Outline

Introduction

The overall strategy to dealing with water pollution should be one of a treatment train approach – first pollution prevention, then treatment. Protecting the water that is currently in good condition by preventing pollution is a high priority. There are a number of water quality issues to deal with in the Cannon River watershed. In the Upper Cannon lobe there are several lakes that are showing good water quality and for those lakes protection through pollution prevention is needed. Most of the rivers, streams and lakes in the watershed fall into the category of needing treatment.

A Best Management Practice (BMP) is a land management practice that a landowner implements to control sources or causes of pollution. There are three types of BMPs that treat, prevent, or reduce water pollution.

• Structural BMPs: "brick and mortar" practices that require construction activities to install, such as storm water basins, grade stabilization structures, and rock rip-rap

• Vegetative BMPs: that use plants, including grasses, trees, and shrubs, to stabilize eroding areas

• Managerial BMPs: that involve changing the operating procedures at a site." (Brown, Peterson, Kline-Robach, Smith, & Wolfsom, 2000)

The key to proper selection of a single or series of BMPs is to match the pollutant to be controlled against the pollutant removal mechanism of a specific BMP.

There are many manuals and technical resources available to provide detail on how to carry out each practice. A list of some useful resources includes:

- Minnesota State Stormwater Manual www.pca.state.mn.us/index.php/water/water-types-and-programs/stormwater/stormwater-management/minnesota-s-stormwater-manual.html
- Stream Corridor Restoration: Principles, Processes, and Practices http://www.nrcs.usda.gov/technical/stream_restoration/
- Reconnecting Rivers: Natural Channel Design in Dam Removal and Fish Passage www.mndrn.gov/eco/streamlab/reconnecting_rivers.html
- Managing Grazing in Stream Corridors http://www.mda.state.mn.us/news/publications/animals/livestockproduction/grazing.pdf

- Natural Resource Conservation Service Field Office Technical Guide www.nrcs.usda.gov/technical/efotg
- University of Minnesota Extension publications www.extension.umn.edu/Agriculture/
- Minnesota Shoreland Management Resource Guide www.shorelandmanagement.org/
- Best Management Practices for Nitrogen Use in Southeastern Minnesota, publication #08557, (http://www.extension.umn.edu/distribution/cropsystems/DC8557.pdf)
- Best Management Practices for Nitrogen use in South-Central Minnesota, publication #08554, (http://www.extension.umn.edu/distribution/cropsystems/DC8554.pdf)
- The Minnesota Phosphorus Index – Assessing Risk of Phosphorus Loss from Cropland (http://www.extension.umn.edu/distribution/cropsystems/DC8423.html)

Detailed descriptions of all possible management strategies and practices could and do fill books as noted above. For the Cannon River watershed there are some more commonly used practices that fit into the following categories: agricultural, in-lake, shoreland, septic systems, stream channel, urban stormwater, and municipal and industrial point sources. The following is a summary of those practices.

Agricultural Practices

Agriculture plays a central role in nonpoint source pollution issues and water quality restoration strategies (National Resource Council, 2008). As mentioned in chapter 2, seventy percent of land in the Cannon River watershed is in some form of agricultural production. The primary production is corn and soybean row crops followed by animal feedlots. Conventional row crop production requires tillage, fertilizer (chemical and/or manure) and usually some sort of pesticide treatment. This can result in sediment, nitrogen, phosphorus, and chemicals reaching the water. For feedlots manure storage and management are significant issues. If the manure is not handled properly it results in bacteria, nitrogen and phosphorus being added to the water. There are many opportunities and methods available to agricultural producers to assist them in mitigating the effects their operations have on surface and groundwater. The following is a list of some, of the practices available to prevent and treat pollution generated from agriculture.

Prevention

Conservation Tillage and Residue Management

Conventional row crop methods of tillage (such as mold board plowing) result in soil organic matter that is dramatically reduced when heavy tillage incorporates oxygen into the soil and disaggregates, or breaks up, the soil. Once the soil is disaggregated, it is exposed to wind and water erosion, which further deplete the organic materials in the most productive few inches of topsoil. With lowered organic matter fecal material runoff is more likely.

Conservation tillage is a cost-effective way to build organic matter and reduce field runoff of sediment. In times of increasing fuel and equipment costs, these methods of reduced tillage and fewer trips over the field provide considerable financial benefit to the producer. No-till farming has also been shown to dramatically reduce fuel and equipment costs while providing the most effective way to reduce erosion. However, producers perceive that Minnesota's climate and soils that are slow to warm up in the spring are major factors that compel them to use heavy tillage to expose black soils to the sun's warmth. The University of Minnesota Extension Service publication, "Tillage Best Management Practices for Water Quality Protection in Southeastern Minnesota" can serve as an effective tool in facilitating changes in tillage practices with farmers. Conservation tillage is one step that can and is being taken to make a positive difference to reduce soil loss.

Cover crops (Minnesota Department of Agriculture [MDA], 2011)

Cover crops, are quick-growing crops, such as winter rye or clover that are planted between periods of regular crop production to prevent soil erosion and provide humus or nitrogen. Cover crops help increase productivity and profitability, and help improve water quality.
The environmental benefits of cover crops are well documented:

- prevent soil erosion from wind and water;
- build soil organic matter (grass cover crop);
- improve water quality;
- suppress weeds;
- resurface plant nutrients (nitrogen and phosphorus);
- provide wildlife habitat; and
- Provide nitrogen to following cash crop (legume cover crop).

Strip cropping (MDA, 2011)
Strip cropping is a system of growing crops, forages, small grain and fallow in equal width strips arranged across a field. Strips of row crops are alternated with strips of small grain, grass or legumes. In contour strip cropping**,** crop strips alternate down a slope on the contour (across or perpendicular to the slope) to reduce soil erosion and runoff. Benefits of these practices include reduced soil erosion from wind and water and protection of growing crops from damage by wind-borne soil particles.

