3 Green Infrastructure for MS4 Post-Construction Runoff Management

Municipalities that own and manage their own stormwater infrastructure may be regulated under the federal National Pollutant Discharge Elimination System, or NPDES, permit program. The NPDES permit program is a national program designed to reduce pollutants associated with stormwater runoff. This chapter reviews the process for establishing a post-construction stormwater management program utilizing green infrastructure so that regulated Municipal Separate Storm Sewer Systems, or MS4, communities can develop their own program for compliance with state and federal regulations and their MS4 permit. However, this chapter will also be useful to those non-regulated MS4s desiring to incorporate green infrastructure as a matter of good business practice.

Successful implementation of green infrastructure into a stormwater management program plan will require many unique considerations and decisions. Chapter 4 of this guide provides recommendations and examples of how to integrate green infrastructure and other sustainable development concepts into ordinances that support a post-construction runoff management program.

There are many available guides describing the requirements and methods for developing such a post-construction management program. One recommended comprehensive guide can be found in the *Center for Watershed Protection's Managing Stormwater in Your Community, A Guide for Building an Effective Post-Construction Program*.

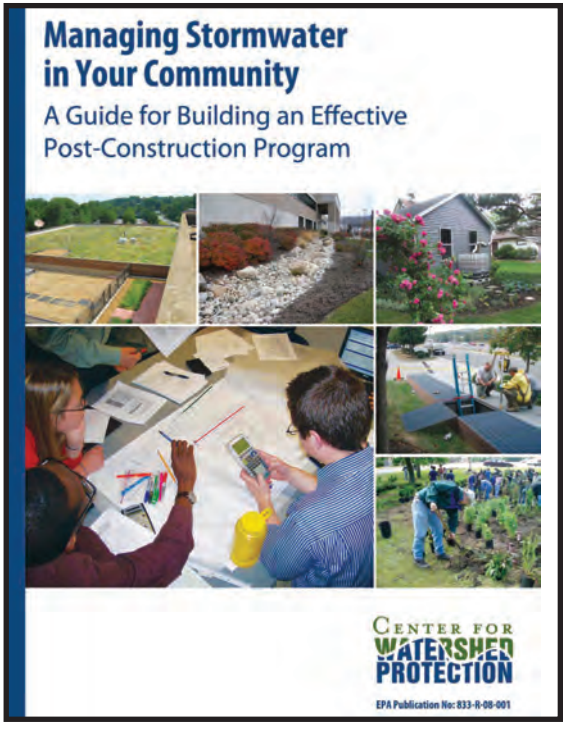

Figure 3.1- *Managing Stormwater in your Community. A Guide for Building an Effective Post-Construction Program*. Source: www.epa.gov/npdes/pubs/stormwaterinthecommunity.pdf

3.1 MS4 Program Requirements

The Missouri Department of Natural Resources is authorized to administer the federal water quality and stormwater laws and regulations through the Missouri Clean Water Law and Revised Statutes of Missouri. As a state agency, the department is responsible for administering the NPDES stormwater permit program for both Phase I and Phase II communities. Phase I communities include those with populations of 100,000 or more per 1990 federal regulation, and Phase II communities include those with populations of 1,000 or more within urbanized areas or 10,000 or more outside of urbanized areas. See the list of regulated municipal separate storm sewer systems (MS4s) at www.dnr.mo.gov/env/wpp/stormwater/sw-phaseii-communities.pdf. For a list of MS4s visit:

- Missouri Department of Natural Resources - Phase II stormwater information: www.dnr.mo.gov/env/wpp/stormwater/sw-phaseii-info.htm
- EPA - National Pollution Discharge Elimination System: www.epa.gov/npdes/stormwater
- EPA, January 2007. MS4 Program Evaluation Guide: www.epa.gov/npdes/stormwater
- NPDES Phase II general permit requirements: www.dnr.mo.gov/env/wpp/permits/issued/R040000.pdf

In Missouri, NPDES permits require MS4 communities to establish a post-construction runoff management program as one part of their comprehensive stormwater management program. At a minimum, a post-construction program must:

1. Determine measurable goals for control of post-construction runoff. Measurable goals gauge program compliance and effectiveness. Goals should reflect the needs and characteristics of the area served by its MS4 and address the water quality management requirements of the permit.

2. Develop and implement structural and/or non-structural stormwater control measures, for meeting established goals.

Non-structural stormwater control measures include planning procedures and site-based stormwater control measures. Planning procedures, such as those described in Chapter 2 of this document, can help minimize impervious surfaces and promote improved water quality.

- Site-based non-structural stormwater control measures include stream buffer setbacks. They also include preserving reparian zones, minimizing areas of disturbance and imperviousness, and maximizing open space.
- Structural stormwater control measures can include practices that infiltrate, evapotranspirate or reuse stormwater.
- Vegetative stormwater control measures are landscaping features that may store, convey, filter, infiltrate or evapotranspire runoff while helping to preserve natural site hydrology, promote healthier habitats, provide recreational opportunities and increase aesthetic appeal. Examples include grass swales, filter strips, constructed wetlands, rain gardens and other bioretention practices.
- Other retention or detention stormwater control measures include wet ponds, dry basins, or multi-chamber catch basins that settle out and retain solids while helping control the rate of runoff to receiving streams.
- Infiltration stormwater control measures facilitate percolation of runoff through infiltration basins, subsurface trenches and pervious pavements to filter pollutants and reduce stormwater runoff quantity.

3. Have an Ordinance:

Develop, revise, adopt ordinances or other regulatory mechanisms requiring the implementation of non-structural and structural post-construction runoff controls to the extent allowable under state, tribal, or local law. Chapter 4 of this guide discusses how to integrate green infrastructure into ordinances.

