

CITY OF
SPRINGFIELD



THE CITY OF SPRINGFIELD, MISSOURI

MUNICIPAL SEPARATE STORM SEWER SYSTEM (MS4) PERMIT MO-0126322 ANNUAL REPORT JULY 2010-JUNE 2011

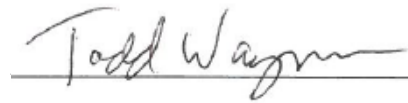


PREPARED BY: DEPARTMENT OF PUBLIC WORKS STORMWATER ENGINEERING DIVISION
DECEMBER 2011

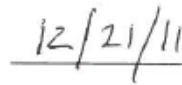
SIGNATORY REQUIREMENTS

As required by Part VI.H of NPDES Permit MO-0126322, this report is signed by a duly authorized representative for the City Manager, a principal executive officer of the City of Springfield, as submitted in writing to the Director on January 16, 2003.

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fines and imprisonment for knowing violations."



Todd Wagner
Principal Storm Water Engineer



Date

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1.0 INTRODUCTION

This report documents the annual activities completed for the City of Springfield's (City's) National Pollutant Discharge Elimination System (NPDES) Permit MO-0126322 issued July 26, 2002 by the Missouri Department of Natural Resources (MDNR) for the City's Municipal Separate Storm Sewer System (MS4). This 5-year permit expired July 25, 2007 but has been administratively continued by MDNR until a revised permit is issued. This annual report provides the necessary documentation to fulfill the reporting requirements specified in Part V.D of the Permit for July 1, 2010 through June 30, 2011. The City's Department of Public Works Stormwater Engineering Division compiled this report with input from other City departments and divisions.

2.0 CONTACTS LIST

Todd Wagner, P.E.

Principal Storm Water Engineer 417-864-1901

twagner@springfieldmo.gov

Carrie Lamb

Water Quality Coordinator 417-864-1996

clamb@springfieldmo.gov

3.0 STORMWATER MANAGEMENT PROGRAM SUMMARY AND EVALUATION

As stated in the Permit, the primary objective of the City's Stormwater Management Program (SWMP) is to reduce the discharge of pollutants from the MS4 to the Maximum Extent Practicable (MEP). An overall evaluation and summary of the SWMP is provided in this section as required in Part V.D.2.b of the Permit.

3.1 MAJOR ACCOMPLISHMENTS

BEST MANAGEMENT PRACTICES FOR CITY FACILITIES

The City's Green Building Policy has facilitated the use of low impact development/green infrastructure techniques in the design of City facilities. This policy, adopted in February 2008, requires all new city-owned buildings intended for human occupation to be designed and built for Leadership in Energy and Environmental Design (LEED)-NC Silver certification. The policy also requires that all new city-owned buildings not intended for human occupation and all renovations of city-owned buildings include as many prerequisites and benchmarks as possible of the LEED-NC and LEED-EB programs respectively.

Construction was completed this year on the [SPRINGFIELD-GREENE COUNTY BOTANICAL CENTER](#). The building is designed for LEED Silver Certification and includes a rainwater cistern for irrigation use, parking lot bioswales, a bioretention/water quality basin with native plants, and other green features. The building is owned and operated by the Springfield-Greene County Park Board.

LOW IMPACT DEVELOPMENT

LID is an approach to land development (or redevelopment) that works with nature to manage stormwater as close to its source as possible (EPA).

GREEN INFRASTRUCTURE

Green infrastructure is systems and practices that use or mimic natural processes to infiltrate, evapotranspire, or reuse storm water or runoff on the site where it is generated (EPA).

Construction was completed this year on the City's **TRAFFIC MANAGEMENT CENTER**. The new building is a redevelopment of an existing impervious parking area at the Public Works Operations Center, resulting in no net increase in impervious area. The design includes a water quality basin and other green building features.

In 2012, the construction of the new **DOLING AQUATIC CENTER** and the renovation of the City's **ENVIRONMENTAL RESOURCE CENTER** will both include rainwater harvesting.

CAPITAL IMPROVEMENT PROJECTS

The City's **FIRST GREEN STREETScape** was completed this year. The project includes a 770 square-foot pervious pavement parking turnout that is designed to drain itself and an equivalent amount of sidewalk on Park Central West (Figure 1). On Park Central East, a 130 square foot rain garden collects runoff from 1,000 square feet of street pavement and 600 square feet of sidewalk (Figure 2). These BMPs were partially funded by a Water Quality Improvement Grant from James River Basin Partnership. Educational signage will also be installed.

The **CARLETON AND McCANN STORMWATER IMPROVEMENTS** involved retrofitting two detention basins by replacing concrete low flow channels with gravel infiltration trenches as well as construction of a new detention basin with an infiltration trench. These improvements will provide for increased infiltration of runoff.

PARKS WATERWAYS PROJECTS

Construction began on the Parks/Waterways projects for **SEQUIOTA PARK, DICKERSON PARK ZOO, AND DOLING PARK**. Green infrastructure designs for these projects include rain gardens, water quality basins, a wetland, pervious pavement parking (Figure 3), trees and native plants. These projects also include stream stabilization and lake improvements to address erosion and lake water quality. Design is underway for the **WARD BRANCH STREAM STABILIZATION AND TRAIL, CLOSE PARK LAKE & WATERWAY IMPROVEMENTS, AND FASSNIGHT PHASE II PROJECTS**. Designs will address waterway erosion, flood reduction, and trail connections. These projects are funded by the 2006 County-wide Parks Sales Tax for Lake/Waterways Improvements. Project updates, photos, and plans are available at springfieldmo.gov/stormwater.

Construction was completed on the **FASSNIGHT PARK WATERWAY IMPROVEMENT PROJECT**. The project objectives were channel stabilization, flood control, trail development, historical reconstruction, and water quality protection. Major components of



FIGURE 1: PERVIOUS PAVEMENT ON PARK CENTRAL WEST



FIGURE 2: RAIN GARDEN ON PARK CENTRAL EAST



FIGURE 3: PERVIOUS PARKING LOT IN SEQUIOTA PARK

the project included reconstruction of the crumbling historic rock walls of the creek to reduce erosion and resulting sediment loads for water quality protection (Figures 4-5), replacement of bridges at Campbell, Grant, and Main Avenues, including pedestrian underpasses at Campbell and Grant, and completion of the first section of the Fassnight Creek Greenways Trail.

STORM DRAIN REVEAL

A new education project was launched this year with James River Basin Partnership called Storm Drain Reveal. Artists painted murals on 10 storm drains in downtown Springfield to educate the public about stormwater (Figures 6 and 7). Photographs of the completed storm drain murals along with stormwater education information were featured at local events and businesses. The project received significant media coverage, including national attention. The brochure created for the project continues to be used as part of education efforts and the murals themselves will continue to be a visual reminder for the public about the connection between storm drains and waterways. See Section 5.10 for more details.

3.2 MAJOR FINDINGS (MONITORING PROGRAMS)

Water quality monitoring data collected since 2002 indicates that local streams are characterized by typical urban runoff pollutants during wet weather including nutrients, sediment, and bacteria but have not shown impacts from less common pollutants such as pesticides, volatile organic chemicals, oil and grease, or cyanide. Toxicity monitoring has not shown baseflow or stormflow pollutant levels toxic to aquatic life. Heavy metals have also generally not been at levels of concern for most streams.

Based on multiple years of data, *Jordan Creek and Ravenwood Branch are priority watersheds for further investigation and potential BMP implementation*. Runoff samples collected at these streams exhibited the highest levels of nutrients and total suspended solids (TSS) as well as high *E. coli*. Ravenwood Branch samples also contained the highest copper and zinc levels. The probable source of high TSS as well as one possible source of nutrients in Ravenwood Branch is severe stream channel erosion. Channel stabilization of Ravenwood Branch is on the priority list for future stormwater funding initiatives. Several projects are ongoing or on the priority list for the Jordan Creek watershed in conjunction with the Jordan Creek Feasibility Study and West Meadows projects (see sidebar, p.23). The Jordan Creek watershed has also been targeted for BMP



FIGURE 4: EROSION IN FASSNIGHT CREEK



FIGURE 5: RECONSTRUCTED HISTORIC ROCK WALLS



FIGURE 6: LOCAL ARTIST PAINTING A MURAL FOR STORM DRAIN REVEAL



FIGURES 7: STORM DRAIN REVEAL MURAL

implementation with a Section 319 Nonpoint Source Pollution Grant received by Watershed Committee of the Ozarks in May 2011, for which the City is providing significant matching funds and in-kind assistance. For more information on that grant, visit www.bigurbie.org.

3.3 PROGRAM STRENGTHS AND WEAKNESSES

STRENGTHS

The **LAND DISTURBANCE PERMIT PROGRAM**, implemented in February 2009, is a comprehensive program that has improved erosion and sediment control on construction sites in Springfield with excellent compliance and training tools, proactive inspections, and a progressive enforcement policy. See Section 4.9 for program details.

PUBLIC EDUCATION/OUTREACH AND INVOLVEMENT continues to be one of the program's biggest strengths. This year 101 education activities were completed and over 2,500 educational materials were distributed on topics including storm water and watershed basics, rain gardens, rain barrels, pollution reporting, environmentally-friendly yard care and fertilizer use, pet waste, trees, and low impact development. Activities included field trips and classroom lessons for students K-College, media exposures, presentations to community groups, and displays at community events. The **RAIN BARREL PROGRAM** also continues to be a very popular program in educating citizens about storm water impacts and engaging them in reducing runoff from their homes. This year, 89 barrels were sold, for a grand total of 1190 barrels sold since the program began in January 2007. In addition, the Solid Waste Management Division completed 137 tours, presentations, and events, and distributed over 97,000 educational materials. Many of these activities and materials include information about proper disposal of household chemicals, environmentally-friendly lawn care and other water quality-related topics. See Section 4.10.

WEAKNESSES

The lack of a dedicated **LONG-TERM FUNDING** source continues to be a program weakness. The passage of the Parks/Waterways sales tax in August 2006 was a major accomplishment in providing program funding for fiscal years 2008-2012. Among the activities this tax funded was a preliminary study of potential strategies to provide long-term funding completed last year. The national economic downturn has reduced existing program funding and increased the difficulty of obtaining public support for future funding. On a positive note, funding continues to be recognized as a weakness and a priority in community reports and planning documents. It was listed as a red flag in the 2005, 2007, and 2009 Community Focus Reports published by the Community Foundation of the Ozarks, and most recently in the recommendations of the Natural Environment Committee (see sidebar) as part of the City's Strategic Planning process. The Greene County Commission voted not to seek renewal of the Parks/Waterways Sales Tax in 2011. The tax sunsets in June 2012. It is estimated that the City and County can

NATURAL ENVIRONMENT COMMITTEE

In 2010 the City began a new strategic planning process for the next 20 years. Citizens and City staff served on committees that addressed a variety of topics by developing a vision statement as well as a 5-year action plan with specific goals and performance measures. The Natural Environment Committee developed an action plan to address issues related to air, land, and water. The plan includes goals for increasing the use of low impact development and green infrastructure techniques, BMP retrofitting, riparian corridor restoration, trees, native plants, and storm water funding. The plan is expected to be adopted and implemented in 2012. For more information, visit springfieldmo.gov/strategicplan.

continue to fund their water quality programs with reserves from the current tax for 2-3 years following the sunset, at which time another funding source will need to be in place to ensure compliance with MS4 permits.

3.4 FUTURE DIRECTION OF PROGRAM

The City's **MS4 PERMIT** has been expired and administratively continued since July 2007. In accordance with permit requirements, the City submitted its permit reapplication proposal in the year four annual report (2005-2006) and continued to work cooperatively with MDNR permit staff this year to finalize a revised permit for reissuance. At the time of this report, the revised permit has not yet been issued. It is anticipated that the requirements of this new permit will require changes to the City's standards for new development and redevelopment and other stormwater management program areas.

3.5 SWMP SUMMARY TABLE

The SWMP Summary Table (Table 1) has been prepared according to the format outlined in Part V.D.2.c. of the Permit. The table documents program activities that are quantifiable. Some activities could not be quantified and therefore do not appear in the summary table but are discussed in Section 4.0 Narrative Report.

4.0 NARRATIVE REPORT

The purpose of this section of the report is to discuss those SWMP elements required under Parts II and III of the Permit. The activities for each element are identified with their corresponding number and letter listed in Part II.A of the Permit.

4.1 OPERATION AND MAINTENANCE OF STRUCTURAL CONTROLS

ACTIVITY 1.A: CONTINUE TO UPDATE AND MAINTAIN THE INVENTORY DATA FOR THE MS4 WITHIN THE CITY BOUNDARIES.

The required task of GIS mapping of the MS4 is complete. Staff continues to input new storm water structures as they are constructed and to field-verify portions of the MS4 that were either overlooked during initial mapping or were incorrectly entered. ***This year, an additional 45.49 miles and 1470 point features were mapped for a total of 630.7 miles and 16,239 point features.*** The City will continue to improve the accuracy of the MS4 inventory. An interactive map of the MS4 is available on the City's website at springfieldmo.gov/maps/index.html.

ACTIVITY 1.B: DEVELOP AND IMPLEMENT A PROGRAM FOR PERIODIC INSPECTIONS OF THE STORM WATER QUALITY CONTROL STRUCTURES.

This year, 23 maintenance activities to remove sediment and debris were completed on City-owned water quality control structures, which include detention basins and inlet separator units. The City also contracts with landscape professionals for vegetation maintenance on City-owned rain gardens and parking lot bioswales. The majority of the storm water quality control structures in the MS4 are privately owned. These structures are maintained by the property owner and are inspected on a complaint-basis.

TABLE 1: STORM WATER MANAGEMENT PROGRAM SUMMARY TABLE

Task	Required Schedule	Schedule Adhered	Activities Accomplished	Documentation and Comments
MS4 inventory	N/a	N/a	45.49 miles and 1470 point features mapped	Section 4.1, Activity 1.a
Inspections and cleaning of the MS4	Periodic/As needed	Yes	MS4 locations inspected 19,067 times and cleaned as needed; 23 maintenance activities on City BMPs; 25 Adopt-A-Stream cleanups collecting 29cy of trash	Section 4.1, Activities 1.b and 1.c; Section 4.10 Adopt-A-Stream
Street Cleaning	Existing schedule	Yes	1965 tons of street sweepings	Section 4.3, Activity 3.b
Dry-Weather Field Screening	50 points/year	No	48 points	Section 4.7, Activity 7.b
Wet-Weather Field Screening	25 samples/year (rainfall dependent)	No (due to rainfall; See Section 4.7)	17 samples	Section 4.7, Activity 7.b
Illicit Discharge Investigations	As needed	Yes	19	Section 4.7, Activity 7.d
Household Chemical Collection Center	N/a	N/a	626 customers; 31,135 lbs. collected; 72% recycled	Appendix
Infiltration/Inflow Program	N/a	N/a	11,613 lineal feet of sanitary sewer lines and 524 manholes rehabilitated; 4 CIPP repairs; 1,801 lineal feet winched	Section 4.7, Activity 7.g
Stream Monitoring	1 baseflow at 5 sites and 4 storm events at 12 sites (rainfall dependent)	No (due to rainfall; See Section 5.3)	51 samples (5 baseflow, 46 storm event)	Section 5.3; Appendix
Education	N/a	N/a	101 activities completed and over 2,500 brochures/flyers distributed (does not include Solid Waste Management education program)	Section 4.10

ACTIVITY 1.C: CONTINUE EXISTING MAINTENANCE PROGRAM BY PERIODIC COLLECTION AND REMOVAL OF FLOATABLES FROM THE MS4 TO THE MAXIMUM EXTENT PRACTICABLE (MEP).

The Bridge & Waterways Section of Public Works Street Maintenance routinely checks and removes debris from the MS4 during rain events. This scheduled maintenance activity consists of four route types of priority locations where debris tends to collect:

- Bridge route with 10 locations
- Sinkhole route with 12 locations
- Waterway routes, north and south, with 85 locations
- 12 grate routes with over 1700 locations

Maps of these routes were included in the first and second annual reports. The MS4 is also cleaned in response to citizen service requests. As part of these maintenance routes or in response to service requests, *MS4 locations were inspected 19,067 times and cleaned if needed.* This included 18,927 inspections of grate/inlet/pipe locations and 140 inspections of waterway/bridge/sinkhole locations. The number of inspections is tracked in the Public Works Street Maintenance work order system. The two monitoring locations designated for the removal of floatable materials as required in Part V.B. of the Permit are reported in Section 5.4.

4.2 NEW DEVELOPMENT AND SIGNIFICANT REDEVELOPMENT

ACTIVITY 2.A: THE CITY'S EXISTING WATER QUALITY PROTECTION POLICY REQUIRING STORM WATER BMPs FOR THE FULBRIGHT SPRING, PIERSON CREEK, AND SINKHOLE WATERSHEDS WILL CONTINUE AND CONSIDERATION WILL BE GIVEN TO INCLUDE ALL THE REMAINING AREAS OF THE CITY SERVED BY THE MS4.

