ordinances commonly reflect concerns for obvious catastrophic environmental incidents, such as spills of hazardous materials, uncontrolled releases through floor drains or leaking underground storage tanks. However, many municipalities do not have a mechanism for easily and consistently evaluating insidious storm water-related NPS pollution impacts to surface and ground water source areas. Review and control of NPS pollution issues are further complicated by several factors:

(1) Town officials are not usually technical experts on natural resource protection. They have minimal support staff available to gather background technical information to aid in development decisions and planning
(2) Continuity of the NPS pollution review and town planning processes may be disrupted when key officials leave office
(3) NPS pollution impacts are not often well addressed in town planning and management activities because the impacts are not commonly manifested as acute conditions with obvious cause and effect

(4) NPS pollution impacts are likely to appear as subtle, chronic trends of environmental resource deterioration. For these reasons, NPS pollution impacts are typically difficult to recognize, manage or correct at an early stage.

Currently, the Town of Plainfield has an Aquifer Protection Overlay District (APOD) covering most of the town. The APOD includes zoning regulations to protect the ground water resource. However, the town has identified that within the zoning regulations no guidance is specified to (1) consistently evaluate potential NPS pollution impacts related to future development opportunities or (2) assess or manage current storm water-related NPS pollution impacts to source water (ground or surface water). This guidance manual addresses these issues and is prepared in a transferable format that can be used by other municipal or tribal entities.

Because NPS pollution sources are diverse and may be non-specific in character, control and prevention techniques may take many forms in order to address local conditions contributing to NPS pollution impacts. These techniques are typically called Best Management Practices (BMPs). A large variety of BMPs have been developed and modified by various groups and agencies over the last two decades to minimize or prevent NPS pollution impacts. BMPs may take many forms, including regulatory land use controls, pollution source controls, structural practices, vegetative practices and activity management practices. On-going public education and increased awareness about NPS pollution impacts and prevention is extremely important to the success of monitoring and enforcement efforts to implement BMPs. The BMPs presented in this manual focus on structural, vegetative and management practices that serve to complement the Plainfield's APOD regulations.

As a basis for the manual, a matrix of land use management goals and BMPs for the major land use areas of the town (Industry, Forest, Agriculture, Village and Rural Residential) was created. The manual provides a new evaluation tool for current and future Plainfield authorities to reference during land use planning and site plan review. It can also serve as a basis to support consistent review and assessment of potential

NPS pollution impacts to ground and surface water in a complementary fashion to the existing APOD regulations. The matrix of management goals and BMPs enhances the scope of overall town land use management and specific site plan review processes that serve to protect source water at the local community level. Establishing land use management goals in association with BMPs to address NPS pollution heightens awareness of NPS pollution problems. It can facilitate proactive planning by the town and private developers that can lead to better management of NPS pollution impacts through earlier focus and recognition of potential problem situations. Early identification of NPS pollution impacts can help minimize or eliminate consequent adverse effects to the environment and human health.

How to Use This Manual

This manual and accompanying Land Use Management Area map is designed to serve as a resource for laypersons involved with site plan review and property use planning activities. The manual is intended as a basic guide for identifying and reminding town board members and other citizens of BMPs that may be appropriate for controlling NPS pollution and achieving Plainfield's land use management goals. The BMPs were selected from a variety of published information prepared by federal, state and non-government organization sources. The publications used are listed in the References Cited section of the manual. The manual is not a blueprint on how to design specific BMPs, it is a selection of BMPs with simple descriptions that should be considered during site use and activity planning by developers, town citizens, town board members, elected and non-elected town leaders, and other interested parties to help prevent the pollution of Plainfield's surface and ground water resources.

The land use areas shown on the Land Use Management Area map were developed through reviewing land resource, historical resource, zoning and proposed economic development maps available from at the Plainfield Town Office. The land resource maps include soils maps of prime agricultural and forest land. The boundaries of the

land use areas shown on the Land Use Management Area map are approximate in nature and do not represent specific zoning areas. The land use areas are defined to include land with the character and criteria necessary for a particular land use. Within a particular land use area there are smaller sub-areas that may have different uses because of existing zoning, soil conditions or proposed uses based on Plainfield's Plan for Economic Development. The land use areas defined are broad and inclusive in order to encourage consideration and application of BMP's for particular land use types and management goals.

The land use management goals (Table I) in this manual are based on information and goals presented in the *Town of Plainfield Marketing Plan 1998-2000* (Plainfield Economic Development Commission, 1998) and *Plan of Conservation and Development 1997 - 2007* (Plainfield Planning and Zoning Commission, adopted 1998). Nineteen land use management goals are identified.

Tables I and II and the Appendix are used to relate the land use areas, land use goals and BMPs in a matrix. Table I cross-references the applicability of the 19 land use management goals to Plainfield's principal land use areas: Industry, Agriculture, Forest, Rural Residential and Village.

Table II is a matrix which displays the BMP that may be most applicable for achieving particular land use management goals. As a project reviewer or site planner considers development options for a parcel, Table II offers the "first cut" choices among BMPs that may be appropriate for implementation within a successful development plan for a given land use area. The choices may then be checked for general performance and applicability by consulting BMP descriptions compiled in the Appendix of this manual. When helpful to the descriptions, a figure of the vegetative or structural BMP type is included. In many cases it will be apparent which BMP(s) will provide the most appropriate protection for Plainfield's surface and ground water resources. However, additional information and analysis of the development impacts on water resource conditions and potential mitigating effects of the BMP choices will be necessary in some

cases to ensure and support an appropriate and effective choice. Past practice has shown that a combination of several complementing BMPs are usually necessary to achieve best water resource protection and sustainable land uses for a particular parcel of land and surrounding area.

The Appendix contains a compilation of information on 35 BMPs that relate to land use conditions in Plainfield. A brief description of the information presentation format in the Appendix is provided at the beginning of the Appendix. The compilation should not be considered exhaustive because new innovations to control pollution and runoff the subject of ongoing research by may organizations. Furthermore, specific conditions in Plainfield may evolve, requiring new approaches and considerations to control storm water runoff and protect surface and ground water resources.

Each Best Management Practice in Appendix includes several sections of information to help the user understand how the BMP functions and which NPS pollution objectives it may achieve or support. Qualitative performance comments and evaluations are then listed for significant water quality factors, including:

- Erosion Control
- Sedimentation Control
- Runoff Control
- Infiltration
- Ground Water Quality Effects
- Surface Water Quality Effects
- Habitat Suitability
- Capital or Implementation Costs
- Operation and Maintenance
- Potential Side Effects
- Concurrent Land Management Practices
- Feasibility

Also listed are brief comments concerning the effectiveness of the BMP at preventing contamination by major categories of NPS pollution.

Non-Point Source Contaminants

There are several primary types of contaminants that contribute to NPS pollution. They may be derived from a variety of causes and land uses including natural and anthropogenic (human-related) sources (Morris, 1996). The major categories include low dissolved oxygen, metals, nutrients (fertilizers and organics), pathogens, salinity (sodium and chloride), sediments, thermal loading (water temperature) and toxic chemical pollutants (pesticides, herbicides, fuels, solvents, other synthetic chemicals). Brief descriptions of these categories are provided in the following paragraphs.

Low Dissolved Oxygen

Dissolved oxygen is depleted from slower-moving water such as lakes and estuaries as microorganisms consume biodegradable organic material (Bingham et al., 1993; Holbrook, 1995). Runoff from agricultural practices, urban areas, poor septic systems, combined sewer overflows (CSO), and landfill leachate may contribute high quantities of biodegradable substances to source water resources. The larger the quantity of organic material in storm water runoff, the more oxygen may be removed, potentially changing aquatic conditions from “aerobic” (oxygen present) to “anoxic” (zero oxygen) in downstream, slow-moving or impounded water bodies. Extreme changes of this nature can lead to fish kills, noxious odors and long-term sediment conditions that promote sustained low oxygen situations.

Metals

Metals in the environment may result from naturally occurring sources in bedrock and soil. They also may enter the environment as byproducts from industrial processes, hydrocarbon fuel combustion, metal corrosion situations (motors, copper and lead pipes), atmospheric deposition from remote sources, landfills and pesticide and herbicide applications. These metals are commonly referred to as “trace” or “heavy” metals and include cadmium, chromium, copper, lead, mercury, nickel and selenium (Morris, 1996). The most commonly detected metals in storm water runoff from developed environments (residential, commercial and light industrial) include copper, lead and zinc (Doenges et al., 1990; Holbrook, 1995). They are of concern due to their tendency to bioaccumulate in aquatic life and contaminate drinking water resources. These metals are commonly in solid particulate form and/ or bound onto absorbed sediment particles (Schueler, 1987). The most effective treatment of heavy metals will include physical (mechanical) filtration and settling of the solid particles combined with uptake into plants and/or adsorption onto soil particles of the dissolved metals.

Nutrients

Nutrients include nitrogen, phosphorus and organic materials (manure, septage, fertilizers) that contain nitrogen and phosphorus compounds. Nutrients may enter the environment in agricultural and urban (residential, commercial) runoff, atmospheric deposition, landfill leachate, residential septic system exfiltration, and municipal wastewater treatment effluent (Bingham et al., 1993; Holbrook, 1995). Commercial fertilizers, animal waste and nitrogen in precipitation are the principal sources for the majority of nitrogen and phosphorus in storm water runoff (Doenges et al., 1990). Excessive nitrogen in drinking water supplies can cause methemoglobinemia (“blue baby syndrome”). Nutrients can lead to adverse algal blooms and eutrophication of water bodies thus decreasing the dissolved oxygen and increasing turbidity levels of aquatic habitats. Nitrogen occurs as organic nitrogen (i.e., urea [$CO(NH_2)_2$]), ammonia

(NH_3), ammonium (NH_4^+), nitrate (NO_3) and nitrite (NO_2). On average, fifty to seventy percent of the nitrogen and phosphorus in runoff is in a dissolved form (Schueler, 1987) and is difficult to remove from the runoff. Biological uptake into plants, such as that which occurs in wetland or extended detention basins, is the most effective removal mechanism for nitrogen and phosphorus. Biological uptake is not permanent unless the plants die and are buried with sediment or are harvested and removed from the local nutrient system. It is usually more cost effective to control (reduce) the loading of nutrients entering the environment than to remove them from the ecological system at a later time. Excessive nutrient loading may also lead to lower dissolved oxygen levels (See Low Dissolved Oxygen).

Pathogens

Pathogens include bacteria (e.g., E-coli, Salmonella, Shigella, Legionella), protozoan parasites (e.g., Cryptosporidium and Girardia and viruses (e.g., Polio, Norwalk and Hepatitis) that can cause disease in humans. Animal and human feces are the most common sources of waterborne pathogens. Other sources include failed septic systems, runoff from impervious areas, animal feedlots (concentrated animal waste areas), wildlife populations, combined sewer overflows, and boat discharges (Morris, 1996). Symptoms from exposure to pathogens range from no effect to severe illness and death. Pathogens may be filtered out before reaching ground water as the runoff infiltrates downward through thick overlying soils. Natural microbial competition in the shallow soil horizons also acts to remove pathogens from recharge water. Surface water supplies are more susceptible to contamination from pathogens because of the lack of filtration and competition. Minimizing contact between runoff and pathogen sources as well as preventing direct inflow of contaminated runoff to surface and shallow ground water resources is necessary to maintain satisfactory water resource quality.

Salinity

Salinity impacts to ground water in New England result primarily from the application of sodium chloride salt to travel surfaces during winter de-icing activities (Bingham et al., 1993; Holbrook, 1995). Snow removal activities may pile salt-rich snow in a single area where snowmelt and/ or rain will carry the salt to underlying ground water or nearby surface water locations. Salt concentrations in snow-related runoff may be on the order of several thousand milligrams per liter (mg/L) (Schueler, 1987). Sodium and chloride are highly soluble in water and are difficult and expensive to remove. High salinity water may be corrosive to piping systems and unhealthy for individuals on low sodium diets. Salinity impacts are greatest on slow moving or impounded surface water and ground water. Most BMPs have little effect on reducing salinity in runoff or preventing it from entering the ground water resource. Limiting or prohibiting de-icing application rates and covering salt stockpile areas from precipitation are the most effective ways to reduce salinity impacts on source water.

Sediments

Sediment may encompass a wide range of low solubility particulate material, both inorganic (clay, silt and sand, metals) and organic (plant material, pathogens) substances (Doenges et al., 1990). The quantity and type of sediment may be significantly affected by construction activity, farming, logging, mining and a variety of development-related (urban, residential, commercial) conditions. These activities and conditions commonly increase runoff volumes and flow concentration times, decrease slope stabilities and remove stabilizing vegetation. Suspended sediment from these land uses may also carry, as adsorbed ("surface attachment") components, contaminants such as metals, pesticides, herbicides, and pathogens (Bingham et al., 1990; Holbrook, 1995). Suspended sediment increases turbidity in surface water, which may lead to clogged fish gills, buried bottom dwelling fauna, reduced photosynthesis and reduced dissolved oxygen levels. The particle size range and quantity of

suspended sediment that may be entrained and transported by runoff is controlled primarily by the runoff's velocity and discharge quantity. Typically, the sand-sized and some larger silt-sized sediment will drop out of suspension at velocities of less than three feet per second. BMPs to minimize the availability of unstable or contaminated sediment, combined with BMPs that provide sedimentation mechanisms are needed to prevent excessive sediment loads in runoff. A good rule is that pre-site and post-site development ground water recharge and runoff conditions should be the same in terms of volume and time of concentration. Surface and ground water quality should not be compromised to meet pre- and post-development runoff volume and time of concentration conditions. It is important to consider the effects pf changes to the amount and location of ground water recharge caused by development. Altering the location where ground water recharge actually occurs can affect the quality and quantity of ground water in an area.

Thermal Loading (Water Temperature)

Thermal loading is the condition of significantly changing the ambient seasonal temperature of a surface water body. Typically, thermal loading is an increase in temperature through the introduction of relatively warmer water to a lake, pond, river, stream or similar water body. Sources of thermal loading include heated industrial process water (e.g., non-contact cooling water), power plants, or more commonly heated runoff (Morris, 1996). In urban environments, runoff is often heated as the result of several conditions (Morris, 1996). First, the large mass of development materials (e.g., building masonry, wood, asphalt shingles, road asphalt, concrete, etc) used in urban areas retains the heat of the sun and passes it to runoff flowing over these surfaces. Second, urban areas tend to have fewer trees and shade over watercourses, which cause urban watercourses to heat up more than watercourses in rural areas. Finally, detention facilities, designed to handle the increased runoff in urban areas, provide opportunities for stored water to heat up between storms and then be released rapidly as overflow during the next storm. As water from these three situations mixes

with cooler water in downstream areas, temperature increases may be significant. In general, summer time water temperatures above 70 degrees Fahrenheit (21 degrees Celsius) are considered potentially stressful to "coldwater" fish species such as trout and salmon (Schueler, 1987). Increased temperature loadings appear to increase the bioaccumulation of heavy metals along the aquatic food chain that can eventually be consumed by humans (Morris, 1996). Maintaining natural vegetation (pervious surfaces) and tree canopy are important in minimizing thermal loading impacts. Ground water maintains a relatively constant temperature throughout the year (near 50 to 55 degrees Fahrenheit). Increasing infiltration to ground water can help reduce the effects of thermal loading of surface water.

Toxic Chemical Pollutants

There are many examples of toxic chemical pollutants, including inorganic (e.g., metals, discussed previously) and organic (containing carbon) chemicals. By far the largest amount of organic material in runoff is related to natural decaying vegetation (leaf litter, aquatic plants) and microorganisms. Although synthetic (man-made) organic chemicals (SOCs) are present in much lower quantities and/ or concentrations than natural organics, the presence of SOCs can frequently have greater adverse impacts on water quality. SOCs in runoff may have a variety of sources that are frequently related to industry and are site specific in occurrence. Health impacts to humans, animals and plants from SOC contamination are frequently significant and vary by chemical. A description of the impacts is beyond the scope of this manual. Enforcement and monitoring of land and chemical use through Plainfield's Aquifer Protection Overlay District regulations is an important control.

Hydrologic Impacts of Development

Water in the hydrologic system is a dynamic resource, moving between various storage types (ground water, surface water, oceans, ice, rain, snow) and phases (solid, liquid and vapor). Rain and snow are the most significant forms of hydrologic input with regard to NPS pollution and resource management in Plainfield. When rain or snow falls to the ground there are several options for movement and storage. Depending on the time of year, a large portion of the precipitation is returned to the atmosphere through evaporation and plant transpiration. Following heavy rain or snowmelt, some water will flow over the ground to rivers and lakes as storm water runoff. A relatively small fraction of the precipitation infiltrates into the ground to become ground water, which may be slowly released as base flow to rivers.

The allocation of the precipitation within the hydrologic system can be altered significantly by changing the nature of the ground surface on which a raindrop lands. In general, the more thickly vegetated a land area, the more likely a drop of water is to infiltrate the ground or be used by plants for photosynthesis and growth. Vegetation tends to "hold" the water drop on plant surfaces, which slows the process of concentrating the drops into larger pools and channeled paths. The consequence of this is that runoff volumes are smaller from vegetated areas than from impervious rock or paved areas; all other variables (precipitation rate and quantity, percent slope, season of year) being equal.

Changing the ground surface conditions affects the characteristics of storm water runoff. As vegetated lands are reduced in area (acreage) and density (tree canopy and understory) and replaced with non-vegetated or paved (impervious) surfaces, infiltration and evapotranspiration decrease, and the following changes in runoff character are commonly observed (Holbrook, 1995):

- Increased peak discharges
- Increased volume of storm runoff

- Decreased time for runoff to reach receiving waterbodies
- Increased frequency and severity of flooding
- Reduced stream flow (base flow) during periods of prolonged dry weather
- Greater runoff and stream velocity during storm events
- Scouring of streambanks and channels and deterioration of aquatic habitat
- Lower ground water table levels

These conditions and other impacts can produce increasing pollution problems and habitat degradation as undeveloped land is converted to developed land.

Glossary

The list of words selected for this glossary includes commonly used technical words related to aquifer protection and Best Management Practices. Some words have been selected from related subjects such as geology and hydrology. The language used in the glossary is intended to provide brief, easy to understand explanations for non-specialists. The glossary is not intended as a source for precise scientific definitions or for specific legal interpretations. A citation for each definition has been included and is listed in the references.

Acid Soil: Specifically, soil with a pH value of less than 7.0, but for most practical purposes, a soil with a pH less than 6.6. The term is usually applied to the surface layer or to the root zone unless specified otherwise (Liles, Jr., 2000).

Acre-foot: The volume of water that will cover 1 acre to a depth of 1 foot (Liles, Jr., 2000).

Adsorption: The adhesion of one substance to the surface of another (Wayland, 1993).

Alkaline Soil: A soil that has a pH greater than 7.0, and particularly above 7.3 throughout most or the entire root zone. However, the term is commonly applied to only the surface horizon of a soil (Liles, Jr., 2000).

Alluvial: Pertaining to material that is transported and deposited by running water (Liles, Jr., 2000).

Alluvium: A general term for all detrital material deposited or in transit by streams, including gravel, sand, silt, clay and all variations and mixtures of these. Unless otherwise noted, alluvium is unconsolidated (Liles, Jr., 2000).

Angle of Repose: Angle between the horizontal and the maximum slope that a soil assumes through natural processes (Liles, Jr., 2000).

Aquifer: A geologic formation or structure that transmits water in sufficient quantity to supply the needs for water development (Wayland, 1993).

Background Load: Naturally occurring levels of pollutants in a stream prior to watershed development (Schueler, 1987).

Bankfull Discharge: A flow condition where streamflow completely fills the stream channel up to the top of the bank. In an undisturbed watershed, the discharge condition occurs on average every 1.5 to 2 years and controls the shape and form of natural channels (Schueler, 1987).

Baseflow: The portion of stream flow that is not due to storm runoff, and is supported by groundwater seepage into a channel (Schueler, 1987).

Bedrock: The solid rock underlying soils and the regolith at depth ranging from zero (where exposed by erosion) to several hundred feet (Liles, Jr., 2000).

Bedload: The sediment that is moved by sliding, rolling, or bounding on or very near the streambed (Liles, Jr., 2000).

Benthic Organisms: Organisms living in or on bottom substrates in aquatic habitats (Schueler, 1987).

Best Management Practices (BMPs): Schedules of activities, prohibition of practices, maintenance procedures, and other management practices to prevent or reduce the pollution of waters of the United States. BMPs also include treatment requirements, operating procedures, and practices to control plant site runoff, spillage of leaks, sludge or waste disposal or drainage from raw material storage. With regard to construction these may include structural devices or nonstructural practices that are designed to prevent pollutants from entering water or to direct the flow of water (EPA, 1992).

Bioassay: Laboratory tests used to determine the response of organisms to specified conditions relating to the natural environment (Schueler, 1987).

Biochemical Oxygen Demand (BOD): The quantity of oxygen consumed during the biochemical oxidation of matter over a specified period of time (see also COD) (Schueler, 1987).

BOD: See *Biochemical Oxygen Demand*

Cable Logging: A system of transporting logs from stump to bading by means of steel cables and winch. This method is usually preferred on steep slopes, wet areas, and erodible soils where tractor logging cannot be carried out effectively (Wayland, 1993).

Chemical Oxygen Demand (COD): A monitoring test that measures all the oxidizable matter found in a runoff sample, a portion of which could deplete dissolved oxygen in receiving waters (Schueler, 1987).

Clear Cutting: A silvicultural system in which all merchantable trees are harvested within a specified area in one operation to create an even-aged stand (Wayland, 1993).

COD: See *Chemical Oxygen Demand.*

Contour: 1) An imaginary line on the surface of the earth connecting points of the same elevation. 2) A line drawn on a map connecting point of the same elevation (Liles, Jr., 2000).

Cut- and –Fill: Process of earth moving by excavating part of an area and using the excavating material for adjacent embankments or fill areas (Liles, Jr., 2000).

Denitrification: A biological process in which nitrate (NO_3), a compound of nitrogen often found in sewage or water, is turned into nitrogen gas, which can dissipate into the atmosphere (Schueler, 1987).

Design Life: The period of time for which a facility is expected to perform its intended function (Liles, Jr., 2000).

Design Storm: A rainfall event of specified size and return frequency (e.g., a storm that occurs only once every 2 years) that is used to calculate the runoff volume

and peak discharge rate into BMP. For example, a 10-Year, 24-Hour Storm is a rainfall event of 24-hour duration and 10-year frequency (Schueler, 1987).

Detention Time: The amount of time a parcel of water actually is present in an impoundment. Theoretical detention time for a runoff event is the average time parcels of water reside in the basin over the period of release from the BMP (Schueler, 1987).

Discharge (hydraulics): Rate of flow, specifically fluid flow; a volume of fluid passing a point per unit time, commonly expressed as cubic feet per second, million gallons per day, gallons per minute or cubic meters per second (Liles, Jr., 2000).

Dispersion, Soil: The breaking down of soil aggregates into individual particles, resulting in a single grain structure. Ease of dispersion is an important factor influencing the erodibility of soils. Generally speaking, the more easily dispersed the soil, the more erodible it is (Liles, Jr., 2000).

Dissolved Oxygen (DO): The concentration of free molecular oxygen in the water column (Wayland, 1993).

DO: See *Dissolved Oxygen*

Drawdown: Lowering the water surface (in open channels), water table, or piezometric surface (in groundwater) resulting from a withdrawal of water (Liles, Jr., 2000).

Drift: Sediments deposited by glaciers that repeatedly advanced and retreated across the North American landscape until about 10,000 years ago (Hust and Murphy, 1997).

Dryfall: The deposition of atmospheric pollutants on the land surface (Schueler, 1987).

Effluent: Solid, liquid, or gaseous wastes that enter the environment as a by-product of man-oriented processes (Wayland, 1993).

Emergent Plants: Aquatic plants that are rooted in the sediment but whose leaves are at or above the water surface. These wetland plants often have high habitat value for wildlife and waterfowl, and can aid in pollutant uptake (Schueler, 1987).

Erodible: Susceptible to erosion with reference to soil (Liles, Jr., 2000).

Erosion: 1) The wearing away of the land surface by running water, wind, ice, or other geological agents, including such processes as gravitational creep. 2) Detachment and movement of soil or rock fragments by water, wind, ice, or gravity. The following terms are used to describe different types of water erosion (Liles, Jr., 2000).

Accelerated Erosion: Erosion much more rapid than normal, (geologic) erosion, primarily as a result of the influence of the activities of man, or in some cases, of other animals or natural catastrophes that expose base surfaces, (e.g., fire).

Geologic Erosion: The normal or natural erosion caused by geological processes acting over long geologic periods and resulting in the wearing away of mountains, the building up of floodplains, coastal plains, etc.

Gully Erosion: The erosion process whereby water accumulates in narrow channels and rapidly removes the soil from this narrow area to considerable depths, potentially on the order of tens of feet.

Natural Erosion: Wearing away of the earth's surface by water, ice or other natural agents under natural environmental condition of climate, vegetation, etc., undisturbed by man.

Rill Erosion: An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently disturbed and exposed soils. See *Rill*.

Sheet Erosion: The removal of a fairly uniform layer of soil from the land surface by runoff water.

Splash Erosion: The spattering of small soil particles caused by the impact of raindrops on wet soils. The loosened and spattered particles may or may not be subsequently removed by surface runoff.

Erosion and Sediment Control Plan: A plan for the control of erosion and sediment resulting from a land-disturbing activity (Liles, Jr., 2000).

Erosive: Having sufficient velocity to cause erosion; refers to wind or water. Not to be confused with erodibility as a quality of soil (Liles, Jr., 2000).

Evaporation: The process by which a liquid is changed to a vapor or gas (Wayland, 1993).

Exfiltration: The downward movement of runoff through the bottom of an infiltration BMP into the soil layer (Schueler, 1987).

Existing Grade: The vertical location of the existing ground surface prior to cutting or filling (Liles, Jr., 2000).

Fertilizer: Any organic or inorganic material of natural or synthetic origin that is added to a soil to supply elements essential to plant growth (Liles, Jr., 2000).

Fertilizer Analysis: The percentage composition of fertilizer, expressed in terms of nitrogen, phosphoric acid, and potash. For example, a fertilizer with a 6-12-6 analysis contains 6 percent nitrogen (N), 12 percent available phosphoric acid (P_20_5) and 6 percent water-soluble potash (KO_2). Minor elements may also be included. Recent analysis expresses the percentages in terms of elemental fertilizer (nitrogen, phosphorus, potassium) (Liles, Jr., 2000).

Finished Grade: The final grade or elevation of the ground surface forming the proposed design (Liles, Jr., 2000).

First Flush: The delivery of a disproportionately large load of pollutants during the early part of storms due to the rapid runoff of accumulated pollutants. The first flush of runoff has been defined several ways (e.g., one-half inch per impervious acre) (Schueler, 1987).

Forebay: An extra storage area provided near an inlet of a BMP to trap incoming sediments before they accumulate in a water impoundment BMP (wetland, pond, basin (modified from Schueler, 1987).

Forwarding: The operation of moving timber products from the stump to a landing for further transport (Wayland, 1993).

Ground Water: Subsurface water occupying the zone of saturation. In a strict sense, the term is applied only to water below the water table (Wayland, 1993).

Gully: A channel or miniature valley cut by concentrated runoff but through which water commonly flows during and immediately after heavy rains or during the melting of snow. A gully may be dendritic, or branching, or it may be linear; rather long, narrow, and of uniform width. The distinction between gully and rill is one of depth. A gully is sufficiently deep that it would not be obliterated by normal tillage operations, whereas a rill is of lesser depth and would be smoothed by use of ordinary tillage equipment. See *Erosion, Rill* (Liles, Jr., 2000).

Habitat: The environment in which the life needs of a plant or animal organism, population, or community is supplied (Liles, Jr., 2000).

Head: The water-level elevation in a well or elevation to which the water of a flowing artesian well will rise in a pipe extended high enough to stop the flow (Bates and Jackson, 1987).

Headwater: The source of stream. 2) The water upstream from a structure or point on a stream (Liles, Jr., 2000).

Heavy Metals: Metallic elements with high atomic weights (e.g., mercury, chromium, cadmium, arsenic, and lead). They can damage living things at low concentrations and tend to accumulate in the food chain (Wayland, 1993).

Herbicide: A chemical substance designed to kill or inhibit the growth of plants, especially weeds (Wayland, 1993).

Hydraulic Gradient: In an aquifer, the rater of change of total head per unit distance of flow at a given point and in a given direction (Bates and Jackson, 1987).

Hydrograph:A graph showing variation in the water depth or discharge in a stream or channel, over time, at a specified point of interest (Schueler, 1987).

Infiltration: The downward entry of water through the soil surface in the soil. (Ward and Elliot, 1995)

Impervious Area: Impermeable surfaces, such as pavement or rooftops, which prevent the infiltration of water into the soil (Schueler, 1987).

Impervious Surface: A hard surface area that either prevents or retards the entry of water into the soil mantle under natural conditions prior to development (e.g., exposed bedrock or ledge surface). Also, a hard surface area that causes water to run off the surface in great quantities or at an increased rate of flow from the flow present under natural conditions prior to development. Common impervious surfaces include, but are not limited to rooftops, walkways, patios, driveways,

parking lots, storage areas, concrete or asphalt paving, gravel roads, packed earthen material, and oiled, macadam, or other surfaces that similarly impede the natural infiltration of urban runoff (modified from Wayland, 1993).

Impoundment: The collection and confinement of water as in an artificial reservoir or dam (Liles, Jr., 2000).

Induced Infiltration: When pumping lowers the water table under a nearby river or other water body so that surface water flows downward through the streambed into the aquifer (Hust and Murphy, 1997).

Inert: A substance that does not react with other substances under ordinary conditions (Wayland, 1993).

Infiltration: The penetration of water through the ground surface into sub-surface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls (EPA, 1992).

Infiltration Rate: A soil characteristic determining or describing the maximum rate at which water can enter the soil under specified conditions, including the presence of excess of water (Liles, Jr., 2000).

Inlet: An entrance into a ditch, storm sewer, or other waterway (EPA, 1992).

Intensity: Rainfall rate usually stated in inches per hours (in/hr) (Liles, Jr., 2000).

Interflow: That portion of rainfall that infiltrates into the soil and moves laterally through the upper soil horizons until intercepted by a stream channel or until it returns to the surface as a spring at some point down slope from its point of infiltration (Liles, Jr., 2000).

Intermittent Stream: A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs. It is dry for a large part of the year, ordinarily more than 3 months (Liles, Jr., 2000).

Jute: A plant fiber use to make rope, mulch, netting, or matting (EPA, 1992).

Leachate: Liquids that have percolated through a soil and that contain a substance(s) in solution or suspension (Wayland, 1993).

Leaching: the removal from the soil in solution of more soluble material by percolating waters (Liles, Jr., 2000).

Legume: A member of the legume or pulse family, Leguminosae. Legumes are one of the most widely distributed plant families. They include many valuable food and forage species, such as peas, beans, peanuts, clover, alfalfas, sweet clovers, lespedezas, vetches, and kudzu. Practically all legumes are nitrogen-fixing plants (Liles, Jr., 2000).

Lime: Lime, from the strictly chemical standpoint, refers to only one compound, calcium oxide (CaO); however, the term “lime” is commonly used in agriculture to include a great variety of materials that are usually composed of the oxide, hydroxide, or carbonate of calcium or magnesium. The most commonly used forms of agriculture lime are ground limestone (carbonates), hydrated lime

(hydroxides), burnt lime (oxides), and marl and oyster shells (modified from Liles, Jr., 2000).

Litter: In forestry, a surface layer of loose organic debris in forests, consisting of freshly fallen or slightly decomposed organic materials (Liles, Jr., 2000).