4. Ensure Adequate Long-Term Operation and Maintenance:

Missouri's Phase II Stormwater Regulations for small MS4s allow three permit options for small MS4 discharges: a general permit, a site specific permit, or a co-permittee option.

The Metropolitan St. Louis Sewer District is the coordinating authority under the St. Louis Metropolitan Small MS4 Stormwater Permit, MO-R040005, issued by the Missouri Department of Natural Resources, Water Pollution Control Program. The district partners with 60 municipalities (co-permittees) to comply with stormwater permit requirements for the St. Louis Metropolitan Small Municipal Separate Storm Sewer System. All co-permittees within St. Louis County operate under a common stormwater management program plan which can be viewed at www.stlmsd.com/educationoutreach/phase2/Phase%20II%20Stormwater%20Plan%20Overview.

"The department encourages cooperation between potential small MS4 applicants when addressing application requirements and in the development, implementation and enforcement of the six minimum measures under issued permits…"
(St. Louis Municipalities Phase II Stormwater Planning Committee , 2008-2013).

In annual MS4 report forms, the department asks the following post-construction questions of MS4 permittees. While it is not necessary to answer "yes" to all questions, answers can help the permittee and the state determine adequacy of the MS4 post-construction program.

F. NEW AND REDEVELOPMENT (POST-CONSTRUCTION) STORM WATER MEASURES

1. Do you have ordinances or other mechanisms to require:
   a. Pre-site design meetings with developers?
      ☐ Yes ☐ No
   b. Site plan reviews for storm water quality of all new and re-development projects of an acre or more?
      ☐ Yes ☐ No
   c. Reasonable mimicking of pre-construction storm water runoff quality in all new development projects of an acre or more?
      ☐ Yes ☐ No
   d. An incremental improvement of existing storm water runoff quality in redevelopment projects of an acre or more?
      ☐ Yes ☐ No
   e. Long-term operation and maintenance of storm water management controls?
      ☐ Yes ☐ No
   f. Retrofitting to incorporate long-term storm water management controls?
      ☐ Yes ☐ No

2. If you have retrofit requirements, what are the circumstances or criteria?

3. What are your criteria for determining which new/re-development storm water plans you will review for water quality? (such as all projects, projects disturbing greater than one acre, etc.)

4. Do your ordinance(s) or other regulatory mechanism(s) allow for:
   a. Non-structural site design options to allow for optimal water quality management in long-term storm water runoff? (such as minimized/disconnected impervious surfaces, cluster housing in exchange for green space, resource protection boundaries, etc.)
      ☐ Yes ☐ No
   b. Structural contemporary, dispersed micro-infiltration/filtration practices such as grassed swales, sand filters, neighborhood roundabouts with rain gardens, etc.?
      ☐ Yes ☐ No

5. Do you require water quality design standards or performance standards, either directly or by reference, be met for new development and re-development?
   ☐ Yes ☐ No

6. Do these design standards/performance measures require pre-construction runoff conditions in new development be met for:
   a. Flow volumes.
      ☐ Yes ☐ No
   b. Peak discharge rates.
      ☐ Yes ☐ No
   c. Discharge frequency.
      ☐ Yes ☐ No
   d. Flow duration.
      ☐ Yes ☐ No
   e. Water quality.
      ☐ Yes ☐ No

7. Please provide the Web address/reference where all post-construction storm water management standards are located.

8. Do your zoning bylaws, ordinances or other regulatory processes allow or enable:
   a. Flexible site design criteria such as smaller lot sizes, reduced setbacks and narrow streets in exchange for functional green space and optimal water quality management in storm water runoff.
      ☐ Yes ☐ No
   b. Established regulatory controls over tree clearance and removal of mature trees or forest stands?
      ☐ Yes ☐ No
   c. Green space residential developments (cluster development or conservation subdivision design)?
      ☐ Yes ☐ No
   d. The location of bioretention areas, rain gardens, filters strips, swales and constructed wetlands in required setback areas?
      ☐ Yes ☐ No
   e. Construction of low impact development, or LID, storm water management techniques (bioretention, swales, filter strips) on land held in common (when appropriate)?
      ☐ Yes ☐ No
   f. Use of permeable paving for parking stalls and spillover parking areas?
      ☐ Yes ☐ No
   g. Limited clearing within the right-of-way to the minimum necessary to construct roadway, drainage, sidewalk and utilities, and to maintain site lines?
      ☐ Yes ☐ No

9. Does your review and approval process include using a water quality checklist?
   ☐ Yes ☐ No

10. If yes to # 9, please check all of the following checklist items that apply:
    a. Existing and proposed mapping and plans (recommended scale of 1" = 50'.) which illustrate:
       1. Existing and proposed topography (minimum of 2-foot contours recommended).
          ☐ Yes ☐ No
       2. Compatibility with watershed plans, land use plans, comprehensive plans, (contemporary street standards) etc.
          ☐ Yes ☐ No
       3. Perennial and intermittent streams.
          ☐ Yes ☐ No
       4. Mapping of predominant soils from USDA soil surveys as well as location of any site-specific borehole investigations that may have been performed.
          ☐ Yes ☐ No
       5. Boundaries of existing predominant vegetation and proposed limits of clearing.
          ☐ Yes ☐ No
       6. Location and boundaries of resource protection areas such as wetlands, lakes, ponds and other setbacks (e.g., stream buffers, drinking water well setbacks, septic setbacks).
          ☐ Yes ☐ No
       7. Grading plan with location of existing and proposed roads, buildings and other structures.
          ☐ Yes ☐ No
       8. Location of existing and proposed utilities (e.g., water, sewer, gas, electric) and easements.
          ☐ Yes ☐ No
       9. Location of existing and proposed conveyance systems such as grass channels, swales and storm drains.
          ☐ Yes ☐ No
       10. Flow paths.
          ☐ Yes ☐ No
       11. Location of floodplain/floodway limits and relationship of site to upstream and downstream properties and drainages.
          ☐ Yes ☐ No
       12. Location and dimensions of proposed channel modifications, such as bridge or culvert crossings.
          ☐ Yes ☐ No
       13. Location, size, maintenance access and limits of disturbance of proposed structural storm water management practices.
          ☐ Yes ☐ No
       14. Location of proposed community recreation/green space areas.
          ☐ Yes ☐ No
       15. Functional landscape plan.
          ☐ Yes ☐ No

