



Boulder Green Infrastructure Strategic Plan





City of Boulder Green Infrastructure Strategic Plan 2019



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Table of Contents

Executive Summary	1
1.0 Project Background	4
2.0 Project Organization and Deliverables	5
3.0 Stakeholder Engagement Strategy	6
4.0 Stakeholder Groups/Roles/Charge	8
5.0 Internal Stakeholder Meeting Summaries	10
6.0 Process and Policy	11
7.0 Engineering and Projects	19
8.0 Future Program Recommendations	30

List of Tables

Table 1. Core Team Members	8
Table 2. Internal Stakeholder Group	8
Table 3. Critical Success Factor for Post-Construction Process and Policy Strategies	13
Table 4. City Staff Interviewed for Process and Policy Data Gathering	13
Table 5. Abbreviated Critical Success Factors and Strategies for Post-Construction Processes and Policies	15
Table 6. Performance Standard Hierarchy and Selection Criteria	16
Table 7. SOPPs Target Work Groups and Primary Project Reviewer	18
Table 8. Project Evaluation Criteria	23
Table 9. Pilot Project Priority Summary for Planning Level	26
Table 10. Tantra Park Pilot Projects	29
Table 11. Post-Construction Program Recommendations	31



List of Figures

Figure 1. Maintenance Process Defined in SOP	18
Figure 2. GIS Aerial Map Showing City-Owned Properties in the Boulder Creek Watershed	20
Figure 3. GIS Analysis Flowchart for GI Specific	21
Figure 4. Summary of Top Ranked CIP and GI Specific Selection and Analysis	23
Figure 5. Locations of the Seven Pilot Projects Selected for Planning Level Design	24
Figure 6. Tantra Park Documented Drainage Issues	27
Figure 7. Tantra Park Pilot Project	27

List of Appendices

Appendix 1: Internal Stakeholder Meeting Summaries and Presentations
Appendix 2: Post-Construction SOPPs
Appendix 3: Summary Memo of Stakeholder Exercise to Create GI Evaluation Criteria
Appendix 4: Concept Design Boards for Selected Pilot Projects
Appendix 5: Detailed Design Memo: Tantra Park

Executive Summary

Introduction

Boulder's current National Pollutant Discharge Elimination System (NPDES) Phase II Municipal Separate Storm Sewer System permit is more prescriptive than the City's previous permit, particularly in the requirements for Post-Construction Stormwater Management (*i.e.*, management of water quality on new developments and redevelopments *after* construction is complete). Some of the new requirements pertain to the use of Low Impact Design (LID) principles and Green Infrastructure Stormwater Control Measure (GI SCMs) for post-construction water quality management, and how such controls are designed.

This **Stormwater Green Infrastructure Strategic Plan** (the Plan) identifies and describes how the City can meet the post-construction requirements of the Phase II MS4 permit requirements; proactively identify future City projects that can be addressed by green infrastructure; and promote the use of green infrastructure throughout the City. To achieve these goals, the development of the plan focused on three distinct project areas:

1. internal stakeholders;
2. post-construction process and policy; and
3. engineering analysis and prioritized City projects.

This Executive Summary outlines the accomplishments of each project area and presents the future recommendations of the Stormwater Green Infrastructure Strategic Plan.

Internal Stakeholder Process

It is City staff who will be left with the outcomes of the Green Infrastructure Strategic Plan; therefore, information and input from City staff throughout the Plan development were critical to the Plan's effectiveness. Because of this, an internal stakeholder (*i.e.*, City staff) process was used to guide the Plan development and project outcomes. More specifically, City staff: 1) identified needs, opportunities, and problems for the use of green infrastructure in Boulder; 2) provided overarching guidance on the Plan's objectives, strategies, and prioritization of City projects; and 3) collaborated on City project outcomes.

Two Internal City staff groups were formed: **the Core Group** and **the Internal Stakeholder Group**. The primary role of the Core Group was to review and provide comments on Plan strategy recommendations (*e.g.*, Design and Construction Standards revisions) before providing them to the larger Internal Stakeholder Group. Individual staff meetings and touch points with the **Core Group** occurred throughout the course of this project. The primary role of the **Internal Stakeholder Group** was to provide high-level input, overall program visioning, and assist in the development of specific strategies for engagement of additional stakeholders. Five interactive meetings were provided to the Group over the course of the project (February 2018 through February 2019). Initially, the Group created the overarching vision for the Plan and developed Critical Success Factors for project deliverables. Plan strategies, the engineering analysis, and City project conceptual designs were measured against these Critical Success Factors many times throughout the project. In this way, the Group steered all project deliverables as they were developed. The Group also identified engagement strategies for City administration, external (non-City staff) stakeholders, and the public to build support for the Plan and ensure its effectiveness.

Ultimately, the involvement of City staff throughout this project provides a strong foundation for the strategies contained in the Plan and the other deliverables of this project. The internal stakeholder process ensures that the Plan is effective and achievable **for Boulder**.



Internal Stakeholder Meetings were used to gain input and provide collaboration between departments. The picture above is from Stakeholder Meeting 4 in which 7 Pilot Projects were presented and Stakeholders shared their likes and dislikes about each project.

Executive Summary

Process and Policy

The primary objective of the process and policy task was to develop strategies for the integration of LID principles and GI SCMs in keeping with Colorado's Phase II MS4 Permit. In this light, the strategies must address GI SCMs for both private and public land development projects and across the SCM life-cycle (*i.e.*, design, construction, and maintenance). The steps employed to develop process and policy strategies for the Plan are listed below.

1. Reviewed relevant data and documents. Identified and listed initial process and policy needs and gaps.
2. Interviewed key City staff and gathered stakeholder input and critical success factors. Refined list of process and policy needs and gaps and began preliminary strategy development.
3. Reviewed preliminary strategies with staff. Added, eliminated, and prioritized preliminary strategies.
4. Reviewed prioritized list with stakeholders and gained input.
5. Refined and expanded to create fully formed draft strategies. Reviewed and commented on by staff.
6. Finalized strategies.
7. Executed critical, top priority strategies for permit compliance and created Work Plans for the remaining highest priority strategies (see Future Program Recommendations below).

Two critical, top priority strategies were executed during this project, as follows. The project outcomes for these strategies are summarized below.

1. Update of the Boulder Design and Construction Standards (DCS) to address the post-construction requirements of the Phase II MS4 permit.
2. Development of interdepartmental Standard Operating Policy and Procedures (SOPPs) for use on City land development projects.

DCS Revision Summary

The DCS required updating to comply with several specific post-construction requirements of the permit and to facilitate the integration of LID and GI SCMs as tools for planning and design of public and private land development projects. Note that DCS updates did not pertain solely to LID and GI SCMs. In fact, many updates were needed to comply with the new, and more prescriptive, requirements of the Phase II MS4 permit. These requirements are in place regardless of the post-construction SCM (*e.g.*, green infrastructure, traditional detention/filtration SCMs, and proprietary SCMs) selected by the designer.

SOPPs Summary

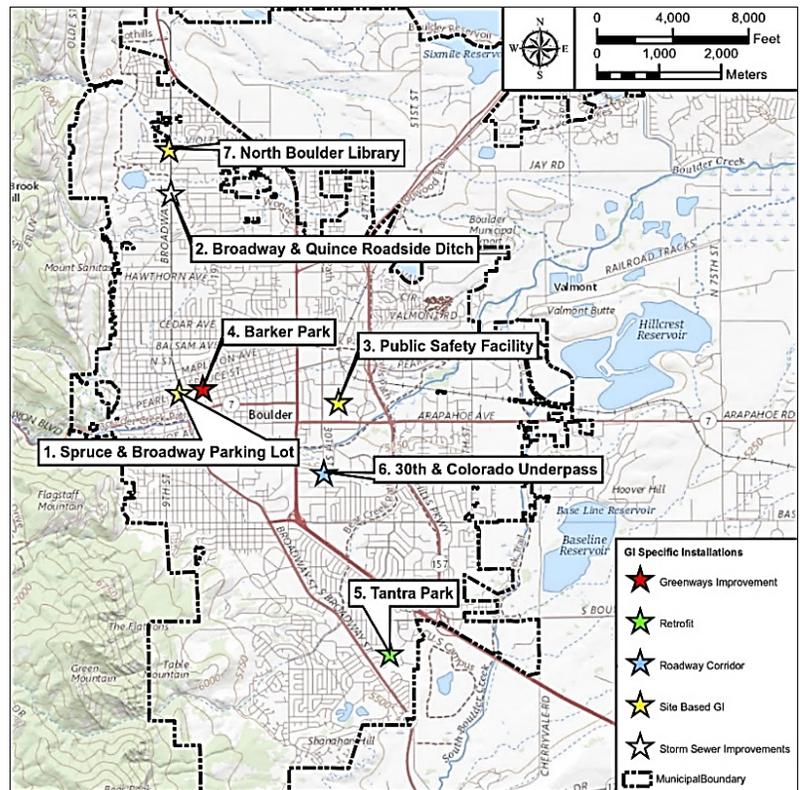
The SOPPs ensure permit compliance, establish clear expectations, facilitate knowledge sharing, and identify collaboration opportunities for public projects. They address the life-cycle of SCMs by addressing planning, design, construction and maintenance of SCMs. The SOPPs were prepared with substantial input from the Core Group. This was done to: explain requirements and responsibilities based on the Phase II MS4 Permit; ensure the SOPPs could fit within department and group work flows; develop design processes; and facilitate SOPP acceptance.

Executive Summary

Engineering and Projects

The goal of the Engineering & Projects task was to define a process to identify pilot projects within the City based on a repeatable prioritization process. This included development of a prioritized list of projects that can be adapted for incorporation of GI SCMs as part of current and future Capital Improvement Program (CIP) projects across City departments.

The identification and development of candidate projects and locations for GI began with a review of existing City CIP plans and budgets by department. In addition, a GIS-based mapping and assessment exercise overlaying specified criteria to identify locations for potential GI installation projects within the City limits was completed. Over thirty potential projects resulted from these two exercises. A project evaluation tool that provides a uniform set of objective evaluation criteria for rating and ranking projects for the prioritization of CIP funds to both assist with larger city CIP projects and to implement GI specific installation projects based on opportunities and City priorities was developed and vetted by the Internal Stakeholder Group. The projects were further evaluated by this tool and staff discussions, and seven representative projects were selected for concept plan development. The concept plans were shared with the Internal Stakeholder group during Meeting 4 and feedback was obtained. The feedback obtained was used to further refine the concept design plan for Tantra Park and a detailed Design Memo was created for this site.



Seven preliminary pilot project locations were identified and preliminary planning level designs were shared with the Internal Stakeholder Group during Meeting 4.

Future Program Recommendations

The **Stormwater Green Infrastructure Strategic Plan** provides the strategies to implement a Green Infrastructure Program and meet Phase II MS4 permit requirements. As mentioned in the Process and Policy section, execution of the critical, top tier strategies for permit compliance were completed during this project. However, many other strategies are identified and prioritized in the Plan to ensure development of an effective and fully-formed Program. **Work Plans** for the remaining highest tier strategies were developed and are included in the Plan. These are as follows.

- Work Plan 1: Establish WQES as City Authority for Permit Required SCMs.
- Work Plan 2: Post-Construction Stormwater Education and Training.
- Work Plan 3: Upgrade Long-Term O&M Program for City-Owned SCMs.
- Work Plan 4: Further Develop and Implement a Water Quality CIP Project.

The stakeholder input and assistance of City and UDFCD staff were invaluable to the development of the project vision, critical success factors, and the development and implementation of the strategies in this Plan. As each of the Work Plans are created and implemented, it is recommended to continue to engage the Core Group as needed for each Work Plan. It is also recommended that the Internal Stakeholder Group meet on a biannual basis to provide continual input on the overall project vision and direction.



1.0 Project Background

Located at the base of the foothills of the Rocky Mountains, Boulder is a small city with a high quality of life, a diverse and vibrant economic base, and tremendous open space resources. The community enjoys the natural and recreational amenities resulting from decades of progressive land use planning, which preserves a vast rural and undeveloped landscape that encircles the City. Boulder’s identity and future are inextricably linked with the natural environment, and environmental sustainability has been a long-standing and primary guiding principle in planning and policies.

The City’s current Phase II Municipal Separate Storm Sewer System (MS4) permit with the State of Colorado is more prescriptive than the previous permit, particularly around Post-Construction water quality. It also expands options by providing for a **volume reduction-based approach to water quality**, which lends itself well to green infrastructure (GI). Taking a more intentional approach to stormwater requirements and strategic implementation allows green infrastructure to potentially address City stormwater quality and quantity issues. Benefits can include water quality treatment of polluted stormwater, reduction of localized (nuisance) flooding, beautification of urban corridors using vegetation, mitigation of the urban heat island effect, and public outreach and education on water quality via appropriate signage and educational materials at GI installations.

The goal of this Stormwater Green Infrastructure Strategic Plan is to assist the City with meeting the requirements of the Phase II MS4 permit while taking a proactive approach to identifying future stormwater needs and influencing sustainable planning and design throughout the City. The plan focuses on two primary stormwater related areas with internal City stakeholder engagement being an integral part of the project: **(1) process and policy**; and **(2) engineering analysis and prioritized projects**.



Environmental sustainability has been a long-standing principle in the City of Boulder.



2.0 Project Organization and Deliverables

The project deliverables were organized in the four specific areas below and are further described in the following sections of this Plan.

▶ Internal Stakeholder Process (Section 3-5)

- List of core group and internal stakeholders and related contact information;
- List of staff interview participants; and
- Facilitate and develop content for the five internal stakeholder meetings.

▶ Process and Policy (Section 6)

- Series of staff interviews to determine existing procedures and processes;
- Background data review identifying challenges and opportunities to GI implementation; and
- GI Process and Policy Strategy for incorporation into the overall Stormwater GI Strategic Plan for future implementation. This included:
 - Updated Design and Construction Standards (DCS), and
 - Established Standard Operating Policies and Procedures (SOPPs).

▶ Engineering and Projects (Section 7)

- A prioritized list of opportune City Capital Improvement Project (CIP)-based projects and GI-specific installations;
- Identification of seven planning-level pilot projects with the creation of initial concept designs; and
- Development of preliminary design and costing for one pilot project.

▶ Future Program Recommendations (Section 8)

- Development of process and policy strategies for a permit-compliant Post-Construction Program;
- Development of a detailed strategy table tied to the internal stakeholder-developed project Critical Success Factors;
- Development of four program specific work plans:
 - Work Plan 1: Establish WQES as City Authority for Permit Required SCMs;
 - Work Plan 2: Post-Construction Stormwater Education and Training;
 - Work Plan 3: Upgrade Long-Term O&M Program for City-Owned SCMs;
 - Work Plan 4: Further Develop and Implement a Water Quality CIP; and
- Recommended next steps for Stakeholder Involvement.



