CHAPTER 4 - ACTIONS AND BEST MANAGEMENT PRACTICES

The 2003 Watershed Management Plan (WMP) identified many Best Management Practices (BMPs) associated with the goals as recommendations for communities and entities to implement. The revisions to this WMP have combined, categorized, and defined those BMPs to come up with a list of actions and BMPs that relate to each objective, thereby enabling communities and entities to more easily focus efforts on their priorities.

The 2003 WMP recognized that the pollutants identified in the earlier chapters are most often by-products of human impact on the land that makes up the Anchor Bay Watershed (Watershed). In order to protect and restore Anchor Bay and its tributaries, the impact of these human activities must be minimized, either by actions that result in changes in behavior or through the use of BMPs. Actions include policy implementation and educational programs. BMPs are practices selected to address specific environmental issues and can be implemented individually or in a series to address impairments within the Watershed. Some BMPs are better suited to newly developing communities, while others are more applicable to established urban areas. Rural and agricultural BMPs are often dissimilar to urban BMPs, but rely on many of the same concepts.

The many stresses on the environment identified in the earlier chapters can be divided into several broad categories that are closely associated with the major goals of this WMP. Thus, actions and BMPs proposed to be used by the communities have been organized into four long-term goals:

- Goal 1: Restore and enhance recreational uses
- Goal 2: Restore and protect aquatic life, wildlife, and habitat
- Goal 3: Protect public health
- Goal 4: Reduce impacts from peak flows

Actions and BMPs can be structural, vegetative, or managerial practices, and educational programs that reduce sources of pollutants from both urban and rural areas. A list of actions and BMPs was prepared and reviewed by the Anchor Bay Technical Subcommittee (Technical Subcommittee) that included the characteristics to be considered in their selection as an appropriate practice for a particular site. The structural and vegetative BMPs listed in Table 4-1 include practices of pretreatment, detention/retention, vegetated treatment, infiltration, filtration, and agricultural. A similar spreadsheet was developed for managerial and educational actions (Table 4-2), which include practices of agricultural, zoning ordinances/land use policies, recycling/composting, turf management, operations and maintenance, education, and municipal operations. The actions and BMPs to address each specific long-term goal are listed below and are associated with the objectives to meet those goals.

Table 4-1: Structural and Vegetative Best Management Practices

BMP#	BEST MANAGEMENT PRACTICES	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	MDEQ/ NRCS LINK
1	Cattle Exclusion (NRCS practices: Use Exclusion (472), Fence (382))	Fencing to exclude cattle access and protect the stream. 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 for fencing and use exclusion (12)	Livestock access, animal manure	Buffer/filter strip, alternative water sources, planned grazing system, stream crossing and livestock access	10 years (use exclusion) (15) 20 years (fence) (9)	Repair fence as needed. Remove off-stream watering systems in the winter, if needed.	NRCS available for assistance	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) 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://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/472.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/382.pdf
1	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 (12), fertilizers (12), and polluted storm water runoff)	Animal manure	Cattle exclusion fencing, roof runoff management, diversion, Comprehensive Nutrient Management Plan (CNMP)	15 years (15)	Inspect storage structures for leaks or seepage periodically and make necessary repairs. Repair any damaged fences immediately. Empty storage structure twice a year.	NRCS available for assistance	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.	Slight decrease in runoff/ flooding and excess subsurface water	Approximately $10,000 - 250,000 (14) - (12) - EQIP	$250 - 1,000 maximum (14)	Storage period should be 6 months unless winter applied risk index is completed.		ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/313.pdf
6	Composting Facility (317)	A facility for the biological stabilization of waste organic material. The purposed is to treat 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 will help prevent the depletion of oxygen in surface waters.	Nutrients, low DO	?	Upland source (yard trimmings and kitchen waste)	NA	15 years / composting facility (2004)	Composting requires proper aeration, watering and mixing in order to result in a useable end-product. Product can be sold, delivered, and applied.	Design and installation should be done by a professional	Widely applicable to dense residential or riparian sites. Soils, topography and climate will all affect the types of composting options available.	Waste needs to be composted and correctly applied as fertilizer. Possibility of runoff of compost application contaminating surface waters.	NA	$37,000/ composting facility (2004)	Annual Maintenance: $370/ year /composting facility (2004)	As of March 27, 1993, yard waste collected or generated in Michigan on public property is banned from land fills and incinerators.		
8	Vegetated Buffers or Filter Strips (NRCS Practice 393)	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) (12) Insignificant (runoff/ flooding) (12)	Runoff from parking lots, roof tops, and outflow from ponds, soil erosion, agricultural runoff	Conservation tillage in agricultural areas	10-20 years (9)	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 available for assistance	Widely applicable		Will reduce the velocity of storm water runoff and increase infiltration.	Low. $350/acre (10). $250/ herbaceous acre (11) - CRP, EQIP	Low. $10/acre (9)	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).		http://www.deq.state.mi.us/documents/deq-swq-nps-bfs.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/393.pdf
8	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) (12)	Runoff from parking lots, roof tops, and outflow from ponds, soil erosion, storm water runoff	Filter strip	15 years (9)	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/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/forrested acre (11) - CRP, EQIP	1% of original cost (11)	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://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/390.pdf
10	Check dams, Grade control structures (NRCS practice 410)	Stones, sandbags, or gravel generally used to stabilize grades in natural or artificial channels by carrying runoff from one grade to another. Designed to prevent banks from slumping, reduce runoff velocity, and prevent channel erosion from an excessive grade.	Sediment and attached pollutants, hydrologic flow	High (classic gully erosion) (12) Moderate (streambank erosion) (12) Low (runoff/ flooding) (12)	Streambank erosion, soil erosion, storm water runoff	Buffer/filter strips, grassed waterway, diversion, check dams, critical area planting	20+ 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 engineer	Widely applicable to erosive areas with an excessive grade. Place in drainage channel.	Concentrated flows may cause erosion downstream - discharge point should be investigated.	Cause backwater effect; slows down water velocities; capacity equal to channel	Low to moderate. $4,650/structure or $800/vegetated chute (9) - EQIP, WHIP	Low. $60/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-nps-cd.pdf

Table 4-1: Structural and Vegetative Best Management Practices

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14	Streambank and Shoreline Protection (580)	Treatment(s) used to stabilize and protect banks of streams or constructed channels, and shorelines of lakes, reservoirs, or estuaries. Benefits include: a) Prevents the loss of stream bank vegetation b) Reduces sediment loads to streams c) Maintains the capacity of the stream channel d) Improves or enhances the stream corridor for fish and wildlife habitat, aesthetics, recreation	Sediment and attached pollutants	High (streambank erosion, soil mass movement) (12)	Soil erosion	Geotextile materials (i.e. Filters) are often used underneath Riprap. Consider livestock exclusion, prescribed grazing, buffer/filter strips, diversions, or additional sediment control measures.	20 years (9)	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 (15)	10% of original cost (11)	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://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/580.pdf
14	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 in which the water is released. Some outlets may also provide treatment of various types of pollutants depending on the type of outlet used. Types of outlets include the following: 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.	All of the BMPs cited in the section above require regular maintenance. Follow the maintenance sections in the outlet (BMP) selected.	Stabilized outlets should be designed by registered professional engineers.	Widely applicable.	If practices are not maintained, excessive sediment may be introduced to surface waters downstream.	Practice will reduce the velocity of discharge water to non-erosive velocities.	Dependent on type of outlet used.	Dependent on type of outlet used.	If the outlet is a county or inter county drain, permission to discharge must be obtained from the drain commissioner or drain board. The actual structure may require a MDNR permit if the outlet is in a watercourse or if wetlands are impacted.		www.deq.state.mi.us/documents/deq-swq-nps-so.pdf
14	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 downcutting and lateral cutting of erosive flow velocities. Typically not a significant velocity reducer.	$70/square yard (2003b) Including geotextile	?	An MDEQ permit may be required if placed in waters of the state. Explore downstream impacts.		
17	Restored Wetland (NRCS practice 657)	A rehabilitation of a drained or degraded wetland where the soils, hydrology, vegetative community, and biological habitat are returned to the 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 (pesticides)	Moderate to high (depending on season); 80% of total suspended solids from sheet, rill, wind, or ephemeral gully erosion (4) 50% of total phosphorous (4).	Storm water runoff, soil erosion	Sediment forebay or other form of pretreatment. In agricultural areas cattle exclusion fencing, buffer/filter strip, grassed waterway	50+ years (1)	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 (swamp)	3% of original cost (11)	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 enough to fill 30 Olympic size swimming pools (EPA, 2002)		ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/657.pdf
25	Permanent Sediment Basin	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(4);<20% of Total Phosphorous (4)	Storm water runoff	Detention/Infiltration	50+ years	Moderate; Remove and dispose of sediment, trash and debris, and repair erosion.	Low	Use for large drainage areas (≥ 1 acre), at storm sewer outfalls, may be included with detention pond, and to collect overland flow.			Low; Capital Cost: $0.60/cft of storage volume excluding land purchase. (1)	7% of capital cost/year. (1)	Not always aesthetically pleasing		http://www.deq.state.mi.us/documents/deq-swq-nps-sb.pdf
25	Ponded Type Detention Basin (wet pond)	Small, man-made basin to maintain a permanent pool of water with emergent wetland vegetation around the bank designed to capture and remove particulate matter, nonsoluble metals, organic matter and nutrients through settling. It generally has inlet and outlet structures to regulate flow.	Sediment; nutrients; 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	Sediment forebay or other form of pretreatment, Riprap, Sediment Basin, Filter	50+ years (1,6)	Low; Remove and dispose of sediment, trash and debris, repair erosion; and plant replacement as needed.	Low. Design and installation should be done by a professional	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; West Nile Virus (aerator can remove threat of West Nile Virus)	Provides full control of peak discharges for large design storms and may help increase low flows - Rural	Low to moderate; $1/cft of storage volume, excluding land purchase (1)	5% of capital cost/year. (1)	Need available land area, can include sediment forebay, requires more planning, maintenance and land to construct.		http://www.deq.state.mi.us/documents/deq-swq-nps-wdb.pdf
25	Dry Detention Basin	Small, man-made basin designed to capture and remove particulate matter. It generally has inlet and outlet structures to regulate flow.	Sediment; flow	Moderate; 80% of total suspended solids (4) 50% of total phosphorous (4)	Storm water runoff	Sediment forebay or other form of pretreatment	50+ years	Low; Remove and dispose of sediment, trash and debris, and repair erosion.	Minimum	Needs land that will allow inlet at a higher elevation than outlet	Low bacteria and nutrient removal. If vegetation is not maintained erosion and resuspension will occur.	Reduced peak flows and no standing water	Low to moderate	Low to moderate	Basin grading very important to prevent pools of standing water.	MDOT	

