

## CHAPTER 5: ELEMENT C. - MANAGEMENT MEASURES

### 5.1 GOALS FOR DEER CREEK WATERSHED

Watershed goals are listed below. These goals are also listed in Chapter 9 with interim measurable milestones and Chapter 10 with specific, time-sensitive performance criteria by which we can measure our progress towards each goal. Permitted activities will be addressed by the appropriate regulatory authority and cannot be supported by Section 319 funds.

#### A. Maintain and improve water quality and quantity in watershed related to a one-year storm event or less.

1. Capture the first 1.14 inch of rainfall in rainscaping projects to reduce primary and secondary pollutants of concern. See Table 4-8 on page 4-11 for the estimated number of rainscaping BMPs to be installed in 5-year periods and the minimum estimated load reductions for *E. coli*, sediment (TSS) and nutrients (TP & TN).
  - a. Define Green Infrastructure Management Methods
  - b. Engage residential, municipal and commercial audiences in stormwater management.
  - c. Install at least 760 rainscaping BMPs by 2040.
2. Reduce additional identified pollutant inputs.
  - a. At least 9 tons of trash, plastics, leaf litter, and/or organic debris removed or prevented from entering Deer Creek annually.
  - b. Reach state water quality criteria for *E. coli* levels in Deer Creek by 2040.
  - c. Reach state water quality criteria for chloride levels in Deer Creek by 2050.

#### B. Reduce the risk of stream bank erosion, sedimentation, and flooding from a one year or greater storm event.

1. Maintain and improve the natural stream physical stability and reduce stream widening and bank erosion.
  - a. Capture first 2.5 inches of stormwater runoff to improve channel stability and function.
  - b. Assess, implement, and maintain detention systems to manage channel protection.
2. At least 2000 linear feet or 10 acres of riparian corridor restored and appropriately landscaped to reduce impacts on erosion, sedimentation, and creek widening by 2040.
  - a. Support greenway/trail development along riparian corridors.
  - b. Promote invasive species removal and native plant establishment.
  - c. Identify willing landowners for voluntary purchase/sale and permanent removal from development.
  - d. Enhance existing wetlands using a “wetland arboretum” approach, with minimal soil disturbance.
3. Protect groundwater supplies in sensitive karst areas
  - a. Prevent sinkhole contamination
  - b. Prevent groundwater contamination

#### C. Finalize EPA accepted watershed plan updates in 2022 and in 2027.

1. Expand and improve watershed modeling efforts.
2. Continue and refine watershed monitoring efforts.
3. Continue ongoing planning and implementation efforts.

Following is a list of management measures objectives, as associated with each goal outlined above.

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#### A1 CAPTURE THE FIRST 1.14 INCHES OF RAINFALL IN RAINSCAPING PROJECTS TO REDUCE E.COLI AND NUTRIENTS IN STREAMS

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##### a. Define green infrastructure best management practices (BMPs)

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- 1) Green infrastructure systems are defined as strategies to manage stormwater runoff at the local level through the use of natural systems, or engineered systems that mimic natural systems, to treat polluted runoff.
- 2) Identified Best Management Practices (BMPs) in the Deer Creek Watershed include: Rain gardens, bioswales, and bioretention; soil amendments and mulching; stormwater harvesting; lawn alternatives (i.e. replacing lawn grass with deep rooted plants); urban tree protection, tree planting, and urban forest management strategies; rock weirs and filter socks; permeable pavers and green roofs. See [mobot.org/rainscaping](http://mobot.org/rainscaping) for a detailed description of these BMPs. See Appendix 5B, A Case for Native Soil Landscaping BMPs, for a white paper documenting the scientific basis for these BMPs. One of the key references in this white paper is a 5 year USGS rain garden study (see Appendix 5C). Ninety percent of storms in the greater St. Louis region have historically been 1.14 inches of rainfall or less. These BMPs are not expected to handle all of the rainfall from large storms that are typically associated with flooding problems. However, they should capture most of the rainfall from these small storm events to improve water quality.
- 3) Develop and maintain a map of stormwater BMPs installed by public and private entities across the watershed (to help track projects and progress and help with modeling and reporting load reductions for future plan revisions).

##### b. Engage residential, municipal and commercial audiences in stormwater management

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- 1) Engage residential property owners in managing stormwater as 67% of land in the watershed is single family residential.
  - a. Provide financial incentives for voluntary participation in stormwater management through a rainscaping cost-share program.
  - b. Provide technical support for best management practices through online resources, social media, workshops and webinars.
  - c. Support annual citizen engagement projects in the watershed.
  - d. Involve citizens in local parks maintenance, including tree inventory, tree maintenance, and/or tree planting efforts with emphasis on native trees.
  - e. Encourage downspout disconnections where appropriate. Provide incentives to reroute increased overland flow to rainscaping features.
- 2) Support municipalities to implement stormwater management measures
  - a. Support the development of and implementation of stormwater master plans in each municipality.
  - b. Support the development of municipal planning and zoning efforts that may include a combination of incentives, ordinances, removal of barriers and/or case study implementation.
  - c. Identify and share model ordinances that impact water quality and stormwater quantity, including local and model urban forest management programs.
  - d. Support communities in addressing land disturbance of less than one acre to reduce erosion and/or contain stormwater.