Loamy: Intermediate in texture and properties between fine-textured and course textured materials (Liles, Jr., 2000).

Mulch: A natural or artificial layer of plant residue or other materials, such as sand or paper, on the soil surface (Liles, Jr., 2000).

Nutrients: Elements, or compounds, essential as raw materials for organism growth and development, such as carbon, nitrogen, phosphorus (Wayland, 1993).

Oil/Water Separator: A device installed, usually at the entrance to a drain, which removes oil and grease from water flows entering the drain (EPA, 1992).

Organic Debris: Particles of vegetation or other biological material that can degrade water quality by decreasing dissolved oxygen and by releasing organic dissolved substances during leaching (Wayland, 1993).

Organic Pollutants: Substances containing carbon which may cause pollution problems in receiving streams (EPA, 1992).

Organic Solvents: Liquid organic compounds (typically synthetic) capable of dissolving solids, gases, or liquids (modified from, EPA, 1992).

Peak Discharge: The maximum instantaneous flow from a given storm condition at a specific location (Liles, Jr., 2000).

Percolation: The downward movement of water through soil, especially the downward flow of water in saturated or nearly saturated soil (modified from Liles, Jr., 2000).

Perennial Stream: A watercourse that flows throughout a majority of the year in a well-defined channel (Wayland, 1993).

Permeability: Capacity for transmitting a fluid. It is measured by the rate at which its fluid of standard viscosity can move through material in a give interval of time under a given hydraulic gradient (Liles, Jr., 2000).

Permeability (soil): The quality of a soil horizon that enables water or air to move through it. The permeability of a soil may be limited by the presence of one nearly impermeable horizon even though the others are permeable (Liles, Jr., 2000).

Pesticide: Any chemical agency used for control of plant or animal pests. Pesticides include insecticides, herbicides, fungicides, nematocides, and rodenticides (Wayland, 1993).

pH: A numerical measure of the acidity or hydrogen ion activity with a logarithmic range from 1 to 14. The neutral point is pH 7.0. All pH values below 7.0 are acid and all above are alkaline water (Liles, Jr., 2000).

Plume: A discrete source of pollution extending from its source (such as a landfill or leaky storage tank) along the ground water flow path to a point where the ground water is either pumped from a well or discharged into a surface water body (Hust and Murphy, 1997).

Point Source: Any discernible, confined and discrete conveyance from which pollutants are or may be discharged. Examples include but are not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, or vessel or other floating craft. (EPA, 1992).

Pollutant: Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial, municipal, and agricultural waste discharged into water (Section 502(6) of The Clean Water Act as amended by the Water Quality Act of 1987, Pub.L. 100-4).

Pollution Prevention: Eliminating or reducing the amount of toxicity of potentially harmful substances before they are introduced into the environment (Hust and Murphy, 1997).

Porosity: The volume of open spaces in rock or soil; if pores are large and abundant more water can be stored (Hust and Murphy, 1997).

Pure Live Seed (PLS): A term used to express the quality of seed, even if it is not shown on the label. Expressed as a percentage of the seeds that are pure and will germinate. Determined by multiplying the percent of pure seed by the percent of germination and dividing by 100 (Liles, Jr., 2000).

Rational Formula: A simple technique developed in the 1900's, for estimating peak discharge rates for very small developments. It is based on the rainfall intensity, watershed time of concentration, and runoff coefficient (Schueler, 1987).

Recharge: Addition of water to the saturated zone (Hust and Murphy, 1997).

Regolith: A general term for the layer of fragmental and unconsolidated rock mantling the bedrock surface (Bates and Jackson, 1987).

Retention: The holding of runoff in a basin without release except by means of evaporation, infiltration, or emergency bypass (Schueler, 1987). *Compare with Detention.*

Return Interval: A statistical term for the average time of expected interval that an event of some kind will equal or exceed given conditions (e.g., a storm water flow that occurs every 2 years) (Schueler, 1987), (See *Storm Frequency).*

Rill: A small intermittent watercourse with steep sides, usually only a few inches deep and thus no obstacle to tillage operations (Liles, Jr., 2000).

Riparian: A relatively narrow strip of land that borders a stream or river, and often coincides with the maximum water surface elevation of the 100 year storm (Schueler, 1987).

Riser: The inlet portions of a drop inlet spillway that extend vertically up from the pipe conduit barrel to the water surface (Liles, Jr., 2000).

Runoff: That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surface water. It can carry pollutants from the air and land into the receiving waters (Wayland, 1993).

Salinity: The concentration of dissolved solids or road salt in water (Wayland, 1993).

Saturated Zone: The subsurface locations where all the available pores and spaces are filled with water (modified from Hust and Murphy, 1997).

Scarify: To abrade, scratch, or modify the surface; for example, to scratch the impervious seed coat of hard seed or to break the surface of the soil with a narrow-bladed implement (Liles, Jr., 2000).

Sediment: Solid material, both mineral and organic, that is in suspension, is being transported, or had been moved from its site of origin by air, water, gravity, or ice, as a product of erosion (Liles, Jr., 2000).

Sediment Oxygen Demand (SOD): Biochemical oxygen demand of microorganisms living in sediments (Wayland, 1993).

Senescence: The annual die-back of aquatic plants at the end of the growing season (Schueler, 1987).

Sheet Flow: Water, usually storm runoff, flowing in a thin layer over the ground surface; also called overland flow (Liles, Jr., 2000).

Short Circuiting: The passage of runoff through a BMP in less than the theoretical or design treatment time (Schueler, 1987).

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 vertical distance (rise) and the second is the horizontal distance (run), as 2:1 or 200 percent. Expressed in degrees, it is the angle of the slope from the horizontal plane with a 90-degree slope being vertical (maximum) and 45 degree being a 1:1 slope (Liles, Jr., 2000).

SOD: See *Sediment Oxygen Demand*

Soil: The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants (Liles, Jr., 2000).

Soil Amendment: Any material, such as lime, gypsum, sawdust, or synthetic conditioner, that is worked into the soil to make it more amenable to plant growth (Liles, Jr., 2000).

Soil Horizon: A layer of soil or soil material approximately parallel to the land surface and differing from adjacent genetically related layers in physical, chemical, and biological properties or characteristics, such as color, structure, texture

consistence, kind and numbers of organisms present, degree of alkalinity, etc. (Liles, Jr., 2000).

Source Control: A practice or structural measure to prevent pollutants from entering storm water runoff or other environmental media (EPA, 1992).

Spoil: Soil or rock material excavated from a canal, ditch, basin, or similar construction (Liles, Jr., 2000).

Stabilization: The process of establishing an enduring soil cover of vegetation and/or mulch or other ground cover in combination with installing temporary or permanent structures for the purpose of reducing to a minimum the transport of sediment by wind, water, ice or gravity (Liles, Jr., 2000).

Stabilized Grade: The slope of a channel at which neither erosion nor deposition occurs (Liles, Jr., 2000).

Stokes Law Sedimentation: A model for the settling characteristics of particulate material in bodies of water; whereby, coarser materials are deposited first, followed by the finer-sized fractions (Schueler, 1987).

Storm Frequency: An expression or measure of how often a hydrologic event of a given size or magnitude should on an average occur, based on a reasonable sample (Liles, Jr., 2000) See *Return Interval.*

Stream Banks: The usual boundaries, not the flood boundaries, of a stream channel. Right and left banks are named facing downstream (Liles, Jr., 2000).

Streamflow: Water flowing in a natural channel, above ground (Schueler, 1987).

Stream Load: Quantity of solid and dissolved material carried by a stream (Liles, Jr., 2000).

Structural Practices: Soil and water conservation measures, other than vegetation, utilizing the mechanical properties of matter for the purpose of either changing the surface of the land or storing, regulating, or disposing of runoff to prevent excessive sediment loss. Including, but not limited to, riprap, sediment basins, dikes, level spreaders, waterways or outlets, diversion, structures, sediment traps, etc. (modified from Liles, Jr., 2000).

Subgrade: A layer of stone or soil used as the underlying base for a BMP (Schueler, 1987).

Subsoil: The B horizons of soils with distinct profiles. In soils with weak profile development, the subsoil can be defined as the soil below the plowed soil (or its equivalent of surface soil), in which roots normally grow. Although a common term, it cannot be defined accurately. It has been carried over from early days when "soil" was conceived only as the plowed soil and that under it as the "subsoil" (Liles, Jr., 2000).

Substrate: The natural soil base underlying a BMP (Schueler, 1987).

Subwatershed: A watershed subdivision of unspecified size that forms a convenient natural unit (Liles, Jr., 2000).

Surface Water: All water whose surface is exposed to the atmosphere (Wayland, 1993).

Swale: A natural depression or wide shallow ditch used to temporarily store, route or filter runoff (Schueler, 1987).

Tilth: A soil's physical condition as related to its ease to till (to work with a plow or other implement) (modified from Liles, Jr., 2000).

Time of Concentration: The time required for surface runoff from the most remote part of a drainage basin to reach the basin outlet (Schueler, 1987).

Top Soil: Earthy material used as top-dressing for house lots, ground for large buildings, gardens, road cuts, or similar areas. It has favorable characteristics for production of desired types of vegetation or can be made favorable (Liles, Jr., 2000).

TR-20: A watershed hydrology model developed by the Natural Resources Conservation Service that is used to route a design storm hydrograph through a pond (Schueler, 1987). TR-55 is a similar model.

TR-55: An urban hydrology model developed by the Natural Resources Conservation Service that is used to route a design storm hydrograph in a small watershed.

Turbidity: A cloudy condition in water due to suspended silt or organic matter (Wayland, 1993).

Underdrain: Plastic pipes with holes drilled through the top, installed on the bottom of an infiltration BMP, or sand filter, which are used to collect and remove excess runoff (Schueler, 1987).

Unified Soil Classification System (engineering): A classification system based on the identification of soils according to their particle size, gradation, plasticity index, and liquid limit (Liles, Jr., 2000).

Unsaturated Zone: The area just below the ground surface and above the seasonal-high ground water table, which is filled with air (Hust and Murphy, 1997).

Vegetation Practices: Stabilization of erosive or sediment-producing areas by grading and covering the soil with: (a) Permanent seeding; producing long-term vegetation cover or (b) Short-term seeding; producing temporary vegetative cover or (c) Sodding; producing areas covered with a turf of perennial sod-forming grass (modified from Liles, Jr., 2000).

Watercourse: Any natural or artificial watercourse, stream, river, creek, channel, ditch, canal, conduit, drain, waterway, gully, ravine, or wash in which water flows wither continuously or intermittently and which has a definite channel, bed and banks, and including any area adjacent thereto subject to inundation by reason of overflow or floodwater (Liles, Jr., 2000).

Watershed (U.S. definition): The region drained by, or contributing water to, a stream, lake or other body of water (Bates and Jackson, 1987).

Watershed Management: Use, regulation, and treatment of the water and land resources of a watershed to accomplish stated objectives (Liles, Jr., 2000).

Watershed Planning: Formulation of a plan to use and treat water and land resources within a watershed (modified from Liles, Jr., 2000).

Water Table: The upper surface or top of the saturated portion of the soil or bedrock layer indicating the uppermost extent of groundwater (Schueler, 1987).

Waterway: A natural course or constructed channel for the flow of water (Liles, Jr., 2000).

Well Recharge Area: That portion of an aquifer from which ground water can be diverted to the well (sometimes referred to as area of contribution), and up-gradient areas from which water flows naturally into the drawn down area of the well (modified from Hust and Murphy, 1997).

Wetfall: The deposition of atmospheric pollutants on the land surface that are washed out by precipitation (Schueler, 1987).

References Cited

Anonymous, Sept. 1994, Agricultural Best Management Practices for Protecting Water Quality in Georgia: Georgia Environmental Protection Division through a grant from the U.S. EPA, 36 p.

Bates, Robert L. and Julia A. Jackson, 1987, Glossary of Geology: American Geological Institute, Alexandria Virginia, 788 p.

Bingham, David, William Boucher, Peter Boucher, 1993, Handbook - Urban Runoff Pollution Prevention and Control Planning: US. Environmental Protection Agency, Office of Research and Development, EPA/625/R-93/004.

Brown, Arthur R. (Secretary), 1998, On-Farm Strategies to Protect Water Quality: NJ Assoc. of Conservation Districts in cooperation with the NJ Dept. of Agriculture and the NRCS/USDA, 95 p.

Caraco, Deborah and Richard Claytor, 1997, Storm Water BMP Design Supplement for Cold Climates: Prepared by the Center for Watershed Protection, Ellicott, Maryland for the U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds, EPA Grant #CP 985242-01-0.

Doenges, James S., Christopher P. Allan, Robert J. Jontos Jr., Cynthia A. Liebler, 1990, Carrying Capacity of Public Water Supply Watersheds: A Literature Review of Impacts on Water Quality from Residential Development: CT Dept. of Environmental Protection, DEP Bulletin 11, 130 p.

EPA, September 1999, Storm Water Management Fact Sheet - Coverings: Office of Water, Washington, D.C., EPA/832/F/99/009 3 p.

EPA, September 1999, Storm Water Technology Fact Sheet - Flow Diversion: Office of Water, Washington, D.C., EPA/832/F/99/014 4 p.

EPA, September 1999, Storm Water Technology Fact Sheet - Hydrodynamic Separators, Office of Water, Washington, D.C., EPA/832/F/99/017 6 p.

EPA, September 1999, Storm Water Technology Fact Sheet - Sand Filters, Office of Water, Washington, D.C., EPA/832/F/99/007 7 p.

EPA, September 1999, Storm Water Technology Fact Sheet - Storm Water Wetlands, Office of Water, Washington, D.C., EPA/832/F/99/025 11 p.

EPA, September 1999, Storm Water Technology Fact Sheet - Turf Reinforcement Mats: Office of Water, Washington, D.C., EPA/832/F-99/002, 6 p.

EPA, January 1993, Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters: Office of Water, Washington, D.C., EPA/840/B-92/002, 746 p.

EPA, September 1993, Municipal Wastewater Management Fact Sheets - Storm Water Best Management Practices: Office of Water, Washington, D.C., EPA/832/F-93/013, 87 p.

EPA, 1992, Storm Water Management for Construction Activities: Office of Water, Washington, D.C., EPA/832/R-92/005, NTIS Document # PB92235951, 362 p.

EPA, June 1991, Construction Site Storm Water Discharge Control - An Inventory of Current Practices: Prepared by Kamber Engineering, Gaithersburg, MD for Office of Water, Washington, D.C., EPA-833-P-91-100, 58 p.

EPA, 1987, A Guide to Controlling Nonpoint Source Pollution: Office of Wetlands, Oceans and Watersheds, Washington, D.C., NTIS Document Number PB93-234292, 121 p.

Gibbons, Jim, October 1999, Pavements and Surface Materials (Draft Fact Sheet): University of Connecticut, Cooperative Extension Service (Nonpoint Education for Municipal Officials Program), Haddam, CT.

Holbrook, Sidney J. (Comm.), (revised) 1996, Manual of Best Management Practices For Agriculture - Guidelines For Protecting Connecticut's Water Resources: CT Dept. of Environmental Protection, 277 p.

Holbrook, Sidney J. (Comm.), April, 1995, Assessment of Nonpoint Sources of Pollution in Urbanized Watersheds, A Guidance Document for Municipal Officials: CT Dept. of Environmental Protection, DEP Bulletin #22.

Hust, Robert and James Murphy, April 1997, Protecting Connecticut's Groundwater, A Guide for Local Officials: CT Dept. of Environmental Protection, DEP Bulletin #26, 161 p.

Leiberis, Joseph, August, 2000, Personal Communication - Westfarm's Mall's parking areas incorporating Vegetated Geotextile Mats: Maintenance Supervisor, Westfarm's Mall, Farmington, CT.

Liles, F. Graham, Jr., April, 2000, Manual for Erosion and Sediment Control in Georgia: Georgia Soil and Water Conservation Commission, 5th Edition, Athens, Georgia, 6 chapters with Appendices.

MADEP, March 1997, Storm Water Management- Volume 2 – Storm Water Technical Handbook: Massachusetts Department of Environmental Protection (MADEP) and the Massachusetts Department of Coastal Zone Management.

Minnick, Edwin L. and H. Tillman Marshall, 1992, Storm Water Management and Erosion and Sediment Control for Urban and Developing Areas in New Hampshire: Prepared by the Rockingham County Conservation District in cooperation with the USDA for the New Hampshire Department of Environmental Services.

Morris, Jackie, 1996, Source Protection, A Guidance Manual for Small Surface Water Supplies in New England: New England Interstate Water Pollution Control Comm. (NEIWPCC), 77 p.

Plainfield Economic Development Commission, 1998, Town of Plainfield Marketing Plan 1998-2000: Town of Plainfield, CT., 16 p.

Plainfield Planning and Zoning Commission, (adopted) 1998, Plan of Conservation and Development – 1997 to 2007, Policies Plan for the Town of Plainfield, Connecticut: Town of Plainfield, CT.

Pitt, Robert, Fall 1994, Technical Note #34 - The Risk of Groundwater Contamination from Infiltration of Storm Water Runoff: article in Watershed Protection Techniques, Silver Spring, MD, Vol. 1, No. 3, pp. 126-128.

Richman, Tom, K.H. Lichten, J. Worth, and B.K. Fergusson, December 23, 1998, "Vegetated Swales" in LATIS: Published by American Society of Landscape Architects, Washington, D.C.

Ritter, William F., T. S. Steenhuis, J. Boll, January 1994, Preventing Pesticide Contamination of Aquifers by Best Management Practices: Prepared by University of Delaware and Cornell University for the U.S. Geological Survey, NTIS Document # PB95199964, 45 p.

Schueler, Thomas, R., 1994, Developments in Sand Filter Technology to Improve Storm Water Runoff Quality: article in Watershed Protection Techniques, Silver Spring, MD, Vol. 1, No. 2.

Schueler, Thomas R., P. Krumble, M. Heraty, 1992, A Current Assessment of Urban Best Management Practices – Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone: Anacostia Research Team, Metropolitan Washington Council of Governments, Washington, D.C.

Schueler, Thomas R., July 1987, Controlling Urban Runoff – A Practical Manual for Planning and Designing Urban BMPs: Dept of Environmental Programs, Metropolitan Washington Council of Governments, Washington, D.C.

Spaulding, James T., 1996, Best Management Practices For Urban Storm Water Runoff: New Hampshire Department of Environmental Services, Concord, New Hampshire, Document #NHDES-WSPCD-95-3.

Sojka, Robert E. and Rodrick D. Lentz, (submitted) March 18, 1997, A PAM Primer – A Brief History of PAM and PAM Related Issues: USDA – Agricultural Research Service, Kimberly, ID, article from the web at: http://kimberly.ars.usda.gov/pampage.shtml.

USDA, March, 1999, Irrigation Water Management: Natural Resources Conservation Service, National Practice Standard Code #449, from the Web at: www.nrcs.usda.gov.

USDA, August, 1998, Wetland Creation: Natural Resources Conservation Service, National Practice Standard Code #658, from the Web at: www.nrcs.usda.gov.

USDA, August, 1998, Wetland Development or Restoration: Natural Resources Conservation Service, National Practice Standard Code #657, from the Web at: www.nrcs.usda.gov.

USDA, August, 1998, Wetland Enhancement: Natural Resources Conservation Service, National Practice Standard Code #659, from the Web at: www.nrcs.usda.gov.

USDA, August, 1998, Constructed Wetland: Natural Resources Conservation Service, National Practice Standard Code #656, from the Web at www.nrcs.usda.gov.

USDA, May 1997, Irrigation System / Sprinkler: Natural Resources Conservation Service, National Practice Standard Code #442, from the Web at: www.nrcs.usda.gov.

USDA, May 1997, Irrigation System / Surface and Subsurface: Natural Resources Conservation Service, National Practice Standard Code #443, from the Web at: www.nrcs.usda.gov.

USDA, May 1997, Irrigation System / Trickle: Natural Resources Conservation Service, National Practice Standard Code #441, from the Web at: www.nrcs.usda.gov.

USDA, May 1997, Land Reconstruction – Abandoned Mined Land: Natural Resources Conservation Service, National Practice Standard Code #543, from the Web at: www.nrcs.usda.gov.

USDA, May 1997, Land Reconstruction – Currently Mined Land: Natural Resources Conservation Service, National Practice Standard Code #544, from the Web at: www.nrcs.usda.gov.

USDA, May 1997, Land Smoothing: Natural Resources Conservation Service, National Practice Standard Code #466, from the Web at: www.nrcs.usda.gov.

USDA, May 1997, Prescribed Burn: Natural Resources Conservation Service, National Practice Standard Code #338, from the Web at www.nrcs.usda.gov.

USDA, December, 1996, Conservation Cover: Natural Resources Conservation Service, National Practice Standard Code #327, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Diversion: Natural Resources Conservation Service, National Practice Standard Code #362, from the Web at: www.nrcs.usda.gov.

.

USDA, December, 1996, Contour Buffer Strips: Natural Resources Conservation Service, National Practice Standard Code #332, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Contour Farming: Natural Resources Conservation Service, National Practice Standard Code #330, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Contour Orchard and Other Fruit: Natural Resources Conservation Service, National Practice Standard Code #331, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Field Border: Natural Resources Conservation Service, National Practice Standard Code #386, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Filter Strip: Natural Resources Conservation Service, National Practice Standard Code #393, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Forest Harvesting Trails and Landings: Natural Resources Conservation Service, National Practice Standard Code #655, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Forest Site Preparation: Natural Resources Conservation Service, National Practice Standard Code #490, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Forest Stand Improvement: Natural Resources Conservation Service, National Practice Standard Code #666, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Mulching: Natural Resources Conservation Service, National Practice Standard Code #484, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Nutrient Management: Natural Resources Conservation Service, National Practice Standard Code #590, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Pest Management: Natural Resources Conservation Service, National Practice Standard Code #595A, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Riparian Forest Buffer: Natural Resources Conservation Service, National Practice Standard Code #391, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Residue Management / Mulch Till: Natural Resources Conservation Service, National Practice Standard Code #329B, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Residue Management / No-Till and Strip Till: Natural Resources Conservation Service, National Practice Standard Code #329A, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Residue Management / Ridge Till: Natural Resources Conservation Service, National Practice Standard Code #329C, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Residue Management / Seasonal: Natural Resources Conservation Service, National Practice Standard Code #344, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Roof Runoff Management: Natural Resources Conservation Service, National Practice Standard Code #558, from the Web at: www.nrcs.usda.gov.

USDA, December, 1996, Streambank & Shoreline Protection: Natural Resources Conservation Service, National Practice Standard Code #484, from the Web at: www.nrcs.usda.gov.

USDA, April, 1995, Animal Trails and Walkways: Natural Resources Conservation Service, National Practice Standard Code #575, from the Web at: www.nrcs.usda.gov.

Ward, Andy D. and William J. Elliot, 1995, Environmental Hydrology, Lewis Publishers CRC Press, Boca Raton, 462 p.

Wayland, Robert H. III (Dir.), 1993, Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters: US. Environmental Protection Agency, Office of Water, EPA/840/B-92/002.

Young, G. Kenneth, Stuart Stein, Pamela Cole, Traci Kammer, Frank Graziano, December 1995 (Revised 1998), Evaluation and Management of Highway Runoff Quality: Prepared by GKY and Associates, Inc. for the Federal Highway Commission, NTIS Document Number PB2000-100923, 480 p.

TABLE 1

LAND USE MANAGEMENT GOALS AND LAND USE TYPES
TOWN OF PLAINFIELD, CONNECTICUT

	Plainfield Land Use Management Goals (1)	Land Use Type (2) Industry	Rural Residential	Forest	Agriculture	Village
1	Protect ground water: both public water supplies and private wells	X	X	X	X	X
2	Maintain stream-belt greenway corridors	X	X	X	X	X
3	Protect and manage the Moosup Pond watershed	X	X	X	X	X
4	During land development activities, avoid or minimize wetland impacts and require adequate compensation for any loss of wetland area or function.	X	X	X	X	X
5	Protect the Town's best scenic views and vistas, stone walls and natural areas	X	X	X	X	X
6	Develop a Town Greenway system incorporating a multi-purpose non-motorized trail plan and river access involving view areas, fishing and canoeing	X	X	X	X	X
7	Limit future gravel excavation activities in areas of agricultural importance or ground water aquifer or recharge areas	X	X	X	X	X
8	Require developments of forested parcels of land to maintain forested corridors between adjacent forest parcels. Base the corridors on mapped habitats and habitat intersection information	X	X	X	X	
9	Require open-space set-asides or compensatory open space for developments of large forested parcels	X	X	X		
10	Development should provide for no net loss of floodplain storage from the 100-year frequency flood event.	X	X			X
11	Promote development that limits impervious surface area to less than 30 percent	X	X			X
12	Encourage the relocation of environmentally-aware businesses and light-industry to Plainfield that have low-impact water use operations	X				
13	Direct industrial development to locate in specific economic zones (Plainfield Manufacturing Area or the Industrial Park)	X				
14	Maintain, to the greatest extent possible, uninterrupted tracts of forest land within the Town			X		
15	Foster a Town-wide commitment to long-term forest management			X		
16	Promote private planned forestry management focused on timber, fuel-wood and recreation			X		
17	Manage the Town's 90-acre parcel of land for forest products and recreation			X		
18	Promote farm profitability and protect the most valuable farmland				X	
19	Manage development and renovation in the Historic Districts to promote and maintain the original, more simple balance between development and the rural village character of the Town					X

Notes:
(1) Goals modified or developed from the town publication, "Plainfield Plan of Conservation and Development - 1997 to 2007."
(2) X - indicates the Land Use Management Goal is applicable to the Land Use Type of the column heading

TABLE 2

BEST MANAGEMENT PRACTICES AND LAND USE MANAGEMENT GOALS

TOWN OF PLAINFIELD, CONNECTICUT

Practices	Goal Number (Goals in Table 1) (1): 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Management (M)																			
Crop Residue Management	X						X											X	
Forest Chemical Management	X		X						X					X	X	X	X		
Forest Prescribed Burn Management	X								X					X	X	X	X		
Forest Site Management	X		X	X	X			X	X					X	X	X	X		
Irrigation Water Management	X		X								X	X	X					X	
Land Reclamation	X	X	X	X	X		X			X	X	X	X	X				X	
Lawn Care and Garden Management	X	X		X	X			X	X		X	X	X	X					X
Nutrient Management	X						X									X	X	X	X
Pest and Pesticide Management	X	X	X	X	X	X		X				X	X		X	X	X	X	X
Roof Runoff Management	X			X							X	X	X						X
Structural (S)																			
Coverings	X		X							X		X	X					X	X
Extended Detention Basin	X		X	X						X	X	X	X						X
Forest Logging Roads	X	X	X	X	X	X	X	X	X					X	X	X	X		
Geotextile - Turf Pavement	X	X	X	X	X	X		X		X	X			X	X	X	X	X	X
Geotextile	X	X	X	X	X	X					X	X				X			X
Infiltration - Porous Pavement	X	X	X	X		X					X	X	X				X		X
Infiltration - Trench	X	X	X		X				X	X	X						X	X	X
Infiltration Basin	X		X		X						X	X	X						X
Level Spreader	X		X	X		X	X				X			X			X		
Riprap	X		X	X															X
Sand Filter	X		X	X							X	X	X						X
Soil Stabilization - Polyacrylamide	X	X	X	X															X
Trails and Walkways	X	X		X	X	X		X	X	X	X	X		X	X	X	X	X	X
Water Diversion	X	X	X	X		X		X			X		X			X	X	X	X
Water Quality Inlet (Trap)	X		X	X							X	X	X						X
Wet Pond	X	X	X	X	X	X	X	X	X	X	X	X	X				X		
Vegetative (V)																			
Contour Farming	X						X											X	
Filter Strip	X	X	X	X	X				X	X	X							X	X
Grassed Swale	X	X	X	X	X	X	X	X		X	X			X		X	X	X	X
Land Smoothing	X			X			X			X	X	X	X					X	X
Soil Stabilization - Conservation Cover	X	X	X	X	X	X	X	X	X		X					X	X	X	X
Soil Stabilization - Field Border	X	X	X	X	X	X	X	X	X		X			X	X	X		X	
Soil Stabilization - Mulching	X	X	X	X		X	X				X			X	X	X	X	X	X
Stream (Riparian) Buffer	X	X	X	X	X	X	X			X	X				X	X	X		
Wetland - Constructed	X	X	X	X	X	X	X	X		X	X	X	X						

Notes: (1) **X** - indicates the practice is applicable to the Land Use Management Goal of the column heading

Appendix

BEST MANAGEMENT PRACTICES

Appendix contains a compilation of information on 35 BMPs that are likely to have particular relevance to Plainfield land uses and management goals. In the future, additional BMPs may become appropriate as new innovations to control pollution and runoff are pursued by concerned organizations. Furthermore, specific conditions in Plainfield may evolve requiring new approaches and considerations to control storm water runoff and protect surface and ground water resources. The next few pages describe how to interpret the tabulated Best Management Practice (BMP) information in this appendix.

Title:
The BMP name is found at the beginning of each BMP table. An acronym is found in parentheses next to the BMP name. The acronym is a suggested shorthand representation for the BMP that may be used by those consulting this manual within reports, site plans and development maps that are brought to the town for review.
The first letter of the acronym is a V, S or M. The capital letters indicate whether the BMP is represented as a vegetative, structural or management practice in Table II. The remaining lower case letters are the abbreviation of the initial letters of the BMP name.

Description:
This section provides a basic explanation of the BMP practice including a physical description and some selected examples of implementation and applicability.

Purpose:
This section lists NPS pollution situations that may be addressed with the BMP.

Criteria:
The criteria sections of the table are divided into several categories. These represent NPS pollution mitigation or BMP implementation-related categories that commonly have an impact on the choice of BMPs for a particular situation. Each criteria category is described below.

Performance Comments / Evaluation:
An evaluation rating has been applied to each BMP criteria. In many cases, an additional comment is also included to clarify the context of the rating. The written

rating is based primarily on information available from the "Primary Source of BMP Information" publication cited at the end of each BMP.

The Primary reference listed for each BMP was chosen because it is representative of the consensus of reference information, and presents the BMP information in a concise and comprehensive fashion. Users of this manual are encouraged to check the Primary references for more detailed BMP information. Many of the references also have guidance concerning design and engineering specifications.

The performance comments and evaluations are based on the reference information and our professional experience. The written performance evaluation ratings include excellent, good, fair and poor. These ratings correspond to greater than 80 percent effective, 50 to 80 percent, 20 to 50 percent, and less than 20 percent effective, respectively. These ratings require that the BMP is appropriate for the contaminants at the site, sized appropriately for the expected storm event, installed properly and maintained regularly to continue to achieve original design performance levels.

The cost-related evaluations are classified as low, medium and high and generally include a brief explanation of how the BMP compares to other BMP choices.

Special consideration must be paid to the effects of winter conditions (snow, ice, de-icing salt) on the effectiveness of the BMPs. Caraco and Claytor (1997) provide good insight into many of the situations and "cold weather" BMP modifications that should be addressed for the Plainfield area.