3.0 Stakeholder Engagement Strategy

Implementation of GI strategies by a public entity is simple in concept but far more complex in practice. Boulder staff recognized this when planning for this project with the statement “***The implementation of GI in the city is as much about internal and regulatory policy/process development as it is about planning and engineering***”. In fact, effective and appropriate use of GI within a community is influenced by many factors, including: current municipal codes and land use plans; NPDES permit post-construction requirements; geographic, geologic and topographic features; meteorological conditions; stakeholder and public understanding of GI; current maintenance policies (private) and activities and resources (public); individual land use types (public or private, residential or non-residential, green field or developed); connectivity to public spaces; right-of-way restrictions, etc. As a result, the processes and policies of any municipality that integrates GI into their public and/or private land development program must recognize all of these factors appropriately. There is no “one size fits all” solution for a community, and many times the right solution may already be a part of the community – it just needs to be enhanced. In the end, each jurisdiction requires policy and process solutions that will fit its unique mix of administrative, financial, technical, political and social norms, thus ensuring a successful GI plan implementation.

Ultimately, it is City staff who will be left with the outcomes of the Green Infrastructure Strategic Plan; therefore, the primary goal of the project was to develop a plan that is effective and achievable **for Boulder**. Information and input from City staff throughout this project was critical. It was imperative that stakeholders were engaged early to foster input, collaboration, and acceptance of recommended strategies. Without this, the Green Infrastructure Strategic Plan can break down during implementation as a result of cross-departmental misunderstandings or discontent. As well, the consultant team’s experience is that stakeholders are most engaged when they can understand the concepts being presented and the perceptions or views of other departments. GI can quickly become a highly technical subject matter when discussed among engineers and scientists, and it is common for technical discussions to cause worries about the administrative, resource, or educational aspects of GI. This can obscure understanding and prevent acceptance.

For Boulder, the consultant team used a two-tiered, internal (*i.e.*, City staff only) stakeholder program that was designed to:

- educate City staff on GI concepts and their typical impacts on land development policies and processes for both public and private projects;
- gather information and input from City staff for initial strategy recommendations for GI program implementation;
- engage City staff in GI strategy building, prioritization, and finalization;
- engage City staff to determine possible areas of overlap and collaboration; and
- define strategies for building support for the plan from City administration, external stakeholders, and the general public.

Two stakeholder groups were engaged as follows and are further described in the **Stakeholder Groups/Roles Section**.

- The **Core Group** consisted of City staff that, ultimately, will be tasked with implementation of the future Boulder Green Infrastructure Program on private land developments or public projects. This included the City’s NPDES-MS4 Permit administrator, Water Quality and Environmental Services Manager and other staff, public project engineering managers, private development plan review manager, and a technical representative from Urban Drainage and Flood Control District. The Core Group worked closely with the consultant team, primarily reviewing and providing comments on strategy recommendations before providing them to the larger Internal Stakeholder Group.



- The **Internal Stakeholder Group** consisted of the Core Group plus other key City staff who manage groups or have responsibilities that can be influenced, supported, or impacted by the strategies and outcomes of the overall Green Infrastructure Strategic Plan. The primary role of the group was to provide high-level input, overall program visioning, and assist in the development of specific strategies for engagement of City administration, external stakeholders, and the general public to building support for the plan, where deemed appropriate. The end result of the stakeholder process was to ensure larger support from City staff such that it is a foregone conclusion that these procedures and policies for both public and private will be implemented. The Internal Stakeholder Group met five times over the course of the project.



4.0 Stakeholder Groups/Roles/Charge

City Project Manager

Purpose: The City Project Manager (Candice Owen) provided overall direction and insight into the project and deliverables.

Core Team

Purpose: The Core Team provided technical direction and input for public and private policies and projects. This group helped to shape the deliverables (procedures/tools/policy/pilot projects) to ensure that they were practical and implementable for both permit compliance and to meet the overall City vision for the project. This group was highly involved in helping develop the DRAFT deliverables at each stage of the project.

Table 1. Core Team Members:

Name	Title	Group	Email	Phone
Candice Owen	Stormwater Quality Supervisor	PW/Utilities	owenc@bouldercolorado.gov	303-413-7329
Bret Linenfelser	Water Quality and Environmental Services Manager	PW/Utilities	LinenfelserB@bouldercolorado.gov	303-413-7355
Pieter Beyer	Engineering Services Manager	PW/Utilities	BeyerP@bouldercolorado.gov	303-441-3293
Edward Stafford	Development Review Manager	PW/P&DS	StaffordE@bouldercolorado.gov	303-441-4276
Gerrit Slatter	Principal Transportation Projects Engineer	PW/Transportation	SlatterG@bouldercolorado.gov	303-441-1978
Holly Piza	Standards Development Manager	UDFCD	hpiza@udfcd.org	303-455-6277
Kevin Koryto	Stormwater Quality Engineer	PW/Utilities	KorytoK@bouldercolorado.gov	303-413-7386

Internal Stakeholder Group

Purpose: The primary role of the group was to provide high level input, overall program visioning, and to assist in the development of specific strategies for engagement of City administration, external stakeholders, and the general public to build support for the plan, where deemed appropriate. The end result of the stakeholder process was to ensure larger support from City staff such that it is a foregone conclusion that these procedures and policies for both public and private will be implemented.

Table 2. Internal Stakeholder Group:

Name	Title	Group	Email	Phone
Christin Shepherd	Flood and Wetland Administrator	PW/P&DS	shepherdc2@bouldercolorado.gov	303-441-1889
Kelly Wasserbach	Engineering and Project Management Supervisor	OSMP	wasserbachk@bouldercolorado.gov	720-564-2064
Elizabeth Judd	Senior Landscape Architect	PW/P&DS	JuddE@bouldercolorado.gov	303-441-3138
Jessica Andersen	Landscape Plans Reviewer-Development Review Inspector	PW/P&DS	AndersenJ2@bouldercolorado.gov	303-441-4416
Ward Bauscher	Utilities Maintenance Manager	PW/Utilities	bauscherw@bouldercolorado.gov	303-441-4199
Michele Crane	Facilities Design And Construction Manager	FAM	CraneM@bouldercolorado.gov	303-441-4275



5.0 Internal Stakeholder Meeting Summaries

Name	Title	Group	Email	Phone
Jeff Haley	Planning, Design and Community Engagement Manager	P&R	HaleyJ@bouldercolorado.gov	303-413-7233
Candice Owen	Stormwater Quality Supervisor	PW/Utilities	owenc@bouldercolorado.gov	303-413-7329
Bret Linenfelser	Water Quality and Environmental Services Manager	PW/Utilities	LinenfelserB@bouldercolorado.gov	303-413-7355
Pieter Beyer	Engineering Services Manager	PW/Utilities	BeyerP@bouldercolorado.gov	303-441-3293
Edward Stafford	Development Review Manager	PW/P&DS	StaffordE@bouldercolorado.gov	303-441-4276
Gerrit Slatter	Principal Transportation Projects Engineer	PW/Transportation	SlatterG@bouldercolorado.gov	303-441-1978
Holly Piza	Standards Development Manager	UDFCD	hpiza@udfcd.org	303-455-6277
Kevin Koryto	Stormwater Quality Engineer	PW/Utilities	KorytoK@bouldercolorado.gov	303-413-7385

Communication Schedule:

Five Internal Stakeholder Meetings from February 2018 to February 2019 were provided to this group (see following section).



Meeting 1	<p>Topic: Project Kick-Off Objectives: Ensure stakeholder understanding of project and their roles; identify and prioritize cross-departmental stakeholder goals for the Stormwater GI Strategic Plan. Meeting Length: 2 hours Location: Community Room Alfalfa’s Grocery Store Date: February 6, 2018</p> <p><i>The complete meeting presentation and summary material is provided in Appendix 1.</i></p>
Meeting 2	<p>Topic: GI Engineering and Projects (City Projects) Objectives: Green Infrastructure Visioning: understand City priorities and types of projects that would work in Boulder. Meeting Length: 2 hours Location: Main Boulder Library Date: April 5, 2018</p> <p><i>The complete meeting presentation and summary material is provided in Appendix 1.</i></p>
Meeting 3	<p>Topic: Process and Policy (Private Projects) Objectives: Review, discuss and finalize recommended process and policy strategies. Meeting Length: 2 hours Location: Main Boulder Library Date: May 29, 2018</p> <p><i>The complete meeting presentation and summary material is provided in Appendix 1.</i></p>
Meeting 4	<p>Topic: GI Engineering and Projects Objectives: Review, discuss, and finalize recommended Pilot Projects. Meeting Length: 2 hours Location: Main Boulder Library Date: October 10, 2018</p> <p><i>The complete meeting presentation and summary material is provided in Appendix 1.</i></p>
Meeting 5	<p>Topic: Review of Green Infrastructure Strategic Plan and Next Steps Objectives: Review of project vision and critical success factors, review of major project deliverables (SOPPs and DCS revisions), provide next steps/work plans and obtain feedback, determine future stakeholder involvement. Meeting Length: 2 hours Location: Main Boulder Library Date: February 6, 2019</p> <p><i>The complete meeting presentation and summary material is provided in Appendix 1.</i></p>



6.0 Process and Policy

Background

Part 1.E.4 of Colorado's Phase II MS4 Permit (effective on July 1, 2016) establishes the permit's requirements for post-construction stormwater management in new development and redevelopment. Among many other conditions, Part 1.E.4 requires that post-construction stormwater from applicable developments be managed to meet or exceed at least one of four base water quality treatment standard options. The "Runoff Reduction Standard" is one of the four base standards. It requires the use of GI to infiltrate, evaporate, or evapotranspire a prescribed quantity of post-construction stormwater. The permit further says that GI can be used in place of or in addition to low impact development (LID) principles.

When scoping the Green Infrastructure Strategic Plan, the City recognized the need for strategies pertaining to administrative processes and policies surrounding the use of GI and LID. This need was recognized for both public and private land developments and is not surprising. Changes to land development processes and policies are frequently needed for local governments that are just beginning to integrate GI and LID as accepted approaches for stormwater management. To some extent, the planning of LID and the design, construction, and maintenance of GI stormwater control measures (SCMs) differs from typical site designs that manage stormwater using traditional SCMs. Contrary to traditional SCMs, GI SCMs rely on soil and (often) vegetation to reduce runoff volumes through infiltration, evaporation, and evapotranspiration. Thus, soil and vegetation must be considered as critical functional components of a site's stormwater management system. They must be planned, designed, constructed, and maintained according to performance standards and specifications that will ensure their function over the lifetime of the SCM, as is essential for any other critical component of a traditional SCM (e.g., inlet or outlet structure, grates, headwalls, storage areas, etc.).

This paradigm shift of considering soil and vegetation as functional, engineered components of a site's stormwater management system, as opposed to viewing them simply as landscaping, is highly significant to project designers. Native soil and vegetation, which are often best for infiltration and evapotranspiration, are typically removed, destroyed, compacted, or otherwise changed when land is first developed. For redevelopments, vegetation is typically sparse and non-native. Further, the onsite soil is often non-native (*i.e.*, fill) and highly compacted by the existing development's pavement, buildings, and grading. All these issues complicate the planning, design, and construction of properly functioning green infrastructure SCMs using the existing, traditional design and construction processes and the land development processes and policies of local governments. As a result, this paradigm shift constitutes a real challenge to City staff, project designers and site contractors, most of whom are not trained in the planning and implementation of LID principles and GI SCMs. Cognizant of these disconnects between the GI requirements of the Phase II MS4 Permit and the City's current post-construction processes and policies, City Water Quality and Environmental Services (WQES) staff initiated efforts to develop the GI Strategic Plan as a roadmap for addressing process and policy needs.

Strategy Development Approach

The steps employed to develop process and policy strategies for this GI Strategic Plan are listed below.

1. Reviewed relevant data and documents. Identified and listed initial process and policy needs and gaps.
2. Interviewed key City staff and gathered stakeholder input and critical success factors. Refined list of process and policy needs and gaps and began preliminary strategy development.
3. Reviewed preliminary strategies with WQES staff. Added, eliminated, and prioritized preliminary strategies.
4. Reviewed prioritized list with stakeholders and gained input.
5. Refined and expanded to create fully-formed draft strategies. Reviewed and commented on by WQES staff.
6. Finalized strategies.



7. Executed critical, top priority strategies for permit compliance and created Work Plans for the remaining highest priority strategies. Work Plans are provided in Section 8.

Objectives, Goals, and Critical Success Factors

Task Objective

Initially, the primary objective of the process and policy task was to develop strategies for the integration of GI SCM design, construction, and maintenance in keeping with Colorado's Phase II MS4 Permit. The strategies would address GI SCMs for both private and public projects. However, after the need/gap analysis progressed and program and initial stakeholder input was gathered, the task objective was expanded, as follows.

The objective of the process and policy task is to develop strategies for the integration of post-construction stormwater management program elements, including LID principles and GI SCMs, in keeping with Colorado's Phase II MS4 Permit and stakeholder goals.

This change in objectives was made for two reasons. First, in addition to including GI SCMs as a compliance option, Colorado's 2016 Phase II MS4 permit added numerous other new requirements for permittee's post-construction programs. These requirements pertain to a variety of program elements: excluded developments; control measures and base water quality treatment standards; site plans; construction inspection and acceptance; long-term maintenance and oversight; SCM tracking and enforcement; training; reporting; and recordkeeping. City staff were already aware of needed process and policy updates to align the City's post-construction program with all the permit's conditions. However, the GI need/gap analysis revealed that the City's needs/gaps for implementing GI SCMs were strongly intertwined with its needs/gaps for the post-construction program in general. Thus, GI strategies could be developed in tandem with strategies to upgrade the City's post-construction program, thus obtaining cohesive and comprehensive strategies within a single strategic plan.

The second reason for expansion of the process and policy task objective came from the stakeholder group. In their first and second meetings, stakeholders clearly expressed the desire to emphasize LID principles and GI SCMs as preferred methods for post-construction stormwater management on private and public projects.

Task Goals and Critical Success Factors (CSFs)

Preliminary goals for the process and policy task were developed based on the conditions of the Phase II MS4 Permit and the need/gap analysis. These goals are listed below.

- Prelim. Goal 1. Comply with MS4 Permit requirements by July 2019.
- Prelim. Goal 2. Eliminate conflicts and inadequacies in City of Boulder Code and the UDFCD Manual relevant to design and maintenance needs for SCMs.
- Prelim. Goal 3. Ensure consistent, effective, and efficient oversight of SCMs.
- Prelim. Goal 4. Provide support to site designers and SCM owners.
- Prelim. Goal 5. Establish and adopt rules to guide GI SCM usage on City projects.

These goals were tested against, and combined with, preliminary CSFs developed by stakeholders in their first meeting. CSFs are the group of goals that must be attained for the Strategic Plan to be successful. CSFs broadly guide the strategies being developed.

The preliminary goals and initial stakeholder CSFs aligned well, and the goals were integrated into the initial CSFs. Revised CSFs were presented to stakeholders in their second meeting. Final CSFs were used to guide the development of process and policy strategies. The final CSFs are listed in the following table.



Table 3. Critical Success Factors for Post-Construction Process and Policy Strategies

The Phase II Municipal Separate Storm Sewer System (MS4) permit requirements are clearly communicated to all City staff.
Short- and long-term green infrastructure recommendations and requirements related to development are clearly communicated to the City and the public. The review standards for both development types are consistent.
All stormwater program compliance gaps related to construction control measures are identified and resolved.
The City has a solid understanding of the material, maintenance, equipment and skillsets required for green infrastructure features and the costs associated with such installations and programs.
All departments integrate and collaborate to include green infrastructure into future City plans.
Key green infrastructure projects are identified and conceptually designed for inclusion in the CIP program.
Recommended changes to the City’s Design Construction Standards and Boulder Revised Code have staff support.
The City has clear direction, guidance and tools to implement green infrastructure projects.
The City of Boulder has established metrics and goals for green infrastructure and stormwater management in the City.

