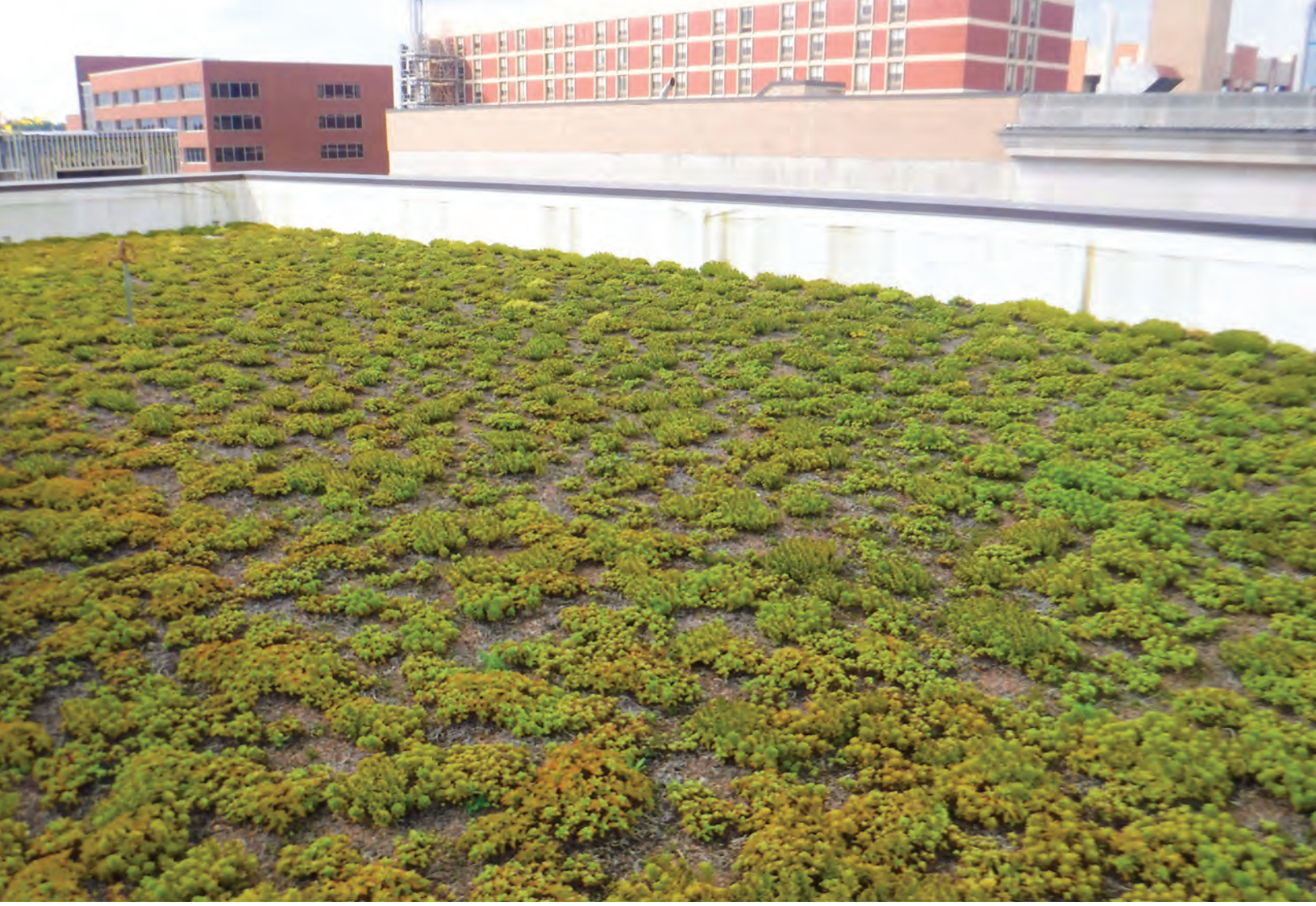

GREEN INFRASTRUCTURE
OPERATIONS & MAINTENANCE PLAN

FEBRUARY 2019

CITY OF LANCASTER
A City Authentic

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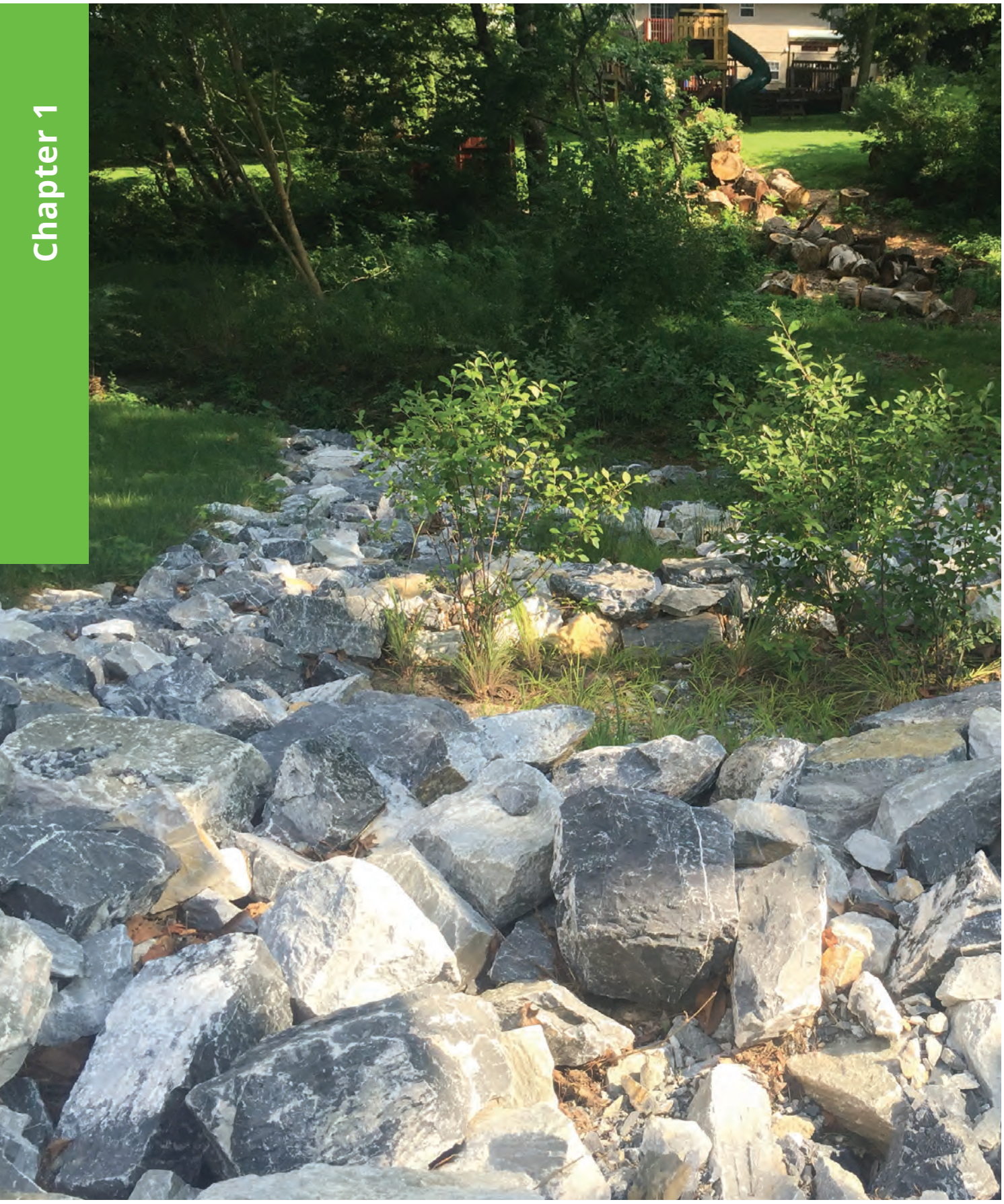
TABLE OF CONTENTS

TABLES

Chapter 1



1. INTRODUCTION AND PURPOSE

The City of Lancaster (City) uses a combination of traditional stormwater infrastructure and Green Infrastructure (GI) to manage stormwater and minimize pollution to the City's streams, rivers, and waterways. Within the GI program, decentralized systems, or stormwater Best Management Practices (BMPs) – including bioretention, porous pavement, and green roofs – are used to add capacity to the combined stormwater and wastewater sewer system, reduce the peak discharge rates of runoff during storm events, and improve water quality while creating additional green space benefits for the community. Stormwater runoff collected by GI is returned to the water cycle through natural processes such as infiltration and evapotranspiration.

Like traditional infrastructure, GI requires regular operations and maintenance (O&M) activities to ensure proper functionality. Common inspection and maintenance needs for GI include but are not limited to: inspection and jet-vacuum cleaning of inlets and subsurface piping, vacuum-sweeping of porous pavement BMPs, clearing and disposing of accumulated trash and sediment, aesthetic maintenance, and winterization. Because many GI systems also incorporate landscaping, there are a number of seasonal tasks that are necessary to keep up the appearance and health of the plants. As these plantings establish over time, the maintenance needs of these BMPs will also change.

This GI O&M Plan (Plan) outlines the protocols for maintenance, inspection, data management, and reporting for each GI type used in the City, as well as scheduling, staffing, and budget allocations necessary to establish a successful program. This maintenance data will also be used by the City, along with the GI Monitoring Plan, to document testing results and update GI maintenance schedules, as needed. In addition, the forms and reports presented in this Plan will be used to collect maintenance data for the City's asset management system. The Plan is meant to formalize operations of the GI maintenance program and is intended for use primarily by the Department of Public Works (DPW) tasked with ensuring the long-term success of the program. The Plan also serves as a reference for City field staff, other City agencies and partners, GI designers, the development community, and interested members of the public.

1.1 GREEN INFRASTRUCTURE IN THE CITY OF LANCASTER

The City captures and conveys stormwater in part through the use of a combined sewer system (CSS). The CSS collects and transports a combination of stormwater runoff and domestic sewage from approximately 45 percent of the City's total area. During typical conditions, the City's Advanced Wastewater Treatment Facility is able to manage and treat water collected by the CSS. Heavy storm events, however, create flow volumes that exceed the treatment facility's capacity, resulting in combined sewer overflow (CSO) discharges into the Conestoga River, eventually leading into the Chesapeake Bay.

The Clean Water Act of 1972 established water quality standards for surface waters in the United States. The Commonwealth of Pennsylvania enforces these standards by issuing permits that regulate combined sewer overflows and stormwater runoff in areas with separate sewer systems. To comply with the Clean Water Act, the Pennsylvania Department of Environmental Protection (PA DEP), through the Pennsylvania Storm Water Management Act (Act 167), issued a Consent Decree to the City to reduce CSO discharges.

The City has agreed to develop and implement an Amended Long Term Control Plan (LTCP) to achieve these regulatory requirements. The City's commitment to sustainable solutions is made evident in a LTCP that prioritizes the use of decentralized GI systems to reduce the combined sewer load on the wastewater treatment facilities.

The remaining portion of the City's sewer system separates stormwater from the sanitary system. These areas are becoming inundated during intense storm events, resulting in surcharges, localized drainage issues, and increased conveyance of pollutants to local waterways. In these areas, the City must adhere to certain pollution reduction requirements set by the PA DEP via the National Pollutant Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) permit program. The City has outlined an approach to mitigating pollution loads in their Chesapeake Bay Pollution Reduction Plan.

GI is a key component of the City's CSO and pollution reduction strategy and can also provide additional benefits beyond pollution and stormwater volume reduction. By choosing GI over traditional "gray infrastructure", the City may see reduced energy demands, cooling effects during warmer months, and improved streetscapes. GI practices often utilize native vegetation as part of the treatment process, which can improve the environment by filtering pollutants from the air and providing habitats for birds and pollinators.

The City of Lancaster Green Infrastructure Plan (2019 Update) outlines strategies for utilizing GI to create livable, sustainable, and safer communities, while reducing pollution associated with CSOs and direct discharges to the MS4. GI can be located on public land (e.g. parks and schools), private land (e.g. private parking lots), and within the right-of-way (e.g. within sidewalks). GI is versatile in its application and can be implemented on rooftops, the ground surface, or underground. These installations commonly employ landscape architecture design elements such as porous pavements, native plantings, shade trees, or artistic signs or murals.

The City agency primarily responsible for implementing the City's GI program is DPW. DPW operates and maintains a portfolio of BMPs using a team comprised primarily of City staff supplemented with the assistance of specialty contractors, as needed. As the program continues to grow, it is necessary to establish protocols for BMP inspection, maintenance, and documentation that will streamline workflows and ultimately improve outcomes of the GI program.

1.2 PURPOSE OF THE OPERATIONS & MAINTENANCE PLAN

The Plan is essential for the functional success of a GI program. The dynamic urban environment in which these systems are located exposes them to heat, drought, and chemical stressors. Different GI systems may have distinct maintenance requirements depending on a large number of factors. The characteristics of these systems and the stressors they encounter creates a unique challenge: establishing a maintenance program focused on adaptive management in order to optimize performance while identifying key recurring tasks addressed routinely to ensure proper appearance and function.

The Plan establishes protocols to ensure the proper function of each GI type used in the City, as well as sustained function of the GI program. Using an adaptive management approach, the Plan offers inspection-driven repair protocols and recurring maintenance tasks as well as the data collection processes needed to continually evaluate the financial requirements of the growing program. In addition, the Plan defines tasks, schedules, a computerized maintenance management system (CMMS), equipment, staffing, and budgets, and includes workflow diagram, checklists, and data sheets that will be used by staff to implement and communicate protocols.

Due to the rapidly changing nature of GI systems and the need for prompt response to issues, managing the flow of information between field and office staff is essential. The City uses an asset management system called Lucity™ for work order management and record keeping across several municipal programs. The Plan establishes forms and tables that are integrated into Lucity™ and can be used in the field (for data collection) and in the office (for reporting, budgeting, and planning) via a software platform that is consistent with other City agencies. This approach allows the City to use data that is continuously collected through the O&M program to inform future decision-making with respect to maintenance strategies and target its investments to optimize performance. This document is one of three documents developed to work in concert to assure that the goals and requirements set forth by the LTCP are met. The other two documents, the GI Design Manual and the GI Monitoring Plan, are described below.

1.2.1 Relationship to Green Infrastructure Design Manual

The GI Design Manual provides technical guidance for the planning, design, and construction of individual GI systems. It serves as a technical reference for the design of both public GI installations implemented by the City and for private GI installations implemented on private property to meet regulatory requirements associated with land development activities and stormwater fee credits. Similar to this manual, the GI Design Manual is broken into several chapters, each of which includes information related to the overall topic.

Though the GI Design Manual is published under a separate cover, its purpose is closely intertwined with that of the Plan. It is critical to the success of the program that designers understand the maintenance impacts of their designs and that maintenance personnel acknowledge the intent of the design. By considering maintenance during the design process, designers are more likely to create GI systems that are more efficiently maintainable.

The Plan as outlined in this document is an adaptive plan, meaning that lessons learned throughout the life of the plan will feedback into the plan itself, making the program efficient over time. Integrated into the adaptive management strategy is the opportunity to feedback information to designers and make changes to design requirements and standards represented in the GI Design Manual.

Prior lessons learned from peer cities regarding maintenance considerations and their implications for design have already been applied to the GI Design Manual. Select design elements influenced by the need for maintenance include: minimum pipe diameters, and minimum pipe bend angles that allow for easy passing of jetting and inspection instruments; inclusion of energy dissipation and settling areas to concentrate sediment and debris; and minimum widths for trench drains or other surface structures to allow for ease of maintenance with a shovel or similar tool.

1.2.2 Relationship to Green Infrastructure Monitoring Plan

In addition to the GI Design Manual, the Plan was developed to work alongside the GI Monitoring Plan to assure that the goals and requirements set forth by the LTCP are met. The GI Monitoring Plan describes evaluating the performance of representative GI projects, including functional testing during/after construction and long-term monitoring. The GI Monitoring Plan has been developed to aid in evaluating the performance of the program from various levels, for example program level or BMP level. The plan outlines strategies for monitoring BMP performance, which will inform possible updates to design and maintenance practices.The GI Monitoring Plan also informs adaptive management decisions for performance optimization. Results of monitoring may be used to increase or decrease maintenance task frequencies (refer to Section 4.6, Recommended Maintence Frequency Based on Service Level) as to better align with the City's goals.