Criteria	Performance Comments / Evaluation
Sediment / Soil	This category covers impacts to soil and sediment that are in locations up-gradient to ground water and surface water resources
Erosion Control	Rates the effectiveness of the BMP at preventing or minimizing soil erosion
Sedimentation Control	Rates the effectiveness of the BMP at controlling, directing or causing the sediment load in a volume of storm water runoff to drop out of suspension (entrainment) at a given location
Prevent Contamination by:	
Salinity	Rates the effectiveness of the BMP at preventing or minimizing increases in the salinity values of soil and sediment. Salinity is a measurement of the level of salts such as chloride, potassium, sodium and magnesium that are in the soil. Sodium and chloride from road salt are the primary salinity concerns for Plainfield
Fertilizers and Organics	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of nutrients in soil and sediment. Organics means manure or animal/human urea used in

	agriculture/forestry turf grass applications. It does not include synthetic organic chemicals with uses other than for fertilizer
Pesticides / Herbicides	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of pesticide and related poisons in soil and sediment
Other	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of synthetic chemicals not covered by the three previous contaminant types in soil and sediment
Water Quantity	
Runoff Control	Rates the effectiveness of the BMP at reducing runoff volumes
Infiltration	Rates the effectiveness of the BMP at controlling or increasing infiltration of runoff to ground water
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of pesticide and related poisons in ground water beneath and near the BMP
Heavy Metals	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of heavy metals in ground water beneath and near the BMP
Pathogens	Rates the effectiveness of the BMP at minimizing or preventing the introduction of pathogens into ground water beneath and near the BMP
Fertilizers and Organics	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of nutrients in ground water beneath and near the BMP. Organics means manure or animal/human urea used in agriculture/forestry turf grass applications. It does not include synthetic organic chemicals with uses other than for fertilizer
Salinity	Rates the effectiveness of the BMP at preventing or minimizing increases in the salinity values in ground water. Salinity is a measurement of the level of salts such as chloride, potassium, sodium and magnesium that are in the ground water. Sodium and chloride from road salt are the primary salinity concerns for Plainfield
Other	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of synthetic chemicals not covered by the five previous contaminant types in ground water beneath and near the BMP
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of pesticide and related poisons in surface water downstream from the BMP

Heavy Metals	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of heavy metals in surface water downstream from the BMP
Pathogens	Rates the effectiveness of the BMP at minimizing or preventing the introduction of pathogens into surface water downstream from the BMP
Fertilizers and Organics	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of nutrients in surface water downstream from the BMP. Organics means manure or animal/human urea used in agriculture/forestry turf grass applications. It does not include synthetic organic chemicals with uses other than for fertilizer
Salinity	Rates the effectiveness of the BMP at preventing or minimizing increases in the salinity values in surface water downstream from the BMP. Salinity is a measurement of the level of salts such as chloride, potassium, sodium and magnesium that are in the surface water. Sodium and chloride from road salt are the primary salinity concerns for Plainfield
Suspended Sediment	Rates the effectiveness of the BMP at preventing or minimizing increases in the suspended sediment load in surface downstream from the BMP
Low Dissolved Oxygen	Rates the effectiveness of the BMP at preventing or minimizing decreases in the dissolved oxygen levels of surface water downstream from the BMP
Water Temperature Increase	Rates the effectiveness of the BMP at preventing or minimizing increases in the water temperature of surface water downstream from the BMP
Other	Rates the effectiveness of the BMP at minimizing increases or preventing excess levels of synthetic chemicals not covered by the eight previous contaminant types in surface water downstream from the BMP
Habitat Suitability	Rates the effectiveness of the BMP at protecting or maintaining the quality of nearby existing habitat and/or at creating new valuable habitat
Capital or Implementation Costs	Rates the expense of building and implementing the BMP relative to other BMP options. These costs are site specific and design specific in nature. It is suggested, specific cost comparisons should be provided for evaluation when reviewing proposals for site development
Operation and Maintenance	Rates and describes the general operation and maintenance goals for each BMP. Operation and maintenance goals should ensure that the BMP operates at the design efficiency specified in the approved development plans for the property
Potential Side Effects	Describes potential negative impacts (if any) and important positive results of the BMP

Concurrent Land Management Practices	Suggests additional BMPs which may improve the function or reduce the maintenance requirements of the subject BMP when they are used together in a comprehensive source water protection plan
Feasibility	Provides general guidance on the applicability of the BMP to various land use situations

Primary Source of BMP Information:

Additional References:

Crop Residue Management (Mcr)

Description: Mcr requires managing the residue from crop growth and harvesting on a year-round basis. Various techniques are available, including till and no-till methods. No-till methods generally involve relatively higher use of herbicides to sustain sufficient volumes of crop residue than do tilling routines. The USDA suggests a minimum 30 percent coverage by residue to consistently achieve the conservation and agricultural purposes/ goals of the practice.

Purpose: The practice is used to promote high organic content in the soil, control runoff, reduce erosion and conserve moisture within the soil.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to excellent by reducing effects of rain splash impacts
Sedimentation Control	Good to excellent by reducing volume of eroded materials
Prevent Contamination by:	
Salinity	Fair. By reducing runoff and allowing more moisture to infiltrate through the soil
Fertilizers and Organics	Fair. By reducing application requirements and potentially increased plant uptake
Pesticides / Herbicides	Fair. By reducing application requirements
Other	Will vary by contaminant
Water Quantity	
Runoff Control	Good by increasing time of concentration
Infiltration	Good by increasing time of concentration
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. No-Till Methods that use pesticides and herbicides are potentially less effective as the increased infiltration resulting from the practice serves to carry more applied chemicals down to the water table Fair to Good. Till Methods that do not use pesticides and herbicides reduce the amount and concentration of chemicals available to leach to the ground water table
Heavy Metals	Generally no significant effect
Pathogens	Generally no significant effect
Fertilizers and Organics	Generally no significant effect
Salinity	Generally no significant effect
Other	Will vary by contaminant
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Fair to Good. Reduces the concentration and amount of chemical-containing runoff leaving the field

Heavy Metals	Generally no significant effect
Pathogens	Generally no significant effect
Fertilizers and Organics	Fair to Good. Reduces the concentration and amount of chemical-containing runoff leaving the field
Salinity	Fair. Reduces the concentration and amount of chemical-containing runoff leaving the field
Suspended Sediment	Good to Excellent. Reduces the amount of sediment in the runoff leaving the field by stabilizing the soil and inhibiting erosion
Low Dissolved Oxygen	Generally no significant effect. Care should be taken to ensure that the residue remains substantially on the field as a cover and is not washed into adjacent water bodies
Water Temperature Increase	Generally no significant effect
Other	Will vary by contaminant
Habitat Suitability	Provides wildlife food and cover
Capital or Implementation Costs	Competitive with other out-of-season methods (winter plantings) to maintain soil cover. Costs will vary with the type of management selected (No-till vs. till)
Operation and Maintenance	No significant additions to annual field care. However, some of the specific techniques may be modified (Refer to NRCS and Cooperative Extension guidance)
Potential Side Effects	May increase leaching to ground water of excess applied fertilizers and pesticides
Concurrent Land Management Practices	Implement Pest and Pesticide Management Plan Implement Nutrient Management Plan
Feasibility	Applicable to cultivated annual row crop fields Crops must produce enough residue to cover the fields adequately

Primary Source of BMP Information: Holbrook, 1996

Additional References:

USDA, December, 1996 (Residue Management / Mulch Till)
USDA, December, 1996 (Residue Management / No-Till and Strip Till)
USDA, December, 1996 (Residue Management / Ridge Till)
USDA, December, 1996 (Residue Management / Seasonal)

Forest – Chemical Management (Mfc)

Description: Mfc is a BMP involving methods and procedures to control the type, use, handling and disposal of chemical products (gas/oil mixtures, bar oil, hydraulic oil, pesticides and herbicides) used during forestry activities such as harvesting, pest control, and fertilization. Practices must be site specific based on the logging plan for the property to accommodate the variable nature of the topography, logging method (e.g., mechanized verses horses), seasonal weather and ground and surface water conditions (see Forest Logging Roads, Forest Site Management). Example practices might include: buffer zones along watercourses and water bodies, designated fueling areas, off-site maintenance of motorized equipment, portable impermeable sheeting for daily maintenance and fueling of small-engine equipment, use of properly calibrated equipment for applying pesticides and fertilizers, and the application, use and disposal of chemicals following manufacturers directions.

Purpose: The purpose of the procedures is to prevent or minimize impacts to soil, ground water and surface water from accidental spills of chemical products required for logging and other forestry related activities.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Not Applicable
Sedimentation Control	Not Applicable
Prevent Contamination by:	
Salinity	Not Applicable
Fertilizers and Organics	Good. Following manufacturer directions for proper application is critical to minimize adverse impacts
Pesticides / Herbicides	Good. Following manufacturer directions for proper application is critical to minimize adverse impacts
Other	Good. Prevents or minimizes contamination from spills and machinery leaks
Water Quantity	
Runoff Control	Not Applicable
Infiltration	Not Applicable
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good. Following manufacturer directions for proper application is critical to minimize adverse impacts
Heavy Metals	Good. Following manufacturer directions for proper application is critical to minimize adverse impacts
Pathogens	Not Applicable
Fertilizers and Organics	Good. Following manufacturer directions for proper application is critical to minimize adverse impacts
Salinity	Not Applicable
Other	Good. Prevents or minimizes contamination from spills and machinery leaks

Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good. Following manufacturer directions for proper application is critical to minimize adverse impacts
Heavy Metals	Good. Following manufacturer directions for proper application is critical to minimize adverse impacts
Pathogens	Not Applicable
Fertilizers and Organics	Good. Following manufacturer directions for proper application is critical to minimize adverse impacts
Salinity	Not Applicable
Suspended Sediment	Not Applicable
Low Dissolved Oxygen	Not Applicable
Water Temperature Increase	Not Applicable
Other	Good. Prevents or minimizes contamination from spills and machinery leaks
Habitat Suitability	Good. Important for the protection of the healthy viability of existing habitats on and adjacent to the logging and staging areas
Capital or Implementation Costs	Capital Costs – Not Applicable Proper use of chemicals minimizes waste and associated expenses. Clean up costs for chemical spills may be eliminated
Operation and Maintenance	Low. Chemical handling and preparation areas should be inspected frequently for conditions that could lead to impacts to nearby surface waters and underlying soil and ground water. Repairs to at-risk situations (e.g., damaged spill containment materials, damaged or leaking engine hoses) should be made before further chemical or logging machinery use is permitted in the area
Potential Side Effects	Proper use of chemical products can increase the productivity of forestry operations
Concurrent Land Management Practices	Erosion and sediment control measures must be part of the chemical management program to stabilize ground surfaces and minimize unplanned runoff that can remove applied chemicals from the location of their intended use
Feasibility	Applicable to silvicultural, forestry and logging efforts

Primary Source of BMP Information: EPA, January, 1993

Additional References:

Morris, 1996

Forest - Prescribed Burn Management (Mfpb)

Description: A planned and controlled burn of a designated and limited area. It may or may not be used in conjunction with other (mechanical) methods to prepare land for planting. Especially for larger parcels, this is a specialized practice that should be carried out by trained and experienced personnel to be effective and safe. Pre-planning of access routes and the burn pattern allows for future runoff to be controlled by constructing or preparing appropriate structural BMPs in advance of the burn.

Purpose: The activity is used for rehabilitation/ preparation of forest lands. Prescribed burns destroy slash, flammable debris, competing vegetation, reduce nitrogen/nitrate loading and modify other soil chemical conditions. The process may improve some habitat regimes and has been used to control plant diseases.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good. Compared to impacts resulting from uncontrolled wildfires
Sedimentation Control	Good. Compared to impacts resulting from uncontrolled wildfires
Prevent Contamination by:	
Salinity	Not Applicable
Fertilizers and Organics	Not Applicable
Pesticides / Herbicides	Not Applicable
Other	Not Applicable
Water Quantity	
Runoff Control	Good. Compared to impacts resulting from uncontrolled wildfires
Infiltration	Good. Compared to impacts resulting from uncontrolled wildfires
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Not Applicable
Heavy Metals	Not Applicable
Pathogens	Not Applicable
Fertilizers and Organics	Not Applicable
Salinity	Not Applicable
Other	Not Applicable
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Not Applicable
Heavy Metals	Not Applicable
Pathogens	Not Applicable
Fertilizers and Organics	Not Applicable
Salinity	Not Applicable

Suspended Sediment	Good. Compared to impacts resulting from uncontrolled wildfires
Low Dissolved Oxygen	Good. Compared to impacts resulting from uncontrolled wildfires
Water Temperature Increase	Good compared to impacts resulting from uncontrolled wildfires
Other	Not Applicable
Habitat Suitability	Good. Compared to impacts resulting from uncontrolled wildfires
Capital or Implementation Costs	Low. Compared to dealing with impacts resulting from uncontrolled wildfires
Operation and Maintenance	Low. Compared to dealing with impacts resulting from uncontrolled wildfires
Potential Side Effects	Successful planning may improve the quality of the forest stand for future harvests Critical habitats are protected
Concurrent Land Management Practices	Erosion and sediment control measures must be part of the prescribed burn program to prevent impacts to vulnerable unvegetated soils Non-burn areas/ buffers along streams and impounded water bodies must be protected
Feasibility	Applicable to parcels larger than 5 acres for silvicultural, forestry and logging efforts. Should be conducted with the supervision and planning of a forester trained and experienced with this technique

Primary Source of BMP Information: EPA, January, 1993

Additional References:

USDA, May, 1997, (Prescribed Burn)

Forest Site Management (Mfs)

Description: The process of preparing or improving (regeneration of a wood lot) a site for logging. Activities include manipulating species and encouraging growth in areas that will avoid or minimize impacts to ephemeral and perennial watercourses and steep or otherwise unstable terrain during logging. During each stage of the planning process, the impacts from access, felling trees and forwarding the logs to a landing area must be considered so that logging activities may be completed with the least amount of impact to surface or ground water resources in the area. Basic management goals for storm water control must be site specific but should include minimizing stream crossings, reducing pesticide or herbicide use, avoiding steep logging road grades and having a fueling and maintenance spill prevention program for small and large equipment use.

Purpose: The process is a method for minimizing disturbance and damage to on-site and off-site natural resources presently and long-term.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salinity	Generally Not Applicable
Fertilizers and Organics	Good. Managed planting and location schedules can minimize chemical use and runoff
Pesticides / Herbicides	Good. Managed planting and location schedules can minimize chemical use and runoff
Other	Not Applicable
Water Quantity	
Runoff Control	Good. Managed planting, location and access during the regeneration/ replanting cycle can stabilize existing disturbed areas and minimize erosion and sedimentation impacts during future logging activities
Infiltration	Fair to Good. Stabilizing disturbed areas with seedling and/ or mulch and seed applications increases infiltration by reducing direct runoff from the site. Transpiration (water use by the growing trees) may use a significant portion of the runoff retained at the site
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good. Managed planting and location schedules can minimize chemical use and infiltration to ground water
Heavy Metals	Not Applicable
Pathogens	Generally not applicable
Fertilizers and Organics	Good. Managed planting and location schedules can minimize chemical use and infiltration to ground water
Salinity	Not Applicable

Other	Not Applicable
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good. Managed planting and location schedules can minimize chemical use and runoff
Heavy Metals	Not Applicable
Pathogens	Generally not applicable
Fertilizers and Organics	Good. Managed planting and location schedules can minimize chemical use and runoff
Salinity	Not Applicable
Suspended Sediment	Good to Excellent
Low Dissolved Oxygen	Generally no significant affect
Water Temperature Increase	Good to Excellent in the long-term. Immediate effects will be site and application dependent
Other	Not Applicable
Habitat Suitability	Good to Excellent. Appropriate forest regeneration plans should identify and maintain significant and critical habitat areas when and wherever possible
Capital or Implementation Costs	Low to moderate. Planned regeneration and layout work is significantly cost effective and may actually lower the overall cost of the logging effort Management and coordination of the felling, staging, hauling (forwarding) and replanting activities can reduce the number and expense of BMPs that must be installed and maintained to prevent adverse storm water impacts
Operation and Maintenance	Low. This is the most important aspect of forest management and storm water control. Proper maintenance of equipment and repair of BMPs before they fail will prevent or minimize adverse storm water impacts. The Forest Site Management plan should include detailed daily, weekly, monthly and yearly inspection and repair schedules to help ensure that the O&M plan is incorporated into the normal operational cycle. Repairs and adjustments should be made promptly
Potential Treatment Side Effects	Successful planning may improve the quality of the forest stand for future harvests Critical habitats are protected Impacts to downstream water resources are minimized
Concurrent Land Management Practices	Chemical and Fuel Storage and Handling methods to prevent soil and ground water contamination must be specified.
Feasibility	Applicable to all silvicultural, forestry and logging efforts

Primary Source of BMP Information: EPA, January, 1993

Additional References:

USDA, December, 1996 (Forest Site Preparation)

USDA, December, 1996 (Forest Stand Improvement)

Irrigation Water Management (Miw)

Description: An efficient planned system for the application of water and (optional) nutrients to crop and turf root zones over a large area. The irrigation system controls the rate, amount and timing of the application. Several types of systems are available, including drip or trickle irrigation, modified sprinkler applications, and surface flow systems (e.g., ditched or furrowed). System components may include (for example): low volume emitters, orifices or porous tubing, conveyance piping and pumps, electric timers and rainfall and soil moisture sensors.

Purpose: To conserve water, prevent soil erosion, minimize leaching and runoff impacts from pesticides and fertilizers to ground water and surface water during irrigation of cropland or golf courses while maintaining proper soil moisture conditions for plant growth.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Excellent
Sedimentation Control	Excellent
Prevent Contamination by:	
Salinity	Good. Applying the appropriate amount of water minimizes the conditions (leaching) that may lead to salt accumulation in the soil. However, not usually a concern in New England
Fertilizers and Organics	Excellent in golf course and agricultural applications
Pesticides / Herbicides	Fair to Good. Proper scheduling and coordination of irrigation and chemical applications helps to eliminate situations where irrigation water may remove previously applied chemicals. Proper irrigation also reduces leaching of the pesticides from the soil before they can be effective
Other	Generally not applicable
Water Quantity	
Runoff Control	Excellent
Infiltration	Excellent
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Fair to Good. Proper scheduling and coordination of irrigation and chemical applications helps to eliminate situations where irrigation water may remove previously applied chemicals. Proper irrigation also reduces leaching of the pesticides from the soil before they can be effective
Heavy Metals	Generally not applicable
Pathogens	Generally no significant effect
Fertilizers and Organics	Excellent in golf course and agricultural applications.

Salinity	Good. Applying the appropriate amount of water minimizes the conditions (leaching) that may lead to salt accumulation in the soil. However, not usually a concern in New England
Other	Will vary by contaminant; Generally no significant effect
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good by eliminating the spray that may remove previously-applied chemicals from above-ground plant parts and transporting them to surface water bodies
Heavy Metals	Generally no significant effect
Pathogens	Generally no significant effect
Fertilizers and Organics	Excellent in golf course and agricultural applications
Salinity	Generally no significant effect
Suspended Sediment	Excellent
Low Dissolved Oxygen	Generally no significant effect
Water Temperature Increase	Generally no significant effect
Other	Will vary by contaminant; generally no significant effect
Habitat Suitability	Good. Protection and/ or improvement of adjacent aquatic habitats by reducing the influx of contaminants carried by incoming surface or ground water
Capital or Implementation Costs	Initial cost to purchase and install the equipment is significant, but is competitive with other irrigation options or the cost to repair and replace turf and crops that do not survive periods of low rainfall
Operation and Maintenance	Irrigation equipment must be inspected and serviced regularly to ensure proper function and reduce losses from poor fittings and valves. This is especially important if the system is also used to apply fertilizers and pesticides The operator must have appropriate training and experience to properly assess the irrigation variables of the plan
Potential Side Effects	Over-irrigation can lead to rising ground water levels in the immediate area of the application. Water levels may fall in the vicinity of the supply well if pumping exceeds the recharge of the aquifer
Concurrent Land Management Practices	Develop a water balance budget based on the soil and climate, etc., to determine the moisture requirements of the crops being grown If fertilizer and pesticides are applied through the irrigation system, then back flow valves, chemical handling precautions and nutrient and pesticide management plans must be applied to ensure that water sources are not contaminated

Feasibility	Applicable to large acreage properties such as golf courses, cultivated land and large commercial properties

Primary Source of BMP Information: Holbrook, 1996

Additional References:

Anonymous, September, 1994
Brown, 1998
USDA, March, 1999
USDA, May, 1997 (Irrigation / Sprinkler)
USDA, May, 1997 (Irrigation / Surface and Subsurface)
USDA, May, 1997 (Irrigation / Trickle)

Land Reclamation (Mlr)

Description: The process of returning a land area to an historical or acceptable land use. A plan of reclamation is an essential foundation for the land reclamation process because it provides a timeline and measurable milestones that may be assessed through time to determine the timeliness and effectiveness of the reclamation process as well as other site specific concerns. The reclamation plan may be developed at any time, especially for existing properties that may change uses or conditions which require significant land use changes. However, a plan of reclamation is most commonly applied at the beginning of a development process to ensure the final land use is appropriate and reclaimed in accordance with town requirements. Reclamation is typically completed on a phased schedule on separate portions of an aggregate and/ or crushed stone mining operation as specific areas are "mined out" and depleted of mineral or stone. Land reclamation should not be limited to mining properties, but should include any property with degraded natural conditions (e.g., brownfields sites, neglected/ abandoned commercial properties) that may be permanently improved through actions that (for example) adjust topography and drainage, establish vegetation for erosion control and habitat, and protect surface and ground water resources. The process commonly includes restoring missing or poorly functioning natural resources (top soil, vegetation, drainage, landscape) to blend with surrounding conditions. Steep slopes and high walls are usually taken down to a stable grade for safety and drainage considerations.

Purpose: Common objectives of reclamation are to:

- prevent permanent damage to the natural resources of an area
- protect surface and ground water quality
- restore productivity to the soil
- control erosion and sedimentation impacts
- maintain landscape aesthetics
- provide post-mining economic use of the land
- improve fish and wildlife habitat
- create a safer and healthier environment

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salinity	Generally no significant effect in comparison to past aggregate and crushed stone mining
Fertilizers and Organics	Generally no significant effect in comparison to past aggregate and crushed stone mining
Pesticides / Herbicides	Generally no significant effect in comparison to past aggregate and crushed stone mining
Other	Will vary by contaminant and previous land use

Water Quantity	
Runoff Control	Good to Excellent
Infiltration	Good to Excellent with grading to minimize uncontrolled ponding
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Generally no significant effect in comparison to past aggregate and crushed stone mining
Heavy Metals	Generally no significant effect in comparison to past aggregate and crushed stone mining
Pathogens	Good. Improving (especially for gravel pits) as the vegetation annual growth cycle increases and enhances the organic (humus) soil horizon and associated microbiological activity
Fertilizers and Organics	Generally no significant effect in comparison to past aggregate and crushed stone mining
Salinity	Generally no significant effect in comparison to past aggregate and crushed stone mining
Other	Will vary by contaminant and previous land use
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Generally no significant effect in comparison to past aggregate and crushed stone mining
Heavy Metals	Generally no significant effect in comparison to past aggregate and crushed stone mining
Pathogens	Good. Improving (especially for gravel pits) as the vegetation annual growth cycle increases and enhances the organic (humus) soil horizon and associated microbiological activity
Fertilizers and Organics	Generally no significant effect in comparison to past aggregate and crushed stone mining
Salinity	Generally no significant effect in comparison to past aggregate and crushed stone mining
Suspended Sediment	Good to Excellent
Low Dissolved Oxygen	Generally no significant effect in comparison to past aggregate and crushed stone mining
Water Temperature Increase	Fair to Good
Other	Will vary by contaminant and previous land use
Habitat Suitability	Good to Excellent for improving the habitat of the mined land
Capital or Implementation Costs	Moderate. Pre-planning and coordinating the reclamation of the land with the mining process can significantly lower costs by incorporating the mining activity with the reclamation process, especially when mining near final limit/ setback locations
Operation and Maintenance	Low to Moderate. Dependent on the reclaimed land use. For example, wet ponds may, or may not, require less

	maintenance than a vegetated field that requires mowing through the year Regular inspections of erosion and sediment control measures to observe and repair failing areas
Potential Treatment Side Effects	No adverse impacts identified
Concurrent Land Management Practices	Various land management, erosion and sediment control and chemical handling procedures should be incorporated into any mining plan for a property to avoid adverse impacts from the operations prior to the reclamation activities
Feasibility	Applicable to all mining or similar activities where land features and natural resources are disrupted. Phased reclamation plans are typical of large operations (2 acres or more)

Primary Source of BMP Information: USDA, May, 1997 (Abandoned Mined Land)

Additional References:

USDA, May, 1997 (Land Reconstruction – Currently Mined Land)

Lawn Care and Gardening Management (Mlcg)

Description: The management of residential, commercial and golf course landscaping activities through control of water, pesticides and fertilizer use including utilization amounts, rates, and application schedules. The practice includes, but is not limited to:

- minimizing land disturbances of topography and existing vegetation during building activities
- applying alternative landscaping approaches involving rock gardens, mulched areas and native plants that require less water, pesticides and fertilizer
- planting low maintenance ground cover such as pachysandra, ivy, periwinkle and other "year-round evergreen" species
- using "slow release" chemical products that resist leaching and subsequent infiltration to ground water
- applying chemicals at optimum times of the season to maximize effectiveness and minimize runoff
- testing of soil to determine chemical requirements and calibration of application equipment to ensure proper application rates
- using timed sprinkler systems to control water application rates, schedule and total amounts, which minimizes runoff

Purpose: The objectives of the practice are to conserve and protect ground water quality by reducing water and lawn/ garden chemical usage.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good. Timed water applications reduce risk of irrigation runoff and potential subsequent impacts
Sedimentation Control	Good. By minimizing runoff volumes through timed water applications, less runoff and associated sediment is created to be managed, stored or treated
Prevent Contamination by:	
Salinity	Not Applicable
Fertilizers and Organics	Good to Excellent. Excess nutrients are minimized with proper application methods
Pesticides / Herbicides	Good to Excellent. Excess nutrients are minimized with proper application methods
Other	Good. Synthetic chemicals (e.g., fuels) related to lawn and garden equipment should be handled carefully over impervious surfaces. Accidental spills should be cleaned up promptly
Water Quantity	
Runoff Control	Good to Excellent. Timed water applications minimize runoff volumes and impacts
Infiltration	Good to Excellent. Properly scheduled water applications to coincide with plant/ soil water needs will provide water at

	times when infiltration rates are greatest
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good to Excellent. Applying pesticides at appropriate times and amounts to address specific problems minimizes residual levels that may leach to ground water. Natural/ alternative pest control methods may be applicable for many lawn and garden conditions and can reduce pesticide use. Information is available from the University Cooperative Extension Master Gardener Program
Heavy Metals	Good. Proper handling of fuels that may contain levels of some heavy metals for lawn and garden equipment minimizes impacts from spills
Pathogens	May be indirectly affected by chemical use: Minimizing chemical use will promote natural microorganism activity which helps remove pathogens
Fertilizers and Organics	Good to Excellent. Applying nutrients at appropriate times and amounts minimizes residual levels that may runoff to surface water
Salinity	Not Applicable
Other	Good. Synthetic chemicals (e.g., fuels) related to lawn and garden equipment should be handled carefully and over impervious surfaces. Accidental spills should be cleaned up promptly
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good to Excellent. Applying pesticides at appropriate times and amounts to address specific problems minimizes residual levels that may leach to ground water. Natural/ alternative pest control methods may be applicable for many lawn and garden conditions and can reduce pesticide use. Information is available from the University Cooperative Extension Master Gardener Program
Heavy Metals	Good. Proper handling of fuels that may contain levels of some heavy metals for lawn and garden equipment minimizes impacts from spills
Pathogens	May be indirectly affected by chemical use. Minimizing chemical use will promote natural microorganism activity which helps remove pathogens
Fertilizers and Organics	Good to Excellent. Applying nutrients at appropriate times and amounts minimizes residual levels that may runoff to surface water
Salinity	Not Applicable
Suspended Sediment	Good. By minimizing runoff volumes through timed water applications, less runoff and associated sediment is created that must be managed, stored or treated
Low Dissolved Oxygen	Good. Minimizing nutrients and runoff volume decreases the oxygen demand loading burden on down stream water bodies
Water Temperature Increase	Good. Controlling watering rates and watering in the early

	morning or evening will minimize the amount of runoff that may leave a site and reduce the temperature of the runoff water
Other	Good. Synthetic chemicals (e.g., fuels) related to lawn and garden equipment should be handled carefully and over impervious surfaces. . Accidental Spills should be cleaned up promptly
Habitat Suitability	Good. Utilizing natural vegetation and a variety of conditions as opposed to large lawn areas promotes the maintenance of natural habitats and diversity
Capital or Implementation Costs	Costs are generally avoided in the long run by retaining existing vegetation and reducing replanting expenses and additional lawn maintenance to support non-native plants
Operation and Maintenance	Turf grass typically needs about 1-inch of water per week. Lawn equipment should be maintained to operate efficiently and cleanly. Used/ empty chemical containers should be disposed of properly; at community household hazardous waste disposal events
Potential Side Effects	No adverse impacts identified
Concurrent Land Management Practices	For large developments with multiple separate internal parcels, the over all site development plan should incorporate effective runoff, erosion and sediment control BMPs that will support and compliment water and chemical use conservation during future landscaping activities on the individual lots. Natural vegetation and topography should be retained as much as possible, especially as buffers around water bodies and drainage channels
Feasibility	These measures and methods are applicable to all residential and commercial properties that have (or will have) landscaped areas

Primary Source of BMP Information: Morris, 1996

Additional References:

Hust and Murphy, 1997

Nutrient Management (Mn)

Description: A comprehensive program to manage the form, amount, rate, placement and timing of delivery of fertilizer to crops. The practice includes, but is not limited to:

- matching the fertilizer application to the crop's growing requirements such as prime growing period and quantity of fertilizer needed (nitrogen, phosphate and potassium)
- planting a second (winter) crop to use excess fertilizer
- conducting soil tests to determine which nutrients or other soil amendments are needed to quantify the amount of fertilizer required by the crops and optimize the impact of the fertilizer application
- calibrating equipment to ensure accurate and correct application amounts
- avoiding the application of manure or commercial fertilizers to frozen ground
- selecting slow release fertilizers that resist leaching and subsequent transport to surface or ground water resources
- coordinating irrigation schedules to minimize the potential of fertilizer movement to ground water or transport to surface water in runoff
- storing fertilizer products under cover on impervious surfaces to afford protection from weather and efficient cleanup of spills

Purpose: To optimize crop productivity and minimize the risk of surface and ground water pollution from fertilizer chemicals and natural nutrients (manure, urea). This primarily concerns the minimization of nitrogen and phosphate concentrations that enter surface and ground water resources.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Generally no significant effect
Sedimentation Control	Generally no significant effect
Prevent Contamination by:	
Salinity	Generally no significant effect
Fertilizers and Organics	Good to Excellent
Pesticides / Herbicides	Generally no significant effect
Other	Generally no significant effect
Water Quantity	
Runoff Control	Generally no significant effect
Infiltration	Generally no significant effect
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Generally no significant effect
Heavy Metals	Generally no significant effect
Pathogens	Generally no significant effect
Fertilizers and Organics	Good to Excellent
Salinity	Generally no significant effect
Other	Generally no significant effect

Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Generally no significant effect
Heavy Metals	Generally no significant effect
Pathogens	Generally no significant effect
Fertilizers and Organics	Good to Excellent
Salinity	Generally no significant effect
Suspended Sediment	Generally no significant effect
Low Dissolved Oxygen	Generally no significant effect
Water Temperature Increase	Generally no significant effect
Other	Generally no significant effect
Habitat Suitability	Improves and maintains downstream habitats by reducing the influx of excess nutrients that frequently degrade these environments
Capital or Implementation Costs	Generally significantly cost-effective through the reduction of wasted nutrients and expenses related to excessive application efforts (labor, machinery use, etc.)
Operation and Maintenance	Upkeep of detailed fertilizer use records (amount, rate, form, date, weather conditions, soil chemistry test results, field location) and training must be on-going by the operator to ensure program consistency
Potential Side Effects	No adverse impacts identified
Concurrent Land Management Practices	The plan must incorporate a full program of storm water controls and effective agricultural methods to optimize the nutrient management plan
Feasibility	Applicable to all agricultural efforts

Primary Source of BMP Information: Holbrook, 1996

Additional References:

Brown, 1998
Morris, 1996
USDA, December, 1996 (Nutrient Management)

Pest and Pesticide Management (Mpp)

Description: A comprehensive program to manage weeds, insects, and plant/ crop diseases. Practices include the proper use of commercial pesticides and related poison products such as herbicides, insecticides, rodentcides, fungicides as well as alternative non-chemical pesticide control methods (Integrated Pest Management, IPM). The practice includes, but is not limited to:

- planting and maintaining crops and plants according to recommended practices
- appling pesticides when they are most likely to be effective based on pest sensitivity (life cycle), temperature, wind and moisture conditions
- following manufacturer recommended handling, preparation and application instructions
- calibrating equipment to ensure accurate and correct application amounts
- designating and labeling specific areas for raw product storage, mixing, loading and waste product storage. These areas should be covered and bermed so that spills are contained on an impervious surface for clean up without impacting surface or ground water
- storing unused or mixed/ prepared products in a secure/ locked area
- coordinating irrigation schedules to minimize the potential of pesticides leaching to ground water or being transported to surface water in runoff.
- IPM methods including crop rotation, use of natural predators, and planting schedules to avoid peak pest populations, and planting pest resistant species. Additional IPM strategies are available from the USDA Natural Resources Conservation Service (Brooklyn, CT) and the Connecticut Cooperative Extension Service (Storrs, CT)

Purpose: To optimize crop productivity and minimize the risk of surface and ground water pollution and adverse impacts to wildlife and wildlife habitats from inappropriate use of pesticides, insecticides and herbicides, etc.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Generally no significant effect
Sedimentation Control	Generally no significant effect
Prevent Contamination by:	
Salinity	Generally no significant effect
Fertilizers and Organics	Generally no significant effect
Pesticides / Herbicides	Good to Excellent
Other	Generally no significant effect
Water Quantity	
Runoff Control	Generally no significant effect
Infiltration	Generally no significant effect
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good to Excellent
Heavy Metals	Generally no significant effect

Pathogens	Generally no significant effect
Fertilizers and Organics	Generally no significant effect
Salinity	Generally no significant effect
Other	Generally no significant effect
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good to Excellent
Heavy Metals	Generally no significant effect
Pathogens	Generally no significant effect
Fertilizers and Organics	Generally no significant effect
Salinity	Generally no significant effect
Suspended Sediment	Generally no significant effect
Low Dissolved Oxygen	Generally no significant effect
Water Temperature Increase	Generally no significant effect
Other	Generally no significant effect
Habitat Suitability	Improves and maintains downstream habitats by reducing the influx of pesticides and herbicides that could degrade these environments
Capital or Implementation Costs	Generally significantly cost-effective through the reduction of wasted pesticides/ herbicides and expenses related to excessive application efforts (labor, machinery use, etc.)
Operation and Maintenance	Keeping detailed chemical use records (amount, rate, form, date, weather conditions, soil chemistry, test results field location) and training must be on-going by the operator to ensure program consistency
Potential Side Effects	No adverse impacts identified
Concurrent Land Management Practices	The plan must incorporate a full program of storm water controls and effective agricultural methods to optimize the pesticide and herbicide management plan
Feasibility	Applicable to all agricultural efforts

Primary Source of BMP Information: Holbrook, 1996

Additional References:

Brown, 1998
Morris, 1996
USDA, December, 1996 (Pest Management)

Roof Runoff Management (Mrr)

Description: The installation of structures to collect, control and dispose of runoff water from roofs. In developed areas such as residential and urban developments, runoff from impervious roof areas can be a significant portion of the total storm water runoff volume.