DRAFT STORM WATER DESIGN CRITERIA

The City's Draft Storm Water Design Criteria manual expands water quality requirements city-wide for new developments, and also includes BMP design guidelines, criteria for protection of open channels, and BMP-specific maintenance guidelines. The water quality requirements for new developments were implemented city-wide in 2004-2005. The finalization of the Draft Stormwater Design Criteria Manual and adoption of ordinances necessary to implement it will be completed in coordination with requirements and timelines established in the City's reissued MS4 permit. It is anticipated that the MS4 permit will be reissued in 2012.

RUNOFF REDUCTION ON NEW DEVELOPMENTS

Although standards for runoff reduction have not been adopted, several new private developments have voluntarily included runoff reduction practices in their storm water design, typically to achieve storm water credits for LEED certification. As the Division considers runoff reduction standards to meet future anticipated MS4 permit requirements, information and lessons learned on these developments will be utilized to develop appropriate local standards.

4.3 ROADWAYS

ACTIVITY 3.A: REVIEW CURRENT DEICING PRACTICES, IMPLEMENTING CHANGES WHERE FEASIBLE TO MINIMIZE THE DISCHARGE OF POLLUTANTS TO THE MS4.

The Street Maintenance Division uses rock salt, liquid salt brine and liquid calcium chloride for deicing the City's streets. The City's current deicing practices emphasize providing safe driving conditions on municipal streets while also minimizing the potential for deicing materials to discharge into the MS4. These practices

CITY TREE PROGRAMS

Trees reduce storm water runoff through interception, evapotranspiration, and increased soil infiltration. On public grounds, parks, and rights-of-way, the City provides tree care and promotion of community forestry through programs and services provided by the Public Grounds Section of the Public Works Operations Division and the Springfield-Greene County Parks Department. This year, 411 trees were planted on public grounds and street rights-of-way, and 75 trees in city parks. In April 2011, the City received the Tree City USA designation from the National Arbor Day foundation for the 26th consecutive year. The Tree City USA Committee continued the "Tree Tag Project", funded by the MO Dept. of Conservation. Tags were placed on community trees to indicate the dollar value of the services that trees of various sizes and species provide. For more information, visit springfieldmo.gov/trees and thistreepays.org.

have been described in previous annual reports and continue to be followed. Stream monitoring results (Section 5.3) do show higher chloride levels during the months of February and March when snow events had occurred; however, all of the results met the acute water quality criterion for chloride.

ACTIVITY 3.B: THE CITY WILL CONTINUE ITS EXISTING STREET SWEEPING PROGRAM ON ALL CURB AND GUTTER STREETS, WHICH INCLUDES PROPER DISPOSAL OF THE STREET SWEEPINGS.

The Street Maintenance Division sweeps and cleans all curbed streets in the City on a rotating schedule with a total service inventory of 1293 curb miles. Collector and residential routes are normally cleaned every 4 weeks, and every 6 weeks during peak leaf season. During peak leaf season, the street sweepers also clean out ditches along the routes. Arterial roads are swept weekly. *This year the City's street sweepers collected 1,965 tons of street sweepings.* In addition, the Division routinely picks up debris such as tires, couches, appliances, and bags of trash that are left on the City's right-of-ways, as well as providing cleanup in response to spills, accidents and special events such as parades. The street sweeping schedule was accomplished this year with four to five full-time equipment operators. The Missouri Department of Transportation (MoDOT) sweeps and cleans state-maintained thoroughfares within the city limits.

ACTIVITY 3.C: THE CITY WILL REVIEW ITS CURRENT STREET DESIGN, CONSTRUCTION, AND MAINTENANCE REQUIREMENTS IN ENVIRONMENTALLY SENSITIVE AREAS; SUCH AS THOSE ADJACENT TO STREAMS, WETLANDS, AND FLOODPLAINS; AND INCORPORATE BMPs TO THE MEP.

The Stormwater Engineering Division works with the Traffic-Transportation Management and Transportation Engineering Divisions to identify opportunities to incorporate post-construction BMPs into the design of streetscapes and other street improvement projects. This year, the City's first green streetscape was completed on Park Central East and West (Figures 1 and 2, p.5). The project includes a 770 square-foot pervious pavement parking turnout that is designed to drain itself and an equivalent amount of sidewalk on Park Central West. On Park Central East, a 130 square foot rain garden collects runoff from 1,000 square feet of street pavement and 600 square feet of sidewalk. These BMPs were partially funded by a Water Quality Improvement Grant from James River Basin Partnership. The Divisions have also been working together on the design of the future East-West Arterial to include water quality basins to catch and filter runoff from the new roadway.

ACTIVITY 3.D: CONTINUE ROUTINE CLEANING OF GRATED INLETS, ROADWAY STORM WATER INLETS, AND CATCH BASINS.

The Bridge and Waterways Section of Public Works administers an established program of cleaning the MS4 during and after rain events. This program includes 12 grate routes covering over 1700 storm grates. The grate route work orders include instructions to clean all pipes and inlets along the route. Maps showing the locations of these routes were included in the first and second annual reports. Grates, inlets, and sub-inlet chambers (catch basins), as well as the rest of the MS4, are also cleaned as a result of citizen requests. As reported under Activity 1.c., 18,927 inspections of grates/inlets/pipes were made and debris removed if necessary.

4.4 FLOOD CONTROL PROJECTS

ACTIVITY 4.A: CONTINUE TO ASSESS THE IMPACTS ON THE WATER QUALITY OF RECEIVING WATERS FROM FLOOD MANAGEMENT PROJECTS USING PROCEDURES AND CRITERIA ESTABLISHED FOR STORM WATER GRANT APPLICATIONS.

The **CARDINAL TO SWALLOW STORMWATER IMPROVEMENT PROJECT** included two new culverts and a channel to reduce flooding in the neighborhood. The channel improvements included a stepped low-flow channel to reduce velocities and better mimic a natural waterway. Turf reinforcement mat was used to reduce erosion while allowing maximum contact with vegetation.

The **JONATHAN & DOVER STORMWATER IMPROVEMENT PROJECT** included several new curb inlets and a trench grate to reduce flooding in the intersection. The stormwater was piped to a natural grass-lined channel.

ACTIVITY 4.B: EVALUATE EXISTING MAJOR FLOOD CONTROL FACILITIES FOR RETROFITTING WITH STORM WATER QUALITY CONTROLS

As part of the **CARLETON/MCCANN STORMWATER IMPROVEMENT PROJECT**, two existing detention basins at Lakewood and Ash were retrofitted with gravel infiltration trenches in place of portions of the low flow concrete channels to promote infiltration. The project also included construction of a new detention basin that also has a gravel infiltration trench. The City will evaluate additional city-owned detention basins for retrofitting, with expected completion of evaluations by June 2013.

4.5 NON-PERMITTED MUNICIPAL WASTE MANAGEMENT FACILITIES

ACTIVITY 5.A: THE CITY WILL CONTINUE TO STUDY ITS MUNICIPAL WASTE MANAGEMENT FACILITIES AND DETERMINE IF ADDITIONAL BMPs ARE NEEDED TO CONTROL POLLUTANTS TO THE MS4 AND, IF SO, DEVELOP A SCHEDULE FOR IMPLEMENTATION.

There are no active landfills within the City limits. The Springfield Sanitary Landfill is located outside the city limits and is permitted by a separate permit. The City does operate two recycling collection centers and a Yardwaste Recycling Center (YRC) which also serves as a recycling collection center. The recyclable materials at the collection centers are contained in bins that do not have drains. Runoff from the YRC drains into the holding basin for the City's Southwest Wastewater Treatment Plant which is permitted by a separate permit. The City also operates a Household Chemical Collection Center (HCCC) and handles street sweepings at its Public Works Operations Center (PWOC). A Stormwater Pollution Prevention Plan, including staff training and a schedule for regular inspections, will be completed by June 2012 for the HCCC and PWOC.

FLOODPLAIN ACQUISITION PROGRAM

Through its voluntary Floodplain Acquisition Program, the City acquires developed and undeveloped floodplain and sinkhole property as well as other flood-prone properties for riparian preservation and storm water capital improvement projects. The City has utilized approximately \$14.9 million for this program since 1993. The community has benefited in terms of flood control, wildlife habitat, recreational opportunities, green space and enhanced water quality as a result of this program. This year the following acquisitions were made:

- 2 flood-prone residential properties (W. Chestnut and E. Edgewood)
- 1 undeveloped parcel in the floodplain of Upper Wilsons Creek
- 1 residential property along Fassnight Creek

ACTIVITY 5.B: ESTABLISH, AS PART OF THE FIELD SCREENING PROGRAM, A MONITORING AND INSPECTION PROGRAM FOR MUNICIPAL WASTE MANAGEMENT FACILITIES.

As explained in Activity 5.a., a Stormwater Pollution Prevention Plan, including staff training and a schedule for regular inspections, will be completed by June 2012 for the HCCC and PWOC.

4.6 PESTICIDES, HERBICIDES, AND FERTILIZERS

ACTIVITY 6.A: CONTINUATION OF PUBLIC EDUCATION PROGRAM TO PROMOTE THE PROPER USE, HANDLING, STORAGE, AND DISPOSAL OF PHFS THROUGH THE INTEGRATED SOLID WASTE MANAGEMENT SYSTEM.

The Show-Me Yards & Neighborhoods program and the Household Chemical Collection Center (HCCC) are promoted through presentations and displays at community events, tours, informational materials, and via the City's website as detailed in Section 4.10. *The HCCC served 626 customers and received 31,135 lbs of material this year.*

ACTIVITY 6.B: REVIEW MUNICIPAL USAGE OF PHFS ON PUBLIC PROPERTIES AND RIGHTS-OF-WAYS TO DETERMINE THE EFFECTIVENESS AND FEASIBILITY OF USING ALTERNATIVES TO PHFS

The City continues to look for opportunities to use alternatives to PHFs; however, prior and current fiscal year operating budgets did not facilitate making changes to current programs.

4.7 ILLICIT DISCHARGES AND IMPROPER DISPOSAL

ACTIVITY 7.A: THE CITY WILL DEVELOP STANDARD PROCEDURES FOR INVESTIGATION OF REPORTS OF ILLICIT DISCHARGES AND FOR ENFORCEMENT TO PREVENT SUCH DISCHARGES.

The Stormwater Engineering Division conducts investigation of illicit discharges and enforcement to prevent such discharges. Investigation is conducted in cooperation with the City's Clean Water Services Division and/or the Missouri Department of Natural Resources when necessary. The assistance of the Emergency Spill Response Team of the Springfield Fire Department is also utilized when necessary for hazardous materials spill response. The standard procedures previously reported continue to be followed.

ACTIVITY 7.B: DEVELOPMENT AND IMPLEMENTATION OF A FIELD SCREENING PROGRAM.

DRY-WEATHER SCREENING

Dry-weather screening was completed at 48 points. The remaining 2 of 50 points were not completed due to a staff miscommunication. Of the 48 points screened, 2 had flow. The field screening results are shown in Table 2. The flow at these two locations would be from the same source; site 224 is approximately ¼-mile downstream in the drainage system from site 128. In 2004, this site had flow which was found to be a potable water main leak that was fixed. The source of the current flow will be investigated.

TABLE 2: DRY-WEATHER SCREENING RESULTS

ID	Location	Date	Flow (cfs)	Phenol (mg/l)	Chlorine (mg/l)	Copper (mg/l)	Detergent (mg/l)
128	2550 W Chestnut St	6/28/11	0.4	0.3	0.8	0	0.5
224	NW Corner College & Scenic	6/28/11	0.5	0.2	0.8	0	0.5

WET-WEATHER SCREENING

Wet weather samples were collected at 17 locations. There are a number of factors that can affect whether or not 25 locations are sampled annually as required by the permit. Rain events must meet the criteria of 0.2" to 3" occurring within a 24-hour period preceded by at least 72 hours of no precipitation greater than 0.1". Sometimes events that do meet these criteria occur during the overnight hours such that no runoff is left to be sampled the following morning. The number of samples that can be collected per event is limited by the timing, intensity, and duration of the event. Due to these factors, 17 out of 25 locations were sampled. The sampling results are included in the Appendix. The MS4 Permit does not contain specific requirements on how to evaluate sample results to determine if pollutant loadings are indicative of illicit discharges that warrant further investigation and enforcement measures. Because the sampling is focused on industrial discharges, the evaluation is generally based on the effluent limitations used in MDNR NPDES industrial permits, the benchmarks in EPA's Multi-Sector General Permit, and best professional judgment. The following is a summary of sampling results of concern.

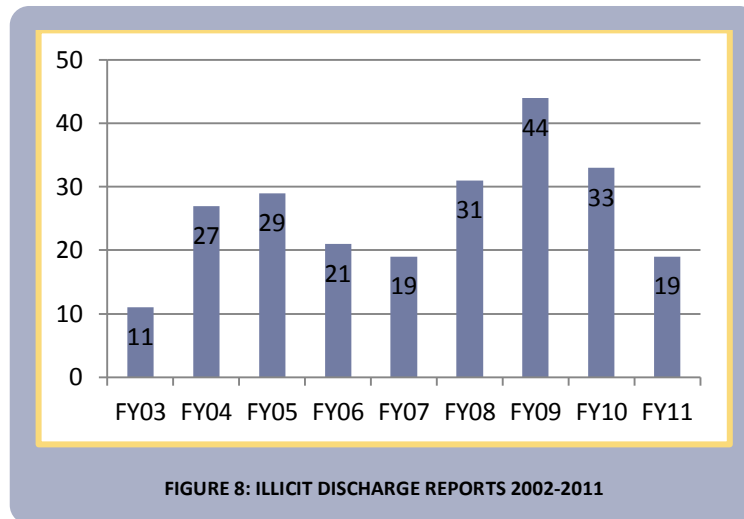
- Site 288 – Samples were taken of the flow going in and coming out of the inlet separator unit at the City's Public Works Operations Center. The inflow had elevated COD and TSS and the outflow had elevated TSS. As indicated in Activities 5.A. and 5.B, a Stormwater Pollution Prevention Plan will be completed for this facility by June 2012.
- Sites 289, 290, 274, and 282 – These sampling points are discharges from scrap metal recycling operations. The sampling results show high levels of several pollutants of concern, including COD, TSS, and metals. The City has previously conducted inspections and issued enforcement letters requiring BMPs at these facilities. Additional BMPs have been installed as required and these facilities will continue to be inspected.
- Site 126 – This site is Upper Wilsons Creek which contains site 289 in its watershed as well as other industrial facilities. Inspection and enforcement for pollutant sources in this watershed is a high priority.
- Site 278 – This site is a drainageway/detention area that contains site 282 in its watershed as well as a major arterial. Site 282 is likely contributing the majority of the pollutant loading at this location which is being addressed with ongoing inspections and enforcement at that facility.

COAL-TAR PAVEMENT SEALANTS

Peer-reviewed studies by the USGS and others have shown that coal-tar based pavement sealant typically used to seal parking lots and driveways is a significant source of Polycyclic Aromatic Hydrocarbons (PAHs) in sediment samples from lakes and streams in other areas of the country. Based on these studies, several municipalities have banned its use. The Springfield-Greene County Environmental Advisory Board brought this issue to the attention of Springfield City Council who held several meetings to hear expert testimony and discuss the issue. Although the Council has not formally considered a ban and did not pass a proposed resolution in December 2010, it has been an educational process for city officials and the community. Additionally, the City has contracted with Missouri State University to do a study of sediment PAH levels in local waterways which is expected to be completed in spring 2012. For more information, visit springfieldmo.gov/stormwater.

ACTIVITY 7.C. (1): THE PERMITTEE SHALL DEVELOP AND IMPLEMENT STANDARD PROCEDURES TO INVESTIGATE PORTIONS OF THE MS4 WHEN ILLICIT DISCHARGES ARE DISCOVERED OR REPORTED.

Standard procedures for investigation of the MS4 when illicit discharges are discovered or reported continue to be followed as implemented in year three and documented in the year three annual report. *The Stormwater Engineering Division investigated 19 illicit discharge reports this year.* This does not include complaints received for erosion and sediment control on construction sites which are reported under Activity 9.a. A program to educate the public to report illicit discharges continues to be implemented as summarized in Activity 7.e.



ACTIVITY 7.C. (2): THE PERMITTEE SHALL DEVELOP AND FOLLOW LEGALLY SOUND PROCEDURES IN PURSUING INVESTIGATIONS ON NON-STORM WATER DISCHARGES, SUCH AS GUIDELINES FOR ENTRY, INVESTIGATIONS OF PRIVATE PROPERTY, NOTIFICATION PROTOCOLS, AND DOCUMENTATION.