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25	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, nonsoluble metals, nutrients, hydrologic flow	Moderate to high	Storm water runoff	Riprap, grassed waterways, sediment basins		Moderate to High	Mow buffer/filter strip, remove debris and inspect basin regularly during wet weather, and remove sediment from basin every 5-10 years.	Depends on infiltration rates and soil permeability	Can significantly warm the water in the marsh area 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. Need spill response plan.		http://www.deq.state.mi.us/documents/deq-swq-nps-edb.pdf
25	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		Storm water runoff, soil erosion	Grassed Waterway, Modular Pavement, Infiltration Trench, Buffer/Filter Strip, Street Sweeping		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 professional	This BMP will work best in areas that do not have a steep slope. Parking lot slope should be 1% or less.	Because detention time is small only some large solids will settle, which must be removed often to prevent resuspension.	Reduces peak runoff from small sites and provide some flood storage and reduces flooding.			A spill response plan must be developed. BMP is most effective when used with other BMPs that allow for infiltration or sediment trapping.		http://www.deq.state.mi.us/documents/deq-swq-nps-pls.pdf
25	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) (12) Moderate (runoff/ flooding) (12) Low (streambank erosion) (12)	Soil erosion, agricultural runoff	Nutrient management, terraces, grassed waterways, contouring, conservation cropping system, conservation tillage, and crop residue management	10 years (9)	Reseed and fertilize as needed. Check basins after large storm events and make necessary repairs.	NRCS available for assistance	Widely applicable.	Over application of fertilizer possible.	Traps storm water runoff and prevents it from reaching lowlands. Moderate decrease in runoff/ flooding. Slight increase in excess subsurface water. (12)	$2,100 - 3,150/basin (11)	5% of original cost per unit (11)	Basin must be large enough to control the runoff from a 10-year storm without overtopping.		ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/638.pdf
25	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; flow	Moderate	Storm water runoff	Sediment forebay or other form of pretreatment	50+ years	Low; Remove and dispose of sediment, trash and debris, and repair erosion.	Minimum	Use for large drainage areas (≥ 1 acre), at storm sewer outfalls, and to collect overland flow.	Possible downstream warming; low bacteria removal; West Nile Virus	Reduced peak flows, storage	Moderate	Low to moderate	Need available land area, can include sediment forebay.		
26	Rain Gardens and other "Landscaping for Water Quality" techniques	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, flooding	High; 75% - 90% of total suspended solids. (3)(8) 75% of total phosphorous. (8)	Storm water runoff, fertilizers	Master Gardeners Program, Mulching	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 - 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. CES, Master Gardeners Program, WMEAC available for assistance.	Site specific, depends on soils. Use for drainage areas ≤ 5 acres (8), 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 evapo-transpiration 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.		
26	Infiltration Trench	An excavated trench (3 - 12 feet deep), backfilled with stone aggregate, and lined with filter fabric (fine particulates should not be routed to this BMP). 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(4); 60% of total phosphorous.	Storm water runoff	Sediment basin, buffer/filter strips, oil/grit separators, filter fabric	Short; 10 years or less (1)	Low to Moderate - Annual; Remove and dispose of sediment, trash and debris. Eroding or barren areas must be revegetated.	Moderate. Design and installation should be done by a professional	Site specific; depends on soils. Soil infiltration rates must be greater than 0.52 inches per hour, with clay content less than 30%.	If storm water runoff contains high amounts of soluble contaminants, groundwater contamination can occur.	Provides full control of peak discharges for small sites, provides groundwater recharge, may augment base stream flow, and allow infiltration.	Moderate; Average $8/cubic feet of storage (1)	9% of capital cost (1)	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	http://www.deq.state.mi.us/documents/deq-swq-nps-it.pdf
26	Infiltration Pond	Water impoundment over permeable soils which received 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	Site specific depends on soils	Potential to contaminate groundwater	May recharge groundwater	Moderate	Moderate	Avoid areas with potential hazardous material contamination	MDOT	http://www.deq.state.mi.us/documents/deq-swq-nps-ib.pdf
26	Porous or Modular Pavement	Permeable asphalt 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 (2)	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 (clogged) filtering material.	Low. Design and installation should be done by a professional	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.	Provides soil infiltration, attenuation of peak flows, reduction in the volume of runoff leaving the site and entering storm sewers, and groundwater recharge.	Moderate	Low to moderate	Pre-treatment of storm water is recommended where oil and grease or other potential groundwater contaminants are expected. Avoid areas with potential hazardous material contamination	MDOT	http://www.deq.state.mi.us/documents/deq-swq-nps-pap.pdf

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BMP#	BEST MANAGEMENT PRACTICES	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	MDEQ/ NRCS LINK
27	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	Moderate to high; 70% of total suspended solids(5); <20% of total phosphorous. Assume same as Hydrodynamic Separators.	Storm water runoff	Catch basin cleaning program	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 important		$50 - 1,500 (5)	$300/CB/year (5)	Useful for retrofit	MDOT	
27	Hydrodynamic Separator Units (CDS Units, Stormceptors, 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. (CDS, Vortechs, Downstream Defender, Stormceptor)	Sediment, solids	Effective; 60% TSS Removal (1); <20% of total phosphorous (4)	Storm sewer system	Street sweeping, stream protection practices	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 important	Catches first flush, high flows by-pass unit through pipe system	High $15,000/acre of impervious (2); 6,000/cfs capacity	$500/practice (2); $1,000/year (3)	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-nps-ogs.pdf

(1) Fishbeck, Thompson, Carr & Huber, Inc. Evaluation of Best Management Practices for MDOT. 2002.
(2) Bannerman, Roger T., Wisconsin Department of Natural Resources. Source Area and Regional Storm Water Treatment Practices: Options for Achieving Phase II Retrofit Requirements in Wisconsin. 2002.
(3) Michigan Department of Environmental Quality. Guidebook of Best Management Practices for Michigan.1996.
(4) Environmental Protection Agency (EPA). National Pollutant Removal Performance Database. June 2000.
(5) Personal Communication with Hydro-Compliance Management, Inc. staff. 2004.
(6) Gruenwald, Paul E. Governmental Accounting Focus, Estimating Useful Lives for Capital Assets. May 2002.
(7) Rouge River National Wet Weather Demonstration Project. Planning and Cost Estimating Criteria for Best Management Practices. April, 2001. TR-NPS25.00.
(8) Rain Gardens of West Michigan. Beautiful Solutions for Water Pollution. [Online] 2003. Available at http://www.raingardens.org/Index.php.
(9) USDA - Natural Resources Conservation Service. Field Office Technical Guide, Section 1 Cost Information (draft). 2004.
(10) USDA - Natural Resources Conservation Service. Michigan Area 3 Component Data. June 2003.
(11) USDA - Natural Resources Conservation Service. Sample County Practice and Maintenance Costs. 2001.
(12) USDA - Natural Resources Conservation Service. Conservation Practice Physical Effect Worksheet[s]. 2004.
(13) Personal Communication with Technical Committee of the Lower Grand River Watershed Project. 2004.
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(15) USDA - Natural Resources Conservation Service. FY04 Michigan EQIP Statewide Eligible Practice List, Land Management Practices (Incentive Payments). 2004.