Purpose: The primary purpose of this measure is to prevent rain and snowmelt water from roof areas from flowing to areas of concentrated waste such as barnyards and roads, thus reducing the overall volume of notably degraded water that must be treated. The installation of roof runoff controls may also reduce local flooding and erosion in residential and urban land use areas. As a conservation measure, roof runoff water may be used for non-potable uses.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent. By reducing or diverting concentrated runoff from roofs
Sedimentation Control	Not Applicable. Not a sedimentation control measure as the runoff from roof areas is essentially free of sediment. Advantage is gained by not adding this runoff source to other runoff flows that do contain sediment and other contaminants
Prevent Contamination by:	
Salinity	Generally no significant effect
Fertilizers and Organics	Generally no significant effect
Pesticides / Herbicides	Generally no significant effect
Other	Generally no significant effect
Water Quantity	
Runoff Control	Good to Excellent. Especially for areas in the immediate vicinity of buildings
Infiltration	Good to Excellent. Design dependent on what is planned for the water after collection (ground water or surface water recharge, drinking water cistern, irrigation)
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Generally no significant effect. Not typically in roof runoff
Heavy Metals	Generally no significant effect. Not typically in roof runoff
Pathogens	Good. Depending on the disposition of the roof runoff after it is collected; must beware of potential impacts from concentrated bird waste
Fertilizers and Organics	Generally no significant effect. Not typically in roof runoff
Salinity	Generally no significant effect. Not typically in roof runoff
Other	Generally no significant effect. Not typically in roof runoff
Water Quality – Surface Water	
Prevent Contamination by:	

Pesticides / Herbicides	Good. If roof runoff is prevented from mixing with other runoff sources that contain this contaminant, if this reduces the volume of runoff that must be treated for pesticides before it can be released appropriately to a water body.
Heavy Metals	Good. If roof runoff is prevented from mixing with other runoff sources that contain this contaminant. This reduces the volume of runoff that must be treated for metals before it can be released appropriately to a water body.
Pathogens	Good. Depending on the disposition of the roof runoff after it is collected; must beware of potential impacts from concentrated bird waste
Fertilizers and Organics	Good. If roof runoff is prevented from mixing with other runoff sources that contain this contaminant it reduces the volume of runoff that must be treated for excessive nutrients before it can be released appropriately to a water body
Salinity	In special cases (potentially requiring state or federal National Pollutant Discharge Elimination System (NPDES) permits) roof runoff may be used to dilute water with high salinity levels as part of a treatment process prior to release to a water body; performance is design dependent
Suspended Sediment	Good to Excellent. If the runoff can be diverted and treated through infiltration before gaining a significant sediment load through erosion
Low Dissolved Oxygen	Generally no significant effect
Water Temperature Increase	Generally no significant effect
Other	Generally no significant effect
Habitat Suitability	Generally no significant effect. Site-specific management plans may choose to divert and allocate roof runoff flows to special habitat situations
Capital or Implementation Costs	Low. Especially if it reduces the volume (and associated treatment costs) of co-mingled roof water and water associated with concentrated wastes or chemical applications (chemically treated cultivated fields or lawns)
Operation and Maintenance	Semi annual inspection of gutters and downspouts to keep them free of debris and blockages to maintain runoff flow Associated treatment practices (such as grass swales) must be maintained to ensure control of the runoff after collection
Potential Side Effects	Collected roof runoff may be recycled for use in non-potable water activities. Roofs can produce 'rechargable' amounts of water from light rains
Concurrent Land Management Practices	Measures must be available to divert, treat and otherwise dispose/ reuse the roof runoff once it is collected
Feasibility	Applicable to all developed properties with buildings

Primary Source of BMP Information: USDA, December, 1996 (Roof Runoff Management)

Additional References:

Holbrook, 1996

EPA, 1991

Covering (Sc)

Description: A permanent or temporary structure or material that shields raw materials, byproducts, finished products, wastes, operating areas, etc. from contact with precipitation and/ or runoff. The covering may be partial or total. Examples or temporary coverings include: tarpaulins, plastic sheeting, inflatable buildings and simple roofs. Permanent coverings include various building styles, from complete closure to half-walled open structures. Excellent temporary coverings may be poor long-term coverings if they degrade (e.g., many plastic sheeting products crack and tear when exposed to the sun). Poor covering situations develop when contact (a "pathway") is provided between the "covered" material and surrounding or underlying soils, water resources, habitats and/ or wastes. Many coverings fail because they are in place beyond their useful service lives and/ or are not properly maintained.

Purpose: The practice eliminates or reduces the amount of runoff that may come in contact with a situation, area or material that could contaminate the runoff. Also, coverings that provide an impermeable surface liner beneath stored material (design dependent feature) can reduce or prevent moisture from draining out of the stockpile over time, and prevent a "leachate" from contacting the soil or entering the ground beneath the stockpile.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Generally not applicable for in-place soils. However, a complete covering of stockpiled soils and other granular materials will eliminate erosion of the pile material
Sedimentation Control	Generally not applicable
Prevent Contamination by:	
Salts	Poor to Excellent. Design dependent
Fertilizers and Organics	Poor to Excellent. Design dependent
Pesticides / Herbicides	Poor to Excellent. Design dependent
Other	Poor to Excellent. Design and contaminant dependent
Water Quantity	
Runoff Control	Generally not applicable
Infiltration	Generally not applicable
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor to Excellent. Design dependent
Heavy Metals	Poor to Excellent. Design dependent
Pathogens	Poor to Excellent. Design dependent
Fertilizers and Organics	Poor to Excellent. Design dependent
Salinity	Poor to Excellent. Design dependent
Other	Poor to Excellent. Design and contaminant dependent

Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor to Excellent. Design dependent
Heavy Metals	Poor to Excellent. Design dependent
Pathogens	Poor to Excellent. Design dependent
Fertilizers and Organics	Poor to Excellent. Design dependent
Salinity	Poor to Excellent. Design dependent
Suspended Sediment	Poor to Excellent. Design dependent
Low Dissolved Oxygen	Poor to Excellent. Design and contaminant dependent
Water Temperature Increase	Generally not applicable
Other	Poor to Excellent. Design and contaminant dependent
Habitat Suitability	Generally not applicable
Capital or Implementation Costs	Generally low compared to controlling and/ or treating runoff after it has become contaminated Costs will vary according to the level of protection/ screening required and the length of time the protection must be effective
Operation and Maintenance	Design dependent A particular practice must be inspected whenever a storm event or human activity has had the potential to impact the integrity, durability or effectiveness of the cover
Potential Treatment Side Effects	Temporary covering materials may be used inappropriately as long term coverings or beyond their useful and effective lives and may then fail, with the potential for creating a contaminated soil, surface or ground water condition
Concurrent Land Management Practices	Other materials handling precautions to prevent contamination incidents outside the covered area, or significant/ chronic releases during handling activities in areas under a [permanent or temporary] covering
Feasibility	Applicable for consideration as a BMP whenever an activity and/ or [stored] material may threaten to contaminate runoff through spills and/ or commingling with waste materials

Primary Source of BMP Information: EPA, September, 1999 (Coverings)

Additional References:

EPA, September, 1993

Extended (Dry) Detention Basin (Sedb)

Description: Excavated basins and/ or berm-encased areas with risers or weir water release structures to promote detention for a certain interval (usually not more than three days). These structures are commonly designed to be "dry" between storm events. This practice relies primarily on settling to remove pollutants. Cold climate design features and maintenance items must be part of any final design to ensure proper operation during winter and spring weather. Typically, an additional storage area (developed by increasing surface area and not overall depth) is required for effective winter and early spring (rain and snowmelt runoff capacity) operation.

Purpose: Extended detention ponds remove particulate pollutants and reduce/ control maximum runoff volumes from storm water that is directed to the basin. The basin design should limit off-site peak discharges to pre-development levels.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salinity	Not Applicable
Fertilizers and Organics	Not Applicable
Pesticides / Herbicides	Not Applicable
Other	Not Applicable
Water Quantity	
Runoff Control	Excellent
Infiltration	Fair to Good. Extended holding times increases infiltration; "silting up" of the basin floor and walls will tend to decrease the overall infiltration (permeability) rate
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Fair to Good. In immediate area as most dissolved pesticides are passed downstream, some will infiltrate into underlying soil or through preferential pathways (large roots and desiccation [drying] cracks) through the soil to ground water. Most impacts are passed to downstream locations
Heavy Metals	Fair to Good. Most effective on particulate or adsorbed forms that settle out in the basin and may be removed during maintenance soil cleanout. Most impacts from dissolved forms are passed to downstream locations
Pathogens	Limited information. Expected to be good if biodegradation is effective in the shallow soil zone under the basin (above the water table)
Fertilizers and Organics	Fair to Good. In immediate area as most dissolved nitrates and phosphates are passed downstream, some will

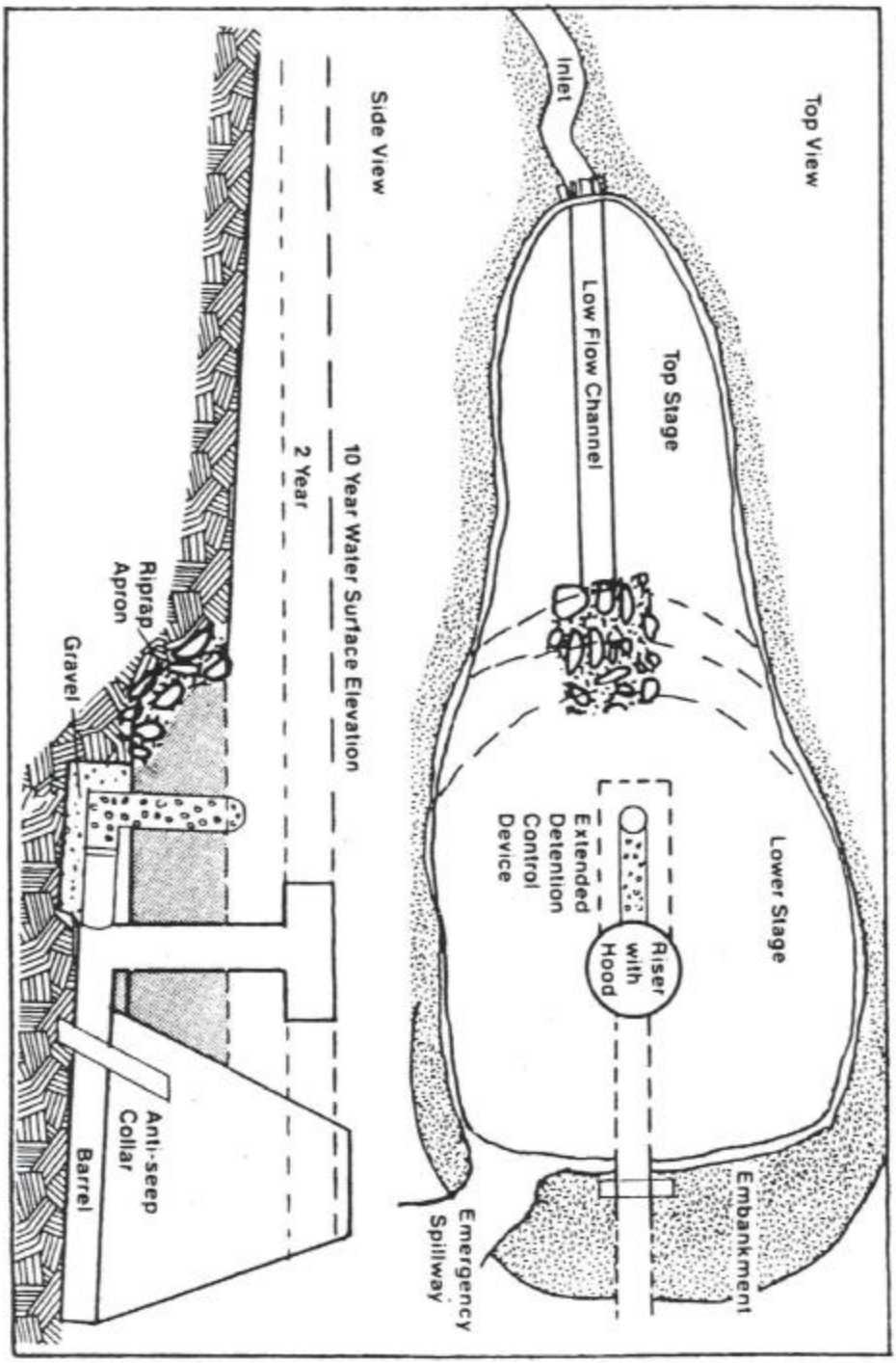
	infiltrate into underlying soil or through preferential pathways (large roots and desiccation [drying] cracks) through the soil to ground water. Most impacts are passed to downstream locations
Salinity	Fair to Good. Most dissolved salts are passed downstream
Other	Will vary by contaminant
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. Basin treatment does not remove a significant amount of dissolved pesticides from the runoff volume. Most impacts are passed in surface flow to downstream locations
Heavy Metals	Good to Excellent. Most effective on particulate or adsorbed forms that remain behind in the basin
Pathogens	Poor. Pathogens are carried in the released surface flow to downstream locations
Fertilizers and Organics	Poor to Fair. Basin treatment does not remove a significant amount of dissolved nutrients from the runoff volume. Most impacts are passed in surface flow to downstream locations
Salinity	Poor. Most dissolved salts are passed downstream
Suspended Sediment	Good to Excellent. Basin retains a high volume of sediment through the settling process
Low Dissolved Oxygen	Good. Proper release rates prevent the low oxygen conditions from developing
Water Temperature Increase	Good. Standing water and thermal heating is minimized with proper release rates
Other	Will vary by contaminant
Habitat Suitability	Poor. Based on short-term (usually less than three days) water storage. Should be sited to minimize impacts to existing wetlands, mature forest and habitat, and thermal impacts to downstream watercourses May provide temporary refuge when impounding storm water
Capital or Implementation Costs	Typically less expensive than a Wet Pond or Constructed Wetlands. Maintenance costs can be relatively low and may be minimized through proper design, construction and regular maintenance. The responsibility for maintenance must be clearly defined, understood by all parties, and enforced

Operation and Maintenance	Normal maintenance tasks include (but are not limited to): inspection, debris and litter removal, mowing, erosion control and nuisance control (persistently wet areas, insects, odors) Inspections for winter-time ice and snow removal activities from release structures (riser, low-flow piping and underdrain [if applicable]) must be included in the O&M plan to ensure proper operation Non-routine maintenance will include sediment removal to maintain design capacities and remove accumulated contaminants in the basin-floor soils/sediment (5 to 10 year plan recommended)
Potential Side Effects	Hydrologic modeling should be completed to assess the hydrologic impacts of individual basins on the cumulative watershed hydrograph (i.e., base flow, peak and flood discharge volumes, timing and locations) for important design storms (suggest 2-, 10-, 50-year events). Adjust basin locations and release rates to avoid overlapping releases and increased flood peaks. The Natural Resources Conservation Service [formerly the Soil Conservation Service] method TR-20, TR-55 or equivalents can be used for this evaluation.
Concurrent Land Management Practices	Alternative: see **Wet Pond** Up-gradient of the basin, grass swales and filter strips may be used to control sediment loading Non-structural vegetative methods and proper chemical handling procedures should be employed at upstream locations to reduce sediment and pollutant loading of the runoff entering the basin
Feasibility	Detention basins are relatively versatile with respect to implementation. Depth to bedrock (must be deep- at least 4 feet), space limitations (need relatively large area) and excessive sediment loading (extra sediment increases maintenance) are the significant restrictions. Modified cold climate features must be incorporated into the design to ensure proper operation of this BMP type during the winter and spring. Refer to Caraco and Claytor (1997) for examples of cold climate design and maintenance information

Primary Source of BMP Information: Young et al., December, 1995 (Revised 1998)

Additional References:

Caraco and Claytor, 1997
EPA, January, 1993
Schueler, July, 1987
Ritter, January, 1994



Extended Detention Basin
(Not for design purposes)
Source: Schueler, July, 1987

Forest Logging Roads (Sflr)

Description: The process of planning, field marking, surveying, constructing and using forest roads and staging areas for logging. The network of roads is surveyed and established with BMP storm water controls prior to actual logging to reduce storm water impacts and to provide efficient access to harvest and log assembly areas. The BMP storm water controls should be fully functional before actual logging begins. Logging roads and staging/ landing areas must be positioned in locations and at grades to reduce runoff velocities and prevent creation of ruts of extended length that follow road tracks in erodable situations (e.g., over erodable unstable soils and/ or in directions that are at significant angles to the topographic contour of the land).

Purpose: The process is a method for minimizing the disturbance and damage to on-site and off-site natural resources. Pre-planning helps to avoid random or poor choices/decisions regarding the placement of roads and the access they provide to the forest resource.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salts	Not Applicable
Fertilizers and Organics	Not Applicable
Pesticides / Herbicides	Not Applicable
Other	Not Applicable
Water Quantity	
Runoff Control	Good. If combined with other selective logging methods to retain, when and where possible, existing tree and under story cover that tend to moderate the relative increases in runoff volume and time of concentration increases associated with clear-cut areas
Infiltration	Fair to Good. If combined with other selective logging methods to retain, when and where possible, existing tree and under story cover that tend to moderate the relative increases in direct runoff volume and time of concentration associated with clear-cut areas
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Not Applicable
Heavy Metals	Not Applicable
Pathogens	Not Applicable
Fertilizers and Organics	Not Applicable
Salinity	Not Applicable
Other	Not Applicable

Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Not Applicable
Heavy Metals	Not Applicable
Pathogens	Not Applicable
Fertilizers and Organics	Not Applicable
Salinity	Not Applicable
Suspended Sediment	Good. Reducing erosion associated with logging roads decreases the overall sediment load in runoff from the logging area, and consequently reduces the suspended sediment load in receiving streams and rivers
Low Dissolved Oxygen	Generally no significant effect
Water Temperature Increase	Good. Planning of harvesting maintains existing forest cover and water shading along streams in the logging area
Other	Not Applicable
Habitat Suitability	Good to Excellent. Plans for appropriate forest harvesting should identify and maintain significant and critical habitat areas whenever and wherever possible
Capital or Implementation Costs	Low. Pre-planning of roads and landings for a logging area is significantly cost effective and may lower the overall cost of the logging effort
Operation and Maintenance	Low. Disturbed areas and stream crossing structures and/ stabilization practices must be inspected regularly and after significant storms to ensure that erosion and sediment control measures are functioning properly. Repairs and adjustments should be made promptly
Potential Side Effects	Successful planning may reduce runoff volumes and erosion effects that will maintain access to and quality of the forest stand for future harvests Critical aquatic habitats are protected Impacts to downstream water resources are minimized
Concurrent Land Management Practices	Temporary and long-term erosion and sediment control measures must be incorporated into the harvest plan Chemical and fuel storage and handling methods to prevent soil and ground water contamination must be specified.
Feasibility	Applicable to all silvi cultural, forestry and logging efforts

Primary Source of BMP Information: EPA, January, 1993

Additional References:

USDA, December, 1996 (Forest Harvesting Trails and Landings)

Geotextile – Turf Pavement (Sgtp)

Description: A porous fabric geotextile mat combined with vegetation (commonly grasses) to create a surface (a.k.a. - turf pavement or turf reinforced mat) that can withstand low traffic situations. (Compare with **Geotextile**). Thick, permanent, synthetic mats (>1-inch thick) are used in low-traffic, light-load bearing situations to create a turf pavement as an alternative to impervious asphalt or concrete pavement. Applicable uses include winter overflow and summer parking areas, and recreational walkways. This application is not recommended for year-round continued use, as the grassed areas will not withstand the constant wear. Multiple sections may be rotated in and out of service to allow for recovery of vegetation. A thick sub-base of gravel should be installed to promote good drainage and reduce frost heaving. This application is not recommended for commercial or industrial areas with significant chemical handling or manufacturing processes.

Purpose: The thick, permanent geotextile material is combined with vegetation to increase the load-bearing capacity of the ground and the resistance to erosion compared to ground with vegetation cover only. Establishing a vegetative cover over the geotextile mat commonly increases the aesthetic character of the location when compared to a geotextile mat only. Turf pavements are used as overflow parking lots (e.g., Westfarms Mall, Farmington, CT) with good success.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salinity	Poor. Salting of these locations is not recommended for de-icing because it would weaken or kill much of the grass, and pass through into the soil and ground water beneath the mat
Fertilizers and Organics	Poor to Fair. Dissolved nutrients are infiltrated through the surface where phosphate may be adsorbed. Total nitrogen values are generally passed to ground water. Vegetated alternatives may have higher success as the vegetation consumes (uptake) the nutrients. However, care must be taken not to over apply fertilizer to vegetated designs during operation and maintenance activities
Pesticides / Herbicides	Poor. Dissolved pesticides are infiltrated through the surface to underlying soil where they may be adsorbed or passed further down to ground water
Other	Generally no significant effect; will vary by contaminant
Water Quantity	
Runoff Control	Good to Excellent. Lengthens the time of the concentration and reduces overall runoff volume compared to standard impervious concrete or asphalt pavements

Infiltration	Fair to Good. Reduces impervious areas related to parking and retains more post-development ground area for infiltration. Reduces the amount of soil compaction that would occur without a turf reinforced mat
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. Not effective at reducing the infiltration of excess pesticides down to the ground water table. Application is not recommended
Heavy Metals	Good. Particulate and adsorbed forms will remain trapped in the grassed turf-mat areas. Dissolved metals may be adsorbed in the natural soil below the mat depending on soil chemistry (the percentage of clay and/ or organic material – higher percentages adsorb more)
Pathogens	Good. Improves protection by establishing/ maintaining an environment where pathogens may be removed before entering ground water. The best protection is to reduce the overall source of pathogens in the area (enforcement of pet control laws)
Fertilizers and Organics	Poor. Not effective at reducing the infiltration of excess nutrients down to the ground water table. Application is not recommended
Salinity	Poor. Salting of these locations is not recommended for de-icing
Other	Generally no significant effect on dissolved contaminants. Will vary by contaminant
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good. If used to reduce the volume of runoff with pesticide loads entering water bodies. May be accomplished by turf pavement through increased infiltration (not recommended) or reducing the amount of pesticide to establish vegetative cover. Pesticide application is not recommended
Heavy Metals	Good. Associated vegetation may filter out particulate or adsorbed forms. Infiltration through underlying soil will allow dissolved metals to adsorb onto soil particles to further reduce metal levels
Pathogens	Good. Improves protection by establishing/ maintaining an environment where pathogens may be removed before entering surface. The best protection is to reduce the overall source of pathogens in the area (enforcement of pet control laws)
Fertilizers and Organics	Good. If used to reduce the amount of fertilizer to establish the vegetative cover. Fertilizer application is not recommended
Salinity	Poor. Salting of these locations is not recommended for de-icing
Suspended Sediment	Good to Excellent

Low Dissolved Oxygen	Will vary by application, generally no significant effect
Water Temperature Increase	Good to Excellent as a substitute for standard concrete or asphalt pavements that absorb heat and then transfer the heat to runoff
Other	Will vary by contaminant
Habitat Suitability	Generally not applicable in this specific application. To the extent that this use helps to support and protect adjacent or downstream habitats by improving water quality, it is a benefit above standard pavement alternatives
Capital or Implementation Costs	Generally more expensive than standard concrete or asphalt pavements depending on site-specific storm water control and treatment requirements. Environmental advantages may be significant over other alternatives (stone liners, standard pavement) and justify additional costs
Operation and Maintenance	Low. Once established, normal maintenance includes regular inspection, mowing, and repairs of sparse or eroded vegetated areas. For permanent installations, (non-biodegradable) matting material should remain covered to avoid loss of strength from UV degradation. Turf pavement applications may require modification to snow removal equipment (small wheels or guides on blade) to avoid cutting the vegetation or disrupting the mat layer
Potential Side Effects	Turf Reinforced Mats (TRM) only perform well within their specified design limitations. Improper installations or uses may create excessive erosion situations if permanent TRMs fail. The Erosion Control Technology Council (St. Paul, MN) publishes installation guidelines for both permanent and temporary rolled erosion (mat-style) control products. Contingencies to clean-up potential chemical or fuel spills must be established when using “turf pavement” applications Not recommended for sites involved with significant chemical handling or manufacturing processes
Concurrent Land Management Practices	Concentrated runoff flow and temporary erosion and sediment control measures up and down stream of revegetated areas are needed

Feasibility	To perform satisfactorily, the mat and vegetation must be installed and established properly and remain in correct (in general "firm and non-sliding") contact with the ground, according to manufacturers specifications Applicable for many revegetation situations and as an off-peak alternative for traditional paved parking lots Restoration of the surface from "wear and tear" may be enhanced by rotating active use among several parking areas to provide time for regrowth and repair

Primary Source of BMP Information: EPA, September, 1999 (Turf Reinforcement Mats)

Additional References:

EPA, 1992 (Geotextiles)
Leiberis, 2000
Pitt, 1994

Geotextile (Sg)

Description: These are porous fabric mats also know as filter fabrics, synthetic fabrics, or construction fabrics. They are constructed by weaving synthetic (permanent) materials (e.g., polypropylene plastic, polyester, nylon, PVC, glass), or natural (biodegradable) materials (e.g., jute, wood fibers, paper, cotton). Geotextiles are placed over graded surfaces to hold unstable soil and rock surfaces in place. They are frequently used for temporary stability while permanent vegetation BMPs are taking root and becoming established. Geotextiles are also used to reinforce grassed channels to increase the erosion resistance.

Purpose: The mats, nets and anchoring products made from these materials are used to separate layers, reinforce surfaces, promote infiltration and drainage, and provide erosion control.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salinity	Poor. The mat does not prevent salt in runoff from either accumulating in the soil beneath the mat, or infiltrating down to ground water
Fertilizers and Organics	Poor to Good. Design dependent
Pesticides / Herbicides	Poor to Good. Design dependent
Other	Generally no effect; will vary by contaminant
Water Quantity	
Runoff Control	Good to Excellent. Design dependent
Infiltration	Good to Excellent. Design dependent
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good if used to reduce the amount of pesticide to establish vegetative cover. Will not treat excess applied pesticide
Heavy Metals	Poor. Will not directly affect the concentrations of metals in runoff that infiltrate down to the ground water table
Pathogens	Fair to Good. Improves protection by establishing/ maintaining a soil cover where pathogens may be removed before entering the ground water table
Fertilizers and Organics	Good if used to reduce the amount of fertilizer to establish vegetative cover. Will not treat excess applied fertilizer or other organic nutrients
Salinity	Poor. The mat does not prevent salt in runoff from either accumulating in the soil beneath the mat or infiltrating down to ground water
Other	Generally no significant effect; will vary by application, design and contaminant

Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good if used to reduce the amount of pesticide to establish vegetative cover. Will not prevent excess pesticide form being carried from the site in runoff
Heavy Metals	Poor to Fair. Associated vegetation may filter out particulate or adsorbed forms but is likely to have minimal effect on dissolved forms that may travel in the runoff to downstream water bodies
Pathogens	Generally no significant effect; will vary by application, design and contaminant
Fertilizers and Organics	Good if used to reduce the amount of fertilizer to establish vegetative cover. Will not prevent excess fertilizers or organic nutrients from being carried from the site in runoff
Salinity	Poor. The mat may actually protect surface water bodies from direct discharges of salt-ladened runoff. However, the mat does not prevent salt in runoff from either accumulating in the soil beneath the mat or infiltrating down to ground water and becoming a long-term source of salt that may travel to surface water over time
Suspended Sediment	Good to Excellent. When vegetation is well anchored by the geotextile, it may filter runoff
Low Dissolved Oxygen	Will vary by application, generally no significant effect. May indirectly affect oxygen demand in downstream waterbodies by filtering out organic nutrients
Water Temperature Increase	Good if used instead of riprap, or pavements that tend to transfer heat to runoff
Other	Generally no significant effect; will vary by application, design and contaminant
Habitat Suitability	Potentially poor if permanent, non-biodegradable mats are used, such as might be required for some stream/ riverbank applications because wildlife may consume degraded portions of these materials. Burrowing animals may impact the mat design. Stabilization and water quality benefits must be balanced with habitat requirements on a project by project basis with consideration also given to the downstream impacts of the decision Temporary mats (biodegradable jute and wood fibers) are recommended whenever possible because they are not permanent and degrade without significant oversight
Capital or Implementation Costs	Relatively inexpensive for certain applications. Environmental advantages may be significant over other alternatives (stone liners, pavement with their potentially detrimental thermal effects on runoff) and justify additional costs

Operation and Maintenance	Low. Normal maintenance includes regular inspection and repairs of breaches and tears. For permanent installations (non-biodegradable) matting material should remain covered to avoid loss of strength from UV degradation
Potential Side Effects	Geotextiles only perform well within their specified design limitations. Improper installation or use may create excessive erosion upon failure. The Erosion Control Technology Council (St. Paul, MN) publishes installation guidelines for both permanent and temporary rolled erosion (mat or net style) control products.
Concurrent Land Management Practices	Concentrated flow and temporary erosion and sediment control measures up and down stream of revegetated areas are necessary Follow/ implement pesticide, chemical and nutrient management plans to reduce the amounts of these substances that must be handled by downstream BMPs
Feasibility	Refer to appropriate State agencies to determine what regulations may control the use and specifications of these materials To perform satisfactorily, the mat and vegetation must be installed and established properly and remain in correct (firm and continuous) contact with the ground Many products are light sensitive and must be protected from sunlight (UV exposure) prior to installation to avoid premature degradation.