City Code Sections 96-31 through 96-36 provide legal authority and procedures that are being followed for entry and investigations of private property, notification protocols, and documentation.

ACTIVITY 7.D: CONTINUE OPERATION OF THE EMERGENCY SPILL RESPONSE TEAM.

The City of Springfield Fire Department continues to respond to spills and other situations in accordance with their standard operating procedures to assist with containment and cleanup to minimize the discharge of pollutants to the MS4.

ACTIVITY 7.E: DEVELOP AND IMPLEMENT A PROGRAM THAT INFORMS THE PUBLIC ON HOW TO REPORT SPILLS, ILLEGAL DUMPING, ILLICIT CONNECTIONS AND WATER QUALITY PROBLEMS. THE PROGRAM SHALL PROVIDE THE PUBLIC INFORMATION AS TO WHAT TO LOOK FOR AND HOW TO REPORT INCIDENTS.

The City continues to administer a public education program on pollution reporting. Pollution reporting information is posted on the Stormwater Engineering Division's website and included in the Division's primary educational brochure and other handouts. This information is distributed via displays at community events, presentations, and informational materials as summarized in Section 4.10.

ACTIVITY 7.F: CONTINUE PROGRAM THAT INFORMS THE PUBLIC ON PROPER MANAGEMENT AND DISPOSAL OF USED OIL AND TOXIC MATERIALS.

The City's Household Chemical Collection Center (HCCC) is available to Springfield and Greene County residents for proper disposal of used oil and other household chemicals. *The HCCC served 626 customers and received 31,135 lbs of material this year.* The City also produces *A Guide to Recycling in Springfield* that lists several area retailers that accept used oil and other recyclable toxic materials. This guide is available at springfieldmo.gov/recycling. Public education on these topics is provided annually through presentations and displays at community events, tours, distribution of informational materials, and via the City's website as reported in Section 4.10.

ACTIVITY 7.G: IMPLEMENT PROGRAM TO REDUCE OR ELIMINATE TO THE EXTENT PRACTICABLE THE INFLOW, INFILTRATION AND DISCHARGE OF SANITARY SEWAGE INTO THE MS4.

SANITARY SEWER INFILTRATION AND INFLOW (I/I) PROGRAM

Efforts are ongoing to address I/I in the sanitary sewer public infrastructure. *This year 11,613 lineal feet of sanitary sewer lines and 524 manholes were rehabilitated.* Also, 4 cured in place pipe (CIPP) point repairs were done, and 1,801 lineal feet of sanitary sewer trunk lines were winched to restore capacity in the pipe.

FOG MANAGEMENT PROGRAM

The Fats, Oils and Grease (FOG) management program was implemented in 2009. FOG in sanitary sewer lines can cause sanitary sewer overflows. Food Service Establishments (FSE's) are inspected and issued permits that require a maintenance and clean-out schedule for the grease interceptors that serve these facilities. Approximately 410 FSE's have been permitted. Enforcement is conducted to address FSE's that are non-compliant with their maintenance and clean-out schedule. City staff have been able to reduce the frequency of cleaning of some sanitary sewer lines where FOG accumulation has been a problem, indicating that the program has resulted in some reductions in the amount of FOG entering the sanitary sewer.

4.8 INDUSTRIAL AND HIGH RISK RUNOFF

ACTIVITY 8.A: THE CITY WILL DEVELOP A PROGRAM TO IDENTIFY THE FOLLOWING INDUSTRIES THAT DISCHARGE TO THE MS4: (1) MUNICIPAL LANDFILLS (2) HAZARDOUS WASTE TREATMENT, STORAGE AND DISPOSAL FACILITIES (3) INDUSTRIES SUBJECT TO REPORTING REQUIREMENTS PURSUANT TO SARA TITLE III SECTION 313; AND (4) INDUSTRIAL FACILITIES THAT THE CITY DETERMINES ARE CONTRIBUTING A SUBSTANTIAL LOADING OF POLLUTANTS TO THE MS4.

The City has identified the industry categories listed above as follows:

1. There are no active municipal landfills within the City limits.
2. The list of hazardous waste treatment, storage and disposal (TSD) facilities is updated annually from the Missouri Department of Natural Resources website (dnr.mo.gov).
3. A list of industries discharging to the MS4 that report under SARA Title III Section 313 is updated annually from the Toxic Release Inventory (TRI) on the Environmental Protection Agency's website at epa.gov/triexplorer.
4. Wet-weather screening data collected under Activity 7.b. in previous years and this year indicate that motor vehicle salvage/scrap metal recycling operations are contributing a substantial loading of pollutants to the MS4. Inspections and enforcement measures for these facilities are ongoing as reported under Activity 8.b.

ACTIVITY 8.B: DEVELOP A SELF-MONITORING PROGRAM FOR FACILITIES IDENTIFIED IN 8.A ABOVE. THIS MONITORING PROGRAM WILL INCLUDE THE COLLECTION OF QUANTITATIVE DATA ON ANY POLLUTANTS LIMITED IN AN EXISTING NPDES PERMIT FOR AN IDENTIFIED FACILITY.

In previous years, the facilities identified in 8.A have been inspected, some of them multiple times. As additional facilities are identified, they will be prioritized for inspection. Re-inspections will also be completed as needed for facilities at which enforcement measures are ongoing. Copies of discharge monitoring reports continue to be collected from facilities required by MDNR to conduct self-monitoring under an NPDES permit.

4.9 CONSTRUCTION SITE RUNOFF

ACTIVITY 9.A: CONTINUE CURRENT EROSION AND SEDIMENT CONTROL REGULATIONS FOR LAND DISTURBANCE ACTIVITIES FOR AREAS LESS THAN FIVE ACRES.

The Land Disturbance Permit Program requires a land disturbance permit from the City for construction activities that disturb one acre or greater and for smaller sites near valuable water resources. A Storm Water Pollution Prevention Plan (SWPPP) is required to be submitted and approved before a permit is issued. Other key components of the program include a permit fee and security requirement, required inspections by City staff of initial BMP installation and post-construction stabilization, permittee self-inspections and reporting, a progressive enforcement policy, and an extensive education and training program which is detailed under Activity 9.c. The program has two full-time employees. *This year, 43 land disturbance permits were issued.* A total of 271 meetings and inspections were completed on permitted sites which included the pre-construction meetings, initial BMP inspections, and post-construction inspections, as well as spot inspections completed as part of the inspector's routine daily activities. In addition, 7 complaint-based inspections were completed on sites that did not require a permit.

ACTIVITY 9.B: CONTINUE TO REQUIRE LAND DISTURBANCE PERMITS FROM THE MDNR FOR SITES OF FIVE OR MORE ACRES.

The City has a cooperative agreement with the MDNR Southwest Regional Office that allows applicants for a City Land Disturbance Permit to submit a Conditional Letter of Approval from the City to the MDNR office to receive their MDNR permit. The City requires that the MDNR permit has been obtained before issuing a City permit. Public Works maintains a MOR100 land disturbance permit issued by MDNR for all Public Works construction projects with land disturbance of 1 acre or more as required. The City submits a quarterly activity report to MDNR detailing the status of these Public Works construction projects.

ACTIVITY 9.C: PROVIDE INFORMATION FOR EDUCATION OF CONSTRUCTION SITE OPERATORS.

The City provides information and training for construction site operators and SWPPP designers to assist them in meeting land disturbance permit requirements. Information and handouts are provided via pre-application and pre-construction meetings, construction site inspections, and the Stormwater Engineering Division's website at springfieldmo.gov/stormwater/esc. An annual training opportunity is also provided. This year, a workshop was held on December 8, 2010 in partnership with Watershed Committee of the Ozarks, MDNR and local MS4 Phase II communities. The workshop provided an overview of local land disturbance programs and information on maintaining compliance.

To expand upon existing educational materials, and address specific issues, several new documents were developed this year. A series of informational brochures were created, each covering a unique aspect of sediment and erosion control. Topics include the City's permitting process, erosion control for small sites (<1 acre) and best management practices for masonry and concrete projects (Figure 9). To address issues with Land Disturbance Permit termination, including expired permits and failing post-construction inspections, a system was created wherein developers are sent notifications 90 days and 30 days from permit expiration. This notification is in the form of an informational brochure detailing the requirements that must be met before termination. This brochure includes a perforated "Request for Termination of a Land Disturbance Permit" form, which can be filled out, torn off, and mailed back to the City.

The following is a complete list of handouts that have been developed and are available on the website:

- Erosion Prevention and Sediment Control Guidelines BMP manual
- Erosion and Sediment Control brochure
- How to Maintain Your SWPPP
- Masonry and Concrete Projects brochure
- Small Site brochure
- Construction and Demolition Waste Management brochure
- Land Disturbance Inspection Checklist and Companion Guide
- SWPPP Template
- SWPPP Checklist
- Land Disturbance Permit Issuance Checklist
- Terminating Your Land Disturbance Permit brochure

4.10 PUBLIC EDUCATION/OUTREACH AND INVOLVEMENT

Public education/outreach and involvement on storm water issues is provided through a variety of programs and projects as well as displays and presentations at community events, media and publications opportunities, and presentations, workshops and information packets for area citizens. In addition to the activities of Stormwater Engineering and Solid Waste Management staff, the City has outstanding partners that help provide public education/outreach and involvement. These partners are part of a larger network of organizations, agencies, and institutions that provide environmental/conservation education for the region. Every year an education summit is coordinated by City staff in the Solid Waste Management Division as part of Springfield-Greene County *Choose Environmental Excellence* to bring this network of formal and non-formal educators together to discuss education issues and collaborate on projects.

The City's partners include [WATERSHED COMMITTEE OF THE OZARKS \(WCO\)](#), and [JAMES RIVER BASIN PARTNERSHIP \(JRBP\)](#), as well as the [MISSOURI DEPARTMENT OF CONSERVATION \(MDC\)](#) and others. The City provides funding support to WCO for education/outreach services. The City works very closely with JRBP on the rain barrel program, rain garden implementation, and other projects. This report does not include all of the many projects and activities by these two groups, which are vital components of the overall advancement of education



FIGURE 9: NEW LAND DISTURBANCE PROGRAM BROCHURE

on storm water and water quality issues in the area. According to their 2010 Annual Report, WCO alone reached over 14,000 individuals. The City also continued its partnership with Missouri State University, Greene County, and WCO to jointly-fund a full-time position that serves half-time as **PROJECT WET** (Water Education for Teachers) State Coordinator and half-time as a storm water educator to facilitate storm water education in schools through education activities, teacher training and curriculum development. The Project WET State Coordinator position and the WCO Education Coordinator conducted the majority of the 28 classroom lessons and 25 field trips provided for students this year, with assistance from other staff and volunteers.

The following are activities completed that provided education specifically targeting the topics of storm water, watersheds, and an overall understanding of water quality impacts and indicators in our streams and lakes.

- 14 media exposures
- 8 presentations to community groups (rain gardens, rain barrels and other storm water/water quality topics)
- 15 educational booths at community events
- 28 classroom lessons and activities with students (K-College)
- 25 field trips to the Watershed Center at Valley Water Mill and other locations for students (K – College)
- 11 field trips/tours for adults
- Over 2,500 storm water educational brochures/flyers provided for classroom lessons, community groups and event displays, topics including storm water and watershed basics, rain gardens, rain barrels, pollution reporting, environmentally-friendly yardcare and fertilizer use, pet waste, trees, low impact development, and storm water booklets for kids.

In addition to these activities, the City's Integrated Solid Waste Management Program has a very comprehensive education program. Many of their education activities also include an emphasis on storm water/water quality. For instance, tours and presentations on the Household Chemical Collection Center include an emphasis on how proper disposal helps to protect water quality. Their booths at community events and packets of information distributed to citizens often include stormwater educational materials as well as materials on Show-Me Yards & Neighborhoods, an excellent program on environmentally-friendly yard care that is primarily coordinated by Solid Waste. The following activities were completed by the Solid Waste staff this year:

- 137 tours, presentations, and events
- 4,964 packets totaling an estimated 59,000 brochures/handouts and an additional estimated 38,000 handouts distributed at community events
- 28 media exposures

WATERSHED CENTER

WCO has been working for several years on the development of The Watershed Center at Valley Water Mill as an education and demonstration site for storm water best management practices and a destination for field trips and community events to learn about water. The park has several unique natural hydrologic and geologic features with learning stations and educational signage. Construction has been completed on the C.W. Titus Watershed Center Education Building at the park. It is designed to be a LEED Certified Gold building and will house education staff and provide a facility for learning and events at the park. For more information, visit watershedcommittee.org.

STORM DRAIN REVEAL

A new education project was launched this year with James River Basin Partnership called Storm Drain Reveal. Artists were invited to submit designs for storm drain murals to educate the public about stormwater. JRBP and the City selected the top 10 designs and the selected artists painted their murals on storm drains in downtown Springfield. Photographs of the completed storm drain murals along with stormwater education information were featured at the Canvas Art Gallery for the downtown First Friday Art Walk in May (Figure 10), one of the most attended Walks of the year. They were also displayed for two days at the annual Artsfest in May which is attended by 15,000 – 20,000 people. During Artsfest and Art Walk, the public had the opportunity to vote for their favorite mural. The “People’s Choice” winner received a cash prize and was recognized at a City Council luncheon. The following quote from the People’s Choice winner, Brad Davenport, expresses the educational value of the project for the artists themselves and the general public.

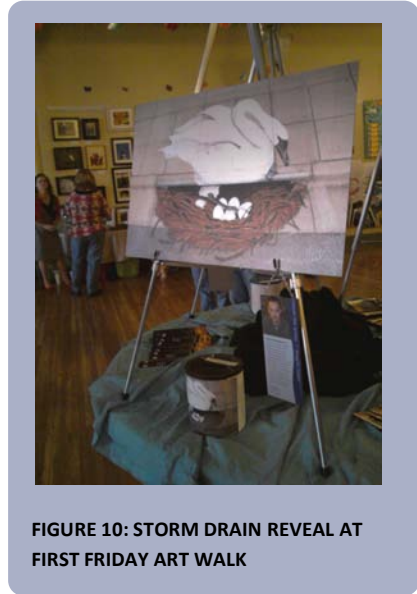


FIGURE 10: STORM DRAIN REVEAL AT FIRST FRIDAY ART WALK

“To be honest when the project was brought to my attention I knew very little about what happens to water once it enters a storm drain. I don’t think I ever really took the time to think about it. However, once I was made aware, being a person who enjoys floating and trips to the lake with friends and family during the summer, I felt this was my chance to help and possibly make a difference. The project has been successful in bringing awareness to the public, which hopefully will make people think before they throw trash out a car window or dump chemicals in the street.” –Brad Davenport

Following these events, the photographs were on display for several months at local coffee shops. Two press releases, one announcing the project and one for the People’s Choice winner, resulted in multiple media stories. The project was also featured on the City website and JRBP’s website, newsletter, and social media. Additionally, the project attracted national attention including coverage in stormwater and paint industry publications, and inquiries from other cities about how to implement this type of project. The educational brochure created for the project continues to be distributed at community events. It is expected that the murals will last for several years, serving as visual reminders to the public about the connection between storm drains and waterways.

RAIN BARRELS

The City and JRBP continued the rain barrel program this year, including the \$25 instant rebate per barrel funded by the City of Springfield Public Works Department, Greene County Resource Management, and City Utilities. JRBP sells the barrels at two local retailers, Wickman’s Garden Village and Habitat for Humanity ReStore. This year, 89 barrels were sold, for a grand total of 1190 barrels sold since the program began in January 2007.

RAIN GARDENS

This year, rain gardens were featured along with other stormwater information in presentations to college classes and area conferences. Rain garden information was also distributed via displays at community events. The City partnered with JRBP, WCO, and MDC to create a new rain garden brochure for use in rain garden education activities (Figure 11). The brochure provides how-to information, plant selections, and a list of local demonstration projects, and is used by all partners when promoting rain gardens in the community. Many of the rain garden demonstration projects also have signage to educate viewers about the purpose of a rain garden. Most recently, a rain garden sign was designed for the rain garden constructed as part of the Park Central East streetscape (see p.5).

STREAM CLEANUPS

A total of 25 cleanups were completed by Adopt-A-Stream program participants and other volunteers, collecting 260 bags of trash (estimated at 29 cubic yards). JRBP also held a volunteer cleanup event at Lake Springfield on Earth Day as well as their annual River Rescue cleanup. River Rescue is a very popular river cleanup and fundraising event that provides citizens of Springfield and the surrounding area an opportunity to participate in helping to keep our rivers clean.

WEBSITES

The City continues to maintain and improve the following webpages that provide information related to components of the City's SWMP. The number of visits to each website this year is shown in parentheses.