Data and Documents Reviewed

The following documents were reviewed to inform the need/gap analysis and guide development of post-construction program strategies. City of Boulder documents shown in black font. Non-City documents are shown in purple.

- Boulder Revised Code (relevant sections)
- Design and Construction Standards
- Construction Review Document
- Land Use Review Document
- SOP Inventory and Code Assessment
- Erosion Control Permit Application
- ROW Inspection Process
- Comprehensive Flood and Stormwater Utility Master Plan
- Stormwater Master Plan
- Boulder Valley Comprehensive Plan (2017)
- Boulder Urban Forest Master Plan
- Boulder Climate Commitment
- Colorado Phase II MS4 Permit
- UDFCD Manual, Volume 3
- UDFCD T-0 Quantifying Runoff Reduction
- Denver Ultra-Urban Green Infrastructure Guidelines
- Colorado Stormwater Center BMP Inspection and Maintenance Field Guide

Summary of City Staff Interview

Staff interviews were conducted on February 6, 7, and 8, 2018. The purposes of the interviews held were to: 1) determine additional goals and objectives for changes to green infrastructure process and policies, 2) discuss SOPPs developed for City projects, and 3) discuss potential GI Pilot Projects.

Table 4. City Staff Interviewed for Process and Policy Data Gathering

Name	Title	Department/Division/Group
Candice Owen Bret Linenfelser	Stormwater Quality Supervisor Water Quality and Environmental Services (WQES) Mgr.	PW/Utilities/WQES
Pieter Beyer	Engineering Services Manager	PW/Utilities/Engineering
Ward Bauscher	Utilities Maintenance Manager	PW/Utilities/Maintenance
Edward Stafford Scott Kuhna Elizabeth Judd Christin Shepherd	Development Review Manager Development Review Supervisor Senior Landscape Architect Flood and Wetland Administrator	PW/P&DS
Gerrit Slatter	Principal Transportation Projects Engineer	PW/Transportation/Project Management
Michele Crane	Facilities Design and Construction Manager	PW/FAM
Cory Forrester	Applications System Administrator	PW/Information Resources



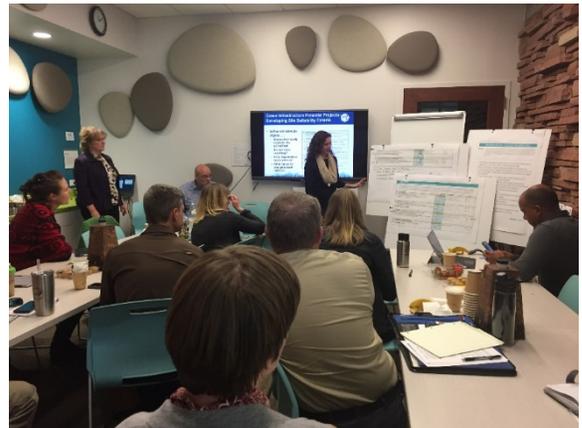
Name	Title	Department/Division/Group
Kathleen Alexander Callie Hayden Jeff Haley	City Forester Urban Parks Operations Manager Planning, Design and Community Engagement Manager	Parks and Recreation
Kelly Wasserbach	Engineering and Project Management Supervisor	OSMP/Trails and Facilities Management
Kendra Tupper	Chief Sustainability Officer	City Manager's Office

Volume 3 of the UDFCD Manual guides site designers in the design of post-construction stormwater quality SCMs. The manual also includes detailed guidance on the calculation of water quality treatment volumes and other parameters that are used to size SCMs. The UDFCD Manual is a great resource for Phase II MS4 permittees because it provides a comprehensive design document that can be referred to in local government ordinances. In 2018, UDFCD provided supplemental guidance that addressed volume reduction practices in the document entitled T-0 Quantifying Runoff Reduction, which can be used by local governments and site designers for compliance with the permit's Runoff Reduction Standard. The UDFCD Manual is important to Boulder as the City develops and implements strategies with the permit's post-construction requirements. Therefore, UDFCD staff (already included in the stakeholder group) was consulted at different times during the project to better understand the current UDFCD documents and plans for future resources to be developed.

Process and Policy Strategies

A preliminary list of process and policy strategies were developed based on the data and documents reviewed, City staff interviews, and stakeholder input gathered at the first and second meetings. Each preliminary strategy was tested against the CSFs established by stakeholders, to ensure that the CSFs do, in fact, drive the strategy development. With further input from WQES and UDFCD staff and alignment with CSFs, the strategy list was refined, and strategies were expanded with more detail.

The final post-construction program strategies are provided in Table 11 in Section 8. An abbreviated table is provided below. Strategies are categorized by the CSFs they align to and where appropriate by SCM life-cycle stage (e.g., planning and design, construction, or maintenance).



CSF Review in Stakeholder Meeting

The table also indicates the priority of each strategy. Priority categories (first, second, and third) are defined below. Implementation of all strategies is necessary for a compliant, comprehensive, and effective post-construction stormwater program. First-, second-, and third-tier categories should not be interpreted as a range of strategy need (i.e., high to low need).

- **FIRST**-tier strategies must be implemented by July 1, 2019, to ensure compliance with the Phase II MS4 Permit. These strategies have already been implemented and are at, or nearing, full completion. Implementation outcomes for first-tier strategies are described below the table.
- **SECOND**-tier strategies will begin soon after first priority strategies are completed. These strategies are needed to ensure revised codes and new City procedures (i.e., the outcomes of first-tier strategies) are interpreted properly and to ready WQES for future education and support functions.
- **THIRD**-tier strategies will be implemented based on the outcomes of prior implemented strategies. Third-tier strategies tend to be associated with maintenance education and tracking. These activities need to be planned but are not necessarily critical to be fully implemented by the July 1, 2019 deadline.



Table 5. Abbreviated Critical Success Factors and Strategies for Post-Construction Processes and Policies

<p>Critical Success Factors</p> <ul style="list-style-type: none"> ▶ GI recommendations and requirements under the new permit are clearly communicated to City staff for both public and private development. ▶ The review processes for both private development and City CIP project types is consistent. ▶ Recommended changes to the City’s Design Construction Standards and Boulder Revised Code have staff support. ▶ All stormwater program compliance gaps related to construction control measures are identified and resolved. ▶ The City of Boulder has established metrics and goals for green infrastructure and stormwater management in the City. 	
<p>Strategies for the SCM Design Stage</p> <ol style="list-style-type: none"> 1. Update Boulder code to support permit design requirements. 2. Eliminate Boulder code conflicts and design/planning guidance inadequacies. 3. Develop education and training plan for private land development stakeholders. 4. Develop training plan on GI SCM construction for developers, site designers, contractors, City plan reviewers, and City project managers. 	<p>Tier FIRST FIRST SECOND SECOND</p>
<p>Strategies for the SCM Construction Stage</p> <ol style="list-style-type: none"> 5. Update Boulder code to support permit construction requirements. 	<p>Tier FIRST</p>
<p>Strategies for the SCM Maintenance Stage</p> <ol style="list-style-type: none"> 6. Update Boulder code to support permit maintenance requirements. 7. Use Beehive to assist with lifecycle tracking of all SCMs, both public and private. 8. Upgrade long-term O&M program for private SCMs. 9. Upgrade long-term O&M program for public SCMs. 	<p>Tier FIRST THIRD THIRD SECOND</p>
<p>Critical Success Factor</p> <ul style="list-style-type: none"> ▶ City staff and private SCM owners have a solid understanding of the materials and maintenance required for GI features. 	
<p>Strategies</p> <ol style="list-style-type: none"> 10. Provide private SCM owners with education and support for SCM maintenance. 11. Provide City departments with education and support for SCM maintenance. 	<p>Tier THIRD THIRD</p>
<p>Critical Success Factors</p> <ul style="list-style-type: none"> ▶ The City has clear direction and tools to implement GI projects. ▶ Long-range planning incorporates green infrastructure into future City plans. 	
<p>Strategies</p> <ol style="list-style-type: none"> 12. Establish WQES as the City authority for permit-required SCMs. 13. Create and implement SOPPs to guide City usage of SCMs in keeping with permit requirements. 14. Create and implement water quality CIP program. 	<p>Tier SECOND FIRST SECOND</p>

First Tier Strategy Outcome 1: Revision of the Boulder DCS

Strategies 1, 2, 5, and 6 are all implemented through the revision of the Boulder DCS. Revisions were made in keeping with the requirements of the Phase II MS4 Permit and Critical Success Factors.

The process of revising the Boulder DCS began with a detailed need/gap analysis of the existing DCS general requirements, and detailed requirements for drainage reports, stormwater quality management, and maintenance. A series of meetings was held between WQES, Planning and Development Services (P&DS), and project consultants. The analysis compared existing DCS requirements with the post-construction conditions in the Phase II MS4 Permit, current and planned information in the UDFCD Manual, and necessary elements for comprehensive post-construction ordinances/codes, including LID and GI SCMs.



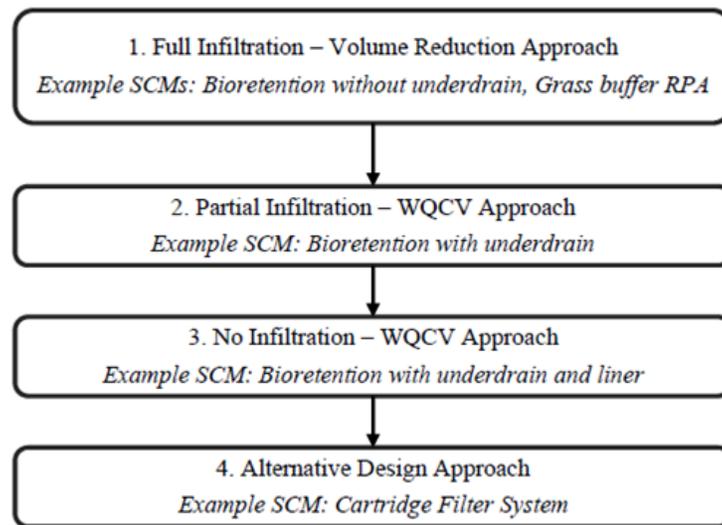
Needs and gaps were identified, and potential resolutions were discussed extensively with WQES and P&DS. As draft revisions were made, additional guidance and input was provided from UDFCD staff. Two full drafts of the revised DCS were developed as understanding of permit requirements and UDFCD guidance matured, with minor changes to each draft throughout the process.

Final revisions to the Boulder DCS were made in December 2018. It will be submitted for City Council consideration and adoption prior to the July 1, 2019 permit deadline.

Revisions made to the Boulder DCS are summarized below.

- Land development project applicability and exclusion are defined relative to several different levels of post-construction water quality management requirements, and generally based on project size and/or type.
- Requirements for meeting SCM design performance standards are included for applicable developments, generally based on project size and/or type. Accepted performance standards are fully described, including the Runoff Reduction Standard using GI SCMs.
- The required design approaches (by performance standard option) and procedures for implementing the approaches are provided. The table below, taken from the revised DCS, shows the performance standard hierarchy and selection criteria.

Table 6. Performance Standard Hierarchy and Selection Criteria



- In keeping with stakeholder guidance: all projects need to incorporate LID principles by conserving existing amenities, minimizing impacts, and minimizing directly-connected impervious area (MDCIA) to the degree possible as the first step for project design.
- The Runoff Reduction Standard is established as the preferred performance standard. Essentially, site designers will select the appropriate performance standard based on infiltration (*i.e.*, GI SCM) feasibility and other site conditions.
- The infiltration standard for GI SCM feasibility is clearly stated and requirements for infiltration feasibility assessment and tests are provided.
- The following technical reference manuals are identified and accepted for use in Boulder.
 - ▶ UDFCD Manual – Volume 3
 - Aligned with MS4 Permit.



- Calculation guidance for SW quality volumes.
- Design specifications for GI and treatment SCMs.
- ▶ Denver Ultra-Urban GI Manual
 - Design specifications for GI SCMs in highly urban environments (mostly transportation).
 - Limited to design specifications. Designers will still need to refer to UDFCD Manual for calculation guidance.
- ▶ Colorado Stormwater Center BMP Maintenance Guides
 - Owner level guidance and checklists for SCM maintenance for a limited number of GI SCMs.
 - Limited to several GI SCMs at this time, so SCM Owners will still need to refer to the UDFCD Manual for SCMs not included.
- Requirements for preparation and submittal of an as-built plan and subsequent final inspection of the project's stormwater system and SCMs are included, as well as approval of the plan and inspection before the City will recognize constructed SCMs as functional, operating post-construction water-quality SCMs. This "final acceptance" by the City indicates that construction is complete, City post-construction inspections will begin, and the owner should begin long-term SCM maintenance.
- Requirements for owner maintenance of SCMs are included.
- Detailed lists of required plan elements are included for Conceptual, Preliminary, and Final Drainage Reports.

First Tier Strategy Outcome 2: Development of Post-Construction SOPPs for City Projects

Strategy 13 led to the development of interdepartmental SOPPs for use on City projects. The SOPPs ensure permit compliance, establish clear expectations, facilitate knowledge sharing, and identify collaboration opportunities. They address the life-cycle of stormwater quality SCMs by addressing planning, design, construction and maintenance of SCMs. While the SOPPs themselves do not directly satisfy a requirement of the Phase II MS4 Permit, they establish the policies and procedures that will be used on City projects to ensure City compliance with the requirements of the revised Boulder DCS (see Outcome 1 above). Refer to Appendix 2 for the SOPPs.

The SOPPs are aligned with the requirements of the DCS to ensure City projects meet DCS conditions without necessarily repeating those conditions. For example, the SOPPs establish early on that they pertain to all City projects that disturb land, with projects over one acre of disturbance meeting post-construction water quality requirements or demonstrating exclusion in keeping with the DCS. WQES must be included in the planning, design, construction, and maintenance for all projects greater than one acre, as these projects are directly associated with the requirements of the Phase II MS4 Permit.

The SOPPs were prepared with substantial input from impacted City departments and work groups. This was done to: explain requirements and responsibilities based on the Phase II MS4 Permit; ensure the SOPPs could fit within department and group work flows; develop the LID and SCM design processes; and facilitate SOPP acceptance. The following meetings were held with the work groups.