Primary Source of BMP Information: EPA, 1992 (Geotextiles)
Additional References:

Infiltration - Porous Pavement (Spp)

Description: Porous pavement may take several forms to provide enhanced infiltration of runoff through the surface to stone and/ or soil layers below. Some examples include:

- specially designed and installed paved surface of non-conventional porous asphalt or concrete
- placement of interlocking, high-strength blocks ("pavers") of various materials (concrete, plastic or brick) with central holes to provide space for grass to grow within the surface
- high density plastic mats (See **Geotextile**) with a "honeycomb structure" to provide space for grass to grow through the mat

The spaces in the blocks and mats may be filled will gravel and sand mixtures as an alternative to vegetation. These alternative surfaces are generally installed in low traffic areas (parking lots) over relatively flat areas, set back (>100 feet) from foundations and drinking water wells.

Purpose: To reduce storm water runoff volumes typically associated with conventional concrete or asphalt paved areas.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent. Reduces storm water runoff volumes that are typically concentrated on impervious surfaces and may otherwise be erosive leaving the site
Sedimentation Control	Excellent. However, sediment should actually be trapped before reaching porous pavement systems to prevent premature clogging
Prevent Contamination by:	
Salinity	Poor. Dissolved salts are passed through the surface to underlying soil layers where they may accumulate or continue to ground water
Fertilizers and Organics	Poor to Fair. Dissolved nutrients are infiltrated through the surface where phosphate may be adsorbed on soil beneath the design layers. Total nitrogen values are generally passed to ground water. Vegetated alternatives may have higher success as the vegetation consumes (uptake) the nutrients. Care must be taken not to over apply fertilizer to vegetated designs during operation and maintenance activities
Pesticides / Herbicides	Poor to Fair. Dissolved pesticides are infiltrated through the surface to underlying soil where they may be adsorbed or passed further down to ground water
Other	Will vary by contaminant; dissolved chemicals may pass through the surface to underlying soils where they may be adsorbed or passed further down to ground water
Water Quantity	
Runoff Control	Excellent for limited and/ or small runoff volumes; may be somewhat less effective as volumes increase above the

	infiltration capacity of the pavement design
Infiltration	Good to Excellent
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. High likelihood that pesticides will pass through the porous design down to ground water
Heavy Metals	Good. For vegetated alternative designs that may consume (uptake) the metals. Particulate forms are trapped and may clog the pavement. Dissolved forms may be adsorbed on soil beneath the pavement design
Pathogens	Fair to Good; Pathogens may be removed through filtration and/ or uptake by vegetation (See **Geotextile – Turf Pavement**)
Fertilizers and Organics	Poor to Fair. Dissolved nutrients are infiltrated through the surface where phosphate may be adsorbed on soil beneath the design layers. Total nitrogen values are generally passed to ground water. Vegetated alternatives may have higher success as the vegetation consumes (uptake) the nutrients. Care must be taken not to over apply fertilizer to vegetated designs during operation and maintenance activities
Salinity	Poor. Dissolved salts commonly pass through the porous surface sand of the design to underlying ground water
Other	Poor. Hydrocarbon fuels and other organic chemicals may pass through the porous design to ground water
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good to Excellent. In comparison to impervious pavement, by reducing the discharge of runoff to water bodies containing high levels of pesticides
Heavy Metals	Good to Excellent. In comparison to impervious pavement, by reducing the discharge of runoff to water bodies containing high levels of metals
Pathogens	Good to Excellent. In comparison to impervious pavement, by reducing the discharge of runoff to water bodies containing high levels of pathogens
Fertilizers and Organics	Good to Excellent. In comparison to impervious pavement, by reducing the discharge of runoff to water bodies containing high levels of nutrients
Salinity	Good to Excellent. In comparison to impervious pavement at reducing discharge of runoff to water bodies containing high salinity concentrations based on not using de-icing salt
Suspended Sediment	Good to Excellent. However, pre-treatment of the runoff prior to crossing/ entering this BMP is necessary to remove most of the sediment to avoid clogging the surface
Dissolved Oxygen	Good to Excellent. In comparison to impervious pavement, by reducing the discharge to water bodies of runoff containing large amounts of oxygen demanding substances

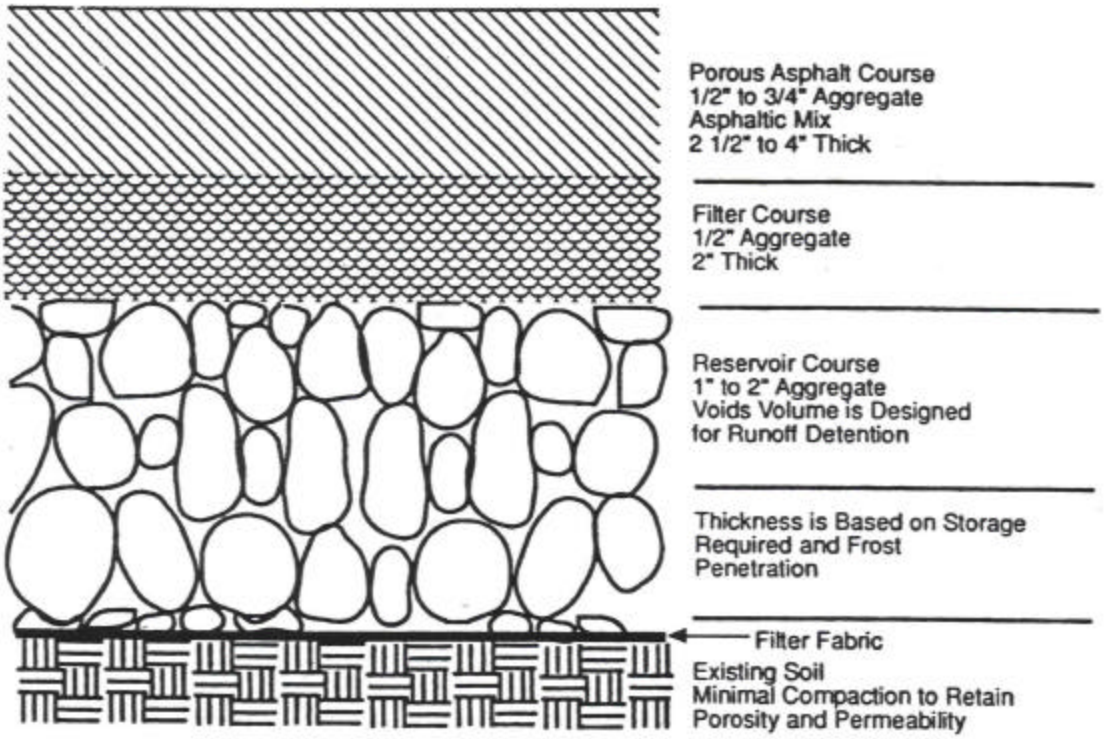
Water Temperature	Good to Excellent. For the vegetated alternatives, compared to the stored heat held by conventional pavement
Other	Enhanced ground water recharge helps to increase baseflow in nearby streams and headwater areas in dry weather
Habitat Suitability	Not directly applicable as habitat. May help to protect surrounding habitat areas by controlling runoff character
Capital or Implementation Costs	Non-conventional porous asphalt and concrete only marginally more expensive than conventional pavement. Mats and Pavers are much higher cost (2 to 4 times) than conventional pavement Porous pavements are difficult and costly to rehabilitate if allowed to clog
Operation and Maintenance	The surface MUST be cleaned regularly, especially where water pools (puddles) to avoid becoming clogged by fine materials. Every effort should be made to prevent sediment from reaching porous pavement areas. Cleaning is best accomplished with a vacuum cleaning street sweeper Experience has shown the need for close control of contractor vehicles to prevent clogging of newly installed porous pavement. Caked mud must be cleaned from vehicle wheels and the pavement must be cleaned daily by sweeping and high-pressure water washing for porosity to be retained
Potential Side Effects	Runoff volumes may be concentrated above design expectations if the pavement is not properly maintained. Ground water could be impacted by accidental chemical releases if porous pavement is used on sites with significant chemical storage and/ or processing or snow stockpiling from removal activities Not recommended for snow storage areas near drinking water sources because of spring time release and infiltration of accumulated chemicals (salt and hydrocarbons)
Concurrent Land Management Practices	Sediment control measures (e.g., bordering vegetated filter strips) must be in place to minimize sediment in the runoff that passes across porous pavement areas

Feasibility	May not be effective during winter months when infiltration is prohibited by frozen ground Porous pavement is not effective for sites with soil infiltration rates of less than 0.27 inches per hour (D soils) or any soil with a clay content greater than about 30 percent. Design slopes for the area should be less than 5 degrees These surfaces should be protected from traffic and untreated runoff during site construction. These situations can create excess sediment that will clog the porous pavement before the entire BMP program is brought online

Primary Source of BMP Information: Schueler, July, 1987

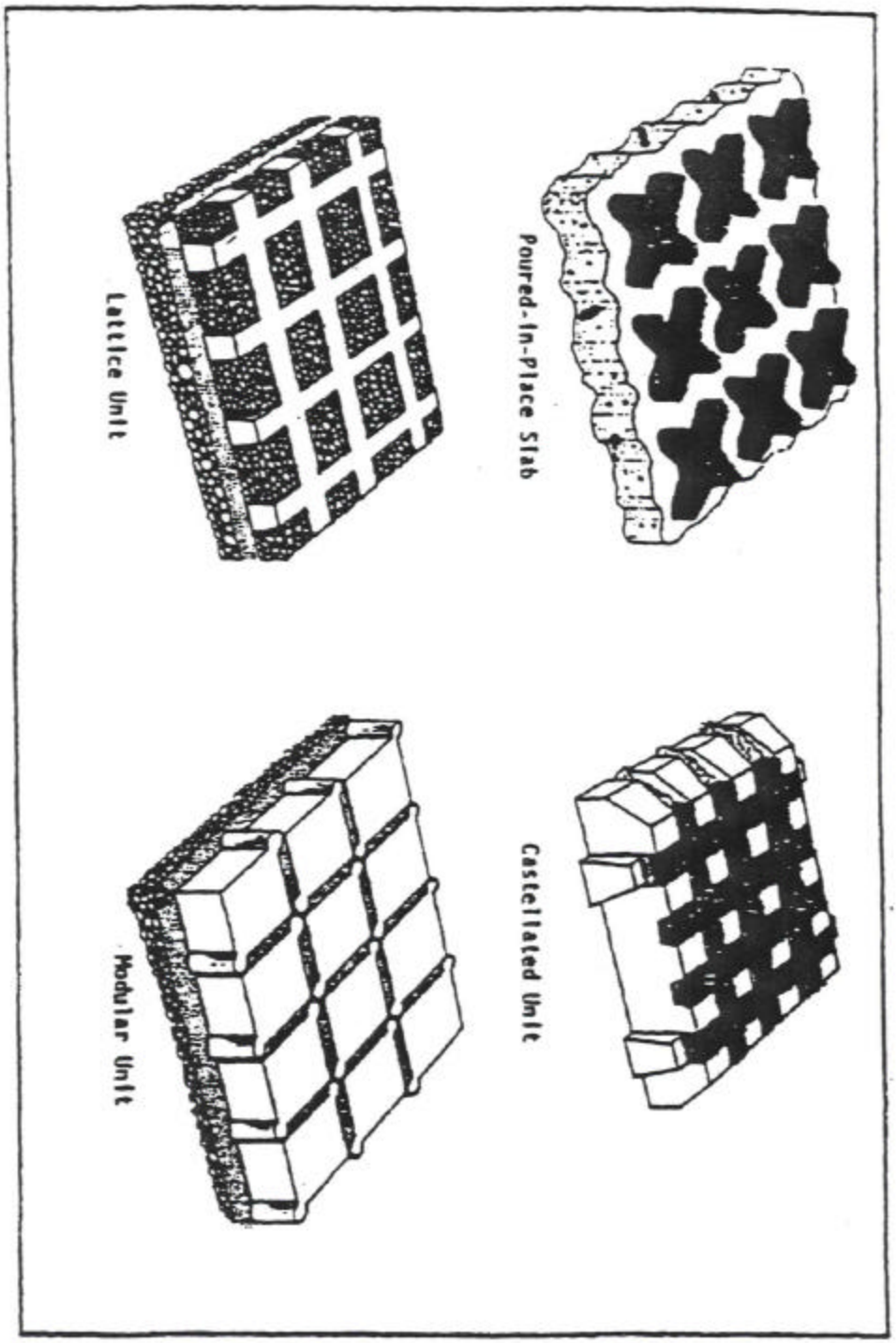
Additional References:

Caraco and Claytor, 1997
EPA, January, 1993
EPA, September, 1993
EPA, 1987
Holbrook, April, 1995
Gibbons, 1999
Pitt, 1994
Young et al., December, 1995 (Revised 1998)



Asphalt-Type Porous Pavement
(Not for design purposes)

Source: Holbrook, April, 1995



Examples of Grids and Modular Pavements for Porous Pavement Surface Applications

Source: EPA, June 1991

Infiltration Trench (Sit)

Description: A backfilled-trench system designed to collect runoff from a limited area and then provide subsurface storage and infiltration to ground water. Many designs are possible as long as adequate infiltration is assured. Pre-treatment of the runoff entering the trench is critical for maintaining function. Fine sediment (sand sizes and smaller) will clog the trench if it is not removed prior to the infiltration zone of the trench. Pretreatment may include low-velocity **grassed swales**, **filter strips** and **level spreaders**. The system should have a thick section of gravel to promote drainage that will reduce frost heaving during the winter and enhance overall infiltration.

Purpose: To reduce overall runoff volumes, reduce peak runoff flows, enhance ground water recharge and remove certain soluble and particulate contaminants on small sites.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent. By reducing storm water runoff volumes that may otherwise be erosive leaving the site.
Sedimentation Control	Excellent. However, sediment should actually be trapped before reaching trench system to prevent premature clogging
Prevent Contamination by:	
Salinity	Not Applicable
Fertilizers and Organics	Not Applicable
Pesticides / Herbicides	Not Applicable
Other	Not Applicable
Water Quantity	
Runoff Control	Excellent for small runoff volumes (less ten 10 acres)
Infiltration	Good to Excellent
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor
Heavy Metals	Good to Excellent
Pathogens	Good to Excellent
Fertilizers and Organics	Good
Salinity	Poor
Other	Will vary by contaminant
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor
Heavy Metals	Good to Excellent
Pathogens	Good to Excellent
Fertilizers and Organics	Good
Salinity	Poor

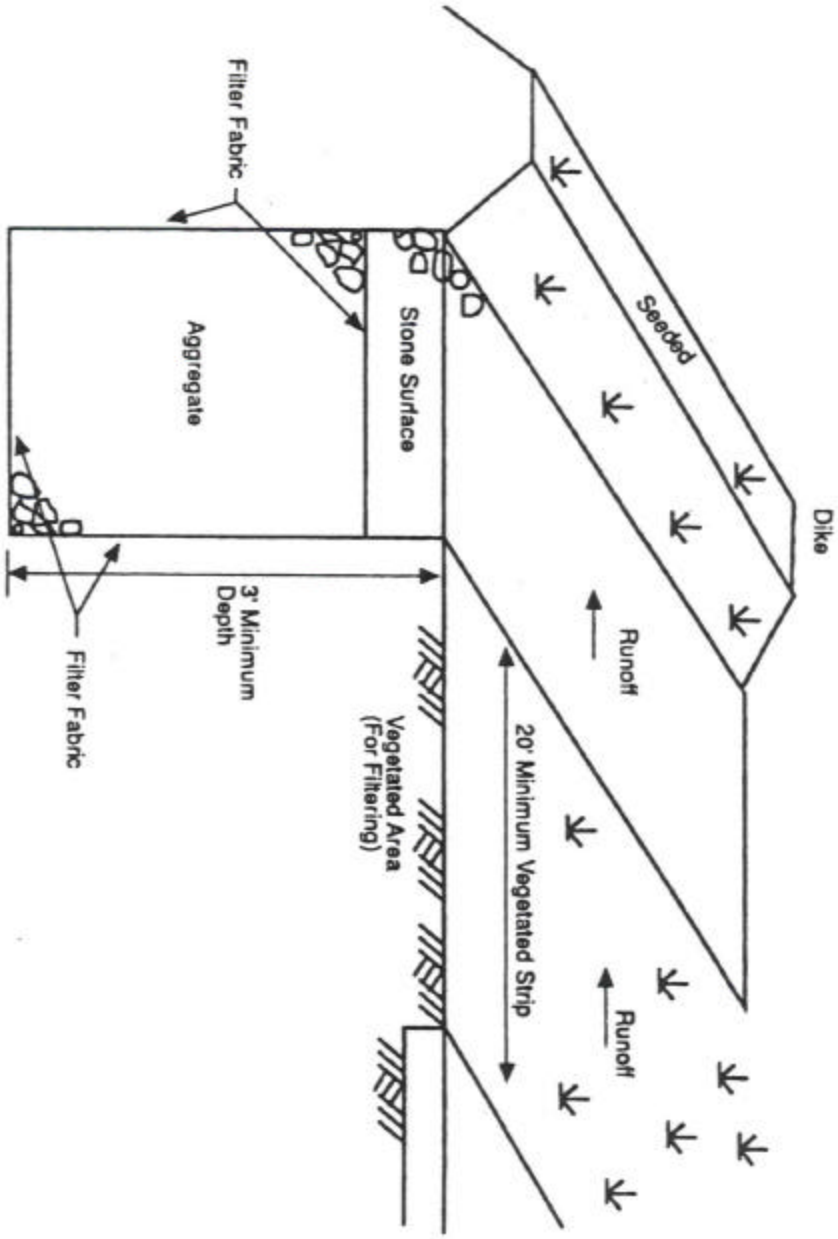
Suspended Sediment	Good to Excellent
Dissolved Oxygen	Good to Excellent
Water Temperature	Good to Excellent
Other	For larger-capacity trench systems, enhanced ground water recharge helps to increase base flow in nearby streams and headwater areas in dry weather
Habitat Suitability	Not directly applicable as habitat. May help to protect surrounding habitat areas by controlling runoff character
Capital or Implementation Costs	Generally the most economical storm water control BMP for small sites (less than 10,000 cubic feet of required runoff storage). May be costly to replace if allowed to clog. Improper or "missed" maintenance is the most common reason for system failure
Operation and Maintenance	Normal maintenance tasks include, but not limited to: inspection, buffer maintenance (vegetative strips, etc.), mowing, sediment removal and tree pruning. One of the important goals of the tasks is to prevent clogging of the trench system and to prolong its life. Non-routine maintenance may eventually include replacement of portions, or all, of the trench to maintain design capacities and remove accumulated contaminants in the basin-floor soils/sediment
Potential Side Effects	Ground water contamination from soluble chemicals (road salt, pesticides) used in surrounding areas that collect in the trench system and then exfiltrate from the trench to the ground water table. This is especially important if the trench is likely to receive snowmelt from parking lots or roads treated with de-icing salt
Concurrent Land Management Practices	May be combined with oil/ grit separators to further inhibit petroleum-related pollution and provide sedimentation control. Sediment pre-treatment measures must be in place to minimize sediment in the runoff that passes to the trench. Pretreatment may include low-velocity grassed swales, vegetated filter strips and level spreaders. Must be combined with detention or infiltration basins to control large storm events
Feasibility	The effects of cold weather conditions on infiltration must be addressed in the design of the infiltration basin. Site slopes in the surrounding area should be less than 20 degrees and directly contributing slopes should by less than 5 degrees. The trench must extend below the frost line to maintain high effectiveness during winter months. The minimum infiltration rate considering the cold climate is 1-inch per hour.

	Many design options with similar effectiveness and construction costs are available - choice is commonly based on cost and scheduling of long-term, non-routine maintenance

Primary Source of BMP Information: Schueler, July, 1987

Additional References:

Caraco and Claytor, 1997
EPA, January, 1993
EPA, September, 1993 (see "Infiltration Drain Fields")
Doenges et al., 1990
Holbrook, April, 1995
Young et al., December, 1995 (Revised 1998)



Infiltration Trench
(Not for design purposes)
Source: Holbrook, April, 1995

Infiltration Basin (Sib)

Description: An impoundment formed by excavation and/ or constructed embankment. The bottom floor of the basin is designed at a level grade and planted with a dense water-tolerant turf grass to promote infiltration and bind deposited sediments. The practice uses settling and infiltration to remove pollutants. Good designs for infiltration basins constructed "in-line" with existing streams include a low flow outlet pipe so that natural base flow is maintained. Alternative designs may collect an entire design storm event for smaller watersheds or may automatically divert "first flush" runoff to the basin for treatment.

Purpose: To significantly reduce overall runoff volumes, reduce peak runoff flows, enhance ground water recharge and remove certain soluble and particulate contaminants on moderate to large sites and for large design storms.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent. By reducing storm water runoff volumes that may otherwise be erosive leaving the site
Sedimentation Control	Excellent. Can accommodate limited sediment storage if maintenance plans account for regular dredging to remove accumulated sediment and sustain specified minimum water storage volume and infiltration rate. Use of a sediment forebay is recommended
Prevent Contamination by:	
Salinity	Not Applicable for controlling sources up stream of the basin
Fertilizers and Organics	Not Applicable for controlling sources up stream of the basin
Pesticides / Herbicides	Not Applicable for controlling sources up stream of the basin
Other	Not Applicable for controlling sources up stream of the basin
Water Quantity	
Runoff Control	Excellent for large runoff volumes and sites (50 acres)
Infiltration	Good to Excellent
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. The pesticides in solution are likely to infiltrate to ground water in the vicinity of the basin
Heavy Metals	Good to Excellent. Metals in solution are adsorbed to soil beneath the basin. Metals adsorbed to sediment entering the basin are deposited on the floor of the basin and trapped
Pathogens	Good to Excellent. Pathogens floating in the runoff or adsorbed to sediment entering the basin are deposited on the floor of the basin. Microbial activity and filtering through the soils beneath the basin remove many of the pathogens before they impact ground water
Fertilizers and Organics	Good. Fertilizers in solution are adsorbed to soil and used by the plants in the basin

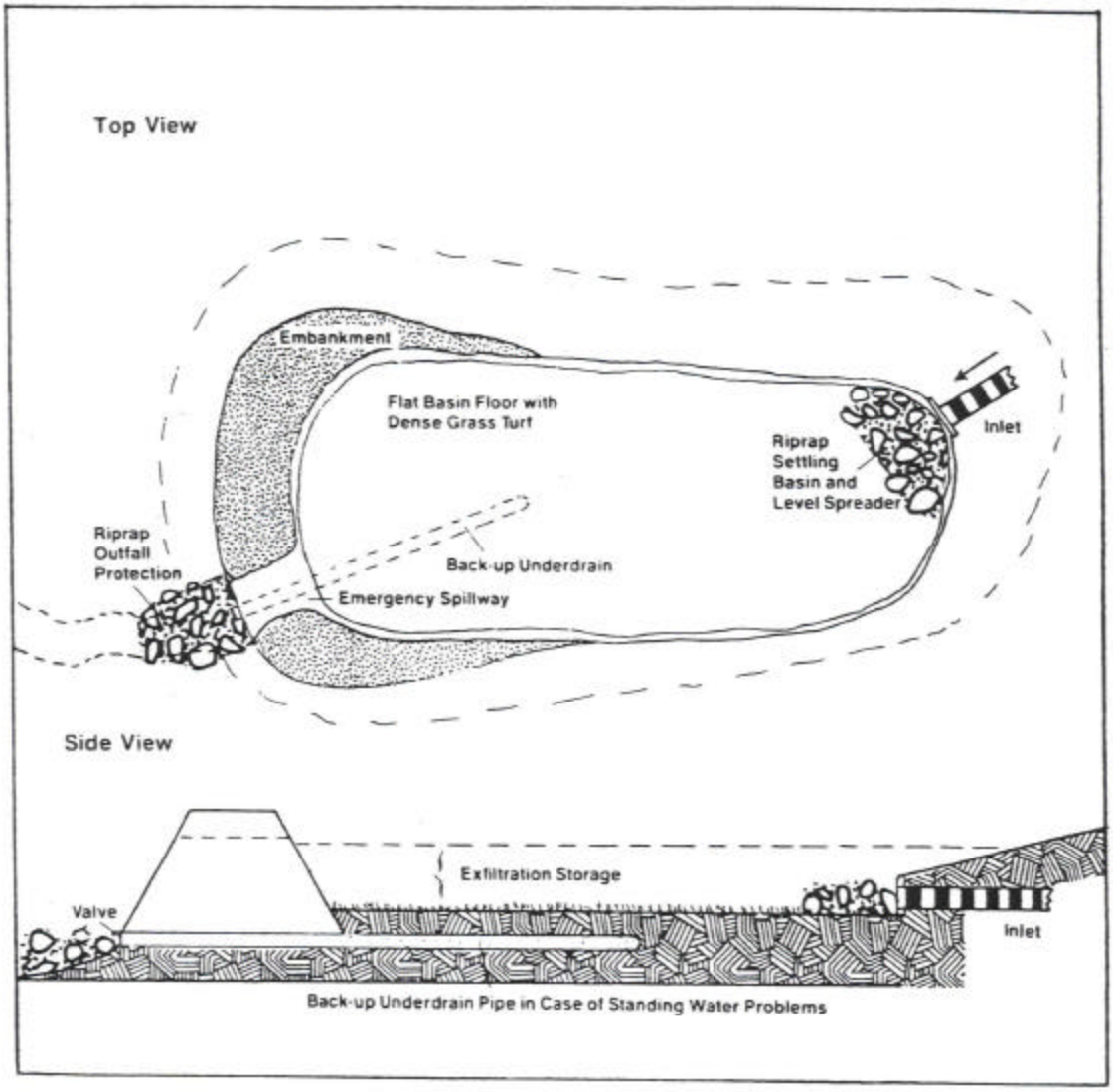
Salinity	Poor. Salt in solution may infiltrate to ground water
Other	Will vary by contaminant
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. The pesticides in solution may pass through the basin to continue to downstream water bodies
Heavy Metals	Good to Excellent. Metals in solution are adsorbed to soil beneath the basin. Metals adsorbed to sediment entering the basin are deposited on the floor of the basin and trapped
Pathogens	Good to Excellent. Pathogens floating in the runoff or adsorbed to sediment entering the basin are deposited on the floor of the basin. Microbial activity in the soils beneath the basin diminishes the number of the pathogens in the runoff
Fertilizers and Organics	Good. Fertilizers in solution are adsorbed to soil and used by the plants in the basin
Salinity	Poor. Salt in solution may pass through the basin to downstream locations
Suspended Sediment	Good to Excellent
Dissolved Oxygen	Good for properly designed basins that release the design storm within approximately 3 days
Water Temperature	Good if long periods of standing water are minimized and/ or shade is provided over basin
Other	Enhanced ground water recharge helps to increase base flow in nearby streams and headwater areas in dry weather
Habitat Suitability	Excellent for maintaining downstream aquatic habitat. Basins should be designed to maintain summer base flow of affected and adjacent streams at pre-development level conditions
Capital or Implementation Costs	Good to Excellent. Infiltration basins are one of the more cost-effective water quality BMPs available. Operation and maintenance costs are comparatively low relative to other BMP options. Non-routine maintenance (see below) could be expensive by requiring reconstruction of some of the structure
Operation and Maintenance	Normal maintenance tasks include, but not limited to: inspection, debris and litter removal, mowing, sediment removal, erosion control and basin floor tilling. One of the important maintenance goals is to prevent clogging of the basin floor to maintain the infiltration capacity. Non-routine maintenance will include sediment removal to maintain design capacities and remove accumulated contaminants in the basin-floor soils/sediment (5 to 10 year plan recommended)

Potential Side Effects	Ground water contamination from soluble chemicals (road salt, pesticides) used in surrounding areas that collect in the basin may infiltrate the basin floor and sides to the ground water table. During winter salting it may be appropriate to divert runoff to alternative treatment (wet pond) to avoid salt infiltration Hydrologic modeling should be completed to assess the hydrologic impacts of individual basins on the cumulative watershed hydrograph (i.e., base flow, peak and flood discharge volumes, timing and locations) for important design storms (suggest 2-, 10-, 50-year events). Basin locations and release rates should be designed to avoid overlapping releases and increased flood peaks
Concurrent Land Management Practices	The longevity of an infiltration basin will be enhanced if sediment "forebays" (smaller separate basins) are constructed ahead of the main infiltration basin to collect (pre-treat) a majority of the sediment load. Some design information recommends redundant pre-treatment (more than one filter-type BMP ahead of the infiltration basin) because of the cold weather conditions negative impact on the filtering performance in CT. The forebays should be designed for easy, regular clean out
Feasibility	The effects of cold weather conditions on infiltration must be addressed in the design of the infiltration basin (e.g., additional storage, filtering, etc., to make up for the reduced effectiveness of the basin during winter. Alternative BMP: **Wet Pond** Underlying unconsolidated material must be thick and permeable (A and B soils). A minimum infiltration rate of 1 inch per hour is recommended to account for poorer infiltration during the winter. Similarly, infiltration rates of 2 to 3 inches per hour may be required for basins receiving runoff from large watersheds (>10 acres). Bedrock and seasonal high ground water table should be at least (>4 feet) to provide space (volume) and bacterial treatment of the infiltrated water Basins should not be constructed over fill material, near “hotspot" sites (e.g., gasoline stations), within 100 feet of a drinking water well, to treat runoff from parking lots/ roadways receiving de-icing salt or within 100 feet of building foundations Optimistic projections of infiltration rates may lead to excessive periods of standing water. Basins should be designed to drain within three days in order to promote periodically dry conditions in the underlying soils', a conducive environment for aerobic bacteria that help to remove pollutants. However, basins should not drain by design in less than 6 to 12 hours because this inhibits the removal of some dissolved pollutants and suspended sediment

Primary Source of BMP Information: Schueler, July, 1987

Additional References:

Caraco and Claytor, 1997
EPA, January, 1993
Holbrook, April, 1995
MADEP, 1997
Young et al., December, 1995 (Revised 1998)



Infiltration Basin
(Backup Underdrain Schematic Example)

Source: Schueler, July, 1987

Level Spreader (SIs)

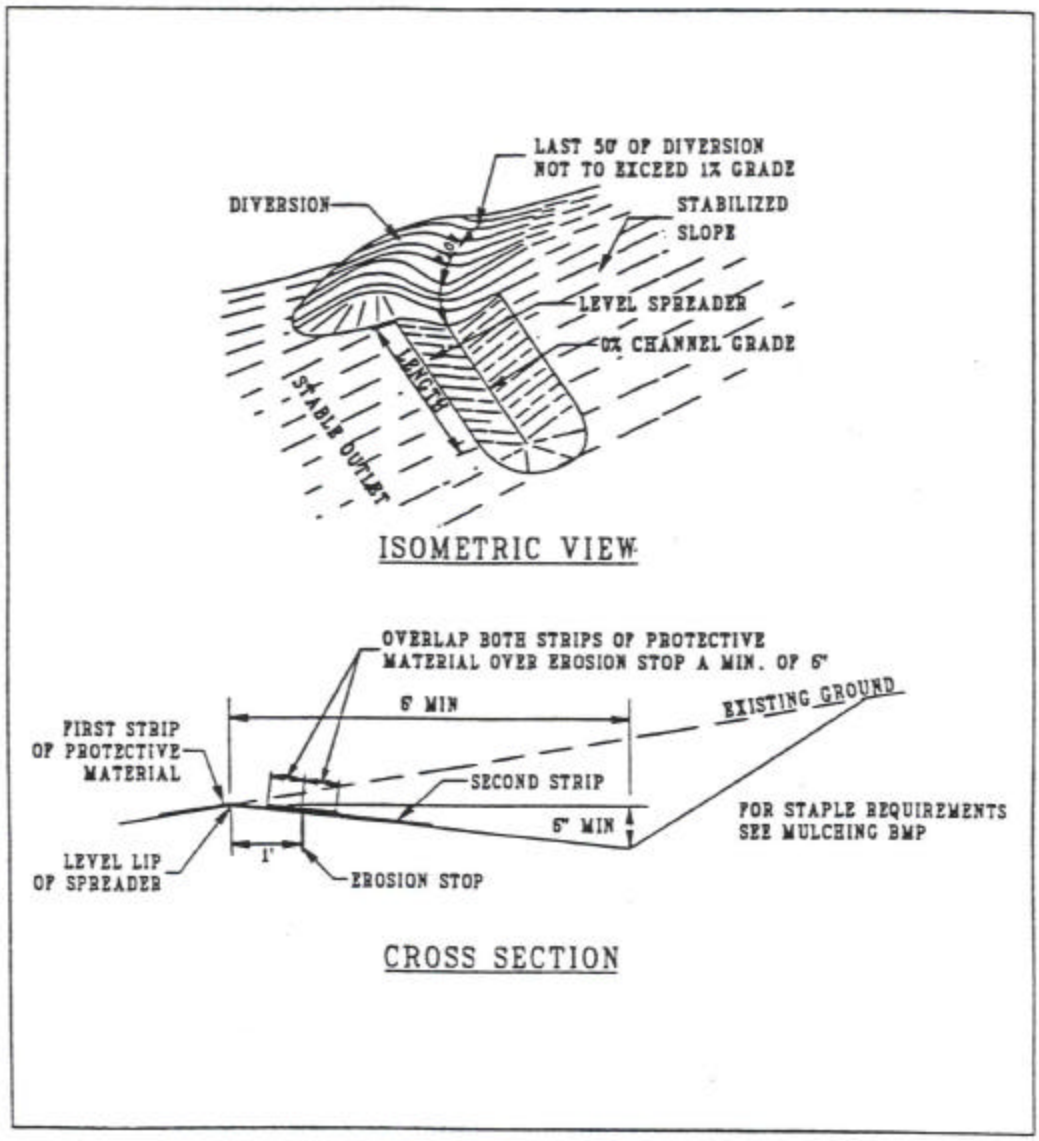
Description: A channel constructed at a zero grade (contoured) to accept concentrated storm water runoff for discharge at non-erosive velocities to undisturbed or stabilized vegetated areas such as a **Filter Strip**. The device converts channeled runoff into sheet flow across vegetated areas. The level spreader is designed to collect/ control a certain design volume of runoff entering at a relatively high velocity (discharge) and then release it at a lower discharge rate. Level spreaders are generally limited in size (less than 50 feet long and 15 feet wide).