- e. Assist municipalities in managing parks and existing public lands for stormwater management.
- 3) Develop strategies to assist commercial entities to engage as responsible watershed stakeholders.
  - a. Target landscaping companies and horticultural industry to receive education on rain gardens and bio-retention systems. Develop a long-term rain garden maintenance strategy that includes training for landscapers, education for installers, and provide technical assistance.
  - b. Encourage retail to stock/sell Low Impact Development (LID) products: rain barrels and attachments, rain garden kits/instructions, rain garden plants, soil amendments, etc.
  - c. Identify invasive plants as undesirable and discourage nurseries from stocking; encourage nursery stocking of native plants.
  - d. Encourage use of pervious pavement and bioretention in parking lots.

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## **A2 REDUCE ADDITIONAL IDENTIFIED POLLUTANT INPUTS**

### **a. At least 9 tons of trash, plastics, leaf litter, and/or organic debris removed or prevented from entering Deer Creek annually.**

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- 1) Identify and prioritize parcels in the watershed needing yard waste and organic debris removal as recommended by watershed municipalities.
- 2) Support annual volunteer trash clean-ups in the watershed.
- 3) Pilot test the use of aquatic collectors.
- 4) Reduce the volume of homeowner leaf litter entering streams in the watershed. Target outreach to property owners along creeks.

### **b. Reach State Water Quality Criteria for *E. Coli* Levels in Deer Creek by 2040**

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- 1) Identify septic systems in the watershed.
- 2) Design and pilot an inspection, maintenance, and replacement cost-share program for septic systems.
- 3) Target market septic system cost-share program to streamside landowners with septic systems.
- 4) Reduce *E. Coli* from pet waste through education.
- 5) Develop and maintain a map of the area streams, storm sewers and storm sewer outfalls.
- 6) Survey the creeks for illicit connections to storm sewers, illegal dumping, and failing septic systems.
- 7) Develop and implement a program to detect and eliminate illicit discharges into area streams (MSD)
- 8) Eliminate 100% of combined sewer overflows by 2030, 85% of sanitary sewer overflows by 2023 and 100% of sanitary sewer overflows by 2033 to reduce *E coli* and nutrient loads in streams (MSD)

### **c. Reach State Water Quality Criteria for Chloride Levels in Deer Creek by 2050**

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- 1) Collect salt usage and chloride data.
- 2) Conduct brining training workshop for road salt applicators and maintenance crews on private developments.
- 3) Reduce chloride from salt use by private and public entities through education.
- 4) Develop a TMDL for chloride for Black Creek and Deer Creek and gain EPA approval.

For a chart of recommended chloride pollution reduction strategies and detailed links and resources, see Appendix 4-A.

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**B1 MAINTAIN AND IMPROVE THE NATURAL STREAM PHYSICAL STABILITY AND REDUCE STREAM WIDENING AND BANK EROSION.**

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**a. Capture first 2.5 inches of rainfall to improve channel stability and function**

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- 1) Design rainscaping features that capture 2.5 inches of rainfall
- 2) Conduct seminars on the mechanics of stream dynamics related to flow for planners, public works staff, and developers.
- 3) Explore opportunities to restore pool-riffle-pool sequences in the creek and tributaries.
- 4) Maintain instream flow and explore other opportunities to restore habitat and species diversity.

**b. Assess, implement, and maintain detention systems to manage channel protection.**

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- 1) Assess technical and cost feasibility of regional detention systems.
- 2) Reassess protocols for private on-site basin maintenance and implement best management strategies.
- 3) Assess existing on-site basin facilities for opportunities for channel protection retrofitting (i.e. changing outlet structures to provide channel protection function).

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**B2 AT LEAST 2000 LINEAR FEET OR 10 ACRES OF RIPARIAN CORRIDOR RESTORED AND APPROPRIATELY LANDSCAPED TO REDUCE IMPACTS ON EROSION, SEDIMENTATION AND CREEK WIDENING BY 2040.**

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**a. Support greenway/trail development along riparian corridors.**

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- 1) Trail construction along parts of Deer Creek and its tributaries will provide additional public access to the creek, serve to heighten awareness and interest in the creek and its condition, and highlight water quality management strategies to the general public.
- 2) Implement Phase I and remaining phases of Deer Creek Preserve with trail along riparian corridor in Ladue.

**b. Promote invasive species removal and native plant establishment**

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- 1) Implement model invasive species removal projects.
- 2) Replant with trees and other native plants.
- 3) Engage citizens in invasive species removal efforts.
- 4) Provide invasive species education for planning, public works, and parks and recreation departments, landscape architects, and the general public.

**c. Identify willing landowners located in the floodplain for voluntary purchase/sale and permanent removal from development.**

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- 1) Identify and prioritize parcels for purchase in the riparian corridor and set aside development rights in perpetuity as recommended by watershed municipalities.
- 2) Facilitate the purchase and set-aside of development rights of these properties as prioritized.
- 3) Use FEMA buyout opportunities to buy back floodplains.
- 4) Educate FEMA Administrators at municipalities on floodplain development/ redevelopment restrictions (as a tool for opening floodplains).
- 5) Solicit FEMA and others for additional floodplain buyout funding.
- 6) Explore opportunities to pass municipal ordinances that restrict or eliminate building in the floodplain.

**d. Support appropriate wetland restoration and enhancement.**

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- 1) Establish a wetland arboretum at the corner of Brentwood Blvd. and Marshall Ave.
- 2) Identify and implement other suitable wetland enhancements

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**B3 PROTECT GROUNDWATER SUPPLIES IN SENSITIVE HIGH KARST AREAS.**

**a. Prevent sinkhole contamination.**

- 1) Assess if pollutants in stormwater are being adequately filtered before entering sinkholes.
- 2) Redirect stormwater to prevent it from directly draining in sinkholes

**b. Prevent groundwater contamination.**

- 1) Assess the effectiveness of the incorporation of forebays/underdrains in bioretention systems to prevent groundwater contamination in high karst areas.