Table 4.2: Managerial Best Management Practices

BMP#	BEST MANAGERIAL PRACTICES	DESCRIPTION	BENEFIT	POLLUTANT ADDRESSED	POTENTIAL SOURCES OF POLLUTANTS	ENVIRONMENTAL IMPACTS AND SPECIAL CONCERNS	COMPARATIVE COSTS	COMMUNITIES USING BMP	MDEQ/ NRCS LINK
1	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 provides cover for the soil 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 reduces 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 USDA office or Conservation District. No local government controls in place. Crop reside reduces the velocity of storm water runoff. Rainfall stays in the crop field allowing the soil to absorb it. Moderate to high decrease in runoff/ flooding.	$28-36/acre (includes no-till and strip till, ridge till) (11). Maintenance costs are 100% of original cost (11). EQIP (for mulch till, ridge till, and seasonal residue management). Equipment rental or purchase $40+ per acre. Consider costs for pest control.		ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/329a.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/329b.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/329c.pdf ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/344.pdf
1	Nutrient Management (590) (Comprehensive Nutrient Management Plan (CNMP)	After taking 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 wash or 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 ASAP - Analyze manure and other organic waste for nutrient content before field application - Test soils once every three years according to Extension recommendations - Establish a winter cover crop if nitrogen leeching is possible due to poor crop yield * Consider the Michigan Agriculture Environmental Assurance Program (MAEAP). Must be trained technical person to compile a CNMP (service provided by NRCS or Cons. District). Consider potential groundwater contamination - proximity to waterbodies critical.	$5.00/acre (9) - EQIP (Costs associated with waste water collection, soil testing, ICM are low but have a high start up.)		ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards/590.pdf
5	Pet waste disposal and collection facilities	Installing signs and pet waste collection facilities in high traffic areas	Moderate	Nutrients, bacteria	Animals, dogs or other household pets				
6	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. Soils, topography and climate will all affect the types of composting options available.	Nutrients, chemicals, and pesticides, low DO, 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.		
6	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 pert management.		http://www.deq.state.mi.us/documents/deq-swq-nps-lm.pdf
6	Fertilizer management	Includes the proper selection, use, application, storage and disposal of fertilizers. Used with pesticide management, soil management, lawn maintenance, and nutrient management	Moderate; can be other sources	*E. coli* and other bacteria, nutrients	Landscaping, storm water runoff	Consider consulting professional, such as Michigan State University Extension.	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-nps-fm.pdf
6	Soil testing of lawns and gardens	See Soil Management		Nutrients	Lawn and garden fertilizer	Testing should be done at qualified lab	Typically yearly testing required, contact local MSU Extension office. Test results may result in operations and maintenance costs. Low cost tool in management of lawns and gardens. $9.50 per test.		
9	Storm Drain Marking	Affixing plaque on storm drain inlets with "No Dumping" (of such materials as Oil, Pet Waste and Grass Clippings)	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, and yard waste	Volunteers need to take care to properly adhere plaques. Public education campaign is also needed for effective reduction in illegal dumping. Short term effectiveness.	Ceramic tiles $100 or more - metal stencils		
12	Snow and ice control operations and storage	Storage of materials for removal of snow and ice from roadways, utilizing plows, salt, and sand.		Salts	Storm water runoff	Moderate, all storage facilities have standards and specifications.	Moderate. Time for inspection of facilities		

Table 4.2: Managerial Best Management Practices

BMP#	BEST MANAGERIAL PRACTICES	DESCRIPTION	BENEFIT	POLLUTANT ADDRESSED	POTENTIAL SOURCES OF POLLUTANTS	ENVIRONMENTAL IMPACTS AND SPECIAL CONCERNS	COMPARATIVE COSTS	COMMUNITIES USING BMP	MDEQ/ NRCS LINK
12	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 $1500 per truck, minimal additional cost.		
12	Pre wet road salt		High if also used with environmentally friendly alternatives to salt	Salts	Road salt		Low/Moderate; $25/lane/mile, Equipment maintenance costs - $5000 per truck.		
13	SESC programs	Programs that specify 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	unvegetated areas, land development	State training, Soil Erosion and Sedimentation Control and/or Certified Operator.	Act 91 mandated, ongoing local administrative costs. Fee based to landowner option.		
15	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 drain material. 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	Atmospheric, 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 (MDEQ, Public Health, Transportation). Sweeping schedules and timing critical - sweep after snow melt and before spring rains. Vehicle maintenance required.	RC Road maintenance budget - $300,000/yr County for Local units. Mechanical - Total cost per curb mile = $14.40 + $65 + $40 = $119.40/curb mile. Vacuum Assisted - Total cost per curb mile = $12.95 + $35 + $40 = $87.95/curb mile (GR BMP Study)		http://www.deq.state.mi.us/documents/deq-swq-nps-sw.pdf
17	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 programs designed to preserve, protect, or enhance wetland values.	Benefits offered by wetlands are restored. 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 DEQ must be notified if a community adopts a wetland ordinance, but it has no review or approval authority.	$11,240 / ordinance development (Corporate sponsored workshops)		
18	Development/Enforcement of Stream Buffer Ordinance	Ordinance protects a given area of buffer adjacent to stream systems. Protected buffers can provide numerous environmental protection and resource management benefits.	Moderate to high. Reduces the risk of sediment and contaminants entering the stream. Practices give a 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.	$11,240 / ordinance development (Corporate sponsored workshops)		
18	Green Space Protection Ordinance - preserving 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/sqft. Land acquisition and management costs depend on site. May double as park/open space usage with related costs.		
19	Yard waste collection and disposal	Composting of collected refuse	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		
19	Recycling Program (MDOT)	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	$200,000/year. $1.15/person/yr		
20	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.		http://www.deq.state.mi.us/documents/deq-swq-nps-hhhw.pdf
22	Illicit Discharge Ordinance (MDOT)	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/ac (assuming 1 system monitored every 5 sq. miles. Maintenance program. $0.83/acre/year $50/ac/yr (with TV inspection)		
24	Development/Enforcement of Storm Water Ordinance	Ordinance can provide for the regulation and control of storm water runoff; provide for storm water permits an 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	Storm water runoff	Establishing storm water management control will minimize storm water runoff rates and volumes from identified new land development and encourage groundwater recharge.	$11,240 / ordinance development (Corporate sponsored workshops)		
26	Low Impact Design practices - bioretention, 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	Rainfall, runoff, solar, fertilizers				http://www.lid-stormwater.net/

Table 4.2: Managerial Best Management Practices

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27	Clean and maintain storm inlets and catch basins (MDOT)	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 - 3 years. General fund, RC road maintenance budget - $250,000	Moderate/high; Total annual cost per catch basin = ($8/catch basin) + ($40/catch basin) = $48/catch basin. (GR BMP Study). $21/acre/year maintenance.		

(1) Fishbeck, Thompson, Carr & Huber, Inc. Evaluation of Best Management Practices for MDOT. 2002.
(2) Bannerman, Roger T., Wisconsin Department of Natural Resources. Source Area and Regional Storm Water Treatment Practices: Options for Achieving Phase II Retrofit Requirements in Wisconsin. 2002.
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Long-term Goal 1: Restore and enhance recreational uses

- ***Objective: Reduce bacterial loading***
  - Develop manure management plans and comprehensive nutrient management plans (part of Generally Accepted Agricultural Management Practices [GAAMPs]) (No. 1)
  - Control sanitary sewer overflows (SSOs) and maintain sanitary sewer system (No. 2)
  - Eliminate failing onsite sewage disposal systems (OSDSs) (No. 3)
  - Manage lagoon systems and package wastewater treatment plants (WWTP) (No. 4)
  - Manage pet waste and wildlife populations (No. 5)
- ***Objective: Reduce nutrient loading***
  - Support environmentally friendly lawn and garden maintenance (No. 6)
  - Install buffers and protect riparian corridor (No. 8)
- ***Objective: Provide additional public access to water resources***
  - Identify riparian land areas for recreation enhancement and conserve for future parks and public access (No. 7)

Long-term Goal 2: Restore and protect aquatic life, wildlife, and habitat

- ***Objective: Protect and re-establish riparian and instream habitat***
  - Install buffers and protect riparian corridors (No. 8)
  - Install storm drain markers (No. 9)
  - Utilize habitat restoration techniques (No. 10)
  - Install/maintain oil and grease trap devices (No. 11)
  - Minimize the effects of salt and deicing chemical storage areas (No. 12)
- ***Objective: Reduce soil erosion and sedimentation***
  - Improve soil erosion and sedimentation control (SESC) programs (No. 13)
  - Implement streambank stabilization measures (No. 14)
  - Perform street sweeping (No. 15)
- ***Objective: Reduce excess runoff***
  - Support environmentally friendly lawn and garden maintenance (No. 7)

- ***Objective: Protect open space and natural areas within the Watershed***

    - Conduct natural feature inventory and assessments (No. 16)
    - Increase wetland conservation (No. 17)
    - Implement natural features and floodplain protection ordinances (No. 18)
    - Continue and expand litter and debris cleanup and recycling programs (No. 19)
    - Continue and expand household hazardous materials management programs (No. 20)