Purpose: To control erosion by reducing the energy (velocity) of concentrated runoff.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Fair to Good. They are very effective at causing sedimentation. However, because of their limited size, it is generally not recommended that they be used for this purpose as there is typically little space to handle well both sediment and runoff volume
Prevent Contamination by:	
Salinity	Poor. Performance will depend on the filter strip down-gradient of the level spreader. Physical/ mechanical filtering through a filter strip has little significant effect on dissolved salt in the runoff
Fertilizers and Organics	Fair. (20ft grass filter strip down-gradient of the level spreader), Good (100ft forested filter strip down-gradient of the level spreader); for soil areas located down-gradient of the Level Spreader/ Filter Strip combination
Pesticides / Herbicides	Fair. (20ft grass filter strip down-gradient of the level spreader), Good (100ft forested filter strip down-gradient of the level spreader); for soil areas located down-gradient of the Level Spreader/ Filter Strip combination
Other	Will vary by contaminant, generally expected to be poor
Water Quantity	
Runoff Control	Fair to Good. Limited capacities
Infiltration	Fair to Good. In combination with down stream filter strips
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. No ability to treat this contaminant
Heavy Metals	Poor. No ability to treat this contaminant
Pathogens	Poor. No ability to treat this contaminant
Fertilizers and Organics	Poor. No ability to treat this contaminant
Salinity	Poor. No ability to treat this contaminant
Other	Will vary by contaminant, generally no significant effect

Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. No ability to treat this contaminant
Heavy Metals	Poor. No ability to treat this contaminant
Pathogens	Poor. No ability to treat this contaminant
Fertilizers and Organics	Poor. No ability to treat this contaminant
Salinity	Poor. No ability to treat this contaminant
Suspended Sediment	Poor. The limited storage capacities of most spreaders does not allow them to act as effective sediment settlement devices
Low Dissolved Oxygen	Generally no significant effect
Water Temperature Increase	Generally no significant effect
Other	Will vary by contaminant, generally no significant effect
Habitat Suitability	No significant impact as a stand-alone device. May be used effectively to maintain adjacent habitat areas by controlling the velocity of the entering flow
Capital or Implementation Costs	Low to Moderate
Operation and Maintenance	Low to Moderate cost. The exit rim must be maintained at a level elevation across its enter length or concentrated flow and erosive situations may develop at exit points Normal maintenance includes regular inspection and correction of eroded areas, mowing and sediment removal to maintain capacity
Potential Side Effects	Wet areas downstream from the spreader may develop if the permeability of the receiving soils are inadequate to, pass-on or infiltrate the runoff
Concurrent Land Management Practices	Sediment removal and/ or control BMPs to reduce sediment load entering the spreader Down-gradient Filter Strip or Vegetated Geotextile Mat to accept and distribute flow in a non-erosive manner from the spreader
Feasibility	Applicable for low to moderate flow situations.

Primary Source of BMP Information: Liles, Jr., April, 2000
Additional References:



Level Spreader
(Not for design purposes)
Source: Minnick et al., 1992

Riprap (Sr)

Description: A layer of loose rock or aggregate placed over a soil surface susceptible to erosion.

Purpose: Riprap structures are used to control erosion against active high-energy water flows and / or wave action. Also may be used to stabilize (buttress) cut slope areas.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good. Rock sizes and structures must be large enough to withstand wave action and / or discharge from a minimum return storm or weather (wind) event based on site-specific conditions. As a hill slope buttress, the riprap must be of sufficient mass and placed properly to prevent slope failure.
Sedimentation Control	Not Applicable
Prevent Contamination by:	
Salinity	Not Applicable
Fertilizers and Organics	Not Applicable
Pesticides / Herbicides	Not Applicable
Other	Not Applicable
Water Quantity	
Runoff Control	Poor. Riprap itself does not affect the quantity of runoff created by a storm. It may be used to line channels/ swales to allow them to carry and divert more runoff than if the channel/ swale was stabilized with vegetation only
Infiltration	Poor to Good. Design specific
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Not Applicable
Heavy Metals	Not Applicable
Pathogens	Not Applicable
Fertilizers and Organics	Not Applicable
Salinity	Not Applicable
Other	Not Applicable
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Not Applicable
Heavy Metals	Not Applicable
Pathogens	Not Applicable
Fertilizers and Organics	Not Applicable
Salinity	Not Applicable
Suspended Sediment	Good. As an armor over loose, poorly consolidated and / or fine-grained soil slopes and shore lines

Low Dissolved Oxygen	Not Applicable
Water Temperature Increase	May increase water temperatures through transfer of absorbed sunlight-heat to runoff water that then enters other water bodies
Other	Not Applicable
Habitat Suitability	May be effective as complimenting portion of an overall comprehensive habitat management plan. Adds diversity to the vegetated areas in water bodies such as **Wet Ponds**, and Constructed Wetlands
Capital or Implementation Costs	Low to High. Varies greatly depending on site specific conditions
Operation and Maintenance	Low. Periodic observation and repair of settled areas or areas affected by severe storms
Potential Side Effects	In streams, erosion may start in a new unprotected location. The design must include an assessment of the stream channel conditions below and above the rip-rapped area to ensure against this potential Heat Impacts: May increase water temperatures through transfer of absorbed sunlight-heat to runoff water that then enters other water bodies
Concurrent Land Management Practices	Alternative: Vegetated and non-vegetated **Geotextile** Use in conjunction with other shoreline stabilization (vegetative) and/ or management methods
Feasibility	Highly versatile, but may require long-term access for large equipment to facilitate installation and maintenance

Primary Source of BMP Information: Doenges et al., 1990

Additional References:

EPA, 1992 (pp. 3-28 to 3-30)

USDA, December, 1996 (Streambank & Shoreline Protection)

Sand Filter (Ssf)

Description: A concrete-walled or similar catchment structure that includes an energy dissipation inlet, sediment settling tank followed by an infiltration tank with sized-filter media over an underdrain gallery. Layers of sand and/ or gravel are common filter media materials. Peat has been used to aid in the collection (sorption) of dissolved pollutants. Runoff capacities are usually larger than for a typical "oil/ water" or "oil/ grit" separator (See **Water Quality Trap**). The inlet may be designed as a vegetated area (bioretention design) to promote pollutant uptake by plants and to pre-treat (trap) sediment in the runoff.

Purpose: Controls and treats the "first flush" of pollutants and sediment from impervious area storm water runoff.

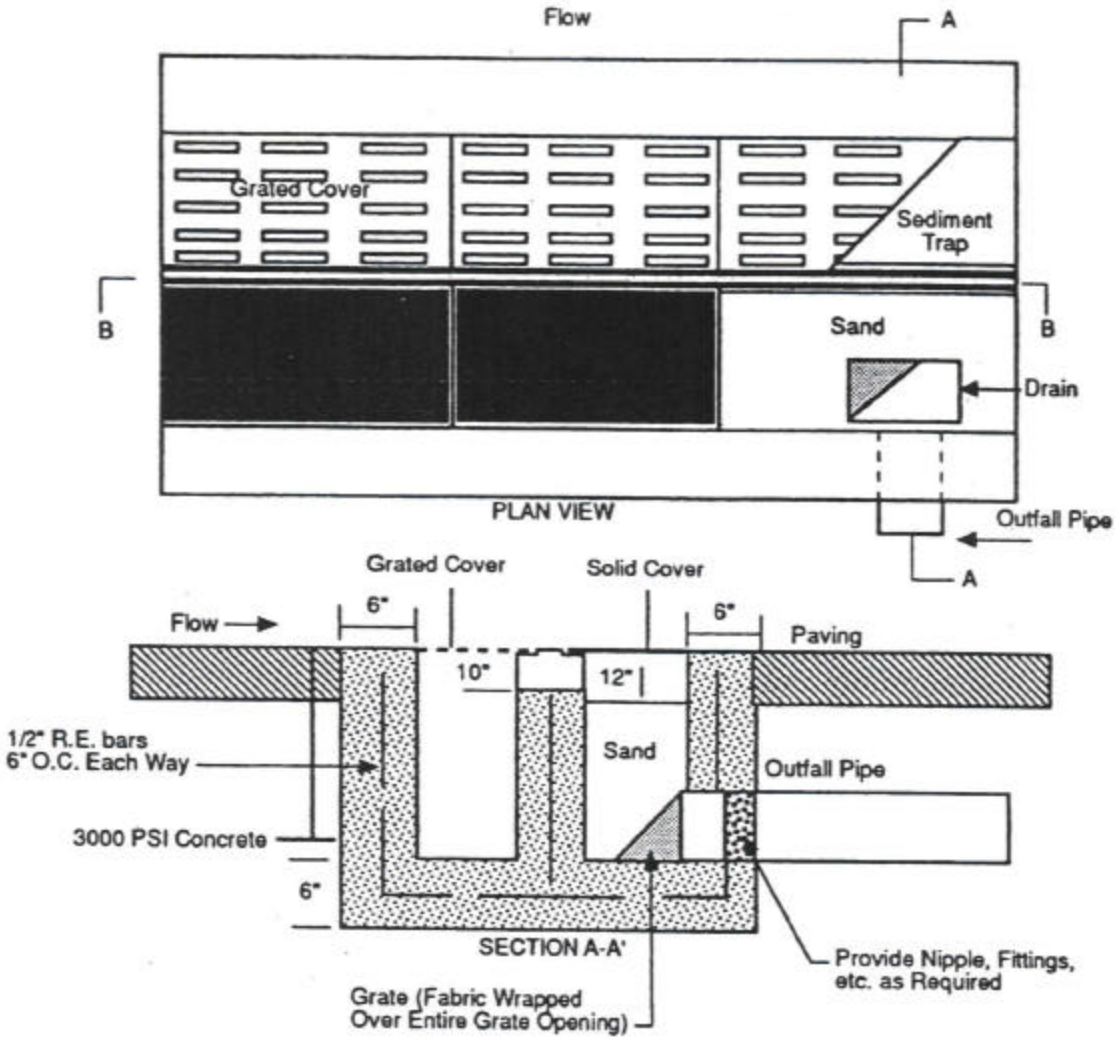
Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Excellent
Prevent Contamination by:	
Salinity	Poor. Salt in solution passes through filter
Fertilizers and Organics	Fair to Good. Adsorbed nutrients on particles are trapped. Also, with a design that includes vegetation at the inlet to the sand filter, some of the nutrients will be used in plant uptake
Pesticides / Herbicides	Poor. Pesticides in solution pass through the filter and may impact soil in the vicinity of the sand filter
Other	Varies by contaminant and design
Water Quantity	
Runoff Control	Good to Excellent
Infiltration	Excellent
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. The pesticides in solution pass through the filter and may impact ground water in the vicinity of the sand filter
Heavy Metals	Fair to Good. Metals in solution may pass through, but the larger percentage that is in particulate form and/ or adsorbed to sediment particles may be trapped in the filter
Pathogens	Fair to Good. Trapped in the filter
Fertilizers and Organics	Poor to Fair. Adsorbed nutrients on particles are trapped. Also, with a design that includes vegetation at the inlet to the sand filter, some of the nutrients will be used in plant uptake
Salinity	Poor. Salt in solution passes through filter and may infiltrate to ground water

Other	Will vary by contaminant Hydrocarbons appear to be removed through adsorption to the filter media followed by volatilization. The use of peat may enhance the adsorption process
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. The pesticides in solution pass through the filter and continue on to downstream water bodies
Heavy Metals	Fair to Good. Metals in solution may pass through, but the larger percentage that is in particulate form and/ or adsorbed to sediment particles may be trapped in the filter
Pathogens	Fair to Good. Trapped in the filter
Fertilizers and Organics	Poor to Fair. Adsorbed nutrients on particles are trapped. Also, with a design that includes vegetation at the inlet to the sand filter, some of the nutrients will be used in plant uptake
Salinity	Poor
Suspended Sediment	Excellent
Dissolved Oxygen	Good to Excellent. Traps oxygen demanding substances
Water Temperature	Generally Poor or No Effect due to short holding time (< 1 day)
Other	Will vary by contaminant Hydrocarbons appear to be removed through adsorption to the filter media followed by volatilization. The use of peat may enhance the adsorption process
Habitat Suitability	Not directly applicable as habitat. May help to protect surrounding habitat areas by controlling runoff quality
Capital or Implementation Costs	Relatively new BMP approach and historically more expensive than traditional storm water BMPs. May become more price competitive as the method becomes more widely known
Operation and Maintenance	As with other infiltration-type BMPs, these structures require scheduled maintenance to function efficiently. Normal maintenance tasks include, but not limited to: inspection, buffer maintenance (vegetative strips, etc.), and sediment removal. One of the important maintenance goals is to prevent clogging of the filter media and prolong its life. Structures with permanent pools or oil/ water separators should be pumped out regularly and filled with water to reestablish the water seal
Potential Side Effects	No adverse impacts identified
Concurrent Land Management Practices	May be combined with oil/ water separators (See Water Quality Trap) to further inhibit petroleum-related pollution

	Sediment pretreatment measures must be in-place to minimize sediment in the runoff that passes into the sand filter. Pretreatment may include low-velocity grassed swales, vegetated filter strips and level spreaders Must be combined with detention or infiltration basins to control large storm events
Feasibility	Not effective where significant concentration or quantities of petroleum substances may be released to the environment (i.e., more than incidental drips). Design plans should demonstrate the total loading of petroleum substances to soil, ground water and surface water expected from the site after treatment with the sand filter. Most appropriate for small, impervious watersheds (parking lots, road ways) The design should include a bypass for excess flow from storms larger than the design flow and/ or for cold weather situations if freezing of the filter tank is likely

Primary Source of BMP Information: Young et al., December, 1995 (Revised 1998)
Additional References:

Caraco and Claytor, 1997
EPA, September, 1999 (Hydrodynamic Separators)
EPA, September, 1999 (Sand Filters)
Schueler, 1994



Sand Filter
(Not for design purposes)
Source: Holbrook, April, 1995

Soil Stabilization – Polyacrylamide (Sp)

Description: A temporary soil treatment used to bind soil particles to stabilize an area against erosion when vegetation practices are (or may be) ineffective, such as late in the growing season. The material (an anionic polymer) is spray-applied to soil areas subject to erosion where vegetation is sparse or non-existent. It is most effective when the soil conditions are dry. The product has been used since the 1950s in western states and is also known as PAM. It is currently not approved for use in Connecticut.

Purpose: A practice to reduce erosion in difficult planting areas.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Not directly applicable. May reduce sediment load by reducing erosion, but does not directly aid settling of particles.
Prevent Contamination by:	
Salinity	Generally no significant effect
Fertilizers and Organics	Generally no significant effect
Pesticides / Herbicides	Generally no significant effect
Other	Generally no significant effect
Water Quantity	
Runoff Control	Fair to Good. Proper application and use does not reduce runoff significantly compared to vegetative practices
Infiltration	Good. Following manufacturer's recommendations
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Generally no significant effect (In the long term, vegetation or some other stabilization practice must be established for the area and may require pesticides or herbicides)
Heavy Metals	Generally no significant effect
Pathogens	Generally no significant effect
Fertilizers and Organics	Generally no significant effect (In the long term, vegetation or some other stabilization practice must be established for the area and may require fertilizer)
Salinity	Generally no significant effect
Other	Generally no significant effect
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Generally no significant effect (In the long term, vegetation or some other stabilization practice must be established for the area and may require pesticides or herbicides)
Heavy Metals	Generally no significant effect
Pathogens	Generally no significant effect

Fertilizers and Organics	Generally no significant effect (In the long term, vegetation or some other stabilization practice must be established for the area and may require fertilizer)
Salinity	Generally no significant effect
Suspended Sediment	Not directly applicable. May reduce sediment load by reducing erosion, but does not directly aid settling of particles
Low Dissolved Oxygen	Generally no significant effect
Water Temperature Increase	Generally no significant effect
Other	Over application may adversely effect water quality (e.g., increased runoff, off-site erosion, elevated levels of PAM in downstream water bodies
Habitat Suitability	To date, studies by the USDA indicate that PAM is not harmful to aquatic habitats. However, PAM is NOT currently approved (September 2000) for use in Connecticut because it has not undergone in-state testing
Capital or Implementation Costs	Potentially High for large-scale situations requiring soil stabilization. May be the most cost effective method for unusual and difficult stabilization problems (steep slopes and late season planting)
Operation and Maintenance	Periodic inspection to identify failing areas that may require a re-application. PAM breaks down somewhat when subjected to ultraviolet light and may not be suitable for winter applications (check with manufacturer's recommendations for specific use restrictions). Areas requiring an extended period of stabilization should also employ additional stabilization BMPs
Potential Side Effects	Over-application may significantly restrict infiltration and increase the speed and amount of runoff by creating impervious surfaces (literally a rubber-like layer). PAM is not designed for direct application to water bodies; setbacks must be used. It is an FDA and EPA regulated substance
Concurrent Land Management Practices	Pre-planning of erosion, sediment and material control is the most effective way to avoid critical and difficult situations that require PAM applications for soil stabilization
Feasibility	Applicable to most stabilization situations The operator/ applicator must follow all local, state or federal laws governing anionic PAM. This may require a permit from the CT Department of Environmental Protection and/ or other agencies before application may proceed PAM is also used in surface irrigation applications as a soil binder and infiltration enhancing measure

Primary Source of BMP Information: Liles Jr., April, 2000

Additional References:

EPA, 1992 (Chemical Stabilization)

Sojka and Lentz, 1997

Trails and Walkways (Stw)

Description: A travel way or structure to provide ease of movement for animals or people through difficult or ecologically sensitive terrain. These structures may be simple trails for people or animals to guide access, or more substantial structures constructed of wood, stone, gravel or pavement materials to limit or reroute access from water resource or habitat areas. Access control using Stw allows complimenting BMPs to be applied to the trail and walkway areas, which may reduce the number or size of the BMPs required to effectively manage storm water runoff impacts for the overall area.

Purpose: This BMP may be applied as part of a conservation management system to accomplish one or more of the following purposes:

- divert travel away from ecologically sensitive and/or erosive sites
- provide or improve access to forage, water and/or shelter
- improve grazing efficiency and distribution
- with surface modifications [paving, graveling, mulching], Stw may be used for recreational walkways.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good. As a method of stabilizing and improving a travel-way that may otherwise be degraded and eroded.
Sedimentation Control	Good. As a method of stabilizing and improving a travel-way that may otherwise be degraded and eroded. Reduces the need for "downstream" sedimentation control BMPs.
Prevent Contamination by:	
Salinity	Not Applicable
Fertilizers and Organics	Not Applicable
Pesticides / Herbicides	Not Applicable
Other	Not Applicable
Water Quantity	
Runoff Control	Good. Design dependent as part of an overall runoff control plan
Infiltration	Not Applicable
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Not Applicable
Heavy Metals	Not Applicable
Pathogens	Not Applicable
Fertilizers and Organics	Not Applicable
Salinity	Not Applicable
Other	Not Applicable

Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Not Applicable
Heavy Metals	Not Applicable
Pathogens	Not Applicable
Fertilizers and Organics	Not Applicable
Salinity	Not Applicable
Suspended Sediment	Appropriate trail design, BMP implementation and maintenance of the trails will reduce erosion and suspended sediment associated with travel and use of the area
Dissolved Oxygen	Not Applicable
Water Temperature	Not Applicable
Other	Not Applicable
Habitat Suitability	Appropriate as part of an overall management plan to protect significant habitats adjacent to development
Capital or Implementation Costs	Capital: Low to moderate: Reduces the expense and need for additional or larger sediment catch basins and other sediment control BMPs when areas subject to erosion are protected from degradation
Operation and Maintenance	Operation will consist of periodic grading or shaping on trails and walkways to maintain designed dimensions Maintenance will consist of regular periodic inspection and repair of runoff control BMPs along the trails/ walkways that may be needed following major storm events or other incidents that may cause damage Also, reference **Porous Pavement** BMP
Potential Side Effects	Animal wastes and trash may be concentrated on trail/ walkway and carried with runoff if not controlled by design and planned/ scheduled maintenance
Concurrent Land Management Practices	Other practices that facilitate grazing distribution and proper intensity, such as prescribed grazing, should be implemented along with this practice Where this BMP allies to recreational walkways, **Porous Pavement** may be used for a potentially smoother surface and access for the physically challenged
Feasibility	Applicable to all trails and walkways

Primary Source of BMP information: USDA, April, 1995 (Animal Trails and Walkways)
Additional References:
EPA, 1987 (Proper Roads and Trails", p. 83)

Water Diversion (Swd)

Description: A diversion BMP is typically a ditch or swale (vegetated or stone-lined), sometimes a dike, designed to intercept and alter the course of runoff flows. The diversion is commonly constructed across a moderate to steep slope to catch water flowing down the incline. They may be constructed to separate runoff between different land use or waste type areas.

Purpose: Diversions are used to control the volume of runoff that enters a particular storm water BMP structure or facility so as not to exceed the design capacity of the BMP feature. In this case, additional measures must be considered to handle the impacts of the "untreated" runoff that bypasses the BMP. Diversions may also be designed to collect runoff before it contacts/ co-mingles with concentrated waste that may be in the form of water, soil or other material. Alternatively, contaminated runoff may be diverted from uncontaminated areas or materials to prevent mixing. In either case, the diversion results in a decrease in the volume of contaminated water that must be treated. The diverted runoff may be recycled, usually for non-potable activities.

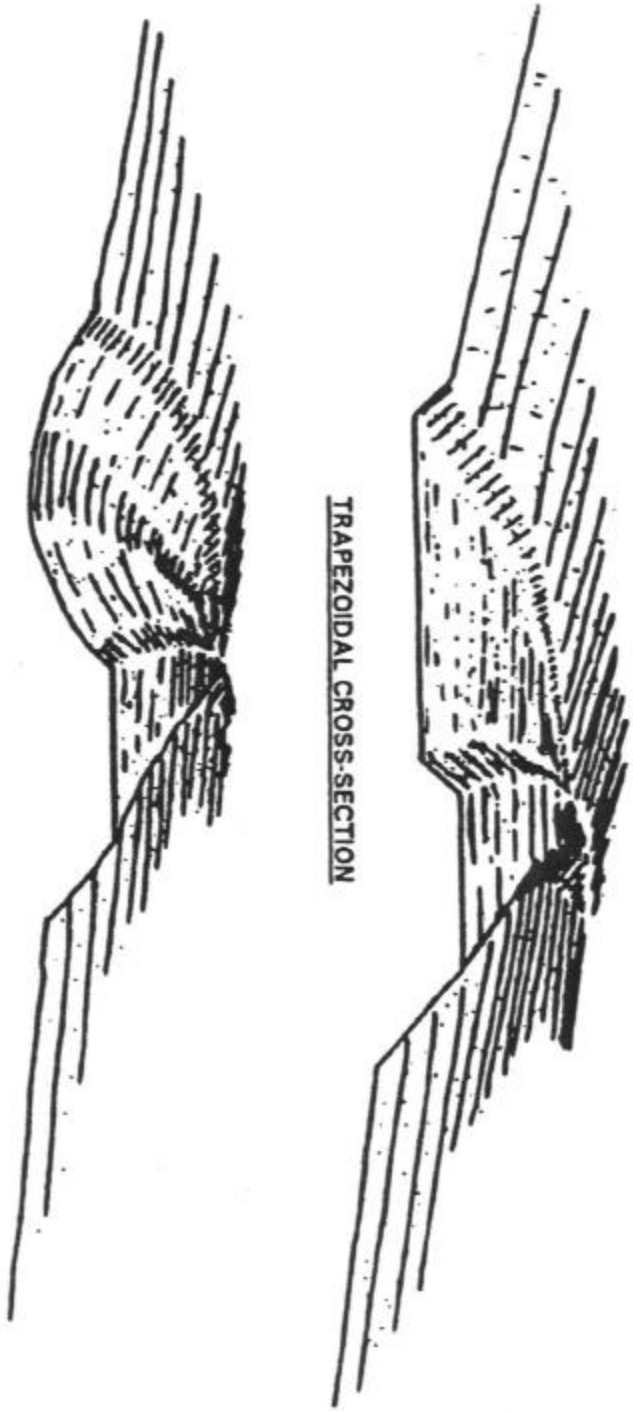
Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salinity	Generally no significant effect
Fertilizers and Organics	Fair to Good. Design dependent. Nutrient laden runoff may be diverted from a location, preventing the soil in the bypassed area from receiving the nutrients
Pesticides / Herbicides	Fair to Good. Design and contaminant dependent. Chemical laden runoff may be diverted from a location, preventing the soil in the missed area from receiving the chemicals
Other	Will vary by design and contaminant
Water Quantity	
Runoff Control	Good to Excellent
Infiltration	Will vary by application and design: Runoff may be diverted to a specific ground water recharge area
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor to Good. Design dependent. Chemical laden runoff may be diverted from a location, preventing the ground water beneath the bypassed area from receiving the chemicals
Heavy Metals	Poor to Good. Design dependent. Metal laden runoff may be diverted from a location, preventing the ground water beneath the bypassed area from receiving the metals
Pathogens	Poor to Good. Design dependent. Pathogen laden runoff may be diverted from a location preventing the ground water beneath the bypassed area from receiving the pathogens

Fertilizers and Organics	Poor to Good. Design dependent. Nutrient laden runoff may be diverted from a location, preventing the ground water beneath the bypassed area from receiving the most concentrated impact from the nutrients
Salinity	Poor to Good. Design dependent. Salt laden runoff may be diverted from a location, preventing the ground water beneath the bypassed area from receiving the most concentrated impact from the salt
Other	Will vary by design and contaminant
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Fair to Good. Design dependent. Chemical laden runoff may be diverted from a water body preventing that surface water from receiving the chemicals
Heavy Metals	Fair to Good. Design dependent. Metal laden runoff may be diverted from a water body, preventing the surface water from receiving the metal
Pathogens	Fair to Good. Design dependent. Pathogen laden runoff may be diverted from a water body, preventing the surface water from receiving the pathogens
Fertilizers and Organics	Fair to Good. Design dependent. Nutrient laden runoff may be diverted from a water body, preventing the surface water from receiving the nutrients
Salinity	Generally no significant effect
Suspended Sediment	Fair to Good. Design dependent. Sediment laden runoff may be diverted from a water body, preventing the surface water from receiving the sediment
Low Dissolved Oxygen	Fair to Good. Design dependent.
Water Temperature Increase	Generally no significant effect
Other	Will vary by design and contaminant
Habitat Suitability	Not usually an important habitat by themselves, but may support appropriate drainage of adjacent habitats. May add to diversity of the overall area depending on design features Care should be taken to ensure that post-development drainage does not change pre-development habitat conditions
Capital or Implementation Costs	Generally low compared to the additional cost of treating added water volumes resulting from the mixing of “clean” runoff with contaminated runoff or soil areas
Operation and Maintenance	Diversion structures or methods should be inspected after every significant storm to ensure that they have not been damaged or clogged with debris. On an annual basis they should be evaluated to ensure that they meet hydraulic design criteria as part of a site’s overall storm water and/ or pollution control plan Costs may be low to moderate depending on specific design plan requirements and site conditions

Potential Side Effects	Recharge of ground water may be diminished in areas previously receiving runoff, now cutoff from surface flow Habitat may be impacted in areas previously receiving runoff now cut off from [surface or ground water] flow by the diversion. Similarly, any habitat areas that receive additional water as a result of the diversion are also likely to change
Concurrent Land Management Practices	Incorporate practices to limit the creation of contaminated soils and runoff. Minimize the areas where contamination may occur, and restrict contact with "clean" runoff
Feasibility	Generally applicable to most sites and activities. May be difficult to implement depending on topographic constraints (pre-planning at the conceptual project phase of management of storm water and handling of regulated materials is critical)

Primary Source of BMP Information: EPA, September, 1999 (Flow Diversion)
Additional References:

EPA, 1987
Holbrook, 1996
Liles Jr., April, 2000
USDA, December, 1996 (Diversion)



Water Diversion and Swale
Source: EPA, 1992

Water Quality Inlet (Trap) (Swqi)

Description: A chambered structure designed with baffling and siphoning capability (inverted elbow pipes) to trap sediment and hydrocarbon loadings from "first flush" runoff (also known as “oil/ grit” or “oil/ water” separators and traps). The traps are typically of limited storage capacity and designed for small “at risk” areas (<<1 acre) such as parking lots and gasoline stations. They may or may not be designed with infiltration capability (usually simple weep holes). Infiltration capability is not recommended for “at risk” locations. [Compare: **Sand Filters** have larger runoff handling capacities, a large filtering bed for infiltration or runoff, but do not have siphoning capability for hydrocarbon treatment].

