Appendix N

Appendix N.1 Best Management Practices – Structural or Vegetated

Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	Communities Using BMP	MDNRE/NRCS Link
Pretreatment (e.g., sediment traps, drainage channels, water quality inlets)																
Catch Basin Inlet Devices	Devices that are inserted into the storm drain inlets to filter or absorb sediment, pollutants, and sometimes oil and grease. The capture of hydrocarbons can be enhanced with the use of absorbents.	Solids, Sediments, Petroleum if specific types are used	Moderate to high; 70% of total suspended solids; <20% of total phosphor us. Assume same As Hydrodynamic Separators.	Storm water runoff	Catch basin cleaning program, Proper disposal of sediment at WWTP	2 - 5 years	High; Remove and dispose of sediment, trash and debris, and change filters as needed (approximately every 6 months)	Low/moderate	Needs less than 5 acres of drainage area.	Proper disposal of sediment	Assess contributing area to size inlet grate and assure bypass can handle flows	$70 - 1,200	$300/Catch Basin/year	Useful for retrofit	MDOT	
Permanent Sediment Basin (including forebays)	Man-made depression in the ground where runoff water is collected and stored to allow suspended solids to settle out. May have inlet and outlet structures to regulate flow.	Sediments, solids	Moderate to high; 50% of Total Suspended Solids; <20% of Total Phosphorous	Storm water runoff	Detention/ Infiltration Vegetation, Stone filter at outlet structure	50+ years	Moderate; Remove and dispose of sediment, trash and debris, and repair erosion at inlets or outlets. Keep vegetation to a moderate level	Low	Use for large drainage areas (≥ 1 acre), at storm sewer outfalls, may be included with detention pond, and to collect overland flow.	Proper disposal of sediment unless journal documentation supports normal procedures for disposal	Assess contributing area and sediment load	Low; Capital Cost: $0.60/cft of storage volume excluding land purchase.	7% of capital cost/year.	Not always aesthetically pleasing, keep vegetation to a normal level to blend into landscaping		http://www.deq.state.mi.us/documents/deq-swq-npssb.pdf
Curb cuts with Water Spreader and Vegetated Swale	Inlets cut or formed into curbs. Stormwater runoff is directed off the Street or parking lot at the inlet cuts	Sediments, water volumes	High; 80% of total suspended solids. 50% of total phosphorous.	Stormwater runoff	Vegetated swale, detention basin	30+ years	Moderate; Remove and dispose of sediment, trash and debris, and repair erosion.	Low	Use in areas where swales can be designed, parking lots or other large impervious areas		Asses contributing area and design inlet accordingly, assure swales are properly sized	Moderate	Low	Need to stabilize cut out sections behind curb to prohibit soil erosion. Requires a vegetated swale behind the curb. Street sweeping.	BASWA, SASWA	
Check Dams, Grade Control Structures (MACDC BMP NRCS practice 410)	Stones, sandbags, or properly sized gravel generally used to stabilize grades in natural or artificial channels by carrying runoff from one grade to another. Designed to prevent banks from sloughing, reduce runoff velocity, and prevent channel erosion from an excessive grade. Also used to settle out sediments	Sediment and attached pollutants, hydrologic flow	High (classic gully erosion) Moderate (streambank erosion) Low (runoff/ flooding)	Streambank erosion, soil erosion, storm water runoff Surface drainage V-ditches for ag.	Buffer/filter strips, grassed waterway, diversion, critical area planting	25+ years	Low. Periodic inspections. Repair/replace failing structures. Address any vegetation and erosion problems.	Moderate. Design and installation should be done by a registered professional civil engineer	Widely applicable to erosive areas with an excessive grade. Place in drainage channel. Or for surface drainage in farm fields	Concentrated flows may cause erosion downstream - discharge point should be watched. If used with V-ditch drainage use vegetation of buffers as needed	Cause backwater effect; slows down water velocities; capacity equal to channel	Low to moderate. $3,650/ structure or $800/ vegetated chute - EQIP, WHIP	Low. $50 structure (9)	Use native grasses when planting filter strip. Easements or permits may need to be obtained.		http://www.deq.state.mi.us/documents/deq-swq-npsed.pdf
Baffle Box Systems Hydrodynamic Separator Units (Continuous Deflective Separation (CDS) Units, Stormceptor, Vortechnics, Downstream Defender)	Precast, flow-through, underground units that capture sediments, debris, and oils (in some units). The capture of oils can be enhanced with the use of absorbents. (Sun Technologies, CDS, Vortechs, Downstream Defender, Stormceptor).	Sediment, solids	Effective; 60% TSS Removal ; <20% of total phosphorous	Storm sewer system	Street sweeping, stream protection practices, Sediment trap, vegetation,	50+	Moderate; Remove and dispose of sediment, trash and debris	Minimum	Use for small drainage areas (≤ 1 acre) with high pollutant loads, in line with storm sewer system, and to collect overland flow.	Proper disposal of sediment	Catches first flush. Baffle Box system by Sun Technologies does not bypass high flows High flows on CDS & vortechs by-pass some units through pipe system	Moderate to high . $2,000 per acre of impervious 6,000/cfs capacity	$500 practice; $1,000/year	Placed upstream of storm sewer discharge. Unit is below grade. Need to allow access for cleaning the chambers.		http://www.deq.state.mi.us/documents/deq-swq-npsogs.pdf

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Detention/Retention Basins																
Wet Detention Basin (wet pond)	Small, constructed detention / retention basin to maintain a permanent pool of water with emergent wetland vegetation around the bank. Designed to capture and remove particulate matter, non soluble metals, organic matter and nutrients through settling. It generally has inlet and outlet structures to regulate flow.	Sediment; nutrients; hydrologic flow	Moderate; 80% of total suspended solids (4) 50% of total phosphorous (4). Of the detention/ retention basins, this practice may be the most effective in removing pollutants.	Storm water runoff	Swales, vegetation Sediment forebay or other form of pretreatment, riprap, sediment basin, stone filter	50+ years	Low; remove and dispose of sediment, trash and debris; repair erosion; and plant replacement vegetation as needed.	Low; design and installation should be done by a registered civil engineer and go through review process	Use for large drainage areas (≥ 10 acre), at storm sewer outfalls, and to collect overland flow. Ponds generally will not work in soils with high infiltration rates.	Possible downstream warming; low bacteria removal; Mosquito controls	Provides full control of peak discharges for large design storms. Outlet device regulates the flow from the basin.	Low to moderate; $1.50/cft of storage volume, excluding land purchase	5% of capital cost/year.	Need available land area, can include sediment forebay, requires more planning, maintenance, and land to construct. Emergency overflow must be planned out..	Bay, Midland, Saginaw Counties	http://www.deq.state.mi.us/documents/deq-swq-npswdb.pdf
Dry Detention Basin	Constructed basins designed to capture and remove particulate matter. It generally has inlet and outlet structures to regulate flow, but is dry for most of the year.	Sediment, nutrients; hydrologic flow	Moderate; 80% of total suspended solids 50% of total phosphorous	Storm water runoff	Sediment forebay or other form of pretreatment Stone filter outlets	50+ years	Low; remove and dispose of sediment, trash and debris; repair erosion at inlet and outlets	Minimum, design and installation should be done by a registered civil engineer and go through review process	Needs land that will allow inlet at a higher elevation than outlet.	Low bacteria and nutrient removal. If vegetation is not maintained, erosion and re-suspension can occur.	Reduced peak flows and no standing water. Outlet device regulates the flow from the basin.	Low to moderate. $1.50/cft	Low to moderate. 3% of capital cost / yr	Basin grading very important to prevent pools of standing water or underdrain with 4 inch tiles to keep dry bottom Emergency overflow must be planned out..	MDOT Bay, Saginaw and Midland Counties	
Extended Detention Basin	Extended detention basins are designed to receive and detain storm water runoff for a prolonged period of time, typically up to 48 hours. Benefits include: receives and detains storm water runoff, minimizes downstream erosion, reduces flooding, and provides enhanced pollutant removal.	Sediment and attached pollutants, non-soluble metals, nutrients, hydrologic flow	Moderate to high Moderate; 80% of total suspended solids (4) 50% of total phosphorous	Storm water runoff	Riprap, grassed waterways, sediment basins, stone filter outlets	50+ years	Moderate to high dispose of sediment, trash and debris; repair erosion at inlet and outlets	Mow buffer/filter strip, remove debris and inspect basin regularly during wet weather, and remove sediment from basin every 5-10 years.	Needs land that will allow inlet at a higher elevation than outlet	Can significantly warm the water in sensitive discharge areas over a short period of time.	Designed to receive and detain storm water runoff for a prolonged period of time. Outlet device regulates the flow from the basin.			Determine site location of BMP through a hydrologic analysis. Designed as either single stage or two-stage. Emergency overflow must be planned out..	Bay, Saginaw and Midland Counties	http://www.deq.state.mi.us/documents/deq-swq-nps
Parking Lot Storage	Storage of storm water on parking lots is used primarily to reduce the peak discharge of storm water from the surrounding area during moderate storms. Will reduce peak runoff from small sites and provide some flood storage. This helps reduce stream bank erosion and flooding.	Sediment and attached pollutants, hydrologic flow	Low – most sediments are trapped in CB sumps	Storm water runoff, soil erosion	Grassed waterway, porous or modular pavement, infiltration trench, buffer/filter strip, street sweeping, CB inserts	25+ years	Low to moderate - sweep and clear debris from the parking lot after storms. Regularly inspect and clean the release drain.	design and installation should be done by a registered civil engineer and go through review process	This BMP will work best in areas that do not have a steep slope. .	Because detention time is small, only some large solids will settle. Solids must be removed often to prevent re-suspension.	Reduces peak runoff from small sites, provides some flood storage, and reduces flooding.	$2.00/cft	Moderate to high when considering the replacement of pavement due to failures	BMP is most effective when used with other BMPs that allow for infiltration or sediment trapping. Emergency overflow must be planned out	Bay, Saginaw and Midland Counties	http://www.deq.state.mi.us/documents/deq-swqnpspls.pdf
Water and Sediment Control Basin (638)	An earth embankment or a combination ridge and channel generally constructed across the slope and minor watercourses to form a sediment trap and water detention basin. Improves water quality by trapping sediment on uplands and reducing gully erosion. Grass cover may provide wildlife habitat. Dissolved substances, such as nitrates, may be removed from discharge to downstream areas because of the increased infiltration.	Sediment and attached pollutants, nutrients, hydrologic flow	High (gully erosion) Moderate (runoff/ flooding) Low (streambank erosion)	Soil erosion, agricultural runoff	Nutrient management, terraces, grassed waterways, contouring, conservation cropping system, conservation tillage, and crop residue management	10 years	Reseed and fertilize as needed. Check basins after large storm events and make necessary repairs.	USDA Natural Resources Conservation Service (NRCS) available for assistance	Widely applicable.	Low bacteria and nutrient removal. If vegetation is not maintained, erosion and re-suspension can occur.	Traps storm water runoff and prevents it from reaching lowlands. Moderate decrease in runoff/flooding. Slight increase in excess subsurface water.	$2,100 - 3,150/basin	5% of original cost per unit	Basin must be large enough to control the runoff from a specific design storm without overflow	Bay, Saginaw and Midland Counties	ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/638.pdf

