Industrial Stormwater

Best Management Practices Guidebook

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Minnesota Pollution Control Agency

One regulated facility, Murphy Warehouse, has implemented impressive industrial stormwater management systems. Photo: Murphy Warehouse Company

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Introduction

Most industrial facilities expose materials to stormwater through the outdoor storage, handling, and transfer of product materials, by products, and waste products. These industrial products often contain pollutants such as metals, fuel, oil, and grease which negatively impact stormwater runoff. Additionally, industrial activities can cause erosion and sediment problems that also impact stormwater runoff.

Even though a single industrial facility may contribute minimal pollution to the state's water resources, the cumulative impact of thousands of facilities' stormwater discharges accounts for significant water quality problems.

As part of Minnesota Pollution Control Agency's (MPCA) goals to better protect surface water and ground water quality through adaptive Best Management Practices (BMPs), the industrial stormwater program developed this guidebook to help permittees reduce pollutants in industrial stormwater discharges.

What is stormwater? Why is it regulated?

The term "stormwater" refers to precipitation, snowmelt, surface runoff, and drainage. The US Environmental Protection Agency (USEPA) has delegated authority to the MPCA to carry out federal Industrial Stormwater Permit requirements within Minnesota.

How does this guidebook help?

The suggestions in this guidebook can help the facility manager select new or modify existing BMPs to:

- Meet facility requirements
- Meet site-specific conditions
- Be adaptable to facility changes
- Meet permit requirements while balancing industry needs and environmental benefits

There are a variety of significant materials and activities at industrial facilities.

Chapter 1 Introduction to Industrial Stormwater Best Management Practices

1.1 Introduction to Best Management Practices

Best Management Practices (BMPs) are pollution control measures designed to prevent or reduce the effects of pollutants on state waters from industrial stormwater discharges. Permittees have a wide variety of BMP options, including schedules of activities, treatment devices, operating procedures, and practices to control industrial stormwater runoff, spillage or leaks, waste disposal or drainage from raw material storage[1].

Some BMPs are specific and well defined, while others are general in nature. The Permittee determines which BMPs to use based on permit requirements, the facility's specific industrial materials, and the facility's specific activities.

BMPs should be considered as a system or series of activities which may include multiple management options. These options can range from avoidance (education, training and planning) to minimization (litter control, street sweeping and secondary containment) to mitigation (construction of treatment structures).

Industrial activities can affect off-site surface and ground water.

Consider the options

When selecting BMPs, the first objective is to avoid stormwater contact with industrial materials and activities by selecting BMPs that could allow the facility to apply for the No Exposure exclusion. If the No Exposure exclusion is not possible, or is not the best or most appropriate option, the facility can then look to BMPs such as training, housekeeping practices and spill plans that help minimize potential impacts.

The third option, treatment, is considered mitigation for unavoidable stormwater pollution impacts. Though listed last in this example, it is an equally-important step in environmental protection.

Consider the simple solutions first

Cost-effective, protective and simple solutions include the No Exposure exclusion, non-structural BMPS such as increased good housekeeping, and stormwater reduction or reuse. Complex solutions, including stormwater ponds and wetland treatment systems, are allowable options as well.

Implementation costs will vary with the type of BMP(s) selected.

Consider possible effects on other resources

When planning to implement a BMP, consider the effect it will have on other natural resources. Proper BMP design and planning can help avoid shifting a water quality problem elsewhere or creating a new water quality problem.

Improperly designed structural BMPs can have secondary impacts adversely affect stream hydrology. For example, an improperly designed stormwater pond may increase water temperature, encourage excessive algae, diminish the pond's aesthetic qualities and may also pollute groundwater.

Consider site characteristics

Some of the important physical site characteristics to consider when choosing BMPs are soil type, watershed area, depth to water table, depth to bedrock, facility size and topography.

If conditions are not suitable for a particular design, a BMP can lose its effectiveness, require excessive maintenance or may stop working after a short period of time.

Consider BMP maintenance requirements

Maintenance is an important part of any BMP's operation. For non-structural BMPs, maintenance requirements may be primarily training staff in good housekeeping techniques and proper spill response. For structural BMPs such as ponds, maintenance requirements include more detailed tasks such as pre-treatment or sediment removal.

Consider cost effectiveness

To properly compare alternatives, consider all costs for a BMP's design life. These include the initial costs for land, engineering and construction plus expected maintenance.

Blue water isn't always clean water.

Chapter 2 Most common pollutants of concern in industrial stormwater

This chapter addresses the most commonly-found categories of industrial stormwater pollutants:

- Total Suspended Solids (TSS)
- Biological Oxygen Demand (BOD)
- Carbonaceous Biological Oxygen Demand (CBOD)
- Chemical Oxygen Demand (COD)
- Nutrients
- Metals
- Petroleum-derived hydrocarbons
- Chlorides/salt
- Temperature
- Turbidity
- pH

Each facility may have multiple sampling requirements; review the sector-specific monitoring table(s) within Part VII of the permit for a complete list of sampling parameters required for your industrial sector(s).

2.1 Introduction to Total Suspended Solids

Total Suspended solids (TSS) are inorganic (e.g., sand, metals) and organic (e.g., vegetative and animal waste) particles and debris that are washed off surfaces into lakes and streams. TSS is the largest pollutant by volume in the Minnesota's surface waters and is considered one of the state's more damaging pollutants.

TSS-related problems affecting surface waters include:

- Affecting aquatic life by smothering fish eggs and larvae
- Causing turbidity, which impairs sight-feeding fish, clogs fish gills, and increases the cost of treating drinking water
- Acting as a vehicle to transport other pollutants such as nutrients and metals to surface waters

BMPs frequently used to treat TSS

Control of TSS can be achieved by avoiding or minimizing erosion of under-vegetated areas, and areas exposed to clearing, grading, or filling of roads, vehicle tracking, logging, and mining operations. The suggestions below can be implemented as a single BMP or in various combinations.

Sediment from facilities and construction sites can quickly clog up sensitive creeks and streams.

BMPs that reduce TSS include:

- Good housekeeping measures such as implementing a frequent outdoor sweeping schedule
- Non-structural BMPs such as grassed or vegetated areas to catch sediment particles in flowing stormwater
    - Adding fiber logs or rock filters upstream of existing grassed areas to slow down water velocity
    - Adding fiber or synthetic mats on eroded areas or bare, non-vegetative areas.
- Structural BMPs such as detention ponds

2.2 Introduction to Biological Oxygen Demand, Carbonaceous Biological Oxygen Demand, and Chemical Oxygen Demand

Just as land-based animals extract oxygen from the air, aquatic life depends on oxygen dissolved in water. The availability of oxygen to aquatic life is impacted by substances in water which use oxygen to break down materials washed into the water. When stormwater runoff deposits large quantities of organic substances in lakes or streams, their decomposition depletes oxygen supplies in shallow, slow-moving or poorly-flushed waters and results in fish kills.

Biological Oxygen Demand (BOD) and Carbonaceous (CBOD) are measures of how much oxygen needed in water to decompose organic material into either nitrogen-containing compounds (BOD) or carbon-containing compounds (CBOD). The amounts of oxygen needed for this decomposition varies by organic material; the higher the BOD or CBOD value, the less oxygen is available in the water for fish and other aquatic life.

Chemical Oxygen Demand (COD) is a measure of the amount of oxygen needed in water for microorganisms to break down both organic and inorganic materials, metals, and nutrients. If the concentration of high-COD materials becomes large, oxygen available for aquatic life is depleted and results in organisms' stress or death.

High BOD and CBOD materials include:

- Grass clippings
- Sugar-containing substances (milk, molasses, juice, vegetables, energy drinks, etc.)
- Animal wastes

BMPs frequently used to manage BOD, CBOD, and COD

- Erosion control
- Litter prevention/management
- Sheltered/contained loading and unloading practices
- Stormwater detention ponds
- Constructed wetlands
- Filtration devices
- Infiltration devices

2.3 Introduction to nutrients (phosphorus and nitrogen compounds)

Excessive amounts of some nutrients can lead to algal blooms or other conditions toxic to aquatic life. Most of the complaints received by MPCA are related to water-quality problems caused by excessive nutrient concentration[3].

Phosphorus

High amounts of phosphorus can cause algal blooms and excessive aquatic plant growth; as phosphorus loadings increase, the potential for algal blooms also increases which results in oxygen depletion and accelerated sediment filling of lakes when the algae die. Phosphorus sources include:

- Chemicals and fertilizers
- Animal wastes and by-products (animal rendering facilities)
- Food/energy processing wastes (silage, silage leachate, husks, seeds, shells)
- Wood processing wastes (chips, slabs, sawdust, shavings)
- Cleaning agents (including biodegradable) and rinse water

Large nutrient wastes/products often coincide with materials that are high in BOD. Therefore, many of the same control strategies for BOD are also effective for phosphorus.

Small spills can quickly add up to big environmental problems.

BMPs used to treat phosphorus

- Properly storing materials
- Cleaning up materials from impervious surfaces
- Covering raw material, waste piles, transfer processes
- Storing materials indoors, where possible, or cover with a roof or tarp
- Capturing and treating high-strength waste streams separately (such as silage leachate)
- Slowing down water to allow nutrient attenuation by grasses/vegetation before runoff occurs

- Placing stockpiled material(s) on a curbed, impermeable surface to contain runoff

Nitrates/nitrogen

Nitrates and nitrogen-containing substances can affect both surface water and ground water; large concentrations of nitrates present a health hazard in groundwater and drinking water.

Nitrates/nitrogen sources include:

- Fertilizer manufacturing
- Mining
- Food manufacturing
- Leather tanning
- Fabricated metal manufacturing activities

BMPs used to treat nitrates/nitrogen

- Source control by implementing fertilizer application limits
- Minimizing or eliminating exposure prior to discharge
- Housekeeping such as sweeping spilled solid materials
- Detention ponds

Ammonia (NH_3)

Ammonia can cause the pH of surface waters to become basic or to be converted to nitrate and nitrite through nitrification processes; this conversion consumes large amounts of oxygen and can kill fish by lowering dissolved oxygen concentrations.

BMPs used to treat ammonia (NH_3)

- Source control by using non-ammonia based cleaners
- Minimizing or eliminating exposure prior to discharge
- Housekeeping such as sweeping spilled solid materials
- Detention ponds

2.4 Introduction to metals

Metals originate from galvanizing, chrome plating and other industrial operations. As metals corrode, dissolve or settle out of the air, small amounts are carried away by wind or water and can concentrate in stormwater runoff. Many of these metals become attached to sediment particles and are carried with it to receiving waters. When these sediments settle out, the attached metals accumulate over time to concentrations that are harmful to sediment-dwelling and other aquatic life. Studies have shown that certain metals in sediment, such as mercury, will also accumulate in plants and aquatic life[1].

Aluminum (Al) and zinc (Zn)

Aluminum and zinc can be naturally present in soils, surface waters, and minerals. When industrial activities such as galvanizing, herbicide use, accumulation of tire debris and dust increase the concentration of these elements in stormwater, the resulting runoff can be toxic to plants by affecting plant roots which prevents nutrient intake.[2]

BMPs frequently used to treat aluminum (Al) and zinc (Zn)

- Source control by limiting metal exposure to stormwater
- Modify processes, storage or handling
- Minimize or eliminate usage of metal-containing products processes
- Replace or paint galvanized surfaces
- Consider using forklift tires made from non-rubber materials
- Implement vegetative buffer strips to capture sediment particles
- Add recycling to recover and recycle specific metals from the production processes

2.5 Introduction to other commonly-found pollutants

This section addresses some of the remaining commonly-found pollutants. Please review the sector- specific monitoring table(s) within Part VII of the permit for a complete list of sampling parameters required for your industrial sector(s).

Hydrocarbons

Hydrocarbons are a concern because many are known to be toxic to aquatic organisms at relatively low concentrations.[3] Several types of hydrocarbons (e.g., naphthalene, phenol, and oil and grease) are commonly found at industrial facilities. These materials are very mobile, can exist for extended periods in a toxic state, and can concentrate in sediments to become re-suspended later. They contribute to significant water quality problems if they are not properly managed.

Petroleum-derived hydrocarbons commonly found in stormwater runoff often float on the surface of the water and create the familiar rainbow-colored film, or sheen.

Common sources of hydrocarbons include:

- Spills at oil-storage and fueling facilities
- Incomplete combustion of oil and fuels
- Leaks from engine crankcases
- Improper disposal of drained oil[4]

Suggested BMPs to treat hydrocarbons

- Oil/ water separators, grease traps and adsorbents to manage stormwater prior to discharge
- Sedimentation/settling processes prior to discharge
- Surface skimming of ponds
- Indoor maintenance and storage to eliminate contaminated materials from coming into contact with stormwater

Chlorides and other salts

In Minnesota, the vast majority of chloride sources is from ordinary salt, sodium chloride (NaCl), but sources also include calcium chloride (CaCl) and magnesium chloride (MgCl). Salt is used each year to melt or de-ice roads, parking lots, and sidewalks because it is extremely soluble, almost all salt applied to roadways ends up in surface or groundwater[5]. As salt-containing runoff comes into contact with aquatic habitats, the potential toxicity to many freshwater organisms also rises.

Contaminants or materials added to salt-based de-icing agents to prevent caking (such as phosphorus and cyanide compounds) may also be of concern. Refer to Section 8.1 for more information on extreme weather events and de-icing.

Suggested BMPs to treat chlorides and other salts

- Proper storage
- Non-excessive application rates
- Sweeping and proper disposal of any visible salt deposits once the application surface has dried
- Sweeping and proper disposal of any visible salt deposits at the end of the de-icing season
- Using chemical or special filters to remove dissolved salts from stormwater before it leaves the facility

Temperature changes

Temperature changes that occur over short periods can cause shock, changes in the growth, reproduction and death rates of fish species such as trout. The two most common sources for elevated temperature are facilities with large impervious surfaces and large stormwater ponds used for stormwater treatment. Stormwater temperature should be considered whenever a facility discharges to a temperature-sensitive waterbody such as a trout stream or trout lake, or if the discharge is heated excessively.

Suggested BMPs to treat temperature

- Disconnect drain pipes discharging to impervious surfaces and divert water to grassed/vegetated areas.
- Direct roof drains to vegetated areas.
- If stormwater ponds are used, consider using filtered bottom withdrawal for the outlet.
- Constructed wetlands can be designed to minimize temperature increases.

Turbidity

Turbidity is a measure of water cloudiness most commonly caused by TSS or dissolved materials. Although the permit does not require monitoring for turbidity, monitoring for TSS is used as a surrogate parameter if the facility discharges to a water body designated as impaired for turbidity.

Suggested BMPs for turbidity are the same as used for TSS. If the turbidity cause is dissolved substances, chemicals may need to be added to the water to remove the problem materials.

pH

Ranges of pH are measured on a scale of 1 to 14; low pH (1-3) is considered acid, neutral pH is considered non-impacting (7), and high pH (10-14) is considered caustic or basic. A deviation in either direction from neutral could be toxic to aquatic life and cause other detrimental effects such as dissolving concrete or metal pipes. Extreme pH values, very low or high pH, can cause burns to skin or eyes.

Suggested BMPs to treat pH

- Reduce the sources of pH-related chemicals
- Apply pH-related chemicals at the lowest possible rates

Once the stormwater has been contaminated, treatment usually requires adding chemicals to neutralize the mixture and bring the pH into an acceptable range.

Chapter 3 The Stormwater Pollution Prevention Plan

Implementing and maintaining the facility Stormwater Pollution Prevention Plan (SWPPP) is the most cost-effective way to satisfy the industrial stormwater general permit requirements. By implementing the SWPPP, the facility helps ensure their industrial stormwater discharges are being properly managed.

3.1 Preparing a SWPPP

The facility SWPPP will only be valuable if it is cost effective, workable and is implemented. Forming a stormwater team to prepare and implement the SWPPP is recommended to research existing conditions, gather maps and facility plans, and develop procedures for implementation.

See Appendices A and B for a SWPPP development checklist and a blank SWPPP template if you do not have a current one or wish to update your existing version. Use of the template is not mandatory.

3.2 Implementing a SWPPP

Most SWPP activities can be implemented through the use of two categories of BMPs:

- Nonstructural BMPs
- Structural BMPs

Nonstructural BMPs focus on changing behavior and management to prevent pollutants from interacting and becoming associated with stormwater runoff. These measures include moving materials inside to reduce exposure, prohibiting certain practices, training, and implementing spill-prevention plans. Nonstructural BMPs are further discussed in Chapters 4 and 5 of this guidebook.

Structural BMPs are measures that control or manage stormwater runoff and drainage. Examples of structural BMPs include swales, dikes, ponds, filtration devices, and infiltration basins. Structural BMPs are discussed in Chapter6.

3.3 Unique SWPPP considerations

There are required industrial stormwater management activities which are unique to certain industries. If your facility falls into one of these unique situations, your SWPPP needs to include BMPs to address the following:

Industrial stormwater management can have added benefits such as increased aesthetics, even at municipally-owned facilities. Photo: University of Minnesota Recycling Center

Handlers of oil and hazardous substances

Minnesota's "Spill Bill"[1] (M.S. chapter 115E) requires all handlers of oil and hazardous substances to prevent and prepare for spills of these substances; handlers of these substances shall be prepared at all times to rapidly and thoroughly recover discharges.