Critical Area Planting (Natural Resources Conservation Service-Minnesota [NRCS-MN], 2007)
Critical area planting is establishing permanent vegetation on sites that have or are expected to have high erosion rates, and on sites that have physical, chemical or biological conditions that prevent establishment of vegetation with normal planting practices. This practice is applied as part of a conservation management system to stabilize erodible soil surface areas with high rates of soil erosion by water or wind, restore degraded sites that can not be stabilized through normal methods and reduce damage from sediment and runoff to downstream areas.

Unused Well Sealing (NRCS-MN, 2000)
While not an agricultural practice, unused or abandoned wells are common on farm and rural properties. Unused well sealing is just as the name implies - the sealing and permanent closure of a water well no longer in use. Sealing the well prevents vermin, debris and foreign materials from entering the well thus helping to prevent pollution of the groundwater.

Pest Management
Managing pests (weeds, insects and plant diseases) can be done in a variety of ways to include the use of chemicals, mechanical control, prevention of pests, timing of activities, crop rotation, and using natural enemies of pests. The Minnesota Department of Agriculture is the state agency that oversees pesticide applicator licensing and provides information on Best Management Practices. Limited usage of pesticide and adhering to setbacks for sensitive areas are ways to protect surface and ground water from contamination.

Nutrient Management (MDA, 2011)
Nutrient management is using crop nutrients as efficiently as possible to improve productivity while protecting the environment. Nutrients that are not effectively utilized by crops have the potential to leach into groundwater or enter nearby surface waters via overland runoff or subsurface agricultural drainage systems. Too much nitrogen or phosphorus can impair water quality. Therefore, a major principle of crop nutrient management is to prevent the over-application of nutrients. This not only protects water quality but also benefits a farm's bottom line.

Important aspects of nutrient management include:

- Regular soil testing to understand nutrient levels, what the nutrient needs of the crops will be and making application decisions based on this information.
- Application methods, rates, and timing to ensure as much efficiency as possible
- Paying special attention to area with high slopes, in environmentally sensitive areas, and in areas with high soil phosphorus levels. Sensitive areas include shoreland (land near rivers, stream, lakes and wetlands), areas around sinkholes, wells and surface drainage inlets, areas with sandy soil or shallow soil over bedrock (especially fractured bedrock) and wherever groundwater is close to the surface.

Feedlot Management

Feedlots without adequate runoff controls are a significant source of fecal bacteria during periods of spring melt and high rainfall events. Feedlots need to be built and operated so that water running over and through them does not wash manure off the feedlot and into ditches, streams and other water bodies.

Minnesota Rules Chapter 7020 governs the storage, transportation, disposal, and utilization of animal manure and process wastewaters from feedlots. There are four major sections in the rules:

1. Registration program.
2. Permit program.
3. Delegated county program (all counties in the Basin, except Olmsted, are delegated counties).
4. Technical standards for discharge, design, construction, operation, and closure.

Manure Management (MDA, 2011)

Manure management planning ensures careful handling and use of livestock manure to obtain its full value as a crop nutrient while protecting water and air quality.

Manure management plans describe how manure generated at a feedlot will be used in upcoming cropping years. Plans typically specify nutrient rate limits and setback distances for applying manure near lakes, streams, wetlands, drainage ditches, open tile intakes, sinkholes, wells, mines and quarries. Once a manure management plan is developed, following the plan often involves using specially designed facilities and technologies to store, process and transport manure securely and special techniques for applying manure to cropland.

Minnesota's feedlot rule (Minn. R. part 7020.2225) and some local county ordinances require developing and following a manure management plan in certain circumstances. Additional manure management activities required for many livestock operations (and recommended for all) include keeping manure application records, testing manure for nitrogen and phosphorus content and testing soils for phosphorus.

Wetland protection (Minnesota Department of Natural Resources [DNR], 2011)

For a long time wetlands were considered nuisances to get rid of so that farming or development could take place. Over 52% of our original wetlands in Minnesota have been lost due to development. Much of the rich farmland we have is on land that was once wetlands. However, wetlands provide many benefits and protection of them whenever possible should be done. When functioning properly, wetlands act as filters for pollutants such as nutrients and sediment. They hold water that can then recharge groundwater and prevent flooding. Wetlands provide important seasonal and permanent habitat for many species.

Conservation Planning (MDA, 2011)

Conservation planning involves assessing a farm's natural resource challenges and opportunities and identifying appropriate conservation practices. It is a valuable but often overlooked process that can help farmers streamline conservation efforts and integrate environmental management with agricultural production goals.

Farm conservation plans are highly customized. They address not only where, when and how to implement practices, but also what is needed to continue or maintain practices over time - including renovation or enhancement of existing practices. This information makes it easier for farmers to apply for funding to implement practices.

In the broadest sense, farm conservation planning includes many kinds of documents - from whole-farm assessments of soil, water, habitat and other natural resources to single-practice engineering/design specifications and seeding plans. As a stand-alone activity, however, conservation planning usually means a comprehensive resource assessment and implementation plan. For livestock operations, this includes specialized environmental quality assurance (EQA) assessments and comprehensive nutrient management plans. (A comprehensive nutrient management plan is a conservation system unique to an animal feeding operation.)

Planning documents are more than paperwork - the goal is to take action and get things done on the land. Conservation plans are flexible, working blueprints. They can be adapted or revised to meet evolving land management goals or address the changing needs of a farm undergoing a transition such as intergenerational transfer or switching to a different type of production.