1.3 USING THE GREEN INFRASTRUCTURE OPERATIONS & MAINTENANCE PLAN

TABLE 1.3-1. HOW TO USE THE GREEN INFRASTRUCTURE O&M MANUAL

Chapter	How to Use
Chapter 1 – Introduction and Purpose	Brief description of the City's current stormwater system and description and purpose of the Plan.
Chapter 2 – Stormwater Management and Green Infrastructure Background	Overview of the City's goals with regard to runoff water quality and volume reduction based on the regulatory requirements set forth by the Federal Clean Water Act and its provisions. Additionally, this chapter describes how this Manual relates to other GI manuals and initiatives within the City.
Chapter 3 – Green Infrastructure Asset Maintenance Data	Outlines the City's CMMS, GI hierarchy, and how GI assets are stored within this hierarchy. GI asset categories, workflow diagrams, cost tracking, and indicators of performance are all defined within this chapter.
Chapter 4 – Standard Inspection and Maintenance Protocols	Detailed guidance for standard maintenance and inspection protocols. Recommended tasks, frequencies, equipment, materials, and other applicable protocols based on GI asset type are defined here.
Chapter 5 – Green Infrastructure O&M Forms, Logs, and Reporting	Template forms and reports necessary to implement the asset management strategy outlined in Chapter 3. This chapter also includes protocols for data tracking, notifications, and reporting.
Chapter 6 – Inspection and Maintenance Scheduling	Documents recurring maintenance frequencies for different inspection and maintenance tasks for different types of BMPs, as well as workflows for inspection-driven maintenance activities. This chapter also outlines an adaptive management approach for evaluating and modifying maintenance schedules based on field observations.
Chapter 7 – Personnel, Equipment, and Budget Requirements	Includes 1-year, 5-year, and 30-year budget estimates for the inspection and maintenance (as outlined in this document) of the City's portfolio of GI. Budgets include staffing requirements (for operations as well as management) and a breakdown of equipment, labor, and materials costs. While it may not be possible to budget for all possible needs, this chapter includes a discussion and standard assumptions for replacement of components such as plants and soil media.

TABLE 1.3-1. HOW TO USE THE GREEN INFRASTRUCTURE O&M MANUAL (cont.)	
CHAPTER	HOW TO USE
Appendix A – Maintenance Protocols by GI Type	List of standard maintenance procedures (SMPs) for each of the GI types within the City: bioinfiltration & bioretention, porous pavement, green roof, subsurface infiltration and detention, cisterns, and naturalized basins.
Appendix B – Detailed Protocol Instructions	SMPs for typical maintenance tasks as well as other general guidance for non-routine maintenance tasks and various inspection protocols. SMPs are presented as tear sheets that will be torn out of the manual and used by field personnel.
Appendix C – CMMS Workflow Charts	Data management workflows that show the flow paths of both data and work throughout the O&M process, as well as critical decisions and resultant actions. These diagrams will be used by City staff to standardize lines of communication and data management.
Appendix D – CMMS Asset Inputs	Data tables that display the fields and input options for the inspection and maintenance forms that will be used by City staff. These data tables range from those intended to be filled upon acceptance into the program, to those that match the back-end of the digital inspection and maintenance forms used by the City's CMMS Lucity™.
Appendix E – Reporting Forms & Logs	Reporting forms and logs include all of the necessary data fields to be collected by City staff during inspection and maintenance events. These forms can be printed and used as paper alternatives to the CMMS during outages or other unforeseen circumstances.
Appendix F – Personnel Classifications	List of O&M personnel required to carry out various tasks. Personnel organized by role, titles, position, and job description.

Chapter 2

2. STORMWATER MANAGEMENT AND GREEN INFRASTRUCTURE BACKGROUND

This chapter provides an overview of the City's goals and objectives with regard to runoff water quality and volume reduction based on the regulatory requirements set forth by the Federal Clean Water Act and its provisions. It describes the City Stormwater Management Ordinance.

2.1 CITY OF LANCASTER GOALS AND REGULATORY REQUIREMENTS

The City has entered into a consent decree with PA DEP to ensure that the City undertakes measures necessary to comply with the Clean Water Act. The City has agreed to develop and implement an Amended LTCP to achieve these regulatory requirements. The City's commitment to sustainable solutions is made evident in a LTCP that prioritizes the use of decentralized GI systems to reduce the combined sewer load on the wastewater treatment facilities.

2.1.1 City of Lancaster Stormwater Management Ordinance

The City's current Stormwater Management Ordinance §260-301 was adopted by the City Council of the City of Lancaster on April 17, 2018. According to the Ordinance, the City Council stated the following findings:

A. Inadequate management of accelerated stormwater runoff resulting from development throughout a watershed increases flood flows and velocities, contributes to erosion and sedimentation, overtaxes the carrying capacity of existing streams and storm sewers, greatly increases the cost of public facilities to convey and manage stormwater, undermines floodplain management and flood reduction efforts in upstream and downstream communities, reduces groundwater recharge, and threatens public health and safety.

B. A comprehensive program of stormwater management, including reasonable regulation of development and activities causing accelerated erosion, is fundamental to the public health, safety, welfare, and the protection of the people of the City and all the people of the commonwealth, their resources, and the environment.

C. Stormwater is an important water resource, which provides groundwater recharge for water supplies and base flow of streams, which also protects and maintains surface water quality.

D. Federal and state regulations require certain cities to implement a program of stormwater controls. These cities are required to obtain a permit for stormwater discharges from their MS4 under the NPDES.

E. Riparian forest buffers enhance water quality by filtering pollutants in runoff, providing light control and temperature moderation, processing pollutants, increasing infiltration and providing channel and shoreline stability thus decreasing erosion (PA DEP Riparian Forest Buffer Guidance, November 27, 2010).

F. Much of the City is served by a combined sewer system that collects and transports both domestic sewage and rainwater that flows from impervious surfaces such as roofs, streets, and parking lots. The City's Advanced Wastewater Treatment Facility is normally able to manage and clean the volume of wastewater flowing through the combined sewer system; however, during intense rainstorms and other wet weather events, the system becomes overwhelmed, causing untreated wastewater to overflow into the Conestoga River. These events are referred to as "combined sewer overflows."

The Ordinance sets out to promote health, safety, and welfare within the City through provisions intended to minimize potential damages caused by the findings of the City Council. These provisions are designed to:

A. Manage accelerated runoff, erosion, and sedimentation problems at their source by regulating activities that contribute to these problems.

B. Utilize and preserve the existing natural drainage systems.

C. Encourage recharge of groundwater where appropriate and prevent degradation of groundwater quality.

D. Maintain existing flows and quality of streams, watercourses, and water conveyance facilities in the City and the Commonwealth of Pennsylvania.

E. Preserve and restore the flood-carrying capacity of streams.

F. Provide proper operation and maintenance of all stormwater BMPs that are implemented within the City.

G. Provide performance standards and design criteria for watershed-wide stormwater management and planning.

H. Meet state water quality requirements, including regulations at 25 Pa. Code Chapter 93 to protect, maintain, reclaim, and restore the existing and designated uses of the waters of the commonwealth.

I. Prevent scour and erosion of stream banks and streambeds.

J. Provide standards to meet NPDES permit requirements.

K. Help preserve and protect exceptional natural resources, and conserve and restore natural resource systems.

L. Promote stormwater BMPs that emphasize infiltration, evaporation, and transpiration.

M. Reduce CSOs.

Furthermore, the Ordinance lays out the general requirements for the Amended LTCP and all regulated activities relating to the management of stormwater as described by the findings of the City Council. A majority of these requirements relate to design and calculation standards, which are discussed in the GI Design Manual. Article VI §260-601 through §260-605 of the Ordinance defines the O&M requirements of owners of GI practices.

This Plan provides further detail of the requirements of O&M agreements and the responsibilities of owners (as outlined in Article VI of the Ordinance). Minimum requirements and frequencies set forth in the Ordinance will be met or exceeded by those set forth in the Plan.

2.1.2 Amended Long Term Control Plan

The Plan is in support of the requirements set forth in the Amended LTCP and the Consent Decree regarding the inclusion of GI to reduce CSOs.

2.2 RELATIONSHIP TO GREEN INFRASTRUCTURE DESIGN MANUAL

This O&M Plan is one of three documents developed to work in concert to assure that the goals and requirements set forth by the LTCP are met. The first of these additional documents, the GI Design Manual, outlines design requirements, standard design features, and calculation methods related to GI design. The GI Design Manual is the resource for details on GI design guidelines and construction guidance. In general, the information conveyed by this Plan is typically more suited towards post-construction BMPs.

2.2.1 Green Infrastructure Design Standards Overview

The GI Design Manual provides technical guidance for the planning, design, and construction of individual GI systems. It serves as a technical reference for the design of both public GI installations implemented by the City and private GI installations implemented on private property to meet regulatory requirements associated with land development activities and/or achieve stormwater fee credits. Similar to the Plan, the GI Design Manual is broken into several chapters, each of which includes information related to design.

2.2.2 Maintenance Considerations for Designers

Though the GI Design Manual is published under a separate cover, its purpose is closely intertwined with that of this Plan. It is critical to the success of the program that designers understand the maintenance impacts of their designs, and that maintenance personnel acknowledge the intent of the design. By considering maintenance during the design process, designers are more likely to create GI assets that are easier to maintain.

The Plan, as outlined in this document, is an adaptive plan. Lessons learned throughout the life of the Plan will be incorporated – and the plan revised – to make the program more and more efficient over time. Integral to the adaptive management strategy is the opportunity to acquire feedback and information from designers, and to make changes to the design requirements and standards in the GI Design Manual that improve the overall design and long-term performance of BMPs. Further detail on the adaptive management strategy can be found in Section 3.3, Performance Indicators and Adaptive Management.

Prior lessons learned from peer cities with regards to maintenance considerations – and their implications for design – have already been applied to the GI Design Manual. Examples of design elements informed by maintenance needs include, but are not limited to: minimum pipe diameters and minimum pipe bend angles (to allow for easy passing of jetting and inspection instruments); inclusion of energy dissipation and settling areas (to concentrate sediment and debris); and minimum structure widths for trench drains or other surface features (to allow for ease of maintenance with hand shovels or similar equipment).

2.3 RELATIONSHIP TO GREEN INFRASTRUCTURE PERFORMANCE MONITORING PROGRAM

In addition to the GI Design Manual, this Plan is developed to work in concert with the GI Monitoring Plan to assure that the goals and requirements set forth by the LTCP are met. The GI Monitoring Plan describes evaluating the performance of representative GI projects, including testing during/after construction and long-term monitoring.

2.3.1 Green Infrastructure Monitoring Program Overview

The GI Monitoring Plan has been developed to aid in evaluating the performance of the program from various levels, for example the program level or BMP level. The plan outlines strategies for monitoring BMP performance, which will inform possible updates in design and maintenance practices.

2.3.2 Maintenance to Optimize Performance

The GI Monitoring Plan also informs adaptive management decisions for performance optimization. Results of monitoring may be used to increase or decrease maintenance task frequencies (refer to Section 4.6, Recommended Maintenance Frequency Based on Service Level) as to better align with the City's goals.

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Chapter 3

3. GREEN INFRASTRUCTURE ASSET MAINTENANCE DATA

This chapter outlines the City's CMMS, GI asset hierarchy, and how GI assets are stored within this hierarchy. GI asset categories, workflow diagrams, cost tracking, and performance indicators are also defined within this chapter.

3.1 COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM PROTOCOLS

All inspection and maintenance tasks being performed will be recorded within the CMMS. At the beginning of each work day, inspection and maintenance crews will log into the CMMS to confirm their daily schedule and responsibilities. The CMMS will display all assigned work orders to the crew. During mobilization, the crew will review all assigned work orders to assess whether any specialized equipment or materials will be required during the workday. By performing this review daily, the crew will increase their preparedness and reduce the number of surprises they experience during the workday.

Completion of CMMS work orders should occur on-site during or immediately following completion of the inspection or maintenance work. By abiding by this practice, the crew is able to use the work order as a checklist to confirm that all requested maintenance tasks were performed. Completing work orders at the end of the day or en route to the subsequent site does not allow for this additional quality control checkpoint.

Upon completion of work for the day, the crew will review all work orders that were completed and scheduled to be completed for the day. Non-completed work orders will carry over to the next day. Significant discrepancies between work done and work scheduled should be communicated to the Program Manager so that scheduling delays do not compound (refer to Chapter 6).

3.1.1 Scope of Maintenance Asset Management

To ensure a robust, efficient, and cost-effective O&M Plan, various asset data must be stored, collected, and updated as the maintenance of BMPs takes place. More detail on the Lucity™ system is within Section 3.1.3, Lucity™ Platform.

During the final stages of design and construction, a computerized record will be created to represent each physical stormwater asset. Within this system, site inspection and site maintenance events will also be related to each of these computerized assets. An overall list of assets requiring input into the City's CMMS is provided in Appendix D: CMMS Asset Inputs and summarized in detail in Section 3.1.4, Asset Category Definitions Hierarchy. Proper use and organization of the CMMS will be essential in assuring that information is properly organized and utilized during the continued growth of the program.

A database consisting of all assets, their respective features, and any associated inspection and maintenance events will play a crucial role in determining the lifecycle performance of each individual asset. As the program progresses, the database of BMP attributes will increase in size. Over time, population of fields within this asset database will allow for data analysis and inform the level of performance of BMPs. Based on lessons learned from this analysis, the Plan can be adjusted, following the Adaptive Management Strategies prescribed in Section 3.3, Performance Indicators and Adaptive Management.

3.1.2 Overview of Computerized Maintenance Managment Sytem Workflow

The goal of the CMMS is to create a simple, streamlined workflow for asset management, inspection, and maintenance of BMPs. An illustrative depiction of the workflow is located in Appendix C: CMMS Workflow Charts.

When a computerized record is created for an asset, the asset management team populates the asset information for the site in GIS and Lucity™. Inspection work orders for an asset will be generated by Lucity™ based on pre-defined recurrence intervals. As part of the inspection, the inspector determines the need for maintenance. If maintenance is required for a given asset, a maintenance work order is generated and communicated to a maintenance crew. As required, the maintenance crew then fulfills the work order by conducting maintenance activities and completing the work order form by filling in all applicable data fields (refer to Chapter 5). Over the project lifecycle, a site history is generated based on the information gathered during each inspection and maintenance event. By coupling site information with information gathered during these events, the asset management team is able to generate reports with respect to regulatory compliance, project planning, design and construction considerations for future BMPs, as well as consideration for future proactive O&M activities.

The CMMS workflow is cyclical and adaptive in the sense that it continues to evolve and help inform both itself and the overall asset management system. By structuring the Plan in this way, decision makers can use the collected information to provide meaningful level-of-service recommendations, guide future design considerations, view and predict program costs, and make other informed decisions about the future of the program.

3.1.3 Lucity™ Platform

The Lucity™ platform is the CMMS software implemented for the GI program by the City. It was developed to allow public works entities, such as Lancaster's DPW, to track and manage their assets in a computerized environment. This software is able to be tailored to suit specific needs of a program. In the case of the City's GI program, Lucity™ will store data about the assets and their previous inspection and maintenance events, as well as generate new work orders. Another advantage of Lucity™ is that the data it stores can be exported to generate reports tailored to match regulatory reporting requirements, or otherwise be used to conduct budget assessments and inform adaptive protocols and frequencies of O&M activities.

3.1.4 Asset Category Definitions and Hierarchy

The City will track all information and produce all reports for their collective assets. An asset is a general term which can be categorized at one of two levels: the project-level and the BMP-level.

Project Asset – At the Project Asset level, the software defines the asset by the geographic location where a stormwater infrastructure asset is present. Project assets are primarily used to store information about this location and status of the asset. A project can be named after a property, such as a park or other parcel, or an intersection or roadway length. A project may consist of a single BMP or multiple BMPs.

BMP Asset – A BMP Asset is a singular unit of stormwater infrastructure that may be part of a larger Project Asset. Each BMP asset must be associated with exactly one Project Asset. When compared to Project Assets, BMP Assets are associated with more information specific to the design, construction, and maintenance related to the asset. Inspection and maintenance event work orders for individual stormwater infrastructure assets will be generated at the BMP Asset level.

Information related to specific assets will be stored in data tables within the Lucity™ platform. These data tables are summarized in Table 3.1.4-1. More detailed information about each of these data tables is provided in Appendix D: CMMS Asset Inputs.

TABLE 3.1.4-1. DATA TABLE DESCRIPTIONS

Data Table Name	Description
Project Assets	The Project Asset table is created by the City upon approval of the Detailed Design. The data table has a unique project identifier and stores project data such as the owner, location, construction cost, and current project status.
BMP Assets	BMP Asset data tables are associated with Project Assets and given their own unique identifier. The BMP Asset data table includes more detailed information about the design goals of a BMP based on as-built data. Draft information for this table is entered by the Design Engineer as part of the pre-final construction package. Information in this table may be modified by the City upon completion of the as-built survey.
BMP Pipe Runs	The pipe runs data table will be associated with each BMP's unique identifier. Pipe data is input by the City upon completion of the as-built survey.
BMP Structures	The structures data table will be associated with each BMP's unique identifier. Structure data is input by the City upon completion of the as-built survey.
BMP Trees	The tree data table will be associated with each BMP's unique identifier. Tree data is input by the City upon completion of the as-built survey.
Infiltration Data	The infiltration data table will be associated with each BMP's unique identifier. Infiltration data is input by the City upon completion of the pre-construction infiltration testing.
Surface Inspection Work Order	This data table is associated with each requested surface inspection work order – generated at the BMP level. This table will be filled out by the inspector during the inspection. Each inspection will create a new data table, all of which are associated with the BMP through the unique identifier.
Subsurface and Sweeping Inspection Work Order	This data table is associated with each requested subsurface and sweeping inspection work order – generated at the BMP level. This table will be filled out by the inspector during the inspection. Each inspection will create a new data table, all of which are associated with the BMP through the unique identifier.
Maintenance Work Order (All BMP Types)	This data table is associated with each requested maintenance work order – generated at the BMP level. This table will be filled out by the maintenance crew during the maintenance event. Each maintenance event will relate to an instance of this data table, all of which are associated with the BMP through the unique identifier. Different types of BMPs will have different fields in the work order to be filled in by the crew.
Watering Work Order	This data table is associated with each requested watering work order – generated at the BMP level. This table will be filled out by the maintenance crew during the maintenance event. Each maintenance event will relate to an instance of this data table, all of which are associated with the BMP through the unique identifier.
Corrective Work Order	This data table is associated with each requested corrective maintenance work order – generated at the BMP level. This table will be filled out by the maintenance crew during the maintenance event. Each maintenance event will relate to an instance of this data table, all of which are associated with the BMP through the unique identifier.
Project Level Reporting	This data table is filled in by the City at the project level, using data gathered through all other data tables. This table reports on high level, program wide metrics.
BMP Level Reporting	This data table is filled in by the City at the BMP level, using data gathered through all other data tables. This table reports on more specific metrics per BMP.