- springfieldmo.gov/stormwater - Storm Water Services Division of Public Works (8,364 visits)
- springfieldmo.gov/recycling - Solid Waste Management Division of Public Works (19,555 visits)
- springfieldmo.gov/showmeyards - Show-Me Yards & Neighborhoods (see CEE below)
- springfieldmo.gov/cee - Springfield-Greene County Choose Environmental Excellence (371 visits for CEE and SMY&N)
- ozarksenvironment.com - A clearinghouse for environmental information (1,733 visits)



FIGURE 11: NEW RAIN GARDEN BROCHURE

5.0 MONITORING PROGRAM

5.1 KNOWN MAJOR OUTFALLS

An updated list of 90 known major outfalls was included in last year's annual report.

5.2 TOTAL ANNUAL RUNOFF VOLUME

The total annual volume of urban runoff discharges for the City for this year is estimated at over 18.5 billion gallons. The spreadsheet used to calculate this estimate is included in the Appendix. The calculation is based on an **average total precipitation of 48.59"** according to three of the City's rain gages located in the northern, middle, and southern parts of the city (Disney, Sunshine, and Williams). To calculate the annual runoff volume, the individual precipitation events that occurred throughout the year at these three rain gauges were categorized by precipitation amount. The runoff volumes for categories 5 and 6 were calculated using the SCS Runoff Curve Number method.

Using the SCS Curve Number method, the precipitation amount for categories 1-3 is not great enough to overcome the calculated infiltration loss, resulting in a runoff volume of zero. However, experience dictates that these small rainfall events do in fact create a substantial amount of runoff, which is largely due to the amount of directly connected impervious area within the watershed. Therefore, a more accurate estimate for these categories can be obtained by assuming that directly connected impervious area is the sole source of runoff from precipitation events in these categories. The area within the City limits is estimated to be 30% impervious. It is estimated that half of the impervious area (15% of the City limits), equaling 7,604 acres, is directly connected. The runoff volume for these categories is estimated by multiplying the precipitation amount by 7,604 acres. For category 4, the calculation of runoff using the SCS Curve Number method results in a volume less than the calculated volume for category 3. Therefore, the runoff volume for category 4 was calculated with the same method used for categories 1-3.

5.3 MONITORING PROGRAM SUMMARY

The monitoring program includes storm event sampling 4 times per year at 12 in-stream sites and base flow sampling once per year at 5 in-stream sites (the remainder of the 12 in-stream sites do not sustain baseflow). These are grab samples and are, accordingly, limited in their ability to represent the broader water quality of the stream. The City contracts with the Ozarks Environmental and Water Resources Institute (OEWRI) at Missouri State University to conduct sample collection and delivery to the laboratory. Samples are analyzed at the City's Wastewater Laboratory at the Southwest Wastewater Treatment Plant. Sample collection and analysis are conducted as specified in the Quality Assurance Project Plan (QAPP) developed for the program.

A total of 46 first flush storm event grab samples and 5 baseflow grab samples were collected. The first flush storm event samples are not representative of storm water contributions over the entire storm event. Rather than an event mean concentration, the first flush samples are taken as one way to try to assess potential stormwater runoff influences on in-stream water quality conditions. These pollutant concentrations are short-term and not suitable for direct comparison with most water quality criteria. For example, most water quality criteria are expressed in terms of hourly (acute) or four day (chronic) exposures. Four storm event samples were collected at all sites except Valley Water Mill. No storm events met the rainfall criteria and generated ample stage to fill the samplers for summer and winter at that site. The winter runoff sampling event for Spring Branch, Grandview, Jones Branch, Galloway, South Creek, and Jordan Creek was a snowmelt event (2/14/11).

Based on multiple years of data, *Jordan Creek and Ravenwood Branch are priority watersheds for further investigation and potential BMP implementation*. Runoff samples collected at these streams exhibited the highest levels of nutrients and total suspended solids (TSS) as well as high *E. coli*. Ravenwood Branch samples also contained the highest copper and zinc levels. The probable source of high TSS as well as one possible source of nutrients in Ravenwood Branch is severe stream channel erosion. Channel stabilization of Ravenwood Branch is on the priority list for future stormwater funding initiatives. Several projects are ongoing or on the priority list for the Jordan Creek watershed in conjunction with the Jordan Creek Feasibility Study and West Meadows projects (see sidebar). The Jordan Creek watershed has also been targeted for BMP implementation with a Section 319 Nonpoint Source Pollution Grant received by Watershed Committee of the Ozarks in May 2011, for which the City is providing significant matching funds and in-kind assistance. For more information on that grant, visit www.bigurbie.org.

STORM EVENT DATA

The storm event data for each sampled storm event are reported as specified under Part V.A.2 of the Permit. The City has a network of 20 real-time rain gages located throughout the City. Rainfall data from one or more rain gages in each of the sampled watersheds were used. If more than one gage was used, an average rainfall total was calculated. The total discharge volume at each sampling location for each sampled storm event was estimated using the SCS Runoff Curve Number method outlined in Section 5.2. Runoff from directly connected areas and unconnected areas were calculated separately and summed to account for runoff from directly connected areas during small rain events. The storm event data and estimated total discharge volumes are included in the Appendix. Reported discharge volumes are the best estimates we are able to derive using our best professional judgment at this time. However, they remain gross estimates as flows were not directly measured.

NITROGEN AND PHOSPHORUS

Figures 12-15 show the geometric means and ranges of the TP and TN first flush data collected since 2009, as well as baseflow data collected since 2002. Neither TP nor TN shows a strong correlation with TSS, although TP has a stronger correlation than TN (Figure 19). There were some individual grab sample results this year that appear to be outliers. These instantaneous grab sample results have very limited applicability to the water quality criteria of concern, since nutrient criteria and targets are typically considered long-term averages (e.g. multi-year geometric means). The 4/11/11 Galloway Creek result for TP (6.51 mg/L) appears to be an outlier.

JORDAN CREEK FEASIBILITY STUDY

The City contributed 528 hours towards this ongoing study this year. The US Army Corps of Engineers began this feasibility study in 2004 to identify cost-effective alternatives to mitigate long-standing flooding concerns and advance environmental restoration along Jordan Creek. The City is assisting the Corps through a 50/50 cost share agreement with local matching funds and in-kind tasks. The cost of the study is \$3 million and is expected to be completed by the Corps in 2013.

BROWNFIELDS

The City has an award-winning Brownfields Program that works to assess, clean up, and facilitate the redevelopment/reuse of brownfields properties. The City has obtained over \$3.9 million in EPA brownfields grants since 1999, including \$600,000 this year to continue and fully complete the cleanup of the Jordan Valley West Meadows. Cleanup of sites 1-4 was completed this year, removing 45,000 tons of contaminated soil and creating an estimated 23,000 cubic meters of additional floodplain storage and two pocket wetlands. For more information, visit springfieldmo.gov/brownfields.

Jordan Creek showed relatively high results for TN (11.81 mg/l) on 4/11/11, which appeared correlated with high TSS (1842 mg/l). Spring Branch and Valley Water Mill each had a relatively high TN result also at 9.21 (6/28/10) and 9.04 (9/2/10) respectively. Ravenwood Branch had an extremely high result for TN (36.84 mg/l) on 9/2/10. While this value is suspiciously high with respect to potential laboratory error, this observation warrants further investigation, such as review of laboratory quality assurance metrics, timing of residential fertilizer application with respect to rainfall, and collection of additional wet weather data at this location.

E. COLI BACTERIA

Figures 16-17 show the geometric means and ranges for all *E. coli* data collected for each site since 2009. The *E. coli* results for the 2/14/11 snowmelt event are not included in the first flush geometric means because these results are outliers more similar to the lower levels of *E. coli* seen during baseflow conditions. These data primarily represent wet weather conditions due to the monitoring system design. These data should be used to prioritize areas for further investigation rather than comparison to water quality criteria, which are long-term averages (recreational season geometric means) and are based upon steady-state conditions.

TOTAL SUSPENDED SOLIDS

Jordan Creek showed elevated TSS for three out of four storm events and had the two highest values out of all the sampling results (912 mg/l on 9/24/10 and 1842 mg/l on 4/11/11). Galloway Creek also exhibited elevated TSS (512 mg/l) on the 4/11/11 stormflow event. Spring Branch had elevated TSS (800 mg/l) on 6/28/10. Pea Ridge Creek, Ravenwood Branch, and Ward Branch also exhibited elevated TSS (>400 mg/l) for one stormflow event each, but none of these results correlated with a particular storm event. Figure 18 shows the geometric means for the first flush TSS data collected since 2009 and baseflow data collected since 2002. Figure 19 compares TSS with TP and TN, showing that TSS may be a source of TP although the correlation is not strong.

METALS

Metals results are not at levels of concern, with the exception of Ravenwood Branch. When compared to acute water quality criteria (which are hardness dependent), the zinc result on 9/2/10 (68.5µg/l with acute standard of 65µg/l) and the copper results on 9/2/10 (16.8µg/l with acute standard of 7µg/l) and 10/12/10 (7.8µg/l with acute standard of 7µg/l) warrant further investigation, although they may be outliers due to sampling or analytical problems as they are elevated for what we would expect to find for in-stream results. This location also had one elevated copper result last year on 7/30/09 (11.1µg/l with acute standard of 7µg/l). This watershed is residential with no known history of industrial uses that would typically be associated with heavy metals of these magnitudes.

CHLORIDE

Individual grab sample chloride results ranged from 1.7-358.9 mg/l. For comparison, the acute water quality criterion for chloride is 860mg/l for Protection of Aquatic Life, indicating that these instantaneous grab sample values are not at levels of concern.

SPECIFIC CONDUCTIVITY

With the exception of Galloway Creek, baseflow samples had consistently higher specific conductivity than stormflow samples per site this year (as in previous years), suggesting that baseflow is more characterized by dissolved materials which become diluted during stormflow.

OIL AND GREASE

All of the results were below the method detection limit of 10mg/l which is also the water quality criterion for Protection of Aquatic Life.

CYANIDE

All of the results were below the method detection limit of 0.005 mg/l, which is well below the acute water quality criterion of 0.022 mg/l.

MICROTOX

All of the results were nontoxic for Microtox® toxicity.

PESTICIDES AND ORGANICS

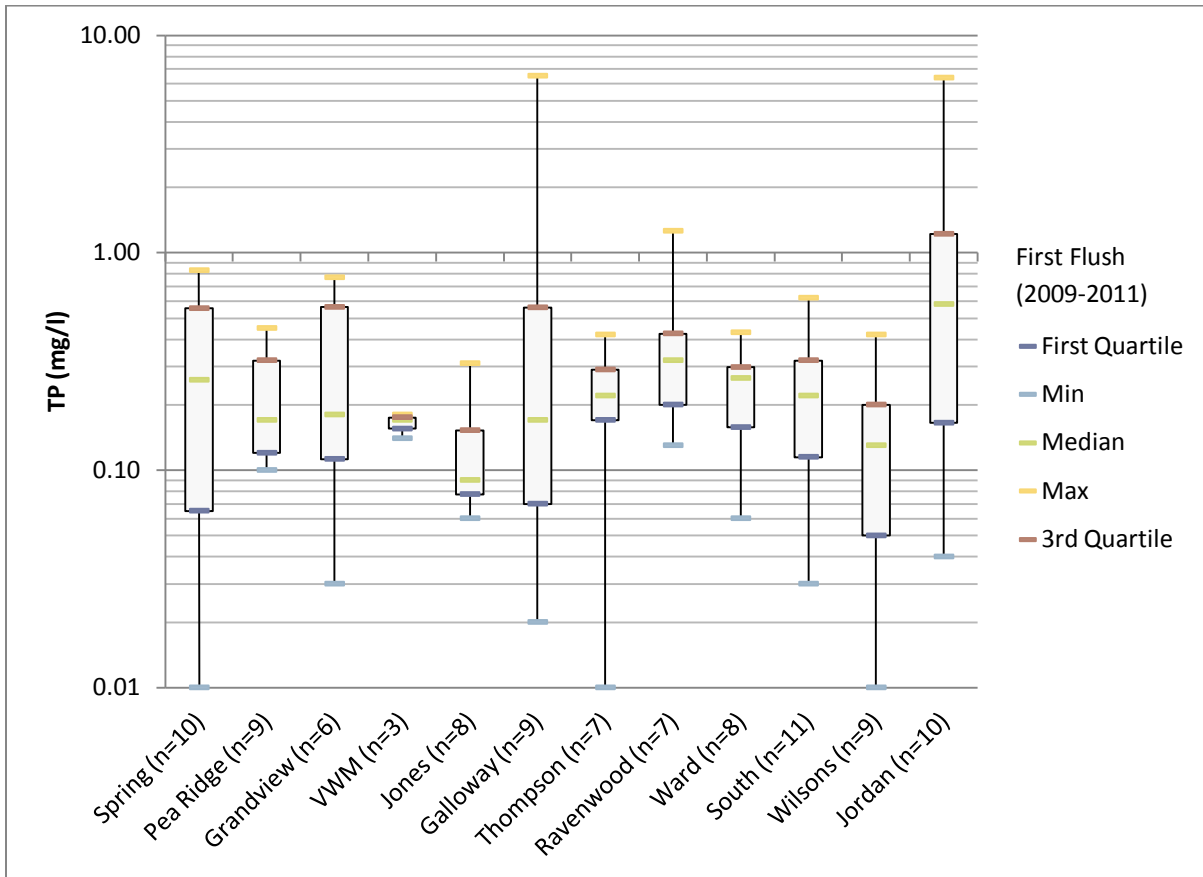
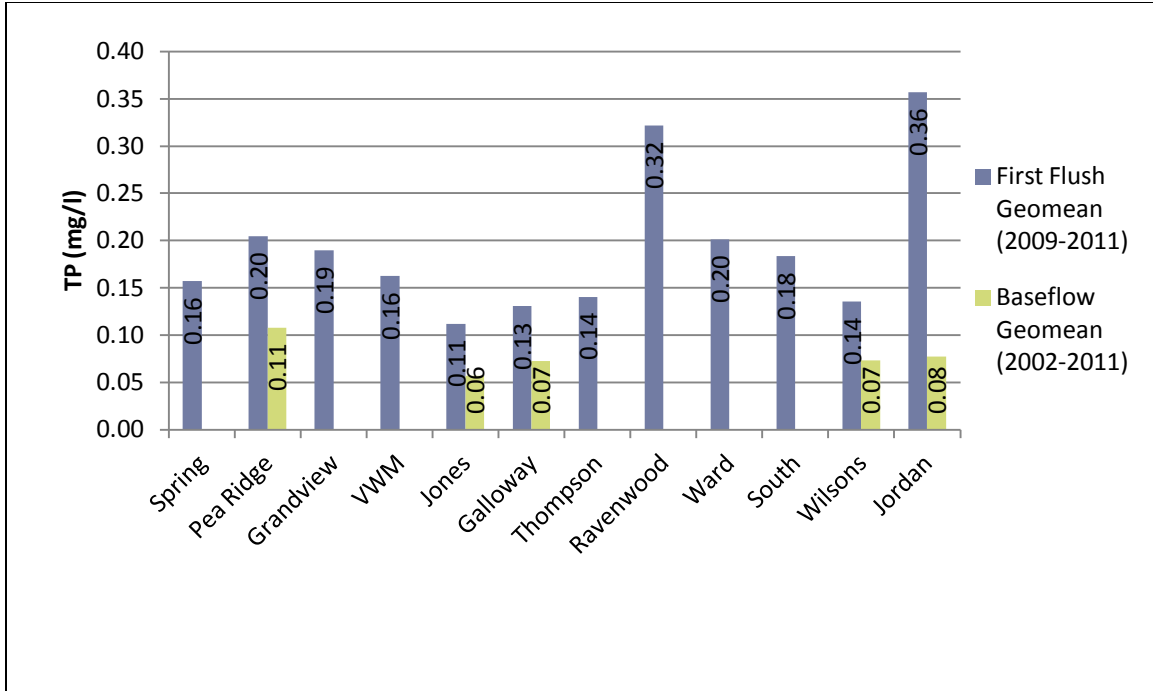
All of the results for pesticides, volatile organics (method 624 & 603), and acid/base neutral organics (method 625) were below the method detection limits. These method detection limits are included in the Appendix.