Treatment

Buffers (Helmers, 2008)

Buffers are vegetative strips of land that function to reduce speed of runoff, help to trap and filter sediment and nutrients, and increase infiltration leading to an overall reduction in the outflow of water and contaminants. They can be grouped into two categories: edge-of-field and in-field buffers. Edge-of-field buffers include filter strips, riparian forest buffers, and riparian herbaceous cover. In-field-buffers include conservation cover, contour buffer strips, alley cropping, and grassed waterways. Vegetative barriers could be either in-field or edge of field buffers.

Terraces (MDA, 2011)

A terrace is an earthen embankment, ridge or ridge-and-channel built across a slope (on the contour) to intercept runoff water and reduce soil erosion. Terraces are usually built in a series parallel to one another, with each terrace collecting excess water from the area above. Terraces can be designed to channel excess water into grass waterways or direct it underground to drainage tile and a stable outlet.

There are three main types of terraces. Broad-based terraces are designed to be entirely farmed; they are generally suitable for long, uniform gentle slopes of up to 6% or so. Grassed back-slope terraces are designed to be farmed on the front slope of the ridge but the back slope is graded to a steep pitch and grassed; they are generally suitable on slopes up to 15%. With narrow-based terraces, the entire ridge is grassed instead of just the back slope, and both sides of the ridge are steeply pitched; the narrow ridges require only a small part of the field to be removed from production.

Water and Sediment Control Basins (MDA, 2011)

A water and sediment control basin is a small earthen ridge-and-channel or embankment built across (perpendicular to) a small watercourse or area of concentrated flow within a field. They are commonly built in a parallel series with the first ridge crossing the top of the watercourse and the last ridge crossing the bottom, or nearly so. They are designed to trap agricultural runoff water and sediment as it flows down the watercourse; this keeps the watercourse from becoming a field gully and reduces the amount of runoff and sediment leaving the field.

Conservation drainage (Sands, 2010)
Surface drainage (ditches) and subsurface (tile) drainage are artificial drainage practices that began to be used in the 1830's to allowed poorly drained soils to be farmed. Both types of drainage have different effects on water quality. Surface drainage may result in increased sediment and phosphorus from overland flow. Subsurface tiles may increase dissolved nutrients such as nitrate. Conservation drainage practices such as controlled drainage (aka drainage water management), two-stage ditches, woodchip bioreactors, improved surface and side inlets, cover crops, nutrient retention basins, and other practices can be implemented to reduce flows and pollutants from drainage.

Grazing (Cannon River Watershed Partnership, 2007)
From the 1960's to the present, the need for pasture lands to support beef and dairy production has declined significantly. In addition, producers have found growing corn and soybeans on their better land to be more profitable. Land that has extreme slope, poor soil profile or other factors that make it unsuitable for row crop production have been left for pasture and grazing. With pressure to keep maximum acres in crop production, producers have chosen to let cattle graze areas that are prone to erosion, have less productive soils, or are in close proximity to water bodies.

As per Minnesota Rules 7020, pastures are defined as "areas where grass or other growing plants are used for grazing and where the concentration of animals is such that a vegetation cover is maintained during the growing season except in the immediate vicinity of temporary supplemental feeding and watering devices". Overgrazed or mismanaged pastures exist within the watershed and are potential sources of fecal, nitrogen, phosphorus and sediment contamination to surface waters.

In order to reduce this source of fecal coliform, grazing must be managed. One method to accomplish this is the practice of rotational grazing. Under this strategy, livestock are rotated through partitioned paddocks every few days, thus spending less time by the streams and allowing vegetation to regrow . Development of a grazing management plan will aid in supporting robust vegetative cover that will reduce transport of fecal material. Not all producers will need plans, but they do need to avoid overgrazing in riparian areas.

Wetland Restoration (MDA, 2011)
Wetland restoration reestablishes or repairs the hydrology, plants and soils of a former or degraded wetland that has been drained, farmed or otherwise modified since European settlement. The goal is to closely approximate the original wetland's natural condition, resulting in multiple environmental benefits.

Restoring wetland hydrology typically involves breaking drainage tile lines, building a dike or embankment to retain water and/or installing adjustable outlets to regulate water levels.

Environmental benefits:

- Improves surface and ground water quality by collecting and filtering sediment, nutrients, pesticides and bacteria in runoff
- Reduces soil erosion and downstream flooding by slowing overland flow and storing runoff water
- Wetland plants and ponded conditions utilize trapped nutrients, restore soil organic matter and promote carbon sequestration

- Provides food, shelter and habitat for many species and enables the recovery of rare or threatened plant communities
- Restored prairie pothole wetlands provide breeding grounds for ducks, geese and other migratory waterfowl whose habitat is threatened
- Connects fragmented habitat when part of a larger complex of wetlands

In-Lake

Lake management and restoration is often broken into two categories: in-lake management and watershed management techniques. In-lake management is treatments to reduce pollutant loading to the lake from the sediments and aquatic life within the lake itself.

Prevention

Watershed management techniques can be viewed as prevention because watershed management techniques seek to stop or reduce nutrients, sediment, or other pollution from reaching the lake. Watershed management techniques are covered in the other parts of this section, such as shoreland restoration, wastewater treatment, and agricultural practices.

Treatment (Freshwater Society, 2004)

Aeration and circulation are techniques that involve moving the water and adding oxygen, which increases dissolved oxygen levels. This may prevent fish kills and create a larger habitat for fish and microscopic animal communities. Aeration can also slow the tapping of phosphorus from bottom sediments. Results, however, are not always predictable.

Dredging removes sediment, which can be a major source of phosphorus in the water and can hinder recreational use of the lake. Sediment removal, however, is costly. Disposal of the dredged sediment is often a problem.

Dilution and flushing introduces nutrient-poor water and flushes out nutrient-rich water, decreasing the concentration of pollutants and thus the potential for algal growth.

Drawdown lowers water in an impoundment and can sometimes control weeds by exposing them to drying or freezing. Exposing the littoral zone may also result in shrinkage of soft muck, thus deepening the lake without expensive dredging. Drawdown can be useful in encouraging growth of plants beneficial to waterfowl.