3.1.5 Maintenance Cost Data

One of the most important outcomes of collecting maintenance data is understanding true maintenance costs. Similar to most other data collected through work orders, maintenance cost data will be collected at the BMP Asset level. In each work order, cost data will be associated with one of two categories – labor costs and material/equipment costs. Cost information will be calculated upon completion of the work order. Labor costs consider the rate of the crew that was assigned to the work order and the difference between the start and end time of the work order. For special circumstances, work orders also allow manual input of labor time by either the crew or asset manager. The names and unit costs associated with commonly used types of materials and equipment will be stored in a drop-down list within Lucity™. The types and quantities of materials and equipment are typically entered by the crew on-site, though Program Managers may also enter this information pre-emptively or retroactively. If alternate unit costs or materials are used on-site, these costs can be entered into the work order manually.

While collecting data at this resolution provides benefit on its own, greater value typically lies in the ability to compare Asset-level cost data against itself at different resolutions. This type of data collection provides the City with valuable information on which site locations may require more frequent (or proactive) maintenance to avoid larger costs. Similarly, data can be used to identify specific locations where future BMPs may not be as cost-effective. Ultimately, cost data will be used by Program Managers to determine appropriate maintenance frequencies and plan for the future of the program (refer to Chapter 5).

3.1.6 Database Schema

Schema can be thought of as the structure or organization of the underlying database in Lucity™. The intent of database organization is to minimize the amount of time spent by crew members entering data into work orders, thus maximizing work performed in the field. In an effort to accomplish this (while not compromising the quality or detail of the data collected), the data schema has been specifically tailored to consider the circumstances under which the data is being collected. Where possible, data entry is automated. For example, work orders may default to the current date and time for work start/end times, and/or perform simple mathematic operations. Pre-screened drop-down lists reduce the effort required by the crews to input data, while also increasing the quality of the collected data. Out of necessity, some of the input fields will require numerical or written inputs. While this type of data entry is more time-consuming, it is critical for the success of the program.

3.2 COST TRACKING AND REPORTING

As mentioned above, cost data is collected during individual inspection and maintenance events. This data can be tracked and reported in numerous ways to pinpoint the underlying performance indicators associated with maintenance.

3.2.1 Historical Cost Analysis

Historical cost analyses use existing data to report on maintenance that has been performed. One of the most significant impacts of maintaining detailed information about historical costs is the ability to balance an annual budget based on dynamic spending information. Queries of historical data will be used to analyze data aggregated to the BMP-level or Project-level, or by BMP type, maintenance crew, etc.

3.2.2 Predictive Cost Analysis

By using historical data and trends, the Program Manager is able to have a better understanding of cost indicators and make more informed data-driven decisions about the future of the program. This type of predictive cost analysis is one of the hallmarks of an adaptive long-term asset management system. Predictive cost analyses will be centered around queries designed to determine cost indicators, such as: BMP type, BMP size, or maintenance frequency. Predictive cost analyses allow an asset manager to effectively plan for the future of a growing program – as well as optimize the maintenance regime of existing assets – by projecting past data trends into the future.

3.3 PERFORMANCE INDICATORS AND ADAPTIVE MANAGEMENT

Through the Consent Decree with PA DEP, the City has agreed to adopt an adaptive management approach for O&M of its current and future GI assets.

Typically, large-scale maintenance regimes – such as those for city GI programs – are based on recurrence intervals driven exclusively by the time elapsed between maintenance events. This strategy is most effective when there is little variability between assets and when maintenance strategies are simple and well-established. Since GI maintenance doesn't meet either of these requirements, the most effective maintenance strategy should focus on the specific needs of GI assets.

3.3.1 Adaptive Management Strategies

The adaptive management approach allows the City to modify its O&M protocols based on an iterative decision-making process with a goal of optimizing functional outcomes and resource expenditures. The adaptive management approach will be based on data collected by O&M crews, with decisions being made by Program Managers. Adaptive management decisions will fall into one of two categories: inspection-driven decisions, and systematic adaptations. Thinking about maintenance from both of these perspectives promotes accomplishment of both short- and long-term goals, simultaneously.

Routine inspections by trained GI inspection professionals are the cornerstone of the City's adaptive maintenance program. Interval-based maintenance regimes of GI assets often result in maintenance crews arriving to a site without the appropriate equipment or materials. In an adaptive management approach, inspections of each BMP will be carried out at regular intervals, with maintenance requests being generated as a result of inspections. By generating maintenance requests directly from inspection data, there is an opportunity for the inspector to convey notes from the inspection to the maintenance crew performing the work. These generated requests will include detailed information about the maintenance requirements, allowing the crew to be more prepared for a specific maintenance event. Each maintenance request will specify which tasks are required, allowing the maintenance crew to arrive to the site with all necessary equipment and materials, and prepared to perform the required tasks.

Data collected from individual events continues to inform O&M procedures beyond each individual event. This adaptive management plan allows Program Managers to review data systematically to make large scale adjustments to the program.

3.3.2 Definition of Performance Indicators

Performance indicators are a measurable indicator aimed at evaluating the success of the program. Performance indicators can be categorized into three major goals: ensuring the ongoing stormwater management function of BMPs, maintaining the appearance of plants, beds, and surface components, and optimizing maintenance effort and resources. More detailed descriptions of these indicators are expressed in Table 3.3.3-2.

3.3.3 Tracking Performance Over Time

Another facet of systematic adaptation is monitoring the maturation of individual sites over time. An adaptive approach allows the City to focus efforts on programs within this establishment period, allowing mature systems to self-maintain more effectively. Newly-constructed or modified sites, known collectively as establishing sites, are likely to require more attention than those that have been maintained for an extended period. The adaptive plan has defined two classifications based on site maturity, as defined below. Guidance for assigning each of these classifications has been provided below. However, the best judgement of the inspector and Program Manager should be the foremost authority.

Establishing site – This is the default category for sites entering the program, or those that have recently undergone significant plantings or alterations. These sites require the most oversight and early care and are most likely to have vulnerable target vegetation (i.e., vegetation that may not be hearty enough to be self-sustaining). Depending on site conditions, specific BMPs may remain in this classification for an extended period of time.

Mature site – Sites in this category have been designated by the inspector and the Program Manager to be partially self-sustaining. While site specific conditions may expedite or delay this designation, a site is typically considered mature upon completion of two years of maintenance. Site issues related to design or construction have likely been addressed by this stage. If present, vegetation at these sites has become self-sustaining, requiring less oversight. These sites require less frequent inspection and maintenance compared to establishing sites.

Guidance for standard inspection and maintenance protocols are detailed in this chapter. Recommended tasks, frequencies, equipment, materials, and other applicable protocols based on GI asset type are defined here.

TABLE 3.3.3-2. PERFORMANCE INDICATORS		
Goal	Metric	Performance Indicator
Goal 1: Ensure the ongoing stormwater management function of BMPs	BMPs capture and infiltrate/detain stormwater at a rate similar to design	Infiltration rate
		Inspection condition score for function
	GI assets capture and infiltrate/detain stormwater at a rate similar to design	Surveyed storage volume
		Inspection condition score for function
	Designated vegetated areas are covered with target plantings	Percent vegetative cover
		Inspection condition score for function
	Pipes remain clear, with regards to sediment and debris and are structurally sound and free of structural defects	Number of structural pipe defects observed (National Association of Sewer Service Companies [NASSCO])
		Maximum percent occlusion of cross-sectional area
Goal 2: Maintain the appearance of plants, beds, and surface components	Designated vegetated areas are covered with target plantings	Percent vegetation coverage
	Vegetation growth conforms to a shape, color, texture, and habit that is appropriate for the species and location	Aesthetic condition score
		Number of complaints received
	Systems remain free of trash and debris	Amount of trash and debris removed
		Aesthetic condition score
		Number of complaints received
	No visible structural defects of (walls, hardscapes, flow control structures, etc.) are present	Aesthetic condition score
		Number of complaints received
Goal 3: Optimize maintenance effort and resources	Maintenance investments per unit of service decrease over the lifetime of the program	Length of GI pipes inspected
		Length of GI pipes cleaned
		Number of functional corrective work orders completed
		Number of routine work orders completed
		Annual O&M tasks, labor effort, and labor cost
		Quantities and cost of materials used
		Equipment utilization
		Gallons of water used
		Hours spent in transit (crews and inspectors)
		Number of site visits

4. STANDARD INSPECTION AND MAINTENANCE PROTOCOLS

Guidance for standard inspection and maintenance protocols are detailed in this chapter. Recommended tasks, frequencies, equipment, materials, and other applicable protocols based on GI asset type are defined here.

4.1 OVERVIEW OF INSPECTION AND MAINTENANCE PROTOCOLS

In order for inspection and maintenance tasks to be carried out efficiently and consistently, protocols have been developed for the most commonly occurring tasks. This chapter includes a detailed description of those tasks, and the required tools and equipment needed to conduct each of them. This chapter does not include all potential maintenance protocols. If the need to enact a maintenance protocol not detailed within this chapter arises, proper communication of the task goals and procedures will be required.

4.2 LIST OF GREEN INFRASTRUCTURE BEST MANAGMENT PRACTICES ASSET CATEGORIES AND TECHNOLOGIES

Brief descriptions of each type of GI BMP asset category within the City are found in Table 4.3-1. Maintenance protocols for a site are typically prescribed based on the asset category. A more detailed description of each GI asset category is located within Chapter 5 of the GI Design Manual.

4.3 INSPECTION PROTOCOLS FOR GREEN INFRASTRUCTURE ASSETS

It is essential that inspections be conducted consistently and communication between inspectors and other team members be upheld. Inspections can be classified as one of three types: routine, vegetation, and subsurface. These types of inspections are explained in Table 4.3-2.

Inspection frequency is dependent on BMP ownership, maturation level, and inspection type as described in the following subsections. As sites mature, required inspection frequencies may be reduced per the adaptive management plan (refer to Section 3.3, Performance Indicators and Adaptive Management, and Section 6.1, Inspection and Maintenance Scheduling).

4.3.1 Inspection Frequencies and Protocols for Public Green Infrastructure

Publicly owned GI, especially BMPs located within the public right-of-way, are typically subjected to a significant amount of stormwater loading, resulting in the need for continued inspection and maintenance to assure its function. Routine inspections of public GI are recommended to be conducted monthly regardless of BMP type. If the BMP includes vegetation, a vegetation inspection is recommended to be conducted twice annually. BMPs that include subsurface features are recommended to be subjected to an annual subsurface feature inspection.

TABLE 4.3-1. BMP ASSET CATEGORIES	
Category	Description
Bioinfiltration and Bioretention	Bioretention BMPs are vegetated depressions designed to reduce stormwater runoff via detention and retention processes. Maintenance efforts focus primarily on maintaining healthy vegetation and sufficient infiltration rates.
Porous Pavement	Porous pavement combines the design principles of subsurface infiltration systems with permeable paved surfaces that allow stormwater to drain directly into the stone filled bed below. Maintaining the permeability of the pavement surface is the primary focus for pavement efforts. Regular sediment removal from the surface should be performed to prevent pore clogging.
Green Roofs	Green roofs are vegetated stormwater BMPs that retain and detain precipitation on (flat or moderately sloped) rooftops of buildings. Green roof maintenance should focus on preserving healthy vegetation and preventing orifice clogging. Furthermore, preserving roof integrity to avoid leaks and water damage is critical.
Subsurface Infiltration and Detention	Subsurface infiltration/detention trenches are subsurface stormwater BMPs, generally stone-filled, beneath a paved or landscaped surface. These practices incorporate distribution pipes and underdrains to aid appropriate hydrologic function. Sediment removal is the main maintenance need for these systems; generally, trenches are designed to facilitate periodic sediment flushing.
Cisterns	Cisterns are large above and/or below ground tanks to which rainwater is routed into and stored. Regular use of stored rainwater is critical for regenerating storage capacity. Ongoing maintenance require periodic sediment removal from storage area and pipes.
Naturalized Basins	Naturalized basins are large surface depressions designed to maintain a large permanent ponding zone. These systems allow for both long-term and temporary runoff storage. For maintenance exercises, emphasis should be placed on preventing outlet clogging and debris/ sediment removal in the ponding area.

4.3.2 Inspection Frequencies and Protocols for Private Green Infrastructure

Generally, privately owned BMPs experience less extraneous disturbances than their publicly owned counterparts. For this reason, expected inspection and maintenance frequencies are lower by comparison. Routine inspections are recommended to be conducted seasonally at a minimum. Sites with vegetation are recommended to receive an annual vegetation inspection, and those with subsurface features are recommended to have subsurface feature inspections at least once every two years.

TABLE 4.3-2. INSPECTION TYPES			
Inspection Type	Description	Applicable BMPs	Recommended Frequency
Routine Inspection	During a routine inspection, the inspector will visually assess the safety, function, and aesthetic character of the BMP and all of its surface-accessible features. This type of inspection will inform any upcoming routine maintenance work orders and may result in the generation of maintenance work orders.	All BMP Types	Monthly
Vegetation Inspection	Inspectors will assess the quality, coverage, and health of vegetation within the boundaries of a BMP. This type of inspection will be carried out only during the growing season and will inform the need for replanting or other vegetation-related items to be included in upcoming routine maintenance work orders. Vegetation inspections will be used to establish future watering frequencies.	All BMP Types with Vegetation	Monthly, as season permits
Subsurface Feature Inspection	The inspector will use a closed-circuit television (CCTV) camera to assess the condition of subsurface features such as pipes, and access structures. This type of inspection may result in the generation of a Subsurface Maintenance Work Order.	All BMP Types with Subsurface Features	Annually

4.4 ROUTINE MAINTENANCE PROTOCOLS FOR GREEN INFRASTRUCTURE ASSETS

Table 4.4-1 summarizes key maintenance protocols including the task name, a brief description, maintenance triggers, and recommended frequency. Appendix A: Maintenance Protocols by GI Type lists all protocols applicable to a specific GI type. More detailed protocols including applicable GI types and step-by-step instructions are outlined in Appendix B: Detailed Protocol Instructions.

