BEST MANAGEMENT PRACTICES
FOR
STORM WATER DISCHARGES ASSOCIATED WITH INDUSTRIAL ACTIVITIES

State of Oregon
Department of Environmental Quality

Guidance for Reducing or Eliminating
Pollutants in Storm Water Discharges
Associated with Industrial Activities

DEQ Northwest Region Document

Revised – January 2001

Background: In 1998 a Total Maximum Daily Load (TMDL) was developed and approved by the U.S. Environmental Protection Agency for the Columbia Slough. This TMDL indicated that additional and more effective environmental pollution prevention practices were required to meet water quality standards and the basin beneficial uses criteria and that more commercial and industrial businesses would be required to participate in the permitting process in order to achieve water quality standards and restore those beneficial uses within the Slough. This lead to the development of the Best Management Practices (BMPs) addressed in this document and the concept of treating the potential point sources that may contribute to the non-point storm water discharges.

Best Management Practices: BMPs are practices or procedures that include methods to prevent toxic and hazardous substances from reaching receiving waters. They are designed to address the quality of a facility's practices with respect to storm water leaving the site, and may ultimately affect the ability of the facility to meet environmental control standards or benchmarks. They are most effective when organized into a comprehensive Storm Water Pollution Control Plan. Many different practices can be used to achieve similar environmentally protective results. With facility-specific or activity-specific pollutant(s) of concern as the major consideration(s) in selecting appropriate BMPs, this flexibility allows a facility to tailor a Storm Water Pollution Control Plan to meet its needs using the capabilities and resources available.

The BMPs included in this document, for the most part, address activities and operations that take place outdoors or have a direct impact on the areas outside of the buildings. These BMPs are to be considered a work-in-process and are by no means to be considered a complete list of appropriate pollution control measures. Additional BMPs will be added periodically to this document.

Contributing Agencies: Assistance in developing these BMPs was provided by the Columbia Slough Technical Advisory Committee. This document was compiled by Dennis Jurries, Environmental Engineer with the Department of Environmental Quality, and formatted by Carolyn Sharp, an intern also with DEQ.

Best Usage: The best way to use this guide is to assess your site and your storm water discharge(s). Determine the pollutants in the storm water discharge(s) and the potential sources of those pollutants on site, then determine which potential sources have the most significant impact on the discharge(s). Select BMP(s) that will be most effective in controlling pollution in the storm water discharges for the resources and costs that will be required to implement those BMPs. Implement the BMPs selected and sample the storm water discharges to check the results of the BMP implementation and determine if more BMPs will be required in order to meet the benchmarks for the various pollutants of concern.

Caution: The efficiencies provided in this document should be used as indicators of the potential effects the implementation of any particular BMP may provide. The efficiencies can be variable depending on a number of factors including flow, maintenance of BMP, loading, and other factors.

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BMP Selection Table			
Pollutant	**Activity**	**BMP Nº**	**Page Nº**
Heavy Metals, BOD_5, Bacteria, Fungicides Oil, Corrosion Inhibitors, Emulsifiers, Biocides, pH	Mechanical metal removal	CS1	1
Oily air emissions, Metal Particles, Gaseous Metal, Vaporized Flux	Cutting and welding of metal	CS2	2
Oil, Hydraulic Fluid, Antifreeze, Paint, Solvent, Cleaners, Petroleum Hydrocarbons, Toluene, Ethylene Glycol	Oil (& Other Fluids) Dispensing & Outside Storage	CS3	3
Oils, Diesel, Gasoline(Petroleum Hydrocarbons), Antifreeze(Ethylene Glycol), and Solvents(Toluene, Mineral Oil)	Storage of liquids in bulk containers or tanks.	CS4	5
Zinc	Galvanized corrugated sheet metal roof and/or outside walls on buildings	CS5	6
Petroleum Hydrocarbons	Parts & equipment cleaning in Parts Cleaners containing mineral spirits/oil or petroleum products	CS6	6
Grease (Petroleum Hydrocarbons with heavy metal additives)	Vehicle maintenance, equipment maintenance, involving grease	CS7	7
Degreasers, Soap, Heavy Metals, Oil, Grease	Pressure washing/steam cleaning of equipment and/or vehicles.	CS8	8
Oil, Grease, Suspended Solids	Steel, equipment, or vehicles stored outside	CS9	15
Oil	Use of compressed air at the site.	CS10	16
Oil & Grease, Suspended Solids	Retrofiting standard catch basins and drains with sediment and oil retention catch basins	CS11	17
Metal Fines, Suspended Solids	Arc furnace or mechanical removal operations creating dust that is collected in baghouses.	CS12	18
Biocides, Algaecides, Fungicides, Corrosion Inhibitors(BOD_5, COD), Suspended Solids, Zinc, Copper, pH	The use of cooling towers with the associated water treatment chemicals & blowdown discharges.	CS13	19
Copper, Zinc, Total Suspended Solids	Exposed copper/galvanized piping, galvanized siding /roofing, or exposed copper, brass, or zinc coated materials exposed to storm water, heavy vehicle traffic.	CS14	20

BMP Selection Table			
Pollutant	**Activity**	**BMP Nº**	**Page Nº**
Total Suspended Solids, Copper, Zinc	Exposed copper/galvanized piping, galvanized siding/roofing, other copper, brass, and/or zinc coated materials exposed; heavy vehicle traffic; particulate discharge from vehicular traffic.	CS15	22
Oils, Suspended Solids, Heavy Metals, Organics	Disposal of waste water from street and floor scrubbing	CS16	24
Lead, Nickel, Cadmium, Sulfuric Acid	Replacement or storage of lead/acid or nickel/cadmium batteries or long time storage of vehicles or powered equipment outside.	CS17	24
Antifreeze (ethylene glycol), gasoline, oil, grease, brake fluid, diesel	Wrecked or damaged vehicle storage.	CS18	25
Hazardous stripping chemicals, lead from old lead based paints, zinc chromate from old paint preparations, metal particulate, low pH, and increased suspended solids	Stripping metal or wood surfaces outdoors.	CS19	26
Asbestos, Copper, Total Suspended Solids	Vehicle repair/brake shoe replacement.	CS20	27
Any and all	Employee environmental education and training.	CS21	28
Total Suspended Solids	Any site that stores material outside.	CS22	29
Fertilizers, Pesticides, Herbicides, Fungicides, Phosphorus, Nitrogen, Zinc, Copper, pH	Facilities with lawns or vegetated areas.	CS23	31
Suspended Solids, Nutrients, Bacteria, Dioxin, Chemicals	Storage of general rubbish or food rubbish outside in dumpsters.	CS24	35
Petroleum Hydrocarbons, Antifreeze, Other Potentially Toxic or Hazardous Liquids	Pumping liquids from storage tanks into site buildings or into vehicles.	CS25	33
Oil and Grease	Trucking firms or other operations where semi-trailers are parked on site and dollies are used to attach to the trailers to move the trailers around the site or operations in which fifth wheel tractors are used on site.	CS26	36
Gasoline and Diesel Fuels (Petroleum Hydrocarbons)	Fueling operations performed by employees on-site or through restricted access systems such as Cardlock sites.	CS27	37
Sediment(TSS), Metals, BOD, Phosphorus, Hydrocarbons(Oil & Grease)	Vegetated filter (buffer).	CS28	38
Sediment(TSS), Metals, BOD, Phosphorus, Hydrocarbons(Oil & Grease)	Catch Basin Filter System.	CS29	39
Sediment(TSS), Metals, BOD, Phosphorus, Hydrocarbons(Oil & Grease)	Constructed Wetland.	CS30	41

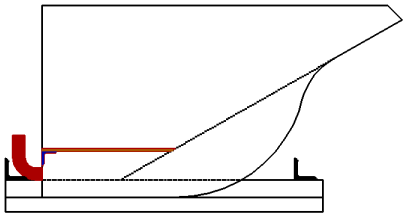
BMP Selection Table			
Pollutant	**Activity**	**BMP Nº**	**Page Nº**
Sediment(TSS), Metals, BOD, Phosphorus, Hydrocarbons(Oil & Grease)	Grassy Bioswale.	CS31	44
Heavy Metals	Sand Filter.	CS32	45
Sediment(TSS), Metals, BOD, Phosphorus, Hydrocarbons(Oil & Grease)	Storm Treat System.	CS33	47
Sediment(TSS), Metals, BOD, Phosphorus, Hydrocarbons(Oil & Grease)	Multi-Chambered Treatment Train (MCTT).	CS34	48
Sediment(TSS), Metals, BOD, Phosphorus, Hydrocarbons(Oil & Grease)	Flocculation System.	CS35	50
TSS and Heavy Metals	ElectroFloc..	CS36	54

BMP Nº CS1 (Reference #2 &7)

Activity: Mechanical metal removal through the use of high-speed equipment and the associated discharge of metal fines in the form of swarf, grindings, chips, etc.

Typical Pollutants: Heavy metals, i.e. chromium, copper, manganese, lead, zinc; Dissolved Oxygen consuming organisms, i.e. bacteria, fungi; Chemicals in the coolant, i.e. corrosion inhibitors, emulsifiers, biocides, and etc.; Tramp oil; and Decreased pH

Typical Problem: Swarf and turnings are discharged into a hopper along with varying amounts of coolant and tramp oil. The hopper is transported outside and dumped into a dumpster or special portable scrap bin supplied by a scrap dealer. Typically the outside bin or dumpster is not liquid proof nor is it covered. The coolants, metal fines, and tramp oil leak out of the outside bin or are spilled in the process of loading onto a transport vehicle. Quite often the discharge continues as the truck carries the scrap down the highway.



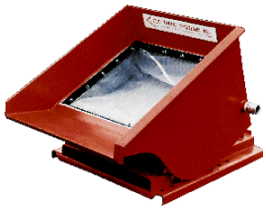
BMP: Locating the outside scrap bin on a concrete pad that drains into a dead-end containment sump and is bermed to prevent storm water run-on may resolve the potential source providing that the sump is emptied periodically. The sump should either be double contained or be coated on the inside with a flexible epoxy to minimize any seepage from any small cracks that may develop in the concrete sump.

Another approach that works is to modify the scrap hopper located at the metal removing machinery for coolant/oil separation from the swarf while the coolant/oil is warm and less viscous. This approach would minimize or eliminate leakage outdoors by removing most of the potential contaminants at the source.
A removable plate, either solid or with small perforations, either screened or unscreened,

can be added to the bottom of the swarf/chip hopper. This creates a sump for the coolant and oils to drain into while the liquid is very hot and thus less viscous. A piping connection should be made into the lower chamber sized to fit the hose end on your sump sucker. If holes are made in the bottom plate, the number of holes will be determined with experimentation. They should be sufficient to provide the air draw of the sump sucker and should be located to encourage the best flow out of the lower chamber when the liquid is sucked out.

Coolant should be of the synthetic type and should be recycled on site. Small package recycling units are available from several manufacturers.

A few manufacturers will modify existing hoppers or sell new hoppers that have a filtering screen and filter material separating the scrap from the liquid chamber.



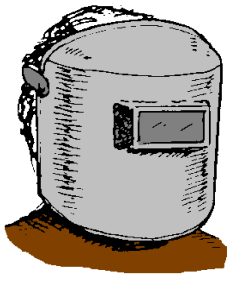
Two commercially available bins with built in screening.

As the scrap bins are moved outside, pause at the outside door where someone should use a sump sucker to draw the liquid/fines out of the lower chamber for either proper disposal or recycling of the coolant.

Efficiency/Impact: Virtually all liquid and metal fines from this activity are eliminated by implementation of this BMP provided the outside scrap dumpster/bin is covered when scrap from inside bins are not being discharged in to it. This point source should no longer be a significant contributor of pollutants to the storm water discharge.

BMP Nº CS2

Activity: Metal cutting with gas burners, oxygen/acetylene torches, and welding of metal with stick, wire, or gas welders.



Typical Pollutants: Oily air emissions;
Metal particles;
Gaseous metal; and
Vaporized flux

Typical Problem: The fume from the metal cutting/welding operation is

exhausted to the outside where it comes in contact with rain and precipitates out into the storm water. Indoor air quality is also of concern.

BMP: Welding creates an oily soot type smoke. The amount of smoke produced from the welding process can be estimated using the table below.

Fume Ratio:

MIG (Wire Feed)	**0.005-0.01 lb. of smoke/lb. of rod**
TIG	**0.004 lb. of smoke/lb. of rod**
Oxy-acetylene torch	**0.004 lb. of smoke/lb. of rod**
Stick	**0.015 lb. of smoke/lb. of rod**
Flux core	**0.02 lb. of smoke/lb. of rod**

This fume has products that can be very small, submicron in size. There are two methods to control this fume. If it is properly maintained, the use of a self-washing electrostatic precipitator mounted near the room ceiling is the most efficient and cost effective. Air extraction units with HEPA and charcoal filters can also be used.

Efficiency/Impact: Implementation of one of these BMPs will mostly eliminate this source of pollutants, not only to storm water but also to air, and significantly improve indoor air quality. As an added benefit, if the air inside of a building is heated, it may be possible to recycle the air and provide a significant energy cost savings in the winter months. This point source should no longer be a significant contributor to the storm water discharge concerns.

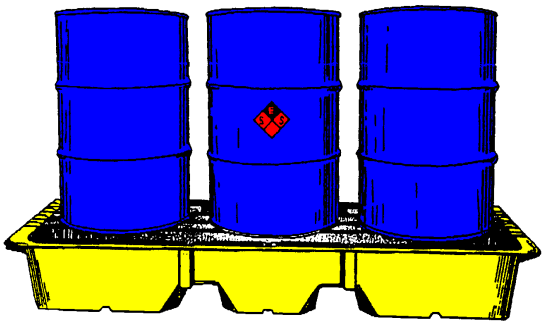
BMP N^{o} CS3 (Reverence # 43 & 44)

Activity: Oil (& other fluids) dispensing and outside storage

Typical Pollutants: Oil, hydraulic fluid, antifreeze, paint, solvent, cleaners, etc.
i.e. petroleum hydrocarbons, toluene, ethylene glycol, etc.

Typical Problem: Drums, pails, and small containers of liquids are stored outside in unbermed, noncontained areas, which through expansion and contraction of the container, can damage the container, or the container bungs casing leaks, or filling/dispensing operations can discharge pollutants to the ground in the vicinity. Rain and snow contact this material and transport it off site or into the ground water.