The "Spill Bill" includes specific requirements for:

- Trucks or cargo trailers transporting more than 10,000 gallons per month
- Above-ground storage tank facilities storing 10,000 or more gallons
- Railroad rolling stock transporting more than 100,000 gallons per month
- Facilities that transfer more than 1,000,000 gallons per month

If your facility is required to meet the "Spill Bill" requirements and has already developed a Spill Prevention Control and Countermeasure Plan (SPCC), the SPCC requirements can be incorporated by reference and kept with the SWPPP.

For additional information, refer to the Minnesota Spill Bill[2] fact sheet and www.epa.gov/oem/ content/spcc/ index.htm for federal requirements.

Hazardous waste

If hazardous waste is stored outdoors, the following measures will meet the mandatory requirements of both the stormwater and hazardous waste permits:

- Storage areas must be curbed and protected from unauthorized access with a locked fence or other wall
- Ensure the capacity of any curbed storage areas retain the contents of the largest hazardous waste container in the storage area
- Prevent precipitation from collecting in the storage area or on containers to prevent corrosion
- Roof any storage area(s) that contain ignitable or reactive hazardous wastes

For more information, refer to the "Label and Store Hazardous Waste" fact sheet at www.pca.state.mn.us/publications/w-hw1-04-05.pdf.

Above ground and below ground storage tanks

Facilities with storage tanks must conduct required periodic system testing. This includes leak detection and corrosion protection. Common requirements for both above and below ground tanks include:

- Retention of inspection records
- Immediate clean up drips or small spills
- Inspection of secondary containment areas for sheen
- Management of any contaminated stormwater in containment areas
- Reporting of spills exceeding reportable quantities in the federal or state laws to the Duty Officer

See the "Reporting Spills and Leaks"[3] fact sheet for information on when to report spills and leaks.

Storage tank Inspection requirements

Underground storage tanks (UST), including dispensers, must be visually inspected once a month for leaks and structural concerns for secondary containment areas. Aboveground storage tanks should be inspected weekly for leaks and monthly for deterioration and maintenance issues such as cracks.

Salt storage

Facilities using salt or other de-icing agents need to take additional measures to ensure the product does not contaminate stormwater runoff. Recommended storage practices include:

- Store salt inside in containers that are in good condition
- Keep containers closed when not in use
- Cover salt containers stored outdoors and store on impervious surfaces
- Ensure tarp covers have sufficient durability and integrity (no tears or rips) and are anchored

Stormwater and infiltration systems

All sediment and materials removed from stormwater treatment systems must be properly disposed of in accordance with MPCA disposal requirements. Sediment removed from ponds may need to be tested prior to disposal to determine proper disposal methods.

Floatable materials from ponds, sand and other debris swept, vacuumed, or otherwise collected, constitute solid waste in accordance with Minn. R. 7035[4] Contact the MPCA at 651-296-6300, or 800-657-3864) to discuss proper disposal practices with solid waste staff. Document the contacts in the SWPPP.

Voluntary investigation and cleanup (VIC) sites

Facilities considering new stormwater control structures, or have existing structures undergoing modification, are required to consider the leaching of contaminated soil and buried waste materials on the site in order to prevent ground and surface water contamination. The design of any type of stormwater control structure must also avoid creating a vapor barrier that would prevent the release any contaminant vapor into the air, and must avoid creating new migration pathways for contaminant vapor to reach monitoring receptors. Stormwater control structures should also direct drainage away from areas of contaminated media.

Control measures such as pavements and soil covers used as part of a cleanup action may not be disturbed, except under an MPCA-approved work plan. Institutional controls recorded on the property deed, such as environmental covenants and affidavits, shall be followed.

Any soil that is contaminated above standards (i.e., Soil Leaching Values [SLVs] or Appendix [SRVs]) cannot be reused outside the zone of contamination; buried solid waste, liquid wastes and semi-solid wastes excavated during system installation must not be reburied on-site.

Infiltration systems need to be designed in a manner that will not increase the magnitude or extent of any existing ground water contaminant plumes, and will not cause the local ground water elevation to rise to the level of nearby contaminated soil or buried wastes. The construction of infiltration systems cannot be in or above buried waste materials or soil with contamination concentrations above the MPCA SLVs.

For more information, visit the Voluntary Investigation and Cleanup Program[5].

Chapter 4 No Exposure: The first option for BMPs

When facilities can eliminate contact between rain, snow, runoff, and pollutants from significant materials or industrial activities, the facility may certify for a five-year conditional exclusion called "No Exposure." This exclusion eliminates the need for a permit during that timeframe.

If industrial activities or materials become exposed, the No Exposure exclusion no longer exists and the facility must immediately apply for the industrial stormwater general permit. The permittee can make changes to the facility to meet the requirements, and re-apply for No Exposure at a later date. Runoff from office buildings and employee parking lots where no industrial activities are occurring are excluded from determining No Exposure.

No Exposure is only available on a facility-wide basis; exposed industrial materials or activities on any portion of the facility disqualifies the facility from meeting the No Exposure requirements.

4.1 No Exposure considerations

Storm-resistant shelters Storm-resistant shelters include completely roofed and walled buildings or structures. Some structures with only a top cover but no side coverings may be considered storm-resistant, provided any material under the structure is not subject to stormwater and subsequent runoff. Materials and activities may be sheltered with temporary covers such as tarpaulins, until permanent structures are created.

There are some products and materials which can be stored outside and still fall within the No Exposure requirements:

- Final products meant to be used outdoors, such as concrete culverts or stop signs
- Non-deteriorated sealed drums, barrels, or tanks without operational taps or valves
- Non-deteriorated containers, racks, or wooden pallets used for the storage or conveyance of final products
- Lidded dumpsters
- Adequately-maintained vehicles

The following materials and activities need to be addressed when determining No Exposure for a facility:

Table 4-1 Examples of outside materials and activities that do not meet No Exposure requirements

Materials	Activities
Fuels, solvents, coolants, lubricants and cleaners	Outdoor storage or fueling activities, including the pump itself
Raw, intermediate, and final products	Outside manufacturing, storage, delivery, staging, loading/unloading, washing areas
Metallic materials	Vehicle and equipment washing, maintenance and storage areas
Chemicals	Loading and unloading operations
Wastes and scrap materials	Transfer, storage, staging, delivery, washing areas
Hazardous materials/ wastes	Outdoor manufacturing or processing activities
Processing or production operations	Significant dust or particulate generating activities
Machining fluids	Onsite waste disposal practices
Dust or residuals	Outside storage areas for raw materials, by-products, and finished products
Fueling stations	Grinding, cutting, degreasing, buffing, and brazing
Above-ground tanks for liquid storage	Industrial waste management areas (landfills, waste piles, treatment plants, disposal areas)

Aboveground storage tanks (ASTs) ASTs typically utilize transfer valves to dispense materials or fuel for delivery, therefore additional considerations are needed when determining No Exposure applicability.

ASTs with secondary containment may qualify for No Exposure if they meet the following:

- Physically separated from vehicle maintenance operations
- Not associated with vehicle maintenance operations
- No leaking pipes, valves, or pumps
- Surrounded by physical containment such as an impervious dike or berm, to prevent runoff in case of structural failure

Outdoor Dumpsters Industrial waste and trash stored uncovered in outdoor dumpsters is considered exposure.

Outdoor dumpsters may qualify for No Exposure if they meet the following:

- Completely covered/lidded. Completely covered means nothing can enter from the top, nothing can drain out of holes in the bottom and no material is lost in loading or unloading
- Plugged drainage holes
- No leaking seams or holes
- Surrounded by physical containment such as an impervious dike or berm, to prevent runoff in case of structural failure

The cover or lid must have sufficient durability and integrity and be anchored in a way to keep water from entering the dumpster.

If the cover fails and water enters the dumpster, the exposure must be documented in the SWPPP and a permanent fix of the failure installed. If that is not possible, the No Exposure exclusion will be lost and the facility must apply for permit coverage.

Particulate emissions from roof stacks or vents need additional considerations when determining No Exposure applicability. Deposits of particles from roof stacks/vents could be transported by stormwater runoff or be "tracked out" on the tires of vehicles.

To qualify for No Exposure, particulate emissions must:

- Be in compliance with any required air quality permits and applicable environmental protection programs
- Not cause stormwater contamination

4.2 No Exposure: Non-structural BMPs

Many facilities may certify for No Exposure immediately or require only small changes to do so. Consider the following BMP options:

Eliminate exposure

- Move materials or operations into buildings or warehouses
- Store materials in weather-proof containers, shelters, or dumpsters
- Place scrap or waste products directly into covered transport containers rather than stockpiling
- Ensure particulate matter or visible deposits from roof stacks and/or vents that are not otherwise regulated (i.e., have an air quality control permit) are not evident in the stormwater outflow
- Conduct fueling, equipment maintenance, finishing or warehousing under a shelter or off-site
- Install particulate collection equipment to prevent dust or material accumulation
- Shelter loading and unloading areas

Manage runoff

- Prevent stormwater from flowing into areas with dikes or berms
- Provide curbs or slopes to prevent stormwater run-on or runoff
- Minimize stormwater run-on into an activity (e.g., fueling area) by using a permanent cover canopy over the fueling area, berms and/or other diversionary measures

Optimize operations

- Educate and train employees about No Exposure requirements
- Modify operations or install collection equipment to minimize dust generation
- Install monitoring equipment to detect and control leaks and overflows
- Outsource activities such as fueling and equipment maintenance that cannot be conducted under an onsite sheltered location

Optimize maintenance practices

- Maintain dumpsters; keep lids closed and sealed, plug drain holes, replace when seams crack or holes develop
- Recycle unused equipment rather than stockpiling
- Clean equipment and parts prior to storing outdoors
- Frequently remove debris and wastes at loading docks, truck unloading entrances, paint booths, and material handling operations

With no industrial activities or materials exposed to stormwater at this facility, it meets the requirements for No Exposure.

Control spills and leaks

- Develop and implement a spill management plan
- Use dikes and berms to prevent liquids from flowing to exposed areas
- Use drip pans and empty frequently
- Install adequate containment around liquid storage areas

Chapter 5 Non-structural BMPs for stormwater management

Non-structural BMPs are management techniques implemented through simple daily duties. Facility staff identify and implement site-specific BMPs which have a direct impact on the facility day-to-day processes. This chapter outlines some of the more common non-structural BMPs.

5.1 Good housekeeping

These practices usually take a minimal amount of effort compared with cleanup efforts and should be part of the facility's daily routine:

- Daily trash pick-up sweeping, erosion control and vegetation
- Mowing/maintenance
- Daily sweeping
- Mowing vegetation
- Ensuring dumpster lids are closed
- Inspecting dumpsters and storage areas for leaks, cracks, and other sources of exposure

5.2 Eliminating and reducing exposure

By eliminating or reducing exposure of materials, processes, and waste products to stormwater, runoff contamination is also eliminated or reduced.

- Store and manage materials in covered buildings
- Use tarps or similar temporary covers until permanent storage is available
- Place impervious pads under stockpiles
- Place exposed material piles away from stormwater flows
- Consolidate similar materials into fewer locations to reduce management needs
- Use covered chutes or booms when loading and unloading materials
- Install vegetative areas upstream of stockpiles to infiltrate stormwater before it contacts any materials.
- Install vegetative areas downstream of stockpiles to slow down stormwater discharges after it contacts any materials
- Recycle unused materials to reduce stockpiling
- Manage operations to avoid buildup of dust or other deposits on exhaust vents and roof stacks

Closed dumpsters are one of the easiest, and most overlooked, BMPs available to a facility. Photo: Honeywell Inc.

5.3 Salt storage

Any facility using salt or having salt storage must manage it to prevent contact with stormwater. If you have an National Pollutant Discharge Elimination System (NPDES) permit addressing salt storage at your facility, follow the requirements in that permit.

Optimal BMPs include covering the salt piles and placing an impervious pad under salt storage and work areas.

Additional BMPs to manage salt storage:

- Manually clear sidewalks, driveways and parking lots
- Use environmentally-friendly de-icing products
- Apply de-icing products sparingly
- Sweep up salt that is tracked out of the storage area
- Train employees about proper salt application and storage

5.4 Erosion prevention, sediment control, and runoff management

Where soils are exposed to water, wind, or ice, erosion can result. Erosion occurs when these exposed soils loosen, become suspended in water or air, and are transported to another location. SWPPPs must address areas that have potential for soil erosion.

Note: *A construction stormwater permit is required for any land disturbance activities of one acre or more. Activities of less than one acre are covered under the industrial stormwater permit requirements.*

Non-structural BMPs that can be implemented to limit erosion and control sediment include:

- Leaving as much vegetation onsite as possible
- Minimizing the length of time bare soil is exposed
- Diverting or preventing runoff from flowing across exposed areas
- Stabilizing disturbed soils as soon as possible
- Slowing the runoff flowing across the site

5.5 Dust control

Dust comes from smokestacks and vents, stockpiles, cleared ground, gravel roads, and open areas. Construction activities, such as land grading for road construction and commercial, industrial or subdivision development, are also a significant source of dust.

Non-structural methods to control dust include:

- Storing all materials, products, and waste inside the facility
- Routine cleaning of vents and filters
- Spraying controlled amounts of uncontaminated stormwater to dampen dust-generating areas
- Regular sweeping

5.6 Eliminating unauthorized non-stormwater discharges (illicit discharges)

Unauthorized discharges are any discharges not covered by the permit; some are legal and some are not. Illicit discharges are not covered by any permit and are illegal.

The industrial stormwater permit authorizes certain types of non-stormwater discharges under specific circumstances. These discharges include:

- Groundwater
- Tap water
- Irrigation or lawn watering
- Water from fire-fighting activities

See the permit for the complete list of allowable non-stormwater discharges.

Non-structural BMPs for non-stormwater discharges include:

- Inspecting and test floor drains, sinks, and process drains; eliminate connections to storm sewers, surface or subsurface drains
- Preventing mixing of non-stormwater and stormwater discharges; once mixed, the discharge cannot be managed as stormwater and requires different permits

Illicit discharges are not authorized under the industrial stormwater permit. Illicit discharges include:

- Sewage and septic flows
- Washwater
- Spills and/or dumped materials

5.7 Spill prevention and response procedure

A spill prevention and response procedure enables facility staff to quickly and consistently respond to spills that may occur. A proper response can also help prevent a spill from becoming a release.

To develop this procedure, the person or team developing the SWPPP should evaluate where spills have occurred in the past, where they have the potential to occur, determine likely drainage points for potential spill areas, and develop appropriate spill prevention and containment measures.

Spill prevention and response procedures include:

- Identifying potential discharge locations
- Identifying monitoring locations or surface waters that may be impacted by emergency firefighting techniques
- Training employees in proper prevention and response techniques
- Developing and implementing proper material handling, storage, and clean up procedures
- Posting contact information for all individuals who need to be notified in the event of a spill
- Promptly reporting and documenting any spills or leaks to appropriate individuals

5.8 Mercury minimization plan

Mercury-containing devices may be present at any type of facility. Therefore, all permittees need to evaluate their facility to determine whether any mercury-containing sources are exposed to stormwater and develop a Mercury Minimizatin Plan.

Mercury-containing devices include:

- Fluorescent bulbs
- Mercury lamps

- Mercury switches
- Mercury thermometers, gauges, and other medical or scientific equipment
- Certain batteries

To develop this plan, permittees must identify any sources containing mercury that are exposed to stormwater and describe how these sources will be managed to limit or eliminate exposure.

The mercury minimization plan should include:

- Removal of all sources of mercury to the extent feasible
- Management of mercury in accordance with Minn R. 7045 and other applicable state/federal rules
- Training employees in proper prevention and response techniques
- Proper storage of mercury-containing devices to prevent breakage

5.9 Employee training program

To assist employees in becoming more aware of facility waste generation, disposal costs, and environmental issues, the development of an effective employee training program is instrumental.

Facility training must occur at least once a year, and be documented within the facility SWPPP. Training can be achieved by attending formal classes, in-house training sessions, and informal/on-the-job training.

At a minimum, the facility training program documented in the SWPPP will include:

- Sources of pollutants and corresponding stormwater control measures at the facility
- A training schedule
- Documentation of training dates, who gave the training, and individuals attending

The following individuals are required to receive training:

- Employees developing the SWPPP
- Employees implementing the SWPPP
- Employees working in areas of industrial activities
- Employees conducting benchmark and/or effluent monitoring

Chapter 6 Structural BMPs for stormwater management

This chapter will describe common structural BMP options, the pollutants each can treat, and information about efficiency, maintenance issues and limitations.

This chapter also contains more technical information than previous chapters because advanced technical expertise is required to make informed decisions about implementing structural stormwater BMPs. It is suggested to consult with a licensed professional engineer early in your decision process.

For more information and construction details for stormwater treatment practices, refer to Chapter 12 of the Minnesota Stormwater Manual[1].