    b. Narrative and supporting calculations describing:
       1. Representative low-impact development techniques (with supporting evidence that technique is compatible with site characteristics) such as on-lot bioretention, tree clearing minimization, minimizing directly connected impervious surfaces, open section roads (also called roadside swales), etc.
          ☐ Yes ☐ No
       2. Zoning, acreage, types and amounts of land uses. (e.g., parking spaces, density, green areas, building footprint areas)
          ☐ Yes ☐ No
       3. Traffic analysis estimating average daily trips for street network and parking requirements.
          ☐ Yes ☐ No
       4. Site impervious area (including effective disconnections).
          ☐ Yes ☐ No
       5. Reforestation and/or resource conservation protection measures.
          ☐ Yes ☐ No
       6. Comparison of proposed development data with allowable density, land use, etc.
          ☐ Yes ☐ No
       7. Development phasing or implementation sequence.
          ☐ Yes ☐ No
       8. Other?

11. How many development and redevelopment project plans were reviewed during the reporting period to assess impacts to water quality and receiving stream protection?

12. How many of the plans identified in # 11 were approved?

13. How many privately owned permanent storm water management practices/facilities were inspected during the reporting period?

14. Location of proposed community recreation/green space areas.
    ☐ Yes ☐ No
15. Functional landscape plan.
    ☐ Yes ☐ No

b. Narrative and supporting calculations describing:
1. Representative low-impact development techniques (with supporting evidence that technique is compatible with site characteristics) such as on-lot bioretention, tree clearing minimization, minimizing directly connected impervious surfaces, open section roads (also called roadside swales), etc.
   ☐ Yes ☐ No
2. Zoning, acreage, types and amounts of land uses. (e.g., parking spaces, density, green areas, building footprint areas)
   ☐ Yes ☐ No
3. Traffic analysis estimating average daily trips for street network and parking requirements.
   ☐ Yes ☐ No
4. Site impervious area (including effective disconnections).
   ☐ Yes ☐ No
5. Reforestation and/or resource conservation protection measures.
   ☐ Yes ☐ No
6. Comparison of proposed development data with allowable density, land use, etc.
   ☐ Yes ☐ No
7. Development phasing or implementation sequence.
   ☐ Yes ☐ No
8. Other?

11. How many development and redevelopment project plans were reviewed during the reporting period to assess impacts to water quality and receiving stream protection?

12. How many of the plans identified in # 11 were approved?

13. How many privately owned permanent storm water management practices/facilities were inspected during the reporting period?

Figure 3.2 Excerpt from Stormwater Annual Report - Small MS4 Permits Addendum - Water Quality Program Assessment, Form MO 780-2049.

3.2 Establishing, Adapting or Adopting Stormwater Control Measure Design Manuals

Some communities have developed or are developing manuals which may include non-structural and structural stormwater control measures to assist planners and designers to implement the community's stormwater management program. In some cases where the resources are not available or official guidance is lacking, communities are referring designers to reference materials and resources that are found outside of the community.

Adopting Manuals

Many communities are faced with the decision to adopt or develop their own post-construction runoff manual. If your community is proposing to adopt a manual then care should be given to adopting a manual to ensure that it "fits" the needs and requirements of the community. In Missouri, the Mid-America Regional Council and the Kansas City Metro Chapter of the American Public Works Association have developed a post-construction stormwater manual that would assist surrounding communities help meet their MS4 post-construction runoff requirements. If your community decides to adopt a manual, then review of other codes and ordinance will likely be necessary to eliminate any potential conflicts.

3.3 Integrating Green Infrastructure into Program Development

Creating or revising an MS4 post-construction stormwater program that includes green infrastructure elements requires:

- Building a multi-disciplined integrated program team.
- Setting and tracking measurable goals.
- Updating land use policies and procedures.
- Planning for long-term funding, implementation and maintenance.

3.3.1 Building the Program Team

The program team should be comprised of multiple disciplines and stakeholder groups. The completed team should include members with relevant knowledge of general challenges encountered while developing a stormwater management program, such as:

- Consistency among municipal codes, ordinances, or agencies.
- Infrastructure needs in rapidly growing areas or redevelopment.
- Retrofitting in areas of existing development.
- Impacts to sensitive natural resource areas.

A. Consistency among code, ordinances or agencies

Coordination of the municipal agencies and departments having purview over stormwater-related issues is fundamental to a successful stormwater management program. Where several MS4s are partnering together to implement the program, a separate regional stormwater management district may be set up to facilitate program development, implementation and maintenance.

Public outreach, education and participation in program development should occur as early as possible in the process and steps should be taken to ensure regular opportunities for stakeholder input.

B. Rapidly Growing Areas

An MS4 may include areas that are undergoing rapid development. These areas typically include large parcels of private development. Including elected officials, relevant agency personnel, developers and major area commercial residents can help address these typical items.

- The need or desire for additional revenue; property and sales tax in a community often leads to quick development decisions that may have impacts on a community's natural resources.