Dispensing oil, antifreeze, and other potentially hazardous liquids usually results in spills and leaks around the dispensing area. This leaked liquid can be tracked to other locations, or can seep through cracks and floor joints into the soil and groundwater beneath the floor. Rain and snow melt transport these pollutants off site. Containment pallets made from steel or plastic will contain the liquid.



For large numbers of drums a portable containment building will keep containers protected from the elements and provide containment in the event of leaks.

Oil & Flammable Storage:

Outdoor storage of oil and flammable liquids such as paint, usually results in leakage and spillage of the liquids into the environment. The purchase and placing of portable metal storage buildings with built-in containment reduces this risk and better protects the liquid containers from damage and possible contamination. Environmental controls, i.e. heating and air conditioning, and fire protection are usually available in these preconstructed units.

Efficiency/Impact: The use of containment pallets or portable containment/storage buildings will greatly reduce or eliminate storm water contamination from these sources. Some risk of contamination will still exist from the material handling activities associated with moving containers of these liquids to and from the pallets or storage buildings.

BMP N^{o} CS4

Activity: Storage of liquids in bulk containers or tanks.

Typical Pollutants: Oils, diesel, gasoline (petroleum hydrocarbons); antifreeze (ethylene glycol); and solvents (toluene, mineral oil)

Typical Problem: Leakage or spillage occurs around tanks from filling, dispensing, deterioration of pipe connections or failure of secondary containment

BMP: Bulk storage tanks should have secondary containment in the form of a curbed enclosure with a liner to prevent migration of the liquids through the enclosure walls and floor. The liner can be in the form of a compatible flexible epoxy or a liner membrane compatible with the fluids being contained. If a roof is not provided to keep out rain and snow, then the volume of the enclosure should be 110% of the volume of the largest bulk tank inside of the enclosure. Fill locations should have drip trays that drain into a drum or other container. Dispensing areas should have

their own containment. When dispensing into secondary containers, the containment should drain into a drum or other container. Hoses on dispensing stations should not be able to extend beyond the containment area. For dispensing area containment, the volume of the containment area should be equal to the tank being dispensed from. Dispensing areas should be under roof or some other protection from storm water. Caution should be used to ensure that incompatible materials are not contained within the same enclosure.

Double-walled, aboveground storage tanks maybe used instead of single walled storage tanks with containment structures. Filling and dispensing areas associated with double-walled tanks should have containment and protection from storm water.

Efficiency/Impact: Implementation of this BMP will reduce the risk of exposure to storm water of the contaminants associated with the delivery, dispensing, and storage of the materials in bulk tanks.

BMP Nº CS5

Activity: Runoff from buildings with corrugated galvanized sheet metal roofs and/or siding.

Typical Pollutants: Zinc

Typical Problem: As the sheet metal ages zinc from the galvanized coating is released to storm water runoff.

BMP: Avoid using galvanized sheeting on new construction. Clean and paint the exposed galvanized sheet with a good enamel paint. Be sure to contain and collect any liquids used in cleaning for proper disposal. Instigate a regular inspection and maintenance program concerning the building painting.

Efficiency/Impact: With proper maintenance of the painted surface the zinc runoff can be decreased from this source to the non-detect level.

BMP Nº CS6 (Reference #14 & 42)

Activity: Cleaning of parts and equipment in Parts Cleaners containing mineral spirits/oil or petroleum products.

Typical Pollutants: Petroleum hydrocarbons

Typical Problem: The use of petroleum based cleaners leads to the requirement for either storage of the spent cleaner or recycling companies periodically removing old cleaner solution/sludge and adding new solution. This results in spent cleaner storage on site and/or frequent handling of both the clean and contaminated cleaner. This increases the risk of spills and leakage getting into storm water. The spent cleaning solution/sludge must be treated as a

hazardous waste and be properly handled and disposed.

BMP: Large parts and frames are generally cleaned in a shot blast machine. Smaller parts should be cleaned in an aqueous based solution (caustic or other) or in a biological solution. These units typically are heated and may involve agitation. Parts cleaners other than these typically have a sludge residue or the solution has to be replaced periodically. The sludge or removed solution is usually considered a hazardous waste somewhere in its cycle. The sludge from an aqueous based or biological parts washer is not typically hazardous and solutions are only added, never removed. The SmartWasher shown to the right is an example of a biological unit.

Efficiency/Impact: Use of water based or biological parts cleaning solutions could potentially result in no hazardous waste generation, improved health for employees, and overall cost savings in material, labor, and waste disposal. Generally, cleaning with these solutions takes employee involvement in the acceptance of the use of the material and usually takes a little bit longer to perform the cleaning operation.

BMP Nº CS7

Activity: Vehicle maintenance, equipment maintenance, and construction involving the addition of grease to joints, couplings, bearings, etc.

Typical Pollutants: Grease (Petroleum Hydrocarbons with heavy metal additives)

Typical Problem: Grease containers when emptied still contain fair amounts of grease residue in them. Should water mix with this grease, potential adverse impact to the environment in the form of oil/water spillage may occur.

BMP: Some suppliers provide returnable containers (bulk) that, when sealed after use, minimize the potential adverse impact. Another environment friendly option is a container that is lined. After emptying, the liners can be removed and more of the grease squeezed out. The liners can then be placed in a drum for accumulation and properly disposed.

Efficiency/Impact: An increase in the amount of grease available at very little increase in labor cost will result from implementation of this BMP. If the lined containers are used, properly accumulated and disposed of after use or bulk returnable containers are used, very little risk of environmental

contamination through storm water discharges will be present from this source.

BMP Nº CS8 (Reference #14, 50, & 51)

Activity: Pressure washing or steam cleaning of equipment and/or vehicles. Equipment includes forklifts, backhoes, graders, tractors, and similar commercial implements. Equipment does not include motors, engines, generators, compressors, and similar commercial machinery.

Typical Pollutants: Degreasers, soap, heavy metals, oil and grease

Typical Problem: When equipment and/or vehicles are washed outside, contaminants in the washwater and the overspray mix with the storm water runoff.

BMP: Normally wash areas should be located on well-constructed and maintained, impervious surfaces with drains piped to the sanitary sewer. The wash area should extend at least 4 feet in every direction from the perimeter of the vehicle or equipment being washed. When sanitary sewer is not available there are several different approaches to this concern that can be taken depending on the size of the site and the resources available, such as:

- discharging the storm water to a properly sized grassy swale,
- discharging the washwater and storm water to a collection sump for later disposal,
- discharging the storm water through an oil/water separator,
- relocating the washing operations to a commercial washing facility, and/or
- discharging the storm water to a constructed wetland.

Selection of the cleaning detergent to be used is critical to good oil/water separation and retention in control devices. Ensure that the detergents used do not emulsify oils as this would allow the oils and grease to flow though the oil/water separator instead of being separated from the effluent. The detergent should be a low sudsing, low phosphate,

biodegradable type. Design the cleaning area with walls to keep the dirty overspray from leaving the wash area. Place an oil/water interceptor or separator in the wash area's drain to separate out the oil and grease before the effluent is sent to the sanitary sewer. Should sanitary sewer not be available, discharge should be through an oil/water separator into a bioswale or pond and thus to storm water conveyances provided a permit is applied for and granted. Should the site not be large enough for a bioswale or pond, collection of the washwater can be made by using a portable containment enclosure. The wastewater can then be extracted and placed in a suitable holding tank for later oil/water separation and discharge into a sanitary sewer, or other disposal method such as collection and transportation or the waste to a sewage treatment plant. Discharge of wash water and pad rinse water may require a vehicle wash water discharge permit from DEQ. Typically the discharge of washwater from washing activities is not allowed to the Slough. Pressure washing without chemical usage and with treatment BMPs may be eligible for a permit.

Washing systems are available that will recycle the washwater for reuse in washing operations.

General BMPs for Vehicle and Equipment Washing Activities - Site and Activity Conditions

1. Vehicle/equipment washing that occurs on an impermeable surface (i.e. concrete, plastic, or other) should utilize an impervious area which extends to minimum of four (4) feet on all sides of the vehicle/equipment to trap all overspray. Washing areas should be properly graded so that all washwater can be collected from the impermeable surface.

2. Impervious surfaces used for cleaning operations should be marked to indicate the boundaries of the washing area and the area draining to the designated collection point; exceptions include wash areas covered by a roof or wash areas that use portable impervious material with boom collection.

3. Vehicles should not be washed near uncovered repair areas or chemical storage facilities such that chemicals could be transported in washwater runoff. All washwater runoff

should be drained away from a shop area or chemical storage facility.

4. For washing operations that use detergents, soaps, cleaners, hot water or steam, and other chemicals, the washwater should be collected in a manner which prevents the mixture or wash-down of pollutants with storm water runoff. Preventative measures may include:
    a) designating a wash area in an area under a roof,
    b) in open areas, draining to a dead-end sump or grit trap and pump or siphon washwater to sanitary sewer, recycling equipment, or treatment equipment,
    c) a catch basin may be used as a sump provided a positive control valve can close the outlet to the storm drainage system while washing occurs,
    d) as a temporary condition, an existing catch basin may be used as a sump provided the outlet pipe is sealed by a plug (plumber's balloon) to prevent washwater from entering the storm drainage system, or
    e) collecting washwater with a portable vacuum recovery unit.

5. For washing operations that use detergents, soaps, cleaners, hot water or steam, and other chemicals that drain to a catch basin with separate outlets to storm and sanitary sewer, the basin should contain a positive control valve. The positive control valve is open during washing so that washwater discharges to sanitary sewer, and closed during non-washing periods so that storm water runoff discharges to storm sewer. The designated wash area should be thoroughly rinsed after washing activities.

6. At all permanent washwater facilities and catch basins with a valved sanitary sewer outlet, the owner should post a "warning" to customers, employees and others not to dump vehicle fluids, pesticides, herbicides, solvents, fertilizers, organic chemicals, or toxic chemicals; a sign or stenciled note on pavement next to the grit trap or catch basin should be in a visible location and maintained for readability.

7. Washing operations at train yards that use detergents, soaps, cleaners, hot water, steam, solvents, or other chemicals should occur in common area such that all washwater is collected, treated, and discharged properly as approved of in writing by DEQ. Wash areas in train yards should employ an impermeable surface to collect washwater. The impermeable surface may be a concrete pad or a double-lined geotextile material under the railroad ballast. The wash area should be properly graded to direct washwater into a grit trap.

8. All parking lots/stalls of dealerships, vehicle rental agencies, and government/company fleets that wash exterior vehicle surfaces with cold water should furnish or retrofit catch basins with sediment traps and an inverted elbow outlet to trap floating oil. Design guidelines for this type of catch basin are described in Section 4.4 of the Oregon DEQ washing document. Catch basins should be cleaned of solids and oil when the basin becomes 30% full with solids, or at least once a year. Catch basins should be cleaned during dry weather to prevent discharge of pollutants into the storm sewer. Solids and oil must be disposed of in a manner that complies with all State administrative rules.

9. Paved areas where washing will occur (i.e., roads, parking lots, driveways, sidewalks,

and other surfaces) should be cleaned of excessive debris. If excessive debris lies on the pavement surface, the surface should be dry swept or blown and debris collected and disposed of properly.

10. In washing operations involving the washing of buildings and pavement areas and that use detergents, soaps, or cleaners, the washwater should be collected and discharged to sanitary sewer or a treatment system, or discharged to the ground surface provided a minimum buffer of 20 feet exists to the nearest surface water or pavement area that drains directly to storm sewer. A buffer should consist of vegetated ground with a relatively level slope, and soil with adequate permeability to prevent runoff.

11. Washing exterior surfaces of buildings with water only may drain to a catch basin with sediment trap and inverted elbow outlet. Catch basins should be cleaned of solids and oil when the basin becomes 30% full with solids, or at least once a year. Catch basins should be cleaned during dry-weather to prevent discharge of pollutants into the storm sewer. Solids and oil must be disposed of in a manner that complies with all State administrative rules.

12. Wash down of construction vehicles and equipment should prevent soil erosion and runoff from the construction rite. Silt ponds may be used to control erosion.

13. Cleaning operations should be modified to minimize paint residues (chips), heavy metals, or any other potentially hazardous materials that detach from surfaces. Modifications may include a change of cleaning agent or reduction in water pressure. Detached metals should not enter storm sewers or surface waters.

14. The use of acids and/or solvents as cleaning agents for building exteriors and pavement areas should be avoided if possible. Dry or semi-dry methods may be used to clean these surfaces (i.e., sand or other particle blasting, grind-off and vacuum technology, and ice blast technology). If blasting is used as an alternative, all solids should be swept or vacuumed and disposed of properly.

15. For washing operations on painted or metal surfaces, detergents should not possess abrasive properties. Cleaned surfaces should not leave paint residues (chips) or detach heavy metals such that these particles can enter storm sewers or surface waters.

16. Detergents and soaps used in washing activities should be phosphate-free and possess the ability to rapidly biodegrade.

17. At all designated washing areas, spill prevention, control, and management should be planned and designed to prevent any spills of pollutants from entering a publicly- or privately-owned treatment works or surface waters.

18. A chemical management plan should be implemented for cleaning operations that utilize metal brighteners, caustics/acids, halogenated hydrocarbons, or solvents; the plan should include as a minimum:

a) lists of chemicals used,
b) the method of disposal used, such as reclamation or contract hauling, and
c) procedures for assuring that *toxic* chemicals are not discharged into the waters of the State.

Sanitary Sewer Discharge

19. Prior to disposal of washwater to sanitary sewer, minimum pretreatment requirements must be met as required by the local Sewer Authority. Pretreatment may consist of grit removal, followed by free oil removal. Solids can be removed by a grit trap and/or a properly-sized detention tank. Free oil can be removed by a coalescing-type oil/water separator or comparable treatment unit. Grit traps used for pretreatment should be inspected daily. Sludge, grit, and other solids in a grit trap and/or detention tank should be removed by a certified waste hauler and disposed of in a manner that complies with all State administrative rules. Design guidelines for such treatment are described in Section 4.4 of the Oregon DEQ washing document.

20. Pretreatment units should be operated and maintained in accordance with manufacturer specifications and as required by the local Sewer Authority.

Recycling Treatment

21. Recycling treatment equipment should be properly operated and maintained to achieve compliance with all conditions of the permit. Backwash water or concentrate water should be properly discharged to sanitary sewer. Liquid concentrate discharged to the sanitary sewer should meet all pretreatment standards and other requirements of the local Sewer Authority. Solids, grit, or sludge should be disposed in a manner that complies with State administrative rules.