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**C1 EXPAND AND IMPROVE WATERSHED MODELING EFFORTS.**

- a. Model the existing conditions of the watershed as a basis to compare and evaluate proposed improvements or proposed policies.
- b. Take into account the high cost of modeling efforts in a large watershed.
- c. Use the Simple Model and iTree analysis tools to project and assess effectiveness of pollutant reduction from BMPs and other management measures implemented.
- d. Develop a TMDL for chloride for Black Creek and Deer Creek to determine estimated load reductions and additional management measures needed to attain water quality standards.

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**C2 CONTINUE AND REFINE WATERSHED MONITORING EFFORTS.**

- a. Monitor the effectiveness of at least three demonstration BMPs over a 5 year period to inform future efforts. Recalibrate models based upon empirical data collected.
- b. Monitor effectiveness of bioretention systems – underdrains vs. no underdrains.
- c. Track and make available information on size, scope, location and effectiveness of area BMPs.
- d. Assess aquatic and riparian ecotone species diversity.
- e. Continue ongoing water quality monitoring efforts in the Deer Creek Watershed.

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**C3 CONTINUE ONGOING PLANNING EFFORTS**

- a. Utilize the Planting Prioritization Plan to guide the prioritization of watershed projects. (See “Identifying Critical Areas” section of this chapter.)
- b. Convene annual Technical Advisory Group, Community Leaders Task Force, and Steering Committee meetings to achieve regular stakeholder inputs.
- c. Gain acceptance and use of the updated 2022 Deer Creek Watershed Plan by municipalities in the watershed.
- d. Evaluate implementation successes and challenges.

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**5.2 NPDES PERMIT DISCHARGE AND COMPLIANCE INFORMATION**

Metropolitan Sewer District’s Saint Louis County NPDES Phase II Permit requires compliance with six Minimum Control Measures (MCMs) . The following describes their strategy for each of the measures:

***Public Education and Outreach***

Implement a public education program to distribute educational materials to the community and conduct outreach activities about the impacts of storm water discharges on water bodies and the steps that the public

can take to reduce pollutants in storm water runoff. Activities include 1) distribution of brochures on pet waste management, yard waste, on impacts from businesses, and more; 2) sponsoring a storm water school article contest; 3) developing a storm water pollution prevention video airing four storm water infomercials; and 4) seminars for small businesses.

#### ***Public Involvement and Participation***

The public is actively involved in implementation of the storm water management program through community groups of all kinds and participation in activities to reduce storm water pollution. Activities include storm drain marking, stream clean-ups, neighborhood trash clean-ups, volunteer presentations and household hazardous chemical collections.

#### ***Illicit Discharge Detection and Elimination***

MSD has developed and implemented a program to detect and eliminate illicit discharges into our MS4 and area streams. They developed and maintain a map of the area streams, storm sewers, and storm sewer outfalls. Activities include surveying the creeks for illicit connections to storm sewers, illegal dumping, and failing septic systems.

#### ***Construction Site Storm Water Runoff Control***

Land disturbance programs must be implemented to reduce pollutants in storm water runoff from construction activities that disturb the land. The BMPs required by the program focus primarily on erosion and sediment control. Activities include St Louis County government implementing a new Land Disturbance Code requiring storm water pollution prevention plans for all major land disturbance projects disturbing one acre or more of land, and the implementation of the model Land Disturbance Ordinance by all municipal co-permittees.

#### ***Post-Construction Stormwater Management***

A program to address stormwater runoff from new development and redevelopment projects must be implemented to reduce pollutants in stormwater runoff from developed property. The program must ensure that BMPs are in place to prevent or minimize water quality impacts. Structural BMPs include stormwater detention ponds, infiltration basins, filter strips and more. Activities in the plan include revising MSD's rules, regulations and engineering design requirements for storm water drainage facilities, adopting ordinances to support changes to engineering design requirements, and submitting a stormwater funding mechanism based on impervious area for voter approval.

#### ***Pollution Prevention/Good Housekeeping for Municipal Operations***

An operation and maintenance program that has the ultimate goal of preventing or reducing pollutant runoff from municipal operations will be implemented by all co-permittees. Activities in the plan include developing a model operation and maintenance program, initiating a training program to educate the municipal employees, assessment by municipalities of their existing ordinances pertaining to trash and pet waste management, and development of model ordinances for trash and pet waste management for municipalities to adopt.

In addition, MSD has various educational videos available regarding storm water management, trash disposal, pet waste, household chemicals, motor oil disposal, yard waste, and development. These videos are available for viewing on the MSD web site <http://www.stlmsd.com/MSD/PgmsProjs/PhaseII>

### 5.3 LOCAL MUNICIPALITY STORMWATER MANAGEMENT PLANS

Section 319 funds cannot pay for any NPDES/MS4 permit requirements in a Storm Water Management Program (SWMP) Plan nor capture any of the efforts as nonfederal match towards a 319 project. However, everything above and beyond what is required in a MS4 permit can be supported by 319 and counted as nonfederal match with the appropriate documentation.