6.1 General structural BMP considerations

Any constructed embankment, principal spillway or emergency spillway should meet the criteria of accepted engineering manuals such as Natural Resources Conservation Service (NRCS) Standard 378, Ponds[2] and the Minnesota Stormwater Manual[3]. Wherever applicable, comply with Minnesota Department of Natural Resources (MDNR) dam safety program requirements and local flood control ordinances.

Dam safety requirements

The "Dam Safety Requirements" program was created in 1978 in response to the federal Dam Safety Act and regulates the repair, operation, design, construction, and removal of public and private dams[4]. Dams six-feet high or less and dams that impound 15 acre-feet of water or less are exempt from state dam safety rules. Dams less than 25 feet high and impound less than 50 acre-feet may also be exempt unless there is a potential for loss of life due to failure or mis-operation.

The program sets minimum standards for dams regarding safety, design, construction, and operation. Additionally, proposed projects for construction, alteration, repair, removal or transfer of ownership of a regulated dam may require a Public Waters Work Permit.

Emergency spillways

An emergency spillway is needed for all temporary and permanent stormwater control basins used for ponds and infiltration basins. They can be pipes or culverts, but often are vegetated channels with a bottom width greater than 10 feet and a level section of 30 feet or more. Spillway excavations should be in undisturbed soil rather than fill material.

At a minimum, the design capacity should be calculated using accepted engineering design manuals to determine appropriate spillway width and depth of flow. Upon determining the depth of flow, freeboard must be added in to determine the elevation of the top of the dam. Freeboard is the difference in elevation between the designed water surface in the spillway during a storm and the top of the settled excavation. The minimum freeboard distance should be at least 12 inches.

6.2 Sedimentation systems

Sedimentation systems capture and store stormwater runoff; while stored, the sediment contained in the runoff settles out to the bottom of the system.

Sedimentation systems are best used for removing TSS and the pollutants commonly associated with solids such as metals, organic compounds, and oxygen-demanding substances and nutrientsBOD and COD.

Although very versatile, sedimentation systems do have limitations. Very small substances and particles will not settle out completely. Depending on the type of substances in the industrial stormwater discharge, there may be a range of from less than 55% to about 97% removal of solids with a well-designed system[5]. Dissolved materials such as phosphorus can be removed if enough

Table 6-1 Maintenance recommendations: Constructed wetlands[10]

Action	Typical Frequency	Notes
Dredge sediment from forebay and deep pools	Variable (Once every 5 to 10 years is typical in stable watersheds)	In unstable watersheds,the frequency is typically once a year
Monitor sediment depth in forebay and deep pools	Once per year	Can be performed with capacity testing
Maintain outlet structures	Once per month and after every storm over 2 inches	Follow visual inspection guidelines
Remove floating trash and debris	Once per week to once per month	Increase frequency, if needed
Remove vegetation from dam top and faces	Once per year	Increase frequency, if needed
Remove invasive species such as cattails	Twice per year for the first two years. Annually afterward.	Chemical application to control small or new cattail growth
Remove muskrats and beavers	Inspect at least monthly	Contract with a professional trapper

detention time is provided for chemical or biological activity to take place. The amount of detention time is generally longer than traditional sedimentation methods.

Sedimentation systems include wet ponds, extended detention ponds and wetland treatment systems. The effectiveness of each depends on the particle size of the sediments in the stormwater runoff and the size of the system compared with the volume of runoff from the area that drains to the system.

In general, large sedimentation systems hold stormwater runoff longer than smaller size systems, which allows for more sediment to settle out. Larger sediment particles usually settle out faster than smaller sediments and are therefore more readily captured in sedimentation systems.

Sector-specific restrictions

All facilities may use sedimentation systems to manage their industrial stormwater runoff. However, not all sectors are authorized to design a new or expanded sedimentation system without an impermeable liner; sectors A, K, M, N and S have this limitation. See Part VII of the permit for more information on this limitation.

General maintenance considerations

Sedimentation systems generally have high installation costs but low maintenance costs depending on frequency of removing accumulated sediments and methods of disposal. Under anaerobic conditions, some sedimentation systems can become a source of pollutants if they contain metals or nutrients. Conduct regularly-scheduled system maintenance to prevent accumulated sediments from washing out during large storm events.

Common sedimentation system types: Flow-through pond (no extended detention) design[6]

Often called a "wet pond", a flow-through pond has an unrestricted spillway as its primary outlet with its crest at the elevation of the permanent pool. Stormwater is stored in the pond until new runoff enters, with the amount flowing through the outlet being equal to the amount entering. They usually provide a large permanent storage area below the outlet.

Wet ponds provide water quality treatment by holding a volume of stormwater equal to the permanent pool volume; this permits settling of suspended particulates and, if properly sized, can also provide limited reduction of dissolved contaminants such as phosphorus.

The flow-through pond has limitations for northern climates like Minnesota; the storage volume allocated for treatment is entirely below the permanent pool, making it inaccessible to new runoff during frozen conditions. For further information, see Cold climate impact on runoff management.

Wet extended detention ponds[7]

Wet extended detentions ponds are a combination of permanent pool storage and extended detention storage above the permanent pool to provide additional water quality or rate control.

Wet extended detention ponds are designed to use detention upstream from the outlet so the runoff flowing into the pond from large storm events can be captured and released slowly over a period of time. This extended detention allows some settling to occur and keeps flow rates in check. Though all ponds have some aspects of detention, these are specifically designed to use detention above the outlet as the primary method to control the physical settling of pollutants.

Dry ponds[8]

These ponds have no permanent pool; they rely upon extended detention storage for treatment. They are highly susceptible to sediment re-suspension, therefore they generally do not provide adequate treatment unless associated with other BMPs such as filtration or infiltration. They can be useful for flow rate control.

Stormwater wetlands (ponds or constructed wetlands)[9]

Stormwater wetlands are constructed management practices, not natural wetlands. They are similar in design to stormwater ponds; however they differ by varying water depths and associated vegetation. Although wetlands are effective for removing pollutants, care must be taken to protect the plant life for successful long-term operation.

Stormwater wetlands require slightly more surface area than stormwater ponds for the same size contributing drainage area; they are best suited for drainage areas of at least 10 acres. Like ponds, they can contain a permanent pool and temporary storage for water quality control and runoff quantity control.

Stormwater wetlands are considered an end-of-pipe BMP, meaning they are typically installed at the downstream

end of the treatment train. The wetland size and outflow requirements may be reduced with the use of additional upstream BMPs. If no upstream BMPs are planned, the stormwater wetland must be designed to provide adequate water quality and quantity treatment for all storms.

There are three basic types of constructed stormwater wetlands[9]:

- Shallow wetlands
- Pond/Wetland systems
- Extended detention wetland

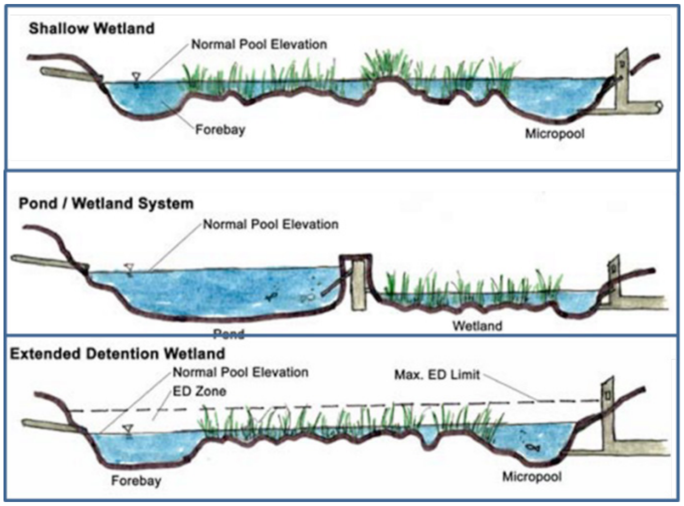
Each one has differing maintenance requirements, as seen in Table 6-1.

This section's material is adapted from "Stormwater Treatment: Assessment and Maintenance[11]".

Detention ponds, wet ponds, wetland treatment, and other sedimentation devices are usually very large and may require from a 0.5% to 6% or more of the surrounding watershed area. This can be especially significant if the watershed draining to the pond is larger than the industrial facility.

The primary reason for a sedimentation pond failure to properly treat stormwater is the build-up of sediment in the pond. This build-up significantly reduces treatment[12]. Additionally, sedimentation systems can be affected by large rain events that can remove the settled material from the pond, pushing it downstream.

Pond and wetland systems need to provide an overflow to drain stormwater from the site; this drainage cannot cause failure of the retaining wall or flooding



of surrounding areas. This overflow will need to be monitored and reported, with the results compared to benchmark values in the permit.

Like all stormwater treatment practices, sedimentation practices need annual inspections and routine maintenance to ensure proper function and extend useable life.

When the pond is not draining or will not drain the design volume within the design discharge time, the following maintenance steps can be taken:

1. Inspect all outlet structures for clogging and/or structural damage; remove debris and repair or replace needed components
2. Inspect the outflow location(s) for water backing up from downstream of the pond; remediate the situation
3. Redesign the pond geometry, outlet structure, or both to allow for proper draining of captured runoff

Annual maintenance costs for sedimentation practices can be significant, ranging from approximately 2 to 10% of the construction cost for wet ponds and 2 to 14% of the construction cost for constructed wetlands[13].

Most maintenance for sedimentation practices is minimal and simple to implement. For large ponds, sediment removal by dredging can be significantly more complex. Most maintenance addresses buildup of sediment, litter, and debris and clogging[14].

Table 6-2 General Stormwater Pond Considerations
Size: Dead pool volume is equal to the 5-year, 24 hour rainfall event.
Pond Depth: Between 3 and 10 feet
Floatable Material: Must use a skimmer or other device

6.3 Infiltration systems

There are several types of infiltration systems, including infiltration trenches, infiltration basins, bio-retention systems and underground infiltration tanks.

Infiltration systems are designed to capture and infiltrate industrial stormwater runoff to reduce runoff volume. They also recharge groundwater and reduce pollutant loads to surface waters. Infiltration system types include man-made and natural infiltration areas receiving diverted runoff.

Unlike sedimentation systems that use gravity to settle out particles, infiltration systems are designed to store a particular volume of runoff long enough for it to infiltrate into the subsurface soils. Infiltration system design and construction methods are required to infiltrate all captured stormwater within 48 hours according to the

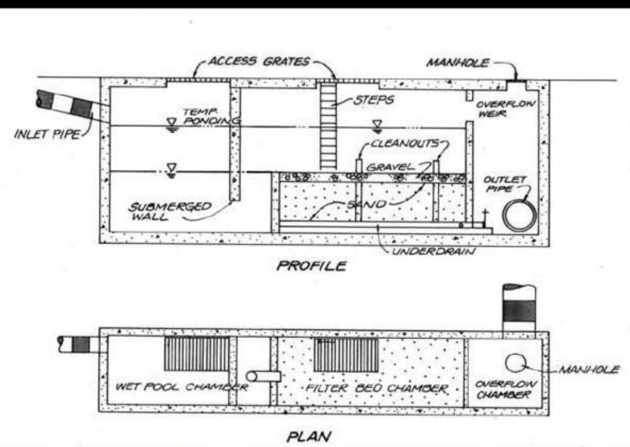
Minnesota Stormwater Manual[15]; other time frames may be appropriate depending on location.

Effectiveness

An infiltration system's effectiveness depends on the size of the system compared with the volume of runoff from the drainage area and the rate of infiltration into the subsurface soils. Infiltration is limited by the sub-surface soils infiltration rate, and should only be installed at facilities in which stormwater runoff will completely infiltrate in a set design time frame, usually about 48 to 72 hours or less.

Infiltration systems should have pretreatment located upstream of the system to capture large sediment and debris to extend the life of the system and reduce maintenance costs.

FIGURE 1.4: UNDERGROUND SAND FILTER



Restrictions/limitations

Sector-specific restrictions

All facilities may use infiltration devices to manage their industrial stormwater runoff. However, not all sectors are authorized to design, construct or implement new infiltration devices, or expand activities or practices that result in infiltration, or expand the volume of existing infiltration once the Multi-Sector General Permit (MSGP) is issued. Sectors A, K, M, N and S have this limitation. See Part VII of the permit for more information on this limitation.

Karst areas

Infiltration devices shall not be used in any high risk karst area unless a geotechnical evaluation is conducted by a qualified professional to ensure that the infiltration device does not present a significant risk to groundwater. See the Minnesota Stormwater Manual, Chapter 14, Section 2.2[16], for specific information on this process.

Class 5 injection wells

Class 5 injection wells are any stormwater infiltration device that is deeper than it is wide. These wells cannot be used as an infiltration system without federal registration with the USEPA. Permittees with any infiltration device defined as a USEPA "Class V injection well" must contact the USEPA Region V[17] to determine the need to register as a Class V injection well.

Refer to the USEPA Underground Injection Well Program for the definitions and complete registration process. Contacts and USEPA response shall be documented with the SWPPP[18].

Minn. Rule chapter 7060

Minnesota laws prohibit the direct discharge of untreated stormwater to the subsurface saturated zone if the discharge threatens groundwater from potential pollutants. If it is determined a discharge has introduced contaminants into groundwater, there could be liability repercussions for a facility for violating state law. Treatment before infiltration is a suggested means to discourage the possible introduction of pollutants into the groundwater.

Wellhead protection plans

Special attention should be given to injection wells or infiltration systems which may pose a large risk to the wellhead, especially for drinking water wells classified by the Minnesota Department of Health as vulnerable to contamination.

For stormwater systems located in defined wellhead-protection areas, the local unit of government must develop a "Wellhead Protection Plan" in accordance with state laws and requirements. Contact the local government unit responsible for drinking water to determine appropriate requirements for your facility. If you are unsure if your facility is in a wellhead protection area, use the interactive map titled "MS4 mapping tool[19]."

General maintenance considerations

Infiltration device maintenance can range from the relatively simple task of trash removal to more complicated tasks such as controlling invasive vegetation and stabilizing eroded banks. Material in this section is adapted from "Stormwater Treatment: Assessment and Maintenance[20]".

General maintenance frequencies may vary from multiple times per year to every five or more years. The agency recommends infiltration system inspections occur after each rain event when the system is new and monthly thereafter, in accordance with the permit.

Most maintenance for infiltration basins is minimal or simple and addresses buildup of sediment, litter, and debris. Additional maintenance may be needed for bio-retention practices to manage vegetation[21].

Annual maintenance costs for infiltration practices can be significant, ranging from approximately 1 to 100% or more of the total construction cost per year[22]. Most maintenance for infiltration practices will cost between 1 and 20% of total construction cost annually.

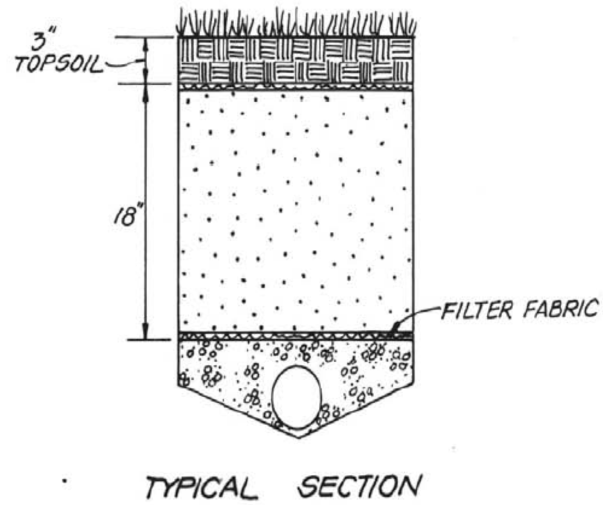
The most commonly-cited reason for failure of infiltration systems is clogging due to sediment and organic debris[23].

Other common failure reasons include:

- Poor site selection
- Poor construction methods, such as over compaction during excavating
- Lack of pretreatment structures
- Clogging of the subsurface soil
- Compaction of soil
- Improper maintenance of surface vegetation

Common infiltration systems: Infiltration trenches

An infiltration trench is a shallow excavated trench, usually 2 to 10 feet wide and 2 to 4 feet deep, filled with a coarse stone aggregate. The coarse stone allows temporary stormwater runoff storage before infiltrating into the sub surface soil.



Claytor, Schueler, Center for Watershed Protection

Table 6-3 Quick facts: Infiltration trenches[24]			
Impervious Area (acres)	0.5	1	2.5
Estimated Construction Cost	$33,000	$59,000	$124,000
Estimated Annual Maintenance Cost	$1,683 – $41,580	$3,009 – $74,340	$6,324 – $156,240
Estimated Total Present Cost	$108,000	$190,000	$402,000
Estimated Total Suspended Solids Effectiveness (Annual pound reduction)	600	1,100	2,800
Estimated Land Required (acres)	< 0.015	< 0.03	< 0.075

Note: *All cost data in 2009 dollars for Minnesota. Assumes Water Quality Volume designed for two inches of runoff from impervious area, with a 9.5% increase from 2005 to 2009 dollars[25]*

Common infiltration systems: Infiltration basins

An infiltration basin captures and temporarily stores stormwater runoff while allowing it to infiltrate into subsurface soils. Their function is similar to an infiltration trench with the exception that stormwater is stored in the basin as opposed to within the coarse aggregate stone.