Long-term Goal 3: Protect public health

- ***Objective: Protect drinking water supply***

    - Include drinking water protection measures in Master Plans, Zoning Ordinances, and Source Water Protection Plans for the Cities of Algonac and New Baltimore and Ira Township (No. 21)

- ***Objective: Reduce pollutants resulting in fish advisories***

    - Continue and expand household hazardous materials management programs (No. 20)
    - Identify and eliminate illicit discharges (No. 22)

- ***Objective: Reduce bacterial loading***

    - Develop manure management plans and comprehensive nutrient management plans (part of [GAAMPs]) (No. 1)
    - Control SSOs and maintain sanitary sewer system (No. 2)
    - Eliminate failing OSDSs (No. 3)
    - Manage lagoon systems and package WWTP (No. 4)
    - Manage pet waste and wildlife populations (No. 5)

Long-term Goal 4: Reduce impacts from peak flows

- ***Objective: Establish target peak flows for tributaries***

    - Conduct hydrologic analysis (No. 23)

- ***Objective: Develop water resource protection and management ordinances to reduce runoff***

    - Implement storm water ordinance that includes Low Impact Development (LID) practices (No. 24)

- ***Objective: Reduce storm water runoff quantity and minimize post-storm instream velocities***

    - Construct and maintain storm water storage facilities (No. 25)
    - Install and maintain storm sewer infiltration devices (No. 26)
    - Enhance storm water treatment (No. 27)
    - Prevent and remove flow obstructions following woody debris management techniques (No. 28)

4.1 ESTIMATED POLLUTION REDUCTIONS FROM PROPOSED ACTIONS AND BMPS

The estimated pollution reductions for sediment and nutrient have been determined using the best available information from the Watershed and the most recent tools developed for calculating these reductions. The reductions are estimated for agricultural cropland sources, urban runoff sources, and all other nonpoint source (NPS) sites that were previously described in Chapter 1. The actions and BMPs selected by the Anchor Bay Steering Committee (Steering Committee) to address those sources and sites were determined to be the most feasible and cost effective for this Watershed.

4.1.1 SEDIMENT AND NUTRIENT LOADINGS AND REDUCTIONS FROM AGRICULTURAL AREAS

The actions and systems of BMPs that have been identified to be implemented in the Watershed to achieve the estimated reductions were determined from the information collected during the Watershed inventory and previous studies. Certain assumptions were made about the agricultural areas to use the Michigan State University's "*Revised Universal Soil Loss Education (RUSLE) Online Soil Erosion Assessment Tool*" and the Michigan Department of Environmental Quality (MDEQ) "*Pollutants Controlled and Documentation for Section 319 Watershed Training Manual*" to estimate the sediment and nutrient loadings and reductions.

All of the calculations were computed for the subwatersheds delineated for the Build Out Analysis (FTC&H, 2005). The following assumptions for the agricultural areas were used:

- The contributing area of the agricultural land was estimated within each subwatershed using Geographic Information System (GIS) land use data and topographical maps.

- Soil types within each subwatershed were evaluated separately and the results were weighted to obtain a single soil loss value for each subwatershed.

- The major soil types of those agricultural areas were categorized using the United States Department of Agriculture (USDA) Soil Surveys of Macomb and St. Clair Counties. Each soil type has an associated range of slopes. The median of each range was used for each soil type.

- The existing (before treatment) crop rotation and tillage conditions were determined from information provided by the USDA Natural Resources Conservation Service (NRCS) District Conservationist and the local knowledge from the Technical Subcommittee.

- The practices implemented (after treatment) of crop rotations and tillage conditions were assumed based on the soil types and rotations, and the conservation tillage practices recommended.

- A weighted average, based on the areas of conservation tillage and filter strips, was used to determine the soil loss after treatment.

The complete methodologies and assumptions are described in Appendix 1E. Calculations at the subwatershed level enabled the evaluation of the specific recommendations in this WMP and prioritization of the remediation efforts on a subwatershed level.

Table 4-3 provides a summary of the calculations of the estimates of sediment and nutrient loadings and reductions in the subwatersheds. The numbers themselves do not necessarily present a completely accurate amount of the sediment and nutrients delivered to the stream, but rather can be used to prioritize the subwatersheds by their relative loadings to Anchor Bay, since the methodologies and assumptions were consistently applied to all subwatersheds.

TABLE 4-3: SEDIMENT AND NUTRIENT LOADINGS AND REDUCTIONS FROM AGRICULTURAL AREAS

Sub District	Total Soil Loss Before Treatment (tons/yr)	Total Soil Loss After Treatment (tons/yr)	Total Sediment Reduction (tons/yr)	Before Phosphorus Content (lbs/yr)	Before Nitrogen Content (lbs/yr)	After Phosphorus Content (lbs/yr)	After Nitrogen Content (lbs/yr)	Total Phosphorus Reduction (lbs/yr)	Total Nitrogen Reduction (lbs/yr)
Islands	584	91	247	534	1,069	116	232	418	837
St. Clair River Drainage	276	43	116	350	700	78	156	272	544
Marine City Drainage	598	93	253	624	1,248	140	279	484	968
Swartout Creek	42	7	18	45	90	10	20	35	71
Beaubien Creek	1,557	219	742	1,596	3,191	329	658	1,266	2,533
Fair Haven Drainage	579	90	244	634	1,269	147	294	487	975
Swan Creek	4,096	582	1,934	4,455	8,909	950	1,900	3,505	7,009
Marsac Creek	994	152	429	1,088	2,176	248	497	840	1,679
Crapau Creek	343	53	146	376	752	87	173	289	579
Goulette Point Drainage	3	0	1	3	6	1	1	2	4
Salt River	4,301	559	2,224	5,242	10,483	995	1,989	4,247	8,494
Anchor Bay Harbor	0	0	0	0	1	0	0	0	1
Pitts Drain	237	37	101	257	513	58	117	198	396
Anchor Bay Shores	27	4	11	29	59	7	13	23	45
Total	13,638	1,931	6,467	15,233	30,465	3,165	6,330	12,068	24,135

Notes:

- This table summarizes the overall or "total" sediment and nutrient reductions.
- Total soil loss before treatment = existing soil loss (sediment loading), before any BMPs have been implemented.
- Total soil loss after treatment = soil loss (sediment loading), after BMPs have been implemented.
- Total sediment reduction = reduction in sediment loading as a result of BMP implementation. Delivery ratio was factored into agricultural fields portion of total sediment reduction.
- Before phosphorus content = existing phosphorus loading, before any BMPs have been implemented.
- Before nitrogen content = existing nitrogen loading, before any BMPs have been implemented.
- After phosphorus content = phosphorus loading, after BMPs have been implemented.
- After nitrogen content = nitrogen loading, after BMPs have been implemented.
- Total phosphorus reduction = reduction in phosphorus loading as a result of BMP implementation.
- Total nitrogen reduction = reduction in nitrogen loading as a result of BMP implementation.

Overall, the numbers suggest that in the agricultural areas, if all recommended practices were implemented at all identified sites, 48% of the sediment delivered from those sites would be reduced, as well as 80% of the nitrogen and 80% of the phosphorus.

Pollutant reductions for phosphorus and nitrogen are based on the amount of sediment delivered, thus the calculations are dependent on the accuracy of the data collected at the site pertaining to soil loss. These estimates are based on limited field measurements, due to time and financial constraints. The results, therefore, are purely estimates of the pollutant removal capability of the actions and BMPs implemented. Detailed site specific measurements and calculations, at the time of implementation, will yield more accurate numbers.

4.1.2 Sediment and Nutrient Loadings and Reductions from Urban Areas

A Pollutant Load Reduction Model was developed by the Illinois Department of Environmental Management Watershed Management Section, based on the MDEQ's "*Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual,*" and further modified by incorporating the Illinois Environmental Protection Agency's (IEPA) calculations for urban settings. This model was adopted by the U.S. Environmental Protection Agency's (EPA) Region 5 office for all states to use and is based on very simple and sound principles. The model does not estimate the load reduction for dissolved pollutants, and was used only to estimate loadings and reductions for selective individual BMPs.

The methodology for the gross estimate of sediment and other constituent load reductions from the implementation of urban BMPs is based on reduction efficiencies and calculations developed by IEPA. The model uses many simplifying assumptions to provide a general estimate of pollutant load reductions through BMP implementation. The land use data was extracted using GIS information. The acreage of areas with storm sewers within each subwatershed's land use was determined through conversations with the drain commissioners and local officials. This model does not estimate pollutant load reductions for dissolved constituents. Multiple practices, determined by the Technical Subcommittee, were considered for each subwatershed and the results were tabulated for all scenarios. The estimated reductions for each practice for each subwatershed can be compared for applicability to that particular subwatershed. More accurate results of pollutant load reductions could be obtained through direct monitoring and/or a more detailed modeling application. A summary of the agricultural and urban pollutants reduced is presented in Table 4-4.

The reductions achieved from the various BMPs selected for analysis, presented in Table 4-5, ranged from 16% to 89% reduction of sediment, with an average reduction of 57%. For nitrogen, the range was from 5% to 57%, with an average of 26%. For phosphorus, the range was from 5% to 67%, with an average of 31%.