#### 5.31 City of Brentwood Flood Mitigation Master Plan

Stormwater flooding has inundated the area along Deer Creek between Hanley Road and South Brentwood Boulevard 26 times since 1957, creating significant public safety issues and causing property damage. The Deer Creek Flood Mitigation project includes the planning, design and construction of improvements to the Deer Creek channel and floodplain to alleviate ongoing flooding problems and protect properties from frequent flooding. These updates will also provide a greater opportunity for businesses to move to the area. <https://www.brentwoodmo.org/21/Comprehensive-Plan>

##### IMPLEMENT IMPROVEMENTS INCLUDING:

- Streambank stabilization
- Native vegetation planting
- Natural floodplain restoration (benching and widening)

##### THE IMPROVEMENTS WILL:

- Improve public safety
- Revitalize an underutilized area of the City by creating an opportunity for the development of the entire Manchester Road corridor in the City
- Reduce emergency response and flood clean-up costs and increase taxable revenue
- Reduce number of flood-prone properties
- Restore floodplain

#### 5.32 City of Clayton Stormwater Master Plan

The City of Clayton is experiencing redevelopment where large areas of small ranch homes are being replaced by larger homes that take up a much larger portion of the lot. This redevelopment, combined with the stormwater problems that have historically occurred in Clayton, is aggravating an already serious urban drainage problem. Although the City has limited redeveloped parcels to a maximum of 55% impervious coverage, this increased coverage has created a stormwater drainage concern for the impacts on both the redeveloped lots and surrounding properties.

The City retained CH2M HILL in January 2006 to provide engineering services necessary to perform a City-wide Stormwater Study. In particular, the study emphasizes the use of low impact development (LID) technologies as an alternative to, or in conjunction with, conventional stormwater management techniques

to solve stormwater problems. The study also includes a review of the City's ordinances and Urban Design District standards and makes recommendations to improve stormwater management.

**Key elements of the study include:**

- Delineation of major and minor watersheds within the City limits on a master map and determine hydrologic characteristics within the City of Clayton
- Interviews with City Staff and City Officials
- Surveys of the public
- Review of complaint records and previous engineering studies
- Identification of the potential causes for flooding, erosion and sewer backups
- Identification of development issues related to stormwater
- Review of the City's development related ordinances and policies, and preparation of recommendations to address these development issues.
- Development of a prioritized list of projects including a conceptual scope of work for each project for financial project planning

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### 5.33 City of Creve Coeur Stormwater Master Plan

The City of Creve Coeur experiences multiple stormwater problems within its boundaries. To benefit its citizens, the City has identified the need to assess the multitude of drainage related problems by updating its last Watershed Plan done in 1999 to develop a new path to implement comprehensive and technically sound solutions to these problems. Many of the problems stem from increased runoff from development. Changes in land use have a major effect on both the quantity and quality of stormwater runoff. Urbanization, if not properly planned and managed, can dramatically alter the natural hydrology of an area because it increases impervious cover. Impervious cover decreases the amount of rainwater that can naturally infiltrate into the soil and increases the volume and rate of stormwater runoff. These changes lead to more frequent and severe flooding, streambank erosion, and therefore, increase potential damage to public and private property.

One solution that helps mitigate these effects is to enact ordinances requiring elements of low impact development (LID). LID is a stormwater management system that works by utilizing the natural processes of the water cycle. LID treatment networks are designed not to exceed the carrying capacity of a site's landscape and can incorporate a number of stormwater BMPs, such as rain gardens, vegetated filter strips, bioswales, pervious pavement, and green roofs.

The scope of the Watershed Management Plan Update has been to review the existing Master Plan, collect the available watershed information (including a stormwater questionnaire distributed to citizens in 2010), evaluate known problems, develop appropriate project alternatives to solve them, and prioritize the projects in a fair and equitable manner.

55% of the City of Creve Coeur lies within the Deer Creek Watershed.

For further details see <https://bit.ly/2WXYTVJ>.

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#### 5.34 City of Ladue Stormwater Master Plan

City of Ladue hired HR Green to complete a citywide storm water needs assessment in 2015. They mapped existing complaint data on file from all available sources, obtained new data from residents as well as their own field evaluations of streams, and developed a basic hydraulic model of the entire City. Over 1000 problem points were mapped. At the September 2016 City Council meeting, the contract with HR Green was approved for the development of the Storm Water Master Plan and five-year implementation plan. A draft of the Master Plan was developed which involved performing field verification work of storm water conditions, hydraulic modeling utilizing specialized software, and developing concept solutions for 55 projects. After approval from the City Council, the plan was then presented to the public in a series of Public Open House meetings in Spring 2017. Over 120 residents attended these open houses and many provided feedback. HR Green made modifications to the plan based on public comment and additional field reconnaissance. The five-year implementation plan was presented to the City Council on July 17, 2017 for adoption. Specific Storm Water project meetings for the eight highest ranking projects took place during Fall 2017 to convey information about the projects and to obtain Letters of Intent from impacted property owners. Once Letters of Intent were obtained from 100% of the impacted property owners from projects approved in the five-year implementation plan, the design phase began. City of Ladue is now working on implementation of projects with funding received through ½ cent sales tax.

For further details see

<https://www.cityofladue-mo.gov/departments/public-works-department/storm-water-management-program-319>.

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#### 5.35 City of Frontenac Stormwater Master Plan

The City of Frontenac Stormwater Master Plan is based on the recommendations made in the Stormwater Needs Assessment (EDM, 2005). The Stormwater Needs Assessment discussed four levels on which stormwater issues occur and made recommendations for each. This document addresses the first level: Physical Stormwater System. This first level is discussed below along with the recommended objectives to the City of Frontenac.