Equipment Treatment - Discharge to Surface Waters, Ground Surface, or Vegetated Swale

22. For cleaning operations that use metal brighteners, caustics/acids, halogenated hydrocarbons, or solvents, washwater should be treated and effluent disposed of either by no discharge methods or by discharge to surface waters not exceeding permit limitations. Treatment may consist of a combination of various process units (e.g., a grit trap can be used to remove suspended solids, an oil/water separator can be used to remove floating oil, a pH adjustment unit can be used to neutralize acids or caustics, an air stripper can be used to remove volatile organics, a dissolved air flotation unit can be used to remove fine solids, polymer chemical mixing and flocculation units, and a sand filtration unit can be used to remove dissolved solids and metals, an ultrafiltration unit can be used to remove solids, a carbon column can be used to remove organics and metals, and a reverse osmosis unit can be used to remove metals).

23. For cleaning operations that use detergents, soaps, cleaners, hot-water, or steam, washwater should be treated and effluent disposed of either by no discharge methods or by discharge to surface waters not exceeding permit limitations.

The following treatment alternatives may be developed:

24a. Washwater may be treated with, in sequence, a grit trap, an oil/water separator, a dosing tank with siphons or pumps, and a multi-media filter bed with underdrains. Discharge from underdrains must meet effluent limitations set forth by the DEQ. Design guidelines for the treatment system units are described in Section 4.4 of the Oregon DEQ washing document. Maintenance of a multi-media filter should consist of cleaning, removing the top inch of sand once every six months; when the total depth of filter sand fall below 18-inches, the sand should be replaced; if clogging and/or short circuiting occurs as observed by uneven infiltration in the filter or formation of surface cracks, the sand should be replaced.

24b. Washwater may be treated with adequately-sized units of grit trap and oil-water separator, or comparable units such as a water quality inlet to remove sediments and floating oils; pH adjustment may be needed as additional treatment. Effluent may be applied on vegetated land by irrigation equipment. Design guidelines for the grit trap and coalescing oil/water separator, and water quality inlet are described in Section 4.4 of the Oregon DEQ washing document. Land irrigation should occur on nonagricultural vegetation with a 20-foot buffer. Treated washwater should not result in surface runoff. All criteria set forth in OAR 340-40 must be met for groundwater quality protection.

24c. Washwater may be treated with adequately-sized units of: grit trap and oil/water separator, or comparable units such as a water quality inlet to remove sediments and floating oils. Effluent may be disposed of to an evaporative storage lagoon or constructed wetlands. The lagoon or constructed wetlands should be designed with no discharge and thus should be designed with sufficient storage. Design guidelines for treatment units are described in Section 4.4 of the Oregon DEQ washing document. An impermeable fabric liner may be needed for the lagoons or constructed wetlands to protect groundwater. All criteria set forth in OAR 340-40 must be met for groundwater quality protection.

On-site disposal (septic tank and drainfield) was evaluated for treatment of washwater that contain detergents, soaps, or cleaners. Lack of data on treatment performance data prohibited its use currently. Groundwater must be protected according to OAR 340-40.

25. If an oil/water separator is used as a treatment component, detergents used as cleaning agents must meet emulsion stability requirements to improve the efficiency of the treatment unit; emulsion stability should meet the fats, oil, and grease (FOG) test, which involves testing a 1,000 ml detergent mixture at an one percent (1%) working concentration of the detergent; one liter of a 50:50 mixture of//2 diesel fuel and 30-weight motor oil is added to the detergent mixture, shaken for 20 seconds and allowed to stand for 30 minutes; an acceptable test performance is less than 20 mg/L total fats, oil, and grease remaining in emulsion.

26. The treatment system must be, at all times, properly operated and maintained to achieve compliance with all conditions of the permit. Records of maintenance activities should be

maintained on-site for DEQ inspection.

27. A Spill Prevention, Control and Countermeasure (SPCC) Plan, in accordance with 40 CFR 112, should be prepared and implemented to prevent the entry of pollutant loads beyond the capabilities of the treatment system.

28. For small cleaning operations that use detergents, soaps, cleaners (i.e., private and nonprofit vehicle/equipment washing, and building and pavement washing, or commercial facilities which wash less than eight of their own vehicles, trailers, or pieces of equipment during any week), washwater can be disposed of onto the ground surface.

Disposal alternatives to ensure contaminated water does not enter surface waters are as follow:

29a. Washwater may be collected in a sump, grit trap, or containment structure to be pumped or siphoned to a vegetated area so that complete percolation into the ground occurs.

29b. Disposal of washwater should occur on ground surfaces with vegetated cover, preferably grasses.

29c. Washwater may be disposed to a dry grassy swale, a minimum of 250 feet in length before a surface water body. Complete percolation in the swale should occur with no direct discharge to the surface water. Discharge into a grassy swale for treatment should not occur within 24 hours after a rainfall event or if water remains ponded in the swale. Guidelines for design of a grassy swale or use of an existing grassy swale to reduce pollutants are in Section 4.4 of the Oregon DEQ washing document. A distance of 250 feet was based on a hydraulic conductivity of 0.2 gal/ft/day, volume per day of 150 gallons, and a swale with a width of 3 feet.

29d. Washwater runoff may be disposed of into an infiltration basin/trench. Guidelines for design of an infiltration basin/trench to reduce pollutants are described in Section 4.4 of the Oregon DEQ washing document.

29e. Commercial mobile washers that use detergents, soaps, or other chemicals should use a portable impervious surface material when washing on a porous surface. A portable wash pit, vacuum recovery unit, or comparable device must be used on location to collect washwater for proper disposal.

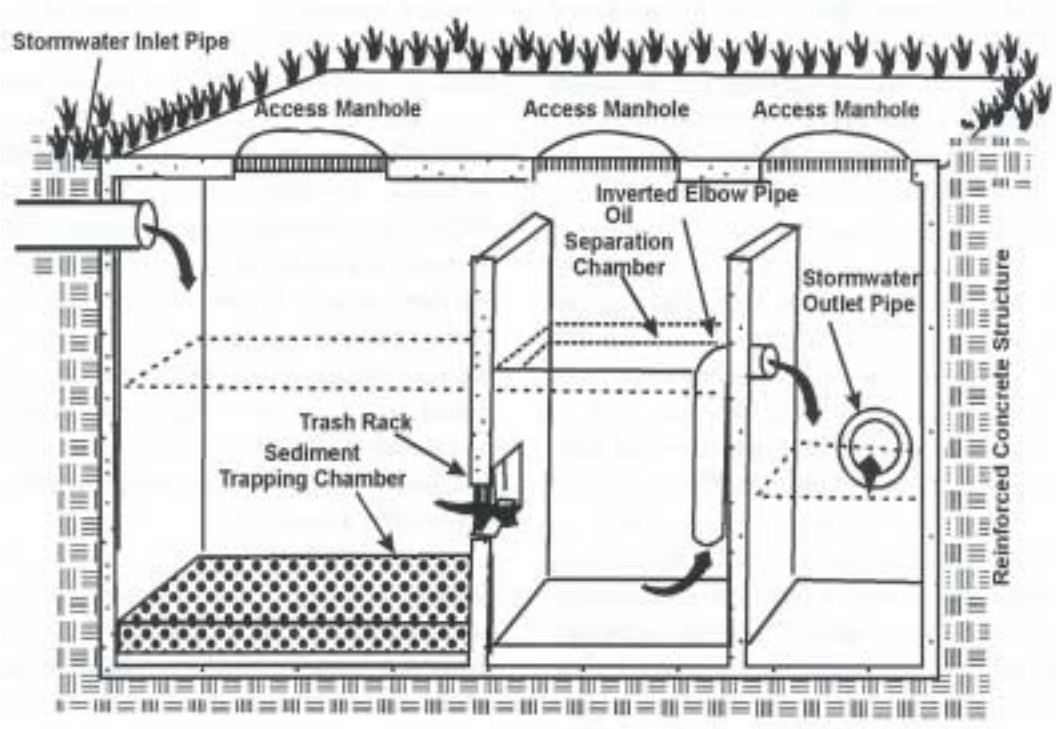
Efficiency/Impact: The use of a recycling system will not only reduce or eliminate the contaminant discharge to storm water or sanitary sewer but it will greatly reduce the amount of water used in the process. The use of a bioswale with an oil/water separator will likewise virtually eliminate the total suspended solids, oil and grease, and heavy metals discharged provided both are properly sized. A portable collection system will provide the collection of the contaminants provided the collection system is large enough to capture significant amounts of the overspray.

BMP Nº CS9 (Reference # 21 & 41)

Activity: Any site that has steel, equipment, or vehicles stored outside and has a potential for oily storm water discharges.

Typical Pollutants: Oil and grease and suspended solids

Typical Problem: Structural steel and plate arrives on the site from the supplier coated with oil to inhibit corrosion. As storm water comes in contact with the steel the oil disperses and runs off. Equipment stored outside has grease and oil on it that washes off when contacted by storm water. Vehicles not only have the normal oil and grease associated with them but they also have road film which contains oil.



BMP: Installation of a properly sized oil/water separator can reduce the amount of both Total Suspended Solids and Oil and Grease in the storm water run-off. Several types of oil/water separators are available (Gravity, Coalescing, Centrifugal, Carbon Absorption, Ultrafiltration, etc.). Gravity Oil/Water Separators are generally the most economical provided emulsifying chemicals have not been used upstream of the separator, dirt is not a major contaminant, and high shear centrifugal pumps are not used to pump the water to the separator.

There are three basic types of oil/water separators, spill control (SC), API (longer retaining time), and coalescing plate (CPS) recommended for use in all pipe drainage systems conveying runoff from paved areas, subject to vehicular use or storage of

chemicals, prior to discharge from the project site or into an open drainage feature. All three types have the following basic application/selection criteria:

- Urban residential runoff usually low flows
- Suitable for smaller sites, draining 5 or less acres
- Land uses associated with include: industrial, transportation, log storage, airports, fleet yard, railroad, gas station, vehicle/equipment dealers and repair, construction and petroleum
- SC can be effective at retaining small spills but does not remove dispersed oil droplets because they have a short residence
- SC type should be required when the site stores petroleum based products and spills are
- API used where there is a relatively high likelihood of dispersed oil contamination.
- API/CPS should be used in areas with high traffic volumes (2,500 vehicles per day), at sites that are used for petroleum storage/transfer, scrap and wrecking yards, or at sites where heavy equipment is stored and/or maintained.
- Oil/water separators cannot deal well with heavy sediment
- Should be used in conjunction with detention, biofiltration, or water quality treatment system to protect groundwater.
- CPS consist of a bundle of plates made of fiberglass or polypropylene installed in a concrete vault. The plates improve the removal of oil and fine suspended sediments and assist in concentrating the pollutants for
- CPS requires frequent inspection and maintenance to operate as
- A mechanism should exist for the system to be bypassed, so the system can be taken off line for maintenance.
- Oil and sediment removed from devices may qualify as hazardous waste and should be tested prior to
- Oil separators should be sized for a local six-month reoccurring 24-hour design storm. Larger storms should be diverted from the separators.

Efficiency/Impact: The use of gravity oil/water separators in the storm water outflow can greatly reduce the free oil droplets larger than 0.015cm (150 microns). Ultrafiltration can virtually eliminate oil in the storm water outflow. Fouling of membranes may become a concern with Ultrafiltration although some newer vibrating membranes show great promise for keeping the membranes clear during backflushing.

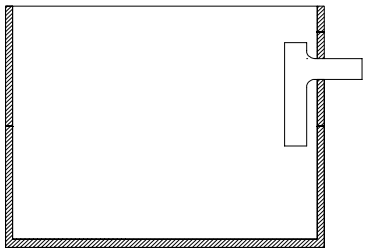
BMP Nº CS10

Activity: The use of compressed air.

Typical Pollutants: Oil

Typical Problem: Compressed air systems typically absorb or condense moisture from the ambient air. Fine oil is released to

the compressed air in the compression cycle. The condensed water is either manually drained out of the compressor, filters, and/or the air receiver tank or is automatically drained by a timed valve system. This condensate may be discharged to the ground or to a location that can leak or be spilled into the outside environment. Storm water then flushes this oil to the storm water outfall.



BMP: Install an oil/water separator especially made for compressors and receiver tanks or manufacture a simple separator similar to the one shown on the following page and siphon off the oil. Discharge the remaining water to the sanitary sewer if it is available on-site.

Efficiency/Impact: Oil from this source can be greatly reduced or eliminated and loading to the storm water conveyances will be reduced.

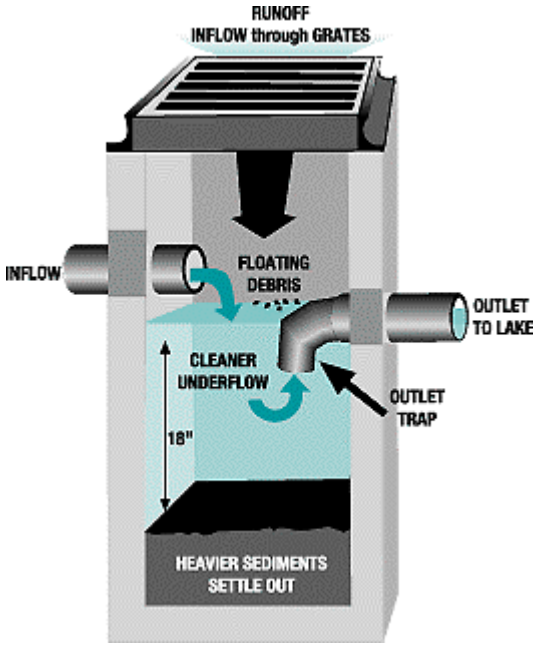
BMP Nº CS11

Activity: Storm water runoff from commercial or industrial sites to standard catch basins or drains.

Typical Pollutants: Oil and sediment

Typical Problem: On sites that use standard catch basins or drains there is no retention of any oils or sediments. This could result in excessive discharges to storm water of these pollutants.

BMP: Retrofitting drains to standard sediment and oil trap catch basins properly designed for the flow-through rate and properly maintained can reduce oil and grease levels in the storm water discharge.



Efficiency/Impact: Proper sizing and maintenance can reduce the discharge concentrations of oil and grease to below 10mg/l and settleable solids to some degree.

BMP Nº CS12

Activity: Arc furnace or mechanical removal operations (grinding, sanding, shot blasting, etc.) that create dust which is collected in baghouses.