- Political pressure for economic development, services and retail options. As population increases, the demand for rezoning or changes to land use codes to provide employment, services and retail options may arise.
- Pressure from developers to delay implementing new standards or emerging development trends. Financial pressure may create a need to build homes and commercial buildings as quickly as possible. Changes in standards can slow down the development process and increase fees and costs. Educating developers on the financial benefits of green infrastructure may help create new standards.
- Staff limitations for implementing programs, plan reviews and inspections. High growth communities may not have sufficient staff to handle the day-to-day operations for keeping up with the large volume of permits that may be requested. Actively educating or including elected officials responsible for budgets can help ensure adequate levels of qualified staff and inspectors trained in stormwater management techniques are funded as part of the program.

Growth can create pressure on infrastructure and open space. High growth areas may have difficulty funding needed infrastructure to areas of new development. Green infrastructure concepts help to limit erratic growth by encouraging density in areas of proposed development. Many types of structural green infrastructure can meet multiple infrastructure needs to help reduce overall costs of development and long-term maintenance. Actively including program team members with non-stormwater infrastructure responsibilities can help gain support for green infrastructure initiatives.

C. Sensitive Relevant Natural Resource Areas

Coordination with local natural resource agencies, watershed groups, or environmental protection groups can help take into consideration relevant natural resources such as karst geology, wetlands, hardwood forests, soils, impaired or listed waters of the state, or drinking water supplies. Planning with these types of resources in advance of implementation will reduce any roadblocks that may occur at a later date.

Karst Geology

Karst geology features such as springs and sinkholes provide challenges relevant to stormwater. It is important to document these features within and near your community up front to help minimize the risks from unintentionally increasing the rate of sinkhole development or accidental contamination of groundwater. Non-structural solutions for

Figure 3.3 Known sinkholes in Missouri. Source: Missouri Department of Natural Resources Division of Geology and Land Survey

Figure 3.4 Known springs in Missouri. Source: Missouri Department of Natural Resources Division of Geology and Land Survey

stormwater management may be needed in sensitive karst areas in order to minimize the need for infiltration stormwater control measures. Figure 3.3 and Figure 3.4 display the known sinkholes and springs in Missouri from the karst, springs and caves website on the Missouri Department of Natural Resources website. Consulting with local Missouri Department of Natural Resources or other knowledgeable natural resource agency offices may help identify areas of special concern within the MS4 related to karst geology. More information on karst and related geology can be found at: www.dnr.mo.gov/env/wrc/springsandcaves.htm

Wetlands

In Missouri, many of the remaining wetlands exist within riparian corridors along streams and rivers. Wetlands are one of nature's tools for water quantity and quality control. Therefore, wetlands within your community's watersheds can be an asset to your stormwater management program. Comprehensive land use plans that identify wetland resources as an asset to be protected and utilized can help you take advantage of these assets.

More information on wetlands can be found at www.dnr.mo.gov/env/wrc/wetlands.htm

Soils

Soils are important natural features that should be taken into consideration when developing a stormwater management program. Soil types vary widely across Missouri and even vary within one community. Communities will need to select stormwater control measures and develop design criteria that are appropriate for the varying soil types in their community, particularly for measures that require greater infiltration rates. Soil maps and general descriptions can be viewed at: www.mo.nrcs.usda.gov/technical/soils.html, websoilsurvey.nrcs.usda.gov/app/HomePage.htm, or www.cares.missouri.edu/.

Impaired or Listed Waters

In Missouri impaired or listed waters are those with documented water quality issues for one or more priority pollutants. Some streams and rivers have total maximum daily loads, or TMDLs, assigned to them. The TMDL limits the overall pollutant load that can be discharged to the receiving water body. When developing or revising a stormwater management program, it is important to reduce and eliminate pollutants that are identified in the TMDL. These restrictions can impact new or additional discharges to the receiving water body. Communities should be proactive in addressing this issue by working closely with stakeholders and the Department of Natural Resources (DNR, 2011).

Drinking Water Supplies

Drinking water supplies within or downhill of a community pose special challenges in stormwater management. Using tools for decision making, such as land use plans, planning and zoning maps, overlay zoning and protection ordinances should be the primary methods to protect and address these community assets.

More information on groundwater and related water supply information can be found at: www.dnr.mo.gov/env/wrc/grdh2o.htm

D. Retrofitting areas of existing development

Built-out or fully developed communities include a variety of stakeholders that can provide positive input to the program. Examples include:

Watershed and Stream Team Organizations

Citizens involved in organizations such as watershed groups or stream teams can participate in the process of goal setting. Citizen inclusion can create buy-in and minimize project opposition. See Missouri Stream Teams at www.mostream.org. Also see the Missouri Stormwater information clearinghouse, local governments page. The post construction page lists several watershed organization. (Missouri. Appendix C.)

Community Development Corporations

Community development corporations are non-profit economic development groups often formed in areas with lower density and lower property values than surrounding areas. Green infrastructure can help revitalize areas where stormwater infrastructure is also rehabilitated with pervious curb, gutter and sidewalks or enhanced landscapes in the form of rain gardens or vegetated boulevards. Abandoned homes and other vacant properties can be converted to pocket parks that manage stormwater while increasing opportunities for public open space, urban farming, or playgrounds.

Combined Sewer Area Programs

Combined sanitary and storm sewers are primarily located in older developed areas. Although these areas are not typically part of an MS4 program because they are exempt per federal regulation and otherwise regulated under sanitary sewer permits, they are often located within an MS4 area. Stormwater programs using green infrastructure infiltration methods can reduce the amount of stormwater entering the combined sewer system, increasing the available capacity of existing and planned collection systems and improve water quality by reducing the probability of sanitary wastewater overflows to receiving streams.

Private Redevelopment Corporations

Private for-profit redevelopment corporations can provide relevant input to the program regarding land value and infrastructure needs. Involving private development stakeholders in plan development can help educate them on whether or not to incorporate green infrastructure into their projects.