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Regional Detention	Large, man-made basin designed to capture and remove particulate matter. It generally has inlet and outlet structures to regulate flow from large drainage areas.	Sediment; nutrients; hydrologic flow	Moderate	Storm water Runoff, nutrients	Sediment forebay or other form of pretreatment, sumps in CB, vegetated ditches, swales, CB inserts	50+ years	Low; remove and dispose of sediment, trash and debris; repair erosion.	design and installation should be done by a registered civil engineer and go through review process	Use for large drainage areas (≥ 40 acres), at, industrial parks, large commercial centers	Possible downstream warming; low bacteria removal;	Reduced peak flows, storage Must assess contributing area and be reviewed	$1.60/ cft	Low to Moderate	Need available land area, can include sediment forebay. Maintenance requirements or agreements in place	Bay, Saginaw and Midland Counties	
Vegetated Treatment (e.g., bio-swales, grassed swale)																
Constructed Wetland	Excavated basin with irregular perimeters and undulating bottom contours into which wetland vegetation is placed to enhance pollutant removal	Sediment, nutrients, bacteria	Moderate to high depending on season; 80% of total suspended solids 50% of total phosphorous	Storm water Runoff, sediment, nutrients	Sediment forebay or other form of pretreatment	50+ years (1)	High when establishing, low after establishment; remove and dispose of sediment, trash and debris; repair erosion.	Moderate to High, design and installation should be done by a registered civil engineer and go through review process	Significant land use requirement; needs appropriate soils, slope, and hydrology	Potential for nutrient release in winter months	Slows flow and reduces peak flow	Moderate to High; $1500 - $8,000 excluding purchase of land (3)	5% of capital cost/year	2% of drainage area needs to be wetland for efficient pollutant removal. Harvesting may be necessary if plants are taking up large amounts of toxics. Needs supplement water to maintain water level.	Bay, Saginaw and Midland Counties	http://www.deq.state.mi.us/documents/deq-swq-npsconw.pdf
Restored Wetland (NRCS practice 657)	Rehabilitation of a drained or degraded wetland where hydrology and the vegetative community are returned to their natural condition to the extent practicable. Provides natural pollution control by removing pollutants, filtering and collecting sediment, reducing both soil erosion and downstream flooding, and recharging groundwater supplies.	Sediment and attached pollutants, nutrients, hydrologic flow, bacteria, chemicals	Moderate to high (depending on season); 80% of total suspended solids from sheet, rill, wind, or ephemeral gully erosion 50% of total phosphorous.	Storm water runoff, soil erosion, nutrients	Sediment forebay or other form of pretreatment. In agricultural areas cattle exclusion fencing, buffer/filter strip, grassed waterway	50+ years	High; remove and dispose of sediment, trash and debris, and repair eroded areas.	Moderate to High Design and installation should be done by a professional.	Site must have previously been a wetland.	Can increase water temperature. Potential for nutrient release in winter months.	Stores storm water and may reduce downstream runoff and flooding. Slows flow and reduces peak flow.	Low: $200 cost to landowner if wildlife organization involved. Break tile and build berm. $2,350/acre	3% of original cost	Many wetlands release water slowly into the ground which recharges groundwater supplies. One acre of wetland can store up to 1.5 million gallons of floodwater (EPA, 2002).		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/657.pdf
Rain Gardens and other "Landscaping for Water Quality" Techniques LID Design in Michigan	Small, vegetated depressions used to promote infiltration and evapo-transpiration of storm water runoff. A rain garden combines shrubs, grasses, and flowering perennials in depressions that allow water to pool for only a few days after a rain. Landscaping for water quality involves planting native gardens in place of turf grass using native grasses, sedges, and wildflowers. Protects water quality, captures rainwater, reduces flooding, eases soil erosion, increases infiltration, and requires less fertilizer and water to thrive.	Sediment and attached pollutants, nutrients, thermal pollution, solids, chemicals, oils, salt, hydrologic flow	High; 75% - 90% of total suspended solids. 75% of total phosphorous.	Storm water runoff, fertilizers, nutrients, oils, sediment	Mulching Vegetated swales leading to rain garden	Assume 25 years, based on rain gardens installed in the early 1990s in Prince George County, MD which are still functioning. Depends on plant types and owner maintenance	Low to Medium; remove and dispose of sediment, trash, and debris, repair erosion, re-vegetate, and weed, water, and mulch, annually. Soil replacement and additional preparation are sometimes needed for success. A mulch of shredded hardwood is an integral part of the rain garden to keep the soil moist and ready to soak up rain,	Moderate, initial work to establish plant community. Aesthetic maintenance after initial establishment of rain garden. Center for Environmental Study, Master Gardeners Program, West Michigan Environmental Action Council available for assistance.	Site specific, depends on soils. Use for drainage areas ≤ 5 acres, at storm sewer outfalls, and to collect overland flow. Highly suitable for residential areas, not on steep slopes	Introduction of exotic/invasive plant species possible. Landowner may treat vegetation with herbicides or pesticides which could be carried via runoff to surface waters.	Will reduce the velocity of storm water runoff and increase infiltration	$1,075 - $12,355/ rain garden (dependent on surrounding land use)	Low. Assume $100/year; similar to yearly landscaping maintenance	Use native plant species. Soils adequate for infiltration are required. Cold climates may reduce evapotranspiration and infiltrative capacity. Practice not suitable for slopes greater than 20% (1). Pretreatment (sediment basin) needed in high sediment load areas. Not used in wellhead protection areas.		PUT IN WEBSITE FROM STATE

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Vegetated Buffers or Filter Strips (NRCS Practice 393) OR Ag BMP developed for the Kawkawlin WMP	A buffer/filter strip is a vegetated area adjacent to a water body. The buffer/filter area may be natural, undeveloped land where the existing vegetation is left intact, or it may be land planted with vegetation. Practice protects water bodies from pollutants such as sediment, nutrients and organic matter, prevents erosion, provides shade, leaf litter, and woody debris. Buffer/filter strips often provide several benefits to wildlife, such as travel corridors, nesting sites, and food sources.	Sediment and attached pollutants, nutrients, thermal pollution	High to Moderate (streambank erosion) Insignificant (runoff/ flooding)	Runoff from parking lots, roof tops, and outflow from ponds, soil erosion, agricultural runoff	Conservation tillage in agricultural areas Use of contouring for V-ditch applications, Use BMPs developed for Kawkawlin ag	10-20 years Can be shorter if experimental program criteria is used	Low. Perform periodic inspections to identify concentrated flows and to verify that vegetative cover is maintaining its effectiveness. Address stream bank erosion if identified. Damaged areas should be repaired.	Low. NRCS or Farm Bureau available for assistance.	Widely applicable.		Will reduce the velocity of storm water runoff and increase infiltration.	Low. $350/acre (10). $250/ herbaceous acre – Conservation Reserve Program (CRP), Environmental Quality Management Program (EQIP).	Low. $10/acre	Several researchers have measured >90% reductions in sediment and nitrate concentrations; buffer/filter strips do a reasonably good job of removing phosphorus attached to sediment, but are relatively ineffective in removing dissolved phosphorus (Gilliam, 1994).	Bay, Saginaw and Midland Counties	http://www.deq.state.mi.us/documents/deq-swq-npsbfs.pdf ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/393.pdf
Forested or Wooded Riparian Buffer (NRCS practice 390)	Forested or wooded areas adjacent to stream.	Sediment and attached pollutants, nutrients, thermal pollution	High (sheet, rill, wind, streambank, soil mass movement, road bank/ construction erosion; organics, fertilizers, pesticides, runoff/ flooding)	Runoff from parking lots, roof tops, and outflow from ponds, soil erosion, storm water runoff, ag runoff	Filter strip	75 years	Low. Perform periodic inspections to identify concentrated flows and to verify that vegetative cover is maintaining its effectiveness. Address stream bank erosion if identified. Damaged areas should be repaired.	Moderate to High. NRCS/Michigan Department of Agriculture (MDA) available for assistance.	Widely applicable.	Poor or lack of maintenance may cause increased erosion if trees fall into stream.	Trees in the floodplain may catch debris and impede flow.	Low. $475/ forested acre - CRP, EQIP	1% of original cost	Keep south and west sides of streams wooded to provide shade. Several researchers have measured >90% reductions in sediment and nitrate concentrations; buffer/filter strips do a reasonably good job of removing phosphorus attached to sediment, but are relatively ineffective in removing dissolved phosphorus (Gilliam, 1994).		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/390.pdf
Two-stage channel design (MACDC BMPs)	A practical procedure that can be used to correctly size the stream channel and minimum bench widths for stable, effective discharge in agricultural drainage ditches. The bench of a two-stage ditch acts as a floodplain within the ditch to dissipate energy, reduces the erosive potential of high flow volumes, and reduces the shear stress on the bank toe. Two-stage ditches will have improved conveyance capacity, will be more self sustaining, will create and maintain better habitat, and will improve water quality.	Sediment, hydrologic flow	Low to moderate during high flow times	Agricultural runoff	Filter/buffer strips	25 yrs	May require less maintenance than conventional ditches.	The MACDC and their consultants have considerable experience in this BMP. The Nature Conservancy has information available for assistance.	Widely applicable.	None	Two-stage drains have improved conveyance capacity compared to conventional drains and enhance drainage.	In comparison to conventional drains, additional costs are related to increased width and more initial earthwork.	May result in less annual Operation & Maintenance (O&M) costs then conventional drains.	Evidence and theory both suggest that drains prone to filling with accumulated sediment may require less frequent "dipping out" if constructed in a two-stage form.	Bay, Saginaw and Midland Counties	