Purpose: The purpose of these devices is to collect and treat the “first flush” runoff from small areas with potential minor petroleum contamination. They are designed to “trap” “lighter than water” substances that float on top of water, such as gasoline. Whenever possible, this BMP should part of an overall plan to control or limit chemical handling and spills, and not as the only mechanism for collecting water contaminated with light density substances.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Not Applicable
Sedimentation Control	Poor to Fair. Limited by capacity size and design focus on retaining floating hydrocarbons
Prevent Contamination by:	
Salinity	Poor. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons
Fertilizers and Organics	Poor. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons
Pesticides / Herbicides	Poor. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons
Other	Petroleum Hydrocarbons; good if the collection chambers are cleaned out on a regular schedule to prevent re-suspension or mobilization of collected material
Water Quantity	
Runoff Control	Poor. Limited by capacity size and design focus on retaining floating hydrocarbons
Infiltration	Poor. This structure is not usually designed to release via infiltration because it is commonly collecting/ trapping synthetic organic chemicals that should not be released ground water. (Swqi) is not recommended for high risk (“hotspot”) areas where chemicals are used or manufactured
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons.

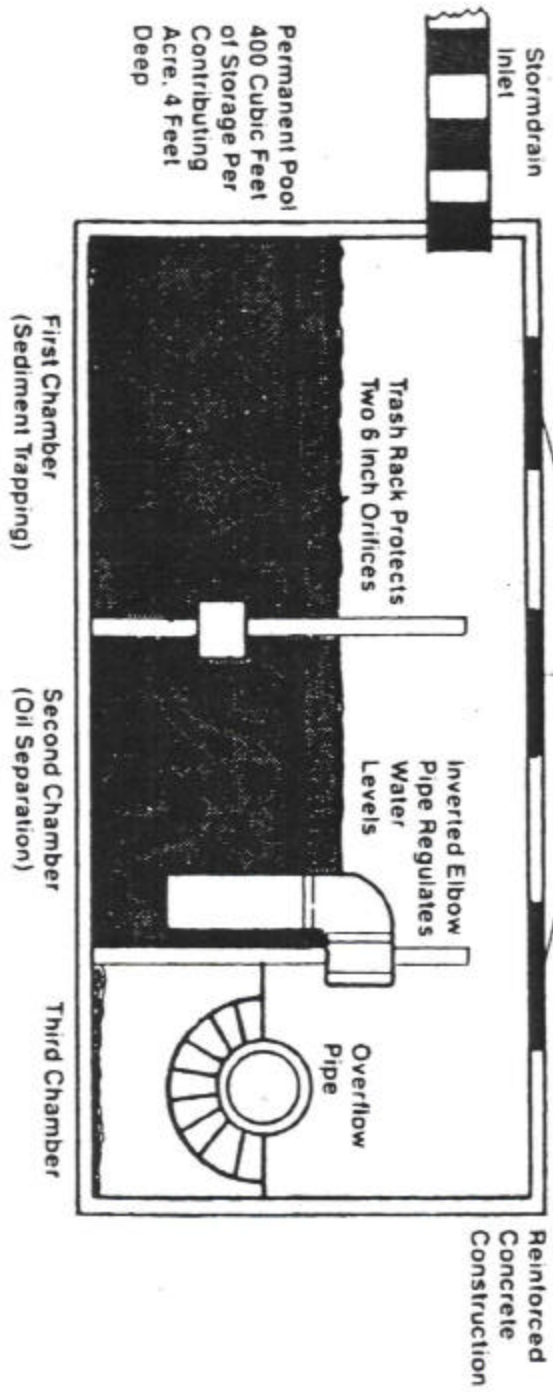
	Release from this BMP structure by infiltration is not recommended
Heavy Metals	Poor to Fair. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons. May retain some metal particles or those adsorbed to larger sized sediment particles. Release from this BMP structure by infiltration is not recommended
Pathogens	Poor. Does not trap organisms that are being carried in the runoff flow or attached to small sediment particles
Fertilizers and Organics	Poor. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons. Release from this BMP structure by infiltration is not recommended
Salinity	Poor. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons. Release from this BMP structure by infiltration is not recommended
Other	Petroleum Hydrocarbons: good if the collection chambers are cleaned out on a regular schedule to prevent re-suspension or mobilization of collected material. Release from this BMP structure by infiltration is not recommended
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons. Release from this BMP structure by infiltration is not recommended
Heavy Metals	Poor to Fair. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons. May retain some metal particles or those adsorbed to larger sized sediment particles. Release from this BMP structure by infiltration is not recommended
Pathogens	Poor. Does not trap organisms that are being carried in the runoff flow or attached to small sediment particles
Fertilizers and Organics	Poor. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons. Release from this BMP structure by infiltration is not recommended
Salinity	Poor. Does not trap dissolved substances; limited by capacity size and design focus on retaining floating hydrocarbons. Release from this BMP structure by infiltration is not recommended
Suspended Sediment	Poor to Fair. Limited by capacity size and design focus on retaining floating hydrocarbons
Dissolved Oxygen	Generally no significant effect because of limited residence time in BMP and relatively small containment capacity
Water Temperature	Generally no significant effect because of limited residence time in BMP and relatively small containment capacity
Other	Unknown. Expected to be poor or of limited effect because of limited residence time in BMP and relatively small containment capacity

Habitat Suitability	Not usually applicable
Capital or Implementation Costs	Relatively expensive (initial installation and for proper maintenance) compared to regulations that limit the use and handling of these types of products in a land use area
Operation and Maintenance	Moderate to High. Must be cleaned out regularly to be effective
Potential Side Effects	Poorly designed or maintained devices may actually concentrate petroleum substances in the chamber only to be flushed out of the device to the environment by subsequent storms that exceed the design capacity of the device
Concurrent Land Management Practices	This BMP should part of an overall plan to control or limit chemical handling and spills and not as the only mechanism for collecting water potentially contaminated with light-density substances Diversion BMPs to shed runoff away from areas where petroleum or chemical products are handled/ used Bermed impervious pads and other collection devices (e.g., portable drum tubs) beneath chemical handling/ use areas to improve daily and/ or emergency clean-up activities
Feasibility	Oil and grease substances must be removed from oil/ water separators after each storm in order to optimize the effectiveness of the separation action. Care must be taken in the design and through maintenance activities/ schedule to prevent re-suspension of sediment with adsorbed oil (oil attached to the surface of the sediment) or mobilization of petroleum substances floating in the oil/ water separation chamber(s)

Primary Source of BMP Information: Young et al., December, 1995 (Revised 1998)

Additional References:

EPA, September, 1999 (Hydrodynamic Separators)
EPA, January, 1993
Schueler, 1987



Water Quality Inlet (Trap)
(Three Chamber Design Schematic)
Source: Schueler, July, 1987

Wet Pond (Swp)

Description: A water impoundment resulting from the construction of a dam or berm-encased area or excavated pit with risers or weir water release structures to promote extended detention for a certain interval (usually not more than three days). The release structure is designed to retain a certain permanent depth of water while releasing runoff volumes that exceed the design storm requirements of the site plan. The design promotes the replacement of existing water with new runoff water during each storm event. The BMP relies on settling and biological uptake to remove pollutants. Similar to a dry pond (i.e., extended detention basin), except a permanent pool of water is present. Maximum depths are less than 6 to 8 feet to support proper operation of the pond as a BMP for the criteria listed below. Wet ponds should include a forebay to facilitate the collection of suspended sediment and efficient periodic clean-out dredging. Cold climate design features and maintenance items must be part of any final design to ensure proper operation during winter and spring weather.

Purpose: Properly designed and maintained wet ponds can be very effective at removing sediment, organic nutrients and heavy metals and at reducing biological oxygen demand (BOD). They can satisfy multiple goals, such as storm water management, pollutant removal and landscaping/ habitat improvement.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Excellent
Sedimentation Control	Excellent
Prevent Contamination by:	
Salinity	Not Applicable
Fertilizers and Organics	Not Applicable
Pesticides / Herbicides	Not Applicable
Other	Not Applicable
Water Quantity	
Runoff Control	Good. Depends on capacity (storage volume) above the permanent water level of the wet pond
Infiltration	Fair to Good. In order to maintain a permanent water level in the pond, the adjacent ground water elevation must be near or equal to the elevation of the water in the pond. This condition will limit the amount of infiltration of surface water that actually adds to the total volume of ground water. Infiltration will be at its greatest when the pond water level is holding extra storm runoff above the normal water level elevation
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Potentially poor or no effect
Heavy Metals	Fair. Particulate or adsorbed forms will settle out. Dissolved forms may pass through

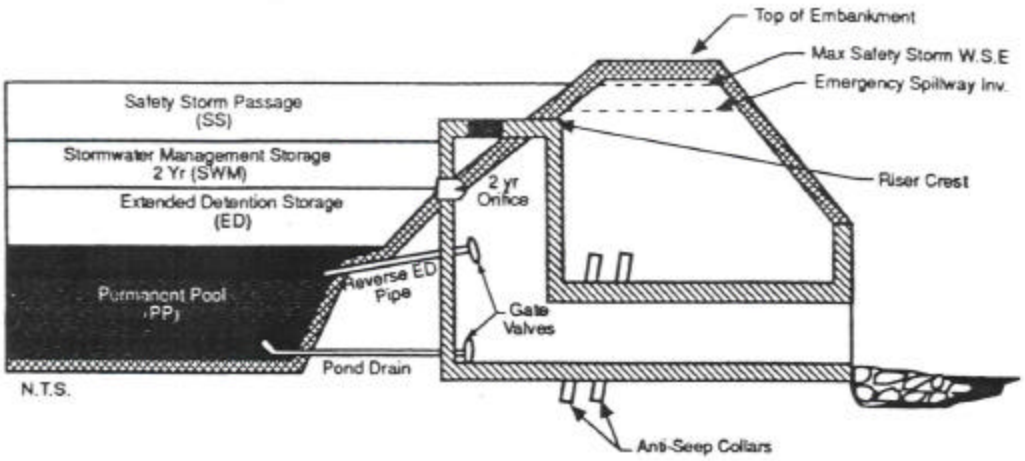
Pathogens	Good. Filtration through the soil beneath the pond removes pathogens
Fertilizers and Organics	Fair to Good. Used in plant uptake
Salinity	Poor. Dissolved salt will tend to exfiltrate out of the pond to the surrounding ground water
Other	Will vary by contaminant
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor or no effect
Heavy Metals	Limited information, potentially good with proper settling times and biological uptake
Pathogens	Limited information; potentially poor
Fertilizers and Organics	Fair to Good. Used in plant uptake
Salinity	Poor. Evaporation will tend to concentrate salts; winter and spring runoff may increase salinity levels in deeper portions of the pond
Suspended Sediment	Good to Excellent. Design dependent: Forebays to collect sediment prior to entering main pond area are recommended
Low Dissolved Oxygen	Poor to Fair. Design dependent; Water must move through the pond, not be "stagnant"
Water Temperature Increase	Poor. The large expanse of water surface and relatively shallow depth will tend to increase and maintain high seasonal temperatures. Border shading will be of limited effect
Other	Will vary by contaminant
Habitat Suitability	Good to Excellent. A wide variety of habitats may be supported in a wet pond environment
Capital or Implementation Costs	Relatively high compared to other structural BMP types (e.g., extended detention basin). The responsibility for maintenance must be clearly and explicitly understood by all parties and enforced. It may be appropriate to include the understanding directly in any permit document that supports the project
Operation and Maintenance	Normal maintenance tasks include, but not limited to: inspection, debris and litter removal, mowing, erosion control and nuisance control (persistently wet areas, insects, odors) Inspections for winter-time ice and snow removal activities from release structures (riser, low-flow piping and underdrain [if applicable]) must be included in the O&M plan to ensure proper operation Non-routine maintenance will include sediment removal to maintain design capacities and remove accumulated contaminants in the basin-floor soils/sediment (10 to 20 year time frame to be determined based on expected [in-filling] sedimentation rates)

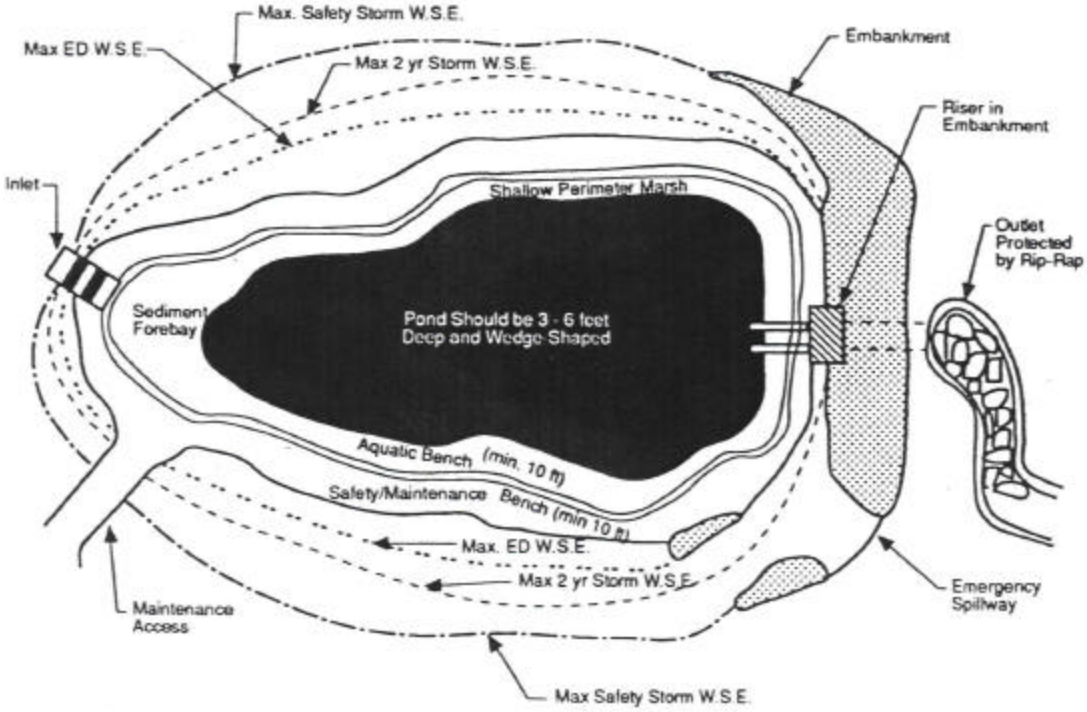
Potential Side Effects	Hydrologic modeling should be completed to assess the hydrologic impacts of individual basins on the cumulative watershed hydrograph (i.e., base flow, peak and flood discharge volumes, timing and locations) for important design storms (suggest 2-, 10-, 50-year events). Adjust basin locations and release rates to avoid overlapping releases and increased flood peaks. In many cases, the Natural Resources Conservation Service [formerly the Soil Conservation Service] method TR-20, TR-55 or equivalents can be used for this evaluation
Concurrent Land Management Practices	Alternative: see **Extended Detention Basin** or **Wetland - Constructed** Perimeter marsh vegetation aids in the mechanical filtering of particulates and biological uptake of some dissolved contaminants Up-gradient of the basin, **Grass swales** and **Filter Strips** may be used to control sediment loading Non-structural vegetative methods and proper chemical handling procedures should be employed at upstream locations to reduce sediment and pollutant loading of the runoff entering the basin
Feasibility	Alternative: See **Wetland – Constructed** Generally most effective as part of a comprehensive nonpoint source pollution control plan for larger land parcels (>10 acres). Modified cold climate features must be incorporated into the design to ensure proper operation of this BMP type during winter and spring seasons. Refer to Caraco and Claytor (1997) for examples of cold climate design and maintenance information

Primary Source of BMP Information: Young et al., December, 1995 (Revised 1998).

Additional References:

Caraco and Claytor, 1997
EPA, January, 1993
Schueler, July, 1987





Wet Pond
(Not for design purposes)
Source: Holbrook, April, 1995

Contour Farming (Vcf)

Description: Vcf is a BMP involving tillage, planting, cultivating and harvesting activities that follow the natural contour of the land surface, established terraces or water diversions. The practice reduces the velocity and time of concentration of the runoff as it travels from the site. This aids in reducing peak discharge levels and erosive conditions.

Purpose: The practice increases moisture infiltration, controls runoff and reduces erosion.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salinity	Fair. Maintains a more consistent soil moisture through infiltration
Fertilizers and Organics	Generally no significant effect because it does not address control of initial amounts applied to the surface soil
Pesticides / Herbicides	Generally no significant effect because it does not address control of initial amounts applied to the surface soil
Other	Generally no significant effect because it does not address control of initial amounts applied to the surface soil
Water Quantity	
Runoff Control	Good to Excellent
Infiltration	Good to Excellent
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor to Fair. Increased infiltration promoted by the practice may carry higher amounts of fertilizer and pesticide to the ground water table. On the other hand, the practice should also facilitate more efficient and appropriate (less) use of fertilizers and pesticides, which may reduce the amounts that infiltrate to ground water
Heavy Metals	Generally not applicable
Pathogens	Generally not applicable
Fertilizers and Organics	Poor to Fair. Increased infiltration promoted by the practice may carry higher amounts of fertilizer and pesticide to the ground water table. On the other hand, the practice should also facilitate more efficient and appropriate (less) use of fertilizers and pesticides, which may reduce the amounts that infiltrate to ground water
Salinity	Generally no significant effect
Other	Will vary by contaminant

Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Fair. By reducing the volume of runoff leaving the field
Heavy Metals	Fair. By reducing the volume of runoff leaving the field
Pathogens	Fair. By reducing the volume of runoff leaving the field
Fertilizers and Organics	Fair. By reducing the volume of runoff leaving the field
Salinity	Fair. By reducing the volume of runoff leaving the field and promoting infiltration of precipitation
Suspended Sediment	Good to Excellent. By reducing the volume of runoff leaving the field and lowering the erosive velocity of the runoff flow
Low Dissolved Oxygen	Generally no significant effect
Water Temperature Increase	Generally no significant effect
Other	Will vary by contaminant
Habitat Suitability	Good to Excellent effect on downstream aquatic habitats by reducing the sediment load entering surface water
Capital or Implementation Costs	Costs may be less than operating "against the natural contour" because of savings through avoided equipment maintenance, minimizing need for additional storm water collection-type BMPs, and promoting potentially higher crop yields per acre
Operation and Maintenance	Maintain contour markers to ensure consistency, following a level grade Inspect furrows and ridges after significant storms, repair as needed to maintain diversion and runoff control
Potential Side Effects	May increase the amount and concentration of fertilizers and pesticides infiltrating to the ground water table if chemical management/ application plans are not followed
Concurrent Land Management Practices	Implement **Pest and Pesticide Management** plan Implement **Nutrient Management** plan Commonly used in conjunction with water diversions, **grassed swales and filter strips**
Feasibility	Suitable for most cultivated land with consistent slopes. Most appropriate for annual row crops. May not be effective on irregularly undulating topography (See Land Smoothing)

Primary Source of BMP Information: Holbrook, 1996

Additional References:

USDA, December, 1996 (Contour Buffer Strips)
USDA, December, 1996 (Contour Farming)
USDA, December, 1996 (Contour Orchard and Other Fruit Area)

Filter Strip (Vfs)

Description: An elongated area of dense, uniform vegetation established perpendicular to the runoff flow direction. Generally located at the lower end (downgradient) of a slope or field between an area of potential erosion or pollutants and a surface water body or infiltration BMP (See **Soil Stabilization - Field Border**). Wider strips (measured parallel to runoff flow direction) with well-established vegetation (grasses, bushes and trees) improve the function and effectiveness of the treatment. For treating nearly level fields (one percent slopes or less) a strip width of 15 to 25 feet is an absolute minimum to affect water quantity and quality. For treating fields with slopes near 10 percent, filter strip widths of at least 50 feet to 100 feet are recommended.

Purpose: Only effective for treating runoff in the form of overland sheet flow before runoff has concentrated into rills or incipient gullies. Performs primarily as a filter to catch and retain sediment from runoff, and as a buffer zone to separate and screen areas treated with fertilizer and/ or pesticides from water bodies or other land subject to degradation from chemical application.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Fair (20ft grass), Good to Excellent (100ft forested)
Sedimentation Control	Fair (20ft grass), Good to Excellent (100ft forested)
Prevent Contamination by:	
Salinity	Poor. Physical/ mechanical filtering has little significant effect on dissolved salt in the runoff
Fertilizers and Organics	Fair (20ft grass), Good (100ft forested). For soil areas located down-gradient of the Filter Strip
Pesticides / Herbicides	Fair (20ft grass), Good (100ft forested). For soil areas located down-gradient of the filter strip
Other	Will vary by contaminant and strip character
Water Quantity	
Runoff Control	Fair (20ft grass), Good (100ft forest). The strip should be designed to handle a specific runoff volume so the capacity of the treatment is known. Larger strips will handle larger runoff volumes.
Infiltration	Fair (20ft grass), Good (100ft forest). Larger strips provide more surface are for infiltration and will be able to infiltrate larger runoff volumes
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. Dissolved pesticide loads pass through the strip
Heavy Metals	Fair (20ft grass), Good to Excellent (100ft forested)
Pathogens	Fair (20ft grass), Good (100ft forested)
Fertilizers and Organics	Poor. Dissolved nutrient loads pass through the strip
Salinity	Poor
Other	Will vary by application, generally no significant effect

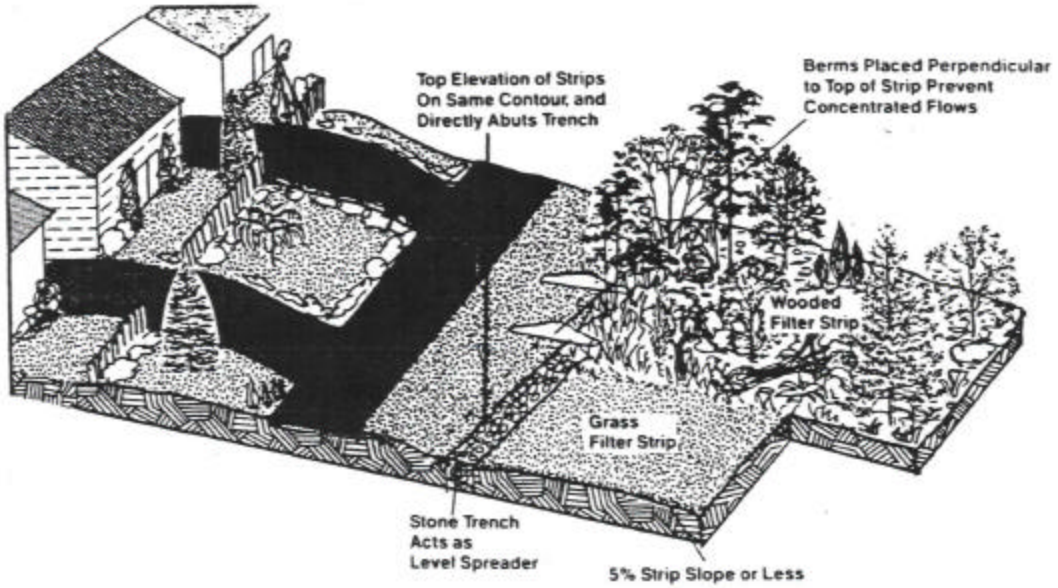
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Fair (20ft grass), Good (100ft forested)
Heavy Metals	Fair (20ft grass), Good (100ft forested)
Pathogens	Fair (20ft grass), Good (100ft forested)
Fertilizers and Organics	Fair (20ft grass), Good (100ft forested)
Salinity	Poor
Suspended Sediment	Fair (20ft grass), Good to Excellent (100ft forested)
Low Dissolved Oxygen	Fair (20ft grass), Good to Excellent (100ft forested)
Water Temperature Increase	Fair (20ft grass), Good to Excellent (100ft forested)
Other	Will vary by contaminant and strip character
Habitat Suitability	Commonly good and versatile, especially if pre-existing vegetation is used in sensitive areas
Capital or Implementation Costs	Low, especially if pre-existing (but appropriate) vegetation is used
Operation and Maintenance	Low, especially if pre-existing (but appropriate) vegetation is used Normal maintenance includes regular inspections and additional inspections after major storms (to observe and correct incipient channelization), seasonal re-seeding, mowing, trash removal
Potential Side Effects	Adverse impacts are not expected with well planned and properly functioning strips and complimenting BMPs
Concurrent Land Management Practices	Requires a method to distribute flow evenly along the "uphill" side of the strip (contouring) to prevent channeling and "short circuiting" of the Filter Strip" (See **Level Spreader**) To optimize the effectiveness of the Filter Strip appropriate vegetation must be established prior to implementation of the practice (See **Soil Stabilization - Conservation Cover**) **Grass Swales** and **Level Spreaders** are required to control concentrated runoff conditions (runoff capable of creating or eroding channels) To minimize the volume of runoff to be treated and optimize the performance of the Filter Strip, it should be implemented in conjunction with other BMPs that reduce the volume of runoff entering the Filter Strip.

Feasibility	Not suitable for treating slopes with grades greater than 10 percent. The Filter Strip itself should be established on grades less than five percent (less than two percent for forested strips with thin grass or humus cover) otherwise channeling and "short circuiting" is likely Filter Strips by themselves do not satisfy the "no discharge" requirement applicable to many operations under the National Pollutant Discharge Elimination System. Forested Filter Strips (mixed *dense* grass and tree plantings) are more effective than "grass-only" strips. Incorporating mature understory (dense grasses, bushes, leaf litter) and forest areas is usually less expensive and more effective than replanting/ reestablishing a new Filter Strip Snow cover may reduce or eliminate the effectiveness of this BMP by substantially covering the vegetation thereby reducing the density of the filter. An alternate site-specific winter treatment BMP may be required if sediment and conditions requiring the Filter Strip are needed during periods of snow cover

Primary Source of BMP Information: Holbrook, 1996

Additional References:

EPA, January, 1993
Minnick, 1992
Schueler, July, 1987
USDA, December, 1996 (Filter Strip)



Filter Strip (Wooded and Grass)

Source: Schueler, July,1987

Grassed Swale (Vgs)

Description: A grassed-lined shallow channel of variable width and depth. Typically designed for low to moderate slope areas across soils that drain well. The vegetation lining resists erosion and acts as a filter to trap particulate pollutants. They are typically used to collect and direct runoff to larger BMPs (**Wet Ponds**, Detention Basins) for further biological and infiltration treatment. As an alternative, grassed swales may be used for detention and infiltration on land parcels that contribute a limited (small) volume of runoff. They are not appropriate for situations were runoff flow velocities are high (steep slopes). Under these conditions, channels need additional reinforcement (see **Geotextile**, **Rip rap**).