TABLE 4.4-1. ROUTINE MAINTENANCE PROTOCOLS

Task	Description	Maintenance Triggers	Recommended Frequency
Photo Documentation	Take one photo of each BMP prior to maintenance and one photo of each BMP following maintenance.	To be performed during all site visits.	Monthly
Signage Care	Wipe down signage. Remove tags, strings, expired no-parking signage.	If dust or grime is present.	Monthly
Graffiti Removal	Remove graffiti from site structures, signage, or BMP surfaces.	If graffiti is present on BMP, signage, or adjacent to BMP area.	Monthly
Sediment Removal	Remove sediment from BMP surfaces (e.g., sidewalks, gutterlines, tree pits, etc.), basin, and forebay areas.	If sediment is present and visible in BMP area.	Monthly
Trash Removal	Remove trash from BMP surfaces. Report large dumping.	If present in the BMP area.	Monthly
Organic Debris Removal	Remove organic debris (e.g., leaves, feces, etc.) from BMP surfaces.	If present in BMP area.	Monthly
Mulch Amendment	Rake mulched areas to maintain a loose, friable layer. Rake mulch away from base of tree trunk or woody-stemmed shrub. Supplement mulch as needed.	If mulch is observed to be compacted or disarrayed.	Monthly
Mulch Replacement	Replace and supplement mulch, not exceeding 3" total depth of mulch. Apply mulch to the perimeter of landscaped beds that are large (>100 sf) and established (aged 2 years or older).	If mulch has not been replaced in two years, fungi/pests occur, or settling and uneven surfaces appear.	Annually in Spring
Soil Amendment	Amend soil as needed following annual nutrient test performed by Owner/Operator.	If soil tests report the need for soil amendment.	Dependent on soil test results

TABLE 4.4-1. ROUTINE MAINTENANCE PROTOCOLS (cont.)			
Task	Description	Maintenance Triggers	Recommended Frequency
Sinkhole and Settling Repair	Pack sinkholes or settling with stone, cover with soil and mulch if applicable.	If sinkholes of 24 in. deep or less are present within BMP area.	As Needed
Erosion Repair	Stabilize any disturbed areas with seed and biodegradable erosion control matting.	If minor (<20 sf), nonrecurring erosion is present within the BMP area.	As Needed
Pest Management	Treat vegetation to remove, destroy, or minimize pests and disease. Apply approved pesticide applicator if necessary.	If harmful insects (e.g., bag worms, wax scale, caterpillars, aphids, etc.); galls, mildew or fungus are present.	As Needed
	Fill animal burrows with stone and compact. Report animal infestations to BMP owner.	If animal burrows are present within the BMP area or multiple animals (e.g., rates, mice, moles, etc.) are observed.	
Manual Weed Control	Remove weeds by hand weeding.	If weeds are present within the BMP area.	Monthly
Pruning	Prune woody plant material as needed. Cut back dense vegetation to ensure safe lines of sight for pedestrians and vehicles.	If damaged, diseased, and/or dead branches are present; suckers present within the BMP area. Prune if height of dense vegetation adjacent to walkways or street intersections exceeds 4 ft.	Monthly
Structural Pruning	Approved arborist to conduct structural pruning to help tree develop one main leader and one trunk.	Trees less than two years of age, with visible completing leaders or codominant stems. Elevate lower limbs of trees, remove crossing or rubbing limbs.	Annually in Winter
Target Perennial - Cutting Back	Cut back dead growth from previous growing season.	If the height of dense herbaceous vegetation exceeds 6 in. above the ground surface elevation.	Annually in March
Target Perennial - Dividing and Transplanting	Target perennials may need dividing or transplanting every 3-5 years to prevent overcrowding and mildew.	Encouraging air circulation between plants maintenance of mature garden (3-4 years).	As Needed in Fall
Plant Removal	Remove dead or diseased herbaceous vegetation, trees or shrubs from the BMP area.	If dead or diseased vegetation is present within the BMP area.	Monthly

TABLE 4.4-1. ROUTINE MAINTENANCE PROTOCOLS (cont.)			
Task	Description	Maintenance Triggers	Recommended Frequency
Mowing	Mow warm season grass/ wildflower meadows to a height of 6-8 in. during the establishment period and annually after establishment (generally year 2). Mow cool season grass meadows to a height of 3-4 in. Mow perimeter edge of naturalized BMPs within vegetated grassy areas.	if height of vegetation exceeds 8 in. above ground surface elevation for warm season grasses.	As Needed
		If height of vegetation exceeds 4 in. above ground surface elevation for cool season grasses.	
Seeding/Sodding	Fill eroded areas, and, if necessary, reseed bare areas.	If minor (<20 sf), nonrecurring erosion is present within the BMP area.	Meadow Seeding: March 15th to June 15th.
			Warm-Season Meadow Seeding: April 15th to June 15th, August 15th to September 15th
Inlet Pretreatment Maintenance	Replace missing, ripped, or clogged pretreatment device fabric.	Ripped pretreatment device fabric: Pretreatment device fabric has a rip or hole greater than 3 in.	Monthly
		Clogged pretreatment device fabric: Pretreatment device fabric has standing water at time of maintenance and inlet is drained down to pipe invert.	
Concrete Repair	Repair hairline or large cracks.	If hairline concrete cracks area present within the BMP area.	As Needed
Pipe Jetting	Jet (i.e., hydro-clean) conveyance, distribution, and underdrain pipes.	If 30% or more of the cross-sectional area of the pipe is blocked by sediment/debris, or as otherwise specified by owner/operator.	Annually
Vacuum Cleaning	Vacuum clean trash/sediment/ organic debris from subsurface access and flow control/ conveyance structures.	If trash/sediment/ organic debris is present within the BMP.	Monthly
Vacuum Sweeping	Sweep away and collect trash/ sediment/organic debris from BMP surface.	If trash/sediment/organic debris is present and visible.	Monthly
Deicing	Apply deicer to BMP surface.	Snow events greater than 2 in., sleet and freezing rain events, and after any plowing event.	As Needed

TABLE 4.4-1. ROUTINE MAINTENANCE PROTOCOLS (cont.)			
Task	Description	Maintenance Triggers	Recommended Frequency
Plowing	Plow snow from surface.	Snow event greater than 2 in.	As Needed
Gravel Joint Filling	Fill gravel in between pavers.	If gravel erodes away from joints.	Annually
Porous Patching	Install porous pavement material to area of concern.	If damage to porous pavement is observed.	As Needed
BMP shutdown	Drain and close all cistern pipes and irrigation systems, reservoirs, and attachments. Implement other winterization tasks as defined by or required by manufacturer.	None	Annually in November
BMP startup	Open all cistern pipes, reservoirs, and attachments.	None	Annually in March
Inlet Pretreatment Clearing	Empty and clean surface inlet pretreatment device.	If trash, sediment, and/ or organic debris present in pretreatment device.	Monthly
Sanitizing	Sanitize and drain all water from the inside of the BMP.	If trash/sediment/ organic debris is present within the BMP, BMP has just been installed, or a bacteria test result is positive.	As Needed
Watering	Water herbaceous plants and trees.	Herbaceous - 4 days without rain 1/3 in. or greater, Trees - 7 days without rain 1/3 in. or greater, Inspector observations.	As needed or triggered between April 1 and November 30

4.5 NON-ROUTINE/CORRECTIVE MAINTENANCE PROTOCOLS FOR GREEN INFRASTRUCTURE ASSETS

Inspectors and maintenance crews should remain vigilant in diagnosing maintenance deficiencies and BMP needs. If these types of items are identified, the inspector must make a judgement call to determine the proper course of action. If at any time the inspector is unsure of how to classify an identified issue not outlined within the O&M Plan, they should confirm their decision with the Program Manager.

These issues can be classified as either a non-routine maintenance task or corrective maintenance depending on their severity and of the amount of work and coordination required to perform the task. Non-routine tasks are items that are not explicitly defined in Section 4.4, Routine Maintenace Protocols for GI Assets above but can be carried out during routine maintenance event without requiring specialized labor or equipment. Sufficient lead time should be provided to the maintenance crew to allow for proper preparation and procurement of materials.

4.5.1 Identifying and Defining Corrective Maintenance Actions

Corrective maintenance is defined as maintenance tasks that require significant effort or specialized labor or equipment to address. All members of the maintenance team, or even community members, are able to identify potential corrective maintenance tasks, whether through notes in work orders, or direct communication with the Program Manager. Inspection work orders contain issue identification built into the work order. This is done to encourage inspectors to think about what types of issues may result in corrective maintenance action.

Regardless of its source, once issues that require corrective maintenance are identified, they will be elevated to the Program Manager who will make a decision on how to address the issue. Corrective maintenance varies widely in scale and complexity. Less intensive corrective maintenance may require minor coordination between maintenance crews and other members of the maintenance team through work order comments. More involved corrective maintenance may require contracting with engineering firms or specialized labor forces. A clear workflow and timeline should be determined by the Program Manager as part of the corrective maintenance planning process.

Examples of corrective maintenance may include, but are not limited to, structural damage to BMP components, grading issues, major repairs, or design issues affecting performance that are not correctable through routine maintenance. It is important that recurring issues are reported to the Program Manager or appropriate staff, rather than be repeatedly deferred to corrective maintenance. Recurring issues may be indicative of other issues that cannot be fixed through corrective maintenance and may require a more thorough analysis of the issues.

4.5.2 Prioritizing Corrective Maintenance

Upon identifying a corrective maintenance need, the project priority should be discussed and decided upon by the Program Manager. Issues that pose a safety hazard or create a condition that prohibits the proper function of the BMP without corrective maintenance should generally be prioritized over aesthetic or preventative tasks.

The amount of time required to address corrective maintenance issues ranges from a few days to months depending on the severity, complexity, and priority of the issue. In certain more complex emergency cases, temporary resolutions should be presented as a stop-gap measure to address public safety or functional issues while a more permanent resolution is determined.

4.6 RECOMMENDED MAINTENANCE FREQUENCY BASED ON SERVICE LEVEL

Recommended maintenance frequency represents a balance between providing enough maintenance to encourage proper development and function of BMPs and requiring a sustainable level of annual investment. This Plan provides an adaptive approach to maintenance frequency, focusing expenditures based on need and allowing mature sites to sustain themselves with a lower level of maintenance intervention. Recommended frequencies for specific maintenance tasks are presented in Table 4.3-2. Site specific adjustments to these frequencies are described in more detail in Section 3.3, Performance Indicators and Adaptive Management, and Section 6.1, Inspection and Maintenance Scheduling.

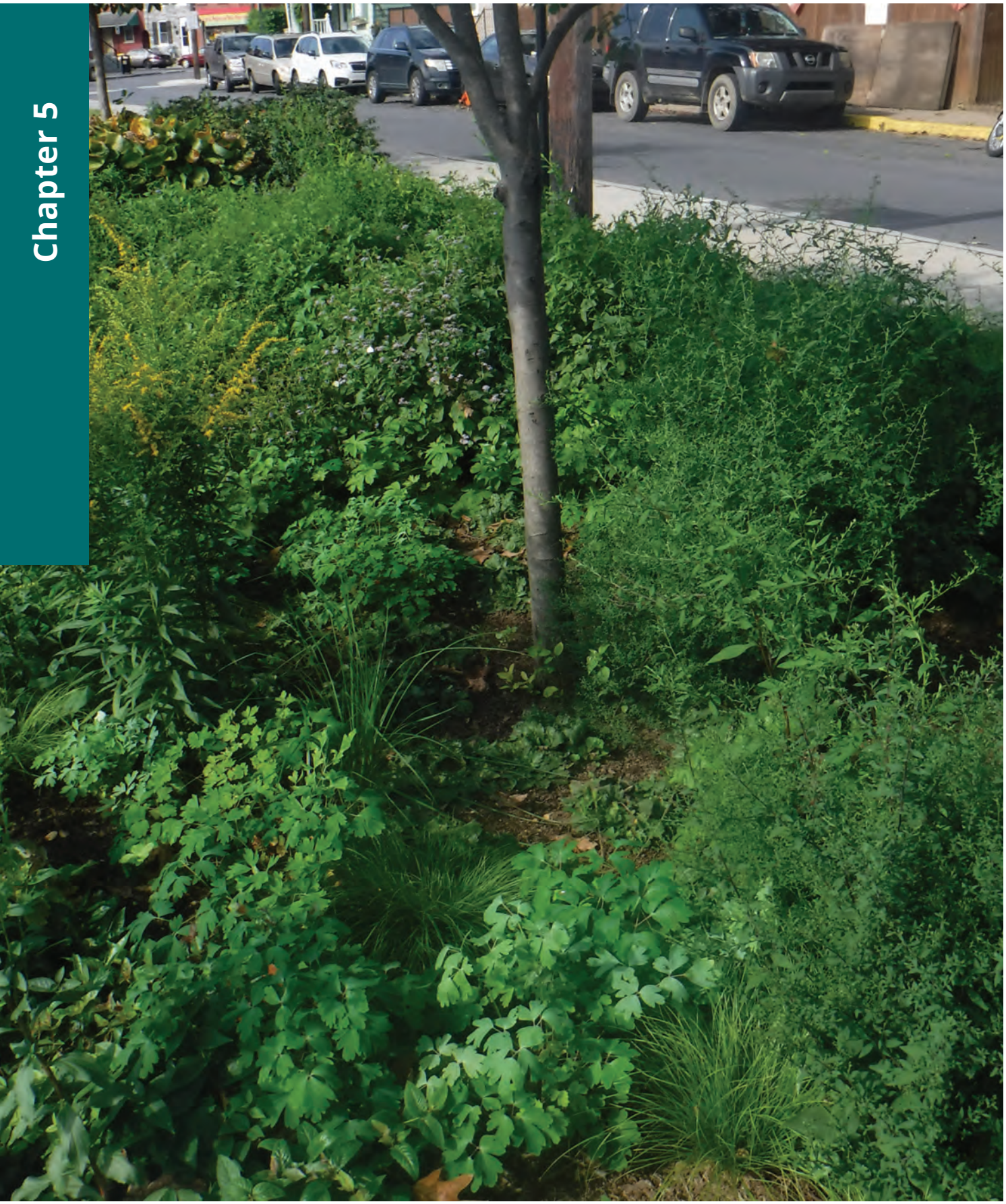
4.6.1 Preventative Functional Maintenance

An inspector's responsibility is not only to determine what issues are currently affecting a BMP, but also to look for signs of future issues. By identifying these issues early, the inspector can recommend preventative measures to prevent functional issues or reduce the cost required to remedy them. Depending on the severity and type of issues identified, preventative functional maintenance tasks may be included in future routine maintenance work orders as inspector notes or may result in the creation of a corrective maintenance work order.

4.6.2 Aesthetic Maintenance

Upholding proper aesthetic of BMPs is one of the primary goals of the program. By maintaining the proper BMP aesthetic, the surrounding community will be more likely to have a positive perception of the BMP. Unruly plantings, defaced surfaces, and damaged components should be reported as aesthetic issues and handled by maintenance staff. Work orders specific to addressing aesthetic concerns, outside of the recurring schedule (refer to Section 6.1, Inspection and Maintenance Scheduling), may be generated prior to a public tour of BMPs or upon receiving community feedback.

Chapter 5



5. GREEN INFRASTRUCTURE OPERATION & MAINTENANCE FORMS, LOGS, AND REPORTING

This chapter contains the template inspection forms, maintenance forms, and reports necessary to implement the asset management strategy outlined in Chapter 3. This chapter also includes protocols for data tracking, notifications, coordination with other agencies, and reporting safety hazards.

5.1 REQUIREMENTS FOR TRACKING AND REPORTING INSPECTIONS AND MAINTENANCE

The City is required to provide a semiannual report for the preceding six-month period to PA DEP on January 30 and July 30 of each year. This report is required to include the status of any construction or compliance measures, completion of milestones, and problems encountered (or anticipated) – along with implemented (or proposed) solutions. The report also must include the status of permit applications, O&M information, and additional reports provided to other state agencies. The majority of these items are beyond the scope of this Plan and are not discussed herein. This section focuses on reporting requirements related to proper O&M of built GI assets, typical problems encountered, and potential solutions.

Section 4.5, Non-Routine/Corrective Maintenance Protocols for GI Assets, describes corrective maintenance as maintenance tasks that require significant effort or specialized labor or equipment to address. The status of corrective maintenance projects will be provided as part of the City's Semi-annual Report. For the purposes of reporting, corrective maintenance will be placed into one of three categories:

A. Need for corrective maintenance identified

B. Corrective maintenance solution proposed

C. Corrective action taken

Reporting will include the status of the project and, depending on that status, a brief written summary of the observed issue and any recommended or performed corrections. Once a resolution has been reached and documented in Lucity™, further reporting related to the issue will not be provided unless the issue resurfaces.

5.2 OVERVIEW OF STANDARD INSPECTION AND MAINTENANCE REPORTING, FORMS, AND LOGS

The majority of data used to support the performance of O&M tasks is collected through a CMMS (refer to Chapter 3). Each work order generated through the Lucity™ system will serve as a data point for reporting purposes. The use of a CMMS system allows all pertinent O&M data to be stored within a single centralized repository.

The work order fields have been specifically designed to both allow for effective communication of site maintenance needs and provide DPW with valuable information necessary to track site performance and generate regulatory reports. Standard forms for inspection of BMPs and routine and corrective maintenance for each BMP type are located in Appendix E, Reporting Forms and Logs.

Inspection Work Orders

Inspection work order forms consist of the following sections: Work Order Information, Inspection Information, Inspection Checklist, and Inspection Effort. Each of these sections plays a specific role in terms of reporting and communicating among the various members of the inspection and maintenance team.

Work Order Information – This section contains background information about the work order necessary to perform the work, including the ID of the BMP, BMP address, type of work order, and date scheduled. This information is pre-populated by the CMMS and does not require input from the inspector.

Inspection Information – This section requires input by the inspector about the start/end date and time that the inspection took place. This section also includes an open-ended text field to include any general comments about the inspection that do not fit directly into any of the categories in the Inspection Checklist.

Inspection Checklist – This section contains the majority of the inspection related information reported by the inspector. There are 19 input fields organized into five subcategories: inflow areas; infiltration, filtration, storage areas; outflow areas; vegetation; and drainage area. For each field, the inspector should rate the condition of the BMP as Good, Fair, or Poor. Each field also includes an optional notes field if the inspector wishes to provide additional information such as instruction to the maintenance crew. There are three additional fields focused on determining the need for maintenance based on the findings of the inspection.

Inspection Effort – This section associates the time spent entered in the Inspection Information section with the cost incurred by the City based on the inspection crew rate. This information is calculated by the CMMS and does not require input from the inspector. To calculate effort, CMMS uses data such as time spent on inspection, maintenance time required, and associated equipment and materials needed.

Maintenance Work Orders

Maintenance work order forms consist of the following sections: Work Order Information, General, Maintenance Information, Maintenance Checklist, Equipment & Materials List, and Associated Cost. Each of these sections plays a specific role in terms of reporting and communicating among the various members of the inspection and maintenance team. The exact data fields present within a maintenance work order will depend on the work order type and BMP type.

Work Order Information – This section contains background information about the work order necessary to perform the work. This includes the ID of the BMP, BMP address, type of work order, and date scheduled. This information is all pre-populated by the CMMS and does not require input by maintenance personnel. Some information is carried over from the inspection work order associated with the maintenance work order.

General – This section includes pre-populated fields that denote information about the work order's current status and priority. This section also includes input fields about the start/end date and the time that the maintenance took place. An open-ended text field is also included in this section to add any general comments about the maintenance event that do not fit directly into any of the categories in the Maintenance Checklist.