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Infiltration																
Infiltration Trench LID Design Manual for Michigan	An excavated trench (3 - 12 feet deep), backfilled with stone aggregate, and lined with filter fabric. Infiltration trenches remove fine sediment and the pollutants associated with them.	Nutrients, sediment, metals, hydrologic flow (soluble pollutants - dependent on holding time)	High; 100% of total suspended solids; 60% of total phosphorous.	Storm water runoff	Sediment basin, buffer/filter strips, oil/grit separators.	Short; 10 years or less	Low to Moderate - Annual; Remove and dispose of sediment, trash and debris. Eroding or barren areas must be re-vegetated.	Moderate. Design and installation should be done by a licensed civil engineer and reviewed	specific; depends on soils. Soil infiltration rates must be greater than 0.52 inches per hour, with clay content less than 30%. OR Soils need to be amended and the trench must have a perforated tile drain to an outlet, must have the grade to establish	If storm water runoff contains high amounts of soluble contaminants, groundwater contamination can occur. However in heavy soil areas this is not as high a concern if the trench is underdrained	Provides full control of peak discharges for small sites, provides groundwater recharge, may augment base stream flow, and allow infiltration.	Moderate; average $6/cubic feet of storage	9% of capital cost	Avoid areas with potential hazardous material contamination. Soils with high infiltration rates required. Cold climates may hinder infiltrative capacity, fines will clog pore space in soil, and practice is not suitable for steep slopes. Use as part of a "treatment train," where soluble organic substances, oils, and coarse sediment are removed prior to storm water entering the trench. A very high failure rate occurs with infiltration trenches if they are not maintained.	MDOT Bay, Saginaw and Midland Counties	
Infiltration Pond LID Design Manual for Michigan	Water impoundment over permeable soils which receives storm water runoff and contains it until it infiltrates the soils.	Nutrients, sediment, metals	High	Storm water runoff	Sediment forebay or other form of pretreatment	25+ years	Annual	Moderate. Design and installation should be done by a licensed civil engineer and reviewed	Site specific depends on soils	Potential to contaminate groundwater	May recharge groundwater	Moderate	Moderate	Avoid areas with potential hazardous material contamination.	MDOT	
Porous or Modular Pavement LID Design Manual for Michigan	Permeable asphalt, porous concrete or interlocking paving blocks providing infiltration. When the brick or concrete is laid on a permeable base, water will be allowed to infiltrate. Benefits include: removal of fine particulates and soluble pollutants; attenuation of peak flows; reduction in the volume of runoff; reduction in soil erosion; and groundwater recharge.	Nutrients, sediment, metals, hydrologic flow	High; 95% TSS removal rate	Storm water runoff	Vacuum sweeping, subsurface drains, extended detention basin, infiltration basin.	10+ years	Moderate; Bi annual sweeping required. Periodically inspect, especially after large storms. If severe clogging occurs, may have to replace filtering material.	Low. . Design and installation should be done by a licensed civil engineer or landscape architect and reviewed .	This practice should only be used on sites with soils which are well or moderately well drained. Must use special materials for high traffic areas.	Potential risk to groundwater due to oils, greases, and other substances that may leak onto the pavement and leach into the ground. May need drainage system under site	Provides soil infiltration, attenuation of peak flows, reduction in the volume of runoff leaving the site and entering storm sewers, and groundwater recharge.	Moderate $7/ sq ft	Low to Moderate	Pretreatment of storm water is recommended where oil and grease or other potential groundwater contaminants are expected. Avoid areas with potential hazardous material contamination.	MDOT Bay, Saginaw and Midland Counties	

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Filtration																
Vegetated Swale or Bio-filtration LID Design Manual for Michigan	A broad, shallow channel consisting of dense vegetation and designed to accommodate concentrated flows without erosion.	Sediment	High; 75% - 80% of total suspended solids 50% of total phosphorous	Storm water runoff	Native vegetation	20-50 years	Moderate; remove and dispose of sediment, trash and debris, and repair erosion.	Moderate	Highly applicable to residential areas, not suited to steep slopes.	Potential to contaminate groundwater	Slows flow, contributing area must be considered	Low; $0.50 0.75/ square foot of swale	Low ~$0.05/sq yd	Does not require a large land area. Should not be used in steep areas or well head areas. Soils adequate for infiltration required to discourage ponding on slopes less than 2%.	MDOT Bay, Saginaw and Midland Counties	
Sand Filters	Area designed to hold and treat the first half inch of runoff discharging from an adjacent impervious area.	Sediment, bacteria, nutrients, metals	Moderate; 83% TSS removal rate	Storm water runoff		Yet to be determined.	Moderate to High depending on amount of sediment	Moderate	Suitable for individual Develop-ments; requires less land and can be placed underground.	Will not filter soluble nutrients and toxics.	Contributing area	Low to moderate.	5% of initial construction costs (1)	BMP performance is still experimental.	Ingham County	
Agricultural BMPs																
Cattle Exclusion (NRCS practices: Use Exclusion (472), Fence (382))	Fencing to exclude cattle from waterbodies and protect drain and streambanks. Fencing prevents cattle from trampling banks, destroying vegetation, depositing waste in the stream, and stirring up sediment in the streambed.	Sediment and attached pollutants, nutrients, pathogens	Moderate to High	Livestock access, animal manure	Buffer/filter strip, alternative water sources for livestock, planned grazing system, stream crossing and livestock access.	10 years (use exclusion) 20 years (fence)	Repair fence as needed. Remove off-stream watering systems in the winter, if needed. Check Dams, sediment traps	SB RC&D or NRCS available for assistance SB RC&D	Widely applicable	Increased grazing in confined areas may reduce vegetative cover.	Fencing in floodplain may catch debris and restrict flow	$1.90/ft of fence (9) - EQIP (use exclusion) Wildlife Habitat Incentive Program (WHIP) (fence)	$0.05/ft of fence (9)	Additional BMPs (e.g. Buffer/Filter Strips) are needed to prevent animal waste runoff from entering the stream.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandads/standards/472.pdfftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/382.pdf
Agricultural Waste Storage Facility (313)	A waste storage impoundment that protects water bodies from manure runoff by storing manure until conditions are appropriate for field application. Several options exist including an earthen storage pond, above or below ground tank, pit underneath a confinement facility, or a sheltered concrete slab area. Allows for field application when conditions are right. Field application cuts fertilizer costs and reduces nutrient losses.	Nutrients, pathogens	Moderate (organics, fertilizers, and polluted storm water runoff)	Animal manure	Cattle exclusion fencing, roof runoff management, diversion, Comprehen-sive Nutrient Management Plan (CNMP)	15 years	Inspect storage structures for leaks or seepage periodically and make necessary repairs. Repair any damaged fences immediately. Empty storage structure twice a year.	SB RC&D or NRCS available for assistance SB RC&D	Widely applicable	Leaks or seepage of the structure could add nutrients and bacteria to downstream water bodies via runoff. However, if building is according to specifications this would not occur.		Approximate-ly $10,000 - 250,000 - EQIP	$250 - 1,000 maximum	Storage period should be 6 months unless winter applied risk index is completed.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/313.pdf