- May 2018 – Department Review Meeting of SOPP
- September 2018 – Department Feedback Meetings
- October 2018 – Final SOPP Review
- December 2018 – Department CIP Planning Meetings
- Early 2019 – Project Manager Training

The SOPPs are also tailored to department work flows and review procedures as shown in the table below:



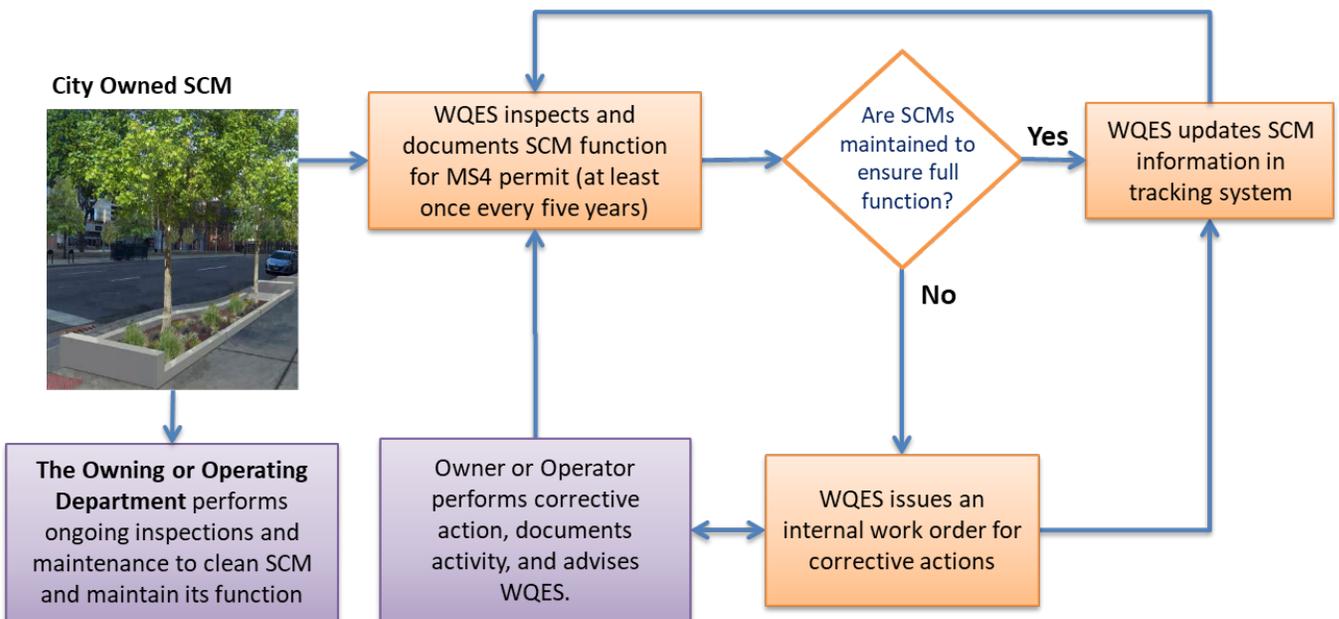
Table 7. SOPPs Target Work Groups and Primary Project Reviewer

SOPP #	Description	Target Work Groups	Primary Reviewer
1	Design and Construction of Stormwater Control Measures	<ul style="list-style-type: none"> ▶ Utilities Engineering ▶ Transportation Engineering 	WQES
2	Design and Construction of Stormwater Control Measures	<ul style="list-style-type: none"> ▶ Facilities and Asset Management ▶ Open Space and Mountain Parks ▶ Parks and Recreation 	P&DS
3	Inspection and Maintenance of Stormwater Control Measures	<ul style="list-style-type: none"> ▶ Utilities Maintenance ▶ All Target Work Groups 	WQES

The purpose of the project design and construction SOPP is to ensure that DCS design and construction requirements are met, to verify design approach, and to collaborate to achieve optimal solutions. A SWMP, preliminary and final drainage reports, and construction drawings are submitted. WQES is involved primarily as a resource for SCM selection and placement, and in conjunction with P&DS is the City’s expert on DCS requirements and interpretation.

A separate SOPP covers inspection and maintenance of City-owned SCMs. This SOPP is applicable to all departments who have SCM maintenance responsibilities. As well, WQES plays a major role in long-term maintenance, as they perform SCM compliance inspections, can request and activate maintenance staff in non-compliance situations, and will provide guidance for SCM maintenance in general. As an example of SOPP content, the maintenance process established in the SOPP is summarized in the flow chart below.

Figure 1. Maintenance Process Defined in SOPP





7.0 Engineering and Projects

Goals and Objectives

The goal of the Green Infrastructure Engineering and Projects task was to define a process to identify pilot projects within the City based on a repeatable prioritization process. This included development of a prioritized list of projects that could be adapted for incorporation of GI as part of current and future Capital Improvement Program (CIP) projects across City departments, as well as identified stand-alone stormwater quality improvements pursued independently.

Data Gathering and Assessment

The identification and development of candidate projects and locations for GI began with a review of existing City CIP plans and budgets by department. Documents included:

- Draft 2018 – 2023 CIP Plan
- CIP Guiding Principles
- BVCP Action Plan
- UDFCD Manual, Volume 3
- Stormwater Master Plan
- Comprehensive Flood and Stormwater Utility Master Plan
- Greenways Master Plan
- Open Space and Mountain Parks Plan
- Storm drain problem list

Potential projects were evaluated for location on property under City department control, physical site characteristics appropriate for GI, a suitable schedule that would allow for incorporating GI, and those that were suggested during individual staff meetings held on February 6 and 7, 2018.

The Draft 2018 – 2023 CIP includes funding of approximately \$490 million for 145 projects ranging from Municipal Facilities Opportunities (new buildings, retrofits, upgrades, consolidation) to transportation and landscape corridors, to planning stage projects in the Boulder Valley Comprehensive Plan (BVCP) Action Plan, to stormwater opportunities related to flood recovery efforts, and to stormwater improvements needed in areas the City has taken over from the County that do not meet City standards.

The initial vetting yielded 20 potential CIP projects for further consideration as pilot projects and for categorization and ranking. Site data for each location was compiled and incorporated into an overall data spreadsheet for use in further narrowing the selection set.

Sites were categorized by type of SCM. The pilot projects may be used as example solutions for future projects that fall into the following categories:

Runoff Collection & Conveyance GI
LID/Greenspace/Passive Recreation GI
Site Based GI Practices
Streetscape / Urban Landscape GI
GI for Area Drainage / Flooding Mitigation
Ongoing Maintenance GI Retrofit
Roadway Corridor GI Practices

The process for identifying GI specific installations was accomplished using a GIS-based mapping and assessment exercise overlaying specified criteria to identify locations for potential GI specific installation projects within the City limits. The process:



1. Identified Boulder Creek Watershed (i.e., Total Maximum Daily Load (TMDL) drainage area) as primary targeted area for pilot project improvements;
2. Limited to City-owned properties;
3. Vetted and ranked properties based on the GIS mapped feasibility and opportunity criteria including:
 - A) Feasibility of Site:
 - Appropriate infiltrative soils;
 - Topography and grading;
 - B) Stormwater Improvement Opportunities:
 - Contributes flow to Boulder Creek TMDL reach;
 - Impervious area available to be captured and treated;
 - Ability to impact reported flooding complaints.
4. Performed desktop analysis of site features for practical implementation of GI resulting in focused list for stakeholder review. Analysis criteria included:
 - Site has drainage pattern with impervious to pervious runoff or opportunity to intercept/re-direct runoff;
 - Site has impervious to pervious ratio of 10:1 or less;
 - Site has additional adjacent pervious ROW area that could be incorporated;
 - Site lends itself well to overall plan goals.

Eleven projects resulted from this process, some of which were not conducive to pilot project status due to site size, composition, or recently completed improvements. The remaining projects were evaluated in conjunction with the CIP-based projects, and seven representative projects were selected for concept plan development.

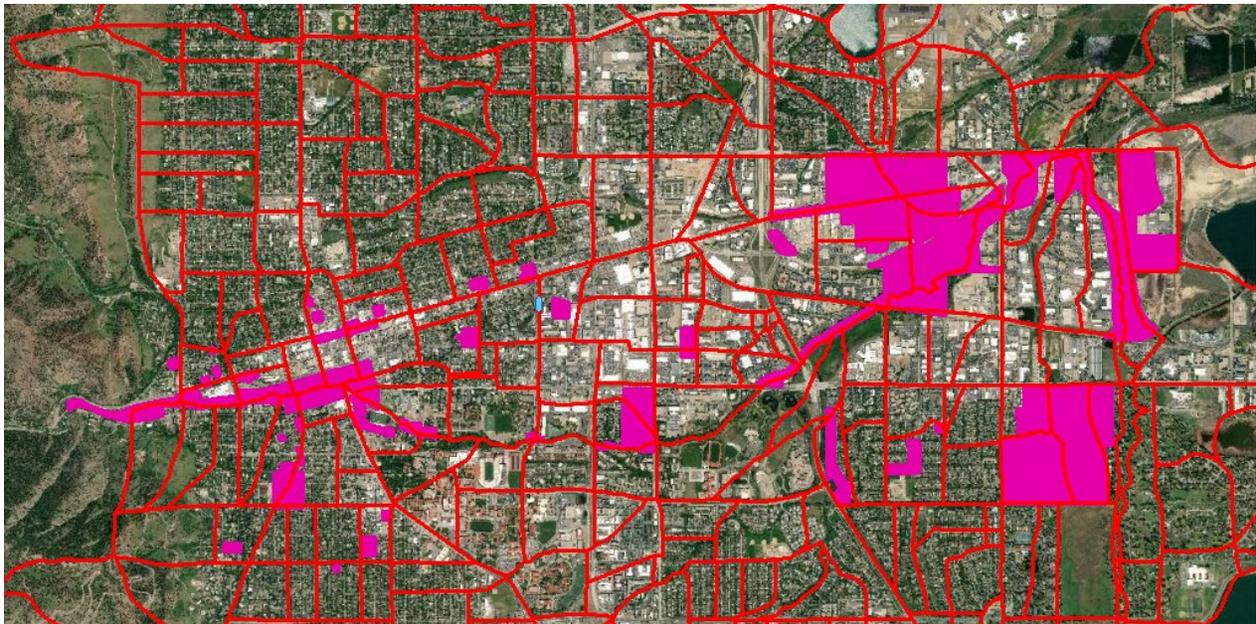


Figure 2. GIS aerial map showing City-owned properties in the Boulder Creek Watershed.

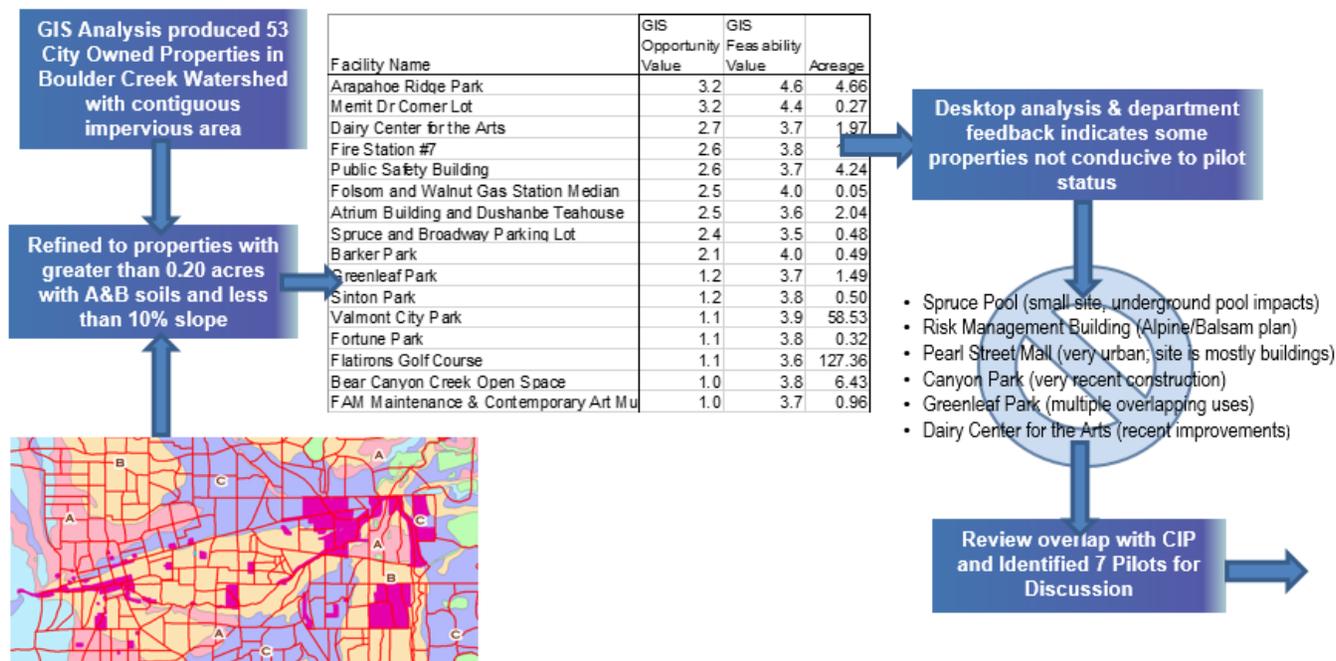


Figure 3. GIS Analysis Flowchart for GI-Specific Projects

Evaluation Tool Development and Definitions

The project evaluation tool provides a uniform set of objective evaluation criteria for rating and ranking projects for the prioritization of CIP funds to both assist with larger City CIP projects and to implement GI-specific installation projects based on opportunities and City priorities. Steps taken to define and develop the evaluation tool were:

1. Nineteen evaluation criteria were identified and grouped into six representative categories by the consultant team.
2. During Stakeholder Meeting 2, the Internal Stakeholder Group completed an exercise to help the consultant team refine and assign ranking values to the draft evaluation criteria for GI projects.
3. Based on the results of the exercise:
 - a. A 7th (Operations and Maintenance) category was added;
 - b. Two additional criteria were added under Operations and Maintenance;
 - c. A weighted factor of importance was assigned to seven site suitability categories; and
 - d. Each detailed evaluation criteria was assigned a graduated numerical score relative to what level the criteria was attained.

The summary memo and work product resulting from the stakeholder exercise are included in Appendix 3. The identified site suitability categories, detailed evaluation criteria, and numerical rankings to be applied to each project are summarized in Table 8.