Maintenance Checklist – This section contains the majority of the data fields that require input from the maintenance crew. The number of fields present depends on the type of BMP and type of work order. For each field, the inspector should rate the condition of the BMP as Good, Fair, or Poor. Each field also includes an optional notes field where the inspector can provide supplementary information or instructions for the maintenance crew. Additionally, there are three fields focused on determining the need for maintenance based on the findings of the inspection.

Equipment and Materials List – This section allows the crew to input any materials used during maintenance performed at the site. The crew will select materials such as mulch, loose stone, herbicide, or tree stakes from a drop-down list of commonly used materials. Once the material is selected, the units (such as cubic yards for bulk materials like mulch, or ounces for liquids like herbicide or sealant) of the material will be auto populated by the CMMS system. The maintenance crew will then input the quantity of the material that were used at the site. This information will be used to calculate the associated cost in the next section.

Associated Cost – This section associates the time and materials spent as entered in the above sections with the cost incurred by the city based on the inspection crew rate. This information is calculated by the CMMS and does not require input from the inspector.

5.3 NOTIFICATIONS

The CMMS will send notifications to crews and individual team members to alert them about upcoming maintenance and inspection work orders. Work orders will be visible in the crew's personalized inbox and are intended to be checked by each user daily. Work orders for inspections are generated based on recurrence intervals dictated by the adaptive management status of the asset (refer to Section 3.3, Performance Indicators and Adaptive Management, and Section 6.1, Inspection and Maintenance Scheduling). Work orders for maintenance can be generated based on the result of routine inspections or minimum recurrence intervals as noted in the adaptive management plan.

Inboxes will be organized based on priority, which typically entails prioritizing work orders that have been in the users' inbox for the longest amount of time. Certain maintenance work orders may also be identified as Emergency within the Priority field. When this occurs, these work orders will be automatically prioritized to the top of the inbox.

Notifications are not only used to assign work to crews as discussed above, they will also be provided to Program Managers daily to summarize work completed during the previous work day and flag any issues identified by the inspection and maintenance crews.

Technical difficulties may temporarily prevent the use of the CMMS system. If this situation is encountered, crews should contact the Program Manager who will provide a schedule. Additionally, crews will be provided paper versions of the CMMS forms, and be directed to transcribe any data collected into the CMMS within one work day of access being restored.

5.3.1 Coordination with Other Agencies

Coordination with other agencies is critical to the success of the program. Encouraging lasting relationships between agencies will create a sense of community and stewardship centered around the BMP assets. DPW can champion this stewardship by remaining responsive to requests set forth by other agencies and community members and through the implementation of a proactive O&M program.

Throughout the life of the program, opportunities for partnership with other agencies may arise to accomplish program goals. As part of these partnerships, a memorandum of understanding between all associated agencies should be developed detailing the O&M responsibilities of each party.

5.3.2 Reporting Safety Hazards

Safety of workers and the public is a key element of the program. Promoting a safe environment is the duty of everyone – from maintenance crews, to Program Managers, to community members. If a safety issue related to a BMP or its components is observed by an inspector or maintenance crew, it should be reported immediately to the Program Manager. The reporting crew should remain on site while the issue is resolved so long as the there is no immediate danger. Identification of safety issues by inspection and maintenance personnel should not be limited to BMP assets. If unsafe site conditions are identified or public safety issues are observed related to other city assets, they should be reported to the appropriate agency found at the following link:

cityoflancasterpa.com/resident/who-call

Safety issues with a BMP reported by community members or crews should be communicated to the Program Manager. Once identified, the Program Manager should create emergency inspection or maintenance work orders as applicable.

5.4 COMPLETION OF STANDARD INSPECTION AND MAINTENANCE FORMS

The final step required for a work order is the completion of the data collection form. Within the CMMS, a data collection form is considered complete once the status field is marked as complete. Certain fields are required to be filled out prior to changing the status of the work order to complete. Once a work order is complete it will be removed from any assigned inboxes. Completed work orders are considered datapoints for the purpose of reporting (refer to Chapter 3). Once completed, a work order is still available to edit should it be required. Paper forms will be completed in a similar manner, being transcribed into the CMMS by the crew upon completion.

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Chapter 6

6. INSPECTION AND MAINTENANCE SCHEDULING

Recurring maintenance frequencies for inspection and maintenance tasks for the various types of BMPs, as well as workflows for inspection-driven maintenance activities are documented in this chapter. This chapter also outlines an adaptive management approach for evaluating and modifying maintenance schedules based on field observations. On occasion, sites will require maintenance outside of the recurring schedule. This need is facilitated by a site requiring emergency, corrective, or reactive maintenance.

6.1 SCHEDULING ROUTINE INSPECTION AND MAINTENANCE

Keeping a well-organized schedule will allow the City to assure that their GI assets are maintained frequently and that crew members maintain a consistent workload. The schedule consists of two major elements, which are explained in detail below.

6.1.1 Recurring Schedule

The recurring schedule encompasses all routine inspection and maintenance tasks covered within Chapter 4. Upon establishing a recurring schedule, sites will be visited in roughly the same order over a set time interval. Typically, the recurrence interval for routine maintenance events is one month. The specific routine tasks that are carried out during each recurring site visit will be defined by the site specific adaptive management classification (refer to Section 3.3, Performance Indicators and Adaptive Management). On occasion, additional tasks will be added to the routine maintenance work order based on a recently conducted inspection event. So long as these additional tasks do not drastically impact the amount of time spent on-site or the remainder of the schedule, special requests may be incorporated into the recurring schedule to limit revisiting sites.

6.1.2 Adjustments to Recurring Schedule and Adaptive Management

The recurring schedule for each site is set to a monthly recurrence interval when the site is adopted into the program. Tasks performed during this routine event are based on site specific requirements. Both the frequency of routine visits and what tasks are performed during these visits can be changed per the adaptive management plan as the site matures (refer to Section 3.3). Generally, more mature sites will have less frequent maintenance visits, which will result in adjustments to the recurring schedule. The City should consider this adjustment process when determining future scheduling and hiring levels.

6.1.3 Scheduling Inspection-Driven Maintenance

As noted above, depending on the magnitude, inspection-driven maintenance can occasionally be incorporated into a previously scheduled routine event without disrupting the remaining recurring schedule. Certain inspection-driven events may include work that will require immediate action, additional time spent on site, or the use of specialized equipment. In these cases, an additional event will be required. These events will be scheduled by the City's Program Manager. While events like this are generally unforeseen, flexibility should be built into the crew schedule to accommodate them without neglecting the recurring schedule.

6.1.4 Weather and Other Conflicts

If site conditions do not allow for work or other conflicts arise resulting in the inability to perform work, the recurring schedule will need to be adjusted accordingly. Cancellation of work for the day for whatever circumstance will be at the discretion of the Program Manager. Typically, if the delay is only a day or two the schedule can be shifted, and all work can still be completed within the month. However, if there are significant delays, the Program Manager may want to consider cancelling the lowest priority work orders to allow for the crew to catch up to the original schedule.

6.1.5 Unscheduled Maintenance

Unscheduled maintenance is typically classified as either emergency maintenance or corrective maintenance. Both types of maintenance are outside of the recurring maintenance schedule, and result in the need to adjust the schedule to accommodate it. Since emergency maintenance often occurs as the result of an unsafe condition or a significant defect to the function of the GI, the recurring schedule must be shifted backward to accommodate the higher priority emergency work. Corrective maintenance, which is often not as high of a priority as emergency maintenance, can be scheduled at the end of the month between recurring schedule cycles. The City can accrue a backlog of corrective maintenance tasks which can be performed during the slow winter months, or months that did not have any other major schedule interruptions.

6.2 INSPECTION FOLLOW-ON PROTOCOLS

Inspections sometimes result in the identification of additional maintenance tasks to be performed during upcoming routine maintenance events. Inspection work orders will include specific instructions relating to these identified issues or maintenance tasks. It is crucial that inspection and maintenance personnel are in communication with each other consistently. This applies to verbal communication, communication written within work orders, and communication about schedule.

6.2.1 Documenting and Reporting Problems

One of the primary goals of GI inspectors is to identify issues with the BMPs they are inspecting and suggest potential solutions to these issues. When an inspector identifies an issue, they should first consider safety implications of the issue both in terms of completing the inspection as well as others who may be interacting with the BMP once the inspector is off-site. If a safety issue is identified, the inspector should immediately report it to the Program Manager. Safety issues should always be coded as high priority within the work order to allow for the rapid resolution of the issue and minimization of the safety risk.

Inspectors should use the Work Order system as a tool for disseminating information to the rest of the inspection and maintenance team. Inspectors should not overly rely on the Work Order system as their only line of communication, especially for issues that may pose safety risks, result in major repairs, or require specialized tools. Inspectors should strive to make sure issues they are identifying are being resolved by the team in the most effective and efficient way.

An inspector has several options within a Work Order to identify the need for additional maintenance tasks. Any inspector comments within a work order will be inherited by the upcoming maintenance work order related to the inspected site. Within the work order, the inspector has an option to create a new separate work order for corrective or emergency maintenance. If either of these options are

selected, the inspector should notify the Program Manager. If for any reason the inspector is unsure if a new work order should be generated, they should confirm the request with the Program Manager.

6.2.2 Initiating Corrective Maintenance

Corrective maintenance is initiated through the work order system. A work order will be generated upon identification of the need for corrective maintenance, however, it will remain unassigned to a crew until additional details are provided and it is manually assigned. The Program Manager and inspector should discuss the corrective maintenance request and define a plan for completing the work. Certain corrective maintenance tasks that do not require additional coordination may be assigned immediately by the Program Manager.

Other types of corrective maintenance actions may require additional visits to the site or consultation with Design Engineers or other experts. Once a plan has been defined, the work order can then be assigned, and the work completed with the necessary oversight. It is not uncommon for some larger corrective maintenance tasks to take several maintenance cycles to plan for and mobilize, making it especially important for the inspector to identify and communicate the issue quickly and effectively.

6.3 ADDING NEW ASSETS TO THE SCHEDULE

As the program grows, new assets will be entered into the maintenance program, and will therefore need to be added to the asset management system and schedule. New assets should be added to the schedule within one full cycle of it entering the program. The simplest way to add a new asset is to append it onto the end of the existing schedule. Alternatively, the asset may be strategically added to the schedule based on its location relative to other assets within the City. During future schedule cycles, the Program Manager may reorder the schedule to most effectively accommodate new assets. Periodically reordering the asset schedule may result in an increase in program efficiency.

6.4 SCHEDULING CAPITAL REPLACEMENT

As the program matures and assets reach the end of their design life or system issues develop beyond the scope of corrective maintenance, these systems will be identified as needing replacement or major reconstruction, which will be classified as capital replacement projects. Capital replacement projects associated with end of design life will be scheduled as part of a long-term asset replacement plan by the Program Manager based on system lifecycles and scheduled accordingly to minimize system downtime. The program will anticipate end of lifecycle durations and replacement events as identified through the O&M and Monitoring Programs. As systems are replaced or reconstructed, they will be removed from the maintenance schedule and then added back with new assets once completed as described in Section 6.3, Adding New Assets to the Schedule.


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7. PERSONNEL, EQUIPMENT, AND BUDGET REQUIREMENTS

This chapter includes budget estimates for the inspection and maintenance (as outlined in this document) of the City's current portfolio of BMPs. Budgets include staffing requirements (for operations as well as management), and a breakdown of equipment, labor, and materials costs. This chapter includes a discussion and standard assumptions for replacement of components such as plants and soil media.

7.1 PROGRAM BUDGET AND STAFFING TOOL

A spreadsheet tool has been developed to properly prepare for and adequately staff the program. A summary of the tool is provided in Table 7.1-1.

TABLE 7.1-1. LANCASTER O&M PROGRAM BUDGET AND STAFFING TOOL SUMMARY

Sheet Name	Description
Summary	This sheet provides a summary of the crew hours, person hours, and costs per subtask in a single table titled Lancaster O&M Budget Summary. A total of hours and costs are available across all tasks, and individually. Also included are estimates of the Corrective Maintenance and Materials as line items. Beneath the budget summary are the effort needs, titled full time equivalent (FTE) and Equipment Utilization. As in the budget summary, the results are displayed per subtask, and are available for all positions in the program. The table is divided and totaled for personnel and then vehicles and equipment.
Variables	The main sheet in the workbook for user input, this sheet is color coded by subtask to match other tabs, and details all assumptions used as inputs into the calculations. The inputs are designed to capture an amount of effort needed to perform tasks and convert that to a cost using the assumed roles for personnel and equipment working on those tasks. Users will find two column groupings, one for the maintenance or inspection assumptions, and another for the crew makeup. The calculation sheet will use the variable information entered on this sheet to determine costs.
Calculations	This sheet pulls input from the Variables and Data sheets to calculate costs per task, using effort as a base. The main calculations for all subtasks are carried out in this sheet and are reported back to the Summary sheet with the same color-coding shared between each sheet.
Data	This sheet contains the initial dataset provided by the City for selected variables needed by the calculations sheet. It contains only those sites that were marked as completed by the City. Additional rows of data can be added to the bottom of the table as needed and included in the overall costs calculations by pulling the calculations sheet down along with it.
Equipment and Personnel	This sheet contains two static tables displaying equipment and personnel positions and rates as provided by the City. Information from the Equipment and Personnel sheet is not referenced elsewhere in the workbook but is copied into the Variables sheet for crew setup for each of the subtasks.

Costs developed using this tool are based on an understanding of the relationships between quantity takeoffs from existing sites within the O&M Program and specific maintenance subtasks. Cost figures provided are a best estimate of probable cost and intended to be used for budgetary planning purposes. Costs are presented below in Section 7.2.2.

Anticipated staffing requirements, estimating FTE positions required for each of the discrete subtasks, are developed alongside costs and provided below in Section 7.2.1.

7.2 PERSONNEL, EQUIPMENT, AND BUDGET OVERVIEW

This section provides an estimate of FTE positions, equipment requirements, and budget requirements for the first full year of maintenance under the plan.

7.2.1 Personnel and Equipment Requirements

At the inception of the program, it is anticipated that FTE roles will be multifaceted with opportunities for specialization as the program grows and more positions are required. For example, at the beginning of the program the same person may be performing watering tasks two days a week and surface maintenance work the remaining three. As the program grows, this work may eventually be split into two positions – one full-time watering position, and one full-time surface maintenance position. A breakdown of the staff and equipment needs for the current portfolio of BMPs, as determined using the budget and staffing tool, is provided in Table 7.2.2-1. A description of the personnel classifications and detailed descriptions of their positions can be found in Appendix F: Personnel Classifications.

7.2.2 Budget Requirements for Green Infrastructure Operations & Maintenance

Total budget requirements for the first full year of maintenance under the plan is estimated to be $644,000. This budget can be attributed to three major categories: labor, equipment, and materials. A high-level breakdown of this cost, as determined using the budget and staffing tool, can be seen in Table 7.2.2-2.

It is assumed that materials account for 6% of the total maintenance budget annually, or $37,000 in total. This estimate is based on similar programs within the region. As sites mature, it is expected that less of certain materials such as mulch and replacement plants will be required and therefore material requirements as a percentage of the total cost will decrease.

TABLE 7.2.2-1. O&M STAFFING SUMMARY - FTE AND EQUIPMENT UTILIZATION

			Subsurface Inspection	Subsurface Maintenance	Sweeping Maintenance	Snow Removal	Surface Inspector	Surface Maintenance	Watering	Asset Management Team	TOTALS
Personnel Roles	Stormwater	GI Asset Coordinator	--	--	--	--	--	--	--	--	
		GI Asset Technician	0.10	--	--	--	1.05	--	--	0.31	1.47
	Street Cleaning	Labor Supervisor	--	--	--	--	--	--	--	--	
		Equipment Operator II	--	--	--	--	--	--	--	--	
		Sweeper Operator II	--	--	0.24	--	--	--	--	--	0.24
		Maintenance Worker	--	--	--	--	--	--	--	--	
		Laborer	--	--	0.24	--	--	--	--	--	0.24
	Grounds Maintenance	GI & Parks Maintenance Supervisor	--	--	--	--	--	1.68	--	--	1.68
		Utility Operator	--	--	--	0.02	--	--	0.10	--	0.13
		Laborer	--	--	--	0.02	--	1.68	0.10	--	1.80
	Sewer Collections	Collections System Supervisor	--	--	--	--	--	--	--	--	
		Labor Supervisor I	--	--	--	--	--	--	--	--	
		Equipment Operator I	--	0.07	--	--	--	--	--	--	0.07
		Equipment Operator II	--	--	--	--	--	--	--	--	
		Utility Locator	--	--	--	--	--	--	--	--	
		Sewer Technician	--	--	--	--	--	--	--	--	
		TV Technician	0.10	0.07	--	--	--	--	--	--	0.17
TOTALS			0.20	0.13	0.48	0.05	1.05	3.36	0.2	0.31	5.78
Vehicles & Equipment	Stormwater	Stormwater Vehicle	0.10	--	--	--	1.05	--	--	--	1.15
	Street Cleaning	Street Sweeper	--	--	0.24	--	--	--	--	--	0.24
		Pickup Truck	--	--	--	--	--	--	--	--	
	Grounds Maintenance	Pickup Truck	--	--	--	0.02	--	1.68	0.10	--	1.80
	Sewer Collections	Vactor	--	0.07	--	--	--	--	--	--	0.07
		Pickup Truck	--	--	--	--	--	--	--	--	
		TV Van	0.10	0.07	--	--	--	--	--	--	0.17

TABLE 7.2.2-2. O&M BUDGET SUMMARY									
	Subsurface Inspection	Subsurface Maintenance	Sweeping Maintenance	Snow Removal	Surface Inspector	Surface Maintenance	Watering	Asset Management	TOTALS
Crew Hours	210	137	499	49	2,184	3,489	212	654	6,781
Person Hours	420	274	998	98	2,184	6,979	424	654	11,378
COST	$22,000	$37,000	$43,000	$4,000	$109,000	$310,000	$17,000	$25,000	$567,000

Corrective Maintainance:	$40,000
Materials:	$37,000
Total Estimated O&M Budget	$644,000

7.2.3 Program Budget and Staffing Summaries by Subtask

A summary of the program's budgeting requirements, as determined using the budget and staffing tool – breaking out cost by inspection and maintenance subtasks – is provided in Table 7-2.3-1. Subtasks identified as part of the program include: subsurface inspection, subsurface maintenance, sweeping maintenance, snow removal, surface inspection, surface maintenance, watering, and corrective maintenance. All budgetary estimates are based on the current portfolio of GI assets within the City. As more assets enter the program, additional budget and resources will need to be allocated accordingly.