Typical Pollutants: Metal fines, suspended solids in storm water

Typical Problem: Mechanical removal operations involving the removal of metal, paint, wood, and other materials generate dust that is collected in bag filter houses. Arc furnaces will generate a metallic fume that condenses out as a dust on the way to the baghouse. The baghouses must discharge the dust collected to a dumpster, drum, or bin. If the connection between the baghouse and the collection container is not airtight then, dust leaks out into the environment. Storm water will contact this dust and convey it off-site, typically causing a TSS discharge problem.

BMP: If a drum is being used for collection of the dust, manufacture from a removable drum top a flange or sleeve that a flexible boot can be clamped to and attach the sleeve to both the discharge point on the baghouse and to the drum sleeve. Use quick release clamps to

attach the removable drum top to the drum. If a dumpster or other large container is used to collect the dust, manufacture a solid reinforced cover for the container using rubber sealing strips and clamps or bolts to hold the cover in place. The cover should have a sleeve or flange that attaches to a flexible boot which is attached to the discharge point on the baghouse. It may be necessary to also include a vent line from the dust receiving container back into the dust collector in order to relieve the air pressure resulting from the dust dropping down in to the collection container.

Spillage that occurs from connecting and disconnecting to the flexible boot should be immediately cleaned up using a vacuum. A fixed vacuum duct may be plumbed into the inlet of the dust collector with a valve so that the spillage can be reintroduced into the dust collector. Also, frequent vacuum sweeping of the area around the dust collector should be performed.

Efficiency/Impact: Through the use and proper maintenance of the container covers most of the dust can be contained significantly reducing the amount of dust that could leak out to the environment. This would, in turn, greatly reduce the impact from this source of suspended solids and metals to the storm water discharge.

BMP Nº CS13 (Reference #29)

Activity: The use of cooling towers with the associated water treatment chemicals and blowdown discharges.

Typical Pollutants: Biocides, algaecides, fungicides, and corrosion inhibitors (BOD, COD); suspended solids; zinc; and copper

Typical Problem: Chemicals such as Biocides, Algaecides, and Corrosion Inhibitors are added to cooling towers to prevent biological growth, and to reduce scaling and corrosion. Periodically cooling tower water must be blown down in order to remove sediment and particulate buildup in the cooling tower sump. This water should be discharged to sanitary sewer but may not be in areas where a sanitary sewer is not available. Even when the water is discharged to a sanitary sewer an upset can occur in which the cooling tower sump water is discharged to outside areas and comes in contact with storm water. This water can contain elevated levels of copper, zinc, and chemicals with high BOD_5 and COD.

BMP: Use ozone instead of chemicals to control biological growth and scaling. Ozone is a powerful oxidizing agent. It has one and one-half times the oxidizing potential of chlorine. A properly operated and controlled ozone treatment system will not allow microorganisms that secrete the glue-like substance called mucilage to survive and will break down existing mucilage. Microbiological induced corrosion(MIC) can be controlled through the use of ozone. The pH of the water when using ozone is around 8 in comparison to levels typically below 7 when using chemical treatment. Cooling tower sumps can be vacuumed out using a swimming pool type vacuum. With little or no biological growth, the absence of chemical additives, and the absence of scaling sediment, particulate accumulation can be restricted to airborne particulates for the most part which should reduce the frequency for the need to remove sediments and particulates by blowing down the sump. Use of a swimming pool vacuum cleaner could eliminate almost all blowdown.

An alternative to introducing ozone is the use of ultraviolet light disinfection to control microbial growth in cooling tower water. In this case the cooling tower is recirculated through the UV unit which kills organisms attempting to grow in the water. Blowdown will still have to occur but will probably be required at a reduced frequency over that necessary when chemicals are used. The computer chip industry has used this method for their ultrapure water processes for years and the machinery coolant recycling equipment industry has also been using UV treatment units to eliminated biological growth in their coolant recycling equipment.

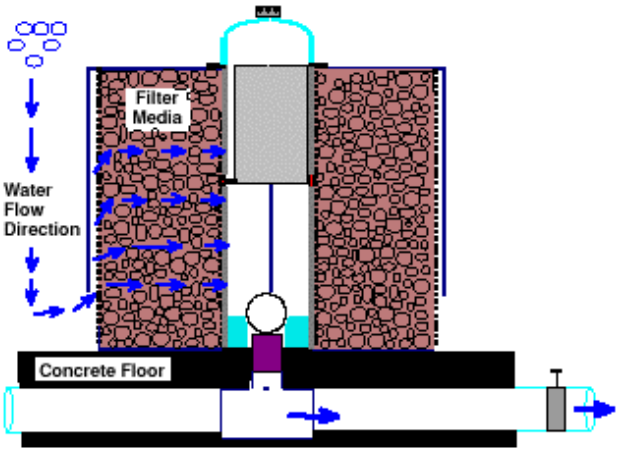
Efficiency/Impact: By replacing chemical additives with ozone or UV treatment and using a swimming pool vacuum cleaner for sediment removal, potential pollutants from this source to the storm water conveyances can be reduced or eliminated.

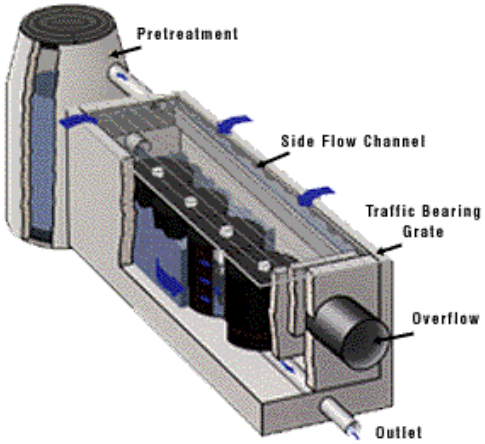
BMP N^{o} CS14 (Reference # 34)

Activity: Operations with exposed copper and/or galvanized piping, galvanized siding and/or roofing materials, cathodic protection coatings of copper such as may be found on boats, or other exposed copper, brass, and/or zinc coated materials that are exposed to storm water may have significant levels of these metals present in their storm water discharge. Operations involving heavy vehicle traffic may also have metals in their storm water discharge such as copper from brake shoes and clutches or zinc from tire wear.

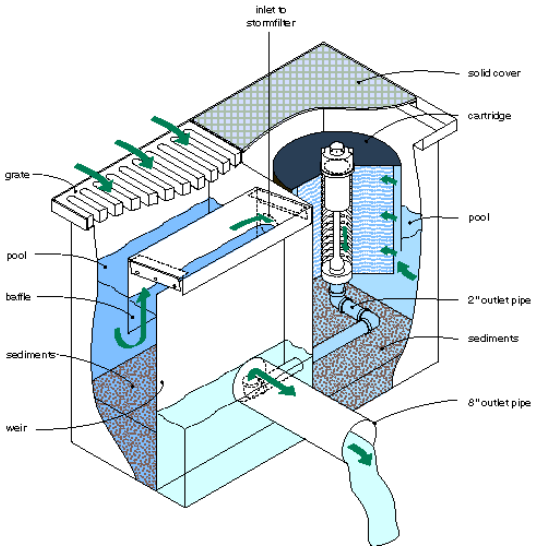
Typical Pollutants: Copper, zinc, and Total Suspended Solids

Typical Problem: Dust from tires (1% Zinc wear rate = 90mg/km/tire) and clutch/brake mechanisms, deterioration from galvanized building materials or corrosion and/or oxidation of copper piping and fixtures cause discharges of particulate and dissolved chemical forms of copper and zinc to the environment when contacted by storm water. Copper based cathodic protection on boats and other equipment generates chemical and particulate forms of copper that becomes combined with storm water.





BMP: The installation of properly sized compost filtration units can remove significant amounts of both chemical and particulate forms of some heavy metals, including copper and zinc, and reduce TSS levels in the storm water discharge. Colloidal particulate levels from clay soils should also be reduced effectively.

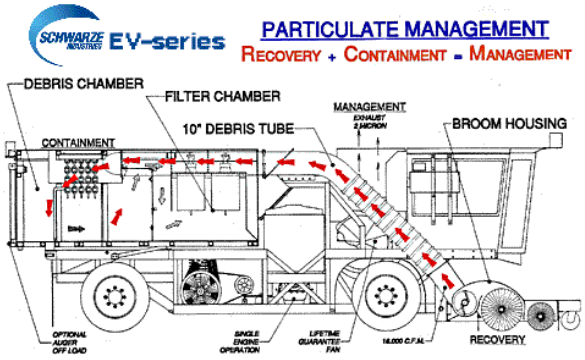


Effectiveness/Impact: Evaluation of existing sites over a three-year period show that the mean reductions of pollutants in storm water for the following were achieved:

TDS	**22.4%**	**Turbidity**	**91.8%**
COD	**70.4%**	**Total Phosphorus**	**44.9%**
Lead	**44.9%**	**Zinc**	**83.2%**
Copper	**65.3%**	**Oil & Grease**	**80.9%**

In general, reductions for Heavy Metals can be expected to be in the range of 65 to 95% and for Oil & Grease up to 85% for a properly designed and sized system.

BMP N^{o} CS15 (Reference #32 & 45)



Activity: Operations that have exposed copper and/or galvanized piping, galvanized siding and/or roofing materials, or other exposed copper, brass, and/or zinc coated materials exposed to storm water can have significant levels of these metals present in the storm water discharge. Operations involving heavy vehicle traffic also produce elevated metal levels in storm water from vehicle brake shoes or clutches (copper) and tire particles (1% zinc wear rate = 90mg/km/tire).

Typical Pollutants: Total Suspended Solids, copper, zinc.

Typical Problem: Dust from tires and clutch or brake mechanisms, deterioration from galvanized building materials, or corrosion and/or oxidation of copper piping and fixtures cause discharges of particulate and dissolved chemical forms of copper and zinc to the environment when contacted by storm water. Copper based cathodic protection on boats and other equipment also generate dissolved chemical and particulate forms of copper that can become combined with storm water.

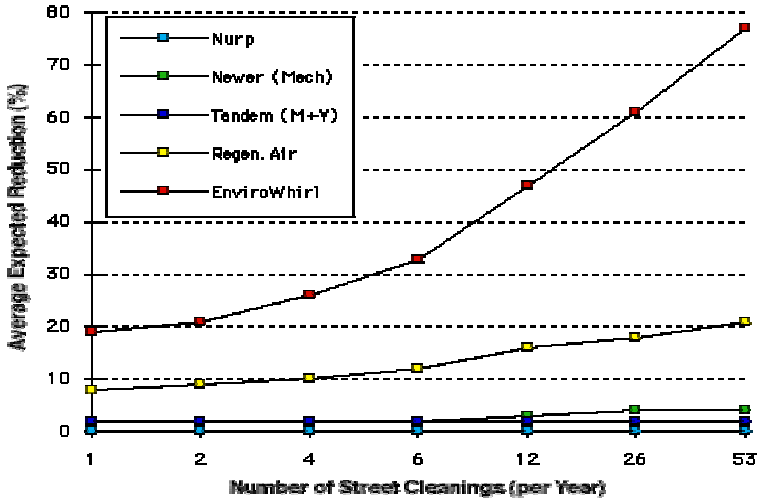
BMP: Sweeping of paved roads, parking lots, and storage areas with a type of vacuum sweeper that incorporates HEPA filtration or other high efficiency method of filtration of the exhaust air from the sweeper to trap the very fine metallic particles found in road or parking lot dust can reduce these discharges to storm water.

Ensure that good control measures are implemented when dumping the contents of the sweeper and practice proper disposal methods for the emptied contents to ensure that there is no adverse environmental impact after

spending so much effort in the initial clean-up.

Efficiency/Impact: This type of Sweeper is capable of collecting and containing up to 99.6% of particles as small as 2.5 microns in size. The elimination of particulates in storm water is related to the frequency of sweeping as is shown comparisons of various types of sweepers in the following graph.

Tennant Company also produces a series of sweepers, ranging from a small, walk-behind model to as large as municipal street sized sweepers. The unique feature of Tennant's products is a stainless steel hopper built in to the sweeper to collect dust and debris as it is picked up from the floor and passed through a polyester filter. When the hopper is full, it can be emptied directly into a dumpster or dump truck, minimizing the chance of particulate matter being re-released into the air. Information from the manufacturer reports that the sweepers will retain particles 10 microns, or 0.001 mm, or larger. The smaller size of the model and four-wheel steering makes it easy to maneuver in small spaces that traditional sweepers would not fit.



BMP Nº CS16

Activity: The disposal of wastewater associated with street or floor scrubbing activities.

Typical Pollutants: Oil emulsions, heavy metals, organics and suspended solids

Typical Problem: When floors, streets and other paved surfaces are cleaned with scrubbing or wet-vacuum type machines, the resulting waste water is frequently disposed of over a catch basin that runs into the storm water system.

BMP: One option is to make sure that all waste water is disposed of into the sanitary system where it can be treated and cleaned. A solution reclaimer system can also be used to separate contaminants from dirty scrubber solution. Dirty water is pumped into the top of the reservoir, and a chemical compound added to separate out the contaminants. The chemicals encapsulate and separate metals, oils, solids, dust and oils in approximately 20 minutes. The clarified solution is drained out of the reservoir, through a filter, and can then be reused. The remaining solids contain only 10% of the original volume, and dry waste disposal is less costly and has fewer environmental issues associate with it.

Efficiency/Impact: With appropriate solid waste disposal, a solution reclaimer system can minimize or eliminate the adverse storm water impact from this potential source of contamination.

BMP Nº CS17

Activity: The outdoor replacement or storage of lead/acid or nickel/cadmium batteries and the long time storage of vehicles or battery powered equipment outside.

Typical Pollutants: Soluble metals such as lead, nickel, or cadmium
Sulfuric acid

Typical Problem: When batteries are replaced, the used batteries are generally stored around a site until enough have been collected to make it feasible to either have them picked up or shipped out to a battery recycler. These batteries are usually stored on the shop floor or outside without containment and with no thought of exposure to storm water. Sometimes electric lift trucks, pallet jacks, welders, portable powered pumps, etc. are stored outside with the batteries used for starting or for operation left in place and poorly protected from storm water contact. Lead sulfate usually present on lead/acid batteries or in the spillage of the lead/acid or nickel-cadmium/acid solution can create soil contamination and a storm water run-off problem.