TABLE 4-4: ANCHOR BAY WATERSHED POLLUTANT LOADINGS AND REDUCTIONS

Subwatershed	Loading			Reduction				
Islands	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other - Oil/Grit Separator
Total Suspended Solids (tons/yr)	584	337		247	219	240	161	42
Total Nitrogen (lbs/yr)	1,069	10,210		837	1,021	4,870	2,657	443
Total Phosphorus (lbs/yr)	534	1,141		418	285	676	257	49
Acres	**1,255**	**11,571**	**11%**					
St. Clair River drainage	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	276	132		247	86	108	72	19
Total Nitrogen (lbs/yr)	700	4,291		837	429	2,204	1,202	200
Total Phosphorus (lbs/yr)	350	444		418	111	282	107	21
Acres	**677**	**1,851**	**37%**					
Marine City drainage	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	598	370		253	240	311	208	54
Total Nitrogen (lbs/yr)	1,248	12,061		968	1,206	6,469	3,529	588
Total Phosphorus (lbs/yr)	624	1,205		484	301	803	305	59
Acres	**2,421**	**7,031**	**34%**					

TABLE 4-4: ANCHOR BAY WATERSHED POLLUTANT LOADINGS AND REDUCTIONS

Subwatershed	Loading			Reduction				
Swartout Creek	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	42	503		18	327	279	186	49
Total Nitrogen (lbs/yr)	90	16,795		71	1,679	5,569	3,038	506
Total Phosphorus (lbs/yr)	45	1,975		35	494	767	291	56
Acres	**193**	**8,389**	**2%**					
Beaubien Creek	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	1,557	704		742	458	616	412	107
Total Nitrogen (lbs/yr)	3,191	21,626		2,533	2,163	11,935	6,510	1,085
Total Phosphorus (lbs/yr)	1,596	2,075		1,266	519	1,427	542	104
Acres	**5,710**	**11,734**	**49%**					
Palms Road Drain	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	579	30		244	19	131	87	23
Total Nitrogen (lbs/yr)	1,269	965		975	97	2,567	1,400	233
Total Phosphorus (lbs/yr)	634	119		487	30	315	120	23
Acres	**1,423**	**1,613**	**88%**					

TABLE 4-4: ANCHOR BAY WATERSHED POLLUTANT LOADINGS AND REDUCTIONS

Subwatershed	Loading			Reduction				
Swan Creek	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	4,096	540		1,934	351	1,100	735	192
Total Nitrogen (lbs/yr)	8,909	13,291		7,009	1,329	19,725	10,759	1,793
Total Phosphorus (lbs/yr)	4,455	1,716		3,505	429	2,414	916	176
Acres	**9,198**	**19,039**	**48%**					
Marsac Creek	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	994	233		429	152	352	235	61
Total Nitrogen (lbs/yr)	2,176	6,668		1,679	667	6,580	3,589	598
Total Phosphorus (lbs/yr)	1,088	806		840	201	838	318	61
Acres	**2,404**	**6,237**	**39%**					
Crapau Creek	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	343	427		146	277	366	245	64
Total Nitrogen (lbs/yr)	752	10,968		579	1,097	5,881	3,208	535
Total Phosphorus (lbs/yr)	376	1,263		289	316	831	315	61
Acres	**837**	**4,567**	**18%**					

TABLE 4-4: ANCHOR BAY WATERSHED POLLUTANT LOADINGS AND REDUCTIONS

Subwatershed	Loading			Reduction				
Goulette Point drainage	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	3	118		1	77	123	82	22
Total Nitrogen (lbs/yr)	6	3,371		4	337	2,367	1,291	215
Total Phosphorus (lbs/yr)	3	424		2	106	295	112	22
Acres	**6**	**891**	**1%**					
Salt River	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	4,301	1,741		2,224	1,132	1,261	843	220
Total Nitrogen (lbs/yr)	10,483	47,389		8,494	4,739	20,903	11,402	1,900
Total Phosphorus (lbs/yr)	5,242	5,422		4,247	1,356	2,964	1,125	216
Acres	**7,803**	**23,069**	**34%**					
Anchor Bay Harbor drainage	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	0	36		0	23	27	18	5
Total Nitrogen (lbs/yr)	1	1,013		1	101	528	288	48
Total Phosphorus (lbs/yr)	0	130		0	32	85	32	6
Acres	**1**	**394**	**0%**					

TABLE 4-4: ANCHOR BAY WATERSHED POLLUTANT LOADINGS AND REDUCTIONS

Subwatershed	Loading			Reduction				
Pitts Drain	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	237	1,071		101	696	814	544	142
Total Nitrogen (lbs/yr)	513	26,078		396	2,608	12,464	6,799	1,133
Total Phosphorus (lbs/yr)	257	2,797		198	699	1,651	627	121
Acres	**546**	**4,837**	**11%**					
Anchor Bay Shores drainage	Agricultural land	Other areas	% Ag. land	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	27	1,481		11	963	1,151	769	201
Total Nitrogen (lbs/yr)	59	29,180		45	2,918	13,792	7,523	1,254
Total Phosphorus (lbs/yr)	29	3,313		23	828	1,986	754	145
Acres	**63**	**4,724**	**1%**					
Totals	Agricultural land	Other areas	Total Loadings	Ag. BMPs with Filter strips	Other - Grass Swale	Other - Ext. Wet Detention	Other - Dry Detention	Other Oil/Grit Separator
Total Suspended Solids (tons/yr)	13,637	7,723	21,360	6,597	5,020	6,879	4,597	1,201
Total Nitrogen (lbs/yr)	30,466	203,906	234,372	24,428	20,391	115,854	63,195	10,531
Total Phosphorus (lbs/yr)	15,233	22,830	38,063	12,212	5,707	15,334	5,821	1,120
Acres	**32,537**	**105,947**	**31%**					

TABLE 4-5: POLLUTANT REDUCTIONS ACHIEVED

	Percent Reduced in Agricultural Areas	Average Reduction in Urban Areas	Percent Average Reduction in Urban Areas	Highest Percent Reduction in Urban Areas	Lowest Percent Reduction in Urban Areas
Sediment (tons/yr)	48%	4,424	57%	89%	16%
Nitrogen (lbs/yr)	80%	52,493	26%	57%	5%
Phosphorus (lbs/yr)	80%	6,996	31%	67%	5%

Many combinations of actions and BMPs can be implemented to realize pollutant reduction goals. The most effective combination will be the one that is most feasible for the stakeholders based on cost, acceptability, and sustainability. Local and national efforts are continuing to identify pollutant removal effectiveness of actions and BMPs and estimated pollutant reductions expected. Not all of the answers to the question of which practices will meet the pollutant reduction goals are included in the WMP. However, the best available information has been referenced to estimate pollutant reduction predictions in the interest of determining a path to appropriate pollutant reductions. Supporting information is included in Appendix 1F.

4.2 EVALUATION OF PROPOSED ACTIONS AND BMPS

The Watershed is comprised of diverse local communities, from rural townships to urban city centers. Subsequently, a variety of actions and BMPs could be considered across the Watershed. Although each action and BMP will most likely apply to at least one of the communities in the Watershed, not all of them apply to every community. Therefore, it is important to note that each action or BMP is a unique solution to a specific pollution source or problem.

The 2003 WMP provided descriptions of the BMPs, summarized in the following paragraphs. The summaries were intended to provide basic explanations of each BMP that correlate with the specific short-term objectives of the long-term goals. The list has been modified to include only those that have been selected in this 2005 WMP. Tables 4.1 and 4.2 further explain the actions and BMPS that are now recommended.

No. 1 - Develop manure management plans and comprehensive nutrient management plans (part of GAAMPs)

Recommended actions and BMPs:

- Cattle exclusion
- Agricultural waste storage facilities
- Crop residue management
- Nutrient management

In rural areas, smaller agricultural establishments and small horse farms may contribute to higher bacteria concentrations if manure is not managed properly. State agencies have the authority to manage agricultural practices through voluntary measures called GAAMPs. GAAMPs provides agricultural landowners with guidelines to follow in regard to nutrient and pesticide application and storage, manure management, groundwater protection, and a host of other agricultural BMPs to protect surface and groundwater as well as habitat. Established outreach programs are available to educate landowners about these recommended practices, which should be utilized as much as possible to control potential pollutants from this land use. The Steering Committee should work closely with the NRCS and the conservation districts to identify and promote the use of GAAMPs in problem areas.

No. 2 - Control SSOs and maintain sanitary sewer system

Recommended actions and BMPs:

- Disconnecting direct storm water discharges to the sanitary sewer by removing downspouts or rerouting storm drain and catch basin connections to the storm sewer
- Repairing or replacing defective manhole structures
- Repairing or replacing damaged sanitary sewer lines
- Constructing new sanitary or storm sewers to carry the excess flow

Sanitary sewers designed and constructed under current standards limit the amount of storm water that can enter the system. Older systems, however, have a number of ways in which excess storm water can enter the sewage collection systems. When this storm water within a sanitary sewer collection system becomes excessive, basements will flood (with sewage) unless the excess flow is discharged to the surface waters. These sewage discharges are known as SSOs. These discharges are illegal under present state and federal rules and regulations. No SSOs have been found in Anchor Bay, but caution should be taken to ensure that systems are maintained.