If the infiltration practice does not drain, or does not drain the design runoff volume as designed, the following steps can be taken to address the problem:

1. Remove and replace mulch, surface layer material, or accumulated sediment, reestablish vegetation according to design
2. Remove and replace the top four to six inches of sand/soil media, reestablish vegetation according to design.
3. Remove and replace the entire media bed, reestablish vegetation according to design

Common infiltration systems: Bio-retention practices

Bio-retention practices include rain gardens or enhanced vegetation swales. They are similar to infiltration basins in function but are generally smaller in size, shallower in depth, and may include soil specifically chosen for the site.

Common infiltration systems – Underground infiltration devices

Underground infiltration devices capture stormwater underground in pipes or tanks and allow stormwater to infiltrate into subsurface soils through open bottoms or perforations. Underground infiltration practices are typically installed at facilities where surface space is limited.

Table 6-4 Typical maintenance activities for infiltration basins and trenches[26]

Activity	Schedule
Remove sediment and oil/grease from pretreatment devices and overflow structures Mow, and remove litter and debris Stabilize eroded banks, repair undercut and eroded areas at inflow and outflow structure	Standard Maintenance (as needed)
Inspect pretreatment devices and diversion structures for signs of sediment buildup and structural damage If dead or dying grass is evident at the bottom or the basin/trench, check to ensure water percolates within 2-3 days following significant rain events	Semi-Annual Inspection
Disc or otherwise aerate basin bottom De-thatch basin bottom	Annual Maintenance
Improve short term infiltration rate by providing an extended dry period	5-year Maintenance
Total rehabilitation of the trench to maintain storage capacity within 2/3 of the design treatment volume and 72-hour ex-filtration rate Excavate trench walls to expose clean soil	Upon Failure

Table 6-5 Quick facts: Bioretention[27]

Impervious Area (acres)	0.5	1	2.5
Estimated Construction Cost	$34,000	$69,000	$175,000
Estimated Annual Maintenance Cost	$238 – $3,434	$483 – $6,969	$1,225 – $17,675
Estimated Total Present Cost	$61,000	$105,000	$214,000
Estimated Total Suspended Solids Effectiveness (Annual pound reduction)	500	1,000	2,500
Estimated Land Required (acres)	< 0.025	< 0.05	< 0.125

All cost data in 2009 dollars for Minnesota. Assumes Water Quality Volume designed for two inches of runoff from impervious area, with a 9.5% increase from 2005 to 2009 dollars[28].

Table 6-6 Maintenance requirements and frequencies for bioretention[29]

Task	Frequency	Notes
Vegetation Pruning	1-2 times/year	—
Vegetation Mowing	2-12 times/year	Frequency is dependent on location and desired aesthetics
Mulching	1-2 times/year	—
Mulch and top layer of soil removal	1 time every 2-3 years	Mulch accumulation decreases infiltration rates.
Watering	1 time every 2-3 days for first 1-2 months	As needed after vegetation is established
Remove/replace dead plants	As needed	Survival rates increase with time
Miscellaneous upkeep	1 time/month	Weeding, trash collection, etc

6.4 Filtration systems

Stormwater filtration systems are a diverse group of techniques for treating stormwater runoff. Filtration systems can be very effective at treating sediment and other pollutants, because they are the most variable and technically-advanced systems available.

Options can be simple sand filter or vegetative filter systems through more complex engineered systems. The commonality is each type utilizes one or more forms of media, such as sand, gravel, peat, grass, soil or compost, or synthetic media to filter stormwater pollutants.

Selecting the right media is important, as each has different hydraulic requirement, pollutant- removal efficiency, and clogging characteristics. Filter media may also incorporate adsorption media such as iron for phosphorus removal or activated carbon for organic materials.

Most filtering systems are typically used for small (five acres or less) drainage areas. The information in this section is based on the Center for Watershed Protection's "Design of Stormwater Filtering Systems[30]."

Effectiveness

Most industrial permittees will find that simple sand or other media filtration will have effectiveness of pollutant removal very similar to the effectiveness of retention ponds.

Restrictions and limitations

All facilities may use filtration devices to manage their industrial stormwater runoff. It is recommended that facilities planning on implementing an in-ground filtration system take the proper design and construction precautions to ensure the filtration system does not become an infiltration system. For sectors A, K, M, N, and S, this may require a liner to ensure there is no infiltration of the stormwater.

Design and installation considerations

The agency recommends all filtrations systems include pre-treatment to capture coarse sediments. Without pre-treatment, the filter will quickly clog and lose its pollutant-removal capability.

The most common pre-treatment technique is a wet or dry settling chamber. Other options include an underground chamber or a small pool or forebay at the surface prior to discharge into the filtration area.

Maintenance considerations

This section's material is adapted from "Stormwater Treatment: Assessment and Maintenance[31]"

As with all stormwater treatment practices, filtration systems need annual inspection and maintenance to ensure proper function and extend useable life. Maintenance can range from trash removal to complete removal and replacement of the filter media and underlying system.

The primary failure mechanism for filtration systems is clogging due to buildup of sediment, litter, and debris[32]. Clogging can result in long periods of standing water, flooding of surrounding areas, by-passing of the filter by untreated stormwater, or any combination thereof.

The following maintenance suggestions should be considered to address a system failure that results from clogging of sediment, litter, and debris:

1. Inspect the outlet structures and under-drain system; remove any obstructions, replace/repair damaged structural components
2. Roto-till the top six inches of sand or soil media filters to break up any consolidation
3. Remove and replace the top four to six inches of sand filter media
4. Remove and replace the entire media bed

Maintenance recommendations include removing and replacing the top layer (four – six inches) as appropriate (e.g. sand media filter) of filter media as often as once per year and at least once every five years.

If there is any indication that the filter is not draining or will not drain the design runoff volume within the required time (use filter-specific design criteria), the watershed and filter size, land use, rainfall amounts and intensities.

Annual maintenance costs can be significant, ranging from approximately one to 13% of the total construction cost per year[33].

6.5 Proprietary treatment systems and mechanical treatment systems

Proprietary treatment systems are commercially-available systems designed to remove specific pollutants from stormwater runoff. Most proprietary stormwater treatment systems are installed underground and are best used at small facilities and areas where there is limited available land for other surface structural controls. Their performance and efficiency are dependent upon flow rate entering the system, and they can be overwhelmed during very high flow volumes.

Table 6-7 Quick facts for filtering systems[34]

Impervious Area (acres)	1	2.5	5
Estimated MN Construction Cost	$89,000	$154,000	$233,000
Estimated MN Annual Maintenance Cost	$801 – $8,455	$1,386 – $14,630	$2,097 – $22,135
Estimated Total Present Cost	$159,000	$275,000	$415,000
Estimated Total Suspended Solids Effectiveness (Annual pound reduction)	1,000	2,400	4,800
Estimated Land Required (acres)	< 0.03	< 0.075	< 0.15

Note: *All cost data in 2009 dollars for Minnesota. Assumes Water Quality Volume designed for two inches of runoff from impervious area, with a 9.5% increase from 2005 to 2009 dollars[35].*

Table 6-8 Filtering systems maintenance recommendations[36]

Action	Typical Frequency	Notes
Roto tilling surface	as needed	If infiltration rates are low, roto tilling may restore infiltration capacity if appropriate (e.g. sand media filter)
Remove & replace sediment layer	1-3 years	—
Replace entire media bed	3-5 years	—

Though proprietary structural controls are typically more expensive than traditional surface ponds, due to on-site space limitations they may be the only viable stormwater treatment option.

Effectiveness

Proprietary treatment systems can be effective but they have to be maintained regularly, typically every one to six months). A proper maintenance program will help ensure the system is performing to its highest potential.

Restrictions and limitations

The permittee is responsible for knowing any limitations to the proprietary device they have chosen, and it is strongly suggested they work with the manufacturer of the device to ensure proper use.

Guidelines for selecting proprietary systems

A proprietary system must be able to meet the treatment levels for which it was designed. This means the system should have independent third-party scientific verification of performance. Proven performance longevity in the field is one of the best indications that it will perform to standards at facilities. Consideration of where the field testing was done is important given the climate extremes in Minnesota.

Design and installation considerations

Most proprietary systems require a stormwater bypass channel in order to function properly; for example, a filtration unit can only pass stormwater through the media at a particular rate.

These systems also rely on gravity; therefore bypasses are used to control the flow rates through the treatment media. When bypasses occur, generally during high intensity rain events, the system's performance will drop. Although the water traveling through the system will receive the desired treatment, once it combines with the untreated bypass water the overall removal rates will be smaller.

Maintenance

Each manufacturer has recommended maintenance activities and schedules and may need to be adjusted for each site's characteristics and use. Each proprietary device will have its own required maintenance schedule; users of these devices must be knowledgeable of the required maintenance.

Additional requirements

If grit accumulates in the proprietary system, it should be removed and handled in accordance with applicable MPCA requirements. The material is often contaminated with a wide array of inorganic and organic pollutants. Disposal without proper precautions is not recommended.

Common proprietary systems

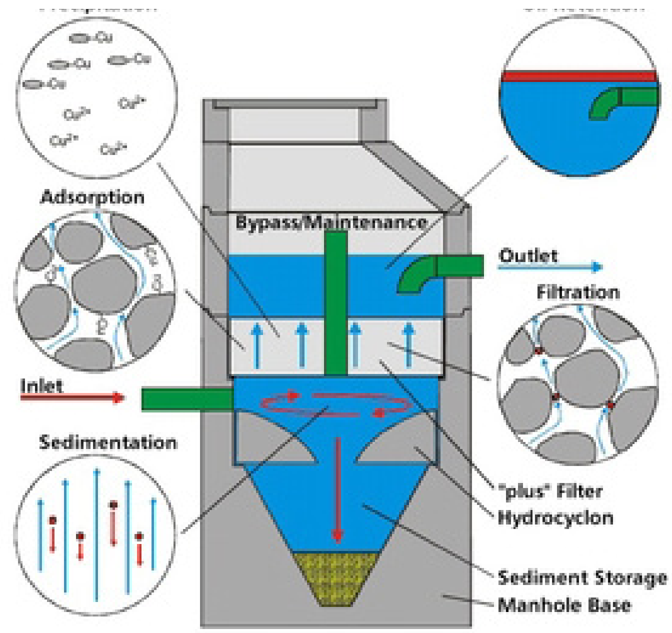
There are many types and configurations of these systems. They generally fall into one of the following categories:

1. Hydrodynamic systems (HDS) that utilize gravity or vortex separators
2. Catch basin media inserts
3. Filtration systems
4. Infiltration systems

1. Hydrodynamic separators that utilize gravity

HDS are small, flow-through devices that remove sediment, trap debris, and separate floating oils from runoff. The HDS devices design varies, and is created by the manufacturer in accordance with local watershed conditions and target water quality treatment objectives. Often, these systems are designed to replace or retrofit existing catch basins.

Typically, HDS devices consist of a chamber that is configured for tangential flow. This means that stormwater enters the device through an angled inlet that creates a swirl action (or vortex) to enhance particle settling. Many also contain a flow partition to minimize sediment re-suspension during times when flow rates exceed the design target. HDS devices are usually equipped with a baffled outlet to remove floating debris, oil, and grease in stormwater runoff.



Hydrodynamic separator with media filter

2. Catch basin media inserts

A catch basin insert, or manufactured inlet protection unit, is typically installed in a storm drain inlet. It filters contaminants out of runoff entering the inlet. These filters remove larger particles and enhance the quality of the runoff delivered to storm sewer systems and streams.

Manufactured inlet protection units can be an alternative to conventional oil-water separators. Filters can be designed for specific pollutants including hydrocarbons, oil and grease, heavy metals, volatile organic compounds, pesticides, and sulfides. Design variations include tray filters installed around the perimeter of the inlet, filter bags placed around the perimeter of the inlet grate, and baskets that are set in the inlet.

Inlet protection systems are typically used as the first BMP of multiple stages of treatment of runoff. They are generally not considered adequate as a stand-alone stormwater treatment system. Upon entering the inlet, runoff is directed to a pre-settling chamber that collects heavy sediments and debris passing through the inlet grate. Runoff then passes through media such as carbon and cellulose filters for removal of microscopic organic pollutants before being channeled to a bottom drain, where the treated water is released into the storm sewer system.

Catch Basin Insert with Basic Sediment Filter

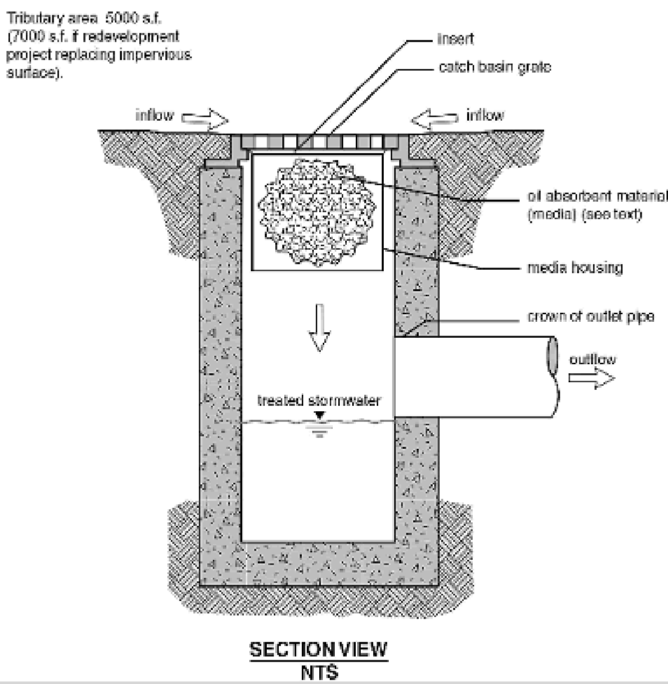
3. Filtration systems

Proprietary stormwater treatment devices which use a filter media may be of particular interest if a facility's sector requires monitoring for a particular pollutant.

Manufacturers of filter-type stormwater treatment systems can supply different filter media to target different pollutants. Filter media can be selected to remove TSS, phosphorus, hydrocarbons, metals or other constituents.

4. Infiltration systems

These proprietary system devices are sometimes buried underground so that the stormwater will drain through them on its way to lakes and streams. Because of the size of the chamber, the water slows as it passes through and the grit settles out. The grit collects in the bottom of the chamber and a maintenance crew periodically cleans it out. Oil separators, skimmers and other oil-removal devices may be used to remove the oil separately from the sediments.



The typical design of a catch basin insert is a set of filters that are specifically chosen to address the pollutants expected at that site (Source: King County, Washington, 2000)

Catch basin insert with media filter

Vendor information

This guidebook cannot endorse one product over another. The number of vendors and type of products is changing rapidly. The Stormwater Equipment Manufacturers Association[37] hosts a clearinghouse for information regarding venders of different types of products. Visit the "buyer's guide" section and search by device type.

Chapter 7 Facility BMP inspection requirements

Regular inspections of a facility's BMPs are required by the Industrial Stormwater General Permit. These inspections are integral in determining if structural and nonstructural BMPs are properly functioning, require maintenance, or need to be changed. Inspections also determine the accuracy of the facility SWPPP, as all observations and any changes made as a result of the inspections must be documented in the SWPPP.

This chapter will focus only on the BMP component of facility inspections.

7.1 What to inspect

All stormwater BMPs, whether structural or non-structural, must be inspected by an appropriately trained person. Condition of BMPs are documented and recorded in the SWPPP. Areas to inspect include:

- Bulk storage areas (tanks, drums, pallets, etc.)
- Waste storage and disposal areas
- Maintenance areas, including fueling
- Loading/unloading or shipping/receiving areas
- Storage areas of raw materials, intermediate products, by-products, and waste products

7.2 Frequency of inspections

BMP inspections must be conducted at least once each month by an appropriately trained person.

At least one of the 12 inspections must occur when there is runoff from rain or snowmelt. For facilities in Sectors C, D, E, H, I, M, N, O, P, Q, R, S, U, V, Z, and AB, additional inspections are required, see Section 7.4.

7.3 Documenting inspections

If the inspection identifies BMPs as functioning properly, note for each BMP on the inspection form and file with the facility SWPPP. Any changes to existing BMPs, additions of new BMPs, or removal of BMPs are also documented in the SWPPP. An inspection form template is provided in Appendix C of this guidance manual.

If BMPs are not functioning properly, the permittee shall replace, maintain or repair the BMPs immediately or no later than seven (7) calendar days beyond discovery. All repairs or replacements including time schedules are documented in the facility SWPPP.

If BMP replacement, maintenance, or repair cannot be completed within seven (7) calendar days, the permittee must implement backup BMPs and identify the schedule for completing the work. All documentation shall be contained within or as an attachment to the facility SWPPP.

7.4 Additional considerations for certain activities and materials

Some facilities may have materials or activities which require additional considerations for inspections. Facility managers should consider more frequent inspection schedules for these activities or materials.

Fueling activities

Fuel-related spills are a major source of contamination in surface waters and aquifers. In addition to the storage tank and dispensing system, fueling activities also include mobile fueling and the pre-flight check of airplane fuel. Though individual spills may be small in volume, they accumulate over time resulting in concentrated contamination when washed off by rainfall or snowmelt.