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Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	Communities Using BMP	MDNRE/NRCS Link
Alternative Water Sources (Watering Facility (614), Water Well (642))	A readily available source of clean drinking water for cattle located away from water bodies. Reduces the direct deposition of cattle waste into water bodies by changing animal behavior through providing alternate drinking water.	Sediment and attached pollutants, nutrients, pathogens.		Livestock access, animal manure	Cattle exclusion fencing, buffer/filter strip, planned grazing system, stream crossing and livestock access	10 years / watering facility 20 years / water well (	Watering facility: check for materials in the trough which may restrict the inflow or outflow system; check for leaks and repair immediately; check the automatic water level device to insure proper operation. Water well: create a maintenance plan including a log of identified problems, corrective actions taken, etc.	NRCS available for assistance	Widely applicable	Depending on the structure, it may not protect watercourse if contiguous with it.	Diversion of water	$1,050 / water facility - EQIP	2% original cost (watering facility) 1% original cost (water well)	Areas adjacent to source that will be trampled by livestock should be graveled, paved, or otherwise treated to provide firm footing and reduce erosion.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/614.pdf ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/642.pdf
Cover Crop (340)	A crop of close-growing, grasses, legumes, or small grain grown primarily for seasonal protection and soil improvement. It usually is grown for 1 year or less, except where there is permanent cover as in orchards. Temporarily protects ground from wind /water erosion, adds organic matter to the soil, recycles or holds nutrients, improves soil tilth, reduces weed competition, retained soil moisture by acting as a mulch, and fixes atmospheric nitrogen (legumes).	Sediment and attached pollutants, nutrients, chemicals (pesticide), hydrologic flow, chloride (salt).	High (sheet, rill, wind, gully irrigation induced erosion, runoff/ flooding) Moderate (salts, organics, fertilizers, pesticides)	Soil erosion, agricultural runoff	Pest management, nutrient management, conservation crop rotation, crop residue management.	1 year	Plant cover crop annually, kill cover crop in the spring, restrict grazing if necessary.	SB RC&D or NRCS available for assistance SB RC&D	Widely applicable. Consider soil type, slopes, etc.	Requires pest management (IPM) to ensure that pesticide use is appropriate.	Significant decrease in runoff/ flooding, moderate reduction in excess subsurface water.	$10/acre - EQIP	$0/acre	Can be used for livestock feed or left alone to build soil organic matter.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/340.pdf
Windbreak/ Shelterbelt Establishment (380)	Rows of trees and shrubs that protect areas from wind and provide food and cover for wildlife. Reduces wind erosion, conserves energy, provides food and cover for wildlife, and beautifies a farmstead.	Sediment and attached pollutants.	High (wind erosion only)	Soil erosion	Cattle exclusion fencing	15 years	Control competing vegetation, inspect regularly	SB RC&D or NRCS available for assistance SB RC&D	Widely applicable	Over application of herbicides or pesticides possible.	Will reduce storm water runoff and increase infiltration.	$150 - 1,000 seedlings (13) - EQIP, WHIP	8% of original cost	Consider if the mature windbreak will cast a shadow over the driveway or nearby road, prolonging icy conditions.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/380.pdf
Conservation Cover (327)	Establishing and maintaining perennial vegetative cover to protect soil and water resource on land retired from agricultural production. Reduces erosion and increases soil tilth due to perennial cover establishment of species adapted to site. Improves water quality when nutrients and sediments are retained on the field. Reduces weed sources. Wildlife food, cover, and water needs will be met.	Sediment and attached pollutants, hydrologic flow, nutrients.	High (sheet, rill, wind, gully erosion; runoff/ flooding) Moderate (streambank erosion)	Soil erosion, agricultural runoff	Upland wildlife habitat management, wildlife food plot, tree/shrub establishment	10 years	If necessary, mow during the establishment period to reduce competition from annual weeds. Annual mowing of the conservation cover stand for general weed control is not recommended. Control noxious weeds.	NRCS available for assistance	Widely applicable	Over application of herbicides or pesticides possible.	Significant decrease in runoff/ flooding, moderate reduction in excess subsurface water.	$260 - 460/acre - CRP, EQIP	$35/acre	Use of fertilizers, pesticides and other chemicals should not compromise the intended purpose. Maintenance practices and activities should not disturb cover during the primary nesting period for grassland species in each state.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/327.pdf

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Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	Communities Using BMP	MDNRE/NRCS Link
Pasture and Hay Planting (512)	Planting grass and legumes to reduce soil erosion and improve production in a low-producing pasture, hayfield, or eroding crop field. Reduces soil erosion by wind and/or water, extends length of the grazing season, provides cover and habitat for wildlife, protects water quality by filtering runoff and increasing filtration, and adds organic matter to the soil.	Sediment and attached pollutants, nutrients, chemicals (pesticides), hydrologic flow	High (sheet, rill, wind ephemeral gully, irrigation inducted erosion; fertilizers, pesticides, runoff/ flooding)	Soil erosion, agricultural runoff	Nutrient management, pest management, prescribed grazing	10 years	Mow weeds, apply fertilizer and herbicide as needed	NRCS available for assistance	Widely applicable. Consider soil type.	Over application of herbicides or pesticides possible.	Significant decrease in runoff/ flooding and excess subsurface water.	$75/acre - EQIP, CRP	5% of original cost per unit	Do not mix warm and cool season grasses in the same pasture. Choose species that will help reduce the use of pesticides and herbicides.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/512.pdf
Critical Area Planting (342)	Establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical or biological conditions that prevent the establishment of vegetation with normal practices. Stabilizes areas with existing or expected high rates of soil erosion by water and wind. Restores degraded sites that cannot be stabilized through normal methods.	Sediment and attached pollutants, salts	High (sheet, rill, wind, gully, streambank, soil mass movement, road bank/ construction erosion) Moderate (salts)	Soil erosion, agricultural runoff	Diversions, riprap, grade stabilization structures, filter/buffer strips, subsurface drains, grassed waterways, nutrient management	10 years	Periodic burning (if needed), prohibit grazing until year 2, prevent overgrazing, inspect after severe storms	NRCS available for assistance	Widely applicable. Consider soil type, slopes, etc. Apply on any area which is difficult to stabilize.	Use of non-native or invasive species is not recommended. Use by recreational users may degrade area.	Will reduce the velocity of storm water runoff and increase infiltration.	$460 - $815/acre (2001 and 2004) EQIP, WHIP, WRP	1 % of original cost per unit	Use native plants with low long term maintenance requirements. Soil tests should be done to determine the nutrient and pH content of the soil.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/342.pdf
Grassed Waterway (412)	The establishment and shaping of grass in a natural drainage way to prevent gullies from forming. Vegetation filters runoff and provides cover for wildlife.	Sediment and attached pollutants, hydrologic flow	High (ephemeral gully erosion) Low (reduction in classic gully erosion, runoff/ flooding)	Soil erosion, agricultural runoff	Grade stabilization structure	10 years	Yearly re-grading, reseeding, and inspection of subsurface drain and related outfall may be needed. Fertilize as needed and mow periodically.	Design and installation should be done by a professional. NRCS available for assistance.	Widely applicable	Better conveyance enhances storm water runoff velocities and possible contamination to surface waters.	Drainage way directs runoff to an outlet.	$400/acre (without tile) $4,500/acre (with tile) (9) CRP, EQIP	$105/acre	A nurse crop, temporary cover or mulching may be necessary until permanent cover is established. Avoid planting end rows along the waterway.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/412.pdf
Diversion (362)	Earthen embankment that directs runoff water from a specific area. Reduces soil erosion on lowlands. Vegetation filters runoff water and provides cover. Allows better crop growth on bottomland soils.	Sediment, nutrients, chemicals (pesticide), hydrologic flow	High (ephemeral gully erosion, runoff/ flooding) Moderate (classic gully, soil mass movement, road bank/ construction erosion) Low (sheet, rill, streambank erosion, organics, fertilizers, pesticides)	Soil erosion, agricultural runoff	Sediment basin or stabilized outlet, buffer/filter strip, nutrient management.	10 years	Clear outlet of debris, maintain vegetative cover on ridge, ridge repair, fertilize as needed.	Design and installation should be done by a professional.	Widely applicable. Do not build in high sediment producing areas unless other conservation measures are installed.	Over application of fertilizer possible.	Catches storm water runoff and prevents it from reaching lowlands, reducing runoff velocity and increasing infiltration.	$5.00/ft - EQIP	$0.26/ft	Important as Soil Erosion and Sediment Control (SESC) in developing sites. Each diversion must have an outlet.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/362.pdf
Sump Filters	Use of filter cloth or stone at sump sites (hickenbackers) in field low spots during non field use times such as late fall to spring, when planting season approaches remove filter media	Sediment, nutrients	Moderate	Ag fields	vegetation	10 years	low	low	Only specific sites	None	None	$100 per site	$50/yr per site			

Appendix N.1 Best Management Practices – Structural or Vegetated

BMPs for surface drain V-ditches	Use of check dams, sediment traps, and vegetation to control sediment runoff from surface drains on ag fields	Sediment and nutrients	moderate	Ag fields	Vegetation, check dams, sediment traps	Varies,	low	Moderate, fields must be assessed for treatment train application by experience farmers or consultants	Specific sites	Erosion if check dam is used	Contributing areas and slope of land	$500 per site	Low	Slope of land, type of soils, size of stone, contributing area		
Field Drop structure	TO BE COMPLETED															
Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	Communities Using BMP	MDNRE/NRCS Link
Other BMPs																
Abandoned Oil / brine Well Closures and pipeline removal (Well decommissioning g (351))	Well decommissioning seals an abandoned well. Abandoned wells are wells which are no longer in use or are in such disrepair that brine or oil are no longer being obtained from them. Benefits include: a) Reduces the risk of surface or groundwater contamination, b) Eliminates the risk of injury, c) Avoids liability under the Michigan Polluter Pay Law	Sediment and attached pollutants, chemicals, nutrients, chloride (salt), pathogens, hydrocarbons	High	Agricultural runoff, hazardous waste spills	Stand alone practice	20 years		High: professional required. A drilled, deep bedrock and brine well should be closed by a licensed well driller.	Widely applicable.	Surface and Groundwater contamination may be present.	Will prevent oil or brine from reaching the surface water via the abandoned well or pipelines	Unknown but estimate the need for $50,000 to remove pipelines alone	Low	Technical assistance is required to properly close an abandoned well.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/351.pdf
Streambank and Shoreline Protection (580) Use of newer "green" technologies for stabilization	Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of rivers, such as bioengineering, riprap, geotextile materials, and vegetative techniques.	Sediment and attached pollutants	High (streambank erosion, soil mass movement)	Soil erosion	Livestock exclusion, prescribed grazing, buffer/filter strips, diversions, or additional sediment control measures.	20 years	Site inspections conducted to ensure the stream bank structures are staying in place within the first few months of installation and following storm events.	Consult the MDEQ (Water Division or Land Division), local Conservation District, NRCS, or other agencies or consultants.	Widely applicable: site-specific practices will depend on soil type, slope of the bank, river gradient, flow, and uses of the watercourse.		Maintains the capacity of the stream channel.	EQIP: 50% cost share	10% of original cost	Since each reach of a watercourse is unique, stream bank protection techniques must be selected on a site-by-site basis; the specifications for each technique differ. Utilize vegetative species that are native and/or compatible with local ecosystems.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/580.pdf
Dam Removal	Releases made from dams commonly cause a decrease in summer temperatures and an increase in winter temperatures downstream. Dam removal benefits fish by: (a) removing obstructions to upstream and downstream migration; (b) restoring natural riverine habitat; (c) restoring natural seasonal flow variations; (d) eliminating siltation of spawning and feeding habitat above the dam; (e) allowing debris, small rocks and nutrients to pass below the dam, creating healthy habitat; (f) eliminating unnatural temperature variations below the dam; and (g) removing turbines that kill fish.	Thermal pollution		Dam	Will depend on the effects of dam removal. Streambank stabilization may be necessary.	Permanent		Design and removal should be done by a professional.	Widely applicable to unsafe dams and dams that no longer serve a purpose.	Recent studies show removal of small dams can have limited negative environmental impacts while restoring stream functions. Negative impacts include elevated sediment loads in addition to transformed channel morphology and hydrology. Dam removal may also wreak havoc on already highly disturbed ecosystems. Reservoirs that store high levels of contaminants may release them following dam removal, creating a contaminant plume.	Dam removal will restore natural stream flow and natural seasonal flow variations.	A number of studies (River Alliance of Wisconsin 2003, American Rivers 2003) have found removal costs to be up to 1/3 to 1/5 the cost of repair, especially when the benefits of the dam are minor. Funding sources include: private or community foundation funding, environment	None	Many aging dams are no longer economically practical or cost effective to operate. Similarly, dam operation and maintenance costs tend to increase as a dam ages. These increased costs, combined with the potentially lower revenue, allow for removal to become the most cost effective alternative for the dam owner.		