The potential solutions to eliminate untreated SSOs are complex due to the nature of the causes and the inter-relationships of the local and regional sewerage systems that serve the communities. The solutions can be very expensive and may take time to implement. The first step is to determine where the excess flow is entering the sewer system by smoke testing, flow measurement, television inspection of the sewer lines, or physical observation of manhole structures on the system.

No. 3 - Eliminate failing OSDSs

Identifying failed OSDS systems can be accomplished through regular inspections of the disposal system or by sampling the waterways. Inspections can occur during property transactions (a time-of-sale ordinance), during septic tank pump outs, or at specific periodic intervals. Surface water sampling to detect failing systems is often unreliable because the small volume of untreated sewage created by failing systems in comparison to total river flow may make it difficult to detect in surface waters. Once sewage is detected, sampling a source outfall or dye testing the suspect facility can identify the system that is failing.

Once a failing OSDS is identified, environmental health codes are in place at the St. Clair County Health Department and the Macomb County Health Department that ensure correction of failed systems. Depending on local ordinances and sanitary sewer availability, some homeowners may be allowed to repair their failing systems, while others may be required to connect to the municipal sewer system. Any onsite corrections need to be done under permit from the county health department and in conformance with their requirements. Either of these efforts can be very costly, because the Watershed's soils often require elevated and expensive new OSDSs and sanitary sewers are not available in many rural parts of the Watershed.

Septic tank maintenance measures can be used to prevent, detect, and control spills, leaks, overflows, and seepage from occurring in the sanitary system. Onsite sewage disposal systems should be designed, sited, operated, and maintained properly to prevent nutrient and pathogen loadings to surface waters and to reduce loadings to groundwater. Septic tanks should be pumped at least every 3 to 5 years, depending on the size of the family or group using the tank.

No. 4 - Manage lagoon systems and package WWTP

Lagoon systems and package WWTP have been used to provide wastewater treatment in many areas of the Watershed. The most suitable use of these systems is in areas where failures have already occurred or where no other viable alternatives are available. From a planning perspective, these systems should not be used to gain additional land development density from that which is planned by the local unit of government.

When operated correctly, lagoon systems and package WWTP can provide adequate protection to the waterways. However, over an extended period of time, these systems are often poorly maintained and operated, resulting in deteriorated discharge quality. Because state regulatory agencies may not be able to provide adequate oversight on an ongoing basis due to funding and personnel constraints, local units of government should establish a mechanism for providing review of the operations, maintenance, and discharge quality of these systems (i.e. special assessment district). When violations of discharge standards are identified, existing enforcement programs should be utilized. Because of these potentially long-term problems and lack of state oversight, local communities should be consulted during the state's permitting process for lagoons and package treatment plants. As the local community is increasingly being forced to oversee many of these facilities, they should be involved in decisions that place these facilities in their municipality.

No. 5 - Manage pet waste and wildlife populations

Recommended actions and BMPs:

- Structural controls can be fences that keep grazing animals out of streams, buffer strips along grazing areas, and lagoons to control and treat manure-contaminated runoff from agricultural operations.

- Non-structural controls can be ordinances that limit the number of animals that can be housed in a given area, require specific management measures by animal owners to keep runoff away from animal waste products, or require manure management plans.

- Non-structural controls can also consist of educational initiatives, such as signs at public beaches and parks that encourage people to pick up pet waste and discourage feeding birds.

While *E. coli* is an indicator of human sewage in surface water, it also signals the presence of waste from other warm-blooded animals, which, like human sewage, can also cause disease. Therefore, animal waste should be kept from the surface waters, especially where people might be swimming.

Municipalities and counties can work with the local conservation district to encourage government agencies, civic leaders, and the agricultural community to implement source controls. Source controls can be either structural or non-structural.

No. 6 - Support environmentally friendly lawn and garden maintenance

Recommended actions and BMPs:

- Proper selection of vegetation and native plants that require minimal watering or nutrient and pesticide applications

- Incorporating integrated pest management techniques and proper watering techniques to reduce runoff and excess transpiration
- Proper lawn mowing techniques to reduce runoff rates and pollutant transport
- Proper organic debris disposal
- Composting facilities
- Proper pest control techniques to minimize the use of herbicides and pesticides

Nitrogen, phosphorus, potassium, and other nutrients are necessary to maintain optimum growth of most vegetation. Fertilizer management addresses the proper selection, use, application, storage, and disposal of fertilizers. Nutrients that are applied beyond what plants require will wash off the soil and runoff into lakes, streams, and wetlands, or leach into groundwater. When nutrients, such as phosphorus runoff into surface waters, they can cause algae blooms and excessive aquatic plant growth. Practicing proper fertilizer management will minimize the potential for pollution of surface and ground waters. Municipalities and the counties should implement these practices on publicly owned properties and encourage landowners to implement these practices on privately owned land. Proper lawn and garden maintenance involves a combination of mechanical methods and careful chemical application. Mechanical methods include:

Particular maintenance techniques are required on steep slopes, in or around drainage channels, streams and detention basins, and adjacent to catch basins. This BMP could be carried out though public education efforts on NPS pollution and/or through regulations requiring licensing for landscaping and lawn care professionals.

No. 7 - Identify riparian land areas for recreation enhancement and conserve for future parks and public access

In order to encourage public awareness and concern for rivers, streams, and wetlands, it is important to increase opportunities for people to access these water resources. These areas provide aesthetics and accessibility by use of amenities, such as a fishing pier, a trail system, or other recreational opportunities. The public will be able to experience the human benefits that water offers and, in turn, can work to protect the resource. Local policies and zoning can identify natural feature areas that are desired for long-term preservation or restoration.

Waterside property is typically in high demand and can be costly. It is often in the interest of local agencies and land conservancies to compete in the open market for riparian lands. This does not diminish the need for these agencies at all levels to continue to identify and obtain the rights to conserve riparian lands. Once the available property has been identified, funding must be secured through general funds, state programs, federal programs, and/or foundations. The acquisition of these areas can be identified by local units of government through the use of natural area inventories. In turn, riparian areas can be included in long-term land use plans and can be included in local policy decisions. The properties, once secured, can provide both recreational opportunities and environmental benefit in the riparian areas.

No. 8 - Install buffers and protect riparian corridors

Recommended actions and BMPs:

- Vegetative buffers or filter strips
- Forested or wooded riparian buffers

Sheet or overland runoff can carry large amounts of contaminants into streams and directly into the bay during wet weather events. Proper maintenance of areas adjacent to riparian corridors that are left in their natural state or are established as buffer strips, provide an excellent filtering mechanism that removes suspended materials contained in the runoff. At a minimum, buffer strips should be twenty feet wide and contain native plant materials in order to provide sufficient filtering. Filter strips are generally located adjacent to agricultural operations to reduce contamination by manure, sediment, and chemicals used for crop production. These strips can also be very effective in urban settings and can be utilized in areas that contribute to storm sewer systems, as well as in direct overland runoff locations. Local units of government can provide land planning tools that will assist landowners and developers with information to properly buffer tributaries, streams, and other water features. These planning tools can utilize overlay districts, required vegetated set back areas, or natural vegetation easements to achieve proper buffering of the riparian land areas. These planning tools can, and should, be incorporated into community comprehensive plans and zoning ordinances. Funding through USDA or Farm Bill programs, grants, and other local agencies and foundations should be investigated to assist putting buffers in critical areas.

No. 9 - Install storm drain markers

Recommended actions and BMPs:

- Support storm drain marking programs

Storm drain marking programs have been implemented in many communities across the nation in an effort to preserve the quality of our water resources through public education. A permanent marker can be permanently affixed to curbs and gutters by volunteer groups or municipal public works departments. A

variety of messages can be printed on the markers, such as "No Dumping, Flows to Bay." As part of public education efforts, markers have been designed with the Lake St. Clair sailboat logo for use on catch basins within the Anchor Bay Watershed.

No. 10 - Utilize habitat restoration techniques

Recommended actions and BMPs:

- Identify waterways ideal for instream habitat enhancement
- Establish drain standards requiring instream habitat enhancement
- Plant trees in riparian areas to provide shade for fish, in coordination with drain commissioners
- Check dams and grade control structures

Habitat restoration techniques include instream structures that may be used to correct and/or improve animal habitat deficiencies over a broad range of conditions. Examples of these techniques include channel blocks, boulder clusters, covered logs, tree cover, bank cribs, log and bank shelters, channel constrictors, cross logs, revetments, and "K-shaped" dams. The majority of these structures are to be installed with hand labor and tools. After construction, a maintenance program must be implemented to ensure long-term success of the BMP.