Harvesting removes nutrients from the system by eliminating algae, plants, and fish. In eutrophic lakes, however, only relatively small amounts of nutrients are removed by mechanical harvesting. It is primarily considered a cosmetic improvement, like mowing a lawn.

Direct nutrient control reduces internal loading of phosphorus by binding the phosphorus in the sediments. Chemicals used for this process include ferric chloride or, more commonly, alum or calcium nitrate. These chemicals are expensive to apply and their effect is limited in duration.

Plant control uses herbicides (plant-killing chemicals) toxic either to a broad group of plants or to specific plants, but not to other non-targeted plants or animals. This is a temporary treatment that must be repeated annually or more frequently.

Fish control uses pesticides such as rotenone that are toxic to fish. These toxins are usually specific for fish. This may be conducted by the MDNR when a lake has become dominated by undesirable fish. Restocking with game fish generally follows.

Shoreland Restoration (Henderson, Dindorf, & Rozumalski, 1999)

Decades of traditional lawn management along shorelines has led to conventional ideas about what the "perfect lakeshore lot" should look like: expansive lawn mowed all the way to the water's edge – and no aquatic vegetation. Landscaping lakeshore lots to achieve this ideal has led to serious loss of natural lakeshore habitat and deteriorating water quality on our watershed lakes.

Shorelands are naturally full of a rich diversity of life: plants, animals, and microorganism. Traditional lawns have few of the benefits of a more natural shoreline because they are shallow rooted, provide little wildlife habitat, need frequent maintenance and are often over-fertilized. These factors can lead to problems on our lakes, such as shoreline erosion and lake sedimentation, algal blooms and excessive aquatic plant growth, loss of wildlife habitat but an increase in nuisance animals, and loss of leisure time.

Prevention (Henderson, Dindorf et al., 1999)

The most effective strategy to prevent the need for shoreland restoration is to leave at least 75% of the property's frontage as a buffer when developing a shoreline property.

Treatment (Henderson, Dindorf et al., 1999)

A buffer zone is recommended along at least 75% of a property's frontage, extending both onto the land and into the water to a distance at least 25 to 50 feet, where possible. The goal of creating a buffer zone is to restore the shoreline – both on shore and in the water – with the vegetation that occurred there in the first place. This includes native trees, shrubs, wildflowers (forbs), grasses, and sedges on land, and emergent, floating, and submergent aquatic plants in the water. The buffer zone restores ecological functions that are reduced or eliminated by traditional lawns planted to the water's edge. Emergent vegetation, like bulrushes and cattails, in the buffer zone reduce shoreline erosion caused by wind and boat traffic. The natural vegetation in a buffer zone also helps prevent lawn fertilizer and pesticide runoff from reaching the lake.

Septic Systems

Pollution from old, noncompliant, or straight-pipe septic systems is a significant problem in the Cannon River watershed. There are many individual septic systems and small communities in the watershed that still discharge untreated, or only partially treated, sewage directly into waterways. The challenges to upgrading many septic systems are numerous: small lots, high cost, high water table, securing funding assistance, etc. For small communities with noncompliant septic systems, the resolution is multi-faceted, needing a team to find a viable solution, enforcement to keep the process moving forward, and funding to help off-set the high cost.

Prevention

The main tool for preventing new pollution from septic systems is proper maintenance, both of newly installed septic systems and existing septic systems that are designed properly. Maintenance, such as pumping the septic tank, is not currently required by county rules, but is strongly recommended. All counties in the watershed offer educational materials to their residents and property owners about proper care and maintenance of their septic system. With larger septic systems serving multiple homes or more complicated septic systems (sometimes called performance systems), operating permits, which do require maintenance and reporting of that maintenance are being phased in.

Treatment

In order to improve the treatment provided by septic systems, the noncompliant and imminent threat to public health threat septic systems (ITPH) that are not properly treating sewage must be upgraded. To increase the rate at which these septic systems are upgraded, five of the six watershed counties (Goodhue County being the exception) require a septic system to be inspected when a property is sold or a building permit is requested. If the property is in shoreland, all counties require an inspection upon sale or request of a building permit. The timeframe for updating the septic system if it is noncompliant varies by county and by if the system is determined to be an imminent public health threat. Because the cost of putting in a new system can be prohibitive, three counties (Le Sueur, Rice, and Steele) have set up loan programs for septic system installations at a reduced interest rate with property tax payback.

Counties have also begun to inspect all septic systems in a target area to increase the rate at which noncompliant and ITPH systems are being upgraded. The target area is normally a sensitive environmental area, such as a recreational lake or along a stream that is a priority for restoration. In 2006 the MPCA began making grants available for counties to conduct these targeted inspection projects. One inspection project has been conducted so far in the watershed, in the Roberds Lake watershed in Rice County. The project found approximately 10% of homes with ITPH and spurred interest in a project to construct a collection system to transport sewage generated around the lake and transport it to Faribault's wastewater treatment system.

Small communities, where nearly the whole community has noncompliant, ITPH or straight pipe septic systems has also been a focus of work for the past ten years in the watershed. The Cannon River Watershed Partnership (CRWP), through its Southeast Minnesota Wastewater Initiative (SMWI) project, and in partnership with watershed counties provides assistance to small communities grappling with upgrading their wastewater treatment. With the assistance of SMWI, three communities (Veseli in Rice County, Hope and Meriden in Steele County) have abandoned their straight pipes and installed new wastewater treatment systems. A number of other small communities are currently working on projects to upgrade their wastewater treatment.