3.3.2 Setting and Tracking Measurable Goals

Post-construction stormwater management program goals drive the development of plans, the actions selected and the context of results. Setting program goals is therefore critical for the creation of a program relevant to both compliance and fitting community-specific needs. Program goals should be reviewed regularly for revisions to improve the program and respond to changes in community or regulatory needs. Environmental and other goals indirectly related to water quality should be encouraged.

Measurable goals quantify the progress of program implementation and the performance of your stormwater control measures. EPA recommends for program goals to include:

- A multiple variety of short- and long-term goals.
- Proposed actions, expected results in quantifiable terms and schedules/milestones for each proposed stormwater control measures. http://cfpub.epa.gov/npdes/stormwater/measurablegoals/index.cfm

EPA also recommends establishing a baseline against which progress can be measured. Information on current water quality conditions, numbers of stormwater control measures already implemented and the public's current knowledge/awareness of stormwater management would be useful in establishing a baseline.

Measurable goals can be based on one or more of the following general categories:

- Tracking implementation over time.
- Track how often and where stormwater control measures are implemented.
- Measure and track the effectiveness of stormwater control measures.

Example Goal: Install at least 10 rain gardens per year in a specified area of the watershed. Identify and fund construction of rain gardens on public land. Constructed rain gardens will be tracked in the municipal GIS database. Data will be collected to track capital cost per square foot of each rain garden and the ratio of rain garden area to contributing watershed.

Measuring Progress in Implementing. Some stormwater control measures are developed over time and a measurable goal can be used to track this progress until the control measure implementation is completed.

Example: Develop a residential rain garden incentive program. A residential rain garden guidance document will be published by [DATE 1] in order to facilitate the funding and construction of 1,000 residential on-lot rain gardens by [DATE 2] in order to reduce annual runoff volume to below a predevelopment condition.

Tracking Total Numbers of Stormwater Control Measures Implemented. Measurable goals also can be used to track stormwater control measures implementation numerically.

Example: Construct a rain garden as part of 50 percent or more future American Disability Act, or ADA, sidewalk ramp rehabilitation projects. Proposed transportation design projects in the watershed will be reviewed quarterly for opportunities. Annual summary reports will be issued listing the location and number of rain gardens and number and location of ADA sidewalk ramp improvements to verify progress.

Tracking Program/Stormwater Control Measures Effectiveness. Measurable goals can be developed to evaluate stormwater control measures effectiveness.

Example: Reduce annual runoff volume. Measure collection system flow rates and correlate to rainfall events and relevant stormwater control measures to estimate reductions in runoff volumes through a five year proposed implementation period. Interim progress reports shall be completed annually to monitor progress.

Tracking water quality and other environmental indicators can provide a benchmark against state water quality standards for the receiving waters such as TMDLs.

Example: Reduce nutrient concentrations in an impaired stream to below TMDL criteria. Stormwater control measures will be implemented in the watershed to filter and remove nitrogen and phosphorus according to a five year implementation plan. Samples will be collected quarterly to track improvements.

Administrative goals evaluating the community's capacity to implement a stormwater management program should be a part of developing the community's goals. Community capacity issues can include anticipated growth, funding resources, political and community support, availability of trained personnel to implement the program and integrating the program into other community efforts.

Example: Conduct a study by [DATE 1] to assess funding needs to adequately implement stormwater program and implement the funding program by [DATE 2].

3.3.3 Assess and Update Land Use Policies

Once the program team has formulated measurable goals, existing land use and other natural resource policies should be compared against the measurable goals. Chapter 2 has discussed comprehensive planning at different geographic and political levels and Chapter 4 of this document discusses methods for updating policies to better meet water quality goals. Common policies relevant to stormwater management may include:

A. Zoning prescribes the type and intensity of allowable land use in different areas. Low density zoning helps allow for green infrastructure concepts such as conservation development and increased open space, but may also contribute to suburban sprawl requiring longer runs of road, water, sewer and other utilities that may create additional land disturbance, impervious surface, long-term operation and maintenance costs that may or may not be funded by the taxes generated in the low density area. In contrast, high density zoning helps consolidate utilities and minimize impervious surface per capita, but may be more likely to degrade natural habitats, increase heat island effects and create more localized stream degradation due to changes in hydrology. Areas that may not have specified zoning should follow the most up to date standard of practice for their planning and engineering, or apply zoning requirements from a municipality with reasonably close proximity.

B. Subdivision control and other infrastructure policies address building footprint size, sidewalk and road widths, parking requirements, setbacks and other elements that affect the amount of impervious surface. Compromises may be required to balance needs among local agencies such as public safety, transportation, environmental protection and economic development in order for subdivision control policy to support stormwater program goals that plan to integrate green infrastructure. Despite their stormwater and infrastructure cost benefits, green infrastructure concepts such as narrowing roads may conflict with public safety access, minimizing parking counts may not support peak seasonal shopping and reducing setback distances may limit the appeal for some residential developers.

C. Watershed Plans and other regional natural resource policies may already support program goals. However, these documents may also generate additional requirements for the stormwater program not previously considered.

3.3.4 Funding and Staffing

Effective stormwater management has many economic benefits and could help avoid significant local expenditures such as for repairing washouts, addressing flooding, reducing downstream erosion and stream bank repair. When weighing the cost of a good post-construction program, consider the millions of dollars associated with stream bank restoration projects, basin dredging and maintenance of clogged collection systems and outlets. Many types of green infrastructure capture solids in a way that can be easier to maintain than these other systems.

MS4s need financing plans for stormwater management programs, including creation of regulatory controls and program implementation, technical services for stormwater plan review, staffing, site inspections and enforcement.

Stormwater programs funding options include taxes, fees, bonds and grants. Some funding resources are limited by state and local laws governing revenue generation and can be dependent on the size of the community and method of governance. Be aware of potential exemption riders on proposed funding mechanisms. Often the largest contributors to runoff find ways to be exempted from funding, and therefore compromise the effectiveness of such funding.