In many municipalities, the distinction is made between public and private stormwater problems. The municipality will typically resolve the public problems leaving the private problems to the homeowners. With such a strong passage of the half-cent sales tax and the nature of many of the returned questionnaires, it does not appear that the City of Frontenac needs to make this distinction. However, the stormwater projects that the City does undertake should be done in a fair, efficient and effective manner with a focus on system-wide impacts.

***The objectives the city adopted are:***

- Correct the noted deficiencies in the stormwater system
- Ensure proposed solutions do not create additional problems
- Resolve problem areas efficiently by understanding the comprehensive needs of the city
- Prioritize problem areas to ensure critical problems are resolved first

- Plan for future development within and adjacent to the city, which may impact the stormwater system

This master plan addresses the above objectives and lays out a clear plan for problem resolution. A hydraulic model has been developed to evaluate the effects of the solutions proposed therein. Solutions are prioritized according to financial, safety, and environmental properties. They consider economies of scale and are grouped accordingly.

The following specific tasks were accomplished in producing that part of the Master Plan:

**L1-1 Survey:** Structure data not currently in the MSD database was surveyed to include top and flow-line elevations as well as missing structures. Approximately 450 manholes, inlets, and outfalls as well as incoming and outgoing pipe sizes and types were surveyed in the field. Top elevations for an additional 280 inlets, manholes, and end of pipes (flow-lines) were also surveyed. Approximately 80 creek-sections were surveyed along with 25 bridges and culverts with road profiles. Surveying was done by Burdine and Associates.

**L1-2 Hydraulic Model:** The existing MSD dynamic hydraulic model of the existing system was expanded using XPSWMM. Hydrology was developed for over 1050 nodes (places for water to enter the model). Characteristic-hydraulic field data was obtained for 26,000 feet of open channels. Eighty-six open channel cross-sections were added to the model along with 25 bridges. Seven detention basins were added to the existing conditions model and five more added to the proposed detention basins model. Survey data was integrated into the existing model. The model was checked to determine missing data, which was obtained and the model refined. Numerous attempts to calibrate the model were made, but MSD results could not be duplicated. The majority of the reason for this is credited to use of a newer version of XPSWMM. Results in the main channel do in general more closely resemble the HEC-2 results used to map the floodplain. Both existing and future conditions were run and are documented therein.

**L1-3 Additional Problem Areas:** Additional areas of concern were identified in the hydraulic model. Stormwater problems in commercial areas, based on results from a city mailing to commercial operations in Frontenac, were analyzed, mapped and conceptual solutions developed. The master plan also accounts for additional residential questionnaires.

**L1-4 Conceptual Solutions:** Conceptual solutions were developed and grouped according to subwatersheds for problems identified in the needs assessment and this master plan. Conceptual solutions were developed in written form and an exhibit was produced. Proposed solutions were analyzed with the existing conditions hydraulic model and impacts were documented. Cost estimates were developed and a benefits analysis was performed. Problem groups were prioritized and a stormwater capital improvement plan was developed.

**L1-5 Identify Financial Benefits:** As with most capital improvement projects, implementation of stormwater projects tends to increase property values. This task evaluates the change in property values that will accompany implementation of the conceptual solutions. This shows the dollar value of the improvement to the residents of Frontenac.

For further details see <https://ascelibrary.org/doi/abs/10.1061/40927%28243%293>.

This update consists of accounting for additional stormwater concerns identified since the completion of the original Master Plan, dated June 2007, as well as changes to planned projects. Completed projects are now shown as existing infrastructure on the appropriate figures.

All the hydraulic models have been updated to account for inaccuracies found since the Master Plan was released. The existing conditions dynamic hydraulic model (XPSWMM) was updated for completed projects and the results are presented. Additional proposed solutions and changed solutions were evaluated in the XPSWMM model. Different alternatives were evaluated for Monsanto-Sunswept Creek in the Glen Abbey-Oak Gate area.

The hurricane Ike storm event of September 14, 2008 was evaluated for severity and documented flooding was compared with the hydraulic model results. A summary of stormwater projects proposed by the St. Louis Metropolitan Sewer District (MSD) is presented. The 5-year Stormwater Improvement Plan was updated as well as a prioritized summary of all projects.

For further details see Appendix 5-D City of Frontenac Stormwater Master Plan Update 2020.

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### 5.36 City Of Richmond Heights Storm Water And Sewer Management Program

Although the City lies within the St Louis Metropolitan Sewer District (MSD), there was a need to assess the storm sewer system. The location, capacity, condition, and shortcomings of the existing system were assessed in 2001.

The Richmond Heights stormwater management program began with several goals.

These goals are:

- Delineation of major watersheds within the city limits (Subwatersheds Plate).
- Determine characteristics (Hydrological and Hydraulic)
- Conduct surveys and interview with city officials and residents.
- Review of complaint records and previous engineering studies.
- Identify the potential causes for flooding, erosion and sewer backups.
- Identify possible solutions and costs to fix the problems based on experience and best engineering judgment.
- Develop a prioritized list of projects for financial planning.

In June 2001, seventeen improvement projects were identified. Of these 17 projects, 10 projects had been completed as of November 12, 2010.

## 5.4 IDENTIFYING CRITICAL AREAS

It has been determined that mean *E. coli* loads for all sources during rain events are many times greater than those measured during base flow.<sup>1</sup> Therefore a key mechanism for reducing bacteria load as well as other

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<sup>1</sup> p. 30, "Occurrence and Sources of E. Coli in Metropolitan St. Louis Streams", Oct. 2004-2007–USGS, MSD  
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pollutants is the reduction of overland stormwater runoff that carries those pollutants.