All reportable spills must be reported to the Duty Officer at 1-800-422-0798 (toll free) or 651-649-5451 (Metro area)[1].

BMPs to consider

Simple BMPs to minimize the impacts of spilled fuel include:

- Avoiding overfilling of fuel tanks (topping them off) during fueling
- Removing locking devices on fuel dispensing handles so fuelers cannot walk away while filling tanks
- Using dry clean-up methods for the fuel area instead of washing or rinsing with water
- Developing an inventory control management plan for underground tanks to aid in detecting releases
- Providing for spill or leak containment by dikes, berms, or double-walled tanks for aboveground tanks

More extensive fueling BMPs include:

- Installing a canopy over the fueling island to prevent precipitation from falling directly upon the fueling pad

- Providing impervious pavements at fueling locations to allow spill cleanup with dry absorbent materials
- Installing a diversion berm and/or trench around the fuel-dispensing pad to minimize the quantity of run-on from outside areas and to keep small fuel spills from washing off the pad

Mobile fueling

Mobile fueling operations can be more problematic than fixed fueling stations at facilities due to the difficulties in implementing the following:

- Containment and/or absorbent materials at each location
- Impervious ground surface at each location
- Proper surface drainage conditions and discharge outlets

The most effective BMP for mobile fueling is locating the fueling station where spills can be easily and quickly cleaned up. The same BMPs used for stationary fueling stations can be applied to mobile fueling operations.

7.5 Mercury-containing devices

Mercury-containing devices may be present at any type of facility. All permittees need to evaluate their facility for sources of mercury that are exposed to stormwater.

When mercury sources or devices are found to be exposed to stormwater, the facility SWPPP must include a Mercury Minimization Plan which describes how mercury sources will be appropriately managed.

Mercury-containing devices include:

- Fluorescent bulbs
- Mercury lamps or switches
- Mercury thermometers, gauges and other medical/scientific equipment
- Certain batteries

BMPs to consider

- Store mercury containing devices in a covered container to prevent breakage. Recycle or dispose appropriately.
- Properly identify and manage batteries containing mercury. See the “Universal Wastes[2]” fact sheet.
- Properly remove and store mercury switches upon discovery. See the “Universal Wastes[2]” fact sheet.

7.6 Oil and grease runoff inspections

For facilities in Sectors C, D, E, H, I, M, N, O, P, Q, R, S, U, V, Z, and AB, at least two of 12 monthly inspections must visually inspect the runoff for grease or oil sheens, and one (1) inspection must be snowmelt runoff.

Chapter 8 Cold climate BMPs and extreme weather

Minnesota's extremely variable climate compels permittees with outside operations to manage stormwater runoff over a wide range of weather conditions. Facility operators need to consider the effects of variable weather from flooding to drought, and blizzards to tornadoes when planning site management and stormwater BMPs.

Knowing existing and anticipating potential weather conditions is very important to successfully manage facility operations in weather extremes, and can be monitored through the National Weather Service Website[1] or local TV stations/websites.

8.1 Winter considerations

Ice and snow accumulations can mask pollutant build up in outdoor handling areas; therefore there can be a number of stormwater management issues to be considered during the winter months.

Anti-icing

Anti-icing is a proactive strategy to limit ice accumulations in winter storms. Depending upon weather conditions, anti-icing can be effective for up to several days following application. Applying small and strategic amounts of deicer before a storm prevents snow and ice from bonding to the pavement. Anti-icing requires about ¼ the material and 1/10 of the overall cost of de-icing and can be effective and cost-efficient when correctly implemented.

Snow, sand, and salt BMPs

These BMPs can be used to reduce, prevent, or minimize contamination due to storage of snow, sand, and salt. For additional cold climate runoff management, see Chapter 9 of the Minnesota Stormwater Manual[2]:

- Store snow piles where solids can be recovered after snow melt
- Locate snow down-slope from salt and sand storage areas to prevent snow melt from flowing through them
- Remove pavement and parking lot snow prior to applying de-icers
- Store sand or salt bags/piles on an impervious surface and protect from rain, snow, and melt water

Appropriately managed salt piles should not cause contaminated stormwater runoff.

- Store sand or salt bags/piles on an impervious surface away from low-lying areas and drainageways
- Use properly adjusted drop spreaders instead of rotary spreaders to apply sand or salt to minimize application rates

8.2 Extreme weather

An extreme (dry or wet) event is one that occurs on a rare interval. Over the course of a year, extreme weather in Minnesota can include tornados, severe lightning storms, sudden high-volume rain events, cumulative effects of normal rainfall over a series of consecutive days, droughts, blizzards, and prolonged sub-zero temperatures. Permittees should take these extremes into consideration when developing and implementing facility SWPPPs.

Permittees should promptly inspect their facility following an extreme weather event to determine impacts and correct any resulting adverse effects on BMPs.

Note: *Stormwater monitoring during extreme weather events is not recommended. Safety is the first consideration, monitoring should not be conducted if there is any question about personnel safety.*

Extreme weather BMPs

Planning for extreme weather events can include the following:

- Routing surface drainage to eliminate or minimize contact with stockpiled significant materials
- Routing roof or gutter/downspout drainage to eliminate or minimize contact with stockpiled significant materials
- Storing significant materials and waste materials upslope of depressions to avoid potential flooding
- Inspecting vegetative BMPs during drought conditions to ensure vegetation is growing
- Inspecting ponds during drought conditions to ensure liners are not cracking or pond walls are not eroding
- Inspecting dams, dikes, or structures for erosion, runoff channels, or washing away of materials
- Notifying the Minnesota Duty Officer at 1-800-422-0798 (toll free) or 651-649-5451(Metro area) of significant material spillage or washing away

8.3 Local controls for flooding events

In many areas, flood control is subject to regulation of the local watershed district or water-management organization. Local needs for flood control can vary widely, depending upon drainage conditions.

For facilities planning new construction, or rebuilding of structural BMPs following a severe weather event, many watershed districts and water-management organizations require run-off rates from the post- development site be equal to the runoff rates from the pre-development site for the one-, 10-, and 100-year, 24-hour rainfall events.

In addition, the elevation of the lowest floor elevation of a building or structure is typically required to be at least 0.5 to 3.0 feet above the 100-year flood elevation.

At minimum, facility planners and managers are expected to follow local codes for the flood events.

When it is impractical to cover salt piles, use BMPs to manage both the material and stormwater runoff.

Appendix A Stormwater pollution prevention plan (SWPPP) checklist

Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

Industrial Stormwater Pollution Prevention Plan Checklist

NPDES/SDS Industrial Stormwater Permit

Doc Type: Permitting Checklist

Purpose: *A Stormwater Pollution Prevention Plan (SWPPP) must be written before a facility can apply for and receive an industrial stormwater permit. Use this checklist to make sure a completed SWPPP contains the required information. A template for creating a SWPPP is available on the Minnesota Pollution Control Agency (MPCA) website at http://www.pca.state.mn.us/8393q9y.*

SWPPP template section	SWPPP requirements	Part of permit with more info	Yes	No	N/A
	The SWPPP was completed before the permit application was submitted to the MPCA.	Part IV.A.2	☐	☐	
	The SWPPP is kept at the facility and can be made available for review within three days of a request.	Part IV.B.6	☐	☐	
1	Individuals responsible for managing, implementing, maintaining, modifying and ensuring compliance with the SWPPP are identified.	Part IV.A.4	☐	☐	
1	Personnel who are trained to conduct facility inspections are listed.	Part IV.A.7	☐	☐	
2	There is a place to record updates to the SWPPP.	Part IV.B.5	☐	☐	
3	Facility description includes a description of facility activities, total acreage and acreage of industrial activities and materials.	Part IV.B.2	☐	☐	
5	Industry-specific requirements listed in Part VII of the permit have been included.	Part IV.A.6 and Part VII	☐	☐	
6	Activities and materials that could come in contact with stormwater have been inventoried; possible pollutants are documented.	Part IV.B.4	☐	☐	
6	Ways to reduce or eliminate stormwater pollution from the facility have been identified and are described.	Part IV.B.1	☐	☐	
7	There is a place to record inspections or attach completed inspection forms.	Part IV.A.8	☐	☐	
8	There is a place to record maintenance of stormwater management methods.	Part IV.A.9	☐	☐	
9	Elimination of unauthorized discharges is documented.	Part IV.A.10	☐	☐	
10	A spill response procedure is included or attached.	Part IV.A.11	☐	☐	
11	Information about the employee training program is included or attached.	Part IV.A.13	☐	☐	
12	If applicable: Mercury Minimization Plan is included or attached.	Part IV.A.12	☐	☐	☐
13	If applicable: Section for mobile industrial activities is included and kept at the mobile locations.	Part IV.A.5	☐	☐	☐
Section 4	Facility map is included.	Part IV.B.3.a	☐	☐	
	Impervious areas on the property are shown.	Part IV.B.3.b	☐	☐	
	Storm sewer inlets are shown.	Part IV.B.3.h	☐	☐	
	Loading dock drains are shown.	Part IV.B.3.i	☐	☐	
	Stormwater flow directions are indicated by arrows.	Part IV.B.3.c	☐	☐	
	Non-stormwater discharges are identified and locations shown.	Part IV.B.3.l	☐	☐	
	Locations of industrial activities and materials are shown.	Part IV.B.3.d	☐	☐	
	Locations of structural management methods are shown.	Part IV.B.3.e	☐	☐	
	Surface water body that receives the facility's stormwater discharges is identified. An arrow is placed in the direction of the water and the name is identified if the receiving water is beyond the scale of the map.	Part IV.B.3.a	☐	☐	

SWPPP template section	SWPPP requirements	Part of permit with more info	Yes	No	N/A
Section 4	Benchmark monitoring locations are named and labeled.	Part IV.B.3.j	☐	☐	
	If applicable: Benchmark monitoring locations within a mile of impaired water are identified.	Part IV.B.3.j	☐	☐	☐
	If applicable: Effluent monitoring locations are named and labeled.	Part IV.B.3.k	☐	☐	☐
	If applicable: Effluent monitoring locations within a mile of impaired water are identified.	Part IV.B.3.k	☐	☐	☐
	If applicable: Impaired waters within a mile of the facility are labeled and the impairment is identified.	Part IV.B.3.g	☐	☐	☐
	If applicable: Appendix A waters within a mile of a monitoring location are labeled.	Part IV.B.3.k	☐	☐	☐

Appendix B Stormwater pollution prevention plan (SWPPP) template

Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

Industrial Stormwater Pollution Prevention Plan for

NPDES/SDS Industrial Stormwater Permit

Doc Type: Permit Information Form

Instructions: Complete each section of this template to create a Stormwater Pollution Prevention Plan (SWPPP). A SWPPP must be completed before a facility applies for industrial stormwater permit coverage.

- Customize the plan to meet the conditions at the facility.
- Use discretion about which items need to be addressed. Some sections may not pertain to the facility.
- Full explanations for each part of this plan are in the permit (found on the Minnesota Pollution Control Agency [MPCA] website at http://www.pca.state.mn.us/enzqa74).
- The plan is not submitted to the MPCA. It is for your use at the facility. You may add pages with other useful information. Note: Double click on checkboxes to select checked.

You may draft a SWPPP from scratch if you prefer. This template, the SWPPP Checklist, and the permit itself are good guides for what to include (found on the MPCA website at http://www.pca.state.mn.us/enzqa74).

Purpose: A SWPPP is just that: a plan to prevent rain, snow, snowmelt and runoff – known collectively as stormwater – from being polluted when they leave the facility's property. Use this plan to establish what will be done and keep track of what has been done.

Tip: *Most regulators will refer to this plan as a SWPPP, pronounced "swip," which rhymes with 'drip.'*

Resources:

Click the link	Or search MPCA website http://www.pca.state.mn.us for:
MPCA Industrial Stormwater General Permit	wq-strm3-67a
Template for writing the plan (this document)	wq-strm3-28
Checklist of what to put in the plan	wq-strm3-57
BMP guidebook. Best Management Practices are ways of reducing or preventing stormwater pollution	wq-strm3-26
Inspection form	wq-strm3-56
Mercury Minimization Plan Checklist	wq-strm3-30
Impaired waters list	lupg1125

The above instructions should be deleted before finalizing the SWPPP.

Stormwater Pollution Prevention Plan (SWPPP) for:

[Type facility name here]

[facility address]

This plan is required by the Minnesota Industrial Stormwater Multi-Sector General Permit.

Keep this plan at the facility and available for review.

1. Pollution prevention team

List the person (or title/role) responsible for each of the following duties:

Name	Stormwater Pollution Prevention Plan duties
	Put together and implement the plan
	Install and maintain the stormwater management methods identified in Section 6 of this plan
	Conduct monthly facility inspections
	Collect quarterly stormwater samples
	Submit the Annual Report due March 31 each year
	Review the plan annually for updates
	Pay the annual fee
	Other:
	Other:

2. Updates

Review this plan at least once a year to make sure everything is current and updated. Make changes as needed. Record the date the plan was reviewed and summarize any updates made. Make additional copies of this page as needed.

Have any of the following changes happened?

- Staffing changes that affect duty assignments or spill response contact information.
- A stormwater management method was determined to be ineffective, or a new one was added.
- Sampling locations have been moved.
- New or different activities or materials come in contact with stormwater.
- Activities from new industry types have been added; check the industry requirements covered in Section 5 of this plan to see if anything needs to be added.
- Impaired waters have been listed within one mile of a facility monitoring location. This list can be found on the MPCA Minnesota's Impaired Waters List website at http://www.pca.state.mn.us/lupg1125.

Date	Reviewed by	Changes made to SWPPP

3. Facility description

Describe what the facility does:

Total acreage of the facility property:

Acreage that has industrial activities or materials. Exclude areas with no industrial activity and no stormwater discharges flowing through them, such as natural or landscaped areas, employee parking lots, and office buildings:

4. Site map

Tip: *Make the site map last, since it includes things you will identify as you write the plan.*

Create and attach a map of the facility at 1:24,000 or larger scale. This means that every inch on the map represents 2,000 feet or less on the ground. An example of a map at 1:24,000 scale is a U.S. Geological Survey topographic map. It may be easier to have more than one map, or a map and a site diagram.

The maps must show:

- ☐ Location of the facility.
- ☐ Impervious surfaces on the property.
- ☐ Storm sewer drains/inlets.
- ☐ Loading dock drains.
- ☐ Directions of stormwater flow indicated by arrows.
- ☐ Non-stormwater discharges. Show all that are identified in Section 9 of this plan.
- ☐ Locations of industrial activities, materials and structural management methods inventoried in Section 6 of this plan.
- ☐ Surface water body that receives the facility's stormwater discharges. If the receiving water is beyond the scale of the map, an arrow in the direction of the water and its name is acceptable instead.
- ☐ Benchmark monitoring locations. Give each one a unique ID, which will be used when submitting sampling data to the MPCA. *For example: BM1, BM2, etc.*
- ☐ If applicable: Effluent monitoring locations. Give each one a unique ID, which will be used when submitting sampling data to the MPCA. *For example: E1, E2, etc.*
- ☐ If applicable: Location of impaired waters that are within a mile of a monitoring location. Include the name of the water body and the reason it is impaired. The list of impaired waters is on the MPCA website at http://www.pca.state.mn.us/lupg1125. Indicate which monitoring locations are within a mile of the impaired waters.
- ☐ If applicable: Name and location of any water body listed in Appendix A of the permit that is within a mile of a sampling location and receives stormwater from the facility (found on the MPCA website at http://www.pca.state.mn.us/enzqa74). Appendix A lists water bodies that are particularly susceptible to pollution, such as trout streams, wetlands, the headwaters of the Mississippi River and Lake Superior.

5. Industry requirements

The industries listed below have extra requirements that must be added to this plan. If this facility's industry isn't listed, there aren't extra requirements.

Definitions for the industrial sectors are in Appendix D (page 148) of the permit (found on the MPCA website at http://www.pca.state.mn.us/enzqa74).

Sector	Description	Permit page
A	Timber Products	30
C	Chemical and Allied Products Manufacturing	35
D	Asphalt Paving and Roofing Materials and Lubricant Manufacturing	39
E	Glass, Clay, Cement, Concrete and Gypsum Products	42
F	Primary Metals	44
G	Metal Mining (Ore Mining and Dressing)	48
H	Coal Mines and Coal Mining-Related Facilities	56
I	Oil and Gas Extraction and Refining	60
J	Mineral Mining and Dressing	63
K	Hazardous Waste Treatment, Storage, or Disposal Facilities	68
L	Landfills and Land Application Sites	74
M	Automobile Salvage Yards	80
N	Scrap Recycling and Waste Recycling Facilities	84
O	Steam Electric Generating Facilities	88
P	Land Transportation and Warehousing	92
Q	Water Transportation	96
R	Ship and Boat Building and Repair Yards	100
S	Air Transportation	104
T	Treatment Works	110
U	Food and Kindred Products	113
V	Textile Mills, Apparel and Other Fabric Products Manufacturing	117
X	Printing and Publishing	121
Y	Rubber, Miscellaneous Plastic Products and Miscellaneous Manufacturing Industries	123
Z	Leather Tanning and Finishing	126
AA	Fabricated Metal Products	128
AB	Transportation Equipment and Industrial or Commercial Machinery	132
AC	Electronic and Electrical Equipment and Components, Photographic and Optical Goods	134
	Definitions of the industries: Appendix D	148

6. Materials and activities inventory and management methods

More information is on pages 11-13 of the permit (found on the MPCA website at http://www.pca.state.mn.us/enzqa74). If flocculants or polymers are added as a stormwater treatment method (this is uncommon), see the permit for additional requirements.