Stream Channel

Stream channel and bank erosion contribute significant amounts of sediment, phosphorus and other chemicals attached to soil particles to rivers and streams. Many streams and rivers in the Cannon River watershed are in poor condition with respect to the state of their channels and banks. From the late 1800's through the 1960's, "improving" streams by dredging and straightening their channels was common. As a result of this, many streams need restoration (Aadland, 2007). In a natural system, slowly eroding banks, developing sandbars, migrating meanders, and channels reshaped by flood flows are all happening in a state of dynamic equilibrium where the stream maintains a stable shape over time (DNR, 2011). Maintaining connectivity to the floodplain and natural flexibility allows the stream to show this dynamic equilibrium (DNR, 2011).

The hydrology of the stream has a significant influence on the channel stability. It is important to understand this system and look to encourage watershed practices that help to restore a more natural flow regime. It will not be feasible nor desired to fix every eroding bank. Successful restorations will require that that causes of channel instability are also dealt with.

Prevention

Protecting stream banks and channels that are in good condition to begin with is a method of preventing erosion. Strategies include ensuring riparian buffers are in place, maintaining connectivity to the floodplain, and limiting high flow events that can scour the channel and erode banks. State and county laws exist that require buffers of varying widths under different land uses. The Cannon River from the north end of Faribault to Red Wing is designated by the state of Minnesota as a Wild and Scenic River. This designation places limits on building within the floodplain which helps maintain connectivity in undeveloped areas. Regulating flow is partially a function of rainfall and snowmelts, over which we have little control, and partially a function of how well we manage land use changes and drainage with respect to water management. The Minnesota Water Sustainability Framework document recommends that the state require comprehensive land use and water planning to help address this issue (University of Minnesota Water Resources Center, 2011).

Treatment

A goal of stream and river restoration is to identify and reestablish the conditions necessary for the natural state to create itself (DNR, 2011). There are many steps in a stream restoration effort such as:

- Understanding why the stream is eroding which means understanding its behavior. This includes gathering field data, modeling, and monitoring.
- Establishing the scale of the project – entire watershed, reach, section, other
- Including an interdisciplinary team of people such as hydrologists, foresters, lawyers, soil scientists, fish and wildlife specialists, social scientists, local residents and others to develop the restoration plan.
- Finding funding sources to help pay for the restoration.
- Defining the desired future conditions.
- Looking at cost effectiveness of restoration options.
- Monitoring the results and checking back at established frequencies to determine if changes are needed.

Some examples of practices that can be used include:

- Stream barb or J-hooks are installed where stream bank erosion is occurring. When installed, the barbs re-direct the energy of the stream bank into the channel, reducing further stream bank erosion and creating habitat. Rock weirs help prevent further head cutting in the stream.
- Cedar Revetments: tying and anchoring dead red cedar trees to an eroding streambank.
- Willow staking: taking cut live willow stems and pushing them into the streambank to promote growth. This practice is often done in combination with a critical area planting seeding and maybe some brush bundles.
- Riprap: slope banks back and place riprap over exposed bank.
- Bend way weirs: placing linear barbs of riprap in the stream pointing them upstream. Diverts intensive flow from outer banks toward the center.

In the end, a successful river or stream restoration should not look like a restoration at all and should not require long term maintenance or manipulation (DNR, 2011)

Urban Stormwater

Changes to the landscape that occur as a result of urbanization also impact natural hydrologic systems by increasing the volume and velocity of runoff. This is largely due to the increase in impervious surfaces like sidewalks, rooftops and driveways. In turn, the natural infiltration of water into the ground is reduced. Larger runoff volumes, quicker and higher runoff peaks, and increased erosion lead to more pollutants eventually making their way to receiving waters. Challenges in managing stormwater runoff include controlling the rate and volume of runoff as well as removing the material (pollutants) that accumulates as this water makes its way to a receiving water (Minnesota Pollution Control Agency [MPCA], 2008).

Stormwater Management Practices

Best management practices (BMPs), as described earlier in this document, are structural and non-structural devices and actions that have the capability of reducing pollutant loading to receiving waters. For the purposes of this section, the BMPs are categorized as Prevention and Treatment practices.

Prevention

Non-Structural or Planning Level BMPs (MPCA, 2008)

The first level of BMP application occurs at the planning stage and is intended to minimize the impact of development. Many of these can also be considered program development activities, including policy and program development and ordinance adoption. These practices reduce the amount of pollution entering the storm sewer system and minimize the increase in runoff volume. They are considered prior to initiation of construction or land altering activity. Examples include the following:

- Pollution Prevention Practices (Water Quality Focus)
  - Yard waste collection
  - Street sweeping
  - Pet waste control
- Better Site Design
  - Cluster development
  - Minimization of impervious surfaces (narrower streets, fewer parking spots, shared use paths, etc.)
  - Stormwater capture and reuse features
  - Runoff volume minimization
- Temporary Construction Sediment Control
  - Phased construction projects

Treatment

Structural BMPs (MPCA, 2008)

Treatment BMPs are the next step in stormwater management. These devices manage runoff by removing pollutants before the water discharges downstream. Treatment BMPs, particularly Low Impact Development (LID) BMPs, often capture runoff with the goal of minimizing or even eliminating the volume of water eventually discharged, thus reducing the potential for pollutants to reach the receiving water. Other BMPs, such as traditional wet ponds, have little impact on runoff volume but effectively remove pollutants. Examples of structural BMPs include the following:

A. Bioretention - This BMP suite includes vegetated systems that provide a combination of filtration and infiltration using a bio-system consisting of plants and soil, including:

- Rain gardens: Depressed parking lot/traffic islands
- Road medians
- Tree pits/stormwater planters

B. Filtration

- Media (sand) filters (surface, underground, perimeter/Delaware filter)
- Surface (vegetative) flow (grass channels, dry or wet swales, filter strips)
- Combination media/vegetative filters

C. Infiltration

- Trenches
- Basins
- Dry wells (not classified as underground injection wells)
- Underground systems

D. Stormwater Ponds. Pond design is based on the functional need and requirements of the pond. Components needed to fulfill the desired function may include forebay/pre-treatment, storage volume or capacity, and physical configuration. These design elements will provide enhanced water quality (including thermal impact) and flow control (rate and volume). Function will also determine whether they are designed as wet, dry, or some combination.