5.4 FLOATABLES MONITORING

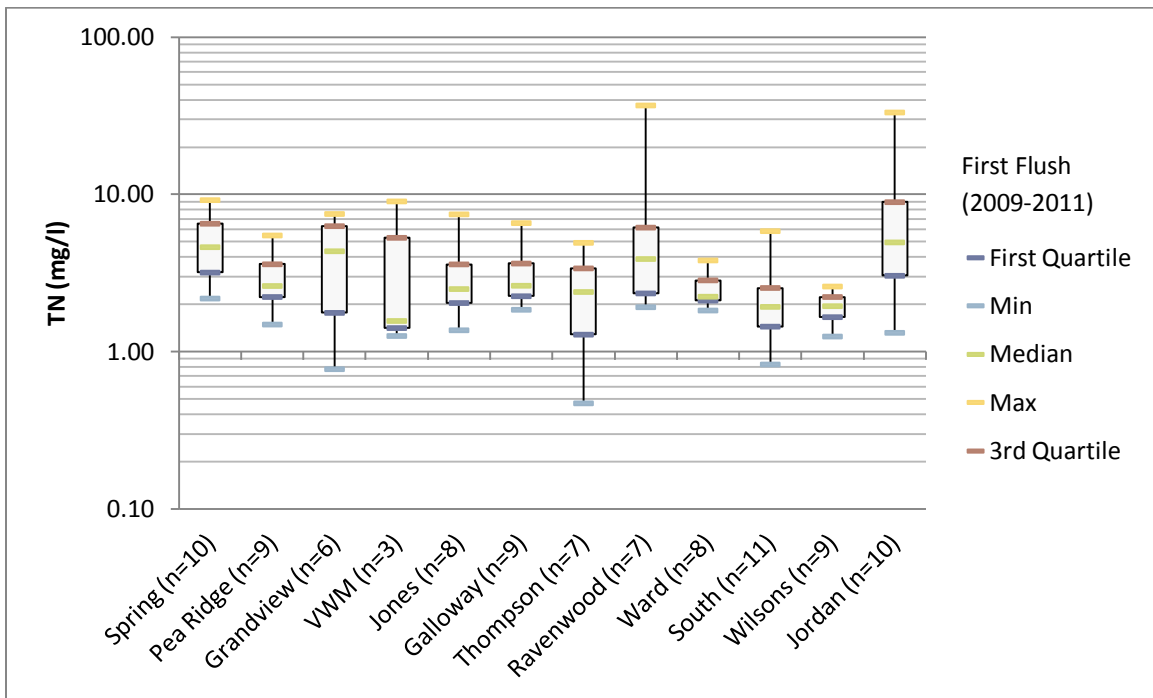
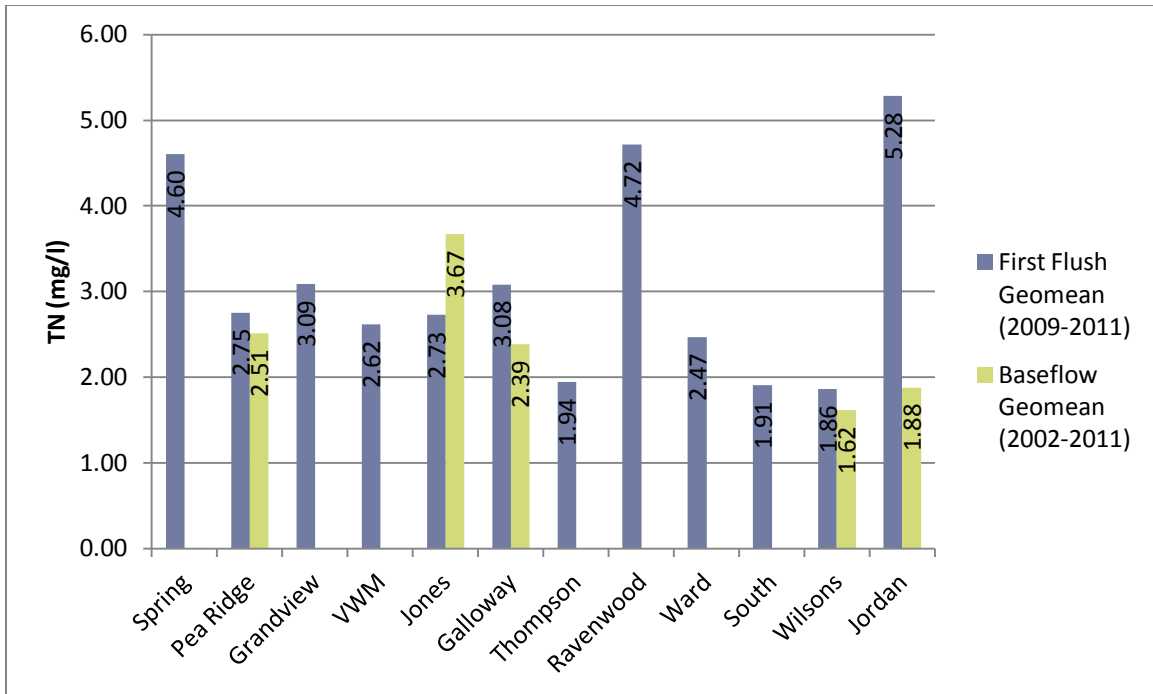
As required in Part V.B. of the Permit. These locations were identified as points of significant accumulation of debris based on the experience of Public Works personnel and the frequency of citizen requests for cleaning at these locations. An estimated 6cy of floatable material was collected from the Grant and Portland channel and 12cy from the Carleton and Bothwell detention basin.

5.5 BIOLOGICAL SAMPLING

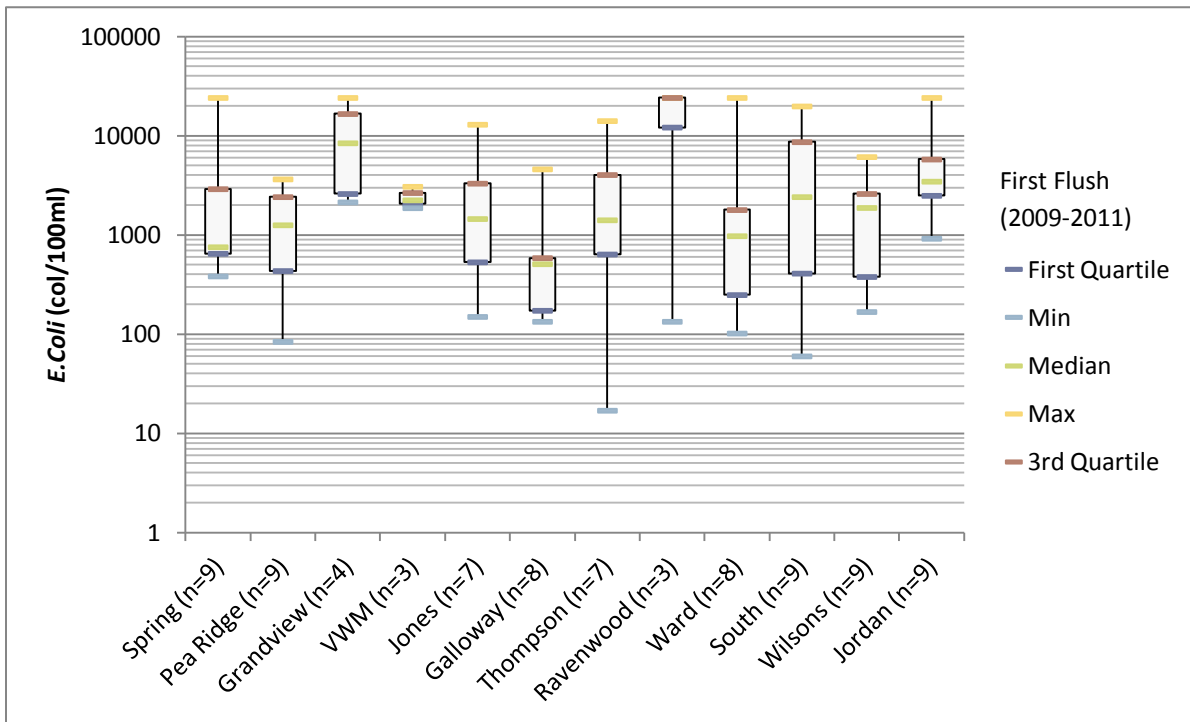
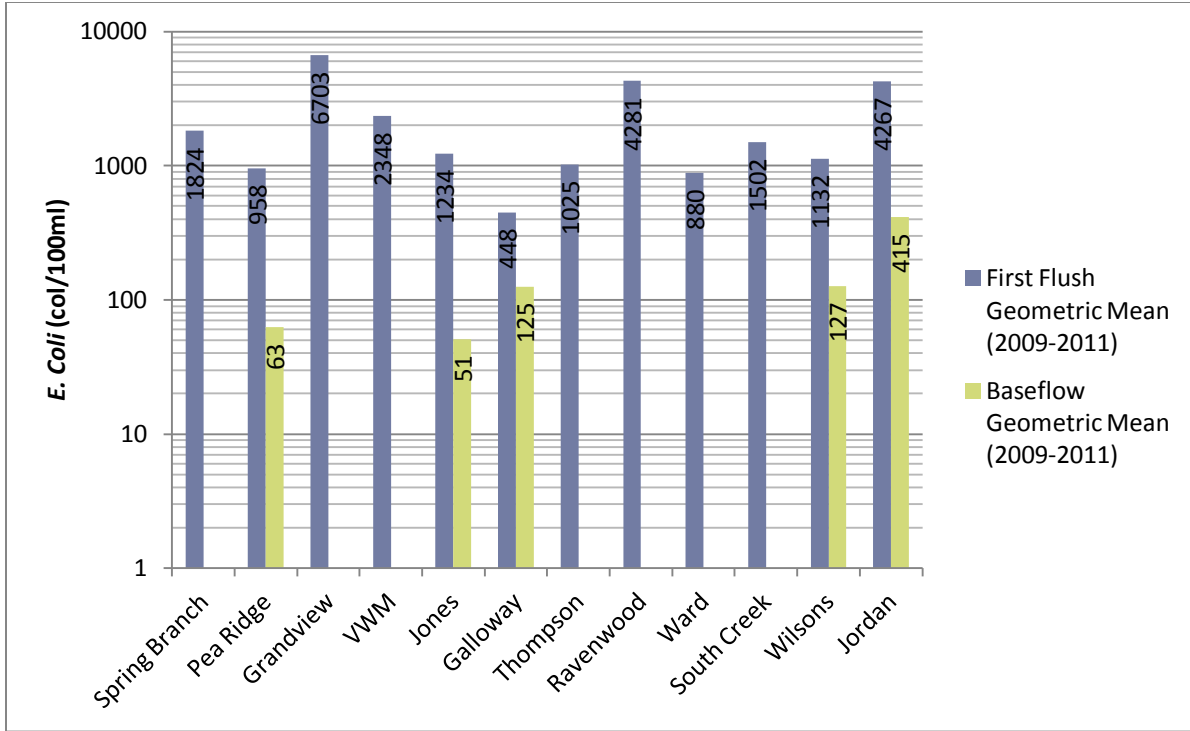
The City continued its annual biological stream assessment program as required in Part V.C. of the Permit. Every year 2 streams are sampled for macroinvertebrates in the fall and spring, and are rotated annually to be sampled approximately every 3 years to assess long-term trends. Those streams included in the program are Galloway Creek, Jordan Creek, Fassnight Creek, Wilsons Creek, South Creek, Pea Ridge Creek and Ward Branch. This year, assessments were conducted on Jordan Creek and Galloway Creek. The City contracts with Missouri State University to perform these assessments. The full report for this year's assessments and a summary of biological metrics for assessments conducted since 2004 are included in the Appendix.