On the next page, list the activities and materials at the facility that could come in contact with rain, snow, snowmelt or runoff. Then explain how contact will be limited or prevented. The things done to accomplish this are referred to as management methods or best management practices (BMPs). This is the heart of the SWPPP. Tips and examples are listed below.

Note: If all stormwater contact can be eliminated, apply for the No Exposure exclusion from the permit.

Tips:

Source of pollution: This can be an activity or a material. Take a walk around the property to see what is exposed to rain, snow, snowmelt or runoff. Common sources of stormwater pollutants include material loading and unloading areas, fuel dispensers, dust from vents or baghouses, old equipment stored outside, dumpsters or compactors and dirty pallets.

Pollutants: Safety Data Sheets (SDS) can be helpful for this.

Management method: Describe how the source of pollution will be protected from rain, snow, snowmelt, or runoff. Ideas for management methods are on the MPCA industrial stormwater webpages at http://www.pca.state.mn.us/enzqa74 and in the MPCA's BMP Guidebook.

Structural or non-structural: Is the management method structural or non-structural? Structural methods are built objects, such as curbs around gas pumps. Non-structural methods are common sense practices, such as storing materials indoors or keeping dumpster lids closed. Implement structural methods within one year of receiving the permit. Start using non-structural methods immediately.

Type: Address each of the following at least once:

- ☐ Good housekeeping. Keep exposed areas clean and debris-free. Pick up around dumpsters and loading docks regularly.
- ☐ Eliminate or reduce exposure. Try to find ways to eliminate exposure to stormwater altogether, such as by moving materials indoors. If exposure can't be eliminated, try to reduce it, such as by keeping dumpsters closed.
- ☐ Management of runoff. Look for ways to divert stormwater away from areas that could contribute pollutants or remove pollutants before the stormwater leaves the property. For example, building a curb uphill of a fueling area so stormwater flows around it rather than through it.
- ☐ Erosion prevention and sediment control. In areas that area easily eroded, such as slopes, garden beds, or gravel parking lots, stabilize the soil and prevent it from being washed off site. Use plants, structures or other means to keep the soil in place.
- ☐ Salt storage piles (if present) must be covered or enclosed.

Examples:

Example 1: Source of pollution: Scrap metal waste stored in dumpster on the loading dock.

Pollutants: *Iron, zinc, cutting oil*

Management method: *Signs are posted to remind everyone to close the dumpster cover tightly after adding scrap, because keeping the cover on keeps rain and snow out. Pat will sweep up debris around the dumpsters weekly to reduce exposure. Pat will also check to make sure dumpsters aren't overfilled.*

Structural or non-structural: *Structural (dumpster covers) and non-structural (cleaning up).*

Type: ☒ Good housekeeping ☒ Eliminates or reduces exposure ☐ Management of runoff
☐ Erosion prevention and sediment control ☐ Salt storage (if present)

Example 2: Source of pollution: Stained, dirty and broken pallets

Pollutants: *Oil, dirt, particles, rust*

Management method: *Move indoors, store in southwest corner of receiving area. Shipping clerk will check loading dock daily to make sure dirty pallets aren't stacked up outside.*

Structural or non-structural: *Non-structural*

Type: ☒ Good housekeeping ☒ Eliminates or reduces exposure ☐ Management of runoff
☐ Erosion prevention and sediment control ☐ Salt storage (if present)

Stormwater management for [facility name]

1. **Source of pollution:**

   Pollutants:

   Management method:

   Structural or non-structural:

   Type: ☐ Good housekeeping ☐ Eliminates or reduces exposure ☐ Management of runoff
   ☐ Erosion prevention and sediment control ☐ Salt storage (if present)

2. **Source of pollution:**

   Pollutants:

   Management method:

   Structural or non-structural:

   Type: ☐ Good housekeeping ☐ Eliminates or reduces exposure ☐ Management of runoff
   ☐ Erosion prevention and sediment control ☐ Salt storage (if present)

3. **Source of pollution:**

   Pollutants:

   Management method:

   Structural or non-structural:

   Type: ☐ Good housekeeping ☐ Eliminates or reduces exposure ☐ Management of runoff
   ☐ Erosion prevention and sediment control ☐ Salt storage (if present)

4. **Source of pollution:**

   Pollutants:

   Management method:

   Structural or non-structural:

   Type: ☐ Good housekeeping ☐ Eliminates or reduces exposure ☐ Management of runoff
   ☐ Erosion prevention and sediment control ☐ Salt storage (if present)

5. **Source of pollution:**

   Pollutants:

   Management method:

   Structural or non-structural:

   Type: ☐ Good housekeeping ☐ Eliminates or reduces exposure ☐ Management of runoff
   ☐ Erosion prevention and sediment control ☐ Salt storage (if present)

6. **Source of pollution:**

   Pollutants:

   Management method:

   Structural or non-structural:

   Type: ☐ Good housekeeping ☐ Eliminates or reduces exposure ☐ Management of runoff
   ☐ Erosion prevention and sediment control ☐ Salt storage (if present)

7. **Source of pollution:**

   Pollutants:

   Management method:

   Structural or non-structural:

   Type: ☐ Good housekeeping ☐ Eliminates or reduces exposure ☐ Management of runoff
   ☐ Erosion prevention and sediment control ☐ Salt storage (if present)

8. **Source of pollution:**

   Pollutants:

   Management method:

   Structural or non-structural:

   Type: ☐ Good housekeeping ☐ Eliminates or reduces exposure ☐ Management of runoff
   ☐ Erosion prevention and sediment control ☐ Salt storage (if present)

Add more if needed.

7. Inspections

More information on page 14 of the permit.

Conduct and document inspections monthly. At least one inspection per year must be done when there is runoff.

Use the inspection forms available on the MPCA website or develop your own inspection forms based on Part III.G of the permit (found on the MPCA website at http://www.pca.state.mn.us/enzqa74).
Attach the inspection forms here or store them with the SWPPP.

8. Maintenance

If monthly inspections find stormwater management methods that aren't working properly, replace or repair them within seven calendar days. If the work cannot be done in seven calendar days, put effective backup methods in place (temporarily or permanently). Record the maintenance done. Explain replacements or repairs that take longer than seven days.

Date of maintenance	Inspector	Summary of maintenance performed
Example: 4/16/15	*Chris L.*	*Dumpster lid was damaged in storm. Large chunk missing and doesn't close properly. Requested a replacement dumpster from hauler. Will be delivered 4/18/15.*

9. Non-stormwater discharges

The permit allows some types of water to be discharged with stormwater even though they aren't stormwater.

List all surface discharges from the property that are anything other than stormwater or snowmelt.

Evaluate whether they are allowed or prohibited. Discharges that the permit allows and prohibits have been reprinted on the next page.

Eliminate prohibited discharges.

Minimize erosion and limit the discharge of dirt and sediment from allowed discharges.

Discharge, source and source location	**Is it allowed or prohibited?**	**How did you determine if it was allowed or prohibited?**	**Action taken**	**Date of evaluation**	**Which monitoring locations were checked for this discharge?**
Example: Air conditioner condensate from rooftop unit on main building.	*Allowed*	*A/C condensate is listed in permit as an allowed discharge.*	*Added a piece of stone under the spout to keep lawn from eroding. Added to monthly inspection list to check and make sure the water is clear.*	*10/1/14*	*All benchmark locations*

Allowed discharges:

- Emergency fire-fighting activities
- Fire hydrant and sprinkler system flushing
- Potable water line flushing
- Uncontaminated condensate from air conditioners, coolers, compressors, or the outside storage of refrigerated gases or liquids
- Landscape watering if all pesticides, herbicides and fertilizers have been applied in accordance with manufacturer's instructions
- Pavement wash water if no detergents are used and there are no spills or leaks of pollutants such as salt, fertilizer, toxic materials, or hazardous materials, or all spilled material has been removed
- Water from washing the outside of a building if no detergents, solvents, or degreasers are used
- Uncontaminated groundwater or spring water
- Foundation or footing drains if water is not contaminated
- Incidental windblown mist from cooling towers that collects on rooftops or adjacent portions of the facility
- Discharges authorized by a separate permit

Prohibited discharges:

- Water from washing commercial equipment or vehicles
- Drainage from floor drains in process areas
- Non-contact cooling water
- Discharges prohibited in the sector-specific requirements of the permit
- Domestic, industrial and process wastewater
- Spills of any substance that may cause water pollution
- Biosolids
- Stormwater discharges from construction activity
- Discharges to impaired waters if the Total Maximum Daily Load (TMDL) report for that water body prohibits discharges
- Discharges prohibited in Minn. R. 7050.0180, subp. 3, 4 and 5. This includes certain discharges to the Boundary Waters Canoe Area Wilderness, Voyageur's National Park, parts of Lake Superior, parts of the Kettle River and the Rum River and Minnesota Department of Natural Resources Scientific and Natural Areas
- Discharges from industrial activity areas that are more than 90 acres in size

10. Spill prevention and response

If this facility already has a spill plan that addresses the requirements listed below, it can be attached here instead of rewriting the procedures.

If this facility stores, transfers, or uses solid or liquid materials that could pollute stormwater, develop a procedure to prevent spills and respond to those that happen. Think especially of materials that are delivered or stored in bulk, such as gasoline, diesel, flour or sand.

Include the following:

- ☐ Which materials could spill
- ☐ Areas where spills could occur
- ☐ How the possibility and impact of spills will be reduced
- ☐ Monitoring locations and surface waters that would be affected by spills
- ☐ Contact information for staff members, emergency agencies, and regulatory agencies
- ☐ Records of spills and quantities

11. Employee training program

Make additional copies of this page for each training event.

For this permit to successfully protect Minnesota's waters, employees need to know what to do and why.

Train the employees who use or update the SWPPP, work with the materials or activities that are exposed to stormwater, do inspections or maintenance of the stormwater management methods and do the stormwater sampling. The topics to cover are listed below.

Train annually, or more frequently if appropriate. How often will stormwater training be conducted?

Attached training documents to this SWPPP.

Trainer:

Trainer's employer:

Topics covered:

- ☐ Purpose of this plan (the SWPPP)
- ☐ What is in this plan (the SWPPP)
- ☐ Use and maintenance of stormwater management methods (BMPs)
- ☐ How to do a monthly inspection
- ☐ How and where samples are taken
- ☐ Other:

Date (month/day/year)	Employee name

12. Mercury minimization

If mercury or mercury-containing devices are exposed to stormwater at this facility, describe the mercury sources or devices and how they will be managed to eliminate exposure to precipitation and stormwater runoff. Use the Mercury Minimization Plan Checklist to do this.

Two sectors have additional requirements. See the permit for details.

Sector M, Automobile Salvage Yards

Sector N, Scrap Recycling and Waste Recycling Facilities

- ☐ No mercury sources or devices exposed to stormwater on site. No mercury minimization required.
- ☐ Mercury present. Mercury Minimization Plan attached.

13. Mobile operations

If this facility has mobile operations, stormwater pollution must be prevented at those locations, too. It isn't necessary to develop an entirely new SWPPP, though. Think of it as a mini-SWPPP. Keep a copy at the location where the mobile operations occur.

Complete new versions of these sections of the SWPPP template with the mobile operations in mind:

- ☐ Section 5. Industry requirements
- ☐ Section 6. Materials and activities inventory
- ☐ Section 7. Inspections
- ☐ Section 8. Maintenance
- ☐ Section 9. Non-stormwater discharges
- ☐ Section 10. Spill prevention and response
- ☐ Section 11. Employee training program
- ☐ Section 12. Mercury minimization

Appendix C Monthly inspection template

Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

Industrial Stormwater Site Inspection Form

NPDES/SDS Industrial Stormwater Permit

Doc Type: Self Audit

Instructions: Use this form to document the inspections required in the Minnesota Pollution Control Agency (MPCA) Industrial Stormwater Permit (MNR050000, Part III.G). Conduct inspections once each calendar month for a total of 12 inspections per year. At least one of the 12 inspections must occur when there is runoff from rain or snowmelt.

Facility information

Facility name: ______________________

Facility address: ______________________

City: ______________ State: ____________ Zip code: ____________

Inspector information

Inspector name: ______________ Date and time: ______________

Weather: ______________________

Inspector has been trained to do inspections: ☐ Yes (required)

Have the following areas been inspected at your facility?

a. Bulk storage areas (tanks, drums, fuels, pallets, etc.) ☐ Yes ☐ No

Describe findings:

____

____

Actions needed:

____

____

b. Waste storage and disposal areas ☐ Yes ☐ No

Describe findings:

____

____

Actions needed:

____

____

c. Maintenance areas ☐ Yes ☐ No

Describe findings:

____

____

Actions needed:

____

____

d. Loading/unloading or shipping/receiving areas ☐ Yes ☐ No

Describe findings:

Actions needed:

e. Raw material, intermediate product, by-product and final product storage areas ☐ Yes ☐ No

Describe findings:

Actions needed:

Evaluate stormwater management methods

Evaluate each of the stormwater management methods (also called Best Management Practices or BMPs) that you developed for your Stormwater Pollution Prevention Plan (SWPPP). If changes or repairs are needed, make them within seven calendar days and record them in your SWPPP. If the work cannot be done in seven calendar days, put backup methods in place.

Management method	Describe changes or repairs needed	Changes and repairs recorded in SWPPP?
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No
		☐ Yes ☐ No

New materials and activities

Describe any materials or activities that are newly exposed to rain, snow, snowmelt, or other runoff since the last inspection. Either move them indoors, or come up with a way to minimize exposure and add it to the management methods section of your Stormwater Pollution Prevention Plan.

New material or activity exposed to stormwater	Choose one:
	☐ Moved indoors ☐ Added to SWPPP
	☐ Moved indoors ☐ Added to SWPPP
	☐ Moved indoors ☐ Added to SWPPP
	☐ Moved indoors ☐ Added to SWPPP

Runoff Inspection

Each year, at least one of your monthly inspections must be done when there is runoff from rain or snowmelt. Visually inspect the runoff for evidence of pollutants. For example, the runoff may have an oily sheen or be rusty, milky, muddy, etc.

Did you conduct a runoff inspection as part of today's inspection? ☐ Yes ☐ No

Runoff was from: ☐ Snowmelt ☐ Rain

Describe the runoff (color, transparency, amount, etc.)

____

____

____

If evidence of pollutants is found, what changes will you make to clean up the runoff, and when will you make the changes?

____

____

____

Oil and grease runoff inspection (if applicable)

Certain industries must do at least two of their 12 monthly inspections when there is runoff from rain or snowmelt, and inspect the runoff for grease or oil sheens. One runoff inspection must be snowmelt.

Does your industry have to do two oil and grease runoff inspections annually? (See *Part VII, Sector-specific requirements* of the permit)	☐ Yes (continue) ☐ No (done with inspection)
Did you conduct a runoff inspection as part of today's inspection?	☐ Yes (continue) ☐ No (done with inspection)
Runoff was from:	☐ Rain ☐ Snowmelt
Was this the first or second runoff inspection for the calendar year?	☐ 1st ☐ 2nd
Was there an oily sheen?	☐ Yes ☐ No
If yes, have you come up with a management method to prevent the oil or grease from contacting stormwater and added it to the management methods section of your SWPPP?	☐ Yes ☐ No

File this completed inspection with your SWPPP.

Appendix D Technical information for structural BMPs

Introduction

The material in this appendix is adapted from "Cost and Pollutant Removal of Stormwater Treatment Practices[1]," and "The Cost and Effectiveness of Stormwater Management Practices[2]".

This appendix contains a cost comparison tool and an effectiveness comparison tool for common stormwater BMPs. The method is based on published, reliable information of construction cost, annual maintenance cost and capture of TSS and total phosphorus for six existing stormwater BMP types. It is assumed that all stormwater BMPs receive regular and sufficient maintenance such that they perform as designed.

Cost estimation

Costs were adjusted to year 2005 dollars; to estimate actual costs, however, cost data should be adjusted to the year in which the proposed stormwater BMP will be constructed using an appropriate adjustment factor[3].

Total construction costs

Values of total construction costs of stormwater BMPs throughout the United States were collected from published literature. Although data were collected on many stormwater BMPs, sufficient data to perform a cost analysis could be found for only dry extended detention basins, wet/retention basins, constructed wetlands, infiltration trenches, bio-retention filters, and sand filters.

Using "regional cost adjustment factors" as reported by the USEPA, all data were adjusted to reflect costs in Rainfall Zone 1 of the United States[4]. Rainfall Zone 1 covers the northeast and north-central United States and includes Maine, New Jersey, Pennsylvania, Michigan, Wisconsin, Iowa, Minnesota and the northern portions of Indiana, Illinois, and Ohio.