Deer Creek Watershed Alliance has identified eleven BMPs that reduce stormwater runoff, as described in this chapter, primarily by improving soil permeability through rainscaping. These eleven rainscaping BMPs are native soil rain gardens, engineered bioretention systems or rain gardens, bioswales, creek corridor vegetative buffer or riparian corridor restoration, lawn alternatives, woodland restoration, green roofs, permeable pavers, soil amendments, filter socks and rock weirs, and rainwater harvesting.

In order to identify critical areas, the Alliance hired Davey Resource Group to assess 5 environmental variables that will maximize the effectiveness of the identified rainscaping BMPs to reduce stormwater runoff and pollutants. Each of these variables were assigned a weighted value and analyzed on separate grid maps using data from various sources. See Table 5-1 below.

**Table 5-1. Priority Ranking Variables**

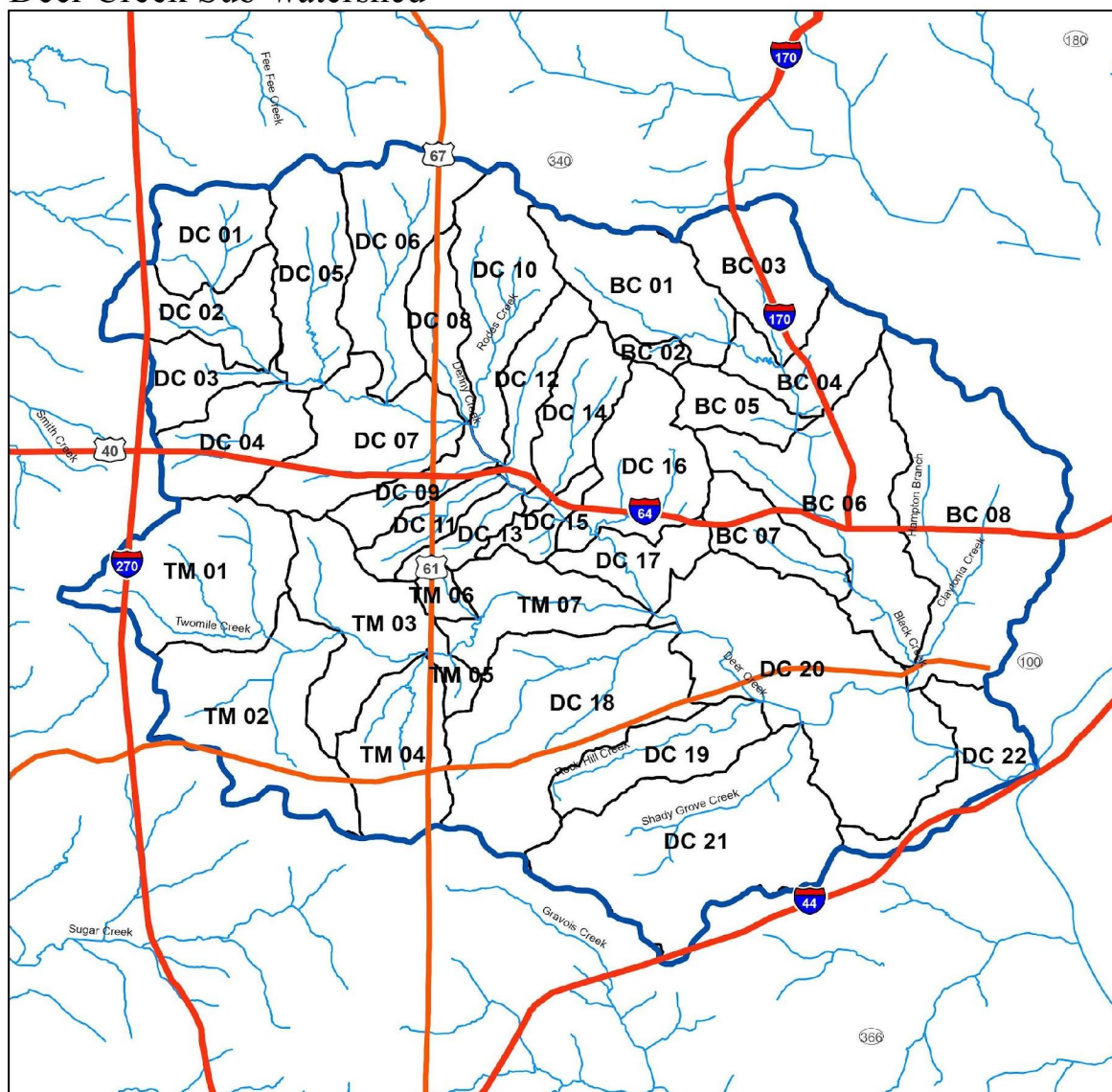
	Dataset Source	Weight
Proximity to Floodplain	FEMA Flood Zones	0.30
Canopy Fragmentation	Urban Land Cover	0.20
Proximity to Hardscape	Urban Land Cover	0.15
Slope	Elevation Data	0.15
Soil Erosion (K-factor)	SSURGO Soils	0.10

Planting location polygons were created by taking all grass/open space and bare ground areas and combining them into one dataset. Non-feasible planting areas such as agricultural fields, recreational fields, major utility corridors, airports, buildings, etc. were removed from consideration. Using zonal statistics, the priority grid raster was used to calculate an average value for each planting location polygon. The averages were grouped and each piece of land was assigned a priority rating from 1 (Very Low) to 5 (Very High).