FIGURES 12 & 13: TOTAL PHOSPHORUS



FIGURES 14 & 15: TOTAL NITROGEN



FIGURES 16 & 17: E-COLI

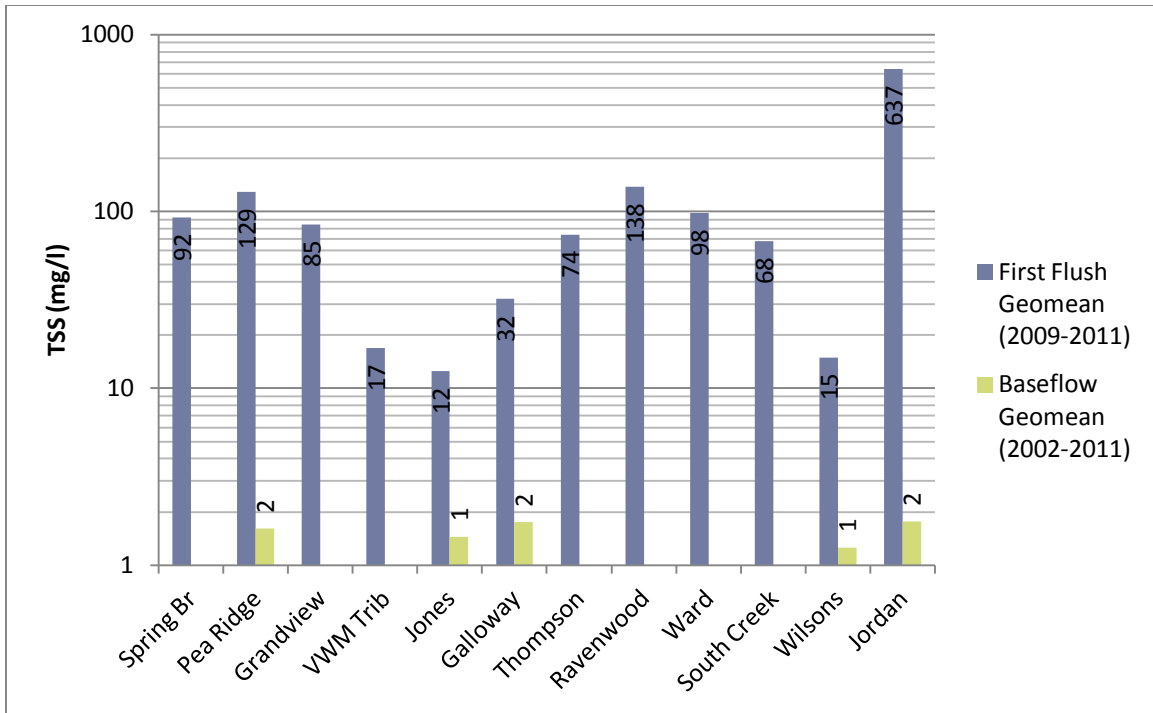


FIGURE 18: TOTAL SUSPENDED SOLIDS

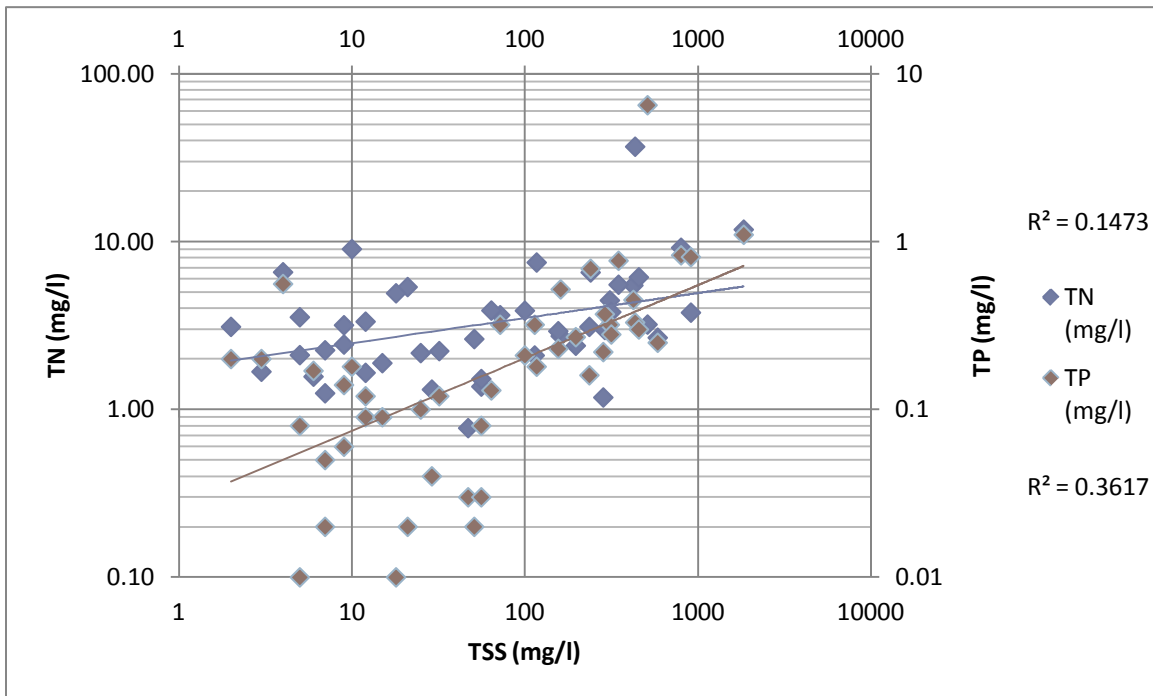


FIGURE 19: TP AND TN VS. TSS FOR 2010-2011 FIRST FLUSH SAMPLES

APPENDIX

FISCAL ANALYSIS

WET WEATHER SCREENING RESULTS

TOTAL ANNUAL RUNOFF VOLUME

STREAM MONITORING STORM EVENT DATA

STREAM MONITORING RESULTS

BIOLOGICAL METRICS SUMMARY 2004-2011

BIOLOGICAL SAMPLING REPORT

City of Springfield Permit MO-0126322 Fiscal Analysis

Expense Item or Program	Funding Source[1]	Expenses FY 03	Expenses FY 04	Expenses FY 05	Expenses FY 06	Expenses FY 07	Expenses FY 08	Expenses FY 09	Expenses FY 10	Expenses FY 11	Estimated Budget FY 12
Hard Costs [2]											
Staff	SWBI, GF,	\$76,000	\$82,000	\$67,000	\$88,000	\$84,535	\$96,321	\$210,738	\$217,910	\$202,558	\$240,000
Supplies & Equipment	SWBI, GF,	\$10,000	\$3,000	\$6,000	\$1,900	\$870	\$4,588	\$2,077	\$3,407	\$6,596	\$5,000
Hardware/Software	SWBI, GF	\$4,000	\$5,000	\$8,000	\$8,000	\$8,000	\$8,000	\$8,000	\$8,000	\$8,000	\$16,000
Professional Services and Studies	SWBI, GF, PWT	\$30,000	\$43,000	\$68,000	\$151,000	\$126,626	\$91,573	\$93,413	\$35,939	\$42,611	\$75,000
Lab Services (sample analysis)	SWBI, GF	\$44,000	\$44,000	\$44,000	\$44,000	\$44,000	\$44,000	\$44,000	\$44,000	\$44,000	\$44,000
Education/Involvement[3]	SWBI, GF, SSF, TF, LTF,	\$47,869	\$48,500	\$55,900	\$59,200	\$57,460	\$72,905	\$77,828	\$56,650	\$71,197	\$75,000
State Permit Fee	SWBI, GF,	\$2,350	\$2,350	\$2,350	\$2,350	\$2,350	\$2,350	\$2,350	\$2,350	\$2,350	\$2,350
Total Hard Costs		\$214,219	\$227,850	\$251,250	\$354,450	\$323,841	\$319,737	\$438,406	\$368,256	\$377,312	\$457,350
Soft Costs[4]											
Water Quality Improvement Projects	SWBI, PWT	\$653,615	\$800,000	\$1,200,000	\$1,150,000	\$1,442,000	\$1,505,000	\$1,715,470	\$1,052,000	\$2,730,000	\$2,000,000
Vegetation Management of Waterways & Basins	DBF, TF, GF, PWT	\$543,975	\$209,187	\$112,267	\$125,071	\$90,311	\$88,455	\$157,045	\$115,800	\$236,311	\$240,146
Tree Planting & Maintenance	GF	\$496,450	\$618,235	\$568,352	\$533,319	\$524,675	\$743,771	\$552,821	\$147,000	\$658,593	\$746,306
Solid Waste Water Quality Education [5]	LTF[5]	\$38,900	\$40,870	\$46,000	\$46,000	\$46,000	\$46,000	\$46,000	\$88,000	\$133,623	\$140,000
Household Chemical Collection Center	SS(50%), LTF(50%)	\$104,500	\$111,713	\$94,500	\$94,500	\$94,500	\$94,500	\$94,500	\$94,500	\$91,000	\$91,000
Yardwaste Recycling Center	LTF	\$348,000	\$238,977	\$329,000	\$329,000	\$329,000	\$329,000	\$329,000	\$329,000	\$436,000	\$436,000
Infiltration/Inflow Program	SSR	\$1,286,471	\$783,150	\$457,000	\$338,000	\$345,000	\$436,103	\$300,000	\$397,000	\$989,000	\$1,200,000
Floodplain Acquisition Program	SWBI	\$856,750	\$488,585	\$938,550	\$1,349,570	\$459,623	\$348,000	\$968,065	\$433,644	\$301,500	\$300,000
Debris collection – grate, waterway, bridge, and sinkhole routes	TF	\$30,000	98,382 [6]	\$114,888	\$33,200	\$102,738	\$134,119	\$176,896	\$124,170	\$91,548	\$100,000
Street Cleaning[7]	TF	\$491,000	\$462,842	\$563,734	\$610,473	\$589,684	\$678,376	\$690,062	\$564,000	\$524,162	\$600,438
Stream & Rainfall Gages	SWBI	\$17,300	\$17,300	\$18,600	\$25,600	\$35,752	\$36,752	\$38,248	\$38,648	\$38,548	\$39,000
Total Soft Costs		\$4,866,961	\$3,770,859	\$4,442,891	\$4,634,733	\$4,059,283	\$4,440,076	\$5,068,107	\$3,383,762	\$6,230,285	\$5,892,890
Grand Total		\$5,081,180	\$3,998,709	\$4,694,141	\$4,989,183	\$4,383,124	\$4,759,813	\$5,506,513	\$3,752,018	\$6,607,597	\$6,350,240
Multi-Year Total Expenses										\$43,772,278	

[1] SWBI – Storm Water Bond Issue funded by Level Property Tax; GF – General Fund; SSF – Sanitary Services Fund; TF – Transportation Fund; LTF – Landfill Tipping Fees; DBF – Detention Buyout Fund; SSR – Sanitary Sewer Revenue; PWT - Parks/Waterways Tax

[2] Hard costs are expenses for activities conducted solely for the purpose of compliance with permit requirements.

[3] Includes funding of operating budgets for the Watershed Committee of the Ozarks, James River Basin Partnership, as well as City activities

[4] Soft costs are expenses for activities that are part of the Permit requirements and/or overall SWMP, but would be conducted by the City regardless of the Permit. Expenses do not include capital purchases, except vegetation management in 02/03 may include these, accounting for the significantly higher expenses than in subsequent years.

[5] An estimated 50% of solid waste education activities include water quality; therefore costs are estimated at 50% of total budget. A small portion of funds for the Solid Waste Management Division

[6] Actual expenses for fiscal year 03/04 are an estimate based on expenses for Dec - June. MoDot conducts curb inlet cleaning of state-maintained thoroughfares within the City limits.

[7] Includes personnel, services, and supplies for all street cleaning activities including sweeping, debris pickup, grate cleaning, and vacuuming ditches. Additionally, MoDot expends funds on sweeping state-maintained thoroughfares within the City limits.

City of Springfield, Missouri Storm Water Permit MO-0126322 Annual Report 2010-2011
 Section 5.7 Activity 7.b Wet-Weather Screening Results

ID	Date	BOD	COD	pH	TSS	TDS	N+N	TKN	DP	TP	O&G	E.Coli	Hardness	CR	CU	PB	NI	AG	ZN	Microtox
288 (In)	8/5/10	10	157	N/a*	126	200	0.24	2.8	0.13	0.49	<10	>24196	264	<10	24.6	70.1	<10	<5	225	Nontoxic
288 (Out)	8/5/10	12	73	N/a*	154	160	0.2	2.41	0.13	0.27	<10	>24196	94	<10	9.4	26	<10	<5	100	Nontoxic
283	9/9/10	4	17	7.89	31	80	1.23	0.8	0.02	0.11	<10	>24196	76	<10	<5	<15	<10	<5	8.8	Nontoxic
289	9/9/10	7	66	7.45	33	160	1.43	2.09	0.07	0.16	<10	14136	94	<10	36.9	72.9	<10	<5	187	Nontoxic
290	9/9/10	6	81	7.52	80	120	1.41	1.87	0.1	0.18	<10	3076	104	<10	61.4	178	12.4	<5	469	Nontoxic
263	9/9/10	8	<10	7.56	26	80	0.9	1.03	0.14	0.21	<10	24196	108	<10	6.9	<15	<10	<5	26.8	Nontoxic
291	9/9/10	3	22	8.83	14	160	1.54	1.14	0.04	0.08	<10	8164	74	<10	<5	<15	<10	<5	<5	Nontoxic
169	9/14/10	7	12	7.25	25	60	0.37	1.22	0.12	0.27	<10	2755	74	<10	8.4	<15	<10	<5	57.1	Nontoxic
137	9/14/10	6	21	7.19	15	40	0.22	1.12	0.02	0.11	<10	7270	40	<10	<5	<15	<10	<5	67	Nontoxic
274	2/24/11	83	1306	7.84	1288	200	1.1	11.3	<0.01	2.67	81.2	10	863	121	8140	2770	138	6.9	7610	91.5
282	2/24/11	33	862	8.9	1164	<40	0.27	8.19	<0.01	1.83	<10	571	1120	91.2	628	1500	101	6.5	10100	44.9
126	2/24/11	<50	66	7.74	184	120	1.15	2.19	0.07	0.3	<10	31	109	<10	17.4	35.5	<10	<5	191	Nontoxic
278	2/24/11	38	1036	8.55	1934	280	0.49	9.2	<0.01	2.15	36	637	1850	89.7	579	1450	94.9	7.8	8830	79.8
228	4/11/11	<2	<10	7.07	2	280	0.52	1.44	0.02	0.02	10.6	1956	50	<10	<5	<15	<10	<5	75.7	Nontoxic
88	4/11/11	<2	<10	7.46	9	240	0.53	3.71	0.02	0.03	10.3	2755	62	<10	<5	<15	<10	<5	27.3	92.8
51	4/11/11	<2	<10	7.28	1	160	0.46	1.88	0.05	0.07	10.6	216	40	<10	<5	<15	<10	<5	19	Nontoxic
69	4/11/11	<2	<10	7.33	16	360	0.2	2.42	0.01	0.06	<10	882	154	<10	<5	<15	<10	<5	15.4	Nontoxic

ID	Latitude	Longitude	ID	Latitude	Longitude	ID	Latitude	Longitude	ID	Latitude	Longitude	ID	Latitude	Longitude
288	37.21526	-93.30656	263	37.23063	-93.34616	282	37.22749	-93.31096	51	37.20325	-93.22805			
288	37.21526	-93.30656	291	37.21679	-93.35141	126	37.21238	-93.35201	69	37.21788	-93.25423			
283	37.23063	-93.3461	169	37.21055	-93.31565	278	37.21905	-93.30806						
289	37.22757	-93.34271	137	37.21326	-93.32492	228	37.2141	-93.2344						
290	37.22712	-93.3435	274	37.21191	-93.28468	88	37.21173	-93.23946						

Parameters are measured in mg/l, except metals are µg/l, E.Coli is CFU/100 ml, and Microtox is % (EC50). The lower the Microtox %, the more toxic.
 Parameter Abbreviations: BOD = Biochemical Oxygen Demand; COD = Chemical Oxygen Demand; TSS = Total Suspended Solids; TDS = Total Dissolved Solids;
 N+N = Nitrate + Nitrite; TKN = Total Kjeldahl Nitrogen; DP = Dissolved Phosphorus; TP = Total Phosphorus; O&G = Oil & Grease; CaCO3 = Hardness;
 CR = Chromium, Total; CU = Copper, Total; PB = Lead, Total; NI = Nickel, Total; AG = Silver, Total; ZN = Zinc, Total
 *pH meter not working.

City of Springfield, Missouri Storm Water Permit MO-0126322 Annual Report 2010-2011
 Section 6.2 Total Annual Runoff Volume

Average Total Precipitation = 48.59

Precipitation Category (in)	Avg. # of Events	Avg. Precipitation	Runoff/event (gallons)	Total Runoff (gallons)	Total Runoff (Cubic feet)
0 - 0.1	40	0.04	7,552,958	299,600,661	40,146,489
0.11 - 0.2	14	0.14	29,525,199	403,511,050	54,070,481
0.21 - 0.4	14	0.26	53,557,337	767,655,169	102,865,793
0.41 - 0.8	12	0.57	118,100,795	1,417,209,543	189,906,079
0.81 - 1.6	11	1.05	145,435,696	1,648,271,225	220,868,344
>1.6	7	3.32	2,100,069,519	14,000,465,461	1,876,062,372

Total Annual Runoff = 18,536,713,109 2,483,919,557

Retention "S" (in)	Runoff "Q" (in)	Volume of Runoff (ft ³)	Cubic Feet	Gallons of Runoff
0.00	0.03667	Basin Area (ac) 7,604.00	1,012,096	7,552,958

Assuming 15 % (7604 ac) of directly connected Impervious area is the sole contributor to runoff.

Retention "S" (in)	Runoff "Q" (in)	Volume of Runoff (ft ³)	Cubic Feet	Gallons of Runoff
0.00	0.14333	Basin Area (ac) 7,604.00	3,956,377	29,525,199

Assuming 15 % (7604 ac) of directly connected Impervious area is the sole contributor to runoff.

Retention "S" (in)	Runoff "Q" (in)	Volume of Runoff (ft ³)	Cubic Feet	Gallons of Runoff
0.00	0.26000	Basin Area (ac) 7,604.00	7,176,683	53,557,337

Assuming 15 % (7604 ac) of directly connected Impervious area is the sole contributor to runoff.

Retention "S" (in)	Runoff "Q" (in)	Volume of Runoff (ft ³)	Cubic Feet	Gallons of Runoff
0.00	0.57333	Basin Area (ac) 7,604.00	15,825,507	118,100,795

Assuming 15 % (7604 ac) of directly connected Impervious area is the sole contributor to runoff.

% Impervious	% Type 1	CN-1	CN _{eff}	Retention "S" (in)	Volume of Runoff (ft ³)	Cubic Feet	Gallons of Runoff
30	70	73	80.5	2.42	50,696.00	19,488,383	145,435,696

% Impervious	% Type 1	CN-1	CN _{eff}	Retention "S" (in)	Volume of Runoff (ft ³)	Cubic Feet	Gallons of Runoff
30	70	73	80.5	2.42	50,696.00	281,409,356	2,100,069,519

City of Springfield, Missouri Storm Water Permit MO-0126322 Annual Report 2010-2011
 Section 6.3 Representative Monitoring Results

Site	Date	Event Type	pH	Sp Cond. (µS/cm)	TSS (mg/l)	TN* (mg/l)	TP (mg/l)	CN (mg/l)	O&G (mg/l)	E-coli (col/100ml)	Chloride (mg/l)	Microtox % (EC50)	Pesticides & PCBs (EPA 608)	Organics (EPA 603, 624, 625)
Spring Branch	6/28/10	Stormflow	8.61	47	800	9.21	0.83	<0.005	<10	24196	8.7	Nontoxic	BMDL	BMDL
	9/24/10	Stormflow	6.32	766	100	3.88	0.21	<0.005	<10	689	36.6	Nontoxic	BMDL	BMDL
	2/14/11	Snowmelt	7.48	110	9	3.18	0.06	<0.005	<10	5	215.4	Nontoxic	BMDL	BMDL
	4/11/11	Stormflow	6.7	746	21	5.37	0.02	<0.005	<10	2909	41.8	Nontoxic	BMDL	BMDL
Pea Ridge Creek	6/28/10	Stormflow	8.95	15	32	2.23	0.12	<0.005	<10	3654	8.8	Nontoxic	BMDL	BMDL
	9/24/10	Stormflow	6.85	786	236	3.11	0.16	<0.005	<10	1723	33	Nontoxic	BMDL	BMDL
	2/25/11	Stormflow	7.2	739	424	5.49	0.45	<0.005	<10	435	58.7	Nontoxic	BMDL	BMDL
	4/11/11	Stormflow	6.9	541	72	3.65	0.32	<0.005	<10	1259	26.7	Nontoxic	BMDL	BMDL
Grandview Branch	6/14/11	Baseflow	6.5	795	1	2.82	0.03	-	-	105	37.2	-	-	-
	6/28/10	Stormflow	9.06	47	240	6.56	0.69	<0.005	<10	>24196	2.3	Nontoxic	BMDL	BMDL
	11/2/10	Stormflow	7.87	244	348	5.55	0.77	<0.005	<10	2142	4.9	Nontoxic	BMDL	BMDL
	2/14/11	Snowmelt	7.68	150	47	0.78	0.03	<0.005	<10	96	358.9	Nontoxic	BMDL	BMDL
Valley Water Mill Trib	4/11/11	Stormflow	7	201	117	7.52	0.18	<0.005	<10	2755	5.5	Nontoxic	BMDL	BMDL
	9/2/10	Stormflow	7.86	266	10	9.04	0.18	<0.005	<10	3076	18.6	Nontoxic	BMDL	BMDL
	4/15/11	Stormflow	7.4	395	6	1.57	0.17	<0.005	<10	1872	25.4	Nontoxic	BMDL	BMDL
	7/12/10	Stormflow	7.53	240	56	1.37	0.08	<0.005	<10	12997	6.4	Nontoxic	BMDL	BMDL
Jones Branch	11/23/10	Stormflow	6.99	205	12	1.66	0.12	<0.005	<10	1455	13.9	Nontoxic	BMDL	BMDL
	2/14/11	Snowmelt	7.9	102	5	3.55	0.08	<0.005	<10	2	137.9	Nontoxic	BMDL	BMDL
	4/15/11	Stormflow	7.3	535	25	2.17	0.1	<0.005	<10	852	21	Nontoxic	BMDL	BMDL
	6/14/11	Baseflow	6	834	2	4.90	0.02	-	-	84	31.5	-	-	-
Galloway Creek	7/12/10	Stormflow	7.5	318	51	2.63	0.02	<0.005	<10	4611	10.7	Nontoxic	BMDL	BMDL
	9/24/10	Stormflow	6.65	605	4	6.58	0.56	<0.005	<10	591	26.6	Nontoxic	BMDL	BMDL
	2/14/11	Snowmelt	7.55	90	7	2.26	0.02	<0.005	<10	24	140.8	Nontoxic	BMDL	BMDL
	4/11/11	Stormflow	6.9	604	512	3.21	6.51	<0.005	<10	586	28.4	Nontoxic	BMDL	BMDL
Thompson Branch	6/14/11	Baseflow	6.4	588	22	3.31	0.02	-	-	117	27.7	-	-	-
	7/12/10	Stormflow	7.38	564	18	4.93	<0.01	<0.005	<10	905	38.1	Nontoxic	BMDL	BMDL
	9/24/10	Stormflow	7.77	193	284	1.18	0.22	<0.005	<10	1597	5.1	Nontoxic	BMDL	BMDL
	3/15/11	Stormflow	6.9	642	197	2.40	0.27	<0.005	<10	17	5.2	Nontoxic	BMDL	BMDL
Ravenwood Branch	4/11/11	Stormflow	7	175	2	3.11	0.2	<0.005	<10	373	8.3	Nontoxic	BMDL	BMDL
	9/2/10	Stormflow	8.07	268	434	36.84	0.33	<0.005	<10	24196	2	Nontoxic	BMDL	BMDL
	10/12/10	Stormflow	7.28	128	161	2.74	0.52	<0.005	<10	NS	1.7	Nontoxic	BMDL	BMDL
	2/25/11	Stormflow	7.3	335	310	4.47	0.32	<0.005	<10	NS	32.9	Nontoxic	BMDL	BMDL
	4/11/11	Stormflow	7	206	64	3.89	0.13	<0.005	<10	NS	8	Nontoxic	BMDL	BMDL