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												al grants, and state or federal assistance programs.				
Tree revetments																
Pool & Riffle designs																
J-hooks and other flow deflectors BMPs																
Other Stream restoration BMPs																
Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	Communities Using BMP	MDNRE/NRCS Link
Stabilized Outlets	Outlets are areas which receive discharge water. Stabilized outlets are outlets which reduce the velocity of discharge water to non-erosive velocities. Stabilized outlets help reduce erosion in the area where water is released. Some outlets may also provide treatment of various types of pollutants. Types of outlets include: conveyance outlets (grassed waterway, stone filters, stormwater conveyance channel); water storage outlets (sediment basin, infiltration basin, detention/retention basin, oil/grit separators, Wet ponds and wetlands); conduits; and outlet protection.	Sediment and attached pollutants, hydrologic flow	Dependent on type of outlet used.	Storm water runoff, streambank erosion	Riprap, if needed	Dependent on type of outlet used.	Requires regular maintenance.	Stabilized outlets should be designed by a registered professional engineer.	Widely applicable.	If outlets are not maintained, excessive sediment may be introduced to surface waters downstream.	Stabilized outlets will reduce the velocity of discharge water to non-erosive levels.	Dependent on type of outlet used.	Dependent on type of outlet used.	If the outlet is a county or intercounty drain, permission to discharge must be obtained from them		http://www.deq.state.mi.us/documents/deq-swq-npsso.pdf
Emergency Spill Kit (absorbent booms)	Kit materials capture oil, gasoline, and diesel spills on water.	Hydrocarbons		Boat spill					Applicable to lakes.							
Pond Construction and Management (378)	A water impoundment made by constructing an embankment or by excavating a pit or dugout. Excavated ponds are made for conditions which require a small supply of water such as a golf course hazard. Embankment ponds hold larger volumes of water. Ponds can be used for storm water management and to attract wildlife. Properly designed and maintained embankment ponds provide a safe, reliable means of water supply, and may become the settling area for sediment and contaminants in the drainage area. If water quantity is more critical than quality, runoff can be used to maintain higher pond levels of an excavated pond.	Sediment and attached pollutants, chemicals, nutrients, flooding	Low (gully erosion, streambank erosion, flooding) None (sheet and rill erosion) N/A (chemicals, nutrients)	Storm water runoff	Slope/Shore-line Stabilization, Seeding, Mulching, Sodding, Pond Sealing or Lining	20 years (2004)	Moderate to High	Design and installation should be done by a professional.	Depends on soil suitability. Build ponds in areas where the water supply is adequate for the intended use.	Purple loosestrife (Lythrum salicaria) is an undesirable, exotic perennial which often becomes established in disturbed sites.	Ponds can be used for storm water management.		1% of original cost per unit (2001)	For excavated ponds, consider drainage characteristics, including depth to the water table. For embankment ponds, consider upstream drainage characteristics and how the pond will affect downstream flows, temperatures, etc.		
Composting Facility (317)	A facility for the biological stabilization of waste organic material. The purposed is to treat	Nutrients, low dissolved oxygen (DO)		Upland source (yard trimmings and kitchen	N/A	15 years / composting facility	Composting requires proper aeration, watering	Design and installation should be done by a	Widely applicable to dense	Waste needs to be composted and correctly applied as	N/A	$37,000/ composting facility	Annual Maintenance $370/ year	As of March 27, 1993, yard waste collected or		

Appendix N.1 Best Management Practices – Structural or Vegetated

	waste organic material biologically by producing a humus-like material that can be recycled as a soil amendment and fertilizer substitute or otherwise utilized in compliance with all laws, rules, and regulations. Keeps organic debris out of surface waters and away from floodplains, which helps prevent the depletion of oxygen in surface waters.			waste)		(2004)	and mixing in order to result in a useable end product. Product can be sold, delivered, and applied.	professional	residential or riparian sites. Soils, topography and climate will all affect the types of composting options available.	fertilizer. Runoff from compost application may contaminate surface waters.		(2004)	composting facility (2004)	generated in Michigan on public property is banned from land fills and incinerators.		
Best Management Practice	Description	Pollutant Addressed	Pollutant Removal Efficiency	Potential Sources of Pollutants	Additional BMPs to Complete Treatment Train	Expected Life Span	Maintenance Requirements	Training Requirements	Applicability to Site	Environmental Concerns	Hydrologic Effects to Consider	Installation Costs	Operation and Maintenance Costs	Special Considerations	Communities Using BMP	MDNRE/NRCS Link
Mulching (484)	The process of placing a uniform layer of straw, wood fiber, wood chips or other acceptable materials over a seeded or landscaped area. Helps keep soil particles and their associated attached chemicals (e.g. phosphorus and pesticides) from entering surface waters. Will suppress weed growth and provide a moist area for vegetative growth.	Sediment and attached pollutants	Low to Moderate	Soil erosion	Seeding, soil management, fertilizer management, grading practices, diversions (if needed).	1 year (2004)	Low: inspect mulched areas following storm events to ensure mulch has stayed in place.	Low	Widely applicable	None known.	Seeded area will eventually reduce the velocity and increase infiltration of storm water runoff.	$3.00/acre (2001)	Annual maintenance 100% of original cost per unit (2001)	Mulch should be applied immediately after seeding has occurred. Anchoring of the mulch should be done immediately after the mulch is applied.		
Riprap	A permanent cover of rock used to stabilize stream banks, provide in-stream channel stability, and provide a stabilized outlet below concentrated flows. The use of riprap protects stream banks and discharge channels from higher erosive flow velocities and decreases sediment input to a watercourse.	Sediment and attached pollutants	High	Soil erosion, agricultural runoff	Filters. (Riprap is often used in making stabilized outlets, in stream bank stabilization, etc.).	10 + years (SV)	Low: Periodically inspect underlying fabric, adjust and add riprap as needed.	Low: consult technical resources	Widely applicable: riprap is most often used in stream banks, on slopes, and at outlets.	Potential to cause additional erosion downstream.	Reduces down cutting and lateral cutting of erosive flow velocities. Typically not a significant velocity reducer.	$70/square yard (2003b) Including geotextile		MDEQ permit may be required if placed in waters of the state. Explore downstream impacts.		