Table 8. Project Evaluation Criteria

Site Suitability Category	Weighting Factor	Detailed Evaluation Criteria			
Policy / Regulatory	2	PROJECT ALIGNS WITH GI STRATEGY PLAN GOALS Completely = 3 Somewhat = 1 No = 0	Economic	1	IMPROVES AREA AESTHETICS (Neighborhood Stability) Yes = 3 No = 0
	2	WATER QUALITY COMPLIANCE POTENTIAL High = 3 Med. = 2 Low = 1 None = 0		1	PROMOTES ECONOMIC DEVELOPMENT (In desirable area) Yes = 3 No = 0
	2.5	PROJECT SITE UNDER MS4 PERMITTING REQUIREMENT Yes = 3 No = 0	Administrative	2	CONFLICTS W/ OTHER DEPT PLANS, GOALS No = 3 Yes = 0
Public Impact	1	PROJECT VISIBILITY/ LOCATED IN PUBLIC AREA Yes = 3 No = 0	Costs & Construction Efficiency	1	REQD PERMITTING -FLOODWAY, FLOODPLAIN, WETLAND, OTHER None = 3 Standard = 2 Complex = 0
	2	ADDRESSES RESIDENT COMPLAINTS 4 or more = 3 2-4 = 2 None = 0		1	COORDINATION WITH CIP PROJECT /OTHER FUNDING P3 Opportun = 3 CIP List = 2 Grant/Loan Fund = 1 Multiple = 3 None = 0
	2.5	PROVIDES CONNECTIVITY OR NATURE BASED RECREATION Yes = 3 Some = 2 None = 0		2	PROJECT COMPLEXITY Standard Pr. = 3 Innovative Pr. = 2 Unproven Technology = 1
Engineering / Resiliency Effects	3	POTENTIAL TO MITIGATE STORMWATER /FLOODING ISSUE Severe = 3 Moderate = 2 Minor = 1 None = 0	Operations & Maintenance	3	CIP BENEFIT/CAPITAL COST High = 3 Moderate = 2 Low = 1
	2	ENHANCED HABITAT / ECOLOGICAL BENEFIT High = 3 Moderate = 2 Low = 1 None = 0		3	LONG TERM MAINTENANCE REQUIREMENTS Low = 3 Standard = 2 Complex = 0
	2	OTHER TBL BENEFITS (carbon footprint, water reuse, alternative energy) Yes = 3 No = 0		3	POTENTIAL TO MITIGATE RECURRING MAINTENANCE ISSUE (times per yr) 4 or more = 3 2 to 4 = 2 1 time/yr = 1
				3	Project Lifecycle Cost & Administration All = 1



Implementing the Evaluation Tool

The numerical rankings assigned to the site suitability categories and detailed evaluation criteria were applied to each project using a customized spreadsheet. First, the detailed evaluation criteria were assigned numerical scores by project and totaled, resulting in a raw score for each project. Next, the weighted factor of importance for each of the seven site suitability categories was applied to each of the raw criteria scores. This provided a weighted total for each site for project prioritization. The list was then sorted by weighted total for discussion with the Internal Stakeholder Group. The full ranking matrix is included in Appendix 3.

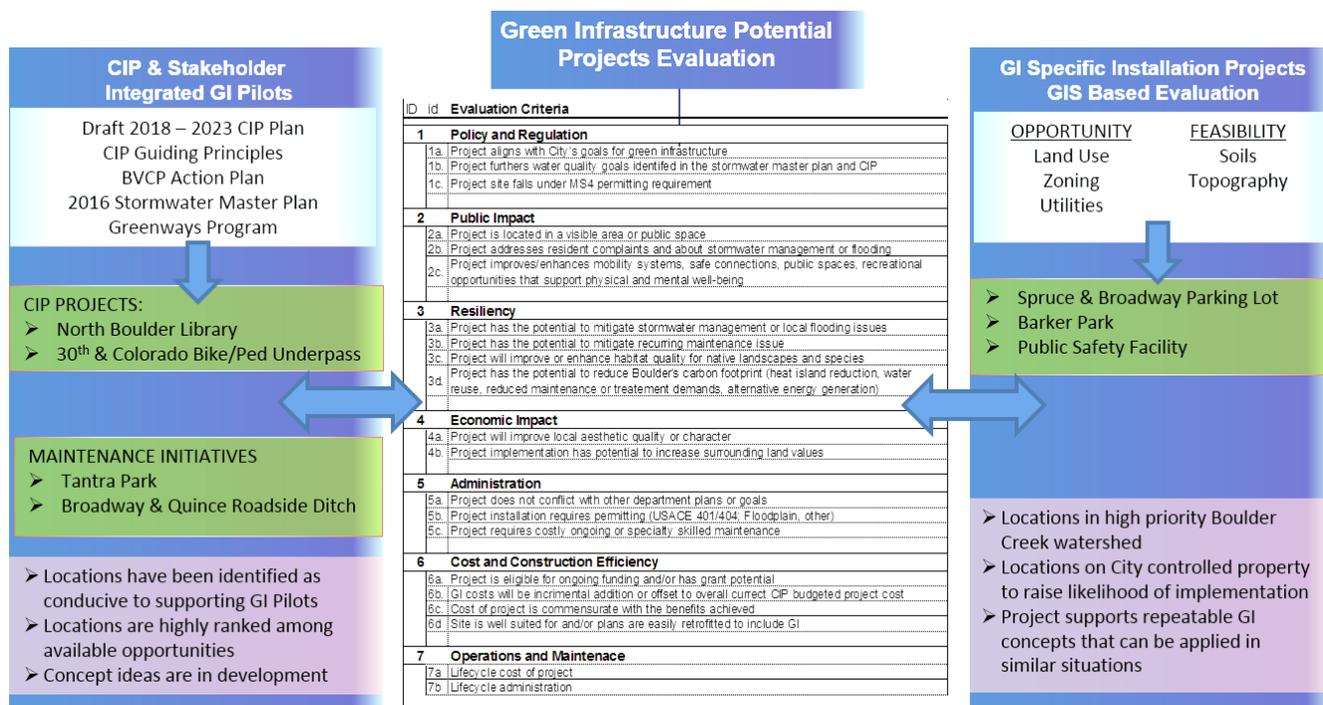


Figure 4. Summary of Top-Ranked CIP- and GI-Specific Selection and Analysis

A detailed desktop analysis of site features for practical implementation of GI was conducted and resulted in a focused list of projects for stakeholder review. The top ranked CIP- and GI-specific installations were further vetted in Stakeholder Meeting 3, and through subsequent calls, discussions, and data evaluation.

The top ranked projects were presented to the Internal Stakeholder Group in Stakeholder Meeting 4. Concept plans and examples were prepared for seven potential pilot projects covering the range of project types with a level of detail that included their location, engineering application, potential GI solution



Pilot Project Boards were presented and stakeholders placed sticky notes with their likes and dislikes.



narrative, and drainage overview. To gain an understanding of any remaining barriers to potential pursuit of pilot GI projects on the seven proposed sites, feedback on the representative examples was collected through an interactive exercise where stakeholders placed site-specific comments on each of the pilot project boards. Comments could be related to specific site- or project-based knowledge, reaction to proposed GI SCMs, critique of the proposed layout, or any other considerations. Potential SCMs, site limitations, additional benefits such as education, and the potential for future expansion of the SCMs were evaluated.

Boards with concept designs, representative GI photos, graphics, project summary information, typical details, and feedback obtained from Stakeholder Meeting 4 are included in Appendix 4.

Summary of the Preliminary Pilot Projects

Preliminary/planning level designs were completed for seven pilot projects and presented to the Internal Stakeholder Group during Stakeholder Meeting 4. (See Figures 4 and 5.) An overview of each potential pilot project is summarized in Table 9 followed by detailed narratives. After stakeholder discussions, planning level designs for four areas within Tantra Park were further refined to concept design plans with associated cost estimates and design details. This information was provided as an independent design memo and is provided in Appendix 5.

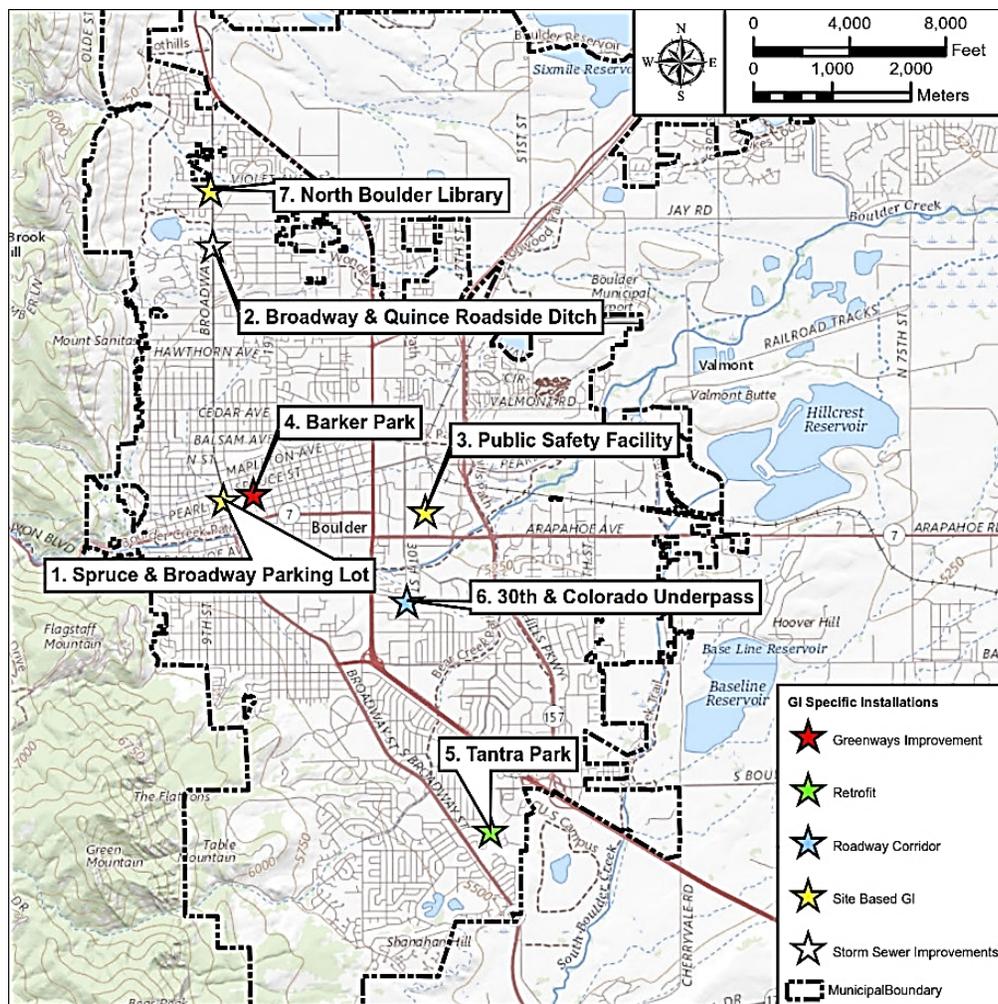


Figure 5. Locations of the Seven Pilot Projects Selected for Planning Level Design.



Table 9. Pilot Project Priority Summary for Planning Level

PILOT PROJECT ID	RAW SCORE	WEIGHTED TOTAL	PROPOSED PROJECT	PROPOSED GREEN INFRASTRUCTURE SCM DESCRIPTION	CIP or GI SPECIFIC
5	41	81.5	Tantra Park (Neighborhood Drainage/Flooding)	Incorporate surface drainage swales, infiltration SCMs and bioretention water quality features to address undersized storm collection pipes and nuisance flooding. Multiple areas separated into Tier I and Tier II priorities	CIP
3	34	62.5	Public Safety Facility (Site Based GI)	Integrated site based stormwater mgmt SCMs intercepting and filtering parking lot surface runoff: bioretention storage in landscape; pervious parking bays with subsurface storage; infiltration swale in street landscape area; educational signage;	GI Specific
7	36	60.5	North Boulder Library (Site Based GI)	Public site with opportunity to showcase many types of site based SCMs: hybrid infiltration swale in landscape; permeable paver & storage in parking and plaza; interactive watershed exhibit; downspout planters; educational signage	CIP
4	33	58.5	Barker Park (Greenspace/Recreation GI)	Pervious walkways, bioretention and narrow infiltration swale behind sidewalk Future ROW add on with paver parking and planters when existing mature trees are removed;	GI Specific
1	32	55	Spruce and Broadway Parking Lot (GI Retrofit/Maintenance)	Retrofit opportunity to intercept, capture, and filter parking lot surface runoff; Replace existing impervious parking bays with permeable paver or pervious concrete parking spaces; retrofit internal islands to bioretention planters with curb turnouts; avoid mature trees	GI Specific
2	29	53	Broadway & Quince Roadside Ditch (Collection & Conveyance GI)	Integrated stormwater management mix of hybrid stormwater swale, permeable pavement shoulder, infiltration trenches w/overflow to storm collection system	CIP
6	30	52	30th & Colorado Bike/Ped Underpass (Roadway Corridor GI)	Inform plan with concept roadway corridor GI SCMs- permeable paver parking/shoulders, Premanufactured Bioretention planters; hybrid swales with curb turnouts; Natural restoration for re-alignment of Wellman canal	CIP

1. Spruce & Broadway Parking Lot

The Spruce & Broadway parking lot pilot project is a **GI-specific** parking lot retrofit project that would showcase site-based and urban parking lot GI SCMs. The site presents an opportunity to intercept and treat surface runoff from a highly impervious area without full reconstruction and to enhance the aesthetics of this public location. Existing landscape islands would be converted to planters to accept and filter surface runoff through curb cut-outs and provide contiguous subsurface storage below permeable paver parking bays. Design considerations include:

- Maintaining existing parking count;
- Avoiding impact to mature trees and existing utilities;
- Potential opportunity to incorporate adjoining alley into plan;
- Coordination with parking lot management group in Community Vitality; and
- Maintenance considerations for permeable pavement and build-up of trash and debris in SCMs.

2. Broadway & Quince Roadside Ditch

The Broadway & Quince roadside ditch pilot project is a **CIP collection and conveyance** solution addressing a short section of open ditch in north Boulder with capacity and erosion issues. The existing storm collection system is overburdened, and soil and grit tend to wash out onto Broadway at the downstream end of the ditch by Redwood. The current deep ditch configuration becomes overgrown and unsightly and presents problems with maintenance. The project is in a high-traffic area and near a bus stop and provides a good opportunity to install and evaluate a hybrid stormwater swale and to test a permeable pavement shoulder installation as an alternative to typical curb and gutter, inlets and pipes, and to promote conveyance, infiltration and filtration of stormwater. Design considerations include:

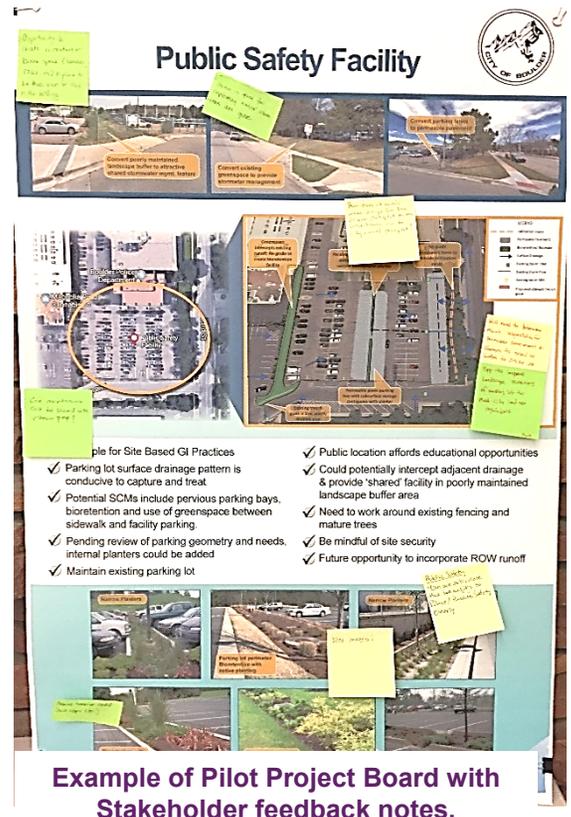


- Working within the Right-of-Way;
- Appropriate design sizing to manage watershed runoff;
- Addressing permeable pavement shoulder surfacing concerns with bicyclists;
- Addressing aesthetic differences from typical curb and gutter and resulting resident concerns; and
- Maintenance considerations for permeable pavement shoulder.