Site	Date	Event Type	pH	Sp Cond. (µS/cm)	TSS (mg/l)	TN* (mg/l)	TP (mg/l)	CN (mg/l)	O&G (mg/l)	E-coli (col/100ml)	Chloride (mg/l)	Microtox % (EC50)	Pesticides & PCBs (EPA 608)	Organics (EPA 603, 624, 625)
Ward Branch	7/12/10	Stormflow	7.55	344	586	2.68	0.25	<0.005	<10	1727	18.7	Nontoxic	BMDL	BMDL
	9/24/10	Stormflow	7.94	233	114	2.10	0.32	<0.005	<10	1291	15.6	Nontoxic	BMDL	BMDL
	2/25/11	Stormflow	7.1	752	316	3.81	0.28	<0.005	<10	102	92.8	Nontoxic	BMDL	BMDL
	4/11/11	Stormflow	6.9	598	12	3.34	0.09	<0.005	<10	663	43.3	Nontoxic	BMDL	BMDL
South Creek	6/28/10	Stormflow	8.75	18.4	156	2.93	0.23	<0.005	<10	19863	2.2	Nontoxic	BMDL	BMDL
	10/12/10	Stormflow	8.34	8	290	2.98	0.37	<0.005	<10	NS	4	Nontoxic	BMDL	BMDL
	2/14/11	Snowmelt	7.67	700	56	1.52	0.03	<0.005	<10	111	91.9	Nontoxic	BMDL	BMDL
	4/15/11	Stormflow	7.5	329	15	1.89	0.09	<0.005	<10	2489	14.5	Nontoxic	BMDL	BMDL
Wilson's Creek	7/12/10	Stormflow	7.67	295	7	1.25	0.05	<0.005	<10	1882	12.1	Nontoxic	BMDL	BMDL
	9/24/10	Stormflow	7.74	274	3	1.68	0.2	<0.005	<10	3255	24.6	Nontoxic	BMDL	BMDL
	2/28/11	Stormflow	7.6	685	9	2.44	0.14	<0.005	<10	365	35.9	Nontoxic	BMDL	BMDL
	4/11/11	Stormflow	7	479	5	2.11	<0.01	<0.005	<10	2603	22.8	Nontoxic	BMDL	BMDL
Jordan Creek	6/14/11	Baseflow	6.1	822	<1	3.41	0.03	-	-	146	48.1	-	-	-
	7/12/10	Stormflow	7.52	341	456	6.14	0.3	<0.005	<10	5794	16	Nontoxic	BMDL	BMDL
	9/24/10	Stormflow	7.82	623	912	3.78	0.81	<0.005	<10	5794	28.8	Nontoxic	BMDL	BMDL
	2/14/11	Snowmelt	7.42	40	29	1.32	0.04	<0.005	<10	<1	271.7	Nontoxic	BMDL	BMDL
Jordan Creek	4/11/11	Stormflow	6.5	2	1842	11.81	1.1	<0.005	<10	2495	30.3	Nontoxic	BMDL	BMDL
	6/14/11	Base flow	6.6	875	6	3.16	0.03	-	-	921	50.9	-	-	-

Abbreviations: BMDL = Below Method Detection Limit; Sp Cond. = Specific Conductivity; TSS = Total Suspended Solids; TN = Total Nitrogen; TP = Total Phosphorus;

CN = Cyanide (Ammon); O&G = Oil & Grease;

*TN calculated as the sum of TKN and Nitrate-Nitrite. Values <MDL were calculated as half the MDL.

Site	Date	Event Type	Hardness (EQ CaCO)	Pb, Dissolved (µg/l)	Hg, Total (µg/l)	Cd, Dissolved (µg/l)	Zn, Dissolved (µg/l)	Ni, Dissolved (µg/l)	Cu, Dissolved (µg/l)	Cr, Dissolved (µg/l)	As, Dissolved (µg/l)	Ag, Dissolved (µg/l)
Spring Branch	6/28/10	Stormflow	390	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	9/24/10	Stormflow	278	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	2/14/11	Stormflow	290	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	4/11/11	Stormflow	240	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
Pea Ridge Creek	6/28/10	Stormflow	228	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	9/24/10	Stormflow	284	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	2/25/11	Stormflow	201	21.5	<0.2	<5	38.1	<10	7.5	<10	<15	<5
	4/11/11	Stormflow	164	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
Grandview Branch	6/28/10	Stormflow	130	<15	<0.2	<5	64.4	<10	6.3	<10	<15	<5
	11/2/10	Stormflow	66	<15	<0.2	<5	17.8	<10	<5	<10	<15	<5
	2/14/11	Stormflow	118	<15	<0.2	<5	7.3	<10	<5	<10	<15	<5
	9/2/10	Stormflow	102	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
Valley Water Mill Trib	4/15/11	Stormflow	94	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	7/12/10	Stormflow	118	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	11/23/10	Stormflow	174	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	2/14/11	Stormflow	252	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
Jones Branch	4/15/11	Stormflow	162	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	7/12/10	Stormflow	156	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	9/24/10	Stormflow	190	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	2/14/11	Stormflow	258	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
Galloway Creek	4/11/11	Stormflow	192	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	7/12/10	Stormflow	224	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	9/24/10	Stormflow	30	<15	<0.2	<5	7.2	<10	<5	<10	<15	<5
	3/15/11	Stormflow	50	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
Thompson Branch	4/11/11	Stormflow	56	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	9/2/10	Stormflow	70	<15	<0.2	<5	68.5	<10	16.8	<10	<15	<5
	10/12/10	Stormflow	58	<15	<0.2	<5	10.2	<10	7.8	<10	<15	<5
	2/25/11	Stormflow	164	19.7	<0.2	<5	135	<10	17.2	10.5	<15	<5
Ravenwood Branch	4/11/11	Stormflow	50	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	7/12/10	Stormflow	158	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	9/24/10	Stormflow	60	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	2/25/11	Stormflow	142	17.9	<0.2	<5	41.7	<10	9.5	<10	<15	<5
Ward Branch	4/11/11	Stormflow	140	<15	<0.2	<5	12.2	<10	<5	<10	<15	<5
	6/28/10	Stormflow	92	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	10/12/10	Stormflow	88	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
	2/14/11	Stormflow	150	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
South Creek	4/15/11	Stormflow	96	<15	<0.2	<5	<5	<10	<5	<10	<15	<5

Site	Date	Event Type	Hardness (EQ CaCO)	Pb, Dissolved (µg/l)	Hg, Total (µg/l)	Cd, Dissolved (µg/l)	Zn, Dissolved (µg/l)	Ni, Dissolved (µg/l)	Cu, Dissolved (µg/l)	Cr, Dissolved (µg/l)	As, Dissolved (µg/l)	Ag, Dissolved (µg/l)
Wilson's Creek	7/12/10	Stormflow	140	<15	<0.2	<5	21.3	<10	<5	<10	<15	<5
	9/24/10	Stormflow	136	<15	<0.2	<5	14.8	<10	<5	<10	<15	<5
	2/28/11	Stormflow	208	<15	<0.2	<5	10.8	<10	<5	<10	<15	<5
	4/11/11	Stormflow	136	<15	<0.2	<5	<5	<10	<5	<10	<15	<5
Jordan Creek	7/12/10	Stormflow	170	<15	<0.2	<5	16.2	<10	<5	<10	<15	<5
	9/24/10	Stormflow	294	<15	<0.2	<5	17.8	<10	<5	<10	<15	<5
	2/14/11	Stormflow	254	<15	<0.2	<5	20	11.4	6.2	<10	<15	<5
	4/11/11	Stormflow	746	<15	0.53	<5	31.3	<10	<5	13	<15	<5

Abbreviations: Pb = Lead; Hg = Mercury; Cd = Cadmium; Zn = Zinc; Ni = Nickel; Cu = Copper; Cr = Chromium; As = Arsenic; Ag = Silver

City of Springfield, Missouri Storm Water Permit MO-0126322: Summary of Biological Assessments						
Stream	Road (upstream/downstream)	Season/Year	Taxa Richness	EPT Index	Biotic Index	Shannon Diversity Index
Jordan Creek	Bennett Street (us)	Fall 2004	18	4	6.77	1.9111
		Spring 2005	15	3	8.19	1.7899
		Fall 2005	11	3	7.557	2.237
		Spring 2006	7	2	7.843	0.754
		Fall 2006	12	5	5.55	1.823
	Grand Street (ds)	Spring 2007	5	1	7.09	1.308
	Bennett Street (us)	Fall 2007	11	3	7.45	1.73
		Spring 2008	7	1	8.33	1.52
	Between Mt Vernon & Grand	Fall 2010	15	3	7.19	1.76
Spring 2011		5	1	7.98	1.12	
Galloway Creek	James River Frwy (us)	Fall 2004	22	7	4.25	2.0397
		Spring 2005	19	7	6.39	2.186
		Fall 2005	14	3	6.912	2.179
		Spring 2006	17	7	6.086	2.114
	Barton Street (us)	Fall 2006	13	4	7.12	1.867
	James River Frwy (us)	Spring 2007	15	4	6.36	1.646
		Fall 2007	10	4	5.74	1.87
		Spring 2008	10	4	7.04	1.51
		Fall 2010	20	3	7.67	2.09
Spring 2011		11	2	7.76	1.62	
Wilsons Creek	Scenic (us)	Fall 2005	14	3	6.912	2.179
		Spring 2006	7	2	7.266	1.108
		Fall 2006	12	5	6.61	1.71
	FR146 (us)	Spring 2007	15	5	5.49	1.316
		Fall 2007	11	4	5.56	1.85
		Spring 2008	9	3	7.12	1.74
		Fall 2008	8	3	6.2	1.27
		Spring 2009	10	3	7.35	1.18
Fassnight Creek	Kansas Expy (ds)	Fall 2008	10	2	7.64	1.8
		Spring 2009	8	1	7.43	0.93
South Creek	Golden (ds)	Fall 2009	21	5	6.3	2.26
		Spring 2010	14	4	9.41	0.91
Ward Branch	FR182 (Plainview) (ds)	Fall 2009	15	5	6.66	1.78
		Spring 2010	15	5	8.99	0.66
Pea Ridge Creek	1500 blk W. FR102 (ds)	Fall 2009	21	6	6.43	2.02
		Spring 2010	12	1	9.52	0.96

us = upstream; ds = downstream.

City of Springfield Missouri
Biological Assessment of Urban Streams VII
2010-2011
Final Report



Prepared by:

Daniel Beckman (Principal Investigator)

Jessica Luraas (Research Assistant)



Department of Biology
Missouri State University
Springfield, Missouri



Summary

This study assessed the health of biotic communities in Galloway Creek and Jordan Creek, Springfield, Missouri. Benthic macroinvertebrates were collected from each stream and identified using US Environmental Protection Agency (EPA) Rapid Bioassessment Protocols (RBP). Data were used to calculate biological metrics, including the EPT Index, Taxa Richness (TA), Biotic Index (BI), and Shannon Diversity Index (SDI). A Physical Habitat Analysis was completed based on Missouri Department of Natural Resources (MDNR) criteria to provide a description of bottom composition, habitat parameters, riparian zone coverage and condition, and potential human influences. Sampling was carried out in fall of 2010 and spring of 2011 at each stream.

A range of 5-20 taxa of macroinvertebrates were collected in each sample. The EPT index indicated from 1-3 relatively sensitive taxa in collections. There were no pronounced differences in overall community condition between sites or between seasons. Community health was evaluated to be superior in Galloway compared to Jordan Creek and in fall relative to spring collections. The sampling and processing protocol and level of taxonomic identification used in this study differ from MDNR protocols; therefore, Missouri Stream Condition Index scores were not calculated. For the habitat analysis, epifaunal substrate and cover were evaluated as “optimal” in Galloway Creek in fall and spring. All other habitat metrics were “suboptimal”, with the exception of riffle quality in Jordan Creek which was “marginal”.

Introduction

Urban streams flowing through Springfield, Missouri are exposed to a number of stressors that can impact the biotic communities. With growth and urbanization, the amount of impervious surfaces, such as roads, parking lots, and rooftops, has increased. These changes increase runoff volume and rate into the streams, increasing the physical disturbances from rain events. The streams also may receive more organic and inorganic pollutants from point and non-point sources than streams in a rural area. Although recent improvements to the streams and their associated watersheds have the potential for improving the health of the biological communities, ongoing construction activities can have at least a temporary effect on stream health. Many organisms in Springfield's urban streams survive and flourish despite the anthropogenic stressors on their environment.

The organisms living in a stream can provide information about the health of the stream; biological communities reflect overall ecological integrity. Monitoring changes in the biological community can provide a broad measure of impacts that integrates stresses over time (Barbour et al. 1999). One tool used to explain and quantify the health of a stream, as indicated by the biota collected, is a multiple metric index. This index is based on categories or metrics and can be adapted for different ecoregions. Metrics reflect aspects of the community such as diversity, sensitive species richness, and community makeup with regards to sensitivity to environmental stressors. The metric scores provide a biological measure of stream health, signifying the level of impairment in comparison to a reference condition. The metrics used are those recommended by Missouri Department of Natural Resources (MDNR) based on analyses of variability, sensitivity, and redundancy (Rabeni et al. 1997; Sarver et al. 2002). The multiple metric index developed by MDNR for Missouri is the Missouri Stream Condition Index (MSCI). For this study, individual

metrics were calculated for the benthic macroinvertebrate communities; however, MSCI scores were not calculated because the sampling and processing protocols and level of taxonomic identification used in this study differ from MDNR protocols. Biological sampling was supplemented by physical habitat analysis to characterize the streams in terms of substrate, habitat, depth, and riparian characteristics.

Methods

Sample Sites

Macroinvertebrate collections and physical habitat analyses were carried out at 2 locations in Springfield, Missouri in fall 2010 and spring 2011: 1) Jordan Creek between Mt. Vernon and Grand Streets, and 2) Galloway Creek north of James River Freeway. Sample dates are given in Tables 1-4.

Sampling and Data Analysis

Benthic macroinvertebrates were sampled and processed according to the *Rapid Bioassessment Protocols for Use in Wadeable Rivers* (Barbour et al. 1999). This procedure includes samples from a variety of depths, current velocities, and substrate mixtures in riffles, runs, and pools in a stream reach that is approximately 20 times the average stream width. Samples were collected with bottom aquatic kick nets by sweeping the net through the water while disturbing the substrate or vegetation. Samples were transferred to containers, preserved, and returned to the lab for processing.