E. Constructed Wetlands. Selection criterion is similar to stormwater ponds. Components include pre-treatment, various storage volumes (detention needed), and biologic character

Regulated Stormwater in the Cannon River Watershed

Of the 27 cities in the Cannon River watershed, five are required to obtain National Pollutant Discharge Elimination System (NPDES) permits for municipal stormwater discharges. These MS4s (Municipal Separate Storm Sewer Systems) are regulated under a general stormwater permit issued by the Minnesota Pollution Control Agency (MPCA). The MS4 permit requires a mix of prevention and treatment strategies to be implemented by all Permittees to reduce stormwater effects on receiving waters. Additionally, the permit requires that regulated communities meet wasteload allocations assigned to them as part of Total Maximum Daily Loads (TMDLs). TMDLs are federally-mandated studies that determine the total amount of pollution a water body can assimilate while still meeting water quality standards and designated use criteria. Through the TMDL process, sources of pollution are identified and loads are assigned to each source. Often in large watersheds, many sources, including agriculture and non-regulated MS4s, contribute to the impairment of water quality. In these large watersheds, the overall pollutant load from urban stormwater is often a small portion of the total load but the required reductions in loading are quite large. Because of the challenges this creates, the MPCA is working to develop a phased approach to implementation of TMDLs in large watersheds, such as the Cannon River. This approach is described below.

Permit Requirements

The current MS4 General Permit requires permittees to review the adequacy of their Stormwater Pollution Prevention Program (SWPPP) to meet any applicable[1] United States Environmental Protection Agency (US EPA) approved Wasteload Allocation (WLA). The permit does not have a reporting requirement and does not provide guidance to permittees on how to evaluate the adequacy of their SWPPP. The permit expires May 31, 2011. The MPCA anticipates having an approved reissued permit by January of 2012. The revised permit, currently in draft form, requires permittees to

1. demonstrate continuing progress toward meeting all applicable WLA(s); and
2. annually submit a form provided by the Commissioner. The form requires the permittee to
    a. list BMPs they have implemented and are applying toward applicable WLAs;

[1] An applicable WLA is a WLA the permittee has been assigned in a TMDL.

b. list general implementation activities that can be applied toward applicable WLAs; and
c. describe an adaptive management strategy, including approximate timelines, for meeting applicable WLAs.

Implementation Strategy to Meet Applicable WLAs

TMDLs with a majority of the total pollutant load[2] as Load Allocation (LA) and requiring more than a 25 percent reduction in pollutant loading from regulated MS4s will be implemented in phases. Figure 9 summarizes the phased approach. Each phase can be considered an interim limit for purposes of permit compliance.

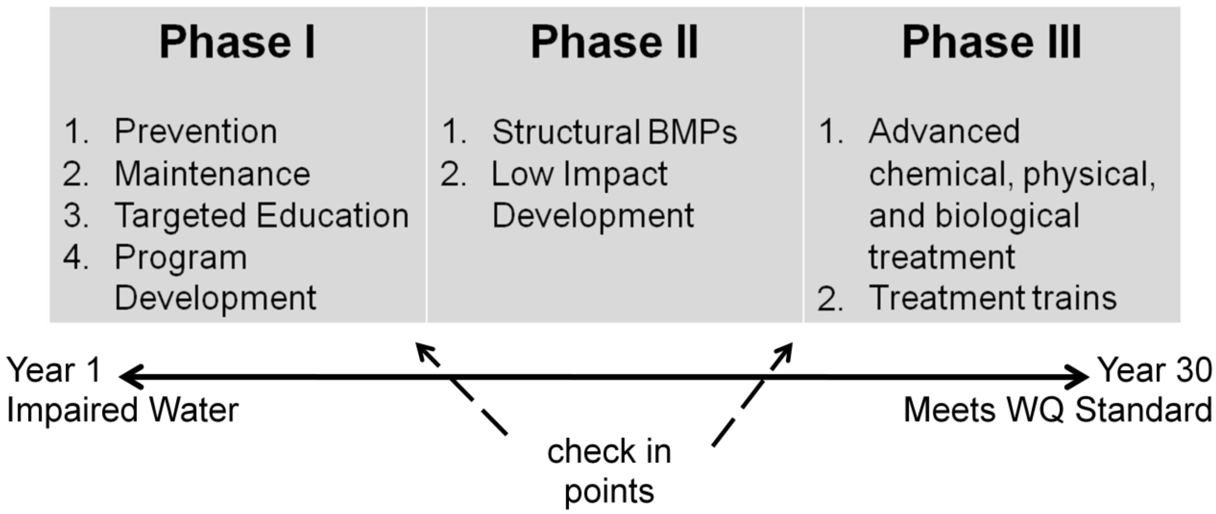

Figure 9. Summary of phased approach for TMDL implementation.

Phase 1

Phase 1 for stormwater focuses on pollution prevention, design and maintenance of BMPs, targeted education, and program development. These activities reduce pollutant loads and establish a framework that aids in achieving further reductions in the second and third phases. Table 4 provides examples for these activity areas.

[2] The total load includes stormwater runoff from point and nonpoint sources; discharges from other point sources, including wastewater treatment facilities, feedlots, and septic systems; and internal loading. It does not include loads from natural background.