BMP: Batteries should be stored in a contained area protected from the weather. Containment pallets can be used to collect any acid spillage. The pallets should be placed inside of buildings to keep storm water from coming into contact with the batteries.

Efficiency/Impact: Containment, protection from the weather, and frequent shipment to the recycler can minimize or eliminate the adverse storm water impact from this potential source of contamination.

BMP Nº CS18

Activity: Wrecked or Damaged Vehicle Storage

Typical Pollutants: Antifreeze (ethylene glycol), gasoline, oil, grease, brake fluid, diesel

Typical Problem: Depending on the damage to the vehicle, fluids may leak due to the damage incurred and/or the damage may expose oily components of the vehicle that would normally be protected from the weather. Storm water will contact these contaminants and infiltrate the

ground, contaminating the soil and groundwater at the site and combining with storm water runoff, depending on the rainfall and soil conditions, to waters of the State.

BMP: Provide containment of wrecked vehicles on impervious surfaces. If wrecked vehicles are stored on impervious surfaces, the drainage from those surfaces should pass through an oil/water separator prior to discharging to a storm water drainage system or to a storm water sewer. Insure that all fluids are completely drained from wrecked vehicles. If possible, provide a roofed storage area to prevent storm water contact with wrecked or damaged vehicles.

Remove engine oil, transmission oil, rear-end oil, antifreeze, freon, and any other fluids before storing the vehicles on the site.

Efficiency/Impact: Storage of all vehicles under a roof with a storm water divergence berm should, by eliminating storm water contact and allowing collection of potential contaminants, eliminate storm water concerns. Providing an impervious surface for the vehicles should eliminate the concern for groundwater contamination. Draining of the vehicle fluids would minimize but not eliminate the contaminant(s) concern.

BMP N^{o} CS19

Activity: Stripping coatings (paint, plastic, etc.) from metal and wood surfaces outdoors.

Typical Pollutants: Hazardous stripping chemicals, lead from old lead based paints, zinc chromate from old paint preparations, metal particulate, low pH, and increased suspended solids

Typical Problem: Stripping of wood and metal parts is usually accomplished with the use of chemicals that have health and environmental hazards. High pressure water blasting can cause increased runoff and can, in the case of blasting wood, damage the surface. Sand blasting creates a large amount of solids to dispose, i.e. the sand plus the paint removed which may be considered hazardous waste.

BMP: Consider using dry ice or baking soda abrasion type removal of old surface coatings instead of chemical or sand blasting. The dry ice system removes the surface coating and leaves only the material removed on the ground, which can be vacuumed or swept up. Using baking soda as the blasting agent leaves the material removed plus baking soda which is not typically harmful and can be fairly easily separated from the paint removed with it by using reclamation equipment or through dissolving the baking soda in water and separating the paint by sedimentation and then evaporating the water. Use a removable

ground cover before blasting to ease the cleanup efforts at job completion.

Efficiency/Impact: By placing a removable ground cover such as a plastic tarp down prior to conducting the work and using one of the blasting methods mentioned, virtually all of the removed material can easily be cleaned up with minimal volumes of material involved. Disposal will be less costly when less volume of combined materials are involved over the conventional sand blasting methods. The overall impact to the environment and especially to storm water discharges will be minimized or eliminated.

BMP Nº CS20

Activity: Vehicle repair/brake shoe replacement including materials handling vehicles.

Typical Pollutants: Asbestos, copper, total suspended solids

Typical Problem: Dust in the brake shoe/wheel housing is typically disturbed and can be released into the environment when brake shoes are replaced. This dust will migrate from inside buildings to outside areas creating an asbestos and/or increased copper discharge when contacted by storm water.

BMP: Use the Low Pressure/Wet Cleaning Method described below for dust removal in brake shoe housings. Some older brake shoes may still be present which contain asbestos. Some new brake shoes on mobile equipment still contain asbestos. Brake shoes contain copper compounds in addition to other materials. The dust in the brake shoe housing can, because of its micron and submicron size, escape the shop area and contaminate the site to a level that, when contacted by storm water, may exceed the copper discharge benchmark. If a vacuum is used, ensure that it is of a type that has a HEPA filtration system that can retain the micron sized particles.

Low Pressure/Wet Cleaning Method

- A drip pan shall be placed under the brake assembly, positioned to avoid splashes and spills.
- The reservoir shall contain water containing an organic solvent or wetting agent. The flow of liquid shall be controlled such that the brake assembly is gently flooded to prevent the asbestos-containing brake dust from becoming airborne.
- The aqueous solution shall be allowed to flow between the brake drum and brake support before the drum is removed.
- After removing the brake drum, the wheel hub and back of the brake assembly shall be thoroughly wetted to suppress dust.

- The brake support plate, brake shoes and brake components used to attach the brake shoes shall be thoroughly washed before removing the old shoes.

- In systems using filters, the filters, when full, shall be first wetted with a fine mist of water, then removed and placed immediately in an impermeable container, properly labeled and disposed.

- Any spills of asbestos-containing aqueous solution or any asbestos-containing waste material shall be cleaned up immediately and properly disposed.

- The use of dry brushing during low pressure/wet cleaning operations is prohibited.

Efficiency/Impact: Use of the wet method for removing the dust in the wheel/brake housing or the use of a HEPA vacuum will significantly reduce or eliminate this practice as a source for copper or asbestos in storm water. It will also significantly reduce the potential health hazard associated with asbestos exposure to employees.

BMP Nº CS21

Activity: Employee environmental education and training.

Typical Pollutants: All

Typical Problem: Many employees are not aware of the potential adverse impact the company's business may have on the environment or how they personally can effect those impacts. They may not have even thought about environmental impacts and can not recognize bad practices. Some may not know whom to inform of upsets or potential problems.

BMP: Provide periodic training that describes the potential adverse environmental

impacts of the business and methods for preventing those impacts. The training should:

- Describe how the company is being environmentally responsible.
- Encourage employees to bring forth suggestions for improving the environmental performance of the business.
- Describe how and to whom the employee should report potential environmentally relate concerns.
- Inform the employee of what to do.
- Provide incentives to employees to offer ideas for improvement.

Record attendance of the training. Show graphics in the presentation such as pictures of the various parts of the site under discussion during the presentation. Schedule regular inspections of the site looking for possible conditions or operations that could produce potential adverse environmental impacts. Use a team approach to this inspection, as it is too easy, even for professionals, to acquire tunnel vision during the inspection. During the site inspections, write up every questionable item or practice for later thought or resolution. To resolve or dismiss a suggestion or question during the inspection may distract from the process of the inspection or discourage employees from providing their input. Do not associate biodegradable with environmentally safe. Verify that the company is not moving wastes from one media to another, i.e. water to air, storm water to groundwater, etc.

Before the training takes place, analyze the potential problem areas of the site and the potential for how the site's manufacturing process can adversely impact the environment. Develop the training program presentation around these areas. Ask the question "what message am I trying to present?" and thoroughly provide the information necessary to answer the question. How and to whom should it be reported? Involve employees in the presentation through discussion items. Don't over look providing this training to temporary employees.

Efficiency/Impact: By making employees aware of the potential adverse impacts of the business and encouraging employees to offer ideas and suggestions, employers will see, not only a decrease in pollutants in their storm water discharge but, potentially in air, hazardous waste, and other media.

BMP Nº CS22

Activity: Any site that stores material outside.

Typical Pollutants: Total suspended solids from erosion, oil and grease, BOD_5, heavy metals.

Typical Problem: Poor housekeeping inside and outside on a site provide a possible indicator of the degree of the site's compliance with environmental, health and safety regulations. In addition, poor outside housekeeping tends to discharge paper, cardboard, wood, pallet and box strapping, and other wastes to the storm water conveyance system. These wastes can plug the storm water conveyances, and divert storm water flows causing increased erosion and localized flooding.

BMP: Good housekeeping includes:

- Orderly storage of bags, drums, and piles of materials and chemicals; prompt cleanup of spilled liquids;
- Frequent sweeping, vacuuming, or other cleanup methods for accumulated dry chemicals and materials can cut down on possible storm water contamination;
- Proper disposal of toxic and hazardous wastes, and
- Removal of accumulated scrap and spare parts.

Good housekeeping doesn't just happen. It occurs when it is well planned, scheduled, and when upper management demonstrates its importance by participating in regular inspections. Set aside time in the work schedule for cleanup activities.

- Schedule personnel to be responsible for the cleanup and rotate every employee through the schedule.
- Periodic inspections and regular site clean up can prevent problems from occurring. The frequency of outside inspections should be increased during the October through May rainy period.
- Encourage employees to pick up trash when it is seen and to report when more intensive clean up is needed.

  Every site that is environmentally responsible has good housekeeping activities. Most sites with environmental problems do not have good housekeeping activities.

Efficiency/Impact: The implementation of a formal housekeeping program with education and encouragement of employees can reduce or eliminate pollution by bringing the importance of how materials are stored and how trash can effect the storm water discharges to their attention along with the importance that management places on the issue. A regular maintenance schedule for storm water conveyances minimizes erosion and visually verifies the condition of the storm water discharges. Several typical pollutants in storm water can readily be identified by visual observance.

BMP Nº CS23 (References #15, 22, 31, 52)

Activity: Facilities having lawns or vegetated areas.

Typical Pollutants: Fertilizers, pesticides, herbicides, fungicides, phosphorus, nitrogen, zinc, copper, and pH.

Typical Problem: Lawn care entails the application of fertilizers, herbicides, pesticides, and water in order to achieve a rich vibrant lawn. Weeds are quite often controlled through the application of chemicals. Over fertilizing and the over-application of pesticides and herbicides can contaminate storm water. Too much irrigation can wash these chemicals off the site into storm water conveyances, streams, rivers, and lakes. The nutrients, phosphorus, nitrogen, and pH can be detrimental to slow moving water bodies by encouraging algae growth. Herbicides and pesticides can adversely impact human health, fish and other wildlife. All of these pollutants can significantly effect the beneficial uses of water bodies.

BMP: If a landscape contractor is hired to take care of the lawn and other vegetated areas of the site, ensure that they do their part to protect the environment by applying the appropriate amount of chemicals. Encourage them to investigate more environmentally friendly alternatives to the use of chemicals.

A few simple precautions can minimize adverse environmental impacts from lawn care. No matter what chemicals are used, over-watering can move the chemicals in to the storm water conveyance system. Use rain measuring equipment to automatically prevent automatic lawn sprinklers from turning on. In the Northwest, watering to a depth of six inches a couple of times a week is sufficient for a lush green growth. Always water in the morning, between 6 a.m. and noon.

Fertilization:

For lawn fertilization, 1,000 square feet of lawn requires 0.5 pound of nitrogen per month of active growth(~8 months in Portland area ~ 4 pounds). A good ratio for fertilizer is 3 parts nitrogen to 1 part phosphorus to 2 parts potassium to 1 part sulfur(3:1:2:1). Use a slow release fertilizer such as one containing water insoluble nitrogen(WIN). After determining the amount of fertilizer to use per year based upon the growing season, apply the fertilizer in four equal applications of approximately one pound per 1,000 square feet each application, i.e. 1/4 in early spring, 1/4 in late spring, 1/4 in late summer, and 1/4 in the fall.

Have your site's soil tested to determine if other materials such as iron(for low pH soil < 6.8), boron, chlorine, copper, manganese, molybdenum, nickel, and zinc should be added for a healthy lawn. If soil testing indicates that one or more of the additives above is needed, contact your county Extension Agent, a lawn and garden center, or a master gardener for advise on how much of the additives to apply for optimum growing conditions.

Fertilizer over-use, over watering, and watering at the wrong time of the day set up a good environment for many grass diseases and for invasion by weeds that are very competitive with the grasses in the lawn.

Pest Management:

Pest management can be conducted in an environmentally friendly manner through:

- **Knowledge**
  - **1.** knowing the variety of grass in your lawn;
  - **2.** knowing its growth characteristics; and

- **Identification**
  - **1.** identifying the weeds present;
  - **2.** identifying the grass disease present; and/or
  - **3.** identifying the insect pests present
    - **a).** Note where the pest is located on the lawn
    - **b).** Draw a picture of the pest or collect a sample
      - **i.** Research in books for a match of the pest found to a photograph;
      - **ii.** Contact local County Extension office for assistance and advice; or
      - **iii.** Take sample to local home and garden center for identification.

Weed removal is best accomplished by hand-pulling.

Maintain a buffer strip next to waterways. Do not apply fertilizer or pesticides to this strip. It is used to absorb excess fertilizer from the care of the rest of the lawn.

It will also retain excess nutrients and sediments.

Healthy Lawn

Step 1: Lawn conversion	Convert lawn areas into groundcover, trees, shrubs, or meadow plantings. For a low input approach, replace the grass underneath mature trees with groundcover. For an even lower input approach, examine your lawn for potential conversion areas and plant groundcovers, trees, shrubs, or perennials in all areas where grass is hard to grow. For the lowest input approach, use turf only where it is the best plant to fulfill a particular function, such as providing a children's sports area.
Step 2: Soil building	Provide a strong foundation for the lawn. For a low input lawn, get a soil test to determine the soil's pH and fertility. You may not need to add any lime or fertilizer to your lawn. For a lower input lawn, test for soil compaction. Can you sink a screwdriver into the ground without pounding or is the soil compacted? If the soil is compacted, aerate with a hand corer or mechanical aerator. For the lowest input lawn, examine the soil's texture- neither extremely sandy soils nor extremely heavy clay soils make for good lawns. Next count earthworms-if none can be found in a square foot of soil, there's a problem. A healthy soil community has over 10 per square foot. With this basic understanding of soil acidity, fertility, compaction, texture, and earth-worms, one can build soil that supports dense, healthy turf.
Step 3: Grass selection	Choose the type of grass that will be easiest to grow. For a low input lawn, select hardy grass species adapted your the region's climate. For a lower input lawn, select named grass varieties to meet your specific needs. For the lowest input lawn, try the new low-input slow-growing or dwarf grass mixes.
Step 4: Mowing and thatch management	Mow to the right height at the right time and recycle clippings. For a low input lawn, leave clippings on the lawn to provide nutrients and moisture. For a lower input lawn, set mowing height as high as possible. For the lowest input lawn, adjust mowing height and frequency during the growing season and monitor thatch levels.
Step 5: Minimal fertilization	Give the lawn what it needs but don't overfeed. For a low input lawn, recycle clippings and (in the right season) apply commercial fertilizer at half the recommended rate; avoid

weed and feed formulations and don't fertilize if rain is imminent. For a lower input lawn, fertilize as above but use encapsulated nitrogen or an organic product instead-and fertilize only if soil tests show it's needed. For the lowest input lawn, substitute home generated compost for commercial organic or encapsulated products.