In the lab, macroinvertebrates were separated from the debris and identified. Due to large numbers of individuals in collections, Galloway Creek samples were sub-sampled into quarters

for processing; counts of individuals were adjusted to estimate numbers for the entire sample. The level of identification was based on *Taxonomic Levels for Macroinvertebrate Identifications Standard Operating Procedure* (MDNR 2001), although some taxa were not identified to the preferred taxon I.D. levels. All Ephemeroptera, Odonata, Trichoptera, and Coleoptera were identified to genus level when possible; other organisms, including chironomids, were identified to the lowest possible level without additional mounting or preparation of samples. Specimens were preserved in 70% ethanol, labeled, and archived. The metrics that were calculated are Taxa Richness (TR); Ephemeroptera, Plecoptera, & Trichoptera Taxa (EPT); Biotic Index (BI); and the Shannon Diversity Index (SDI). Taxa richness should increase with improving water quality. The EPT Index is the number of genera belonging to the EPT orders; i.e., the genera of mayflies, stoneflies, and caddisflies present in each sample. The BI is a regionally modified Hilsenhoff Biotic Index (Hilsenhoff 1987). This index classifies the aquatic macroinvertebrate community relative to its tolerance to organic pollution. Each taxon is assigned a tolerance value ranging from 0-10. These values are averaged over the community to obtain the BI; the higher the BI score, the more tolerant/less healthy the community. The SDI is a measure of community composition that takes into accounts both richness and evenness. Richness is reflective of the number of different taxa collected, and evenness reflects how evenly the taxa collected are distributed within the community. It is assumed that a community with a higher biological diversity is a healthier community.

Physical Habitat Assessment

Physical habitat assessments were made using the Missouri Department of Natural Resources Stream Habitat Assessment Procedure (Sarver et al. 2002) in spring and fall at each

sample site. Data were recorded on Habitat Assessment Forms in the field and later transferred to Excel spreadsheets. Information collected includes epifaunal substrate, available cover, embeddedness, velocity/depth regime, sediment deposition, channel flow status, channel alteration, riffle quality, bank stability, vegetative protection, and riparian vegetative zone width. Potential human influences were also noted, including signs of sedimentation and eutrophication, land uses, and disturbances.

Results and Discussion

Benthic Macroinvertebrates

Collections yielded from 5 to 20 taxa of macroinvertebrates (Tables 1-4). Total numbers of individuals collected in samples ranged from 149 to 2,578. Most collections were dominated by 1-3 taxa. The most prevalent taxon throughout samples was chironomids (identified only to the level of family). The order Plecoptera (stoneflies), the most pollution intolerant group, did not appear in any sample. However, some taxa were present in each sample from the relatively pollution-sensitive orders Ephemeroptera (mayflies) and Trichoptera (caddisflies).

Table 5 presents a summary of the primary metrics for the macroinvertebrate communities at the sample sites. Metric scores may have been affected by the lack of identification of chironomids beyond the family level (BI values for chironomid genera/species fall below and above the value of 8.0 assigned for chironomids at the family level (MDNR 2001). Taxa richness values ranged from 5-20; higher values should reflect better stream health as a reflection of greater habitat diversity and higher water quality. Galloway Creek fall samples had the highest taxa richness; however, all taxa richness values fell within the lower quartile (most impacted) of the expected distribution for a healthy stream in this geographic region.

Values for the EPT Index (number of taxa in sensitive insect orders) were from 1-3. These values are also within the lower quartile (most impacted) of expectations for a healthy stream (EPT values would need to be >12 to fall into a higher quartile). Biotic Index (BI) values were within a range of 7.2-8.0 for all samples. Lower BI values suggest a healthier, more pollution-sensitive invertebrate community. The lowest BI value was for Jordan Creek in fall 2010, in the 2nd quartile, indicating moderate impacts. BI values were in the lower quartile (most impacted) for other samples – this quartile includes values >7.35. Shannon Diversity Index (SDI) values were in the lower quartile range (most impacted) for Jordan Creek in spring 2011. SDI values for fall Jordan Creek and both Galloway Creek samples were in the 2nd quartile, indicating moderate impacts.

Physical Habitat

Summaries of the physical habitat data for each site for fall and spring are presented in Table 6. Photographs taken at sample sites are shown in Figures 1 and 2. Physical variables were similar between seasons at each site. Notable differences between streams include relatively higher percentages of bed rock at Jordan Creek and a higher percent gravel at Galloway Creek. No aquatic macrophytes were present at either site. Although not measured quantitatively, potential anthropogenic influences at both sites included residential and urban influences and siltation and other non-point source pollutants. Potential impacts also include effects of nearby bridge-crossings and roads. At Galloway Creek potential influences included nearby road construction at the James River Freeway downstream and pond construction work at Sequiota Park upstream of the sample site. However, these did not have an obvious influence on measured habitat metrics, including siltation and embeddedness.

The average grade for Habitat Parameters ranged from 12.7-14.8, in the Suboptimal range for both sites during each season (Table 7). Galloway Creek average grades (14.7) were somewhat higher than those for Jordan Creek (12.7). The lowest habitat values were for Jordan Creek riffle quality, the only values falling in the suboptimal range. Optimal Values were observed for Galloway Creek Epifaunal Substrate/Available Cover; this value indicates that the majority of the substrate provided potential surface for attachment or cover for macroinvertebrates, as indicated by the majority of the bottom covered by a mixture of cobble, large gravel, submerged logs, undercut banks, or other habitat. Both streams had Optimal values for Velocity/Depth Regime, and Galloway Creek exhibited Optimal Riffle Quality. All other values were in the suboptimal range. Note that for Galloway Creek the lowest Habitat Parameter scores were for factors reflecting excessive sediment input and poor riparian condition (Parameters B, D, F, I, and J); the highest Habitat Parameter scores were typically reflective of bottom habitat (Parameters A, C, G, and H).

Macroinvertebrate/Habitat Associations

The most apparent differences in macroinvertebrate metrics were seasonal differences, with better scores for most metrics in fall at all sites. Reasons for these differences are not known - there are no obvious indications of differences in habitat condition in fall and spring that would explain observed differences. Differences could reflect seasonality of species collected or be an indication of some impact to the streams between fall and spring sampling. Further information would be needed to draw any conclusions.

Macroinvertebrate metrics and physical habitat parameters tended to be lower in Jordan than Galloway Creek. The specific habitat metrics for Jordan Creek that could explain reduced

macroinvertebrate metrics include epifaunal substrate/available cover, riparian quality, and riparian vegetative zone width (Table 7). Further studies would be needed to define cause-and-effect relationships between habitat parameters and macroinvertebrate community health.

Year-to-Year Comparisons

Tables 8 and 9 summarize macroinvertebrate taxa richness and EPT scores for collections made for Springfield Urban Streams studies from fall 2004 through spring 2011. Samples were not collected in these streams from fall 2008 through spring 2010. Taxa richness scores are similar to those determined for previous years, but higher than average in fall for both Galloway and Jordan Creek. However, EPT scores are lower than average for both streams, most notably for Galloway Creek. We are unable to evaluate reasons for these differences or judge their significance using our data.

Conclusions

Galloway Creek and Jordan Creek each support an assemblage of aquatic macroinvertebrates made up of at least 5-20 taxa. Each location contains some taxa considered to be sensitive to human impacts. There is some indication of a more impacted macroinvertebrate community at Jordan than Galloway Creek. This study was not adequate to define cause-and-effect relationships between physical variables and biological condition; however, indications of stress on the streams included evidence of sediment deposition, poor riparian condition, and residential and urban influences. Observations for these streams over the past 8 years are in concurrence with Cuffney et al.'s (2010) observation that stream macroinvertebrate assemblages are commonly degraded even at low levels of urbanization and that measures previously viewed

as protective of urban streams may be associated with significant degradation of macroinvertebrate communities.

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Figure 1. Galloway Creek sample site.



Figure 2. Jordan Creek sample site.



Table 1. Benthic macroinvertebrate taxa collected in Galloway Creek, Fall (27 September) 2010. N indicates the number of individuals and BI is the Biotic Index value assigned for the taxon.

Class	Order	Family	Genus/Species	N	BI
Insecta	Coleoptera	Elmidae	<i>Stenelmis</i>	48	5.4
Insecta	Coleoptera	Elmidae	<i>Dubiraphia</i>	4	6.4
Insecta	Coleoptera	Haliplidae	<i>Peltodytes</i>	4	8.5
Insecta	Coleoptera	Elmidae	<i>Optioservus</i>	8	2.7
Insecta	Diptera	Chironomidae		820	8
Insecta	Ephemeroptera	Baetidae	<i>Baetis</i>	20	6
Insecta	Trichoptera	Philopotamidae	<i>Chimarra</i>	48	3
Insecta	Trichoptera	Hydropsychidae	<i>Chematopsyche</i>	64	6.6
Nematomorpha				80	na
Crustacea	Amphipoda			4	na
Crustacea	Amphipoda	Hyaellidae	<i>Hyaella</i>	160	7.9
Crustacea	Amphipoda	Crangoncytidae	<i>Crangonyx</i>	192	7.9
Crustacea	Copepoda			132	na
Crustacea	Decapoda	Cambaridae	<i>Orconectes</i>	4	2.7
Arachnida	Hydracarina			12	5.7
Oligochaeta				624	8
Branchiopodia	Cladocera			144	na
Turbellaria	Tricladida	Planarridae	<i>Dugesia</i>	108	8
Gastropoda	Basommatophora	Ancylidae	<i>Ferrissia</i>	4	6.9
Bivalvia	Veneroidea	Corbiculidae	<i>Corbicula</i>	48	6.3
			Total Individuals	2528	
			Average BIV		7.67

Table 2. Benthic macroinvertebrate taxa collected in Galloway Creek, Spring (15 April) 2011. N indicates the number of individuals and BI is the Biotic Index value assigned for the taxon.

Class	Order	Family	Genus/Species	N	BI
Insecta	Coleoptera	Elmidae	<i>Stenelmis</i>	20	5.4
Insecta	Diptera	Chironomidae		292	8
Insecta	Diptera	Ceratopogonidae		4	6
Insecta	Ephemeroptera	Baetidae	<i>Baetis</i>	24	6
Insecta	Trichoptera	Hydropsychidae	<i>Chematopsyche</i>	12	6.6
Crustacea	Amphipoda	Crangoncytidae	<i>Crangonyx</i>	64	7.9
Crustacea	Copepoda			60	na
Crustacea	Decapoda	Cambaridae	<i>Orconectes</i>	12	2.7
Oligochaeta				396	8
Turbellaria	Tricladida	Planariidae	<i>Dugesia</i>	64	8
Bivalvia	Veneroidea	Corbiculidae	<i>Corbicula</i>	12	6.3
			Total Individuals	960	
			Average BIV		7.76

Table 3. Benthic macroinvertebrate taxa collected in Jordan Creek, Fall (27 September) 2010. N indicates the number of individuals and BI is the Biotic Index value assigned for the taxon.

Class	Order	Family	Genus/Species	N	BI
Insecta	Coleoptera	Elmidae	<i>Stenelmis</i>	1	5.4
Insecta	Diptera	Ceratopogonidae	<i>Culicoides</i>	3	6
Insecta	Diptera	Ceratopogonidae	<i>Atrichopogon</i>	1	6
Insecta	Diptera	Chironomidae		36	8
Insecta	Ephemeroptera	Caenidae	<i>Caenis</i>	30	7.6
Insecta	Ephemeroptera	Baetidae	<i>Baetis</i>	44	6
Insecta	Trichoptera	Hydroptilidae	<i>Hydroptila</i>	1	6.2
Insecta	Odonta	Coenagrionidae	<i>Argia</i>	1	8.7
Nematomorpha				1	na
Arachnida	Hydracarina			2	5.7
Crangoncytidae	Amphipoda	Crangonyx		1	8
Oligochaeta				24	8
Crustacea	Copepoda			4	na
			Total Individuals	149	
			Average BIV		7.19

Table 4. Benthic macroinvertebrate taxa collected in Jordan Creek, Spring (18 April) 2011. N indicates the number of individuals and BI is the Biotic Index value assigned for the taxon.

Class	Order	Family	Genus/Species	N	BI
Insecta	Diptera	Chironomidae		69	8
Insecta	Ephemeroptera	Caenidae	<i>Caenis</i>	3	7.6
Arachnida	Hydracarina			1	5.7
Oligochaeta				120	8
Crustacea	Copepoda			59	na
			Total Individuals	252	
			Average BIV		7.98

Table 5. Summary of Primary Metrics for Benthic Macroinvertebrate Data

Location	Date	Taxa Richness	EPT Index	Biotic Index	Shannon Diversity Index
Galloway Creek	Fall 2010	20	3	7.67	2.09
Jordan Creek	Fall 2010	15	3	7.19	1.76
Galloway Creek	Spring 2011	11	2	7.76	1.62
Jordan Creek	Spring 2011	5	1	7.98	1.12

*The sampling and processing protocol and level of taxonomic identification used in this study differ from MDNR protocols and therefore may have affected the MSCI scores calculated in this study.

Table 6. Summary of Physical Habitat data for sample sites, Fall 2010 and Spring 2011. Data are averages of multiple measures or transects sections from MDNR Riffle/Pool Habitat Assessment Form (Sarver et al. 2002).

	Galloway Creek		Jordan Creek	
	Fall	Spring	Fall	Spring
Mean Width (m)				
Riffle	5.5	8	6.5	7.0
Run	5.3	5.8	7.8	7.8
Pool	6.5	6.9	9.5	7.1
Lower Bank Width	5.8		7.4	
Mean Depth (m)				
Riffle	0.13	0.15	0.25	0.10
Run	0.14	0.25	0.27	0.15
Pool	0.45	0.80	0.44	0.40
Substrate Percent				
Bedrock	0	0	40	40
Boulder (>10 in)	2	2	1	1
Cobble (2.5-10 in)	10	10	20	20
Percent Gravel (0.1-2.5 in)	75	75	30	30
Sand (<.1 in)	10	10	5	5
Silt	1	1	2	2
Compact Clay	0	0	0	0
Muck (with organic matter)	0	0	0	0
Woody debris (<6x36 in)	1	1	1	1
Snags (>6x36 in)	1	1	1	1
Riffle/Pool Habitat Assessment				
Mean Epifaunal Substrate/ Available Cover (percent)	88		41	40
Mean Embeddedness (percent)	36	34	30	24
Sediment Deposition (percent)	26	27	24	26
Bank Stability (% Erosion)	~15	~10	~15	21
Riparian Vegetative Protection (%)	68	68	78	67
Left Riparian Vegetative Zone Width (m)	>18	>18	6-12	
Right Riparian Vegetative Zone Width (m)	6-12	6-12	12-18	18
Macrophytes (percent coverage)	0	0	0	0
Periphyton (percent coverage)	<25	<25	<25	10
Human Influences				
Residential area	Yes	Yes	Yes	Yes
Urban industrial/commercial	Yes	Yes	Yes	Yes
Trash	Yes	Yes	Yes	Yes
Pasture				
Non-point source pollution	Yes	Yes	Yes	Yes
Siltation	Yes	Yes	Yes	Yes
Anaerobic sediments				
Filamentous algae prevalent				
Diatoms/blue-green algae prevalent				

Table 7. Grades for Habitat Parameters at sample sites, Fall 2010 and Spring 2011. Grades range from 0-20 for each parameter: 0-5=poor; 6-10=Marginal; 11-15=Suboptimal; 16-20=Optimal (MDNR Riffle/Pool Habitat Assessment Form, Sarver et al. 2002). Optimal values are in bold. Marginal values are underlined. All other values are Suboptimal.

	Galloway Creek		Jordan Creek		Average
	Fall	Spring	Fall	Spring	
Habitat Parameter					
A. Epifaunal substrate/available cover	19	19	11	11	15.0
B. Embeddedness	14	14	15	16	14.8
C. Velocity / depth regime	18	18	17	17	17.5
D. Sediment deposition	13	11	12	12	12.0
E. Channel flow status	13	13	13	13	13.0
F. Channel alteration	13	13	13	13	13.0
G. Riffle Quality	16	16	<u>10</u>	<u>10</u>	13.0
H. Bank Stability	14	14	12	12	13.0
I. Vegetative Protection	14	14	13	13	13.5
J. Riparian Vegetative Zone Width	14	14	11	11	12.5
Average	14.8	14.6	12.7	12.8	
Total	148	146	127	128	137.3

Table 8. Comparison of Macroinvertebrate Taxa Richness Fall 2004–Spring 2011. Samples were not collected from these streams Fall 2008–Spring 2009.

	Galloway	Jordan
Fall 2004	22	18
Spring 2005	19	15
Fall 2005	14	11
Spring 2006	17	7
Fall 2006	13	12
Spring 2007	15	5
Fall 2007	10	11
Spring 2008	10	7
Fall 2010	20	15
Spring 2011	11	5

Table 9. Comparison of Macroinvertebrate EPT Fall 2004–Spring 2011. Samples were not collected from these streams Fall 2008–Spring 2009.

	Galloway	Jordan
Fall 2004	7	4
Spring 2005	7	3
Fall 2005	3	3
Spring 2006	7	2
Fall 2006	4	5
Spring 2007	4	1
Fall 2007	4	3
Spring 2008	4	1
Fall 2010	3	3
Spring 2011	2	1