Purpose: Most effective as a structure to collect and pass sheet flow runoff from small areas prior to the sheet flow becoming erosive in character. Swales direct the runoff to higher volume capacity BMP structures for further treatment.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent for small areas and small storm events
Sedimentation Control	Good. But generally designed to transport runoff and sediment load to downstream sediment control (collection) BMP
Prevent Contamination by:	
Salinity	Poor. Passes dissolved materials on to downstream locations
Fertilizers and Organics	Poor to Fair. Passes dissolved materials on to downstream locations. A limited amount of particulate-bound substances may be caught in the channel vegetation
Pesticides / Herbicides	Poor to Fair. Passes dissolved materials on to downstream locations. A limited amount of particulate-bound substances may be caught in the channel vegetation
Other	Oil and Grease – Good. These materials, as solids, adhere to the channel vegetation. Near heavy fueling use areas (gasoline stations or similar) they may require channel re-excavation in order not to become a concentrated point source for hydrocarbon contamination
Water Quantity	
Runoff Control	Good to Excellent for small areas generally less than 10 acres
Infiltration	Poor to Good. Design dependent. May be good in a local limited area for storm events that are significantly smaller in size than the design flow capacity of the swale (i.e., decreasing flow velocities through the swale). Limited effectiveness because of the overall small holding capacity of the structure. If desired, check-dams placed within the channel may enhance infiltration but will require regular sediment clean-out maintenance to remain effective

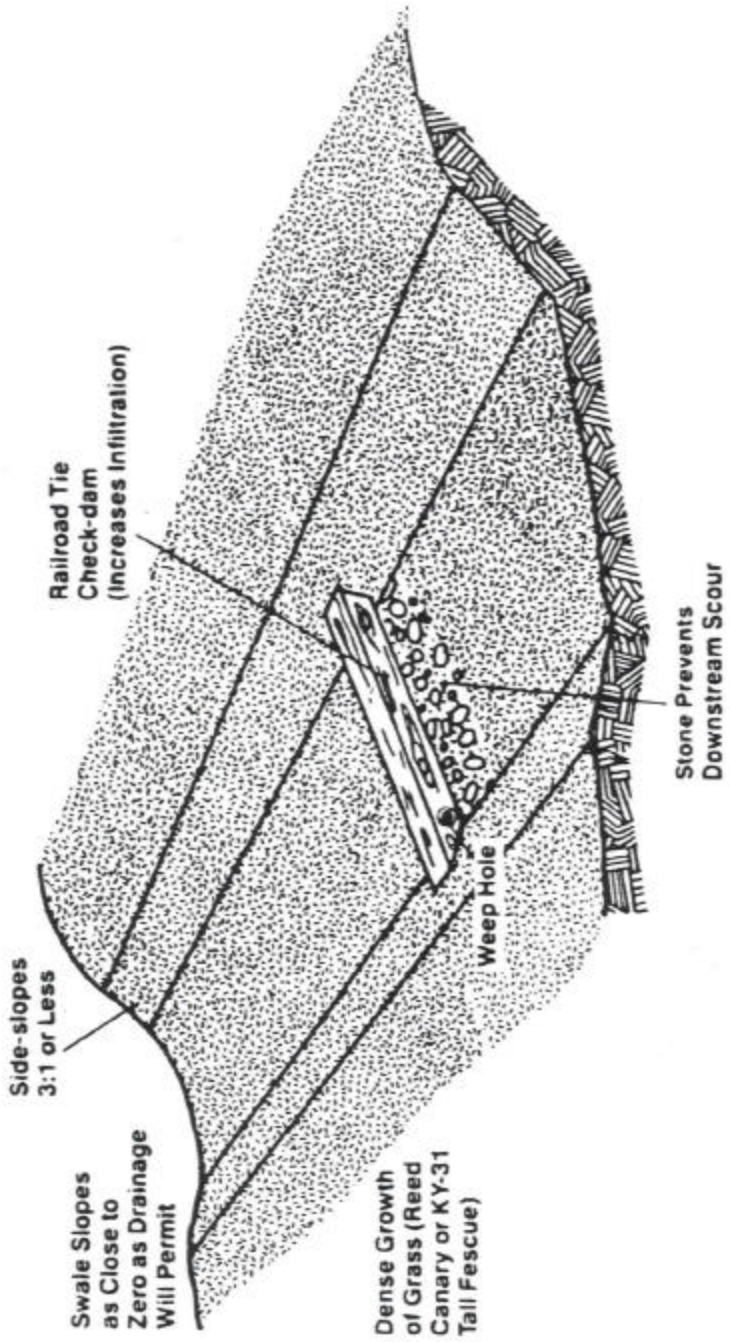
Water Quality – Ground Water	(Note: HIGH flow rates through swale INCREASE treatment performance values in the immediate area of the swale. Contaminants are carried to downstream locations and not permitted to settle and/ or infiltrate
Prevent Contamination by:	
Pesticides / Herbicides	Poor. The swale provides no control over excessive pesticide applications upstream of the swale and is a poor method for removing pesticides in solution. The minor fraction of pesticides adsorbed onto soil particles may be trapped in the swale, but over time are likely to leach to ground water or return to the surface water flow in solution or adsorbed to sediment
Heavy Metals	Poor to Good. Design dependent. The swale is most effective when filtering can occur (low velocities and extended holding time) to retain particles with adsorbed metals
Pathogens	Poor to Good. Design dependent. The swale is most effective when filtering can occur (low velocities and extended holding time) to retain pathogens and particles with adsorbed pathogens
Fertilizers and Organics	Poor to Fair. Similar to pesticide situation except that vegetation in the swale may use some nutrients. The effectiveness is still limited by the relatively short residence time of the runoff in the swale
Salinity	Poor. Residual (road) salt may linger on surfaces after runoff flows have subsided, then may infiltrate ground water. Much of the dissolved materials are likely to pass to downstream locations
Other	Will vary by contaminant and design
Water Quality – Surface Water	Note: HIGH flow rates through swale REDUCE treatment performance values as contaminants are carried to downstream surface water locations
Prevent Contamination by:	
Pesticides / Herbicides	Poor. The swale provides no control over excessive pesticide applications upstream of the swale and is a poor method for removing pesticides in solution. The minor fraction of pesticides adsorbed onto soil particles may be trapped in the swale, but over time are likely to leach to ground water or return to the surface water flow in solution or adsorbed to sediment
Heavy Metals	Poor to Good. Design dependent. The swale is most effective when filtering can occur (low velocities and extended holding time) to retain particles with adsorbed metals
Pathogens	Poor to Good. Design dependent. The swale is most effective when filtering can occur (low velocities and extended holding time) to retain pathogens and particles with adsorbed pathogens
Fertilizers and Organics	Poor to Fair. Similar to pesticide situation except that vegetation in the swale may use some nutrients. The effectiveness is still limited by the short residence time of the runoff in the swale
Salinity	Poor. Residual (road) salt may linger on surfaces after runoff

	flows have subsided and then may infiltrate ground water. Much of the dissolved materials are likely to pass on to downstream locations
Suspended Sediment	Good. Design dependent. The swale is most effective when filtering can occur (low velocities and extended holding time) to retain suspended particles
Low Dissolved Oxygen	Poor to insignificant effect
Water Temperature	Generally insignificant effect
Other	Will vary by contaminant and design
Habitat Suitability	Not usually an important habitat by themselves, but may support appropriate drainage of adjacent "upland type" habitats. May add to diversity of the overall area depending on design features Care should be taken to ensure that post-development drainage does not change pre-development habitat conditions
Capital or Implementation Costs	Low
Operation and Maintenance	Sediment in swales must be removed on a regular basis to maintain effectiveness. Otherwise, each succeeding storm simply carries trapped materials downstream and replaces them with new at the end of the storm. Normal maintenance tasks include, but not limited to: inspection, debris and litter removal, mowing, sediment removal, and erosion control. One of the important maintenance goals is to prevent filling or erosion of the swale channel
Potential Side Effects	Standing water may develop if swale channel grades are too shallow. Installation of an underdrain may encourage infiltration and prevent standing water conditions The higher the velocity of runoff flow through the swale, the less effective vegetative filtering, sedimentation of suspended particles and infiltration into the underlying soils will be Filtering, sedimentation and infiltration work best with longer, low gradient swales (generally 100 to 200 feet is required)
Concurrent Land Management Practices	Infiltration or detention basin areas must be included in the overall storm water plan for larger sites with high runoff volumes. Grassed swales may serve as pre-treatment to remove suspended sediments up-gradient from infiltration BMPs (filter strips, infiltration trenches) Salt tolerant plants are recommended for swales receiving runoff from areas treated for ice
Feasibility	Grassed swales are very easy to implement and versatile in their applicability

Primary Source of BMP Information: Young et al., December, 1995 (Revised 1998).

Additional References:

Caraco and Claytor, 1997
Doenges et al., 1990
EPA, January, 1993
Holbrook, 1996
Richman et al., 1998
Schueler et al., 1992
Schueler, July, 1987
Spaulding, 1996



Grassed Swale

Source: Schueler, July,1987

Land Smoothing (Vls)

Description: The process of rough grading the soil layer and removing irregularities across a land surface, typically with mechanized earth-moving equipment. Creating a more consistent grade reduces the tendency for concentrated erosion to develop as rills and gullies, and promotes the establishment of erosion control vegetation.

Purpose: The objective of this practice is to create a ground surface that is ready for installation of additional conservation, farming or specific erosion, sediment and/ or runoff control measures. The activity increases drainage and infiltration and improves equipment operation in the field and facilitates contour cultivation.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Fair to Good. Compliments and enhances the effect of other erosion control BMPs that rely on efficient and coordinated runoff flow
Sedimentation Control	Fair to Good. Compliments and enhances the effect of other sedimentation control BMPs that rely on efficient and coordinated runoff flow
Prevent Contamination by:	
Salinity	Not Applicable
Fertilizers and Organics	Not Applicable
Pesticides / Herbicides	Not Applicable
Other	Not Applicable
Water Quantity	
Runoff Control	Fair to Good. Helps to prevent or delay concentrated (channelized) flow
Infiltration	Fair to Good. Delaying the occurrence of concentrated flow promotes infiltration
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Generally no significant effect
Heavy Metals	Generally no significant effect
Pathogens	Generally no significant effect
Fertilizers and Organics	Generally no significant effect
Salinity	Generally no significant effect
Other	Generally no significant effect
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Generally no significant effect
Heavy Metals	Generally no significant effect
Pathogens	Generally no significant effect
Fertilizers and Organics	Generally no significant effect
Salinity	Generally no significant effect

Suspended Sediment	Fair to Good. Delays the occurrence of the erosive effects of concentrated flow
Low Dissolved Oxygen	Generally no significant effect
Water Temperature Increase	Generally no significant effect
Other	Generally no significant effect
Habitat Suitability	Generally no significant effect
Capital or Implementation Costs	Relatively high cost compared to other more effective erosion control measures (e.g., Vegetated Buffers, Infiltration and Detention Structures)
Operation and Maintenance	Once the grade is prepared, the land should maintain its form if the smoothing plan has incorporated appropriate soil stabilization measures. Annual tending to cultivated fields should maintain its grade. For other, more passive land uses, period inspections may be required to ensure that erosive conditions do not develop, especially after severe storms that exceed the design criteria (e.g., 10-year return storm with a 24 hour duration) Allows easier and more efficient access by mechanized equipment
Potential Side Effects	Impacted areas proposed for land smoothing treatment should be critically assessed for wetland and habitat character and value prior to modification to avoid unintentional impacts to these natural resources
Concurrent Land Management Practices	Soil Stabilization measures, (temporary and permanent) to prevent erosion of the newly graded surface Erosion and sediment control measures to accommodate runoff as it becomes concentrated flow and/ or a ponded water body Chemical Management measures to control the amounts of chemicals released to the environment (pesticides, fertilizers)
Feasibility	Applicable to any land area with irregular features and subject to local flooding or concentrated flows and erosion. May be appropriate for many cultivated fields where topographic features make implementation of other conservation and storm water control measures difficult and costly

Primary Source of BMP Information: USDA, May, 1997 (Land Smoothing)
Additional References:

Soil Stabilization - Conservation Cover (Vcc)

Description: Planting and maintaining a permanent cover of natural (non-exotic) perennial vegetation on land retired from agricultural, industrial, or mining (sand and gravel) use where vegetation growth on a significantly large parcel of land has been impacted.

Purpose: To protect the area from soil erosion and associated sedimentation, improve or maintain infiltration of storm water to ground water, and create or enhance wildlife and plant habitat.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salinity	Generally no significant effect. Impact will vary compared to previous land use
Fertilizers and Organics	Potentially Good. Depends on the extent of previous land use. A reduction would be likely in comparison to a previous agricultural use. A relative increase, during the initial planting sequence, might be observed in comparison to a previous mining use not involving fertilizer applications
Pesticides / Herbicides	Potentially Good. Normally, pesticide application should not be required to establish the conservation cover. Relative performance depends on the extent to which pesticides were previously in use. A reduction would be likely in comparison to a previous agricultural use. A relative increase during the initial planting sequence might be observed in comparison to a previous mining use not involving pesticide applications
Other	Will vary by contaminant and previous land use
Water Quantity	
Runoff Control	Good to Excellent
Infiltration	Fair to Good. For gravel pits, vegetation may slow runoff from leaving the area and promote infiltration. Summer plant transpiration may increase, and consequently reduce infiltration somewhat in some cases where ground cover was sparse (gravel pits)
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Should not be required. Therefore expect a significant improvement or continued non-impact compared to previous land uses
Heavy Metals	Will vary by application, generally no significant effect
Pathogens	Good. Improving (especially for gravel pits), as the vegetation annual growth cycle increases and enhances the organic

	(humus) soil horizon and associated microbiological activity to control pathogen levels
Fertilizers and Organics	Fair to Good. After initial establishment of the cover vegetation (first year), these substances should not be required. Therefore, expect an improvement or continued non-impact compared to previous land uses
Salinity	Generally no significant effect. Impact will vary compared to previous land use
Other	Will vary by contaminant and previous land use
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Should not be required. Therefore expect a significant improvement or continued non-impact compared to previous land uses
Heavy Metals	Will vary by application, generally no significant effect
Pathogens	Good. Improving (especially for gravel pits), as the vegetation annual growth cycle increases and enhances the organic (humus) soil horizon and associated microbiological activity to control pathogen levels
Fertilizers and Organics	Fair to Good. After initial establishment of the cover vegetation (first year), these substances should not be required. Therefore expect an improvement or continued non-impact compared to previous land uses
Salinity	Will vary by application, generally no significant effect, impact will vary compared to previous land use
Suspended Sediment	Good to Excellent
Low Dissolved Oxygen	Will vary by application, generally no significant effect
Water Temperature Increase	Good. If used instead of Riprap or Impervious Cover measures that absorb heat
Other	Will vary by contaminant and previous land use
Habitat Suitability	Good to Excellent. Vegetation type and setting should be designed to create natural resilient and sustainable habitat types desired by the town
Capital or Implementation Costs	Low
Operation and Maintenance	Low. The vegetation should be self-sustaining and appropriate for the environment of the area
Potential Side Effects	No adverse impacts identified
Concurrent Land Management Practices	Temporary soil stabilization measures (mulching, etc.), should be employed until the conservation vegetation cover is established and able to withstand runoff erosion If land spreading of sludge is contemplated as a fertilizing technique, especially for mining areas, the sludge material should be tested prior to spreading to ensure that excess levels of pathogens, metals, or other chemicals are not

	present. Periodic soil and ground water tests are recommended to evaluate whether any potential contaminants are accumulating in the soil or ground water. Sludge spreading is not recommend in areas of shallow ground water
Feasibility	Applicable to all areas where vegetation is sparse. Easily implemented

Primary Source of BMP Information: USDA, December, 1996 (Conservation Cover)
Additional References:
EPA, September, 1993

Soil Stabilization - Field Border (Vfb)

Description: A strip of perennial vegetation (grasses, shrubs) established along the perimeter/ border of a field. Generally more narrow in width (less than 15 feet) than a **Filter Strip** (compare).

Purpose: Provide erosion protection and stabilization of the field edge where equipment may pass and turn. Provide filtration of runoff from the cultivated field. Reduce competition from trees and shading along the field perimeter. Provide wildlife cover, food, (habitat) and screening of field. The performance comments below reflect a narrow feature compared to a wider **Filter Strip**.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Fair. Will vary by type of cover and width of border
Sedimentation Control	Fair to Good. Will vary by type of cover and width of border
Prevent Contamination by:	
Salinity	Poor
Fertilizers and Organics	No significant effect
Pesticides / Herbicides	No significant effect
Other	Generally no effect. Will vary by contaminant
Water Quantity	
Runoff Control	Fair. Must be used in conjunction with other runoff control measures
Infiltration	Fair. Must be used in conjunction with other runoff control measures. Effect is limited by total area of the strip relative to the field size
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Poor. Effect is limited by small area of the strip available for filtering or infiltration treatment relative to the large field size
Heavy Metals	Poor. Effect is limited by small area of the strip available for filtering or infiltration treatment relative to the large field size
Pathogens	Poor. Effect is limited by small area of the strip available for filtering or infiltration treatment relative to the large field size
Fertilizers and Organics	Poor. Effect is limited by small area of the strip available for filtering or infiltration treatment relative to the large field size
Salinity	Poor
Other	Generally no significant effect
Water Quality – Surface Water	
Prevent Contamination by:	

Pesticides / Herbicides	Poor. Border strip is too narrow to have a significant impact on runoff that may travel off the field through the border
Heavy Metals	Poor. Border strip is too narrow to have a significant impact on runoff that may travel off the field through the border
Pathogens	Poor. Border strip is too narrow to have a significant impact on runoff that may travel off the field through the border
Fertilizers and Organics	Poor. Border strip is too narrow to have a significant impact on runoff that may travel off the field through the border
Salinity	Poor. Border strip is too narrow to have a significant impact on runoff that may travel off the field through the border
Suspended Sediment	Good. Will vary by type of cover and width of border
Low Dissolved Oxygen	Generally no significant effect
Water Temperature Increase	Generally no significant effect
Other	Generally no significant effect
Habitat Suitability	Provides landing and view areas for predator birds Provides cover and/ or food for foraging birds and other animals
Capital or Implementation Costs	Low. Natural vegetation may be encouraged to fill this role.
Operation and Maintenance	Low if established natural vegetation is retained for the border. Natural vegetation will require minimal maintenance
Potential Side Effects	May impact crop yield per acre by occupying some cultivation area Slight wind break if moderately tall shrubs are established
Concurrent Land Management Practices	Pesticide and fertilizer management plans to avoid infiltration and runoff loaded with excess amounts of these substances
Feasibility	Applicable to all cultivated fields

Primary Source of BMP Information: USDA, December, 1996 (Field Border)
Additional References:

Soil Stabilization - Mulching (Vm)

Description: Applying plant residues (e.g., hay, straw, bark, wood chips), or other suitable material to the soil surface. Mulching is a temporary surface treatment when permanent seeding activities are not complete or practical because of weather or other limiting situations. Mulching can help in establishing permanent vegetation cover.

Purpose: The treatment can reduce runoff, water erosion, and sedimentation; promote plant grow through conserving soil moisture; reduce dust and wind erosion; prevent surface compaction and crusting; and inhibit weed growth.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good. Depending on care of installation and follow-up maintenance by protecting the land surface from erosion
Sedimentation Control	Good. Slows runoff velocities, which allows suspended sediment to settle out of the runoff flow
Prevent Contamination by:	
Salinity	Poor
Fertilizers and Organics	Fair to Good. Holds moisture and fertilizer in the root zone for uptake by the crop
Pesticides / Herbicides	Fair to Good. Holds moisture and pesticides in the root zone for uptake by the crop
Other	Will vary by contaminant
Water Quantity	
Runoff Control	Good
Infiltration	Fair to Good. Promotes infiltration by slowing evaporation
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Fair to Good. Holds moisture and pesticides in the root zone for uptake by the crop
Heavy Metals	Generally not applicable
Pathogens	Fair to Good. Introduces organic matter promoting natural microbiological activity and degradation of pathogens
Fertilizers and Organics	Fair to Good. Holds moisture and fertilizer in the root zone for uptake by the crop
Salinity	Poor
Other	Will vary by contaminant
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Fair to Good. Holds moisture and pesticides in the root zone for uptake by the crop

Heavy Metals	Generally not applicable
Pathogens	Good. Introduces organic matter promoting natural microbiological activity and degradation of pathogens; limits runoff of soil pathogens to surface water
Fertilizers and Organics	Fair to Good. Holds moisture and fertilizer in the root zone for uptake by the crop
Salinity	Poor
Suspended Sediment	Good
Dissolved Oxygen	Generally no significant effect
Water Temperature	Generally no significant effect
Other	Will vary by contaminant
Habitat Suitability	Not Applicable as permanent habitat; may stabilize plantings in newly planted/ established habitat settings
Capital or Implementation Costs	Low
Operation and Maintenance	Low. Mulched areas should be inspected at least weekly and after every storm to observe and re-mulch (stabilize) potential erosion areas and repair damaged areas
Potential Side Effects	Use biodegradable mulch. Mulching materials that are not biodegradable will accumulate in the cultivated soil; and may inhibit crop viability and/ or become a hazard to wildlife foraging May lower or modulate changes (decrease the daily range) in soil temperatures May introduce weed seed
Concurrent Land Management Practices	Mulch materials may need tie-down or anchoring to remain in place during seasonal weather conditions
Feasibility	Easily applied and effective, especially if stabilized with matting or similar tie-down materials compatible with the mulch

Primary Source of BMP Information: USDA, December, 1996 (Mulching)

Additional References:

Brown, 1998

Liles, Jr., April, 2000

Stream/ River (Riparian) Buffer (Vsb)

Description: A strip of trees and understory extending back from the waters edge by a distance sufficient to provide protection and/ or enhancement of natural resources such as water temperature moderation, streambank stabilization, nutrient removal, flood control, and wildlife habitat. Minimum buffer widths range between about 50 to 275 feet for the situations mentioned above. Specific site conditions (e.g., steep slopes) may require somewhat wider buffers to be effective. Effectiveness generally increases with buffer width. Whenever possible, existing viable tree and understory habitat should be retained.

Purpose: The purpose of the buffer is to protect and enhance various natural resources associated with streams and rivers.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salinity	Poor
Fertilizers and Organics	Generally no significant affect
Pesticides / Herbicides	Generally no significant affect
Other	Generally no significant affect
Water Quantity	
Runoff Control	Good to Excellent. Best if water follows overland (sheet) flow and is not allowed to "channel" through the buffer zone to the stream
Infiltration	Good to Excellent. Best if water follows overland (sheet) flow and is not allowed to "channel" through the buffer zone to the stream
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Fair to Good. When buffer is established between a land use and adjacent ground water recharge area. Impacts may occur as pesticides travel by "air borne drift" or as part of runoff
Heavy Metals	Fair. When buffer is established between a land use and adjacent ground water recharge area
Pathogens	Fair. When buffer is established between a land use and adjacent ground water recharge area
Fertilizers and Organics	Fair. When buffer is established between a land use and adjacent ground water recharge area
Salinity	Poor
Other	Will vary by contaminant

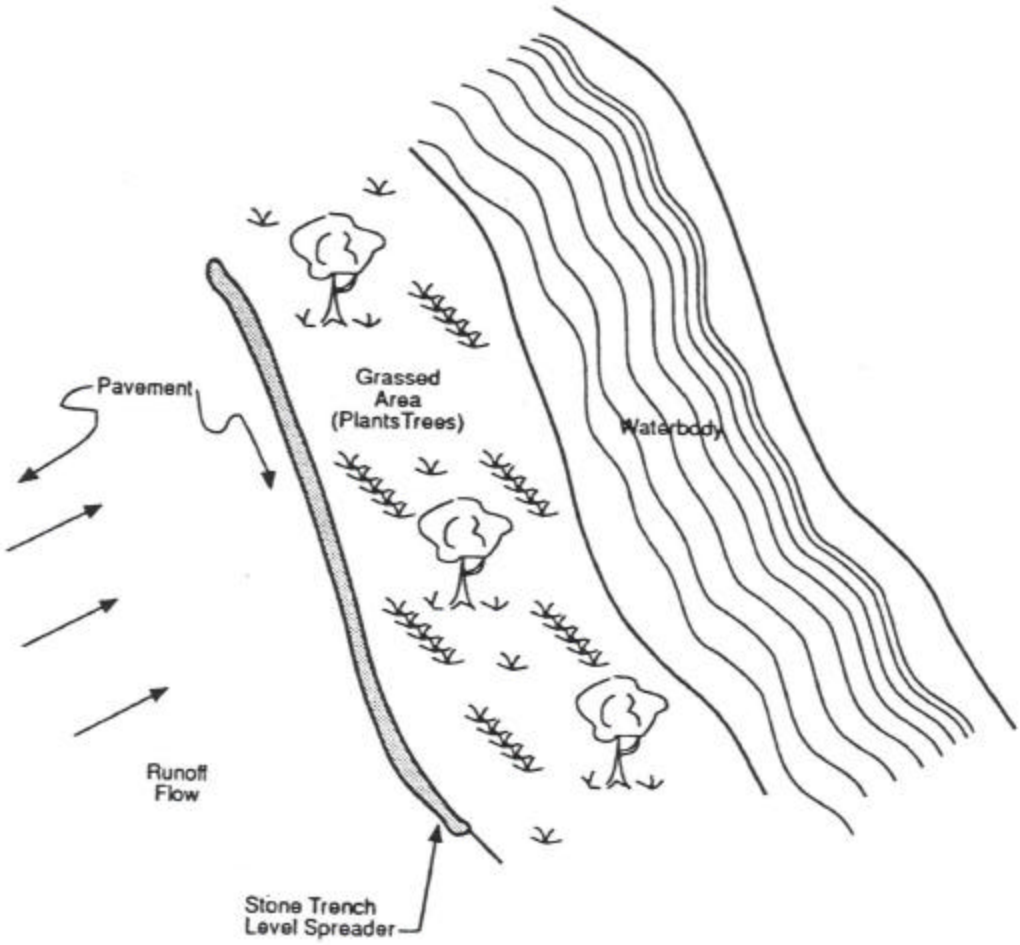
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Good to Excellent
Heavy Metals	Good to Excellent
Pathogens	Good to Excellent
Fertilizers and Organics	Good to Excellent
Salinity	Poor
Suspended Sediment	Good to Excellent
Dissolved Oxygen	Good to Excellent
Water Temperature	Good to Excellent
Other	Will vary by contaminant
Habitat Suitability	Poor to Excellent. Design dependent. Minimum buffer widths range from about 50 to 275 feet. A wildlife biologist should be consulted to assess the buffer width requirements for a specific habitat concern
Capital or Implementation Costs	Very cost effective, especially if original vegetation is maintained not removed during site development/ activities
Operation and Maintenance	Once established, the maintenance requirements are minimal. The buffer area should be inspected periodically to correct early erosive conditions and "short circuiting" of the buffer zone by channels and gullies
Potential Side Effects	No adverse impacts identified
Concurrent Land Management Practices	Appropriate nonpoint source pollution best management practices should be employed in areas up-gradient of the buffer whenever possible, in order to assist the "buffering" process. Original, well established vegetation, (especially mature trees) should be retained as part of any stream buffer BMP design to minimize land disturbance and time lost to reestablish a viable vegetative screen
Feasibility	The practice applies to permanent and ephemeral streams, lakes, ponds, wetlands and areas of ground water recharge

Primary Source of BMP Information: Liles Jr., April, 2000 (Buffer Zone)

Additional References:

USDA, December, 1996 (Riparian Forest Buffer)

USDA, December, 1996 (Streambank & Shoreline Protection)



Stream (Riparian) Buffer

Source: Holbrook, April, 1995

Wetland – Constructed (Vwc)

Description: An area designed and constructed to accept surface water flows and support emergent plant life that requires saturated (inundated) soil conditions. Constructed wetlands can have multiple functions serving several purposes simultaneously (e.g., runoff volume storage, pollutant uptake by plants, creation of wildlife habitat, and increasing potential infiltration). The effectiveness of each function is dependent on the design. Not all functions may be equally effective within a particular wetland system. Constructed wetlands are generally more shallow and incorporate more vegetation than **Wet Ponds**. It is common to combine Wet Pond and Wetland features in one design to take advantage of the special properties of each. Constructed Wetlands should include a forebay to facilitate the collection of suspended sediment and allow for efficient periodic clean-out dredging. Cold climate design features and maintenance items must be part of any final design to ensure proper operation during winter and spring weather.

Purpose: The primary goals of runoff management using wetlands is to treat pollutants in storm water to facilitate downstream water quality improvements, reduce flooding, improve/ create critical wildlife habitat and to a lesser extent, provide infiltration to ground water.

Criteria	Performance Comments / Evaluation
Sediment / Soil	
Erosion Control	Good to Excellent
Sedimentation Control	Good to Excellent
Prevent Contamination by:	
Salinity	Not Applicable
Fertilizers and Organics	Not Applicable
Pesticides / Herbicides	Not Applicable
Other	Not Applicable
Water Quantity	
Runoff Control	Good to Excellent
Infiltration	Fair to Good. In order to maintain saturated and/ or inundated conditions in the wetland the ground water elevation in the adjacent area will need to be near or equal to the elevation of the water in the constructed wetland. This condition will limit the amount of infiltration of surface water to ground water that will occur
Water Quality – Ground Water	
Prevent Contamination by:	
Pesticides / Herbicides	Potentially Poor or no effect. Dissolved pesticides may exfiltrate out of the wetland to the surrounding ground water, or flow to downstream areas in surface water leaving the wetland
Heavy Metals	Fair to Good. Through filtration, settling and adsorption to soil
Pathogens	Good to Excellent. Through microorganism activity and filtering

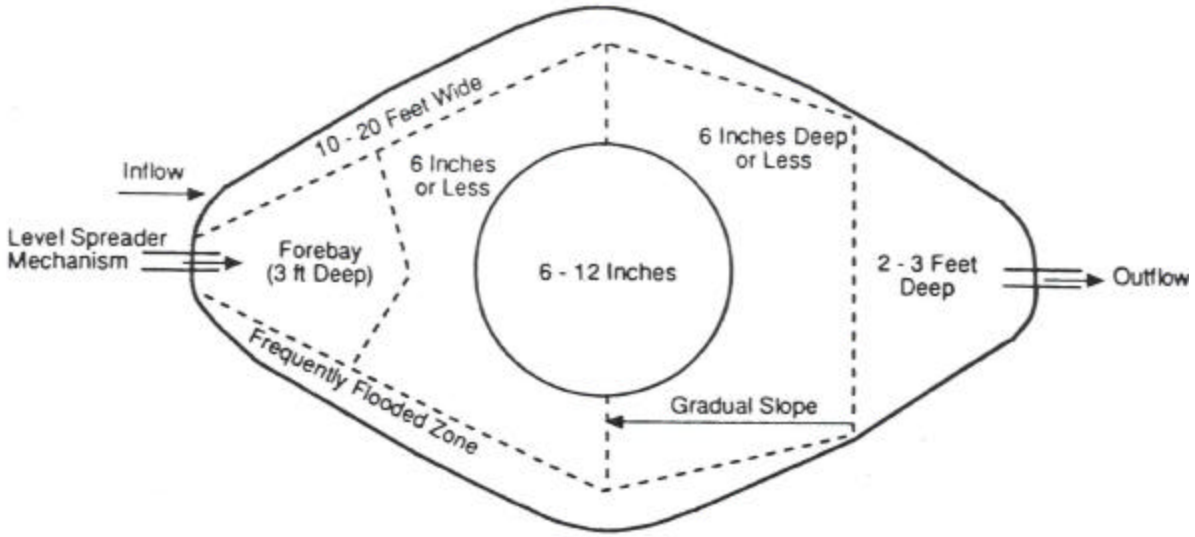
Fertilizers and Organics	Fair to Good. Through plant uptake
Salinity	Poor. Dissolved salt will exfiltrate out of the wetland to the surrounding ground water, or flow to downstream areas in surface water leaving the wetland
Other	Will vary by contaminant
Water Quality – Surface Water	
Prevent Contamination by:	
Pesticides / Herbicides	Potentially Poor or no effect
Heavy Metals	Fair to Good
Pathogens	Good to Excellent
Fertilizers and Organics	Fair to Good
Salinity	Poor. Evaporation will tend to concentrate salts. Winter and spring runoff may increase salinity levels in deeper portions of the wetland
Suspended Sediment	Excellent. Use of a forebay is recommended to remove most sediment before it reaches the main body of the wetland
Low Dissolved Oxygen	Fair to Good. Design dependent
Water Temperature Increase	Poor to Fair. Design dependent
Other	Will vary by contaminant
Habitat Suitability	Good to Excellent. A wide variety of habitats may be supported in a wetland environment
Capital or Implementation Costs	High. Constructed wetlands are one of the more versatile practices for controlling and treating storm water runoff, but may also be one of the more expensive techniques
Operation and Maintenance	Initially the level of monitoring and maintenance to establish an effectively functional wetland may be high, but should decrease significantly once the plant hierarchy is flourishing. It is important to have a forebay to collect sediment that can be easily accessed for clean out to maintain design volumes and plant life. Inspections for winter-time ice and snow removal activities must be included in the O&M plan to ensure proper operation

Potential Side Effects	Excessive influx/ loads of the various contaminants cited above may shorten the effective life cycle of particular wetland functions and/ or exceed the treatment capacity for particular contaminants Hydrologic modeling should be completed to assess the hydrologic impacts of individual constructed wetlands on the cumulative watershed hydrograph (i.e., base flow, peak and flood discharge volumes, timing and locations). For important design storms (suggest 2-, 10-, 50-year events). Adjust constructed wetland locations and release rates to avoid overlapping releases and increased flood peaks. In many cases, the Natural Resources Conservation Service [formerly the Soil Conservation Service] method TR-20, TR-55 or equivalents can be used for this evaluation
Concurrent Land Management Practices	All appropriate BMP methods to prevent contamination of storm water should be in place at upstream locations to prevent excessive loading (high concentrations) of pollutants in the runoff entering the wetland
Feasibility	Alternative: **Wet Ponds** may be equally effective for many runoff treatments, and are frequently less expensive to construct and maintain. Wetlands usually require large land areas to be an effective BMP option. Certain wetland functions may not be effective in small or undersized wetlands. Recommended wetland area is 1 to 2 percent of the watershed area contributing to the wetland Native plants that are salt tolerant and hardy in cold climates should be selected for the wetland construction. A wetland scientist familiar with local conditions should be consulted to complete this process

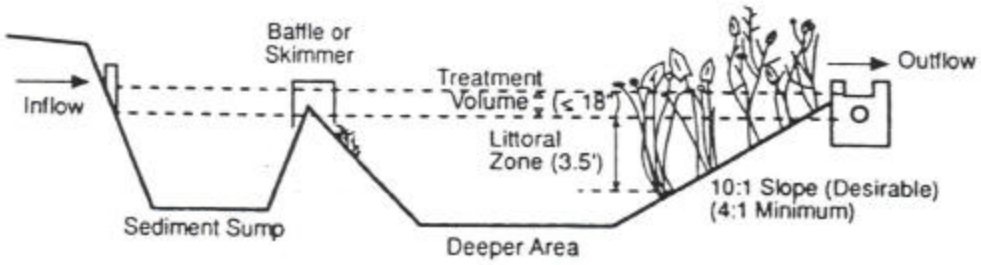
Primary Source of BMP Information: EPA, September, 1999 (Storm Water Wetlands)

Additional References:

Caraco and Claytor, 1997
USDA, August, 1998 (Constructed Wetland)
USDA, August, 1998 (Wetland Creation)
USDA, August, 1998 (Wetland Enhancement)
USDA, May, 1997 (Wetland Development or Restoration)



A. Example Shallow Constructed Wetland System Design for Stormwater Treatment



Constructed Wetland
(Not for design purposes)
Source: Holbrook, April, 1995