Step 6: Weed control and tolerance — Establish a realistic tolerance level for weeds and use least toxic control methods to maintain it. For a low input lawn use least toxic weed control methods such as: cultivation, solarization, flaming, mowing, or herbicidal soap. For a lower input lawn, grow strong healthy grass and it will crowd out weeds. For the lowest input lawn, broaden your definition of "lawn" to include weeds that perform desirable functions.

Step 7: Integrated pest management — Establish a realistic tolerance level for pests and use least toxic control methods to maintain it. For a low input lawn, use least toxic control methods such as removing or trapping pests, introducing biological control agents, or apply least toxic chemical controls such as insecticidal soaps. For a lower input lawn, grow strong, healthy grass that can resist attack. For the lowest input lawn, use cultural controls to prevent infestation, protect natural predators, and add beneficial soil microbes.

Step 8: Sensible irrigation — Practice water conserving landscaping techniques. For a low input lawn, water infrequently, in the early morning, but soak the lawn well. For a lower input lawn, water only when the lawn definitely needs it, and calibrate sprinklers. For the lowest input lawn, accept that the grass may not be green year round.

Efficiency/Impact: Proper maintenance of lawns and vegetative strips can be pleasing to the eye and provide environmental benefits such as reduced pollution to streams, rivers, and lakes, cooler runoff, reduce sediments in the runoff, and in some cases reduce other pollutants from the site. The degree that this BMP will be effective is directly proportional to the degree of involvement in the care of the lawn or the degree of caution exercised in selecting a lawn care contractor and the degree that the watering system is in tune with the lawn and the weather.

BMP Nº CS24

Activity: Storage of general rubbish or food rubbish outside in dumpsters.

Typical Pollutants: Suspended solids, nutrients, bacteria, dioxin, chemicals

Typical Problem: Waste materials are typically removed from inside the site buildings to a collection container(dumpster) outside of the buildings. If these dumpsters have an open top or the top is left open at times when materials are not being dumped into them, storm water makes contact and will mix with the wastes and leak out to the storm water discharge conveyances for the site.

BMP: There are two effective methods for addressing this concern. At the end of a building, extend the roof over the area where the dumpsters will be placed to keep storm water out. Slope the floor that the dumpsters are sitting on to a drain where the contaminated storm water/dumpster drainage can be collected and discharged to a sanitary sewer, if necessary.

The other method is to ensure that covers are on all of the dumpsters and that the covers are lowered when wastes are not being discharged into them. The second method has the most risk in that this method relies on employees always performing the proper procedure and many different situations can arise that may interrupt the procedure and prevent it from occurring. No matter which method is used, ensure that no storm water catch basin is located close by.

Efficiency/Impact: Either method for protecting wastes from storm water exposure will minimize or eliminate storm water pollution from this source. The method that relies on the least effort from employees is usually the most reliable.

BMP Nº CS25

Activity: Pumping liquids from storage tanks into the site buildings or into vehicles.

Typical Pollutants: Petroleum hydrocarbons, antifreeze, other potentially toxic or hazardous liquids

Typical Problem: Pumps and piping can leak the liquids being pumped. Pumps located inside of buildings without containment can leak fluids that may contaminate storm water runoff.

BMP: Spill or leak containment should be constructed around the pumps. Place a curb across door openings and seal the floor and wall/curb with an epoxy compatible with the liquid being pumped. This measure will contain liquids within the enclosure and, unless a catastrophic failure of the discharge piping occurs, the liquid will not escape the building to adversely impact storm water runoff. Periodic inspections of the containment should be made to ensure that a build up of the leakage does not eventually rise to the point that it will pass over the containment berm. The contained liquids should be periodically removed and properly disposed.

Efficiency/Impact: Ensuring that pump houses can provide containment and frequent inspections of the containment within the pump house will minimize or eliminated storm water runoff contamination from this source.

BMP Nº CS26

Activity: Trucking firms or other operations in which semi trailers are parked on site and dollies are used to attach to the trailers to move the trailers around the site or operations in which semi tractors are used on site.

Typical Pollutants: Oil and grease

Typical Problem: Fifth wheel hitching mechanisms used to attach semi-tractors or tow dollies to semi-trailers have a thick coating of grease on them to minimize the friction encountered and to ease the attachment process during connection of tractors or dollies to the trailers. When the dollies or semi-tractors are parked and not attached to trailers the grease on the fifth wheel is exposed to storm water. This allows the storm water runoff to pick up the oil and grease.

BMP: Manufacture or purchase a quick install cover to slip over the hitch. A simple lightweight inexpensive cylindrical slip-on cover could be made out of fiberglass. Ensure that all operators of the equipment are instructed to place the cover over the hitches when they are not being used. Changing from the lubricated type fifth wheel hitch to a teflon non-lubricated type is a better approach but, if rental or transit trailers are in use frequently this may not be a viable option due to the requirement that both the trailer and the tractor fifth wheel slider plates need to be coated with the teflon.

Efficiency/Impact: While there will always be some exposure especially at the times the covers are removed for making the connections and the moving of the trailers, this method should minimize the adverse impact that the practice has on the storm water runoff.

BMP Nº CS27

Activity: Fueling operations performed by employees on-site or through restricted access systems such as Cardlock sites in various locals across the State.

Typical Pollutants: Gasoline and diesel fuels (Petroleum Hydrocarbon)

Typical Problem: Fueling nozzles can stick in the open or on position when fueling vehicles. Employees some times are not instructed in the correct methods for spill clean-up. Frequently, spill clean-up materials are not available at the dispensing pumps. Fueling stations may not have roofed areas or properly sloped or contained areas for collecting spilled fuel. All of these situations and conditions can result in fuel contacting storm water and entering the site runoff.

BMP: The fueling area should be designed and operated to minimize contact between spilled fuel and leaked fluids and storm water.

- Use a damp cloth on the pumps and a damp mop on the pavement for area clean up.
- Clean up spills immediately:
  - Spread absorbent material and sweep it up with a broom.
  - Perform a hazardous waste determination on the absorbed material.
  - Dispose of the absorbed material properly.
- Ensure that the overfill nozzle protection is in working order.
- Remove any nozzle locking mechanism which allows the fuel to stay on with the operator absent. The operator should be present at all times to ensure that overfilling and spillage does not occur.
- Cover fueling areas and berm/slope the pavement under the roof to a drain system that is connected to a holding tank or contains the spillage at the surface for easy clean up.
- Provide an easily accessible and well-marked emergency shutoff for pumps with plainly written instructions on how to operate the shutoff**.**
- Never hose down the fueling area.
- Don't drain spills to the sanitary or the storm water sewers.
- Ensure that the fueling area has an undamaged continuous paved or otherwise impervious surface.
- Ensure that spill clean up materials are readily available.
- For areas where multiple customers or operators from multiple companies have access, provide highly visible, simple instructions on how to clean up spills and report the incidence.
- Provide well placed, understandable instructions on the proper procedures to

follow in the event of an emergency, including reporting information.

Efficiency/Impact: Implementation of this BMP can virtually eliminate this potential source of storm water contamination provided site inspection is frequently performed.

BMP Nº CS28

Activity: Sites with surface water runoff contamination that have implemented specific non-point source BMPs for pollution prevention but have been unable to reduce the pollutant discharges in their storm water runoff to levels below the benchmarks. Unused excess land may be necessary to implement these BMPs.

Typical Pollutants: Sediment(TSS), metals, BOD, phosphorus, and hydrocarbons(Oil & Grease)

Typical Problem: When the implementation of specific point source BMPs has not eliminated or reduced the contaminants in the storm water to the specific benchmarks, end of the pipe or final discharge BMPs may be necessary.

BMP: Install a grassy filter strip and ensure that the storm water passes through the strip in sheet flow**.** Vegetated filter (buffer) strips are best used on sites with sheet runoff, such as parking lots.

- Effective filter strip widths range from a minimum of 50 feet to a maximum of 200 feet.
- Best for smaller drainage basins, five acres or less.
- Not suitable on slopes or sites with shallow depth to bedrock .
- Best for sheet flow. Do not use on slopes over 10%.
- Good for conventional pollutants.
- Cannot be used to convey larger storms, or concentrated flow discharges as their effectiveness will be destroyed plus they could become sources of pollution through erosion.
- Best grasses is tall fescue, followed by western wheatgrass, annual or Italian Ryegrass, Kentucky Bluegrass.
- Rectangular and V shaped cross sections are the least desirable.
- Design to create a low velocity flow, bent grass is not as good a filter.
- Curbing for impervious areas draining to the filter strips should have a one-foot gap every five feet.

Efficiency/Impact: Properly sized and maintained vegetated filter strips can have a removal efficiency of up to 80 percent for suspended solids.

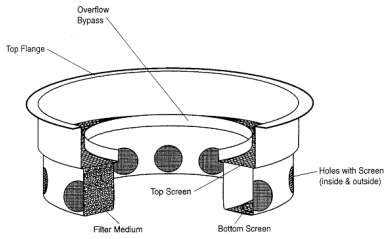
BMP Nº CS29 (References # 9, 21)

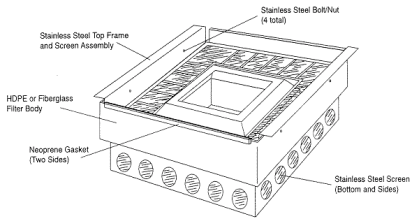
Activity: Sites with surface water runoff

contamination that have implemented specific non-point source BMPs for pollution prevention but have been unable to reduce the pollutant discharges in their storm water runoff to levels below the benchmarks. Unused excess land may be necessary to implement these BMPs.

Typical Pollutants: Sediment(TSS), metals, BOD, phosphorus, and hydrocarbons(Oil & Grease)

Typical Problem: When the implementation of specific point source BMPs has not eliminated or reduced the contaminants in the storm water to the specific benchmarks, end of the pipe or final discharge BMPs may be necessary.





BMP: Install a catch basin filter system: a catch basin coupled with a sump and sediment traps. May also be used with an inlet device, prefiltering insert and screens (see other facilities and retrofit). The inserts consist of several filtering trays suspended from the inlet grate. Common filters are charcoal, wood fibers or fiberglass.

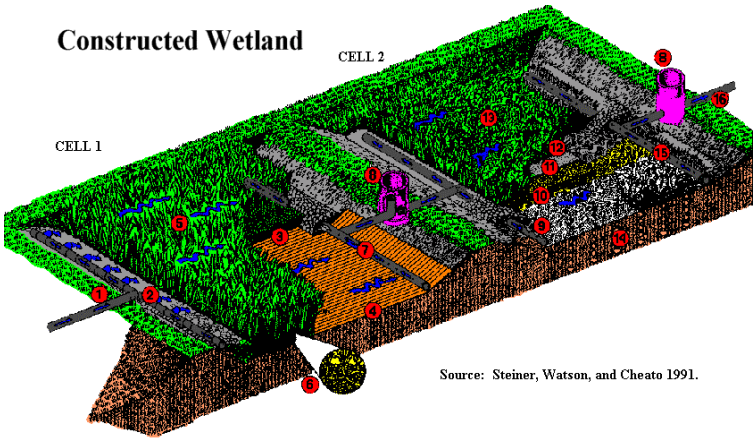
- Retains small particles, partially effective with high levels of particulate heavy metals, oil/grease, and TSS. Moderate reduction in TSS and turbidity. However, few pollutants are associated with these coarser solids.
- Disadvantage: When 60% full, the suspended solid deposition is in equilibrium with scour, and the capture efficiency is reduced to zero.
- Best in small basins and with treatment of highly turbid runoff prior to

discharge to catch basin.

- Do not use on unstable or steep slopes.
- Usually used with vaults, tanks, sumps or inverted (hood) inlet. Inlet can be coupled with a filtration system (see retrofit).
- Maintenance is critical and must be at least semiannual. Require a maintenance schedule and plan for disposal of material removed by the catch basin.
- Insert maintenance is required quarterly and should be inspected more frequently during wet periods.
- Catch basins with a restrictor device (multiple orifice and weir/riser section) for controlling outflow provide minimal control for floatables and petroleum based products.
- Design the size of catch basin sump to handle the site runoff rate, TSS concentration in runoff and how often it will be cleaned out.
- To minimize groundwater pollution problems, be careful where infiltrating catch basins are used (residential areas) and pre-treat the infiltration water.

Efficiency/Impact: Catch Basin Filter System Efficiency: TSS up to 22%, and Turbidity up to 38%

BMP Nº CS30 (Reference #21 & 46)



Activity: Sites with surface water runoff contamination that have implemented specific non-point source BMPs for pollution prevention but have been unable to reduce the pollutant discharges in their storm water runoff to levels below the benchmarks. Unused excess land may be necessary to implement these BMPs.

Typical Pollutants: Sediment(TSS), metals, BOD, phosphorus, and hydrocarbons(Oil & Grease)

Typical Problem: When the implementation of specific point source BMPs has not eliminated or reduced the contaminants in the storm water to the

specific benchmarks, end of the pipe or final discharge BMPs may be necessary.

BMP: Install a constructed wetland. Constructed wetlands are constructed by a combination of excavation and/or berming. The basic types of constructed wetlands are: shallow marsh, a 2 or 3 celled pond/marsh, extended-detention wetland and pocket wetland.

Storm water treatment facilities are not considered waters of the State, however, their discharge is regulated in the same way as any treatment system. Created wetlands built as mitigation for loss of wetlands under the Clean Water Act Section 404, are considered waters of the State. Created wetlands are protected as natural wetlands and cannot be used for conveyance or treatment of wastewater, unlike constructed wetlands.