3. Public Safety Facility

The Public Safety Facility pilot project is a **GI-specific**, site-based GI project that would provide an example and reference for use of GI SCMs on private development projects. The site is within the high-priority Boulder Creek drainage area and has significant impervious area upstream that drains through it. The existing surface drainage pattern is conducive to capturing and treating stormwater in the parking area and existing landscape area with permeable paver parking bays, bioretention areas and stormwater infiltration swales. Design considerations include:

- Incorporation of offsite runoff and potential shared MOU.
- Preserving security and safety of site.
- Avoiding impact to mature trees and perimeter fencing.
- Reviewing parking geometry for potential to add internal planter.
- Work could be incorporated as part of proposed future facility expansion.
- Opportunity to incorporate ROW runoff into area between parking and sidewalk.
- Maintenance considerations for permeable pavement.



4. Barker Park

Barker Park is a **GI-specific** greenspace enhancement site opportunity. The urban park consists of a small, fenced property with a play structure, seating areas, and adjacent on-street parking located on the southeast corner of 15th Street and Spruce Street. The property is not well drained as it is very flat and has no defined offsite runoff path. The pilot project provides an opportunity to manage site, ROW, and parking runoff by installing permeable paver walkways, bioretention, and a narrow infiltration swale behind the sidewalk. The project is a smaller scale retrofit option for a pilot project and will also need to work around existing fencing and mature trees. In the future, permeable paver parking areas and planter options, when trees require replacement, could be added. Design considerations include:

- Incorporation of ROW runoff by diverting inlet capture through trench drain to site SCMs;
- Safety for adjacent daycare use of facility;
- Future opportunity to add paver parking and planters when mature trees need to be replaced; and



- Avoiding impact to mature trees and perimeter fencing.

5. Tantra Park

Tantra Park is a City of Boulder Parks property located in the Table Mesa neighborhood. The pilot project is a potential **CIP neighborhood drainage** stormwater maintenance initiative to address areas of nuisance flooding and erosion. **Tantra Park was selected as the example project to be further refined to a concept design plan with an associated cost estimate and details.**

The Parks department has identified and received complaints of nuisance flooding at several areas along the park. Storm sewers are undersized in most places, and neither the East nor West neighborhoods have street storm sewer systems. Five specific problem areas were identified initially during a site visit between Parks and Utilities staff. (See Figure 6.) Preliminary planning level concept designs were completed for three of the five areas, and subsequently Tier I and II priorities were identified for preliminary design and costing. The Tantra Park Tier I and II pilot project areas addressed in the separate design memorandum are shown in Figure 7 and further described in Table 10 below.

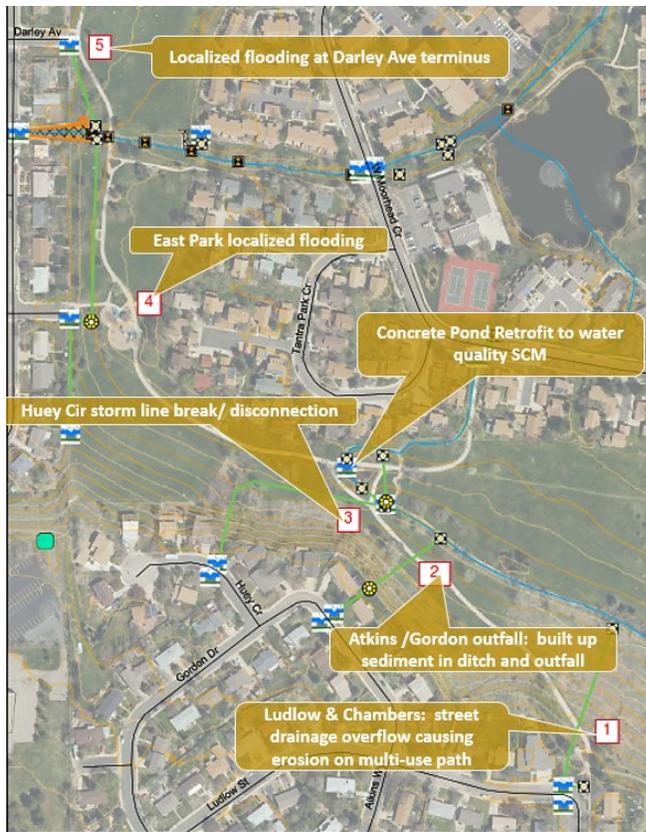


Figure 6. Tantra Park Documented Drainage Issues

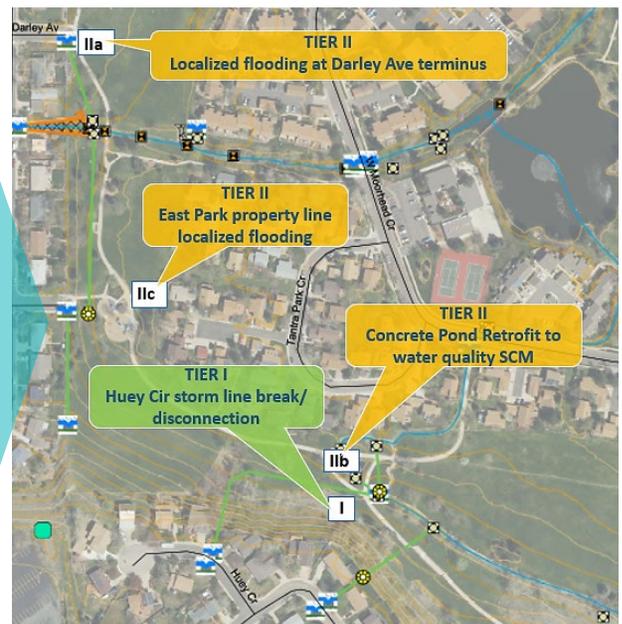


Figure 7. Tantra Park Pilot Project



Table 10. Tantra Park Pilot Projects

Priority	Location	Description	Drainage Area	WQCV (cuft)	Proposed SCM's
Tier I	Huey Circle storm outfall	Drainage outfall from 2 inlets on Huey Circle outlets to wooded area causing minor erosion on the hillside and localized flooding	4.61 acres 1.69 acres impervious	2287 10 yr flow = 3.0cfs	<ul style="list-style-type: none"> Enhanced stormwater swale with check dams, subsurface storage and infiltration Bioswale with check dams for staged storage, conveyance, and infiltration
Tier II	Darley Avenue inlet	Localized flooding at the end of Darley Ave due to undersized inlet and pipe	8.86 acres 3.26 acres impervious	4407	<ul style="list-style-type: none"> ROW stormwater planter with sediment forebay Bioretention storage area Stormwater swale conveyance to Viele Channel outlet
Tier II	Concrete pond Interior park drainage at the end of Bear Creek Ditch	Concrete basin has several inlets and outlets with storm and ditch connections. Pondered water and debris buildup are issues.	N/A	N/A	<ul style="list-style-type: none"> Convert to bioretention basin with overflow Use demolished concrete for check dams for channel and bioswale
Tier II	East park neighborhood line at base of sledding hill	Poor drainage of swale and pipe system along neighborhood fence line at east side of park	4.31 acres 0.43 acres impervious	840	Convert to bioswale to promote positive drainage and underdrain functionality

The design memo, provided in Appendix 5, includes detailed information for each pilot site, with a narrative outlining the existing conditions, proposed GI SCM solutions, and design parameters. Preliminary design plans, details, and concept level cost estimates are provided.

6. 30th & Colorado Bike and Pedestrian Underpass

The 30th & Colorado underpass is a **Roadway Corridor GI** project from the **CIP project list**. The project will construct a grade-separated crossing of both 30th Street and Colorado Avenue. The underpass will provide connections to the existing sidewalks, multi-use path and bicycle lanes; reconstruct the intersection with concrete; reconstruct and enhance the existing transit stops; install underpass lighting, landscaping and other urban designs; and install public art. Streetscape GI options, including bioretention planters, permeable pavers, premanufactured drainage and stormwater management products could be incorporated. Design considerations include:

- Complex drainage patterns and ability to intercept typical crowned roadway drainage;
- Realignment of Wellman Canal;
- Coordination with CDOT and ability to use alternate design solutions within ROW;
- Project is substantially designed (30% plans completed in July 2018); and
- Unique maintenance issues will require staff education, training, and budget.



7. North Boulder Branch Library

The North Boulder Branch Library is a proposed **CIP Project** with opportunities for **Site- Based GI** SCMs that could provide an example and reference for use of GI SCMs on private development projects. The project is early in planning process and site selection is not confirmed. An example plan was created for discussion using the main library footprint for reference on a site at Violet and Broadway. Infiltration swales could be incorporated into perimeter landscaping, permeable paver parking bays could be installed at lower points of the lot, permeable pavers could be used in the plaza, and bioretention planters capturing roof runoff are potential SCMs. The library location provides educational opportunities and options to showcase many types of SCMs, such as by installing an interactive watershed exhibit. This is an up and coming area of Boulder with recent and future development and capital projects planned, and there is the potential to tie into trail system one block to the north.



8.0 Future Program Recommendations

Recommended Strategies

The process and policy strategies for implementation of a comprehensive, effective, and permit compliant post-construction program in Boulder are presented in Table 11. The complete outcomes of the program tasks are provided in the table, including the stakeholder-generated Critical Success Factors and their related strategies for post-construction and/or GI program development. For each strategy, the table presents its implementation tier, suggested tactics for implementation, its implementation status as of February 2019, and any additional recommendations that should be considered during or after strategy implementation. See Section 6 for descriptions of the implementation tier. In addition, a future stakeholder engagement strategy is provided at the end of this section.

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Table 11. Post-Construction Program Recommendations

#	CSFs, Strategies, & Tier	Tactics	Current Project Status	Future Recommendations
Relevant Critical Success Factors: <ul style="list-style-type: none"> • GI recommendations and requirements under the new permit are clearly communicated to City staff for both public and private development. The review processes for both private development and City CIP project Types are consistent. • Recommended changes to the City’s Design Construction Standards and Boulder Revised Code have staff support. • All stormwater program compliance gaps related to construction control measures are identified and resolved. • The City of Boulder has established metrics and goals for green infrastructure and stormwater management in the City. 				
Planning and Design Stage of SCM Lifecycle				
1	Update the Boulder code to support permit requirements (design). FIRST TIER	Update the following items in the DCS: <ol style="list-style-type: none"> 1. Applicable and excluded developments; 2. Post-construction water quality design standards and requirements; 3. List of required drainage report elements; and 4. Allow innovation provided the SCM design meets the City’s performance standards. 	Strategy Implementation Complete. <ul style="list-style-type: none"> • The DCS has been revised to align with NPDES-MS4 permit requirements. • In keeping with stakeholder recommendations, DCS revisions include a water quality planning approach which: <ul style="list-style-type: none"> ○ requires consideration of LID on all applicable projects; and ○ establishes an SCM hierarchy, with consideration of GI SCMs first. 	<ul style="list-style-type: none"> • Continued collaboration between WQES and P&DS is critical to DCS revision success. <ul style="list-style-type: none"> ○ P&DS should keep a running list of DCS difficulties, loopholes, and opportunities based on their review of design plans; and ○ Plan for quarterly or semi-annual discussion of this list with WQES for possible future DCS enhancement. • See Work Plans #1, #3, and #4 for collaboration recommendations.
2	Eliminate code conflicts and design/planning inadequacies. FIRST TIER	<ol style="list-style-type: none"> 1. Allow certain SCMs to be located in landscape buffers. 2. Upgrade DCS in the following areas: <ol style="list-style-type: none"> a. Conceptual plans should include hydrologic characterization to facilitate LID/GI consideration; 	Strategy Implementation Complete. <ul style="list-style-type: none"> • Tactic 1 was not done due to scope changes and may be completed at a future date. • Tactics 2a, b, and f were fully addressed by the DCS revisions. 	<ul style="list-style-type: none"> • Consider performing a conflict analysis for non-stormwater codes that can influence or prevent LID implementation (e.g., subdivision regulations, zoning ordinance). Standard codes analysis procedures are available for US western states including:



#	CSFs, Strategies, & Tier	Tactics	Current Project Status	Future Recommendations
		<ul style="list-style-type: none"> b. Upgrade SCM pretreatment requirements for GI SCMs; c. Provide enhanced pretreatment design specifications; d. Provide SCM typical details specific to Boulder requirements; e. LID site design techniques; f. Guidance on soil protection, testing, amendment, etc.; and g. Guidance on vegetation selection, installation, maintenance, including planting palettes for ornamental, native, and other types of vegetation. 	<ul style="list-style-type: none"> • Tactic 2e is included in the revised DCS to some degree, but supplemental guidance that expands upon LID practices may be advantageous. • Tactics 2c, d, g and h were not addressed and may still need to be considered as an action needed by the City. 	<ul style="list-style-type: none"> ○ Washington: LID Code Update and Integration Toolkit; and ○ California: Municipal Gap Analysis Tool.
3	Develop education and training plan for private land development stakeholders. SECOND TIER	See Work Plan #2 for more information.		
4	Develop training plan on GI SCM construction for developers, site designers, contractors, City plan reviewers, and City project managers. SECOND TIER	<ol style="list-style-type: none"> 1. Identify and promote appropriate offsite educational or training opportunities on construction protection of GI practices. 2. Identify appropriate City staff to attend, frequency desired, and budget accordingly. 	Activities have not begun for this strategy.	Develop and implement an education and training plan for private land developments, like that described for City projects in Work Plan #2 and Work Plan #4 .