The unit construction cost[5] as a function of design water quality volume (m^3) for six stormwater BMP types is shown in Figure 1. The unit construction cost is defined as the total construction cost per cubic meter of Water Quality Volume (WQV). The WQV is typically defined as the runoff volume a stormwater BMP is designed to capture and treat before overflow occurs.

Also shown in Figure 1 is a dashed line representing the average/mean of the data, and solid lines representing the 67% confidence interval of the mean. Assuming a normal probability distribution of statistical uncertainty, two-thirds of the data will be within the 67% confidence interval of the data shown in Figure 1.

The statistical uncertainty can be due to factors such as design parameters, regulation requirements, soil conditions, and other site specific factors. Design parameters affecting the total construction cost include pond side slopes, depth and free board on ponds, total wet pond volume, outlet structures, and retaining walls. Site-specific factors include clearing and grubbing costs and installing fencing around the stormwater BMP. It is therefore important to consider the confidence intervals shown in Figure 1 when estimating construction costs.

Figure 1 can be used to estimate the construction cost of a BMP for any given WQV. For example, the average unit construction cost from Figure 1 with a WQV of 1,000 m^3 is approximately:

- \$60/m^3 for dry ponds
- \$90/m^3 for wet ponds
- \$200/m^3 for infiltration trenches
- \$40/m^3 for wetlands
- \$440/m^3 for bioretention
- \$200/m^3 for sand filters

It is important to also consider the statistical uncertainty in these values, as represented by the solid confidence interval lines shown in Figure 1. For the same WQV of 1,000 m^3, the average unit construction cost above in Figure 1 will vary within the 67% confidence interval for each BMP:

- \$25/m^3 to \$150/m3 for dry ponds
- \$45/m^3 to \$200/m3 for wet ponds
- \$60/m^3 to \$600/m3 for infiltration trenches
- \$20/m^3 to \$100/m3 for wetlands
- \$250/m^3 to \$600/m3 for bioretention
- \$70/m^3 to \$700/m3 for sand filters

The total construction cost can be estimated as the product of the unit construction cost and the WQV (e.g., average = \$60/m^3 for dry ponds X 1,000 m^3 = \$60,000).

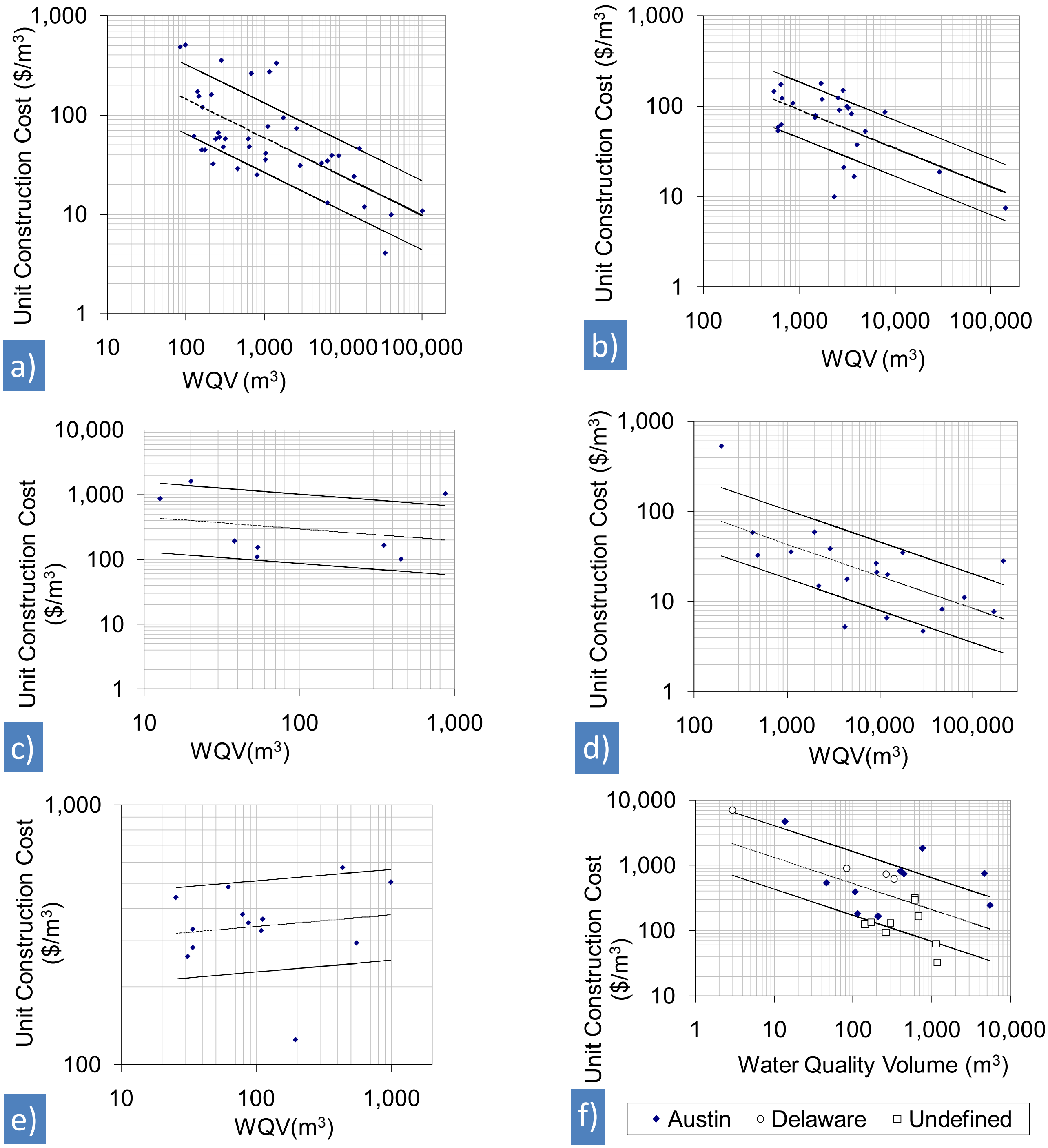


Figure 1 Unit construction costs ($/m^3 of WQV) as a function of water quality volume in 2005 USEPA rainfall zone 1 dollars[6]. (a) dry ponds, (b) wet ponds, (c) infiltration trenches, (d) constructed wetlands, (e) bioretention, and (f) sand filters. Land costs are not included.

With the exception of bioretention practices, all stormwater BMPs exhibit an 'economy of scale' such that practices designed to capture larger volumes of water are cheaper, per volume, than smaller practices. For example:

- The average construction cost of a dry pond that will treat a WQV of 300 m^3 is approximately \$100/ m^3.
- The average construction cost of a dry pond that will treat a WQV of 3,000 m^3 is approximately \$40/ m^3 (Figure 1a).

In this example, the dry pond treats ten times as much water (300 m^3 vs. 3,000 m^3), but only costs four times as much (\$30,000 vs. \$120,000).

Of the data collected for sand filters, some contained information on the type of sand filter (e.g., Austin or Delaware) while other data included no such description. The data suggest that sand filter unit construction costs are independent of the type of filter, and therefore the average and confidence interval calculations are computed for all available data as shown in Figure 1f.

Land area requirements

Land area requirements and associated land costs can vary dramatically for each stormwater BMP. In many cases, land costs can be approximately the same as construction costs for some stormwater BMPs. Land costs can vary significantly within a small area, therefore they must be estimated on a facility-by-facility basis. A guide to typical stormwater BMP land area requirements is presented in Table D-1.

Table D-1 Reported Best Management Practices land area requirements for effective treatment

Best Management Practices	Land area requirement (% of impervious watershed)[7]	Land area requirement (% of watershed)[8]
Bioretention	5	-
Wetland	3 – 5	3 – 5
Wet ponds (retention basins)	2 – 3	2 – 3
Sand filter	0 – 3	2 – 7
Infiltration trench	2 – 3	-
Filter Strips	100	-
Swales	10 – 20	-
Infiltration (basin)	-	2 – 3

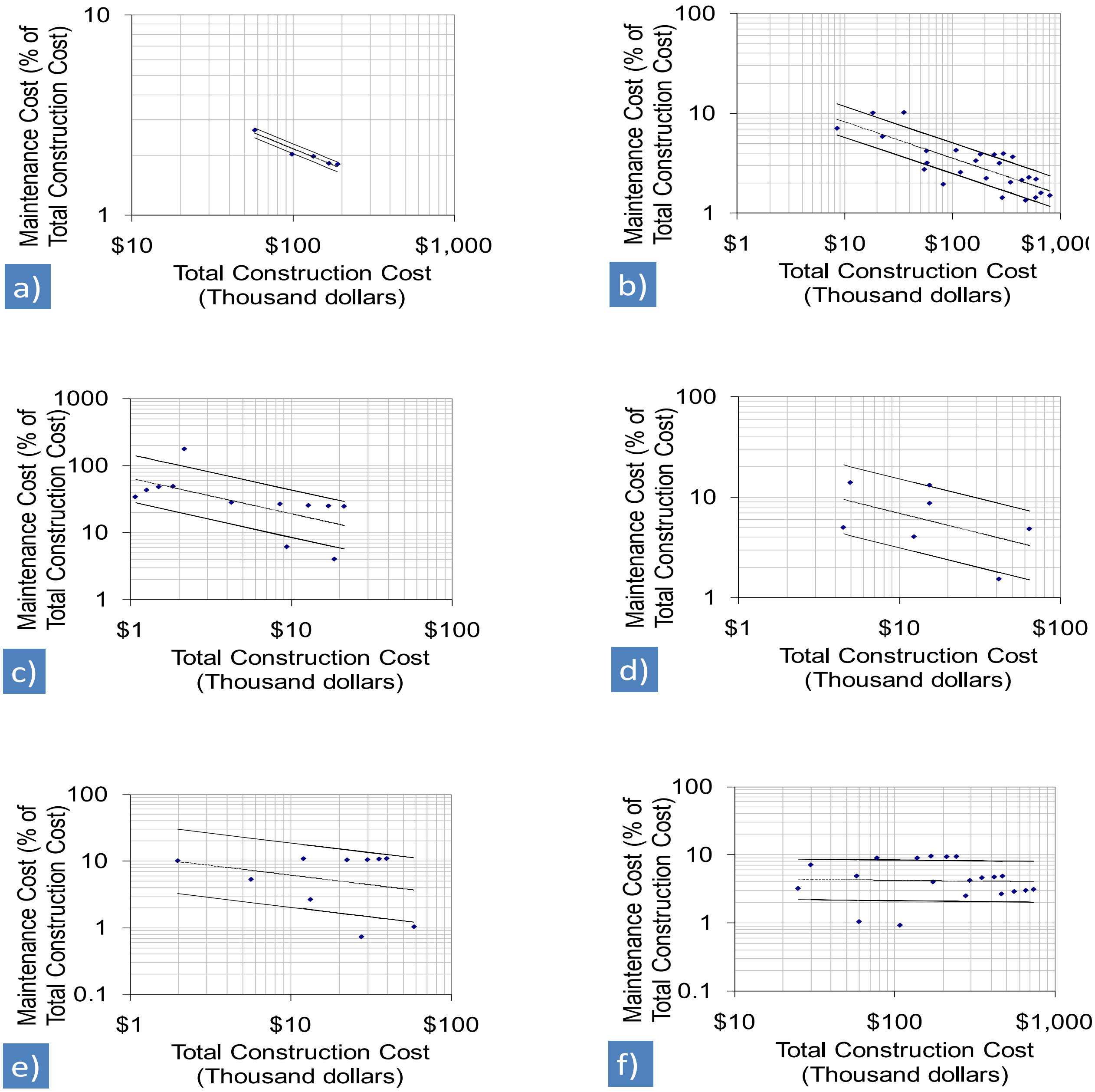


Figure 2 Maintenance cost (percent of total construction cost) as a function of total construction cost in 2005 USEPA rainfall zone 1 dollars[11]. (a) dry ponds, (b) wet ponds, (c) swales, (d) constructed wetlands, (e) bioretention, and (f) sand filters.

Table D-2 Typical annual maintenance cost of Best Management Practices

Best Management Practices	Summary of typical annual maintenance costs (% of construction cost)[9]	Collected cost data: estimated annual maintenance costs (% of construction cost)[10]
Wet ponds (retention basins)	3 – 6%	1.9 – 10.2%
Dry ponds (detention basins)	<1%	1.8 – 2.7%
Constructed wetlands	2%	4 – 14.1%
Infiltration trench	5 – 20%	5.1 – 126%
Infiltration basin	1 – 3%, 5 – 10%	2.8 – 4.9%
Sand filters	11 – 13%	0.9 – 9.5%
Swales	5 – 7%	4.0 – 178%
Bioretention	5 – 7%	0.7 – 10.9%
Filter strips	$320/acre (maintained)	-

Table D-3 Constants for Total Present Cost (TPC) equation and valid WQV range

Best Management Practice	Average total present cost		Upper 67% confidence interval		Lower 67% confidence interval		Water quality volume range (m³)
	$ß_o$	$ß_1$	$ß_o$	$ß_1$	$ß_o$	$ß_1$	
Dry ponds	1,281	0.634	2,024	0.671	1,055	0.585	85 – 101,000
Wet ponds	4,398	0.512	6,119	0.536	3,592	0.484	410 – 215,000
Sand filters	6,153	0.594	13,618	0.596	3,495	0.592	3 – 5,500
Bioretention practices	1,542	0.776	3,838	0.723	897	0.802	26 – 990
Constructed wetlands	1,515	0.565	2,579	0.585	1,076	0.537	200 – 215,000
Infiltration trenches	2,237	0.817	4,039	0.817	1,418	0.817	13 – 870

Maintenance cost

The maintenance costs of a stormwater BMP can be a significant expense that must be considered during selection. Expected annual maintenance costs are shown in Table D-2; estimated annual maintenance costs for many stormwater BMPs are shown in Figure 2.

Similar to Figure 1, the dashed, best-fit line in Figure 2 represents the average (or mean) of the data and the solid lines represents the 67% confidence interval of the mean.

Total present cost

Total present cost is defined as the present worth of a project including the total construction cost and the present worth of 20 years of annual maintenance. Annual maintenance costs are converted to an equivalent present cost using the time value of money and historical values of interest and inflation rates[12]. Total present cost (with 67% confidence interval), excluding land costs, of each stormwater BMP can be described with the equation:

$$TPC = ß_o(WQV)$$

Where: TPC = total present cost[13]; WQV = equation 1 water quality volume (m^3); and ß and $ß_1$ are constants.

Note: *TPC does not include land acquisition costs, costs of any required pretreatment units, design or engineering fees, permit fees, etc.*

Pollutant removal effectiveness

The pollutant removal effectiveness of six stormwater BMP types is summarized in Table D-4[14]. In addition to these removal rates, a method has been developed to estimate the load of TSS captured by six stormwater BMP types over a 20-year span as a function of water quality volume.

Table D-4 Average percent removal rates of best management practice with corresponding confidence interval

Best Management Practices	Total Suspended Solids Removal (%)	67% Confidence Interval
Dry pond	53	+/- 28
Wet pond	65	+/- 32
Constructed wetlands	68	+/- 25
Bioretention practice	85*	+/- 10*
Sand filter	82	+/- 14
Infiltration trench	95*	+/- 5*

To estimate the load captured, multiply the WQV of the chosen stormwater BMP by the load factors provided in Table D-5 for the stormwater BMP type (e.g., dry ponds). See Example Application 1 below.

Table D-5 Load factors for total suspended solids removal as a function of water quality volume

Best Management Practice	Load Factors (kg/WQV)		
	Lower 67% Confidence Interval	Average	Upper 67% Confidence Interval
Dry ponds	9.55	27.49	45.43
Wet ponds	12.73	33.67	54.61
Sand filters	24.85	42.4	59.96
Bioretention practices	26.78	44.19	61.59
Constructed wetlands	16.79	35.27	53.74
Infiltration trenches	30.64	49.39	68.13

Example 1

Several stormwater BMPs are being considered to remove TSS from runoff from a facility on a twenty-acre facility with approximately 100% impervious area in the Minneapolis/St. Paul metropolitan area. The chosen stormwater BMP will be designed to capture all runoff from a rainfall depth of 1.45 inches. Comparison of different stormwater BMP options can be made using the previously discussed tools by following these steps:

1. Determine the WQVm^3 with the equation WQVm^3 = C x P x A x f where:
   - C = a runoff coefficient = 0.05 + (0.009 x % impervious)
   - P = precipitation depth in inches
   - A = contributing watershed area in acres
   - f = conversion to m^3 = 102.8m^3/acre-inch

WQVm^3 = [0.05 + (0.009 x 100)] x (1.45 in) x (20 acre) x (102.8 2. Using the equation constants from part of Table D-3 above, the average total present cost can be estimated: m^3/acre-inch)

WQV m^3 = 0.95 x 1.45 x 20 x 102.8

WQV m^3 = 2832

2. Using the equation constants from part of Table D-3, the average total present cost can be estimated:

Best Management Practice	Total Present Cost[18]		
	Lower 67% Confidence Interval	Average	Upper 67% Confidence Interval
Dry ponds	$110,500	$198,100	$420,100
Wet ponds	$168,600	$257,800	$434,200
Sand filters	$387,100	$692,400	$1,557,000
Bioretention practices	WQV TOO LARGE — OUT OF DATA RANGE		
Constructed wetlands	$77,000	$135,400	$270,200
Infiltration trenches	WQV TOO LARGE — OUT OF DATA RANGE		

Note that the WQV of 2832 m^3 for this site is greater than the applicable range for bioretention practices and infiltration trenches. Therefore the cost of these practices in Table D-3 are not appropriate to use in estimating the total present cost of these practices; more information is needed to determine if these practices are the best choice for facilities as they may be the more cost- effective than other options and should not be excluded from the selection process.