- Extended-detention wetland and pocket wetlands are less effective in removal of some types of pollution than other types of wetlands.
- The constructed wetland should be lined when located over permeable soils for permanent pool maintenance. This is to prevent potential groundwater and soil contamination. Use a Bentonite clay (12" thick) or commercial heavy plastic pond liner (minimum 40 ml). Place a minimum of 18" thick compacted soil over the liner prior to seeding.
- The permanent pool depth should be between three to six feet in depth, plus one foot of dead storage for sediment. Six feet is the minimum depth or the pond will stratify in summer and create low oxygen conditions which result in the re-release of phosphorus and other pollutants. In addition, if the pond is deeper than six feet, it will likely pollute the groundwater.
- Suitable for larger sites up to 100 acres.
- Soils should be tested to determine suitability. Best when located in clay loams, silty clay loams, sandy clays, silty clays and clays.
- Cannot be used in areas with shallow depth to bedrock or unstable slopes.
- Good for removal of nutrients and conventional pollutants such as oil and grease and some heavy metals.
- Needs to have a shallow marsh system in association to deal with nutrients.
- Should be multi-celled, preferably three of equal sizes. The first cell should be three feet deep to trap coarse sediments and slow turbulence. They need to be designed as a flow through facility, and the pond bottom should be flat to facilitate sedimentation.
- Need to be designed with periodic maintenance in mind by using an overhead scooping device.
- Side slopes should be 2:1, not steeper than 3:1, and 10 to 20 feet in width. A length to width ratio of 5:1 is preferred, with a minimum ratio of 2:1 to enhance water quality benefits. The longer length allows more travel time and opportunity for infiltration, biofiltration and sedimentation.
- Pond berm embankments over six feet should be designed by a registered

engineer. Berm tops should be 15 feet wide for maintenance access and should be fenced for public safety.

- Shape should be long, narrow, and irregular since these are less prone to short circuiting, are more effective, and maximize the treatment area.
- Baffles can be used to increase the flow path and water residence time.
- Should have an overflow system/emergency spillway to accommodate a 100 year, 24 hour flood and a gravity drain.
- Maintenance is of primary importance. The site must be responsibly selected. A maintenance plan needs to address removal of dead vegetation (that release nutrients) prior to the winter wet season, debris removal from trash racks, sediment monitoring in forbays and in basin are likely to contain significant amounts of heavy metals and organics (regular testing is advised).
- Access to the wet pond is to be restricted with a gate and posted signs.
- For mosquito control, either stock the pond with fish or allow it to be drained for short periods of time (do not kill the marsh vegetation).
- Constructed wetland is more complex, with more vegetation, and shallower with greater surface area, hydrologic factors (flow) play a larger part in siting.
- Selection of vegetation should be done by a wetland specialist.
- Oil/water separators can be used prior to the constructed wetland, depending upon the surrounding land uses.
- Relatively low maintenance costs.
- Fence off for safety (children), to protect plants/wildlife.
- Disadvantages/constructed wetlands:
  a.) Constructed wetlands have a larger land requirement for equivalent service compared to a wet pond.
  b.) Relatively high construction costs.
  c.) Delayed efficiency until plants are well established (1–2 seasons).
- Buffer width 25 to 50 feet.
- Limit water level fluctuations, as they kill plants.

Efficiency/Impact: Wet pond/wetland removal efficiencies:*

a) Heavy metals = 40 to 80%;
b) Total Phosphorus = 40 to 80%
c) Total Nitrogen = 40 to 60%
d) TSS = 70%
e) Soluble reactive phosphorus 75%
f) Nitrate = 65%
g) Ammonia = -43
h) COD = 2
i) Total copper, lead and zinc = 80 to 95%

* Higher efficiencies are associated with use of O/G trap, larger pond/marsh area and volume. These efficiencies assume that the intensity of the storm water inflow does not exceed the capacity of the wetlands and that the pollutants are not in a concentrated form from a large spill or discharge.

BMP N^{o} CS31 (Reference #21 & 46)

Activity: Sites with surface water runoff contamination that have implemented specific non-point source BMPs for pollution prevention but have been unable to reduce the pollutant discharges in their storm water runoff to levels below the benchmarks. Unused excess land may be necessary to implement these BMPs.

Typical Pollutants: Sediment(TSS), metals, BOD, phosphorus, and hydrocarbons(Oil & Grease)

Typical Problem: When the implementation of specific point source BMPs has not eliminated or reduced the contaminants in the storm water to the specific benchmarks, end of the pipe or final discharge BMPs may be necessary.

BMP: Install a grassy bioswale. Swales basically act as filters for runoff from frequent storms. The principle form of treatment is the settling out of pollutants and the use of vegetation to take up the dissolved fraction. For best results a swale should be designed to deal with the peak runoff for a two year, 24 hour storm event.

- Does well with first flush runoff, economically feasible, improves aesthetics and has minimal environmental impacts. Best in median strips and parking lot islands.
- The organic topsoil layer is good for degrading petroleum solvents, heavy metals, nutrients and hydrocarbons.
- Critical design elements: size of drainage area to be treated, location of bioretention areas, sizing guidelines, calculate water budget.
- Biofiltration is suitable for smaller sites 10 or less acres.
- Needs a minimum width of 20 feet.

- Must be graded to create sheet flow, not a concentrated stream. Sheet flow decreases the chance of producing gully erosion and distributes contaminants over a wider area. Level spreaders (i.e. slotted curbs) can be used to facilitate sheet flow.
- Can be placed anywhere with careful site design.
- Do not use on steep, unstable slopes or landslides.
- Can reduce peak flow rates.
- Best when used for treatment and conveyance of storm water after a settling pond.
- Good for nutrient removal and conventional pollutants such as suspended solids and some heavy metals.
- Best at 200 feet in length, in tight spaces obtain more length by using a curved path. Should have a maximum bottom width of 50 feet. One foot high check dams should be installed every 50 feet starting 20 feet downstream from the inflow point.
- Good when used at a storm water outfall, commercial development or roadside.

Efficiency/Impact: Bioswales can, when sized correctly and when incorporated with an upstream settling pond, provide similar pollutant removal efficiencies to those achieved by a biopond or constructed wetland.

Removal efficiencies:

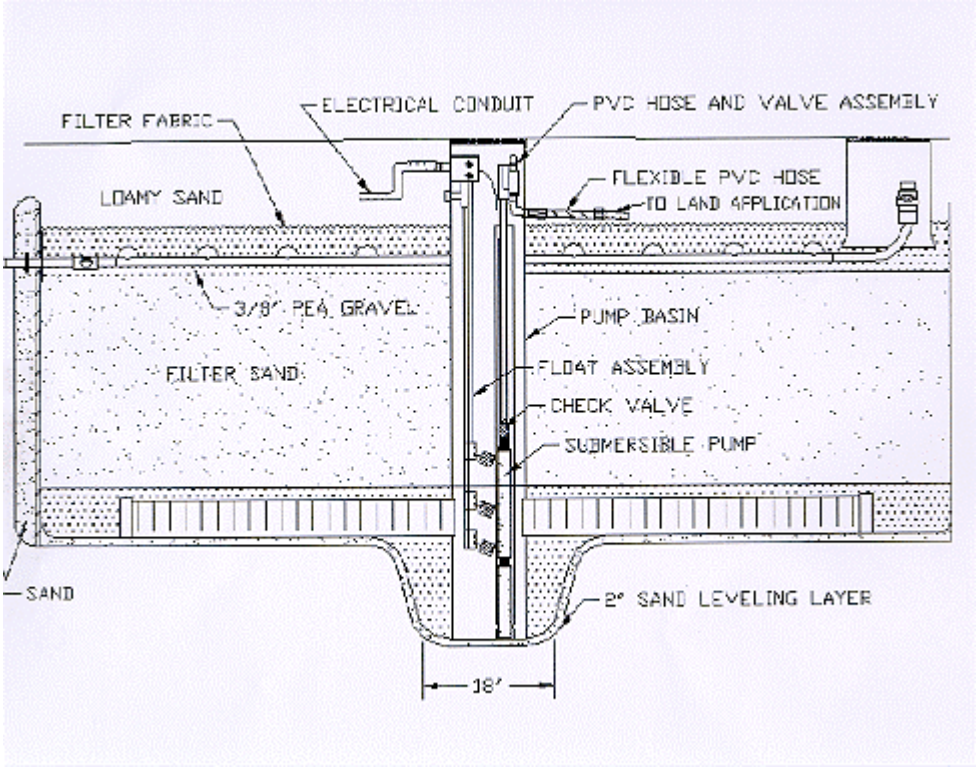
a) TSS = 83 to 92%
b) Lead = 67%
c) Copper = 46%
d) Total phosphorus = 29 to 80%
e) Total zinc and aluminum = 63%
g) Oil/grease/TPH = 75%
h) Nitrate-N = 39 to 89%

BMP N^{o} CS32 (Reference 38, 39, & 40)

Activity: Sites with surface water runoff contamination that have implemented specific non-point source BMPs for pollution prevention but have been unable to reduce the pollutant discharges in their storm water runoff to levels below the benchmarks.

Typical Pollutants: Phosphorus, Heavy metals.

Typical Problem: When the implementation of specific point source BMPs has not eliminated or reduced the contaminants in the storm water to the specific benchmarks, end of the pipe or final discharge BMPs may be necessary.

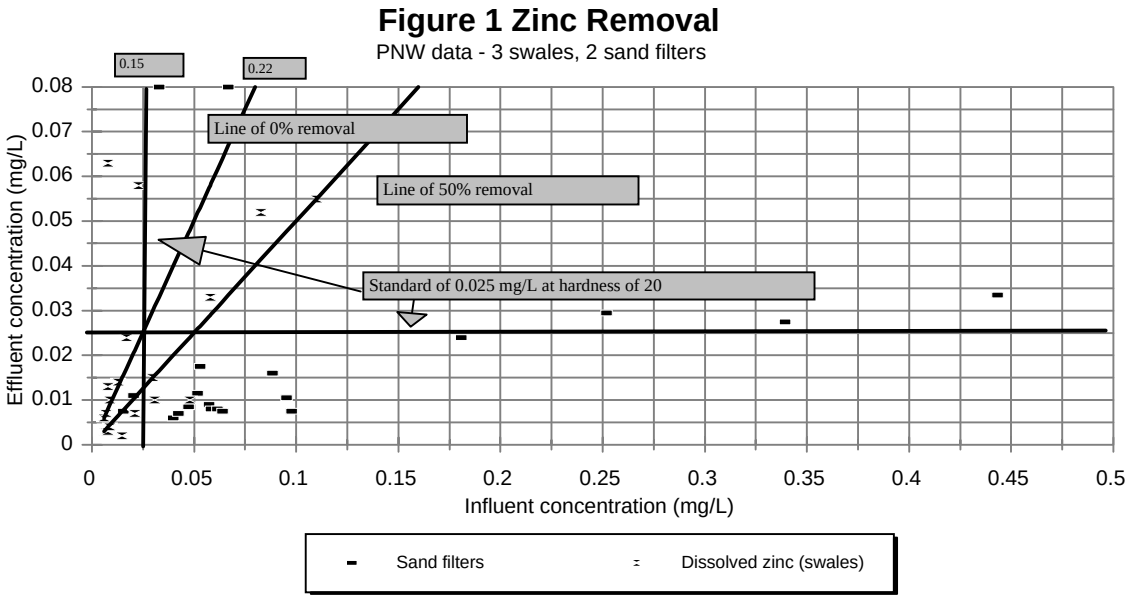


BMP: Installation of a sand filter has shown to reduce some heavy metals.

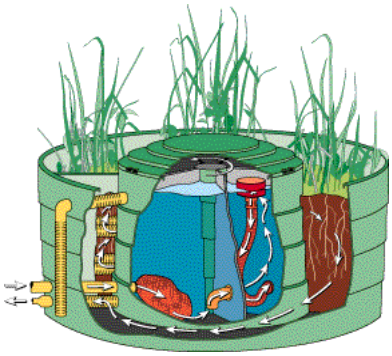
Efficiency/Impact: Research has shown zinc to be reduced to as little as 8% of the original concentration. More research is needed to determine the effect a sand filter will have on other metals. The mechanism for the removal of the metals is not completely understood at this time. Due to the particle size, this method should have negligible effect on the dissolved metals.

Typical Pollutant Removal Efficiency

Pollutant	Percent Removal	Pollutant	Percent Removal
Biochemical Oxygen Demand (BOD)	70	Total Kjeldahl Nitrogen (TKN)	46
Total Suspended Solids (TSS)	70	Total Phosphorus (TP)	33
Total Organic Carbon (TOC)	48	Iron (Fe)	45
Total Nitrogen (TN)	21	Lead (Pb)	45
Zinc (Zn)	45		



BMP Nº CS33 (Reference #47 & 48)



Activity: Sites with surface water runoff contamination that have implemented specific non-point source BMPs for pollution prevention but have been unable to reduce the pollutant discharges in their storm water runoff to levels below the benchmarks. Unused excess land may be necessary to implement these BMPs.

Typical Pollutants: Sediment(TSS), metals, BOD, phosphorus, and hydrocarbons(Oil & Grease)

Typical Problem: When the implementation of specific point source BMPs has not eliminated or reduced the contaminants in the storm water to the specific benchmarks, end of the pipe or final discharge BMPs may be necessary.

BMP: Storm Treat System uses a 4 x 9 chambered treatment tank (sedimentation and

filtration) that discharges to a small constructed wetland, catch basin, swale or sump near the pollution source. The system can capture and treat the first flush runoff when located high in the watershed and near the source of pollution. The number of units used depends upon the design storm, size of sub-drainage area and needed detention volume.

- Significantly smaller (5-10%) than other systems. Good for constrained sites, such as roadside wetlands.
- Discharge is slow enough for discharge to a constructed wetland or groundwater, so it can be located in low permeability soils with a high water table (self-anchored).
- Closed system with no standing water (public health/safety issue) and can be shut off in case of a local spill.
- Requires sediment removal every three to five years by suction pump and annual inspection of skimmers and screens.
- Can connect to existing drainage structure, usually a catch basin, swale or sump to provide treatment.

Efficiency/Impact: Storm Treat System removal efficiency:

a) Fecal coliform = 97%
b) TSS = 99%
c) COD = 82%
d) Total dissolved nitrogen = 44%
e) Total petroleum hydrocarbons = 90%
f) Lead = 77%
g) Chromium = 98%
h) Phosphorus = 90%; and
i) Zinc = 90%

BMP Nº CS34

Activity: Sites with surface water runoff contamination that have implemented specific non-point source BMPs for pollution prevention but have been unable to reduce the pollutant discharges in their storm water runoff to levels below the benchmarks. Unused excess land may be necessary to implement these BMPs.

Typical Pollutants: Sediment(TSS), metals, BOD, phosphorus, and hydrocarbons(Oil & Grease)

Typical Problem: When the implementation of specific point source BMPs has not eliminated or reduced the contaminants in the storm water to the specific benchmarks, end of the pipe or final discharge BMPs may be necessary.