Table 4. *Examples of phase 1 implementation activities*

Pollution Prevention	**Targeted Education**	**Design and Maintenance of BMPs**	**Program Development**
Yard waste collection program	Education to inform residents of impacts of yard waste and ordinances	Demonstrate enforcement of ordinances regarding yard waste	Development of an ordinance prohibiting yard waste in streets
Urban forestry	Landscaper training	Pond sizing evaluation	Development of ordinances
	NEMO (Non-point Education for Municipal Officials)	IDDE (Illicit Discharge Detection and Elimination)	Hot spot identification
Blue Star Award	Certification programs	Street sweeping	Stormwater system mapping

Phase 1 equates with roughly a 25 percent reduction in pollutant loading. Prevention, education, and maintenance BMPs can achieve this reduction. Because it is difficult to quantify the load reductions associated with the practices shown in Table 4, a point system was developed for Phase 1. One point is roughly equivalent to a one percent reduction in pollutant loading. For program development, implementation actions do not directly reduce pollutant loads. However, program development allows for implementation and targeting of BMPs that directly reduce future pollutant loads; therefore, they will be considered progress and receive points in Phase 1. No more than 5 points can be applied collectively to education and development actions.

Permittees in the Cannon River watershed will select and implement BMPs in their communities that can be applied toward Phase 1. Working with the MPCA, applicable points will be determined for these BMPs. The list of BMPs and associated points will be selected in a series of future meetings and correspondences between permittees, the MPCA and the Cannon River Watershed Partnership. Once completed, that list will be included in this implementation document.

Permittees must demonstrate progress during Phase 1 as required in the draft MS4 general permit. Permittees can list BMPs they already have in place or will be implementing in the coming year from this implementation document on the form provided by the Commissioner to demonstrate compliance with permit requirements.

The form requires permittees to describe an adaptive management strategy for meeting TMDL WLAs. The adaptive management strategy requirement can be met with a statement similar to the following:

To meet the Phase 1 requirement for the XXX TMDL, we will accumulate 25 points using MPCA's approach for meeting WLAs for large watershed TMDLs. Implementation actions are described in the TMDL implementation plan. We anticipate two permit cycles will be needed to meet the Phase 1 requirement of accumulating 25 points.

Practices implemented in the BMP categories of pollution prevention and BMP maintenance allow permittees to substitute actual reductions in pollutant loading for the assigned point values if more accurate information is available. One point is considered equivalent to a one percent reduction in total pollutant loading from the portion of the MS4 that contributes to the impairment. The same substitution applies to structural BMPs. For example, if a permittee demonstrates through modeling or monitoring that a particular BMP reduces pollutant loading by 5 percent from the baseline condition provided in the TMDL report, the permittee may apply 5 points toward the final target.

Permittees should continue to seek opportunities to implement structural BMPs as they arise. As such, structural BMPs are not limited to later phases of implementation. In developing cities, implementation of LID practices is likely to achieve considerable progress toward meeting the Phase 1 target; therefore permittees are encouraged to consider developing LID-type ordinances early in Phase 1. Permittees should also be aware that although they may achieve Phase 1 goals, they will likely not have met the overall TMDL reduction goal. This provides continuing incentive to implement BMPs as opportunities arise, even if the Phase 1 goal has been met.

Permittees must accumulate 25 points during the first phase of TMDL implementation to be considered in compliance with their interim limit, which also indicates compliance with the TMDL provisions of the MS4 general permit. This should be accomplished within one or two permit cycles. Once all sectors with required reductions achieve the Phase 1 target, Phase 2 will be implemented. Permittees that choose to implement an approach different than the Phased approach must quantify their pollutant reductions through monitoring or modeling.

Phases 2 and 3

Phases 2 and 3 require additional reductions in pollutant loading but are not implemented until all sectors have met the Phase 1 interim limits. Phases 2 and 3 will largely rely on treatment practices. Interim limits, or targets for these phases, will be described in TMDL reports. Once those limits are set, this implementation document may be modified to reflect implementation actions and timelines for achieving those interim limits.

Municipal and Industrial Point Sources

Discharges from municipal and industrial sources, commonly referred to as point sources are a factor in pollutant loading in the Cannon River watershed.

Per the Minnesota Pollution Control Agency Website:

"National Pollutant Discharge Elimination System (NPDES) permits regulate wastewater discharges to lakes, streams, wetlands and other surface waters. State Disposal System (SDS) permits regulate the construction and operation of wastewater disposal systems, including land treatment systems. Together, NPDES/SDS permits establish specific limits and requirements to protect Minnesota's surface and ground water quality for a variety of uses, including drinking water, fishing and recreation.

For Minnesota industrial facilities, the MPCA strives to issue these permits as consolidated water quality management permits. An individual NPDES/SDS permit for an industrial facility may cover a number of different waste types and activities, including: industrial process wastewater, contact and non-contact cooling water, storm water, contaminated ground water pumpouts, water supply treatment backwash and wastewater treatment sludges. Several general NPDES/SDS permits also are available. NPDES/SDS permit requirements may include monitoring, limits, and management practices designed to protect surface and ground water quality."

Figure 10 depicts point sources with NPDES permits in the Cannon River watershed. Table 5 provides a breakdown of the types and number of municipal and industrial discharge permits in the Cannon River watershed as of June 2011. A complete listing of these permits is found in Appendix J.