TABLE 7.2.3-1. O&M DETAILED BUDGET SUMMARY	
Subtask	Summary
Subsurface Inspection	Annually, subsurface inspection is estimated to cost $22,000 and the generation of 0.20 FTE positions. It is assumed that each BMP is inspected one time per year and that an inspection crew working a full day is able to inspect about eight BMPs per day on average including shop time, travel, and reporting. Estimates of crew efficiency are based on distance between sites, average number of structures and linear feet of pipe per BMP, and maintenance data based on similar work in other geographical areas. A subsurface inspection crew consists of a TV Technician using a TV Van and a GI Asset Technician using the City's Stormwater Vehicle.
Subsurface Maintenance	It is assumed that approximately 20% of sites owned by the City subjected to subsurface inspection each year will require jetter/vacuum maintenance, resulting in a total annual cost of $37,000 and the generation of 0.13 FTE positions. It is estimated that a subsurface maintenance crew is able to maintain 500 linear feet of pipe and up to 12 structures (e.g., inlet, manhole, endwall, etc.) during a normal day of maintenance, and includes video inspection of the cleaned system. Estimates of crew efficiency are based on distance between sites, average number of structures and linear feet of pipe per BMP, and maintenance data based on similar work in other geographical areas. A subsurface maintenance crew consists of a TV Technician using a TV Van and an Equipment Operator using a Vactor Truck.
Sweeping Maintenance	Sweeping maintenance occurs at sites owned by the City and requires an estimated annual budget of $43,000 and 0.48 FTE positions. It is estimated that a sweeping maintenance crew, consisting of a Street Sweeping Operator using a street sweeper and a Street Sweeping Technician, is able to maintain an average of five BMPs daily inclusive of shop time, travel, and reporting. Crew efficiency estimates are based on the area of porous surface, distance between BMPs, and maintenance data based on similar work in other geographical areas.

TABLE 7.2.3-1. O&M DETAILED BUDGET SUMMARY (cont.)	
SUBTASK	SUMMARY
Snow Removal	An estimated budget of $4,000 is required for annual snow removal at porous paving sites owned by the City, and results in an estimated 0.05 FTE positions. More so than other subtasks, snow removal is heavily weather dependent, and the number of required events may vary from year to year. For the purpose of budgeting, it is assumed that all porous paving sites will require snow removal or treatment (deicer) four times per year and a crew can maintain 34 BMPs daily. Snow removal events will be clustered during the winter months. A snow removal crew consists of a Snow Plow Operator using a Pickup Truck and a Snow Plow Technician.
Surface Inspection	It is estimated that a budget of $109,000 is required annually for inspection of surface features resulting in an estimated 1.05 FTE positions at all BMPs. Inspection frequencies are anticipated monthly. Non-City owned sites are estimated to receive inspection monthly. A single GI Inspector is estimated to spend approximately 45 minutes to one hour inspecting each BMP, including on-site time, travel time, and time spent in Lucity™. This estimate may vary depending on the type of site, scale, and relative condition.
Watering	Watering of vegetated BMPs between storm events during the summer months requires a budget of approximately $17,000 and creates an estimated 0.20 FTE positions. Similar to Snow Plowing, Watering events are highly dependent on the weather and may vary significantly from year to year. For budgeting purposes, it is estimated that during an average year approximately 10 watering events will be required at each vegetated site. This estimate assumes that only sites owned by the City and within a two-year establishment window will be watered. A watering crew consists of a GI Maintenance Foreman and GI Maintenance Laborer using a Pickup Truck. Estimates of crew efficiency are based on the number of required fill ups, number of trees on site, vegetated area, and travel time. Watering effort rates are based on maintenance data related to similar work in other geographical areas.
Surface Maintenance	The most significant subtask from a cost perspective is Surface Maintenance. This subtask requires an estimated annual budget of $310,000 based on the current size of Lancaster's GI O&M Program and accounts for City owned sites. Surface Maintenance requires an estimated 3.36 FTE positions. Depending on the type and size of the site, and time of year, a crew consisting of a GI Maintenance Foreman and GI Maintenance Laborer, are able to maintain between one and 10 BMPs per day. Estimates of crew efficiency are based on effort estimates per 1,000 square feet of BMP surface maintained, and are affected by size of vegetated areas, contributing drainage areas, distance between sites, and maintenance data related to similar work in other geographical areas.
Corrective Maintenance	It is assumed that Corrective Maintenance accounts for 7% of the total maintenance budget annually, or $40,000 in total. Corrective maintenance is typically more likely to occur at sites that have been recently constructed. The estimate is based on historical data of percent budget spent on Corrective Maintenance in similar programs in the region over many years.
Asset Management	It is estimated that a budget of $25,000 is required annually for Asset Management, resulting in an estimated 0.31 FTE positions at all BMPs. The asset management includes time generating, reviewing, closing out, and logging work orders. A single member of the asset management team is estimated to spend about seven minutes to review and closeout a work order in the Lucity™ system for each BMP.

APPENDIX A – MAINTENANCE PROTOCOLS BY GREEN INFRASTRUCTURE TYPE

A-1 BIOINFILTRATION AND BIORETENTION MAINTENANCE TASKS					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Concrete Repair	Repair hairline or large cracks.	If hairline concrete cracks area present within the BMP area.	As needed	Routine Surface Maintenance	Appendix B.4
Erosion Repair	Stabilize any disturbed areas with seed and biodegradable erosion control matting.	If minor (<20 sf), nonrecurring erosion is present within the BMP area.	As needed	Routine Surface Maintenance	Appendix B.6
Graffiti Removal	Remove graffiti from site structures, signage, or BMP surfaces.	If graffiti is present on BMP, signage, or adjacent to BMP area.	Monthly	Routine Surface Maintenance	Appendix B.7
Inlet Pretreatment Clearing	Empty and clean surface inlet pretreatment device.	If trash, sediment, and/or organic debris present in pretreatment device.	Monthly	Routine Surface Maintenance	Appendix B.9
Inlet Pretreatment Maintenance	Replace missing, ripped, or clogged pretreatment device fabric.	Ripped pretreatment device fabric: Pretreatment device fabric has a rip or hole greater than 3 in. Clogged pretreatment device fabric: Pretreatment device fabric has standing water at time of maintenance and inlet is drained down to pipe invert.	Monthly	Routine Surface Maintenance	Appendix B.10
Manual Weed Control	Remove weeds by hand weeding.	If weeds are present within the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.11

A-1 BIOINFILTRATION AND BIORETENTION MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Mowing	Mow warm season grass/ wildflower meadows to a height of 6-8 in. during the establishment period and annually after establishment (generally year 2). Mow cool season grass meadows to a height of 3-4 in. Mow perimeter edge of naturalized BMPs within vegetated grassy areas.	If height of vegetation exceeds 8 in. above ground surface elevation for warm season grasses. If height of vegetation exceeds 4 in. above ground surface elevation for cool season grasses.	As needed	Routine Surface Maintenance	Appendix B.12
Mulch Amendment	Rake mulched areas to maintain a loose, friable layer. Rake mulch away from base of tree trunk or woody-stemmed shrub. Supplement mulch as needed.	If mulch is observed to be compacted or disarrayed.	Monthly	Routine Surface Maintenance	Appendix B.13
Mulch Replacement	Replace and supplement mulch, not exceeding 3" total depth of mulch. Apply mulch to the perimeter of landscaped beds that are large (>100 sf) and established (aged 2 years or older).	If mulch has not been replaced in 2 years, fungi/ pests occur, or settling and uneven surfaces appear.	Annually in Spring	Routine Surface Maintenance	Appendix B.14

A-1 BIOINFILTRATION AND BIORETENTION MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Organic Debris Removal	Remove organic debris (e.g., leaves, feces, etc.) from BMP surfaces.	If present in BMP area.	Monthly	Routine Surface Maintenance	Appendix B.15
Pest Management	Treat vegetation to remove, destroy, or minimize pests and disease. Approved pesticide applicator to apply if necessary. Fill animal burrows with stone and compact. Report animal infestations to BMP owner.	If harmful insects (e.g., bag worms, wax scale, caterpillars, aphids, etc.); galls, mildew or fungus are present. If animal burrows are present within the BMP area or multiple animals (e.g., rates, mice, moles, etc.) are observed.	As needed	Routine Surface Maintenance	Appendix B.16
Photo Documentation	Take one photo of each BMP prior to maintenance and one photo of each BMP following maintenance.	To be performed during all site visits	Monthly	Routine Surface Maintenance	Appendix B.17
Pipe Jetting	Jet (i.e., hydro-clean) conveyance, distribution, and underdrain pipes.	If 30% or more of the cross-sectional area of the pipe is blocked by sediment/ debris, or as otherwise specified by owner/ operator.	Annually	Routine Subsurface Maintenance	Appendix B.18

A-1 BIOINFILTRATION AND BIORETENTION MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Plant Removal	Remove dead or diseased herbaceous vegetation, trees or shrubs from the BMP area.	If dead or diseased vegetation is present within the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.19
Pruning	Prune woody plant material as needed. Cut back dense vegetation to ensure safe lines of sight for pedestrians and vehicles.	If damaged, diseased, and/or dead branches are present; suckers present within the BMP area. Prune if height of dense vegetation adjacent to walkways or street intersections exceeds 4 ft.	Monthly	Routine Surface Maintenance	Appendix B.22
Sediment Removal	Remove sediment from BMP surfaces (e.g., sidewalks, gutterlines, tree pits, etc.), basin, and forebay areas.	If sediment is present and visible in BMP area.	Monthly	Routine Surface Maintenance	Appendix B.24
Seeding/ Sodding	Fill eroded areas, and, if necessary, reseed bare areas.	If minor (<20 sf), nonrecurring erosion is present within the BMP area.	Meadow Seeding: March 15th to June 15th. Warm-Season Meadow Seeding: April 15th to June 15th, August 15th to September 15th	Routine Surface Maintenance	Appendix B.25
Signage Care	Wipe down signage. Remove tags, strings, expired no-parking signage.	If dust or grime is present.	Monthly	Routine Surface Maintenance	Appendix B.26

A-1 BIOINFILTRATION AND BIORETENTION MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Sinkhole and Settling Repair	Pack sinkholes or settling with stone, cover with soil and mulch if applicable.	If sinkholes of 24 in. deep or less are present within BMP area.	As needed	Routine Surface Maintenance	Appendix B.27
Soil Amendment	Amend soil as needed following annual nutrient test performed by Owner/ Operator.	If soil tests report the need for soil amendment.	Dependent on soil test results	Routine Surface Maintenance	Appendix B.28
Structural Pruning	Approved arborist to conduct structural pruning to help tree develop one main leader and one trunk.	Trees less than 2 years of age, with visible completing leaders or codominant stems. Elevate lower limbs of trees, remove crossing or rubbing limbs.	Annually in Winter	Routine Surface Maintenance	Appendix B.29
Target Perennial - Cutting Back	Cut back dead growth from previous growing season.	If the height of dense herbaceous vegetation exceeds 6 in. above the ground surface elevation.	Annually in March	Routine Surface Maintenance	Appendix B.31
Target Perennial - Dividing and Transplanting	Target perennials may need dividing or transplanting every 3-5 years to prevent overcrowding and mildew.	Encouraging air circulation between plants maintenance of mature garden (3-4 years).	As needed in Fall	Routine Surface Maintenance	Appendix B.32
Trash Removal	Remove trash from BMP surfaces. Report large dumping.	If present in the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.33

A-1 BIOINFILTRATION AND BIORETENTION MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Vacuum Cleaning	Vacuum clean trash/ sediment/ organic debris from subsurface access and flow control/ conveyance structures.	If trash/ sediment/ organic debris is present within the BMP.	Monthly	Routine Subsurface Maintenance	Appendix B.34
Watering	Water herbaceous and trees.	Herbaceous - 4 days without rain 1/3 in. or greater, Trees - 7 days without rain 1/3 in. or greater, Inspector observations.	As needed or triggered between April 1 and November 30	Watering	Appendix B.35

A-2 POROUS PAVEMENT MAINTENANCE TASKS					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Concrete Repair	Repair hairline or large cracks.	If hairline concrete cracks area present within the BMP area.	As needed	Routine Surface Maintenance	Appendix B.4
Deicing	Apply deicer to BMP surface.	Snow events greater than 0.25 in., sleet and freezing rain events, and after any plowing event.	As needed	Routine Surface Maintenance	Appendix B.5
Graffiti Removal	Remove graffiti from site structures, signage, or BMP surfaces.	If graffiti is present on BMP, signage, or adjacent to BMP area.	Monthly	Routine Surface Maintenance	Appendix B.7
Gravel Joint Filling	Fill gravel in-between pavers.	If gravel erodes away from joints.	Annually	Routine Subsurface Maintenance	Appendix B.8
Inlet Pretreatment Clearing	Empty and clean surface inlet pretreatment device.	If trash, sediment, and/or organic debris present in pretreatment device.	Monthly	Routine Surface Maintenance	Appendix B.9
Inlet Pretreatment Maintenance	Replace missing, ripped, or clogged pretreatment device fabric.	Ripped pretreatment device fabric: Pretreatment device fabric has a rip or hole greater than 3 in. Clogged pretreatment device fabric: Pretreatment device fabric has standing water at time of maintenance and inlet is drained down to pipe invert.	Monthly	Routine Surface Maintenance	Appendix B.10

A-2 POROUS PAVEMENT MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Photo Documentation	Take one photo of each BMP prior to maintenance and one photo of each BMP following maintenance.	To be performed during all site visits	Monthly	Routine Surface Maintenance	Appendix B.17
Pipe Jetting	Jet (i.e., hydro-clean) conveyance, distribution, and underdrain pipes.	If 30% or more of the cross-sectional area of the pipe is blocked by sediment/ debris, or as otherwise specified by owner/operator.	Annually	Routine Subsurface Maintenance	Appendix B.18
Plowing	Plow snow from surface.	Snow event greater than 2 in.	As needed	Routine Surface Maintenance	Appendix B.20
Porous Patching	Install porous pavement material to area of concern.	If damage to porous pavement is observed.	As needed	Routine Subsurface Maintenance	Appendix B.21
Signage Care	Wipe down signage. Remove tags, strings, expired no-parking signage.	If dust or grime is present.	Monthly	Routine Surface Maintenance	Appendix B.26
Vacuum Cleaning	Vacuum clean trash/ sediment/ organic debris from subsurface access and flow control/ conveyance structures.	If trash/ sediment/ organic debris is present within the BMP.	Monthly	Routine Subsurface Maintenance	Appendix B.34
Vacuum Sweeping	Sweep away and collect trash/ sediment/ organic debris from BMP surface.	If trash/ sediment/ organic debris is present and visible.	Monthly	Routine Surface Maintenance	Appendix B.30

A-3 GREEN ROOF MAINTENANCE TASKS					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
BMP shutdown	Drain and close all pipes, reservoirs, and attachments. Implement other winterization tasks as defined by or required by manufacturer.	None	Annually in November	Routine Subsurface Maintenance	Appendix B.1
BMP startup	Open all pipes, reservoirs, and attachments.	None	Annually in March	Routine Subsurface Maintenance	Appendix B.2
Concrete Repair	Repair hairline or large cracks.	If hairline concrete cracks area present within the BMP area.	As needed	Routine Surface Maintenance	Appendix B.4
Graffiti Removal	Remove graffiti from site structures, signage, or BMP surfaces.	If graffiti is present on BMP, signage, or adjacent to BMP area.	Monthly	Routine Surface Maintenance	Appendix B.7
Manual Weed Control	Remove weeds by hand weeding.	If weeds are present within the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.11
Organic Debris Removal	Remove organic debris (e.g., leaves, feces, etc.) from BMP surfaces.	If present in BMP area.	Monthly	Routine Surface Maintenance	Appendix B.15