#	CSFs, Strategies, & Tier	Tactics	Current Project Status	Future Recommendations
Construction Stage of SCM Lifecycle				
5	Update the Boulder code to support permit requirements (SCM construction and acceptance into post-construction program). FIRST TIER	<ol style="list-style-type: none"> 1. Update the following items in the DCS: <ol style="list-style-type: none"> a. Construction inspection process/requirements, and b. Update erosion and sediment control design and installation requirements to protect GI SCMs from clogging/compaction during construction. 2. Establish SCM acceptance policies. <ol style="list-style-type: none"> a. Establish requirements for stormwater as-built plans. b. Establish requirements for SCM acceptance inspection and enforcement response. 	<p>Strategy Implementation Complete.</p> <p>The DCS has been revised to align with NPDES-MS4 permit requirements.</p>	No further recommendations.
Maintenance Stage of SCM Lifecycle				
6	Update the Boulder code to support permit requirements (maintenance). FIRST TIER	<ol style="list-style-type: none"> 1. SCM owner inspection maintenance requirements: <ol style="list-style-type: none"> a. SCM identification and responsibility; and b. SCM maintenance (routine and/or remedial). 2. SCM owner source information. 3. Include (or refer to) SCM routine/remedial maintenance guidance. 	<p>Strategy Implementation Complete.</p> <p>The DCS has been revised to align with NPDES-MS4 permit requirements.</p>	<ul style="list-style-type: none"> • Expand upon the requirement for a maintenance plan in the DCS by developing a template that can be used by site designers. • Examine maintenance information developed by the Colorado Stormwater Center and determine if additional guidance/resources are needed. (See Work Plans #2 and #3) • Develop SCM owner engagement processes, procedures, and engagement templates. • Consider adding inspection fees to enforcement options when repeated



#	CSFs, Strategies, & Tier	Tactics	Current Project Status	Future Recommendations
7	Use Beehive to assist with lifecycle tracking of all SCMs, both public and private. SECOND TIER	<ol style="list-style-type: none"> 1. Define data and reporting needs for City IR staff. <ol style="list-style-type: none"> a. SCM owner (private and public) and WQES; b. SCM design approval; c. SCM as-built drawing and final “check-out” inspection approval; d. O&M inspection and enforcement documentation (private SCMs); and e. Inspection documentation (City SCMs). 2. Establish data entry points and staff (by department). 3. Determine data policies and entry needs for existing SCMs. 4. Determine SCM ID schema and SCM location and addressing setups. 5. Develop standard work orders to be used for City maintenance of public SCMs that are prompted by WQES. 	The SCM tracking database is being developed in keeping with item #1 (to the left). In this regard, City staff has established a Post-Construction SCM Asset Management Update Project. A task list has already been developed.	<p>inspections and engagement are needed to achieve corrective actions.</p> <ul style="list-style-type: none"> • Continue implementation of the SCM tracking database (item #1 to the left). • With regard to item #2, ensure that SCM tracking procedures clearly state what data must be tracked and each stage of the SCM life-cycle, and who (department and title) is responsible for data entry. This clarity will reduce inconsistencies in data content. Generally, it is recommended that data entry be performed by as few staff as possible, and that these staff meet regularly to discuss data definitions and entries. • SCM tracking should include metrics needed to define permit compliance including project area, install date and SCM type. Metrics defining SCM design components should also be tracked to support inspection procedures described in strategies 8 and 9.
8	Upgrade long-term O&M program for private SCMs. FIRST TIER	<ol style="list-style-type: none"> 1. Improve current post-construction enforcement authority. <ol style="list-style-type: none"> a. Revise/adopt BRC Title 11, Chapter 5 to include sufficient and effective enforcement for violations of post-construction requirements. 	<p>Work Plan #1 - Enforcement authority for complying with post-construction requirements has been updated in code.</p> <p>Work Plan #2 – DCS revisions address SCM maintenance requirements, but do not offer guidance with regards to SCM protection, especially for GI SCMs.</p>	<ul style="list-style-type: none"> • Implement Work Plan #3 in concert with development of the SCM tracking database. <ul style="list-style-type: none"> ○ Start with inspection SOPs and forms used by other communities and adapt for Boulder’s needs. ○ Consider the use of standard inspection forms based on SCM



#	CSFs, Strategies, & Tier	Tactics	Current Project Status	Future Recommendations
		b. Develop supporting enforcement response plan or SOP. 2. Clarify and expand the current DCS requirements for SCM maintenance. a. Define GI SCM protection requirements and provide appropriate guidance. b. Define SCM maintenance requirements in general and refer to appropriate guidance. 3. Develop SOP and documentation tools for City inspection of private BMPs.	Further, City staff is developing a “Maintenance Plan Template” to address this item. Work Plan #3 – This tactic has not yet been implemented.	type or water quality management mechanism (e.g., infiltration, etc.). ○ Tie SCM inspections to the SCM tracking database and public engagement process to maintain records of site visits and owner correspondence in perpetuity. ○ Consider the use of mobile inspection and reporting apps that can create efficiencies in SCM inspections.
9	Upgrade long-term O&M program for public SCMs. SECOND TIER	See Work Plan #3 for more information.		
Relevant Critical Success Factors: <ul style="list-style-type: none"> • City staff and private SCM owners have a solid understanding of the material and maintenance required for green infrastructure features. 				
10	Provide private SCM owners with education and support for SCM maintenance. SECOND TIER	<ul style="list-style-type: none"> • See Work Plan #2 for detailed information on this strategy. Additional recommendations include: <ul style="list-style-type: none"> ○ Develop policies for addressing maintenance issues on existing privately-owned SCMs. Some communities experience increased questions from owners of existing SCMs once their permit-related maintenance program begins. ○ Develop SCM Owner engagement processes, procedures, and engagement templates for form letters, enforcement actions, corrective action guidance, etc. 		
11	Provide City departments with education and	1. Determine how City maintenance supervisors can be advised they have a SCM. 2. Develop public SCM owner training plan that includes both	Activities have not begun for this strategy.	See Work Plan #3 and #4 for information that will accompany this strategy.



#	CSFs, Strategies, & Tier	Tactics	Current Project Status	Future Recommendations
	<p>support for SCM maintenance.</p> <p>SECOND TIER</p>	<p>City-led and vendor-supplied training (see #3). City-led training should cover the following list. Determine training venue and whether repeat training will be done. <i>This guidance can also be included in any policy document or MOU pertaining to City-owned SCMs.</i></p> <ol style="list-style-type: none"> a. The importance of stormwater SCMs, drivers, etc. b. General City requirements. c. Beehive’s SCM data – what’s important. d. SCM protection. e. What to look for when working in and around SCMs. f. General routine and remedial SCM maintenance information. g. Helpful references. h. Whom to ask for help. <ol style="list-style-type: none"> 3. Identify and promote appropriate offsite educational or training opportunities on LID/GI planning and design. <ol style="list-style-type: none"> a. Consider requiring City maintenance supervisors and WQES staff to obtain the Colorado Stormwater Center training certificates. b. Identify appropriate City staff to attend, frequency desired, and budget accordingly. 4. Develop (or refer to) SCM maintenance guidance. This 		



#	CSFs, Strategies, & Tier	Tactics	Current Project Status	Future Recommendations
		can include guidance developed for private owners and/or create SCM type or SCM-specific SOPs depending on need or location.		
Relevant Critical Success Factors: <ul style="list-style-type: none"> • The City has clear direction and tools to implement GI projects. • Long-range planning incorporates green infrastructure into future City plans. 				
12	Establish WQES as the City authority for permit-required SCMs. SECOND TIER	See Work Plan #1 for more information.		
13	Create and implement SOPPs to guide City usage of SCMs in keeping with permit requirements. FIRST TIER	<ol style="list-style-type: none"> 1. Establish desired minimum compliance level with permit requirements. 2. Establish appropriate language for the use of GI where possible. 3. Establish applicability/exemptions for linear (street, trail, path) projects, utilities, etc., in keeping with permit requirements. 4. Define City SCM owner responsibilities. 5. Define WQES responsibilities. 6. Delineate flow chart for City project planning, design, review, construction, and maintenance with regard to stormwater requirements. 7. Include policies and procedures in keeping with all previous strategies. 	Strategy Implementation Complete. SOPPs were established between WQES and other City departments with responsibilities that fall under the NPDES-MS4 permit's construction and post-construction stormwater requirements. The SOPPs addressed each entity's responsibilities, general policies for City project planning, design, construction, and maintenance, responsibilities for City staff education and training, and modes and frequencies of communication.	Implementation of Work Plans #1, #3, and #4 will enhance the SOPPs created via this strategy.



#	CSFs, Strategies, & Tier	Tactics	Current Project Status	Future Recommendations
14	Further develop and implement WQ CIP program. SECOND TIER		See Work Plan #4 for more information.	



Next Tier Strategy Work Plans

As implied by Table 11, detailed work plans have been developed for strategies that were given a “SECOND TIER” designation. As described in Section 6, SECOND TIER strategies are those to be completed as soon as FIRST TIER strategies have been implemented. A list of work plans developed to implement the “SECOND TIER” strategies are listed below. Note that strategies that overlapped were combined within a single work plan.

Work Plan 1: Establish WQES as City Authority for Permit Required SCMs.

Work Plan 2: Post-Construction Stormwater Education and Training.

Work Plan 3: Upgrade Long-Term O&M Program for City-Owned SCMs.

Work Plan 4: Further Develop and Implement a Water Quality CIP.

The four work plans are provided in the pages that follow. Each plan includes the following information.

- Description of why program area is needed;
- Description of activities completed to date;
- Green Infrastructure lessons learned;
- Recommended activities;
- Recommended timeline; and
- Potential resources needed.

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Work Plan 1: Establish WQES as City Authority for Permit-Required SCMs

Description of Need:

As the City entity responsible for oversight of the NPDES-MS4 permit, WQES must be able to ensure that all City departments who have duties that fall under the post-construction stormwater portion of the permit are performing and documenting their activities in keeping with the permit. However, this responsibility is not generally recognized throughout the City.

Activities Completed to Date:

As of January 2019, the following activities have begun or have been completed as part of this strategic plan:

- SOPPs were established between WQES and other City departments with responsibilities that fall under the NPDES-MS4 permit's construction and post-construction stormwater requirements. The SOPPs address each entity's responsibilities; general policies for City project planning, design, construction, and maintenance; responsibilities for City staff education and training; and modes and frequencies of communication.
- WQES has established planning meetings with appropriate City work groups to:
 - discuss 2019 CIP projects;
 - develop training on the SOPPs for City project managers; and
 - organize and track City CIP projects from conception to completion.

GI Lessons Learned

WQES is the entity responsible for City compliance with the NPDES-MS4 permit. This means WQES implements or oversees City compliance activities and tracks and reports these activities as required by the permit. This does not mean that WQES implements every activity required by the permit. In fact, many of the permit's requirements factor into the typical duties of other departments. This is especially true for post-construction SCM planning, design, construction, and maintenance. For example, the permit requires design review and approval of post-construction SCMs. As the City's design review entity, P&DS has a role to play in permit compliance.

The NPDES-MS4 permit and revised DCS have new requirements for post-construction SCM design, documentation, and reporting. There is therefore a need to educate City staff that have responsibilities under these new requirements, and to establish lines of communication and departmental roles and procedures that align with permit requirements. This is not only essential for permit compliance, but also for the success of post-construction SCMs installed on public and private property.

Recommended Activities

The following activities are recommended:

- A.** Consider working with managers of departments responsible for post-construction related activities to establish measurable goals and metrics with regards to work group interaction, design review documentation, and SCM tracking that must occur between WQES and the departments. Track performance against the goals and meet regularly to review performance and refine processes if needed.
- B.** Specifically work with P&DS to improve collaboration and communication with post-construction stormwater review and documentation. **Establish a meeting schedule with P&DS to ensure the revised DCS is being implemented correctly.**
- C.** Dedicate time during the upcoming SOPP training for City project managers to gauge concerns they may have regarding the new requirements, gain an understanding of their current work process, and ask for input on how best to include WQES in CIP planning, pre-design planning, and design. Also ask about their training needs and preferences. Use this input to refine the SOPP if needed, prepare



education and training elements, and determine the best approach for SCM tracking and documentation for all project phases.

- D. Hold a similar SOPP training for City maintenance departments, again gaining detailed input on departmental work processes, training needs, and how best to insert WQES into these processes in a mutually beneficial way. Also discuss how and when maintenance should be tracked for WQES's purposes.

Recommended Task Sequence

Recommend beginning activities as soon as possible.

Anticipated Resources Needed

Resources needed to accomplish the above-stated activities include the Stormwater Quality Supervisor and staff and the managers of departments responsible for post-construction stormwater activities. Information Resources staff may also be needed to address SCM tracking and documentation needs.

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Work Plan for Program Area 2: Post-Construction Stormwater Education and Training

Description of Need

With regard to private land developments, educational training is needed on different subjects and for different audiences, as listed below. Education and training activities may also be used by the City to comply with education and outreach requirements of the NPDES-MS4 permit.

Developers and Site Designers

- Understand DCS site design, plan preparation and approval (through final inspection) requirements;
- Implement LID principles during site planning;
- Design SCMs tailored to site conditions and constraints, including evaluating soil infiltration capacity;
- Select and maintain GI vegetation appropriate to Boulder's climate; and
- Requirements and procedures for as-built drawing and final "check-out" inspection.

Site Contractors

- Understand DCS requirements for post-construction SCMs and effective installation approaches;
- Implement controls to protect and maintain GI SCMs during site construction (construction sequencing, soil and vegetation protection measures, vegetation management after SCM installation, what to do when construction impacts GI SCMs); and
- Initiate constructed stormwater system and SCM "check-out" inspection;

SCM Owners

- Understand DCS requirements for stormwater SCM maintenance (SCM definition, importance, responsible entity, owner responsibilities, and City responsibilities);
- Know how to protect and maintain an SCM including the importance of soil and vegetation and what to do if an SCM needs repairs; and
- Know whom to contact with questions.

Activities Completed to Date

As of January 2019, no activities have been completed.

GI Lessons Learned

Communities are learning that GI SCMs require specialized knowledge and understanding. This is primarily because most GI SCMs function using soil and vegetation for infiltration or bio-filtration and evapotranspiration. Thus, proper "engineering" of soil and vegetation during design and protection and maintenance during and after construction are critical to the success of a GI SCM. The importance of soil and vegetation for urban and suburban stormwater management is generally a new concept for site designers (who are primarily engineers), contractors, and SCM owners; therefore, education and training on these subjects can be significantly helpful to ensure that GI SCM installations are successful. In general, it is anticipated that training and education for site designers and contractors will be a routine need and activity for MS4 permittees, at least until GI SCMs become a more routine part of the site design, site construction, and landscape maintenance industries (estimated at 5 to 10 years).

Beyond GI, Boulder has many of the same general educational needs for their post-construction program as most other MS4 permittees. As a post-construction program changes and matures, occasional training is needed to keep site designers and site contractors aware of new regulations, changed administrative processes, and typical enforcement challenges. A possible approach is to hold annual or biennial (once every two years) land development training workshops specifically for developers, site designers, contractors,



excavators, homebuilders, and similar stakeholders. In addition, developing a web resource center with fact sheets, case studies, work flows, and other relevant content is recommended.

Recommended Activities

The development of a Private Property Post-Construction Stormwater Education and Training Plan to guide training activities for the next 5 to 10 years (two MS4 permit cycles) is recommended. A suggested table of contents annotated to indicate the extent of the subject matter for each section is provided below.

- A.** Introduction – Explain the purpose and objectives of the Plan (see GI Lessons Learned above).
- B.** Audiences and Goals – Define/describe the different audiences that must be reached by education and training elements. Define/describe in detail the education and training purpose and goals for each audience.
- C.** Activities – Identify the education/training activities for each audience. For each activity, provide detailed descriptions of the following items in sufficient detail to implement each activity.
 - Activity description
 - Activity format (e.g., brochure, workshop)
 - Content format (e.g., MS Word, jpg video)
 - Activity manager and responsibilities
 - Activity start date
 - Activity objectives
 - Description of content to be conveyed
 - Activity length and/or frequency
 - Activity developers/participants and responsibilities
 - Resources needed
- D.** Implementation and Metrics – For each activity, list and fully describe the steps required to implement the activity, metric(s) to be used to measure activity effectiveness, and when metrics will be examined.

Recommended Task Sequence

The NPDES-MS4 permit requires Boulder to implement post-construction requirements in accordance with the current permit by July 1, 2019. Thus, the following general sequence of tasks is recommended. This sequence should be refined and adjusted in the Post-Construction Stormwater Education and Training Plan.

Finalize Post-Construction Stormwater Education and Training Plan
Begin developing education and training elements for site designers Begin developing of education and training elements for site contractors
Begin providing education and training elements to site designers and continue in accordance with Plan
New post-construction DCS requirements become effective
Begin providing education and training elements to site contractors and continue in accordance with Plan
Begin developing and providing education and training elements for SCM Owners
Re-examine education and training element effectiveness and efficiency and adjust Plan accordingly.