Funding could also be distributed among different programs such as transportation for street runoff controls and the parks budget for selected structural stormwater control measures. Examples may include integrating green infrastructure into other infrastructure such as pervious curb and gutter infiltration trenches, parking island rain gardens and dry detention or other basins in parks.

At a minimum, your funding program should:

- Estimate funding needs for each program component.
- Describe administrative and field staff positions.
- Identify funding sources.
- Include a schedule, which may include staff or equipment, when utility fees may be implemented or increased, or when other relevant program phases may occur.
- Provide a large amount of lead time for arranging program financing.
- Identify long-term projects to fund.

Funding maintenance of green infrastructure in the right-of-way should be addressed at the interdepartmental level in most municipalities. Potential maintenance entities include transportation, parks, landscape, or stormwater departments. Green infrastructure is an integral part of a stormwater management system. Volunteer groups are not recommended for maintenance on city stormwater features. However, it is important to work with home owners on maintenance agreements for rain gardens and similar features located on their properties. Some cities have home owners submit annual reports on the status of their rain gardens, in order to minimize encroachment.

Funding methods and mechanisms commonly used for stormwater programs can include:

- General revenue appropriations – using general tax revenues to support stormwater programs.
- Stormwater user (service) fees – creating a stormwater utility to bill and collect user fees to cover some or all of program practices.
- Local parks and stormwater sales tax.

- Plan review fees – dedicated fees collected as part of a project approval process.
- Development inspection fees – dedicated fees collected from HOAs, businesses and other owners of structural stormwater control measures to support inspection programs.
- Special user fees – additional user fees imposed on atypical dischargers, usually associated with other NPDES regulated activities.
- Special assessments – dedicated funding of specific construction projects such as regional stormwater basins.
- Bonding for capital improvements – used to fund large projects that far exceed current revenues.
- In-lieu of construction fees – collected from new developments to construct regional stormwater facilities as substitutes for on-site practices.
- Capitalization recovery fees – collected to recover costs on prior infrastructure installed in anticipation of development.
- Impact fees – collected for actions that contribute to off-site stormwater issues but cannot be effectively mitigated for on-site.
- Developer extension/latecomer fees – collected by a developer as future compensation where oversized systems are tapped into at a later date.
- Federal and state funding opportunities such as grants, loans and cooperative programs.

Stormwater Program Funding Guidance Resources

Guidance manuals and tools available to assist stormwater program managers in developing and implementing funding for a post-construction program include:

- National Association of Flood and Stormwater Management Agencies - Guidance for Municipal Stormwater Funding (Guidance, 2006). www.nafsma.org/Guidance%20 Manual%20Version%202X.pdf
- Center for Urban Policy and the Environment at Indiana University - Purdue University Indianapolis - An Internet Guide to Financing Stormwater Management. http://stormwaterfinance.urbancenter.iupui.edu/.
- Prince William County, Virginia Department of Public Works - Stormwater Management Fee (Storm). www.pwcgov.org/default.aspx?topic=010008000780000828
- Reason Public Policy Institute - Preparing for the Storm: Preserving Water Resources with Stormwater Utilities (Preparing, 2001). http://reason.org/news/show/preparing-for-the-storm
- The Center for Watershed Protection has developed some tools that can assist communities with budget assessment (Tool, 2008): www.cwp.org/store/free-downloads.html
- Managing Stormwater in Your Community Tools - Tool 2- Program and Budget Planning Tool: www.cwp.org/store/free-downloads.html
- Managing Stormwater in Your Community Tools - Tool 7 - Performance Bond Tool; http://www.cwp.org/store/free-downloads.html

3.4 Enhancing and Implementing Your Stormwater Management Program

Successful program enhancement with green infrastructure and its implementation will require leadership, training, inspections, enforcement and reporting. Leadership and support from both the political and administrative levels of local government are essential to implement an effective stormwater management and post-construction program. This support is vital for department directors and staff to conduct their duties and responsibilities with integrity, effectiveness and confidence when working with stakeholders.

A. MS4 Leadership

The prime leadership role may be the MS4 coordinator or other "advocates" that are constantly moving the program forward. Leadership may be a staff person, an elected official or long-time member of the community who is highly regarded among stakeholders and should be given adequate decision making authority by the appropriate municipal leadership. MS4 program leaders should be clearly identified by name and title in the program and their ability to make different level of decisions on behalf of program implementation in cooperation with all departments.

B. Training Programs

A training program should include stormwater control measures operations and maintenance, ordinance enforcement, documentation and how to work with the public. Training opportunities for the community may include participation in regional training courses such as those provided by a regional council of governments, training provided

Training Program Example Topics

Example Trainees	Plans and policies	Ordinances and codes dealing directly and indirectly with stormwater management	NPDES Phase II Program requirements	Stormwater control measures for post-construction control	Stormwater control measures for construction erosion and sediment control	Phase II permit requirements	Phase II regulations	How to work with the public
Elected officials, city administrator, board of zoning, adjustment officials	X	X	X					
Planning and zoning officials, development plan review team	X	X	X	X	X			
Public works staff, community, community development staff, inspectors	X	X	X	X	X	X	X	X

Table 3.1

by local or in-house staff, using purchased programs, or training by an outside consultant. In some cases, the State of Missouri may offer regional training courses through a local organization or government agency.

C. Inspection Program

An inspection program is important for a successful post-construction program because it verifies that the development plans are implemented as approved. Furthermore, it is critical that the designated inspector understands the site drawings and follows through to verify that they are constructed as designed. Some benefits to establishing a new or refining an existing inspection program include:

- Assesses program and ordinance implementation.
- Measures the effectiveness of stormwater control measures (structural and non-structural).
- Identifies the maintenance needs of stormwater control measures.
- Provides knowledge and confidence to staff through the application of the program.
- Assesses the effectiveness of ordinances and codes.
- Provide sease in completion of annual Phase II reports.
- Assures the site drawings are followed.