A-3 GREEN ROOF MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Pest Management	Treat vegetation to remove, destroy, or minimize pests and disease. Approved pesticide applicator to apply if necessary. Fill animal burrows with stone and compact. Report animal infestations to BMP owner.	If harmful insects (e.g., bag worms, wax scale, caterpillars, aphids, etc.); galls, mildew or fungus are present. If animal burrows are present within the BMP area or multiple animals (e.g., rates, mice, moles, etc.) are observed.	As needed	Routine Surface Maintenance	Appendix B.16
Photo Documentation	Take one photo of each BMP prior to maintenance and one photo of each BMP following maintenance.	To be performed during all site visits	Monthly	Routine Surface Maintenance	Appendix B.17
Pipe Jetting	Jet (i.e., hydro-clean) conveyance, distribution, and underdrain pipes.	If 30% or more of the cross-sectional area of the pipe is blocked by sediment/ debris, or as otherwise specified by owner/operator.	Annually	Routine Subsurface Maintenance	Appendix B.18
Plant Removal	Remove dead or diseased herbaceous vegetation, trees or shrubs from the BMP area.	If dead or diseased vegetation is present within the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.19

A-3 GREEN ROOF MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Seeding/ Sodding	Fill eroded areas, and, if necessary, reseed bare areas.	If minor (<20 sf), nonrecurring erosion is present within the BMP area.	Meadow Seeding: March 15th to June 15th. Warm-Season Meadow Seeding: April 15th to June 15th, August 15th to September 15th	Routine Surface Maintenance	Appendix B.25
Sediment Removal	Remove sediment from BMP surfaces (e.g., sidewalks, gutterlines, tree pits, etc.), basin, and forebay areas.	If sediment is present and visible in BMP area.	As needed	Routine Surface Maintenance	Appendix B.24
Signage Care	Wipe down signage. Remove tags, strings, expired no-parking signage.	If dust or grime is present.	Monthly	Routine Surface Maintenance	Appendix B.26
Soil Amendment	Amend soil as needed following annual nutrient test performed by Owner/ Operator.	If soil tests report the need for soil amendment.	Dependent on soil test results	Routine Surface Maintenance	Appendix B.28
Trash Removal	Remove trash from BMP surfaces. Report large dumping.	If present in the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.33
Watering	Water herbaceous and trees.	Herbaceous - 4 days without rain 1/3 in. or greater, Trees - 7 days without rain 1/3 in. or greater, Inspector observations.	As needed or triggered between April 1 and November 30	Watering	Appendix B.35

A-4 SUBSURFACE INFILTRATION AND DETENTION MAINTENANCE TASKS					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Concrete Repair	Repair hairline or large cracks.	If hairline concrete cracks area present within the BMP area.	As needed	Routine Surface Maintenance	Appendix B.4
Erosion Repair	Stabilize any disturbed areas with seed and biodegradable erosion control matting.	If minor (<20 sf), nonrecurring erosion is present within the BMP area.	As needed	Routine Surface Maintenance	Appendix B.6
Graffiti Removal	Remove graffiti from site structures, signage, or BMP surfaces.	If graffiti is present on BMP, signage, or adjacent to BMP area.	Monthly	Routine Surface Maintenance	Appendix B.7
Inlet Pretreatment Clearing	Empty and clean surface inlet pretreatment device.	If trash, sediment, and/or organic debris present in pretreatment device.	Monthly	Routine Surface Maintenance	Appendix B.9
Inlet Pretreatment Maintenance	Replace missing, ripped, or clogged pretreatment device fabric.	Ripped pretreatment device fabric: Pretreatment device fabric has a rip or hole greater than 3 in. Clogged pretreatment device fabric: Pretreatment device fabric has standing water at time of maintenance and inlet is drained down to pipe invert.	Monthly	Routine Surface Maintenance	Appendix B.10
Manual Weed Control	Remove weeds by hand weeding.	If weeds are present within the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.11

A-4 SUBSURFACE INFILTRATION AND DETENTION MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Organic Debris Removal	Remove organic debris (e.g., leaves, feces, etc.) from BMP surfaces.	If present in BMP area.	Monthly	Routine Surface Maintenance	Appendix B.15
Pest Management	Treat vegetation to remove, destroy, or minimize pests and disease. Approved pesticide applicator to apply if necessary. Fill animal burrows with stone and compact. Report animal infestations to BMP owner.	If harmful insects (e.g., bag worms, wax scale, caterpillars, aphids, etc.); galls, mildew or fungus are present. If animal burrows are present within the BMP area or multiple animals (e.g., rates, mice, moles, etc.) are observed.	As needed	Routine Surface Maintenance	Appendix B.16
Photo Documentation	Take one photo of each BMP prior to maintenance and one photo of each BMP following maintenance.	To be performed during all site visits	Monthly	Routine Surface Maintenance	Appendix B.17
Pipe Jetting	Jet (i.e., hydro-clean) conveyance, distribution, and underdrain pipes.	If 30% or more of the cross-sectional area of the pipe is blocked by sediment/ debris, or as otherwise specified by owner/operator.	Annually	Routine Subsurface Maintenance	Appendix B.18

A-4 SUBSURFACE INFILTRATION AND DETENTION MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Pruning	Prune woody plant material as needed. Cut back dense vegetation to ensure safe lines of sight for pedestrians and vehicles.	If damaged, diseased, and/or dead branches are present; suckers present within the BMP area. Prune if height of dense vegetation adjacent to walkways or street intersections exceeds 4 ft.	Monthly	Routine Surface Maintenance	Appendix B.22
Sediment Removal	Remove sediment from BMP surfaces (e.g., sidewalks, gutterlines, tree pits, etc.), basin, and forebay areas.	If sediment is present and visible in BMP area.	Monthly	Routine Surface Maintenance	Appendix B.24
Signage Care	Wipe down signage. Remove tags, strings, expired no-parking signage.	If dust or grime is present.	Monthly	Routine Surface Maintenance	Appendix B.26
Sinkhole and Settling Repair	Pack sinkholes or settling with stone, cover with soil and mulch if applicable.	If sinkholes of 24 in. deep or less are present within BMP area.	As needed	Routine Surface Maintenance	Appendix B.27
Structural Pruning	Approved arborist to conduct structural pruning to help tree develop one main leader and one trunk.	Trees less than 2 years of age, with visible completing leaders or codominant stems. Elevate lower limbs of trees, remove crossing or rubbing limbs.	Annually in Winter	Routine Surface Maintenance	Appendix B.29

A-4 SUBSURFACE INFILTRATION AND DETENTION MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Trash Removal	Remove trash from BMP surfaces. Report large dumping.	If present in the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.33
Vacuum Cleaning	Vacuum clean trash/ sediment/ organic debris from subsurface access and flow control/ conveyance structures.	If trash/ sediment/ organic debris is present within the BMP.	Monthly	Routine Subsurface Maintenance	Appendix B.34
Watering	Water herbaceous and trees.	Herbaceous - 4 days without rain 1/3 in. or greater, Trees - 7 days without rain 1/3 in. or greater, Inspector observations.	As needed or triggered between April 1 and November 30	Watering	Appendix B.35

A-5 CISTERN MAINTENANCE TASKS					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
BMP shutdown	Drain and close all pipes, reservoirs, and attachments. Implement other winterization tasks as defined by or required by manufacturer.	None	Annually in November	Routine Subsurface Maintenance	Appendix B.1
BMP startup	Open all pipes, reservoirs, and attachments.	None	Annually in March	Routine Subsurface Maintenance	Appendix B.2
Chamber Clearing	Clean out accumulated sediment from filter bed chamber and sedimentation chamber.	If sediment is present in either chamber.	Annually	Routine Subsurface Maintenance	Appendix B.3
Graffiti Removal	Remove graffiti from site structures, signage, or BMP surfaces.	If graffiti is present on BMP, signage, or adjacent to BMP area.	Monthly	Routine Surface Maintenance	Appendix B.7
Organic Debris Removal	Remove organic debris (e.g., leaves, feces, etc.) from BMP surfaces.	If present in BMP area.	Monthly	Routine Surface Maintenance	Appendix B.15
Photo Documentation	Take one photo of each BMP prior to maintenance and one photo of each BMP following maintenance.	To be performed during all site visits	Monthly	Routine Surface Maintenance	Appendix B.17

A-5 CISTERN MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Sanitizing	Sanitize and drain all water from the inside of the BMP.	If trash/ sediment/ organic debris is present within the BMP, BMP has just been installed, or a bacteria test result is positive.	As needed	Routine Surface Maintenance	Appendix B.23
Signage Care	Wipe down signage. Remove tags, strings, expired no-parking signage.	If dust or grime is present.	Monthly	Routine Surface Maintenance	Appendix B.26
Trash Removal	Remove trash from BMP surfaces. Report large dumping.	If present in the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.33
Vacuum Cleaning	Vacuum clean trash/ sediment/ organic debris from subsurface access and flow control/ conveyance structures.	If trash/ sediment/ organic debris is present within the BMP.	Monthly	Routine Subsurface Maintenance	Appendix B.34

A-6 NATURALIZED BASIN MAINTENANCE TASKS					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Concrete Repair	Repair hairline or large cracks.	If hairline concrete cracks area present within the BMP area.	As needed	Routine Surface Maintenance	Appendix B.4
Erosion Repair	Stabilize any disturbed areas with seed and biodegradable erosion control matting.	If minor (<20 sf), nonrecurring erosion is present within the BMP area.	As needed	Routine Surface Maintenance	Appendix B.6
Graffiti Removal	Remove graffiti from site structures, signage, or BMP surfaces.	If graffiti is present on BMP, signage, or adjacent to BMP area.	Monthly	Routine Surface Maintenance	Appendix B.7
Manual Weed Control	Remove weeds by hand weeding.	If weeds are present within the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.11
Mowing	Mow warm season grass/ wildflower meadows to a height of 6-8 in. during the establishment period and annually after establishment (generally year 2). Mow cool season grass meadows to a height of 3-4 in. Mow perimeter edge of naturalized BMPs within vegetated grassy areas.	If height of vegetation exceeds 8 in. above ground surface elevation for warm season grasses. If height of vegetation exceeds 4 in. above ground surface elevation for cool season grasses.	As needed	Routine Surface Maintenance	Appendix B.12
Organic Debris Removal	Remove organic debris (e.g., leaves, feces, etc.) from BMP surfaces.	If present in BMP area.	Monthly	Routine Surface Maintenance	Appendix B.15

A-6 NATURALIZED BASIN MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Pest Management	Treat vegetation to remove, destroy, or minimize pests and disease. Approved pesticide applicator to apply if necessary. Fill animal burrows with stone and compact. Report animal infestations to BMP owner.	If harmful insects (e.g., bag worms, wax scale, caterpillars, aphids, etc.); galls, mildew or fungus are present. If animal burrows are present within the BMP area or multiple animals (e.g., rates, mice, moles, etc.) are observed.	As needed	Routine Surface Maintenance	Appendix B.16
Photo Documentation	Take one photo of each BMP prior to maintenance and one photo of each BMP following maintenance.	To be performed during all site visits	Monthly	Routine Surface Maintenance	Appendix B.17
Pipe Jetting	Jet (i.e., hydro-clean) conveyance, distribution, and underdrain pipes.	If 30% or more of the cross-sectional area of the pipe is blocked by sediment/ debris, or as otherwise specified by owner/operator.	Annually	Routine Subsurface Maintenance	Appendix B.18
Plant Removal	Remove dead or diseased herbaceous vegetation, trees or shrubs from the BMP area.	If dead or diseased vegetation is present within the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.19

A-6 NATURALIZED BASIN MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Pruning	Prune woody plant material as needed. Cut back dense vegetation to ensure safe lines of sight for pedestrians and vehicles.	If damaged, diseased, and/or dead branches are present; suckers present within the BMP area. Prune if height of dense vegetation adjacent to walkways or street intersections exceeds 4 ft.	Monthly	Routine Surface Maintenance	Appendix B.22
Seeding/ Sodding	Fill eroded areas, and, if necessary, reseed bare areas.	If minor (<20 sf), nonrecurring erosion is present within the BMP area.	Meadow Seeding: March 15th to June 15th. Warm-Season Meadow Seeding: April 15th to June 15th, August 15th to September 15th	Routine Surface Maintenance	Appendix B.25
Sediment Removal	Remove sediment from BMP surfaces (e.g., sidewalks, gutterlines, tree pits, etc.), basin, and forebay areas.	If sediment is present and visible in BMP area.	Monthly	Routine Surface Maintenance	Appendix B.24
Signage Care	Wipe down signage. Remove tags, strings, expired no-parking signage.	If dust or grime is present.	Monthly	Routine Surface Maintenance	Appendix B.26
Sinkhole and Settling Repair	Pack sinkholes or settling with stone, cover with soil and mulch if applicable.	If sinkholes of 24 in. deep or less are present within BMP area.	As needed	Routine Surface Maintenance	Appendix B.27

A-6 NATURALIZED BASIN MAINTENANCE TASKS (cont.)					
Task	Description	Maintenance Triggers	Recommended Frequency	Work Order Type	Task Instruction Reference
Structural Pruning	Approved arborist to conduct structural pruning to help tree develop one main leader and one trunk.	Trees less than 2 years of age, with visible completing leaders or codominant stems. Elevate lower limbs of trees, remove crossing or rubbing limbs.	Annually in Winter	Routine Surface Maintenance	Appendix B.29
Target Perennial - Cutting Back	Cut back dead growth from previous growing season.	If the height of dense herbaceous vegetation exceeds 6 in. above the ground surface elevation.	Annually in March	Routine Surface Maintenance	Appendix B.31
Target Perennial - Dividing and Transplanting	Target perennials may need dividing or transplanting every 3-5 years to prevent overcrowding and mildew.	Encouraging air circulation between plants maintenance of mature garden (3-4 years).	As Needed in Fall	Routine Surface Maintenance	Appendix B.32
Trash Removal	Remove trash from BMP surfaces. Report large dumping.	If present in the BMP area.	Monthly	Routine Surface Maintenance	Appendix B.33
Watering	Water herbaceous and trees.	Herbaceous - 4 days without rain 1/3 in. or greater, Trees - 7 days without rain 1/3 in. or greater, Inspector observations.	As needed or triggered between April 1 and November 30	Watering	Appendix B.35

A-7 INSPECTION FREQUENCY TABLE			
Inspection Type	Description	Applicable BMPs	Recommended Frequency
Routine Inspection	During a routine inspection, the inspector will visually assess the safety, function, aesthetic character of the BMP and all of its surface-accessible features. This type of inspection will inform any upcoming routine maintenance work orders and may result in the generation of maintenance work orders.	All BMP Types	Monthly
Vegetation Inspection	Inspectors will assess the quality, coverage, and health of vegetation within the boundaries of a BMP. This type of inspection will be carried out only during the growing season and will inform the need for replanting or other vegetation-related items to be included in upcoming routine maintenance work orders. Vegetation inspections will be used to establish future watering frequencies.	All BMP Types with Vegetation	Twice Annually During the Growing Season
Subsurface Feature Inspection	The inspector will use a CCTV camera to assess the condition of subsurface features such as pipes, and access structures. This type of inspection may result in the generation of a Subsurface Maintenance Work Order.	All BMP Types with Subsurface Features	Annually

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APPENDIX B – DETAILED PROTOCOL INSTRUCTIONS

B.1 BMP SHUTDOWN

Description

This section describes procedures and requirements of winterization for BMP shutdown. BMP shutdown should occur before the first major frost, typically around November, to prevent pipes from bursting and keep BMP components safe during the winter.

Applicability

Green Roof	Cistern

Equipment

Screwdrivers	Manhole hooks	Shop-Vac
Wrenches	Crowbar	Non-toxic disinfectant
Pliers	Metal/Plastic brush	Air compressor
Gloves	Mallet	
Safety glasses	Safety vest	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Drain, clean, and seal any surface cisterns, tanks, and rain barrels or any subsurface systems above the frost line.
    - Empty any water using approved vacuum cleaning and waste disposal protocols.
    - Disinfect and rinse storage areas using approved non-toxic disinfectant and dispose using approved waste disposal protocols.
    - Close inflow valves or disconnect inflow pipes as per the manufacturer.
- Drain and seal irrigation systems above the frost line.
    - Remove attachments, stakes, and removable watering heads and store in a dry place.
    - Close inflow valves or disconnect inflow pipes as per the manufacturer.
    - Clean any filters and screens.
    - Using an air compressor, force any leftover water from irrigation pipes.

Special Considerations

- Any remaining standing water must be removed from the BMP system prior to the first major frost.
- Implement other winterization tasks as per the manufacturer.

B.2 BMP STARTUP

Description

This section describes procedures and requirements for BMP startup. BMP startup should occur annually after major frosts have ended for the winter, typically around March.

Applicability

Green Roof	Cistern

Equipment

Screwdrivers	Manhole hooks
Wrenches	Crowbar
Pliers	Metal/Plastic brush
Gloves	Mallet
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Open inflow valves and attachments or connect inflow pipes to surface cisterns, tanks, rain barrels, and irrigation systems as per the manufacturer.
- Restore any attachments, stakes, and removable watering heads to irrigation systems.

Special Considerations

- BMP components should be tested for function prior to departure from the site.

B.3 CHAMBER CLEANING

Description

This section describes procedures and requirements for chamber clearing of cisterns/rain barrels and media filters. Chamber clearing should be performed when sediment is present in cisterns/rain barrels and media filters.