Appendix N.2 – Managerial Best Management Practices

Best Managerial Practices (BMPs)	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	Communities Using BMP	DNRE/NRCS Link
Agricultural								
Crop Residue Management (329A-C, 344), includes no till, mulch till, ridge till, and seasonal	Leaving last year's crop residue on the surface before and during planting operations, providing soil cover at a critical time of the year. The residue is left on the surface by reducing tillage operations and turning the soil less. Pieces of crop residue shield soil particles from rain and wind until plants can produce a protective canopy.	Ground cover prevents soil erosion and protects water quality. Residue improves soil tilth and adds organic matter to the soil as it decomposes. Fewer trips and less tillage reduce soil compaction.	Sediment and attached pollutants	Agricultural runoff, soil erosion	Consider if crop will produce enough residue. Planning for residue cover should begin at harvest. Time, energy, and labor savings are possible with fewer tillage trips. Equipment for specialized tillage techniques needed. Additional chemical treatments may be necessary to control pests. Assistance available from U.S. Department of Agriculture (USDA) office or conservation district. No local government controls in place. Crop reside reduces the velocity of storm water runoff and improves infiltration.	$28-36/acre (includes no-till and strip till, ridge till) . Maintenance costs are 100% of original cost. Environmental Quality Incentive Program (EQIP) (for mulch till, ridge till, and seasonal residue management). Equipment rental or purchase $40+/acre. Consider costs for pest control.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/329a.pdf ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/329b.pdf ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/329c.pdf ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/344.pdf
Conservation Crop Rotation (328)	A sequence of crops designed to provide adequate organic residue for maintenance or improvement of soil tilth and fertility. Other BMPs to use include nutrient and pest management, buffer/filter strips, cover crops	Reduces sheet, rill, and wind erosion. Maintains or improves soil organic matter content. Manages the balance of plant nutrients. Improves water use efficiency. Manages saline seeps. Manages plant pests (weeds, insects, and diseases). Provides food and cover for wildlife. Reduces fertilizer needs and may reduce pesticide needs.	Sediment and attached pollutants	Soil erosion, agricultural runoff	Rotations that include grains, such as corn, or meadow provide better erosion control. Where excess plant nutrients or soil contaminants are a concern, utilizing deep rooted crops or cover crops in the rotation can help recover or remove the nutrient or contaminant from the soil profile. Over application of fertilizer or pesticide is possible. Plants will reduce the velocity of storm water runoff and increase infiltration.	$4.00/acre - EQIP		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/328.pdf
Planned Grazing System	Pasture is divided into two or more pastures or paddocks with fencing. Cattle are moved from paddock to paddock based on forage availability and livestock nutrition needs. Other BMPs to use include alternative water source, cattle exclusions, nutrient management, and soil testing	Improves vegetative cover, reduces erosion, and improves water quality by reducing sediment and nutrient runoff. Rotating also evenly distributes manure and nutrient resources.	Sediment and attached pollutants, nutrients, pathogens	Soil erosion, agricultural runoff	Keep fencing secure. Apply fertilizer and nutrients according to soil tests, mow or hay paddocks if needed and update rotation schedule if needed. Practice is widely applicable. Consider adequacy of the mix of grass and legumes to meet livestock needs. Sediment and nutrient runoff is not eliminated just reduced. This practice will increase harvest efficiently and help ensure adequate forage throughout the grazing season.	EQIP can fund establishment. $25/acre for maintenance		
Irrigation Water Management (449)	Determining and controlling the rate, amount, and timing of irrigation water in a planned and efficient manner. Other BMPs to use include nutrient management, pest management, crop residue management, soil conservation measures	Management of the irrigation system should provide the control needed to minimize losses of water and discharge of sediment and sediment-attached and dissolved substances, such as plant nutrients and herbicides.	Sediment and attached pollutants, nutrients, hydrologic flow	Agricultural runoff	Poor management may allow the loss of dissolved substances from the irrigation system to surface or groundwater. There is an insignificant reduction in runoff/flooding and slight reduction in excess subsurface water. Consider the effects irrigation water has on wetlands, water related wildlife habitats, riparian areas, cultural resources, and recreation opportunities.	EQIP can fund establishment.		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/449.pdf
Contour Strip Cropping (585)	Crop rotation and contouring combined in equal-width strips of corn or soybeans planted on the contour and alternated with strips of oats, grass, or legumes. Other BMPs to use include field border, fertilizer management, grassed waterways.	Meadow slows runoff, increases infiltration, traps sediment, and provides surface cover. Ridges formed by contoured rows slow water flow which reduces erosion. May reduce fertilizer costs.	Sediment and attached pollutants, hydrologic flow	Agricultural runoff, soil erosion	Keep strip widths consistent from year to year. Make adjustments in rotation schedule if needed. Over application of fertilizer possible, if used. Will reduce the velocity of storm water runoff and increase infiltration. Strip cropping is not as effective if crop strips become too wide, especially on steep slopes.	$10/acre - EQIP		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/585.pdf

Appendix N.2 – Managerial Best Management Practices

Best Managerial Practices (BMPs)	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	Communities Using BMP	DNRE/NRCS Link
Contour Farming (330)	Hillsides or in this case gentle slopes to drain or river are cultivated and planted in rows along the hillside or slope contour, not up and down the hill. Crop row ridges on the contour create hundreds of small berms. Other BMPs to use include field border, grassed waterways, and terraces or strip cropping if needed.	Reduces sheet and rill erosion and transport of sediment and other water-borne contaminants. Ridges built by tilling and planting on the contour, slow water flow and increase infiltration, which reduces erosion by as much as 50% from up and down hill farming.	Sediment and attached pollutants, hydrologic flow	Agricultural runoff, soil erosion	To avoid having to lay out new contour lines every year, establish a narrow permanent strip of grass along each key contour line. All tillage and planting operations should be performed parallel to the key contour line. Contour farming will reduce the velocity of storm water runoff, increase infiltration, moderately decrease runoff/ flooding, and slightly increase excess subsurface water. Contouring is less effective in preventing soil erosion on steeper or longer slopes.	$10/acre (9)		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/330.pdf
Pest Management (595)	Crops are surveyed for type of pests and the stage of development. The potential damage of the pest is then weighed against the cost of control. Finally, if pest control is economical, all alternatives are evaluated based on cost, results, and environmental impact. Precaution is taken to keep any chemicals from leaving the field by leaching, runoff, or drift. Other BMPs include buffer/filter strips, crop rotation, and erosion control measures.	Treatments tailored for specific pests on identified areas of a field prevent over-treatment of pests. Using fewer chemicals improves water quality.	Chemicals (pesticide)	Agricultural runoff	Continual scouting to best identify pests and control methods. Keep records to track costs and chemical application. Calibrate spray equipment. Consider which soils on farm are likely to leach pesticides. Consider pest control alternatives.	100% of cost/unit (11) - EQIP		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/595.pdf
Nutrient Management (590) Comprehensive Nutrient Management Plan (CNMP)	Crop nutrient needs are determined after a soil test, setting realistic yield goals, and taking credit for contributions from previous years' crops and manure applications, crop nutrient needs are determined. Nutrients are then applied at the proper time by the proper application method. Nutrient sources include animal manure, sludge, and commercial fertilizers. Other BMPs include manure testing, soil testing, soil conservation measures, waste management system, waste storage facility, and waste utilization.	This practice properly budgets and supplies nutrients for plant production. It also reduces the potential for nutrients to infiltrate into water supplies by preventing over application. Correct manure and sludge application on all fields can improve soil tilth and organic matter. It is very applicable on Concentrated Animal Feeding Operations (CAFOs)	Nutrients	Agricultural runoff, over application of fertilizers	Maintenance requirements: - Perform a periodic plan review to determine necessary adjustments - Protect nutrient storage facilities from weather and accidental leakage/spillage - Calibrate application equipment and document application rates - Spread wastes away from waterbodies on an adequate land base and incorporate as soon as possible - Analyze manure and other organic waste for nutrient content before field application and determine appropriate application rate - Test soils once every three years according to extension recommendations - Establish a winter cover crop if nitrogen leaching is possible due to poor crop yield * Consider the Michigan Agriculture Environmental Assurance Program (MAEAP). The CNMP must be developed by a trained technical person (service provided by USDA Natural Resources Conservation Service (NRCS) or conservation district). Consider potential groundwater contamination - proximity to waterbodies critical.	$5/acre (9) - EQIP (Costs associated with wastewater collection, soil testing, integrated crop management are low but have a high start up.)		ftp://ftpfc.sc.egov.usda.gov/NHQ/practicestandards/standards/590.pdf

Appendix N.2 – Managerial Best Management Practices

Best Managerial Practices (BMPs)	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	Communities Using BMP	DNRE/NRCS Link
Organic Farming Practices	Organic farming differs from other farming systems in a number of ways. It favors renewable resources and recycling, returning to the soil the nutrients found in waste products. Where livestock is concerned, meat and poultry production is regulated with particular concern for animal welfare and by using natural foodstuffs. Organic farming respects the environment's own systems for controlling pests and disease in crops and livestock. Organic farmers use a range of techniques that help sustain ecosystems and reduce pollution. Other BMPs include filter/buffer strips, crop rotation, organic manuring, composting, limited chemical intervention, conservation of wildlife and natural habitats, management of livestock, recycling of organic materials.	Organic farming conserves biodiversity, provides a wide range of habitats, saves energy, improves soil fertility, and protects groundwater and surface waters from nitrates, phosphates, and pesticides. Organic food is grown without using any synthetic pesticides, herbicides, insecticides, fungicides, fertilizers, or hormones.	Nutrients, chemicals (pesticides)	Agricultural runoff	Organic farming methods are usually more labor intensive than conventional farming, so the cost of organic farming will usually be more.	EQIP funds supporting practices such as cover crops, conservation crop rotation, nutrient management, pest management.		
Soil Testing of Cropland	For proper management, a soil test for available nutrients should be made every 3 to 5 years or agreed upon time interval. Use Integrated Crop Management (ICM)	Testing will help prevent over application of nutrients from fertilizers, manures, and other sources.	Nutrients	Agricultural runoff	Soil should be tested to determine nutrient levels. Care should be taken to not add nutrients already present in adequate levels. Soil testing should be undertaken by lab or local Michigan State University Extension (MSUE) office. Proper collection of a soil sample is important. Accuracy of analysis depends on the collection of a representative soil sample.	Costs associated with ICM. Typically a yearly expense. Low cost technique of monitoring soil. EQIP		
Soil Testing of Cropland	Farm Bill programs that offer a rental payment to landowners that agree to take environmentally sensitive areas out of production. Continuous sign-ups for these programs are available to riparian and wetland areas. Rental rates are set by county boards.	Creates incentive for landowners to conserve riparian buffers, wetlands, and wildlife habitats.	Sediment, nutrients, hydrologic flow, pathogens, chemicals (pesticides)	Agricultural runoff	Property enrolled in Farm Bill programs are not protected in perpetuity. Fertilizer cannot be applied to areas under contract. In some cases, land values or crop yields may discourage landowners to use these incentive programs.	In some counties soil rental rates can be very high.		http://www.nrcs.usda.gov/programs
Zoning Ordinance/Land Use Policies								
Stronger County and State Regulatory Oversight of Over Application and Misapplication of Septage	Stronger regulatory oversight can ensure that septage is applied correctly and limited to those areas where it is appropriate. Septic system alternatives should be encouraged where such alternatives prove economical and technically sufficient in order to protect public health and the environment.	Stronger regulatory oversight will reduce the over application and misapplication of septage and help prevent nutrients and *E.coli* from entering waterbodies.	Nutrients, *E. coli*	Agricultural runoff	If existing and future regulations are not enforced, they will be useless in preventing over application and misapplication of septage.			
Implementation/Enforcement of Post Construction Controls	An ordinance or regulatory mechanism can provide for the regulation and control of storm water runoff; provide for storm water permits and the procedures and standards for the issuance; provide regulations for the inspection, sampling and monitoring of storm water and other discharges; establish performance and design standards for storm water management in specified zones of the township/municipality; and provide penalties for the violations of the ordinance.	Storm water runoff rates and volumes are controlled in order to protect floodways. Controls soil erosion and sedimentation; minimizes deterioration of existing watercourses, culverts, bridges, etc.; and encourages groundwater recharge.	Sediment and attached pollutants, hydrologic flow	Urban and some Agricultural runoff	Establishing storm water management control will minimize storm water runoff rates and volumes from identified new land development and encourage groundwater recharge.	$2,500/regulatory mechanism		Saginaw, Bay Counties
Development/Enforcement of Stream Buffer Ordinance or regulatory mechanism	Ordinance or regulatory mechanism protects a given area of buffer adjacent to stream systems. Protected buffers can provide numerous environmental protection and resource management benefits. IF possible determine if this can be implemented through the Drain Code or an amendment or revision of the Drain Code. In commercial settings can this be done in Post Construction Control at township level	Moderate to high. Reduces the risk of sediment and contaminants entering the stream. Provides long term solution to water quality concerns.	Sediment and attached pollutants, nutrients, thermal pollution	Storm water runoff from impervious surfaces (e.g. parking lots and roof tops) and outflow from ponds	Lack of maintenance can increase erosion if trees fall into streams. At a minimum, keep south and west sides of streams wooded to provide shade. Trees in floodway can impede flow.	$6,000/ordinance development		