Elements of an inspection program should define who will conduct the inspections, the methods and tools needed and the frequency of inspections.

Inspectors may represent a single agency within the local government or a shared responsibility. For example, one department could have the legal responsibility for stormwater management while another department has the authority to enforce ordinances, codes and to levy fines for noncompliance. Whether inspection is the sole responsibility of a single department or shared among a group of departments, the responsibility should be identified and specified in the ordinance providing regulatory authority.

An effective tool to use for an inspection program is the revised Missouri Department of Natural Resources' *Protecting Water Quality Manual 2011* provides resources for inspecting construction best management practices that can be adopted for a post-construction program.

Additional tools to support and enforce ordinances include having the necessary equipment such as computers, cameras, transportation and training on how to conduct inspections and how to interact with people.

D. Enforcement

Enforcement plans provide incentives in the form of consequences for non-compliance. Penalties or other consequences should be specified in an ordinance or other enforceable regulation and detailed enough to avoid misinterpretation. A tiered enforcement plan with a combination of actions and imposed fines is a practicable approach.

Example Tiered Enforcement Protocol	
First Offense	Advise on corrections needed, time frame for correction and warn of consequences for non-compliance.
Second Offense	Stop operations and impose fine.
Third Offense	Fines imposed for each violation since first occurrence; place a lien on property until compliance is achieved and fines paid.
Non-compliance after Third Offense	Fines imposed for each violation since first occurrence; place a lien on property until compliance is achieved and fines paid.

Table 3.2

E. Tracking, Record keeping and Reporting

For the post-construction program, there may be overlap in record keeping with other municipal requirements and the Phase II stormwater permit. It is important for a community to develop and maintain an electronic geographical information system, or GIS, database or other documentation protocol and system to track and update program progress.

The MS4 should consult legal counsel regarding their documentation retention procedure and reporting requirements relevant to their NPDES permit.

Monitoring is an important consideration in tracking the success of a program. Without "real" data, performance cannot be evaluated. Tracking indicators alone can be very misleading, but can be used with the monitoring efforts to evaluate performance and determine any necessary changes for program success. (Burten et al. 2002)

The MS4 should ensure documentation, record keeping and reporting are done in accordance with permit requirements and federal and state regulations.

Example Inspection Schedule for Installed Stormwater Control Measures	
During Construction	2 to 3 times following a rain event or as required by code.
Upon Construction	As required by code or design and installation standards.
First year, Post-construction	After average precipitation events, after major precipitation events, upon complaints/comments from public.
Second Year	Biannually, after major precipitation events, upon complaints/comments from public.

Table 3.3

Annual NPDES reporting requirements provide an opportunity to evaluate program progress. Reporting can lead to:

- Shore up weaknesses in specific program areas, such as inspections.
- Clarify portions of policies, plans or ordinances that are ambiguous or open to interpretation.
- Increase or modify training for staff and officials.
- Make system improvements, such as the program tracking and documentation.
- Change ordinances or codes that are inconsistent.

These and additional records that may be tracked include area-wide data specific to the structural stormwater control measures in the MS4 area and administrative program data covering policies, training programs or permit compliance.

Example Area-wide Implementation Records
MS4 Area-Wide Post-Construction Technical Elements

- A GIS database or other system to track:
    - Stormwater control measure description – type, size, location and date of construction of structural control measures.
    - Measurable Goals – what the stormwater control measure is expected to do.
    - Responsible Entity – MS4, transportation department, parks department and homeowners association are all examples of potential responsible entities.
    - Schedule – inspections, training, phased construction, or other relevant schedule specific to the stormwater control measure.

    - Reporting and record keeping – protocol for record retention specific to the stormwater control measure.
    - Relevant minimum control measures addressed – list one or more of the six minimum controls met by the stormwater control measures.
    - Target constituents – residential, commercial, or industrial changes in percent impervious cover.
- Description, function and implementation date of non-structural stormwater control measures.
- Number of development plans submitted and approved under new program.
- Number of developments with low impact development or similar development methods.
- Number of conservation easements negotiated.
- Acreage of riparian corridor protected.
- Water quality and quantity monitoring from stormwater control measure outlets.
- Reduction of flooding in flood-prone areas.
- MS4 Area-wide Inspections.
    - Date, time, location and staff of each inspection.
    - Specific stormwater control measures inspected – notes, photographs, video.
    - Results of each inspection.
    - Follow-up of inspections requiring action by the developer or property owner.
- Project specific plan review process (for each development or redevelopment project).
    - Preliminary meeting with developer or property owner.
    - Preliminary plats and development information.
    - Subsequent meetings with developer or property owner.
    - All communications with developer, property owner, architect and development engineer.
    - Reviews by staff.
    - Reviews by planning and zoning commission or similar board.
    - Approvals and denials of development plans and explanations.
    - Comments from other agencies, the public and other stakeholders.

F. Example Administrative Program Records

Revisions to relevant stormwater management program policies, plans, ordinances and technical design manuals including:

Correspondence and Meeting Logs:

- Meeting notes on development and passage of policies, plans, ordinances and/or manuals.
- Communications with stakeholders regarding development and policies, plans, ordinances and/or manuals.
- Comments from stakeholders on policies, plans, ordinances and/or manuals, including public meetings held.
- Minutes from city council or alderman meetings regarding stormwater management and post-construction policies, plans, ordinances and/or manuals (presentations by staff, discussion, official readings, votes taken).