**The process was further refined by identifying which Deer Creek subwatersheds have the highest ratio of priority area to area of land and the highest estimated *E. coli* load reductions for each of the subwatersheds.** Deer Creek Watershed Alliance determined that the subwatersheds with the highest rankings are the most critical areas to address first in reducing stormwater runoff in the watershed, and the subwatersheds were prioritized accordingly as high, medium, and low. See Map 5-1 below for an alphanumeric identification of each subwatershed, and Table 5-2 below for a priority ranking and implementation schedule of Deer Creek subwatersheds in 5-year periods to 2040.


April 2019

## Deer Creek Sub-watershed



### Legend

- Interstates
- Highway
- Streams
- Deer Creek Watershed Boundry
- Subwatersheds

2 Miles 

Deer Creek Watershed Alliance

a project of  MISSOURI BOTANICAL GARDEN

Sources: Deer Creek Watershed;  
USDA Natural Resources Conservation Service  
Geospatial Data Gateway;  
United States Geological Survey;  
St. Louis County GIS Service Center

St. Louis  
COUNTY  
6th Service Center

USDA  
Natural Resources  
Conservation  
Service

USGS  
science for a changing world

Map 5-1. Alphanumerical Identification of Subwatersheds

**Table 5-2. Priority Ranking and Implementation Schedule of Deer Creek Subwatersheds**

Priority Ranking	Implementation Schedule	Subwatersheds	# of Single Family Residential Landowners	Municipality	Tributary Name
High	Years 1-5 (2020-2025)	DC 01, DC 02*	580	Creve Coeur	Upper Deer Creek
High	Years 1-5	DC 05*	673	Creve Coeur, Westwood, Frontenac	Windrush Creek, Upper Deer Cr.
High	Years 1-5	TM 01	811	Des Peres, Country Life Acres, Crystal Lake Park, Frontenac, Town & Country	Unnamed Tribs., Twomile Creek
High	Years 1-5	TM 02	1532	Des Peres, Frontenac, Kirkwood	Twomile Creek, Claychester Creek
High	Years 6-10 (2026-2030)	TM 03	524	Frontenac, Kirkwood, Huntleigh	Middle Twomile Creek
High	Years 6-10	DC 07	585	Frontenac, Ladue, Creve Coeur	Wildflower Creek
High	Years 6-10	BC 01	928	Ladue, University City, Olivette	Upper Black Creek
High	Years 6-10	BC 08	2603	Richmond Heights, Maplewood	Hampton Branch, Claytonia Cr.
High	Years 6-10	DC 06*	533	Creve Coeur, Frontenac	Monsanto-Sun swept
High	Years 6-10	DC 08*	305	Creve Coeur, Ladue	Denny Creek
High	Years 6-10	DC 10*	525	Creve Coeur, Ladue, Olivette	Pebble Creek
High	Years 6-10	DC 12, DC13, DC 15, DC 17	442	Ladue	Unnamed Tribs., Middle Deer Cr.
High	Years 6-10	DC 19*	1186	Glendale, Rock Hill, Warson Woods, Webster Groves	Rock Hill Creek
High	Years 6-10	DC 21*	2778	Glendale, Warson Woods, Webster Groves	Shady Grove Creek
High	Years 6-10	DC 20, DC22*	3462	Webster Groves, Maplewood	Lower Deer Creek

Priority Ranking	Implementation Schedule	Subwatersheds	# of Single Family Residential Landowners	Municipality	Tributary Name
Medium	Years 11-15 (2031-2035)	TM 04	866	Kirkwood, Huntleigh	Unnamed Tribs. Twomile Creek
Medium	Years 11-15	TM 05	39	Warson Woods, Huntleigh	Unnamed Trib. Twomile Creek
Medium	Years 11-15	TM 06	47	Ladue, Huntleigh	Unnamed Trib. Twomile Creek
Medium	Years 11-15	TM 07, DC 16	330	Ladue, Huntleigh	Lower Twomile Creek, Unnamed Tribs. Middle Deer Creek
Medium	Years 11-15	BC 05	218	Ladue, Clayton, Richmond Heights	Unnamed Trib. Middle Black Cr.
Medium	Years 11-15	DC 03	95	Creve Coeur, Westwood	Unnamed Trib. Upper Deer Cr.
Medium	Years 11-15	DC 04	214	Town & Country, Westwood, Frontenac	Unnamed Tribs. Upper Deer Cr.
Medium	Years 11-15	DC 09	185	Frontenac, Ladue	Unnamed Trib., Middle Deer Cr.
Medium	Years 11-15	BC 07	384	Richmond Heights, Brentwood	Unnamed Trib. Lower Black Cr.
Medium	Years 11-15	DC 18	2627	Glendale, Kirkwood, Rock Hill, Warson Woods, Ladue	Sebago Creek
Low	Years 16-20 (2036-2040)	BC 02, BC 03, BC04, BC06, DC11, DC14	2546	Multiple	Multiple

**\*Highly ranked and riparian corridor areas will be scheduled or already have been scheduled where denoted for targeted implementation efforts during years 1 through 5 (2020-2025) and 6 through 10 (2026-2030).** Forty-two parcels with potential septic systems have been preliminarily identified in the Deer Creek Watershed. See Map 3-1 in Section 3.47. Septic system parcel landowners in riparian corridors, within 500 feet of a stream, will be targeted during years 1 through 5 as well for septic system inspection, maintenance, and replacement as part of the Rainscaping Cost-Share Program to achieve a higher E. coli load reduction. **Medium ranked areas will be scheduled for targeted implementation efforts during years 11 through 15 (2031-2035).** The remaining subwatersheds prioritized as low will be scheduled for targeted implementation efforts during years 16 through 20 (2036-2040).