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Best Managerial Practices (BMPs)	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	Communities Using BMP	DNRE/NRCS Link
Development/Enforcement of Wetland Ordinance	Ordinance promotes a policy to avoid or minimize damage to wetlands and coordinate the planning and zoning process with federal and state wetland programs.	Wetland benefits are preserved. Wetlands provide natural pollution control by removing pollutants, filtering and collecting sediment, reducing both soil erosion and downstream flooding, and recharging groundwater supplies.	Sediment and attached pollutants, hydrologic flow, nutrients, pathogens, chemicals (pesticides), salts	Storm water runoff	Part 303, section 324.30307 authorizes local units of government to adopt and administer their own wetland regulations that address wetlands not protected by the state, provided they are at least as restrictive as state regulations. The Michigan Department of Environment Quality (DNRE) must be notified if a community adopts a wetland ordinance, but it has no review or approval authority.	$6,000/ordinance development		
Green Space Protection Ordinance or county wide Planning effort	Ordinance preserves environmentally sensitive and open areas. Can also use filter strips and tree planting to enhance protection.	High if properly executed. Provides protection of natural pollutant removal methods.	Thermal pollution, sediment, nutrients, hydrologic flow	Construction zones, developed parcels, agricultural land		$3/sq. ft. Land acquisition and management costs depend on site. Affected property may double as park/open space usage with related costs.		
Low Impact Design Practices	Land use planning to incorporate practices onsite. Examples include: bio-retention, dry wells, filter strips, vegetated buffers, grass swales, rain barrels, cisterns, infiltration trenches. Involves careful site planning to reduce the impact to water resources by eliminating impervious surfaces and protecting infiltration areas.	Numerous water quality benefits. Long term solution to concerns.	Thermal pollution, solids, sediments, nutrients, metals	Stormwater runoff, thermal, fertilizers				http://www.lidstormwater.net/
Illicit Discharge Ordinance (NPDES Phase II communities or counties)	Program to seek out and prohibit illicit discharges and connections to municipal separate storm sewers	High if properly executed. Eliminate hazardous and harmful discharges	Hazardous wastes	Industrial, residential, commercial		$2/acre (assuming 1 system monitored every 5 sq. miles). Maintenance program. $0.83/acre/year, $50/acre/year (with TV inspection)	Michigan Department of Transportation (MDOT)	
Pet Waste Disposal Ordinance or regulatory mechanism	Ordinance to require pet owners to clean up after their pets. Can be enhanced by installing signs and pet waste collection facilities in high traffic Areas.	Moderate	Nutrients, bacteria	Animals, dogs or other household pets				
Development/Enforcement of On-Site Treatment System Ordinance	Ordinance abates water pollution caused by failing onsite treatment systems, minimizes infiltration of seepage from systems into the river or storm water drainage system, and establishes penalties for its violation.	Ordinance can be used to enforce regular maintenance of disposal systems, which will minimize threats to public health and combat the degradation of surface and subsurface waters.	Bacteria	Septic systems	Lack of ordinance enforcement (regular inspection) can introduce pollution into groundwater reserves.	$8,000/ordinance development		
Public Access Ordinance	Ordinance controls access to a designated waterbody by limiting hours of access, number of users, etc.	By controlling public access to a waterbody, sediment pollution is Reduced.	Sediment and attached pollutants	Public access, boat wakes	Consider using porous/modular pavement at boat launches locations.	$8,000/ordinance development		
Education and Enforcement of Fertilizer Ordinance	Ordinance limits the use of fertilizers containing more than 1% by weight of anhydric phosphoric acid. Requires soil testing before use of phosphorus	Moderate; other sources of phosphorus may be present in the watershed.	Phosphorus	Fertilizers	Sources of low phosphorus fertilizers are few.	$8,000/ordinance development	Bay, Saginaw Counties	
Recycling/Composting								
Household Hazardous Waste Management	Proper buying, using, storing, and disposal of hazardous materials such as automotive waste, household cleaners and paint.	Moderate: eliminates disincentives and discourages illegal dumping of products into storm sewers and onto the ground.	Hazardous wastes	Residents: Used oil, paints, cleaning products, etc.	Proper credentials needed for management. Typically consultant based.	Recycling station expenses.	Bay, Saginaw and Midland Counties	http://www.deq.state.mi.us/documents/deq-swq-npshhw.pdf

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Best Managerial Practices (BMPs)	Description	Benefit	Pollutant Addressed	Potential Sources of Pollutants	Environmental Impacts and Special Concerns	Comparative Costs	Communities Using BMP	DNRE/NRCS Link
Composting	Converting plant debris, grass, leaves, pruned branches, etc. to compost. Use with lawn maintenance, pesticide and fertilizer management, and diversions (if needed)	Keeping organic debris out of surface waters and away from floodplains. Will help prevent the depletion of oxygen in surface waters. Widely applicable to dense residential or riparian sites.	Nutrients, chemicals, and pesticides, low dissolved oxygen, trash and debris	Neighborhoods, agricultural areas, yard, and kitchen waste	Compost piles placed near floodplains will contribute to the depletion of oxygen in surface waters. Composting requires proper aeration, watering, and mixing in order to result in a useable end-product. Soils, topography, and climate will all affect the types of composting options available.	Recycling vs. garbage hauler costs. Establishment of large scale facility $190,000, land dependant. $70,000 annual maintenance.	Saginaw	
Yard Waste Collection and Disposal Program	Municipalities collect yard waste for compost.	Widely applicable to dense residential or riparian sites	Nutrients and organic sediment, trash and debris	Yard waste and leaf litter	Waste needs to be composted and correctly applied as fertilizer. Need large collection facility for compost operations.	Low	Bay, Saginaw and Midland Counties	
Recycling Program – Bay, Saginaw, Midland Counties	Collection of recyclable materials either by curb-side pick up or at drop off centers	Reduction in potential clogging and harmful discharge	Trash, used construction material reuse	Highways, travelers, vehicle debris	Some materials may require more energy to collect and recycle than using new products. However, recycling programs do build awareness	Programs are functioning now with established budgets	Bay, Saginaw and Midland Counties	
Used Oil Recycling Program	Central collection facilities that allow residents to drop off used motor oil. Can be operated by local governments or businesses that recycle oil.	Reduces risk of surface water and groundwater contamination	Used oil and other transportation fluids reuse, hydrocarbons, metals, nutrients	Vehicle maintenance facilities. Vehicles or other equipment requiring lubrication.	Oil may easily become contaminated during collection making it a hazardous waste.	$79 - $179 recovery charge. Administrative costs to organize. Minimal personnel cost to collect and temporarily store oil. Opportunity to be paid by private business for waste material.	Bay, Saginaw and Midland Counties MDOT	
Turf Management								
Pesticide Management for Turf Grass and Ornamentals	Use of all available strategies (resistant turf, cultural controls, biological controls, mechanical controls and pesticides) to manage pests so that an acceptable yield and quality can be achieved economically with the least disruption to the environment. Used with lawn maintenance, fertilizer management, and soil management.	Moderate to High	Harmful chemicals, pesticides, insecticides	Landscaping, storm water runoff	Must have proper training and credentials to commercially apply pesticides and manage turf.	Pesticide management should reduce application rates and related costs.		http://www.deq.state.mi.us/documents/deq-swq-npspm.pdf
Lawn Maintenance	Includes mowing, irrigating, pesticide and fertilizer management, soil management, and the disposal of organic debris such as lawn clippings and leaves.		Phosphorus, nutrients, and sediments	Landscaping, storm water runoff	Consider minimizing lawn with more native species.	Lawn alternatives may reduce mowing but still require regular maintenance of weed control and pest management.		http://www.deq.state.mi.us/documents/deq-swq-npslm.pdf
Fertilizer Management	Includes the proper selection, use, application, storage and disposal of fertilizers. Used with pesticide management, lawn maintenance, and nutrient management	Moderate	Nutrients	Landscaping, storm water runoff	Consider consulting professional, such as MSUE, or Farm Bureau, Co-ops	Material cost reduction may conflict with traditional aesthetic values. Fertilizer management should reduce chemical costs but may impact maintenance and watering.		http://www.deq.state.mi.us/documents/deq-swq-npsfm.pdf
Soil Testing of Lawns and Gardens			Nutrients	Lawn and garden fertilizer	Testing should be done at qualified lab.	Typically yearly testing required, contact local MSUE office. Test results may result in operations and maintenance costs. Low cost tool in management of lawns and gardens. $9.50 per test.		
Operations and Maintenance								
Operation and Maintenance Programs			Sediment, hydrocarbons, metals, nutrients	Erosion of road footprint and related infrastructure, leaking equipment, etc.		Labor intensive. Equipment required.	MDOT, BCRC, SCRC, MCRC	
BMP Inspection and Maintenance Plan for Roads (MDOT, BCRC, SCRC, MCRC)		A regular inspection and maintenance program will maintain the effectiveness and structural integrity of the BMPs.	Sediment, hydrocarbons, metals, nutrients, etc.	Road related sediments/pollutants	Materials needed for emergency structural repairs may not be easily obtainable and may require stockpiling (MDOT). Should be designed and implemented by trained professional.	$150-$9,000 depending on the BMP. Specialized BMP installation involves planning, design, construction, and maintenance costs.	MDOT, BCRC, SCRC, MCRC	