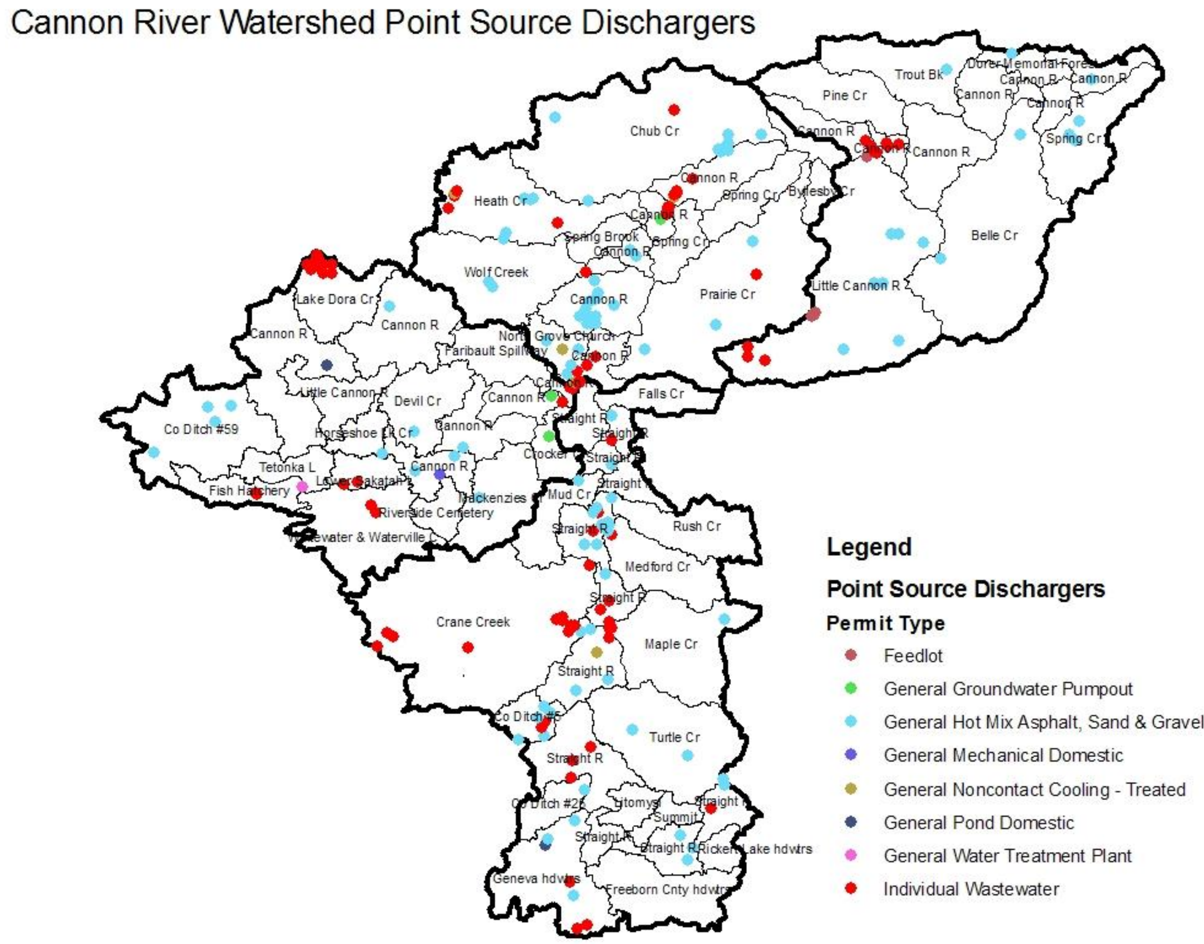

Figure 10. Cannon River watershed point source dischargers.

Table 5. *NPDES/SDS Permit Types in the Cannon River Watershed (2011)*

	Straight River Lobe	Upper Cannon River Lobe	Middle Cannon River Lobe	Lower Cannon River Lobe	**Total**
Municipal					
Stabilization Pond WWTPs	4	2	1		**7**
Mechanical WWTPs	4	2	2	2	**10**
Spray Irrigation WWTPs	1				**1**
Large Subsurface Treatment System WWTPs			1	1	**2**
Subtotal	**9**	**4**	**4**	**3**	**20**
Industrial					
Contact cooling water		2			**2**

Contact cooling water + Spray irrigation of process wastewater	2				**2**
Pit dewatering	3				**3**
Land Application	1				**1**
Natural gas storage		1			**1**
Noncontact cooling water	2		1		**3**
Pipeline	1				**1**
Pretreatment	1	1	2		**4**
Process Wastewater	1			3	**4**
Stormwater	5	1	1	1	**8**
Subtotal	**16**	**5**	**4**	**4**	**29**
Total	**25**	**9**	**8**	**7**	**49**

Municipal

In the past fifty years we have seen a marked improvement in the reduction of raw sewage in the rivers and lakes of the watershed because of the installation and usage of municipal wastewater treatment systems. Past studies indicated the lack of this type of treatment played a large role in the high levels of nutrients and bacteria in the water. Municipal wastewater treatment permits limit the flow of water from the plants as well as levels of fecal coliform bacteria, phosphorus, total suspended solids, mercury, nitrogen, and other pollutants that can be discharged.

The Cannon River watershed includes many lakes, reservoirs and productive large river reaches. Thus, a primary concern regarding municipal wastewater is phosphorus. Most cities in the watershed are permitted to discharge phosphorus at a concentration 1 mg/L . As of December 31, 2011 the WWTPs for Faribault and Owatonna will be required to meet this limit as well. Any future watershed permitting strategy should be focused on assessing nutrient impacts and design accordingly.

Continuing to upgrade and improve treatment technologies will further ensure that the level of pollutants that reach our waters is minimal. Reducing the amount of phosphorus and other pollutants that reach the treatment plants (source control) is an action that everyone can take to reduce the wastewater treatment needs in the watershed.

Industrial

The majority of the industrial permits in the Cannon River watershed are for industrial stormwater. At industrial sites such as factories, salvage yards and airports, stormwater may come into contact with harmful pollutants, including toxic metals, oil, grease, de-icing salts and other chemicals. Industrial stormwater permits are designed to limit the amount of these contaminants that reaches surface water and groundwater, by requiring good practices for storing and handling materials.
Facilities with these permits must prepare a Stormwater Pollution Prevention Plan, detailing the practices they will use to limit stormwater pollution. For more information on industrial stormwater, see: www.pca.state.mn.us/water/stormwater/stormwater.html.

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