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#### 5.41 BMP Prioritization Strategy for Implementation in Critical Areas

A key finding of this Deer Creek Watershed Management Plan is that because a relatively high 67% of the land in the Deer Creek Watershed is owned by single family residents, any successful implementation plan must be capable of reducing nonpoint source runoff from a substantial percentage of the land in the watershed and include a strategy to engage those residents in active watershed management for stream health. Therefore, the majority of implementation projects will be installed through the Rainscaping Cost-Share Program (RCSP) targeting residential landowners for voluntary participation and giving them the option to choose from the identified best management practices. Rainscaping Best Management Practices (BMPs) identified as most suitable for residential application to reduce runoff and pollutants in the Deer Creek Watershed include: Rain gardens and bioswales; soil amendments and mulching; stormwater harvesting; lawn alternatives (i.e. replacing lawn grass with deep rooted plants); urban tree protection, tree planting, and urban forest management strategies; rock weirs and filter socks; permeable pavers and green roofs. See [mobot.org/rainscaping](http://mobot.org/rainscaping) for a detailed description of these BMPs. Implementation projects in the watershed will be concentrated and installed in identified priority focus areas per the schedule and ranking above in order to maximize the combined impacts of the different projects on a single sub-watershed. A list of eligible Rainscaping BMPs, a list of design, installation, and maintenance contractors that have successfully participated in the last 12 months of the RCSP, and other RCSP materials will be maintained at [deercreekalliance.org/cost-share](http://deercreekalliance.org/cost-share) for use by landowners choosing to voluntarily participate in the program. Contractors will be hired by individual landowners to design and install the most suitable Rainscaping BMP(s) for the site. Landowners must follow design and project guidelines to qualify for reimbursement.

Native soil rain gardens will receive the highest rating when landowners apply per the funding selection criteria of the Rainscaping Cost-Share Program. Therefore, native soil rain gardens will be prioritized for installation. They can achieve the goal to capture the first 1.14 inches of rain without an underdrain and without replacing existing soil with a sandy soil mix in residential settings where no development is taking place. Initial infiltration rates must be .25 inches per hour or greater, and the rain garden must be planted with prairie or other deep rooted native plants. A healthy soil ecosystem with a high percentage of organic matter will result in aggregated soil particles, improved soil structure, and therefore improved infiltration rates. Where initial infiltration rates are lower than .25 inches per hour, installing lawn alternatives to improve soil infiltration rates by adding appropriate soil amendments and deep rooted plants across a wide section of the yard will be prioritized instead of rain gardens. These rainscaping BMPs are excellent alternatives to installing an engineered bioretention system with an underdrain as they have a greater estimated *E. coli* removal rate of 90%, TSS removal rate of 90%, TP of 65%, and TN of 58% and are more affordable for residential landowners to design, install, and maintain. See Appendix 5B: A Case for Native Soil Landscaping BMP's for a white paper documenting the scientific basis for these BMPs. One of the key references in this white paper is a 5 year USGS rain garden study (see Appendix 5C: USGS Rain Garden Study). Ninety percent of storms in the greater St. Louis region have historically been 1.14 inches of rainfall or less. These BMPs are not expected to handle all of the rainfall from large storms that are typically associated with flooding problems. However, they should capture most of the rainfall from these smaller, more frequent storm events to improve water quality.

In addition to these Rainscaping BMPs, a septic system inspection, maintenance repair and cleaning, and replacement option will be designed in the 4th quarter of 2023 and added as a pilot of the Rainscaping Cost-Share Program in Round 2024 to achieve a higher *E. coli* load reduction. Septic system parcel landowners in riparian corridors, within 500 feet of a stream, will be targeted for program participation. Forty-two parcels with potential septic systems have been preliminarily identified in the Deer Creek Watershed. See Map 3-1 in Section 3.47 and Table 4-12 *E. coli* (counts/year) load reduction for septic system removal/ replacement or maintenance by type for single family homes. If this septic system inspection, maintenance repair and cleaning, and replacement option is chosen by these targeted landowners, it must be paired with one of the plant-based solutions that removes and replaces a minimum of 100 square feet of established lawn, invasive species, impervious surface, or bare ground to achieve minimum load reduction and program goals. The desired outcome is that at least 4 to 5 of these targeted landowners will apply to and be funded through this program as part of this pilot in years 1 through 5 (2020-2025).

In addition to the implementation projects that will be installed via the RCSP, years 1 through 5 (2020-2025) will include the implementation of the Deer Creek Preserve in Ladue with a linear trail with one loop along the riparian corridor in 2023. This section of riparian corridor along Deer Creek will be restored, and the invasive honeysuckle will be removed and replaced with native plants. Years 1 through 5 (2020-2025) will also include the final design, implementation, and maintenance of a wetland restoration demonstration project in Brentwood in 2023, 2024, and 2025. The City of Brentwood plans to purchase the property south of Bi-State Metro Garage at Brentwood Blvd. and Marshall Ave. in Brentwood. Recommendations for this wetland restoration project came out of the DCWA Technical Advisory Group Metro Wetland Restoration Design Charrette in April 2017, sponsored by Great Rivers Greenway, City of Brentwood, and other partners. The recommendations from this charette will lay a foundation for the final design to implement this project. Both of these projects will also be installed in identified high priority focus areas. **See Chapter 8 for a detailed outline of tasks by management objective with timeline for completion.**