Anticipated Resources Needed



Staff resources needed to develop the Plan include, at a minimum, the Stormwater Quality Supervisor and staff, the Development Review Manager, and Utilities Maintenance Manager. Outside services may also be needed.

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Work Plan for Program Area 3: Upgrade Long-Term O & M Program for City-Owned SCMs

Description of Need

As an SCM owner, the City is responsible for the operation and maintenance (O&M) of its own SCMs. There are a number of needs related to O&M of City-maintained SCMs.

- **Education for CIP Project Managers** – Project managers for design and construction of City projects must understand and ensure that maintenance of SCMs is considered and budgeted for during project design, and that SCMs are protected and maintained during construction.
- **City-Recognized SCM Maintenance Program** – While supervisors of City maintenance staff are aware of the post-construction requirements of the NPDES-MS4 permit, the internal policies, processes, procedures, education/training, and funding that facilitate SCM maintenance need to be further developed.

Activities Completed to Date

As of January 2019, the City has established SOPPs with City departments responsible for design and construction of CIPs. The SOPPs recognize the NPDES-MS4 permit's requirement for SCMs on public projects, establish WQES as the City's internal authority for SCMs, and set up basic lines/modes of communication and education/training with WQES for the design, construction and maintenance of SCMs. Beyond these SOPPs, no other activities have been completed.

GI Lessons Learned

Properly considering the long-term protection and O&M of an SCM during its planning and design is critical to the success of the SCM when construction is complete. This is especially true for SCMs placed in the public rights-of-way, where SCMs will be impacted by traffic and common street maintenance activities such as street sweeping, vegetation control, and snow/ice control. Additional consideration must be given to GI SCMs, which require specialized knowledge and understanding because they use soil and vegetation to function properly. As a result, City project managers must understand SCM maintenance requirements and life-cycle costs and use this information to inform the SCM design. A goal for project managers should be to ensure that SCMs are clean, fully functioning, and properly funded for maintenance needs at the end of construction before the SCMs become the responsibility of City maintenance staff.

When construction is complete, City maintenance programs (Utilities and other) take over SCM protection and maintenance. At this stage it is critical that City maintenance staff have both the understanding and resources needed to properly protect and maintain SCMs. Now that GI SCMs and other non-traditional SCMs can be used for stormwater quality management, Boulder should consider formalizing SCM maintenance into a defined program to protect against future SCM failure. Many communities have installed SCMs only to have them fail due to lack of maintenance or lack of protection, requiring large-scale maintenance or even full replacement. These overhauls are costly, inconvenient, and harm public perception of SCMs. Major obstacles to keeping SCM's functioning long term are:

- Lack of comprehensive maintenance programs – successful communities have included SCM maintenance requirements for CIP projects in comprehensive plans, development codes, and other regulations.
- Lack of education for CIP Project Managers – project managers for design and construction of City projects must understand and ensure that maintenance of SCMs is considered and budgeted for during project design, and that SCMs are protected and maintained during construction.
- Lack of staff education and expertise – staff may require specialized and ongoing SCM training. Relationships with contractors and vendors who have needed expertise and equipment necessary for each SCM must also be established.

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- Lack of dedicated staff – time, technical expertise, and data management are required to inventory SCM locations, track maintenance schedules, carry out maintenance, prevent conflicts with other City projects, and manage contractors.
 - Lack of dedicated funding – successful communities have used tax revenue, water and sewer utility funds, stormwater user fees, and/or fees collected from developers to pay for SCM maintenance. Planning for the long-term costs of each SCM ensures that funds are available when needed.

Recommended Activities

It is recommended that the City develop, recognize and fund SCM maintenance as a sub-program of City maintenance. The following activities are needed to create a successful SCM maintenance program.

- A. Recognize WQES as authority** – See Work Plan 1.
- B. Develop a system to track SCM maintenance** – Maintain ownership and maintenance information for all city-maintained SCMs in a central location. The city could potentially integrate these data into a larger (spatially organized) asset management program or could simply compile them in a database. Developing a system that ensures data is current is critical. The process for populating and maintaining data could be integrated with the project approval and work order process to ensure data is current. A process that triggers notification to City maintenance departments would also improve the budgeting and planning process for these departments.
- C. Budget for SCM maintenance** – The City should develop estimates for various common SCM maintenance activities that can be used for maintenance program budgeting. Estimates should be developed on a per-unit basis, so they can be applied to SCMs of different sizes, types, and vegetative cover. Estimates should be re-examined and updated at least every two years.
- D. Develop program elements** – The SCM maintenance program should also include:
 - a. Routine inspection and maintenance guidance/checklists for public SCMs to be used by maintenance staff. An inspection and maintenance SOP for each individual SCM may also be helpful.
 - b. Policies, procedures, and responsibilities for SCM inspection and maintenance tracking, and for communication between WQES and City maintenance departments.
 - c. Education and training support for City maintenance staff: It is suggested that a City-owned SCM owner education and training plan like that described in Work Plan 1 is developed specific to municipal operations. Education and training should address:

<ul style="list-style-type: none"> • The importance of SCMs • SCM differences • Importance of soil and vegetation • City requirements for maintenance • SCM tracking procedures 	<ul style="list-style-type: none"> • SCM protection • What to look for when working in and around SCMs • Routine and remedial maintenance by SCM type • Helpful references and resources • City organization/policies for SCM oversight
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Recommended Task Sequence

The NPDES-MS4 permit requires Boulder to implement post-construction requirements in accordance with the current permit by July 1, 2019. The following sequence is recommended.

Begin update of SCM inventory and tracking database.

Develop Public SCM Education and Training Plan for City staff. Consider opportunities for optimization with education and training planned for private SCMs (See Work Plan 2).

Begin developing education and training elements for **City project managers**.

Begin developing cost estimates for SCM maintenance on a per-unit basis.

Begin development of maintenance program policies, procedures and support tools.

Begin providing education and training elements to **City project managers**.

SCM database should be on-line and ready to track existing SCMs. A process for database update should be in place as well. Project managers should be educated on SCM types, selection, and maintenance needs at this point.

Begin developing and providing education and training elements for **City maintenance staff**. Consider opportunities for optimization with education and training planned for private SCMs (see Work Plan 2).

Anticipated Resources Needed

Staff resources needed to develop the Education and Training Plan, maintenance policies and procedures, and SCM maintenance cost estimates include the Stormwater Quality Supervisor (and staff) and the managers of City maintenance work groups. Information Resources staff will be needed for SCM database development. Outside services may also be needed.

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Work Plan for Program Area 4: Further Develop a Water Quality CIP Framework

Description of Need

A water quality CIP is included in the overall Utilities CIP for the Stormwater/Flood utility. The goal of this fund is to allocate water quality compliance and water quality projects and resources in the City. CIP planning should include consideration of MS4 requirements at a minimum. Beyond this minimum, consideration of GI SCMs should become a routine part of CIP and municipal project planning and budget allocation regardless of whether the CIP project is subject to permit requirements. In addition, funding could be allocated to potential initiatives and partnerships that are not directly Water Quality CIP driven. Boulder's current CIP planning should be enhanced to include further consideration of stormwater quality management.

Activities Completed to Date

As of January 2019, the following activities have begun or have been completed.

- Developed a ranking criteria to categorize and evaluate existing and future City projects through the assistance of the Internal Stakeholder Group.
- Developed a prioritized list of projects for GI implementation both upcoming City projects and GI specific installations.
- Presented and developed seven planning level pilot project concepts to the Internal Stakeholder group that included GI SCMs. Developed one pilot project full concept design. A detail of these pilot projects are provided in Section 6 of this Plan and the pilot project boards are provided in Appendix 3.
- Collected feedback from Internal Stakeholder group about specific GI SCM likes and dislikes, and appropriate areas for application. This feedback is provided in Section 6 of this Plan.
- An SOPP was established between WQES and other City departments' post-construction stormwater responsibilities. Among other topics, the SOPP addressed the inclusion of WQES in City departments' CIP planning processes. WQES will provide input on the City's post-construction stormwater responsibilities for City projects and can assist with identification of potential stormwater quality opportunities for collaboration and the use of Stormwater Quality CIP funds to enhance proposed projects.
- WQES has established planning meetings with appropriate City work groups to further discuss the City's CIP projects planned for design in 2019.
- Developed a list of potential initiatives and partnerships that could be supported by the water quality CIP fund (see recommended activities).

GI Lessons Learned

The post-construction stormwater requirements of the NPDES-MS4 permit apply to both private and public projects. As a result, CIP planning should include consideration of post-construction requirements at a minimum. In addition, permitted jurisdictions are required to look for opportunities to reduce stormwater pollution impacts from their facilities and municipal operations in general. So, it is conceivable that new CIPs can be identified for stormwater quality purposes as a primary driver, or that planned CIPs (even those excluded by the permit) can be designed to have a stormwater quality management function. GI SCMs are well suited for this, as they can provide both aesthetic and stormwater quality value. During the course of this project, several internal stakeholder meetings were held, and feedback and input was collected from the stakeholders about Water Quality CIP planning and implementation. The following is a summary of the feedback obtained:

- Early coordination and clear communication about the expectations of GI SCM design, implementation and departmental responsibility is important.

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- Identification of and preliminary coordination with all impacted stakeholders (both public and private) that could be involved in making the project a reality should be part of a formal vetting process prior to allocating significant resources to any project.
 - As the scale and complexity of GI SCMs varies, it is important to have a clear understanding of SCMs that can be designed and administered by City resources and those that require full external design services.
 - Standardizing the process for development and submittal of SCM designs to correspond with deliverable requirements of other City departments (30% design concept, 60% design, 90% design, and 100% Bid Documents) is important to provide continuity.

WQES should formalize criteria for allocating resources from the Water Quality CIP to specific project categories and/or initiatives. Possible Water Quality CIP Project Categories and/or initiatives include:

1. **CIP Support:** This process has been initiated as part of this project and the establishment of SOPPs with City work groups. As part of this process, WQES will meet with each City work group that conducts capital projects on an annual basis to determine what upcoming projects may have a water quality component. Stormwater Quality Improvement funds may be used to support CIP projects that go beyond water quality permit requirements.

Example Upcoming Projects: North Boulder Library

2. **Maintenance/Citizen/Staff Complaint Solutions:** This project category would create a framework for which utilities, transportation, and parks maintenance could identify observed drainage issues within the City. Citizen complaints or other avenues for identifying potential problem areas could additionally be incorporated. These project types may often be overlooked due to a lack of capacity, time, or funding within individual work groups, but may present a simple opportunity for mutual benefits to alleviate drainage concerns, enhance water quality, and improve City amenities. Of the developed list of problem areas, not all will present an opportunity for green infrastructure. However, all the problem areas could still be cataloged and used to support collaboration between maintenance work groups even if they are not a part of a water quality CIP. In instances where both a utility, transportation, and park upgrade is needed in conjunction with a water quality SCM, a framework for split funding between water quality and other capital funding sources could be created.

Example Upcoming Projects: Tantra Park, Broadway & Quince Roadside Ditch

3. **Targeted Water Quality Initiatives:** This project category would identify specific initiatives that would support water quality in the City or capitalize on low cost, high impact opportunities when conducted in collaboration with other City initiatives. This is a broader category that could evolve as opportunities are identified over time. The following is a list of example ideas that would fall within this category:
 - A. Collaboration with Planning and P&DS on initiatives to increase green space in parking lots or other highly impervious areas.
 - B. Collaboration with Community Vitality on parking lot improvement projects.
 - C. Targeted efforts to reduce *E. coli* in Boulder Creek as part of the TMDL Implementation Plan.
 - D. Retrofit program to enhance existing City detention basins/water quality SCMs to provide improved treatment.
 - E. Targeted water quality master planning efforts for specific areas such as The University Hill area.
 - F. Incentive program to encourage GI SCM implementation on private property through rewards, cost-share programs, and/or fee discounts.



Recommended Activities

The following activities are recommended.

Further planning

- A. Continue to develop and refine goals and objectives of water quality CIP fund based off of work completed to date and feedback obtained from the internal stakeholder group.
- B. Identify funding support initiatives (e.g. CIP Support, Maintenance/Citizen/Staff complaint solutions, Targeted Water Quality Initiatives) that support identified goals and objectives.
- C. Assess feasibility of identified initiatives based on stakeholder input.
- D. Develop prioritization framework to select focus initiatives.
- E. Define funding allocation process for focus initiatives.
- F. Develop project identification process and tracking procedures.

Implementation

- G. Implement preliminary projects.
- H. Monitor and report on project results.

Recommended Task Sequence

The NPDES-MS4 permit requires Boulder to implement post-construction requirements in accordance with the current permit by July 1, 2019. However, many of these items are beyond permit requirements and may take a longer time to implement. Thus, the following general sequence of tasks is recommended.

Develop goals and objectives of water quality CIP fund.
Identify funding support initiatives that support identified objectives.
Assess feasibility of identified initiatives based on stakeholder input.
Develop prioritization framework to select focus initiatives.
Define funding allocation process for focus initiatives.
Develop project identification and tracking procedures.
Implement preliminary projects.
Monitor and report on project results.
Assess and revise prioritization framework/funding allocation based on project results.



Anticipated Resources Needed

Staff resources needed to develop the WQ CIP Program include the Stormwater Quality Supervisor (and staff) and the managers of other City work groups. WQES or designated maintenance department will need to develop a capital program for procurement and maintenance of GI SCM specific maintenance equipment and/or contracting of services. Additional staff and professional consulting services will likely be needed to evaluate, design, implement and maintain GI SCMs within the City.

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Recommendation for the Future Use of Stakeholder Group

The internal stakeholder input and assistance of various City and UDFCD staff were invaluable to the development of the project vision, critical success factors and the development and implementation of the strategies in this plan. When stakeholders work in an unprejudiced and collaborative manner, as they have during the development of this plan, their input guides the implementation to outcomes and work products that will likely be more readily accepted by those impacted by the outcomes.

Time was spent during Stakeholder Meeting 5 (final stakeholder meeting for this project) to obtain feedback from the participants about the overall stakeholder process and future involvement. The following questions were asked: how did the overall process for this project work for you?; what were your likes and dislikes about the project and process?; what type of future involvement would be valuable to you?; and should there be departmental meetings for specific compliance areas?

The general feedback from the questions above was as follows:

- They valued the involvement in this Stakeholder Group.
- They thought the number of meetings and content provided in those meetings was very beneficial.
- They thought the meeting frequency was appropriate and allowed for enough engagement without being a time burden.
- They felt as though their input was actually incorporated and reflected back in the project deliverables.
- They valued the open communication between departments.
- They would like to keep this group together in some capacity moving forward with the Work Plan recommendations.

Based on the above Stakeholder feedback, the following is recommended for future involvement:

- Provide an overall program update on a semiannual basis to the Internal Stakeholder Group.
- Use focus stakeholder groups to assist in the implementation of the identified Work Plans (see specific recommendations in the above Work Plans).
- Engage with the Core Group on an annual basis to evaluate progress made on aspects of this Plan. This time can also be used to generally check-in on stormwater program communication and opportunities for improvement.
- Development of an External Stakeholder Plan/Strategy:
 - Develop format for soliciting obtaining feedback on DCS revisions.