No. 11 - Install/maintain oil and grease trap devices

Recommended actions and BMPs:

- Install oil and grease traps in floor drains and catch basins where concentrations of oil and grease are located

Oil and grease traps remove high concentrations of petroleum products, grease, and grit by means of gravity and coalescing plates. These devices are particularly useful on industrial sites, in vehicle maintenance and washing facilities, in areas where heavy mobile equipment is used, and in restaurant kitchens and restaurant dishwashing equipment. Conventional oil and water separators have the appearance of septic tanks, but are much longer in relationship to the width. Separators for large facilities have the appearance of a municipal wastewater primary sedimentation tank. These devices should be installed at facilities where high concentrations of oils and grease may spill into floor drains or catch basins.

No. 12 - Minimize the effects of salt and deicing chemical storage areas

Recommended actions and BMPs:

- Annually assess salt and deicing chemical storage and use

The storage of salt and other deicing chemicals at public works buildings should be properly designed to minimize runoff and the potential for pollutants to enter the waterways. Regular inspections of the sites will assess the pollution risk and recommend steps to be taken to minimize that risk.

No. 13 - Improve SESC programs

Recommended actions and BMPs:

- Ensure that the county SESC ordinance addresses state requirements as well as situations unique to the county.
- Provide adequate staff to process permits, inspect sites, and respond to complaints.
- Develop and access training programs to assure that all staff are adequately trained.
- Assure that SESC programs contain adequate enforcement provisions.
- Develop educational programs for developers and contractors within their county that will explain both the control mechanisms associated with, and the environmental reasons for, SESC programs.

Although the Natural Resources and Environmental Protection Act in Michigan requires that counties and municipalities implement and enforce an SESC program, these programs can vary with respect to their effectiveness. Macomb and St. Clair Counties have both adopted an SESC ordinance. The Counties should consider the following in respect to the enforcement of those ordinances:

No. 14 - Implement streambank stabilization measures

Recommended actions and BMPs:

- Identify unstable drains, streambanks, and outlets
- Stabilize drains, streambanks, and outlets

Streambank stabilization measures succeed by either reducing the force of flowing water or increasing the resistance of the streambank to erosion. Several types of streambank stabilization methods exist, such as engineered methods, bioengineered methods, and biotechnical methods. Engineered methods include structures, such as riprap, gabions, deflectors, and revetments. Bioengineering methods use live plants that are embedded and arranged in the ground where they serve as soil reinforcement, hydraulic drains, and barriers to earth movement. Examples of bioengineering techniques include live stakes, live fascines, brush mattresses, live cribwall, and branch packing. Biotechnical methods include integrated use of plants and inert structural components to stabilize channel slopes, prevent erosion, and

provide a natural appearance. Examples of biotechnical techniques include joint plantings, vegetated gabion mattresses, vegetated cellular grids, and reinforced grass systems.

No. 15 - Perform street sweeping

Recommended actions and BMPs:

- Develop a schedule for street sweeping and create statistics on the amount of sediment removed.

When performed regularly, street sweeping can remove 50% to 90% of street pollutants, including fertilizer runoff that can potentially enter surface waters through runoff. Street sweeping can also make road surfaces less slippery during light rains, improve aesthetics by removing litter, and control some pollutants. Street sweeping equipment consists of mechanical brooms, vacuum sweepers, or a combination of both, specifically designed to remove litter, loose gravel, soil, pet waste, vehicle debris, dust, and industrial debris from road surfaces. Sweepers that include vacuum technology are preferred from an environmental standpoint.

No. 16 - Conduct natural feature inventory and assessments

Recommended actions and BMPs:

- Initiate efforts to locate and quantify unprotected unique natural features

The first step in protecting the community's natural resources is to identify what resources should be protected, where they are located, and what benefits they provide to the community. After an inventory, it is often helpful to perform an assessment of these natural features so that they can be prioritized in terms of their importance to the community and their relative need for preservation. Often, it is not feasible to protect all of the natural features in a community. However, an inventory and assessment can provide scientific rationale to support a local protection ordinance and the basis for avoiding the feature during site design and development. Community-wide inventories and assessments can also provide future opportunities to preserve greenways for wildlife as well as recreation.

No. 17 - Increase wetland conservation

Recommended actions and BMPs:

- Develop wetland preservation ordinance
- Develop strategy for wetland conservation and mitigation banking

Preservation of wetlands is essential for the health of the Watershed and many are increasingly being lost through fragmentation and clear-cutting. Many of the wetlands are not regulated but even the regulated

wetlands continue to be destroyed because of weaknesses in the law and because the MDEQ lacks resources for proper enforcement. Municipalities should implement their own wetlands ordinance and/or use programs such as Wetland Mitigation Banking or Wetland Conservation Banking, to ensure protection of wetlands.

Wetlands and wetland complexes provide natural systems that soak up storm water during wet weather events, thus allowing water to infiltrate into vegetation and soil instead of running off directly to surface waters. Many pollutants are filtered out by the plants and soil prior to reaching the groundwater. Wetlands also reduce storm water velocities, reduce peak flows, increase base flows, filter out storm water pollutants, and provide habitat for numerous wildlife species. While storm water detention basins, rain gardens, and newly-created mitigation wetlands can provide some of the water quantity and water quality benefits of wetlands, they have not yet been able to recreate the ecologically diverse habitat values of high-quality natural wetlands. Many of the remaining natural wetlands are forested wetlands, which are particularly difficult to replace. Since fully developed, natural wetlands take decades to properly form, communities and developers should retain wetlands and wetland complexes in their natural state or use them to enhance larger storm water basins rather than remove them during construction and then re-engineer them later.

Wetland preservation may be accomplished through proper enforcement of a wetlands ordinance. In 2005, Macomb County developed a model wetlands ordinance that incorporated and performed a Michigan Natural Features Inventory. The ordinance requires a wetland use permit before any activities can take place within the wetland that may have a negative effect on the wetland's natural functions. A fact sheet explaining this ordinance is included in Appendix 4B.

The Wetland Mitigation Banking Program is an MDEQ approved tool that municipal entities may also use for wetland "preservation." Wetland mitigation is the creation and/or re-engineering of wetlands to compensate for their destruction. The prevalence of wetlands in the Watershed results in very few large development sites that would not need wetland mitigation. The Wetland Mitigation Banking Program permits a municipal entity to create wetlands and sell credits to developers that need wetland mitigation.

There are varying opinions on Wetland Mitigation Banking. Many think it is a good program for wetland conservation because it consolidates small mitigation projects, that may be located outside the Watershed or county, into larger, better designed and managed units, that may be located within the same Watershed where the destruction occurred, helping to maintain the Watershed's hydrology. Wetland Mitigation Banking can also potentially help fund implementation of watershed planning activities and help municipalities acquire wetland areas that may be used for regional detention areas, expansions of floodplain, and recreation. Many think that a Wetland Mitigation Banking Program is not beneficial to wetland conservation because re-engineered wetlands rarely contain all the original functions of the original wetland and they fear the program makes wetland destruction easier.

Another MDEQ tool for wetland preservation is called Wetland Conservation Banking. In this program, a municipal entity is permitted to preserve existing wetland areas through conservation easements. Ten acres of preserved wetlands could then be sold to a developer allowing them to destroy one acre of low-quality wetlands.

No. 18 - Implement natural features and floodplain protection ordinances

Recommended actions and BMPs:

- Develop and adopt natural features and floodplain protection ordinance

In order to direct development while protecting key local natural resources, it is often necessary to implement local ordinances that clarify why protection of certain features is important and how they will be protected under the law. These local ordinances can be more protective than state or federal law and can better reflect priorities of a local community. Example ordinances could address 100-year floodplains, woodland, wetland, and natural features setback, SESC, and fertilizer application.

Macomb County has developed a model overlay district ordinance for communities to protect a specific natural feature of an area. The overlay district will not replace existing regulations, but rather supplement them with language designed to protect significant ecosystems. Other model ordinances developed by Macomb County that offer watershed protection include a natural features setback ordinance, flood prevention, a native vegetation ordinance, and a tree and woodland protection ordinance. Fact sheets explaining these ordinances are included in Appendix 4B.

No. 19 - Continue and expand litter and debris cleanup and recycling programs

Recommended actions and BMPs:

- Organize waterway cleanup efforts
- Ensure recycling availability

Stream aesthetics, water quality, and habitat are all impacted by materials dumped into and along watercourses. Litter and debris cleanup can be achieved through adopt-a-road and local stream cleanup programs. Community organizations, schools, churches, and private companies can pledge to collect debris along local, county, and state roads, and streambanks and channels. This effort is coordinated with the local, county, or state road agencies that will remove the collected debris for proper disposal.

Material recycling benefits the environment. Materials that are recycled reduce the possibility of those materials being dumped into streams, prolong the life of local landfills, and reduce the need for raw materials for new production.

No. 20 - Continue and expand household hazardous materials management programs

Recommended actions and BMPs:

- Minimize the purchase and usage of household hazardous waste (HHW) materials that exhibit characteristics such as corrosivity, ignitability, reactivity, and/or toxicity, or are listed as hazardous materials by the EPA.
- Ensure proper storage and disposal of such materials if they must be purchased and used.
- Sponsorship or promotion of HHW collection.