Training Program:

- Agenda of each training event: topic, time for each topic, instructor and specific training tools used such as videos or publications.
- Attendance sheet for each training event.
- Results of any written exam given during the training.
- Evaluation summaries of the training provided by attendees.

NPDES Post-Construction Program Requirements:

- Permit requirements: measurable goals, tasks, activities.
- Completion or implementation of each task, activity and measurable goal.
- Annual report.
- Inspections or audits by regulatory agencies.
- Communications with regulatory agencies.

Case Study: Small Town USA

Small Town, USA, has substantial existing development and many neighborhoods that are still growing. In existing developed areas, the town plans to disconnect some impervious surfaces and ensure that existing stormwater controls are functioning properly. For new and redevelopment areas, the town plans to enact a new stormwater ordinance and develop supporting design guidance.

Minimum Measure Objective: Reduce the volume and improve the quality of runoff by disconnecting impervious surfaces and installing and maintaining structural stormwater control measures.

- Stormwater Control Measure: Reduce directly connected impervious surfaces in new and redevelopment projects by requiring that swales or filter strips be installed along roadsides in lieu of curbs and gutters.

Measurable Goal: Directly connected impervious road surfaces in new developments and redevelopment areas will be reduced by 30 percent compared to traditional scenario.

- Justification: This practice would provide on-lot treatment of stormwater, reduce the total volume of stormwater being discharged from sites and increase the time of concentration of runoff generated from road surfaces.
- Stormwater Control Measure: Develop a program for maintenance of structural stormwater controls.

Measurable Goals: In year one, conduct an inventory of structural runoff controls. In year two, develop a GIS map to integrate the location of these controls with maintenance and inspection. Conduct four inspections of each structural control per year and conduct regular maintenance as prescribed.

- Justification: In order to implement a maintenance plan, the type and location of structural stormwater control measures must be compiled. An inspection and maintenance schedule can be developed to improve efficiency and minimize labor requirements.
- Stormwater Control Measure: Develop and implement a stormwater ordinance and design guidance that includes performance standards designed to control runoff.

Measurable Goal: By year three of the permit term, 95 percent of all building permits will include descriptions and plans of stormwater control measures that comply with the criteria in the ordinance and accompanying guidance

- Justification: Ordinances are an effective way to establish performance standards for runoff controls. For example, performance standards may include requirements to maintain predevelopment hydrologic conditions.

United States Environmental Protection Agency (2011)

Wetland Swale. Source: Olsson Associates

Sand Filter (Open Basin Design)- North Carolina. Source: *North Carolina Stormwater BMP Manual.*

Excerpt: Missouri Municipal Separate Storm Sewer System Permit for Phase II Communities. June 2008.

4.2.5 Post-Construction Stormwater Management in New Development and Redevelopment

4.2.5.1 Permit requirement. The permittee shall develop, implement, and enforce a program to address the quality of long-term stormwater runoff from new development and redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale, that discharge into the permittee's regulated small MS4. The permittee's program shall ensure that controls are in place that have been designed and implemented to prevent or minimize water quality impacts by reasonably mimicking pre-construction runoff conditions on all affected new development projects and by effectively utilizing water quality strategies and technologies on all affected redevelopment projects, to the maximum extent practicable. The permittee shall assess site characteristics at the beginning of the construction design phase to ensure adequate planning for stormwater program compliance....

Introduction to Case Studies

Throughout the U.S., there is a growing recognition of the benefits green infrastructure provides to communities. Many municipalities and other jurisdictions have begun to effectively incorporate these practices. The following case studies were selected to showcase both site and landscape scale GI projects which have successfully been implemented. Additional case studies are included in Chapter 6. Readers are encouraged to follow the links or titles provided for each case study to learn more about these projects.

Case Study: Municipal Stormwater Funding

Charlotte/Mecklenburg County, NC

Charlotte/Mecklenburg County, NC, utility was instituted in 1994 and relies on centralized funding and regional programs for major systems combined with local management of minor stormwater systems. Charlotte and small towns typically employ a blend of funding from several sources while the county relies almost entirely on the service fee. The total stormwater budget for all entities in 2005 was more than $85 million. The fee for a single-family house is $1.06/month throughout the county.

Local stormwater programs of the county, cities and towns are funded by a separate additional rate component which ranges from $0.30/month to $6.72/month in Charlotte. In 2005, the budget of Mecklenburg County was about $750 million and the population of Charlotte was about 650,000.

Charlotte, NC

Bellevue, WA

The Bellevue, WA, stormwater management program was established in 1974. Funding is primarily derived from a user fee that is based on gross property area and a factor reflecting the intensity of development of each property. Residential fees range from $3/month to more than $20 per month with an average of about $10/month. The annual operating budget is approximately $6 million. The population of Bellevue was about 117,000 in 2005.

Tulsa, OK

The Tulsa, OK, Stormwater Management Program budget has recently ranged from $12 million to $14 million per year and includes comprehensive watershed management, dedicated funds for maintenance and operation and a $200 million capital improvements program.

All residential properties are charged a single rate of $3.49/month and fees for other properties are based on the amount of impervious surface on each property. The population of Tulsa was about 400,000 in 2005.

Louisville, KY

Louisville, KY, consolidates flood control and stormwater management with a regional wastewater collection and treatment program provided by the Metropolitan Sewer District. Most of the smaller cities and towns in Jefferson County do not perform stormwater management functions. The district's stormwater fee is based on a flat rate for single-family residential properties and differential rates for other properties based on an impervious area equivalency unit. The single-family residential stormwater service fee in 2005 was $4.41/month. Stormwater service fee revenues in fiscal year 2005 were expected to be nearly $24 million. Louisville had a population of about 700,000 in 2005.

(Tucker, Harrison, Cyre, Burchmore, & Reese, 2006); (Chan, 2009)