3. Using the percentages from Table D-1 and similar assumptions as the previous example, the land cost of a stormwater BMP can be estimated:

Best Management Practice	Approximate Cost of land needed for stormwater BMP ($)	
	Lower ($20,000 per acre, Minimum Table A-1 values)	Upper ($200,000 per acre, Maximum Table A-1 values)
Dry ponds	$8,000*	$200,000*
Wet ponds	$8,000	$120,000
Sand filters	$8,000	$280,000
Bioretention practices	$8,000	$200,000
Constructed wetlands	$12,000	$200,000
Infiltration trenches	$8,000	$120,000

Optional: In the event none of the best choices for cost coincide with the best choices for total load capture, another comparison criterion may be helpful in choosing the best option. One such criterion is the ratio of total TSS load captured to total cost.

1. To estimate this value, divide the total TSS load captured by the sum of the total present cost and the total land cost.

   For a dry pond capturing approximately 19,500 kg of TSS over 20 years with a total present cost of $82,300 and a total last cost of $50,000:

   19,500 kg / ($82,300 + $50,000) = 19,500 kg/$132,300 = 0.147 kg per dollar

2. Similarly, for each of the other five stormwater BMPs:

   It is apparent that the most efficient stormwater BMP will capture the greatest TSS load at the least expense, and therefore will have the largest ratio of TSS load captured per dollar spent. Using this criterion, the three best (largest ratio) choices are constructed wetlands, wet ponds, and dry ponds.

Best Management Practice	**Total TSS Load Captured (kg) per dollar spent**		
	Lower 67% Confidence Interval	Average	Upper 67% Confidence Interval
Dry ponds	0.069	0.147	0.150
Wet ponds	0.077	0.152	0.164
Sand filters	0.073	0.081	0.057
Bioretention practices	0.085	0.104	0.089
Constructed wetlands	0.137	0.223	0.225
Infiltration trenches	0.066	0.069	0.054

3. Using the load factors from Table D-5, the total TSS load captured by each of the six stormwater BMPs over a 20-year span can be estimated.

Best Management Practice	**Total TSS Load Captured over 20-years (kg)**		
	Lower 67% Confidence Interval	Average	Upper 67% Confidence Interval
Dry ponds	6,900	19,800	32,700
Wet ponds	9,200	24,200	39,300
Sand filters	17,900	30,500	43,200
Bioretention practices	19,300	31,800	44,300
Constructed wetlands	12,100	25,400	38,700
Infiltration trenches	22,100	35,600	49,100

4. From data calculated in steps 2, 3 and 4, the best options are:
   - From Step 2, constructed wetlands, dry ponds, and wet ponds
   - From Step 3, wet ponds and infiltration trenches
   - From Step 4, infiltration trenches, bioretention practices, and sand filters

If none of the best cost choices coincide with the best choices for total load capture, another comparison criterion may be helpful in choosing the best option. One such criterion is the ratio of total TSS load captured to total cost:

Best Management Practice	Total TSS Load Captured (kg) per dollar spent		
	Lower 67% Confidence Interval	Average	Upper 67% Confidence Interval
Dry ponds	0.087	0.196	0.208
Wet ponds	0.125	0.253	0.280
Sand filters	0.106	0.124	0.093
Bioretention practices	WQV TOO LARGE — OUT OF DATA RANGE		
Constructed wetlands	0.172	0.299	0.325
Infiltration trenches	WQV TOO LARGE — OUT OF DATA RANGE		

The most efficient stormwater BMP will capture the greatest TSS load at the least expense, and therefore will have the largest ratio of TSS load captured per dollar spent. Using this criterion, the best (greatest ratio) choices are constructed wetlands, wet ponds, and dry ponds, respectively.

Acknowledgements

The material in this appendix is adapted from "Cost and Pollutant Removal of Stormwater Treatment Practices[16]," and "The Cost and Effectiveness of Stormwater Management Practices[17]." For further information, refer to these documents.

Appendix E Stormwater reduction and re-use

Stormwater reduction and re-use either diverts stormwater from surface outflows, or reuses it on-site. Stormwater reduction and re-use can provide significant benefits to facilities needing additional stormwater control measures to satisfy permit or other requirements.

Checklist of general issues to consider

- Building codes
- Plumbing codes
- Additional local and state regulations
- Concentrated chemicals, pathogens or microbial hazards
- Mosquito control issues (visit www.mmcd.org)
- Maintenance
- Cost

Stormwater runoff reduction

Stormwater runoff reduction can result in lower pollutant loading to receiving waters and less erosion in downstream channels and water bodies. Some stormwater runoff reduction practices, including rain gardens, can also increase aesthetic value and potentially add to property values.

The following techniques can be implemented to reduce stormwater runoff:

- Reduce impervious surfaces by using green roofs, porous pavement, or planned minimal-impact development
- Landscape with rain gardens, infiltration basins and infiltration trenches
- Create swales for conveyance instead of pipes
- Aerate or de-compact lawn areas to promote infiltration

Stormwater re-use

Stormwater re-use is an option with possible benefits including improving surface and groundwater quality, using less potable water and saving money.

NOTE: *Facilities considering stormwater re-use need to discuss this option with their MPCA permit staff to ensure this practice is allowed under the Industrial Stormwater General Permit or requires additional permitting.*

Options for re-using collected stormwater include:

- Car/vehicle wash water
- Storing precipitation or roof runoff in tanks or barrels (cisterns) for industrial processes or landscaping irrigation
- General cleanup wash water
- On-site irrigation of grass and plants
- Cooling tower water
- Boiler feedwater
- Process water

There are many websites and resources to learn more about these types of techniques. Search by each technique or start with the Low Impact Development Urban Design Tools website.

Appendix F Acronyms and definitions

Acronyms

AST Aboveground Storage Tank

BMP Best Management Practice

BOD Biochemical Oxygen Demand

CBOD Carbonaceous Biochemical Oxygen Demand

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act

COD Chemical Oxygen Demand

EPCRA Emergency Planning & Community Right-to-Know Act

HDS Hydrodynamic separators

MDNR Minnesota Department of Natural Resources

MPCA Minnesota Pollution Control Agency

MSGP Multi-Sector General Permit

NPDES National Pollutant Discharge Elimination System (Permits Program)

NRCS Natural Resources Conservation Service

SDS State Disposal System (Permits)

SIC Standard Industrial Classification

SLVS Soil leaching values

SPCC Spill Prevention, Control, and Countermeasure

SRVS Soil Reference Values

WPPP Stormwater Pollution Prevention Plan

TPC Total Present Cost

TSS Total Suspended Solids

USEPA United States Environmental Protection Agency

TMDL Total Maximum Daily Load

UST Underground Storage Tank

VIC Voluntary Investigation and Cleanup

WQV Water Quality Volume

Definitions

Best Management Practices or BMPs: practices to prevent or reduce the pollution of waters of the state, including schedules of activities, prohibitions of practices, and other management practices, and also includes treatment requirements, operating procedures, and practices to control plant site runoff, spillage or leaks, sludge, or waste disposal or drainage from raw material storage[1].

Control measure: refers to any BMP or other method (including effluent limitations) used to prevent or reduce the discharge of pollutants to waters of the state.

Facility: land that shares a common border and that has a stormwater discharge associated with industrial activity as defined by 40 CFR § 122.26(b)(14) with the discharge having a common owner/operator.

Industrial activity: the eleven categories of industrial activity which are directly related to manufacturing, processing, or raw materials storage areas at an industrial plant, as defined in 40 CFR § 122.26(b)(14)(i)-(xi). Not every industrial activity in this definition is eligible for authorization under this permit (e.g., construction activity); see Part I.A for eligibility criteria.[2]

No Exposure: all industrial materials or activities are protected by a storm resistant shelter to prevent exposure to rain, snow, snow melt, or runoff. Industrial materials or activities include, but are not limited to, material handling equipment or activities, industrial machinery, raw materials, intermediate products, by-products, final products, or waste products. Material handling activities include the storage, loading and unloading, transportation, or conveyance of any raw material, intermediate product, final product, or waste product.[3]

Non-Stormwater discharge: any discharge not comprised entirely of stormwater except discharges authorized by a NPDES/SDS permit.

Permittee: a person or persons, firm, or governmental agency or other institution that signs the permit application submitted to the MPCA and is responsible for compliance with the terms and conditions of this permit.

SIC codes: Standard Industrial Classification (SIC) codes are four digit numerical codes assigned by the U.S. government to business establishments to identify the primary business of the establishment. The classification was developed to facilitate the collection, presentation and analysis of data; and to promote uniformity and comparability in the presentation of statistical data collected by various agencies of the federal government, state agencies and private organizations. The classification covers all economic activities: agriculture, forestry, fishing, hunting and trapping;

mining; construction; manufacturing; transportation; communications, electric, gas and sanitary services; wholesale trade; retail trade; finance; insurance and real estate; personal, business, professional, repair, recreation and other services; and public administration.[4]

Significant materials: includes, but is not limited to: raw materials; fuels; materials such as solvents, detergents, and plastic pellets; finished materials such as metallic products; raw materials used in food processing or production; hazardous substances designated under Section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); any chemical the Facility is required to report pursuant to Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA); fertilizers; pesticides; and waste products such as ashes, slag, and sludge that have the potential to be released with stormwater discharges. When determining whether a material is significant, the physical and chemical characteristics of the material should be considered (e.g., the material's solubility, transportability, and toxicity characteristics) to determine the material's pollution potential.[5]

Stormwater: Stormwater runoff, snow melt runoff, and surface runoff and drainage.[6]

Stormwater Pollution Prevention Plan or SWPPP:
A plan for stormwater discharge that includes facility-specific activities and actions to, first, identify sources of pollution or contamination at the facility, and second, select and implement BMPs to eliminate or reduce contact of stormwater with Significant Materials that may result in polluted runoff from the facility.

Appendix G References

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Appendix H Endnotes by chapter

Chapter 1 Introduction Industrial Stormwater Best Management Practices:

1 Minn. R. 7001.1020, subp.5.

Chapter 2 The most common pollutants of concern in industrial stormwater:

1 Meiorin, December 1986; USFWS, 1988

2 Lenntech, Aluminum (Al) and water, http://www.lenntech.com/periodic/water/aluminum/aluninum-and-water.htm

3 Stenstrom et. al, 1984

4 MacKenzie and Hunter, 1979

5 Pitt et al., 1994a

Chapter 3 The stormwater pollution prevention plan (SWPPP):

1 www.pca.state.mn.us/publications/c-er1-03.pdf`

2 www.pca.state.mn.us/publications/c-er1-03.pdf

3 www.pca.state.mn.us/publications/c-er1-03.pdf

4 www.revisor.mn.gov/rules/?id=7035

5 www.pca.state.mn.us/cleanup/vic.html

Chapter 4 No Exposure: The first option for BMPs:

No endnotes cited

Chapter 5 Non-structural BMPs for stormwater management:

No endnotes cited

Chapter 6 Structural BMPs for stormwater management:

1 www.pca.state.mn.us/water/stormwater/stormwater-manual.html

2 NRCS, February 1995

3 www.pca.state.mn.us/water/stormwater/stormwater-manual.html

4 www.pca.state.mn.us/water/stormwater/stormwater-manual.html

5 Pitt, R. E., Wet Detention Ponds, April 29-30, 1998

6 www.pca.state.mn.us/water/stormwater/stormwater-manual.html

7 www.pca.state.mn.us/water/stormwater/stormwater-manual.html

8 www.pca.state.mn.us/water/stormwater/stormwater-manual.html

9 www.pca.state.mn.us/water/stormwater/stormwater-manual.html

10 Hunt and Lord, 2006

11 Gulliver, et. al, 2010. http://stormwaterbook.safl.umn.edu/

12 Erickson, et al., 2009

13 Erickson, et al., 2009

14 Erickson, et al. 2009

15 www.pca.state.mn.us/water/stormwater/stormwater-manual.html

16 Gulliver, et. al, 2010. http://stormwaterbook.safl.umn.edu/

17 www.epa.gov/safewater/uic/class5/types_stormwater.html

18 www.epa.gov/r5water/uic/

19 www.pca.state.mn.us/water/stormwater/stormwater-ms4.html

20 Erickson et al., 2009

21 Erickson et al., 2009

22 USEPA, 1999; Weiss et al., 2007

23 Erickson et al., 2009

24 adapted from Weiss et al., 2009

25 http://oregonstate.edu/cla/polisci/faculty-research/sahr/infcf17742008.pdf

26 adapted from Weiss et al., 2009

27 adapted from Weiss et al., 2007

28 http://oregonstate.edu/cla/polisci/faculty-research/sahr/infcf17742008.pdf

29 Hunt and Lord, 2006

30 www.cwp.org

Chapter 6 Structural BMPs for stormwater management, continued:

31 Gulliver, et. Al, 2010. http://stormwaterbook.safl,umn,edu/

32 Erickson, et al., 2000

33 USEPA, 1999; Weiss et al., 2007

34 adapted from Weiss et al., 2007

35 http://oregonstate.edu/cla/polisci/faculty-research/sahr/infcf17742008.pdf

36 Landphair et al., (2000)

37 www.stormwaterassociation.com

Chapter 7 Facility BMP inspection requirements:

1 www.revisor.mn.gov/statutes/?id=115.061

2 http://www.pca.state.mn.us/index.php/view-document.html?gid=4007

Chapter 8 Cold climate BMPs and extreme weather:

1 www.noaa.gov

2 www.pca.state.mn.us/water/stormwater/stormwater-manual.html

Appendix A SWPPP checklist:

No endnotes cited

Appendix B SWPPP template:

No endnotes cited

Appendix C Monthly inspection template:

No endnotes cited

Appendix D Technical information for structural BMPs:

1 Weiss et al., 2007

2 Weiss et al., 2005

3 http://oregonstate.edu/cla/polisci/faculty-research/sahr/infcf17742008.pdf

4 USEPA, 1999

5 USEPA Rainfall Zone 1, 2005 dollars

6 Weiss et al., 2005, 2007

7 USEPA, 1999

8 Claytor and Schueler, 1996

9 Weiss et al., 2005, 2007

10 USEPA, 1999

11 Weiss, et al., 2005, 2007

12 Ledbetter and Collier, 1998

13 2005 U.S. Rainfall Zone 1 dollars

14 Weiss et al., 2007

15 2005 USEPA Rainfall Zone 1 dollars

16 Weiss et al., 2007

Appendix E Reduction and re-use:

1 Minn. R. 7001.1020, subp.5

2 Minn. R. 7090.0080, subp.6.

3 Minn. R. 7090.0080, subp.9

4 www.siccode.com

5 40 CFR 122.26(b)(12.)

6 Minn. R. 7090.0080, subp.12

Appendix F Acronyms and definitions:

1 Minn. R. 7001.1020, subp.5

2 Minn. R. 7090.0080, subp.6.

3 Minn. R. 7090.0080, subp.9

4 www.siccode.com

5 40 CFR 122.26(b)(12.)

6 Minn. R. 7090.0080, subp.12

Appendix G References:

No endnotes cited

Appendix I Additional resources:

No endnotes cited

Appendix I Additional resources

Best Management Practices for Stormwater Discharges Associated with Industrial Activities
www.deq.state.or.us/wq/Stormwater/docs/nwr/indBMPs.pdf

BMP guidance for various Industrial Activities
www.portlandonline.com/bes/index.cfm?c=43858

Stormwater Photo Gallery
www.pneac.org/Stormwater/PhotoGallery.cfm

Guidance and Submittal Requirements for Rapid Infiltration Basin Wastewater Treatment System
www.pca.state.mn.us/publications/wq-wwtp5-64.pdf

International Stormwater BMP Database
www.BMPdatabase.org/

National Pollutant Removal Performance Database
www.Stormwaterok.net/CWP%20Documents/CWP-07%20Natl%20Pollutant%20Removal%20Perform%20Database.pdf

Recommended Best Management Practices for Stormwater Discharges: Guidance for Eliminating or Reducing Pollutants in Stormwater Discharges Associated With Industrial Activity
www.cleanwaterservices.org/content/documents/Business%20and%20Industry/DEQ%20Stormwater%20BMP%20Guidance.pdf

Stormwater Best Management Practices in an Ultra-Urban Setting: Selection and Monitoring
www.fhwa.dot.gov/environment/ultraurb/

Stormwater Treatment: Assessment and Maintenance
http://stormwaterbook.safl.umn.edu

Suggested Practices to Reduce Zinc Concentrations in Industrial Stormwater Discharges
www.ecy.wa.gov/pubs/0810025.pdf

Virginia Stormwater BMP Clearinghouse
www.vwrrc.vt.edu/swc/BMPSelection.html