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Material Management Plan (MDOT)	Identified hazardous and non-hazardous materials in the facility. Assures that all containers have labels. Identifies hazardous chemicals that require special handling, storage, and disposal.		Chemicals and other potentially hazardous materials.	Varies depending on type of material usage at specific facilities. Oil, salt, degreasers, solvents, antifreeze, etc. Industrial sites where chemicals are used.	Extensive training typically required to prepare and administer plan.	Plan preparation and updates. Inspections mandated. Plan development typically needs consultant or knowledgeable employee. Operation typically employee dependant.	MDOT, BCRC, SCRC, MCRC	
Clean and Maintain Storm Drain Channels (MDOT, BCDC, SCPWC, MCDC)		Prevent erosion in channels. Improve capacity by removing sediment. Remove debris toxic to wildlife.	Sediment, trash, woody debris	Development, natural erosion, vehicle remnants, road winter safety operations.	Should be implemented by trained professional.	$21/acre/year, $45 to $60 per acre (rural). Channels are less expense to construct and easier to maintain than enclosed systems.	MDOT, BCRC, SCRC, MCRC	
Clean and Maintain Storm Inlets and Catch Basins (MDOT, BCRC, BCDC)	Catch basins are periodically inspected and cleaned out using a vacuum truck.	Moderate; reduces pollutant slugs during the first flush, prevents downstream clogging, and restores sediment trapping capacity of the catch basin.	Solids, sediments, metals, oils	Storm water runoff, automobiles	Requires continual maintenance every 1 to 3 years. General fund, Kent County Road Commission (KCRC) road maintenance budget - $250,000	Moderate to High; Total annual cost per catch basin = ($8/catch basin) + ($40/catch basin) = $48/catch basin. (Grand Rapids (GR) BMP Study). $21/acre/year maintenance.	MDOT, BCRC, SCRC, MCRC	
Annual Road/Stream Crossing Inspections	Inspections of stream crossings for evidence of erosion, debris, etc.	Moderate	Sediment	Erosion of streambank		Moderate; regular inspection can prevent major expenditures for potential major points of erosion	MDOT, BCRC, SCRC, MCRC	
Municipal Operations								
Snow and Ice Control Operations	Removal of snow and ice from roadways, utilizing plows, salt, and sand.		Salts	Snow melt runoff	Moderate, all KCRC equipment operators are trained. Training of road maintenance crew required.	KCRC winter maintenance budget - $3.5 million. Maintenance costs $1,000/lane/mile, dependant on severity of winter.	MDOT, BCRC, SCRC, MCRC	
Calibrated Salt Delivery		Low	Salts	Over application of salt	Calibration does not guarantee efficient application of road salt. Annual training and calibration necessary.	Low upfront cost. Long term equipment maintenance vs. reduced salt. Equipment costs $1,500 per truck, minimal additional cost.	MDOT, BCRC, SCRC, MCRC	
Pre-wet Road Salt Application		High if also used with environmentally friendly alternatives to salt	Salts	Road salt		Low to Moderate; $25/lane/mile, equipment maintenance costs - $5,000 per truck.		
Snow Removal Storage on Grassy Areas		Low	Sediment, metals, hydrocarbons, salt	Snow melt runoff	Snow storage may damage vegetation and possibly cause soil erosion. Piled snow melts at a slower rate. Need right-of-way (ROW) for snow removal. Need large grassed area adjacent to buildings and parking areas and properly spaced from waterbody.	Dependant on amount of trucking, distance to site, etc. Cleanup after melt.		
Minimizing Effects from Road Deicing (MDOT)			Salts & chemicals	Maintaining agency, Snow melt runoff, spring rains		Varies	MDOT, BCRC, SCRC, MCRC	
Street Sweeping	The use of specialized equipment to remove litter, loose gravel, soil, vehicle debris and pollutants, dust, de-icing chemicals, and industrial debris from road surfaces. There are generally 2 types of sweepers: mechanical broom street sweepers and vacuum-type street sweepers.	Moderate; 60% TSS removal rate. Reduction in potential clogging of storm drains. Some oil and grease control (MDOT). When done regularly, can remove 50 - 90% of street pollutants (1), makes road surfaces less slippery in light rains, improves aesthetics by removing litter, and controls pollutants.	Sediment, metals, hydrocarbons	Atmosphere, construction, vehicles	Sweeping may wash sediments into catch basins if wash is not vacuumed. Disposal of collected materials must be handled by the governing agency (DNRE, Public Health, Transportation). Sweeping schedules and timing critical - sweep after snow melt and before spring rains. Vehicle maintenance required.	KCRC road maintenance budget - $300,000/year. Ottawa County: Mechanical - $119.40/curb mile. Vacuum Assisted - $87.95/curb mile (GR BMP Study).	MDOT, BCRC, SCRC, MCRC	http://www.deq.state.mi.us/documents/deq-swq-npssw.pdf
Emergency Spill Response and Prevention Plan	Plans detail emergency procedures to respond to a release of hazardous materials. Also plans that describe procedures for proper handling and storage of chemical materials.	Low to High, depending on preparedness. Can be highly effective at reducing the risk of surface and ground water contamination	Hazardous wastes	Equipment, poor training, accidents, Industrial, commercial, residential, and transportation related spills, chemical storage areas	Speed and containment are critical. Requires a well-planned and clearly defined plan, updated regularly. May require training, protective gear, containment and retrieval knowledge. Equipment must be readily available. (MDOT)	Management plan preparation with upgrades. Cost of simulations. In public sector, typically subcontracted to private contractor.	MDOT	
SESC Plans	Plans that specifies the actions that will be taken on a construction site to minimize erosion and sedimentation	High if properly executed. Reduce erosion and sedimentation during construction project. Increased removal using Floc Logs through construction.	Sediment	Un-vegetated areas, land development	State training, SESC and/or certified operator.	Act 91 mandated, ongoing local administrative costs. Fee based to landowner option.	BCDC, MCDC, SCPWC	
Best Managerial Practices (BMPs)	**Description**	**Benefit**	**Pollutant Addressed**	**Potential Sources of Pollutants**	**Environmental Impacts and Special**	**Comparative Costs**	**Communities Using**	**DNRE/NRCS**

Appendix N.2 – Managerial Best Management Practices

					Concerns		BMP	Link
Dust Control (MDNRE)	Using measures such as watering, fencing, mulching and vegetation to prevent soil and attached pollutants from leaving a site and/or entering nearby waterways.	High if properly executed.	Sediment	Lack of vegetation typically associated with dirt or gravel roads	Salt and other potential pollutants are used in the dust control mixture. Rural, urbanizing, and transportation sites subject to wind erosion. Air pollution issue if neglected.	$100 to $500 per treatment. Employee administrative expense. Maintenance of water truck (minimal) - Roads 50 to 55 cents/gal, 1,500 gal/mile for a single pass	BCDC, MCDC, SCPWC	http://www.deq.state.mi.us/documents/deq-swq-npsdc.pdf
Urban Forestry	Management of woods and trees in an urban setting.	Moderate to high. Increases greenspace, reduces storm water runoff, and thermal pollution. Long term solution to concerns.	Thermal pollution, solids, sediments	Rainfall, solar	Woody debris and detritus may require annual maintenance. May eliminate original line of sight.			
Other								
Invasive Plant Species Management	Invasive plant species are controlled using appropriate and effective removal methods for particular species.	Population and spread of invasive plant species is reduced or eliminated.	Invasive plant species	Accidental/purposeful introduction, natural dispersion	Invasive alien plants thrive in disturbed sites. Native plant communities fragmented by human disturbance are most vulnerable to invasion, but the most invasive species can infest even intact ecosystems. Invasive alien plants are free of natural controls such as insects and diseases that keep them in balance in their native habitats. Invasive species can also significantly reduce forest regeneration.			
Woody Debris Management	Through bank erosion the number of trees falling into and impeding flow is high, this needs to be managed to preserve habitat but improve flow conditions							
Waterfowl Management	Waterfowl are numerous on the Main Branch are responsible for nutrient loading, effective management of numbers and use of practices that discourage them from using the river should be researched							
Information and Education								
Public Education Program (BASWA & SASWA)		Can reduce improper disposal of hazardous waste.	Potentially all			$30,000/year	BASWA, SASWA	
Grounds Maintenance Training		Moderate	Nutrients and organic sediment	Leaf litter, grass clippings, fertilizer, and pesticides		Low	BASWA, SASWA	
Employee Training (SASWA)		Low cost and easy to implement storm water management BMPs.	Potentially all				BASWA, SASWA, MDOT	
Storm Drain Marking or requiring only grates and covers with "Dump No Waste" & "Drains to River" during construction or reconstruction	Ordering or replacement of grates and castings or marking Storm Drain Inlets with "No Dumping" signs and symbols.	Moderate; Educates the general public that the storm drain discharges into a natural waterbody. Can tie into hazardous waste collection, yard waste collection.	Hazardous waste and nutrients	Household hazardous waste, motor oil, pet waste, and yard waste	Volunteers need to take care with paint around storm drains. Permanent castings or decals may be more effective. Public education campaign is also needed for effective reduction in illegal dumping. Short term effectiveness.	$0.45/inch - Mylar stencils $5 to $6 each - ceramic tiles $100 or more - metal stencils.	BASWA, SASWA, MDOT	