The average American household contains 3 to 10 gallons of hazardous chemicals, including items such as automotive wastes, cleaners, and paints. In general, the public is unaware of the problems associated with overuse and improper disposal of these materials. In addition, the public generally does not recognize the toxicity of materials used in and around homes.

The proper disposal of hazardous materials will minimize the amount of hazardous materials that will enter surface waters and groundwater supplies.

No. 21 - Include drinking water protection measures in master plans for the Cities of Algonac and New Baltimore and Ira Township

Recommended actions and BMPs:

- Implementation of Source Water Protection Plan recommendations

A Source Water Protection Assessment has been completed for the Cities of Algonac and New Baltimore as a first step to developing a Source Water Protection Plan (Protection Plan). Ira Township has completed a Protection Plan, which outlines the steps that should be taken to ensure the quality of the drinking water. MDEQ has tentatively approved the Protection Plan, and Ira Township is responsible for implementing the recommendations in that plan to protect the drinking water supplies. Communities will eventually adopt ordinances to support the master plans that institutionalize the recommended actions.

No. 22 - Identify and eliminate illicit discharges

Recommended actions and BMPs:

- Prevention, detection, and removal of all physical connections to the storm water drainage system that convey any material other than storm water

- Implementation of measures to detect, correct, and enforce against illegal dumping of materials into storm drains, streams, and lakes

- Implementation of spill prevention, containment, cleanup, and disposal techniques at commercial, industrial, and municipal facilities to prevent or reduce the discharge of spilled materials into storm water

- Maintain or promote county Illicit Discharge Reporting Hotline

Crews of municipal workers have been trained on how to identify illicit discharges and locate illicit connections. Although this effort can be labor intensive, the reduction in the amount of sanitary sewage and chemicals that enter surface waters through elimination of these sources often has significant environmental benefits.

No. 23 - Conduct hydrologic analysis

Recommended actions and BMPs:

- Implement 2005 Hydrologic Analysis recommendations

A hydrologic model was developed by Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H), in 2005, to assess the hydrologic conditions in the Watershed and to determine peak flows associated with water quality impairments. The results recommend practices and management strategies to be adopted in the Watershed to reduce peak flows and address the high-flow issues. The hydrologic model will be an effective tool for communities to use to demonstrate their compliance with the portion of the permit that requires post-construction controls to protect receiving waters from the effects of urbanization.

No. 24 - Implement storm water ordinance that includes LID practices

Recommended actions and BMPs:

- Implementation of storm water ordinance that includes LID practices

In undeveloped areas, or in areas where redevelopment may occur, it is important to have regulations in place that can guide land development with regard to protecting the water quality, water quantity, and biological integrity of the receiving surface water. This regulation can use existing data to determine the development impact that can be tolerated by the surface waters before that system will become degraded. Future development or redevelopment can be guided to control runoff so that local streams and water resources are not negatively affected by the development to the greatest extent practical. Both the counties and communities can protect storm water and water resources through the development and implementation of ordinances.

Macomb County has developed a model storm water ordinance to encourage the use of structural, vegetative, or managerial practices designed to treat, prevent, or reduce degradation of water quality due to storm water impacts. Development projects under the ordinance should be designed, constructed, and maintained using practices to prevent flooding, protect water quality, reduce soil erosion, maintain and improve wildlife habitat, and contribute to the aesthetic value of the project. A fact sheet explaining this ordinance is included in Appendix 4B.

FTC&H developed a model storm water ordinance for the Watershed that recommends design specifications based on the criteria of flood control, stream protection, water quality protection, groundwater recharge, and LID. Standards design specifications were established for the Watershed, as well as specifications for alternative areas where unique conditions exist and coastal zones that directly discharge to Anchor Bay and the St. Clair River. A fact sheet explaining this ordinance is also included in Appendix 4C.

No. 25 - Construct and maintain storm water storage facilities

Recommended actions and BMPs:

- Wet and dry detention requirements
- Reuse of water from wet detention
- Long-term maintenance tool for clean out of basins
- Parking lot storage for storm water

Storm water storage facilities are source-control devices designed to manage flow sufficiently in order to prevent downstream flooding and/or reduce erosive velocities in the receiving stream. They can either be retrofitted into existing systems or designed into new systems. Retrofitting storage into existing drainage systems is usually very expensive. Improperly sized and sited storage facilities can also cause localized parking lot and street flooding, icing in winter months, and increased downstream flooding. Local and county drain ordinances can require development standards for construction of storm water storage facilities.

Wet detention ponds are small man-made lakes that can include emergent wetland vegetation around the banks, as well as within the pond area, and are designed to capture and remove particulate and certain dissolved constituents. Wet ponds are ideal for large, regional tributary areas (10 to 300 acres) where there is a need to achieve high levels of particulate and some dissolved nutrient removal, although they can also be used effectively in smaller size drainage areas. The outlet should be sized to assure retention of an adequate amount of water to support good vegetative growth while still reducing peak discharges to the receiving stream.

Dry detention ponds are designed to capture runoff and release it slowly to allow most of the pollutant-laden sediments to settle. This type of detention pond is designed to be dry between storm events and is primarily used for tributary watersheds ten acres and larger, although they can be effective in smaller drainage areas also. Since the purpose of a dry detention pond is to attenuate peak flow, the outlet is usually sized to draw down the first 50% of volume in 12 to 16 hours and the remaining water in 24 to 32 hours.

Both of these detention devices can be used to treat runoff, accumulate sediments, attenuate flow, and route floodwaters. Water from these devices could be used in sprinkler systems for green belts and commons areas in residential and commercial developments. This would provide relief for potable water systems during peak seasonal demands. The decision to use a dry or a wet detention basin is usually dictated by the location and other surrounding land uses. Either system will provide quality management and some degree of quality enhancement if properly designed, operated, and maintained. In all cases, the pond should be configured for aesthetics, safety, and maintenance.

Other possible detention devices are storage tanks connected to the existing drainage system, street storage, and parking lot storage. Storage tanks are often located underground. This category would include off-line storage and oversized collection pipes. Street and/or parking lot storage is usually accomplished through the use of restricted catch basins or undersized collection pipes that do not allow the maximum design flow from a storm event to be transported through the system as fast as it accumulates. Water that cannot enter the system backs up into the streets and/or parking lots.

Care needs to be taken in utilizing this BMP that the temporary flooding will not cause property damage and that icing that may form in winter months will not create a safety hazard.

To be continually effective, structural BMPs that are installed to eliminate or control storm water contamination must operate at their original design parameters. This can only be achieved if the controls are routinely checked and maintained to assure they are operating as designed. For example, sediment and oil accumulations must be regularly removed from detention ponds to maintain the design retention time at the expected storm water volume. This maintenance requirement needs to be built into the ongoing operational budget for storm water programs.

Macomb County has developed a model flood prevention district and an ordinance to enforce special regulations for the use of the land which may be subject to inundation by floods and floodwaters at predicable intervals. Floodplains are an integral part of a community and include numerous benefits, such as storing flood waters, improving water quality, stabilizing soils, offering unique habitats, and providing open space and greenways.

No. 26 - Install and maintain storm sewer infiltration devices

Recommended actions and BMPs:

- Infiltration trench
- Rain gardens
- Porous pavement

Infiltration devices in the Watershed are generally not a useful BMP because of the Watershed's predominately clay soils. However, under-drained bioretention areas and rain gardens, planted with prairie type plants, can provide an infiltration mechanism for storm water on a site-specific basis that will potentially eliminate runoff from small storms and reduce the quantity of runoff in larger storms.

No. 27 - Enhance storm water treatment

Recommended actions and BMPs:

- Catch basin clearing
- Catch basin inlet devices
- Hydrodynamic separator units

When performed on a regular basis, catch basin cleaning removes pollutants from the storm drainage system, reduces the concentration of pollutants during the first flush of storms, prevents clogging of downstream systems, restores the catch basins sediment trapping ability, and allows the in-system storage capacity of the sewers to be fully utilized. Catch basin cleaning requires the use of a vactor truck, and sumps should be cleaned before they become 40% full. Materials removed from the catch basins should be properly disposed of and not allowed to re-enter the storm sewer system. Pollutant capture within a catch basin can be improved through the use of catch basin insert devices. Depending on the type, these devices can be used to improve sediment capture and provide oil and chemical removal.

No. 28 - Prevent and remove flow obstructions

Recommended actions and BMPs:

- Obstruction removal following woody debris management techniques

Prevention and removal of stream flow obstructions involves the detection of stream blockages caused by debris, sediment, and branches or trees that have fallen into the river. If cleanup is required, it is important to do so in an environmentally friendly manner that minimizes habitat disruptions. Stream cleanup should be considered in lieu of clearing, snagging, channelization, or other severe modifications. Communities and individuals are encouraged to get involved with removing smaller obstructions before they become a major problem. This may include monitoring and maintaining stream flow conditions and checking for obstructions that are hindering the flow of the river and causing upstream ponding problems.