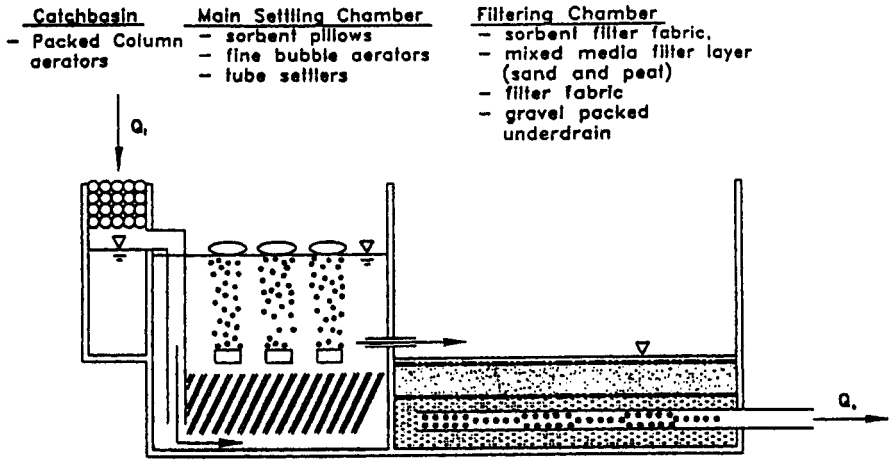


Figure 9. General Schematic of MCTT

BMP: Multi-Chambered Treatment Train (MCTT) uses a catch basin/sump and two chambers: initial grit catch basin for large sedimentation and volatiles, main settling chamber (aeration and sorbent pillows) for the removal of fine sediment, associated toxicants, and floating hydrocarbons (settling time 1-3 days); and a sand/peat filter/ion exchange unit to remove filterable toxicants.

- Best in small, isolated, paved critical source areas (0.25 to 2.5 acres).
- Suggested for the following land uses: vehicle service facilities, convenience store parking areas, equipment storage areas and salvage yards.
- Uses 1/3 the area of a wet detention pond.
- Very effective removal rates for both filtered and particulate storm water toxicants and suspended solids.
- Very new technology, so costs are currently high, but are expected to drop with pre-fabrication. Can be used in retrofitting; preliminary experimental costs at a gas station were $54,000
- Design is very site specific and highly dependent upon local rains (depth, intensity and inter-event time). The size of the main chamber increases as the annual rain volume increases. The inter-event period and rain volume determines the specific runoff treatment volume requirements. Seattle requires a small MCTT because of the small rain depths for each rain.

Efficiency/Impact: Multi-Chambered Treatment Train removal efficiencies:

a) Total toxicity = 96%
b) Filtered toxicity = 98%
c) Suspended solids = 83 to 95%
d) COD = 60 to 90%
e) Turbidity = 40 to 90%

f) Lead = 95%
g) Zinc = 85 to 90%
h) Cadmium = 90%
i) Copper = 65 to 90%
j) Pyrene = 75 to 85%
k) Phosphorus = 80 to 90%
l) Ammonia = 50%
m) n-Nitro-di-n-proplamine = 100%, and
n) pH decreased by 25 to 50%

Color increased by 25 to 50% and nitrate nitrogen had low removal rates.

BMP N^{o} CS35 (Reference #30)

Activity: Sites with surface water runoff contamination that have implemented specific non-point source BMPs for pollution prevention but have been unable to reduce the pollutant discharges in their storm water runoff to levels below the benchmarks. Unused excess land may be necessary to implement these BMPs.

Typical Pollutants: Sediment (TSS), metals, BOD, phosphorus, and hydrocarbons (Oil & Grease)

Typical Problem: When implementation of specific point source BMPs have not managed or eliminated the contaminants in the storm water to the benchmarks or below or where potential point sources for the contaminants can not be identified, end of the pipe or final discharge BMPs may be necessary.

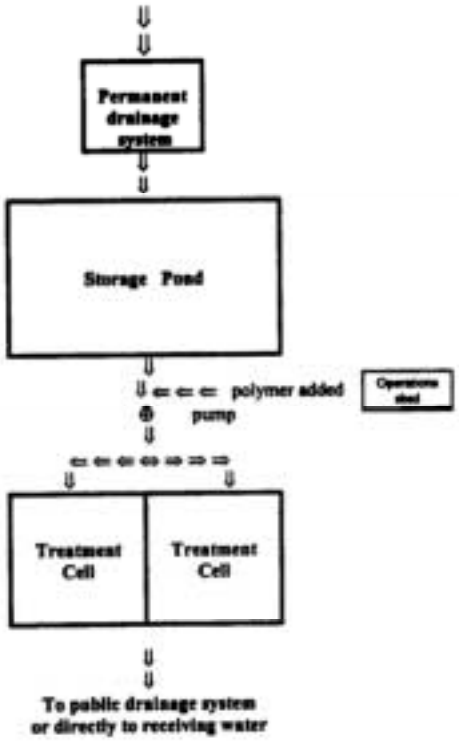
BMP: Install a flocculation system using a flocculent such as Calgon Cat Floc 2953 or a Polyaluminum Chloride such as Sumalchlor-50 or other.

Fine particles suspended in water give it a milky appearance, usually measured as turbidity or total suspended solids. Their small size, often much less than 0.001 mm in diameter, give them a very large surface area relative to their

volume. These fine particles typically carry a negative surface charge. Largely because of these two factors, small size and negative charge, these particles tend to stay in suspension for extended periods of time. Because of this, removal is not practical by settling alone. Polymers and inorganic chemicals speed the process of clarification. The added chemical destabilizes the suspension and causes the smaller particles to agglomerate. The process consists of three steps: coagulation, flocculation, and settling or clarification.

The conditions under which clarification is achieved can affect performance.

Currents can reduce settling efficiency. Currents can be produced by wind, by differences between the temperature of the incoming water and the water in the clarifier, and by flow conditions near the inlets and outlets. Calm water such as that which occurs during batch clarification provides a good environment for effective performance, as many of these factors become less important in comparison to flow-through clarification basins. One source of currents that is likely important in batch systems is movement of the water leaving the clarifier unit. Given that flocs are relatively small and light the exit velocity of the water must be as low as possible. Sediment on the bottom of the basin can be resuspended and removed by fairly modest velocities.



Coagulants and flocculant-aids:

Polymers are large organic molecules that are made up of subunits linked together in a chain-like structure. Polymers that carry groups with positive charges are called cationic. Cationic polymers can be used as primary coagulants to destabilize negatively-charged turbidity particles present in storm water. Inorganic chemicals such as aluminum or ferric sulfate and aluminum or ferric chloride can also be used, as these chemicals become positively charged when dispersed in water.

In practice, the only way to determine whether a polymer is effective for a specific application is to perform preliminary or on-site testing. Polymer effectiveness can degrade with time and also from other influences. Thus, manufacturers' recommendations for storage should be followed.

Application of coagulants and flocculent-aids at the appropriate concentration or

dosage rate for optimum turbidity removal is important for management of chemical cost, as well as for effective performance. The optimum dose in a given application depends on several site-specific features. The turbidity of untreated water is a primary determinant. The surface charge of particles to be removed is also important, as previously noted. Environmental factors that can influence dosage rate are water temperature, pH, and the presence of constituents that consume or otherwise affect polymer effectiveness (for example, color, oils). Preparation of working solutions and thorough dispersal of polymers in water to be treated is also important to establish the appropriate dosage rate.

Design engineers wishing to review more detailed presentations on this subject are referred to the following textbooks:

- Fair, G., J. Geyer and D. Okun, *Water and Wastewater Engineering*, Wiley and Sons, NY, 1968.
- American Water Works Association, *Water Quality and Treatment*, McGraw-Hill, NY, 1990.
- Weber, W.J, *Physiochemical Processes for Water Quality Control*, Wiley and Sons, NY, 1972.

Comparisons

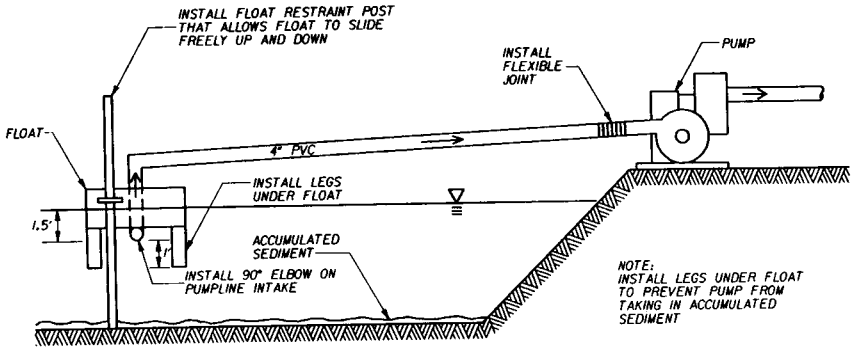
The above discussion indicates that the design and operation of a polymer system should take into consideration the factors that determine optimum, cost-effective performance. It may not be possible to fully incorporate all of the classic concepts into the design because of practical limitations at construction sites. Nonetheless it is important to recognize the following:

- The right polymer must be used at the right dosage. A dosage that is either too low or too high will not produce the lowest turbidity. There is an optimum dosage rate. This is a situation where the adage “more is always better” does not apply.
- The coagulant must be mixed rapidly into the water to ensure proper dispersion.
- A flocculation step is important to increase the rate of settling, to produce the lowest turbidity and to keep the dosage rate as low as possible.
- Too little energy input into the water during the flocculation stage results in flocs that are too small and/or insufficiently dense. Too much energy can rapidly destroy floc as it is formed.
- Since the volume of the basin is a determinant in the amount of energy per unit volume, a basin can be too big relative to the size of the energy input system.
- Care must be taken in the design of the withdrawal system to minimize outflow velocities.

Number and volume of treatment cells

There are three reasons for having two rather than one treatment cell. First, if something goes wrong with the treatment of a particular batch, the contractor can continue treatment in the second cell while dealing with the problem in the first cell. The second reason is the uncertainty over the time required to achieve satisfactory clarification. If one had confidence that satisfactory settling could be achieved consistently within 30 to 60 minutes, it might be reasonable to conclude that only one cell is needed since turnover could occur rapidly. The third reason is the time to empty the cell after treatment. It therefore seems appropriate to use two cells.

The second consideration is the volume of the individual treatment cell. There are two opposing considerations in sizing the treatment cells. There is a desire to have a large cell- so as to be able to treat a large volume of water each time a batch is processed. However, the larger the cell the longer the time required to empty the cell. It is also possible that the larger the cell the less effective the flocculation process, and therefore the settling. The simplest approach to sizing the treatment cell is to multiply the allowable discharge rate by the desired draw-down time. The desired draw-down time is about four hours.
A four-hour draw-down time allows one batch per cell per eight hour work period. A batch can be prepared in the morning including an hour or so of flocculation followed by about two hours of settling followed by discharge, although discharge could occur after hours. Or a batch can be prepared in the afternoon, followed by settling overnight, with discharge the following morning. The main point is that it appears to be most logical to size the cell to fit the desired drawdown time, constrained by the allowable release rate.



FLOATING PUMPLINE INTAKE (TYP.)

Configuration of the outlet device

The withdrawal device used for removing the liquid from the settling pond should be designed so that pulling settled sediments from the bottom of the treatment cell in the vicinity of the device does not occur. Whether this is a problem is not known but it should be evaluated. One approach is to place the discharge outlet near the area where treated water enters the cell. At this location there will be relatively little accumulation of solid because of the turbulence created by the incoming water.

A second approach is to use the float configuration as in the diagram shown above. The use of four rather than one inlet pipe reduces the inlet velocity. Reduced inlet velocity reduces the possibility that sediments will be picked up and discharged from the settling pond.

A third approach is to modify the float to include a square circular weir that the water enters before reaching the outlet pipe. A circular weir with, say, 10 feet of circumference would significantly reduce the overflow rates(velocity) over the weir. As an example, examine how exit velocities are kept as low as possible in water and wastewater clarifiers. These clarifiers include what is known as effluent launders. They are long troughs, placed at the outlet end the clarifier or around the outside circumference in the case of circular clarifiers, into which the water flows. Actually weirs, they reduce the exit velocity of the water leaving the clarification area of the clarifier.

The weir may provide at least one and possibly two benefits with the treatment of storm water. First, it may reduce the carry-out of floc that is still settling while the cell is being drawn down, could result in lower final effluent turbidities and/or allow a reduction in the settling time to achieve the same effluent turbidity. Secondly, the weir could reduce if not eliminate the tendency for the withdrawal pipe to suck-up previously settled sediment.

FLOCCULATION SYSTEMS SHOULD BE DESIGNED BY KNOWLEDGEABLE PERSONNEL. A CONSULTANT SHOULD BE CONTRACTED WITH TO DEVELOP AND IMPLEMENT A SYSTEM. OPERATING PERSONNEL NEED TO BE SPECIFICALLY TRAINED TO OPERATE THESE SYSTEMS.

Efficiency/Impact: Mean turbidity reductions can be achieved in the 95.5% to 99.4% range.

BMP Nº CS36

Activity: Sites with surface water runoff contamination that have implemented specific non-point source BMPs for pollution prevention but have been unable to reduce the pollutant discharges in their storm water runoff to levels below the benchmarks.

Typical Pollutants: Sediment (TSS), metals, BOD, phosphorus, and turbidity

Typical Problem: When implementation of specific point source BMPs have not managed or eliminated the contaminants in the storm water to the benchmarks or below or where potential point sources for the contaminants can not be identified, end of the pipe or final discharge treatment BMPs may be necessary.

BMP: Experiments with a process tentatively called ElectroFloc indicates that it may be possible to use electricity to floc dissolved metals, TSS, and turbidity from storm water runoff. By charging aluminum plates with about 40 volts DC in a batch process, it has been shown to create an approximately equal number of charged particles in suspension. These dissimilar charged particles attract each other and due to aluminum ions present remain in contact with each other in as little as five minutes per liter. This works for TSS and turbidity in the lab and should work for dissolved metals as the metals usually are not really dissolved but submicron in size particles. Dissolved oxygen is increased in the water due to the splitting of the water molecule into hydrogen and oxygen in which the hydrogen leaves the water and the oxygen saturates the volume.

Efficiency/Impact: Lab tests have repeatedly show that TSS and turbidity can be reduced by 98% and the dissolved oxygen content can be increased to around 16 mg/l. To date, no tests have been performed on heavy metals.

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