Applicability

Cistern

Equipment

Metal/plastic brush	Cleaning solution
Gloves	Rags
Safety glasses	Safety vest
Shop-Vac	Pressure washer

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Clean the catchment area (e.g. rooftops and gutters) and remove all debris from conveyance pipes.
- Remove all debris and water from chamber using approved vacuum cleaning and waste disposal protocols as needed.
- Clean and scrub all internal surfaces using a brush or high pressure washer.
- Wash all internal surfaces using a pressure washer or fill the tank with water and let stand for a few hours. Drain all water using approved waste disposal protocols.

Special Considerations

- Water contaminated with fuel or toxic chemicals will not be made safe by disinfection.
- Do not enter the cistern. Gases and vapors can build up, creating a hazardous environment.

B.4 CONCRETE REPAIR

Description

This section describes procedures and requirements for repairing hairline or large cracks in concrete within the BMP area.

Applicability

Bioinfiltration and Bioretention	Subsurface Infiltration and Detention
Porous Pavement	Green Roof
Naturalized Basin	

Equipment

Tarp	Concrete crack repair product
Chisel	Scrub brush
Hammer	Traffic cones
Gloves	Concrete mixing tray
Masonry trowel	Water
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Notify owner/operator if the damaged concrete is greater than 50 ft^2 and more than 10% of the total pavement surface. Block off any areas that are unsafe for pedestrians or vehicular traffic. Repair concrete per the owner/operator's guidance.
- Cover surrounding areas with tarp to protect plants and BMP components.
- Remove loose debris or material from the repair area.
- To repair a hairline/cosmetic crack in concrete:
    - Apply a concrete crack repair product to the surface per the manufacturer's recommendations.
- To repair a large/structural crack in concrete:
    - Undercut the crack using a chisel and small sledgehammer to widen the base of the crack.
    - Remove all debris and small particles.
    - Mix the concrete patching compound and apply per manufacturer's specifications.
    - Tamp the mixture to remove air pockets.
    - Smooth the mixture with a trowel and wait for the patch to set.

Special Considerations

- Schedule concrete work early in the day, if practicable, for final setting to occur during the work day. Protect the newly poured concrete from pedestrian and vehicular traffic using barricades, caution tape, or signage. Ensure that personnel are present during the final setting period to prevent vandalism and damage.
- Maintain protective measures during the five (5) to seven (7) days curing period of concrete.
- Concrete repairs shall be limited to days with a temperature range between 40° and 80° F.
- Concrete repair shall be avoided within a 48 hour period of forecasted rain.

B.5 DEICING

Description

This section describes procedures and requirements for deicing porous pavement.

Applicability

Porous Pavement

Equipment

Beet heet/deicer	Boots
Shovel	Bucket
Gloves	Safety vest
Safety glasses	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Apply deicer before and after:
    - Snow events greater than 2 inches.
    - Sleet events.
    - Freezing rain events.
- Repeat deicer application as necessary for the duration of the storm or as requested by the owner/operator.

Special Considerations

- Any deicers should be used in moderation.
- Do not use fine abrasives to promote increased vehicle traction.
- Sand or cinders should not be applied on or adjacent to the porous pavement.

B.6 EROSION REPAIR

Description

This section describes the procedures and requirements for the control and repair of damaging erosion from soil loss or migration. Erosion repair should be performed to stabilize disturbed areas within the BMP area.

Applicability

Bioinfiltration and Bioretention	Naturalized Basin
Subsurface Infiltration and Detention	

Equipment

Top soil	Clean fill (2A modified gravel)
Shovel/Spade	Stone (various sizes)
Erosion blanket and staples	Tarp
Rake	Hand tamper
Utility blade	Wheelbarrow/Push cart
Gloves	Hammer/Mallet
Seed mix	Mulch
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Fill eroded area with material matching that of the surrounding media (stone, top soil, mulch, etc.).
- Fine grade material with shovel, rake, and other hand tool to match the surrounding undamaged surface.
- Seed area:
    - All areas to be seeded shall be graded and free of weeds and debris.
    - Gullies and disturbed areas shall be repaired prior to seeding.
    - Evenly distribute seed across seedbed and apply in two different directions.
    - Seedbed shall be raked/harrowed to smooth out surface.
- Gently compact material with hand tamper.
- Install erosion blanket:
    - Dig a trench of appropriate size with respect to the erosion blanket (roughly one foot deep).
    - Unroll blanket in the direction of water flow or down the embankment slope.
    - Secure erosion blanket to soil by placing staples at least four (4) inches on center or per manufacturer's specifications.

Special Considerations

- If erosion repair is performed outside the normal season for seeding, then postpone seeding until appropriate time.
- Pending the discretion of the facility maintenance manager or foreman, some areas may be planted rather than seeded.

B.7 GRAFFITI REMOVAL

Description

This section describes procedures and requirements for removal of graffiti from BMP elements. Graffiti should be removed as necessary when present on BMP, signage, or adjacent to BMP area.

Applicability

Bioinfiltration and Bioretention	Porous Pavement
Green Roof	Subsurface Infiltration and Detention
Cistern	Naturalized Basin

Equipment

Tarp	Trash bags
Pressure washer	Paint
Metal/Plastic brush	Utility knife
Gloves	Rags
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Remove surface paint/marking graffiti from concrete, masonry, or metal surfaces:
    - Cover surrounding areas with tarp to protect plants and BMP components.
    - Pressure wash surface.
    - Apply chemical graffiti removal solvent per manufacturer specifications.
    - Scrub surface with metal or plastic brush.
    - Wipe away graffiti removal solvent with rags.
    - Pressure wash or rinse surface clean.
    - Repeat process as needed until graffiti is removed.
    - If applicable, repaint surface per the owner/operator's specifications.
- If necessary, re-paint affected area.
- Remove sticker-based graffiti from metal or other smooth surfaces:
    - Remove sticker from surface by holding utility knife at a low angle relative to surface to prevent scratching the surface.

Special Considerations

- Remove graffiti to the maximum extent possible. Report graffiti that could not be removed.

B.8 GRAVEL JOINT FILLING

Description

This section describes procedures and requirements for filling joints between pavers with gravel. Gravel joint filling should be done annually when gravel has eroded away from joints.

Applicability

Porous Pavement

Equipment

Gravel	Plate compactor
Shovel	Wheelbarrow
Gloves	Push broom
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Place clean gravel, of the size per the paver specifications,on top of the pavers.
- Sweep the gravel in all directions over the pavers to uniformly fill the joints until all joints are full.
- Use a vibratory plate compactor with a protective buffer to consolidate the gravel in the joints.
- Repeat until all joints are full.
- If dust becomes excessive, use water as needed.

Special Considerations

- Sand, silt, and sedimentation should be cleaned or vacuumed regularly from the joints to prevent clogging.

B.9 INLET PRETREATMENT CLEARING

Description

This section describes procedures and requirements for inlet pretreatment clearing. Inlet pretreatment clearing shall be performed monthly.

Applicability

Bioinfiltration and Bioretention	Subsurface Infiltration and Detention

Equipment

Shovel/ Rake	Manhole hooks
Trash picker	Crowbar
Push broom	Scrub brush
Gloves	Trash bags
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Sweep area surrounding the inlet that may be collecting trash/debris/sediment.
- Remove pre-treatment device, if not permanently attached to the structure, by hand or pretreatment device removal tools, if available.
- Remove any trash/debris/sediment that may hinder water flow.
- Invert and shake or gently tap the device until all materials has been removed.
- Use approved waste disposal protocols.
- Clean the inlet pretreatment material to remove fine sediment, taking care not to damage the material.
- Place pretreatment device in its original location. Check to ensure that water is treated prior to entering the inlet.

Special Considerations

- Removal of debris from inlets or other structures may require confined space entry.
- During winter weather events, the removal of organic debris may be challenging due to snow or ice storms. Pending professional judgement of the foreman, such material may be left in place until the following maintenance event where removal shall be attempted again.

B.10 INLET PRETREATMENT MAINTENANCE

Description

This section describes procedures and requirements for maintaining inlet pretreatment. Inlets should be inspected monthly for damage to pretreatment devices and maintained appropriately.

Applicability

- Bioinfiltration and Bioretention
- Porous Pavement
- Subsurface Infiltration and Detention

Equipment

- Manhole hook
- Crowbar
- Gloves
- Safety glasses
- Trash bags
- Inlet filter bags
- Pump
- Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Inspect inlet pretreatment to assess maintenance needs.
- If there is trash, sediment, and/or organic debris is present in the inlet pretreatment device, perform inlet pretreatment clearing.
- If pretreatment device is missing, install a new pretreatment device.
- If pretreatment device has a rip or hole greater than three (3) inches:
    - Remove inlet pretreatment material from pretreatment device frame.
    - Replace inlet pretreatment material.
    - Re-insert inlet pretreatment material into structure and secure.
    - Stockpile damaged pretreatment device filter fabric off-site for repair.
- If the pretreatment device fabric is clogged, where there is standing water at the time of maintenance and the inlet is drained down to pipe invert, use a pump to remove the water.
- Use approved waste disposal protocols.

Special Considerations

- Removal of debris from inlets or other structures may require confined space entry.

B.11 MANUAL WEED CONTROL

Description

This section describes procedures and requirements of weed control using chemical and manual methods. Weeding should be performed throughout the growing season.

Applicability

Bioinfiltration and Bioretention	Green Roof
Subsurface Infiltration and Detention	Naturalized Basin

Equipment

Gardening gloves	Trash bags
Shovel or trowel	Shears
Weeding fork	Soil knife
Draw and oscillating hoes	Safety vest
Safety glasses	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Hand pulling of mature annual and tap-rooted herbaceous plants and tree seedlings:
    - If necessary, use a shovel or spade to loosen the soil surrounding plant root mass.
    - Hand pulling is more successful when plants are big enough to grasp firmly but small enough that they are not established and/or when the soil is moist. Hand pull mature annual and tap-rooted herbaceous plant and tree seedlings.
    - Remove the entire weed by gripping and pulling directly upward, ensuring that the root has also been dislodged.
    - Remove entire plant including root mass to prevent re-sprouting.
    - Refill the remaining hole, regrading by hand or with a hand tool as needed to smooth surface.
    - In areas of intentional ponding, it is best to remove aquatic weeds using an aquatic weed rake.

Special Considerations

- Weeds are defined by the following lists and persons but may include other plants not included below:
    - Pennsylvania Department of Conservation and Natural Resources Invasive Plant List.
    - United States Department of Agriculture as a Federal Noxious Weeds.
    - Volunteer species that do not fit within the aesthetic of the SMP, as defined by the owner.

B.12 MOWING

Description

This section describes procedures and requirements for mowing. During the establishment period (first year), mowing frequency for warm season grasses shall be determined by height of the grasses. Mow to a 6-inch height when weeds have reached a height of 10 – 12 inches and no higher. Use a flail-type mower or equivalent (e.g., string trimmer) to prevent burying of seedlings with mowed material. Finely chop and redistribute mowings to prevent weeds from smothering native meadow seedlings. Do not mow after August 1 to maintain wildlife food and cover for the winter.

After establishment (usually second or third year) mow warm season grasses to an 8-inch height in late winter or early spring. Do not mow during the wildlife reproductive period between April 1 and June 15. A second mowing in mid summer (mid to late July) may be needed to control weeds. Do not mow after August 1 to maintain wildlife food and cover for the winter.

Applicability

Bioinfiltration and Bioretention	Naturalized Basin

Equipment

Flail mower	Trash bags
Weed Wacker	Weed Wacker string
Rake	Oil/Gas
Gloves	Safety vest
Safety glasses	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Flail mow warm season grasses to a height of 6-8 inches:
    - Mow perpendicular to slope.
    - Maintain an even level of string-trimmed vegetation throughout the system.
    - If flail mower cannot be used, rake and dispose of trimmed plant matter.
    - To avoid damaging larger vegetation, do not trim within one (1) foot of trees and shrubs.
- Use walk behind or riding mowers for cool season grasses to a height of 3-4 inches:
    - Mow uniformly to prescribed height without scalping the grasses.
    - If flail mower cannot be used, rake and dispose of trimmed plant matter
    - To avoid damaging larger vegetation, do not trim within one (1) foot of trees and shrubs.
- String trimming should be performed when slopes/terrain prevent regular mowing:
    - To avoid damaging larger vegetation, do not trim within one (1) foot of trees and shrubs.
    - Maintain an even level of string-trimmed vegetation throughout the system.
    - Rake and dispose of trimmed plant matter.

Special Considerations

- Where applicable, efforts should be made to avoid adversely impacting ground nesting birds in the spring and summer (during nesting season).

B.13 MULCH AMENDMENT

Description

This section describes procedures and requirements of mulch amendment. This task should be performed monthly, as needed if the mulch is observed to be compacted or disarrayed.

Applicability

Bioinfiltration and Bioretention

Equipment

Mulch	Bucket
Shovel	Trash bags
Hard rake	Spading fork
Tarp	Pitch fork
Gloves	Wheelbarrow
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Rake mulch to maintain a loose top layer.
- Rake mulch away from base of tree trunk or woody-stemmed shrub, taking care not to disturb vegetation.
- Apply mulch as needed to maintain a three (3) inch layer.
- Keep a three (3) inch non-mulch radius around wood stems. Rake mulch away from woody stems if necessary to maintain the three (3) inch non-mulched radius.

Special Considerations

- Do not perform mulch amendment during heavy rain events or freezing conditions.

B.14 MULCH REPLACEMENT

Description

This section describes procedures and requirements of mulch replacement. This task should be performed annually in the spring.

Applicability

Bioinfiltration and Bioretention

Equipment

Mulch	Bucket
Shovel	Trash bags
Hard rake	Spading fork
Tarp	Pitch fork
Gloves	Wheelbarrow
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Remove mulch using rakes and shovels, taking care not to disturb vegetation.
- Replace and supplement mulch to a thickness of three (3) inches.
- Keep a three (3) inch non-mulch radius around wood stems.
- Rake mulch away from woody stems if necessary to maintain the three (3) inch non-mulched radius.
- In areas near the edge of pavement, add mulch until the mulched area is flush with the pavement.

Special Considerations

- Do not perform mulch amendment during heavy rain events or freezing conditions.
- Mulch replacement to be typically requested annually in the spring.

B.15 ORGANIC DEBRIS REMOVAL

Description

This section describes procedures and requirements for removing organic debris from BMPs and systems. Organic debris includes, but is not limited to: leaves, twigs, branches, etc.

Applicability

Bioinfiltration and Bioretention	Green Roof
Subsurface Infiltration and Detention	Cistern
Naturalized Basin	

Equipment

Trash picker	Leaf blower
Tarp	Wheelbarrow or push cart
Shovel	Push Broom with firm bristles
Rake	Pliers, adjustable wrenches, etc.
Wire or Plastic brush	Assorted Phillips/standard screwdrivers
Gloves	Portable vacuum
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Remove small quantities of organic debris and organic debris contained within shallow structures using hand tools.
- Remove any organic debris from media storage areas, roof storage areas, and SMP perimeter, including sidewalk/paved areas adjacent to any grates and curb openings.
- Remove organic debris from structure surfaces and interiors including culverts, trench drains, pretreatment devices, gutters, and flow control devices.
- Organic debris shall be removed from pretreatment or flow control devices contained within inlet structures prior to removal of debris from the device itself.
- If necessary, debris may be removed by a portable vacuum excavator. Vacuum hose attachments or decreasing suction power are encouraged to prevent damage to filter-bag style devices.
- Dispose of organic debris in an approved manner.

Special Considerations

- During winter weather events, the removal of organic debris may be challenging due to snow or ice storms. Pending professional judgement of the foreman, such material may be left in place until the following maintenance event where removal shall be attempted again.

B.16 PEST MANAGEMENT

Description

This section describes procedures and requirements for removing and minimizing pests and disease. Harmful insects, galls, mildew, fungus, or burrowing animals may damage vegetation or spread disease.

Applicability

Bioinfiltration and Bioretention	Green Roof
Subsurface Infiltration and Detention	Naturalized Basin

Equipment

Shovel	Pesticide (pending site and pest type)
Disposable bag	Disposable gloves
Hand tamper	Disinfectant solution
2A Modified Stone	Rake
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- To remove a large animal carcass:
    - Report the presence of large animal carcass to owner/operator.
    - Report large animal carcasses to the Lancaster Streets Department if located in public streets for prompt removal.
- To remove a small animal carcass:
    - Wear disposable gloves.
    - Use shovel and rake to collect and place animal carcass in disposable bag.
    - Seal and dispose of the bag using approved waste disposal protocols. Clean tools with disinfectant solution (bleach or other household disinfectant liquid).
    - If potable water is available, apply the disinfectant to used tools and hose down.
- To repair animal burrows:
    - Fill animal burrows with 2A modified stone.
    - Compact surface using hand tamper.
- To remove pest insects or fungi:
    - Remove infected leaves, branches, needles, and clean cones around the base of trees and shrubs to mitigate disease reservoirs.
    - Dispose per approved waste disposal protocols.
    - Apply appropriate pesticide per manufacturer's specifications and instructions. Follow recommended safety procedures.
    - It is important to minimize risk of pesticide spillage. Do not use open containers. If a spill occurs, follow appropriate safety protocols for cleanup and notify appropriate parties.

- Avoid introducing pesticide onto unaffected plant areas. Follow manufacturer and safety instructions for proper pesticide clean-up.
- For mosquito infestations within inlets/basins, use Mosquito Dunks or other equivalent products to treat areas of standing water.
- Report wasp/hornet nests, roach, or other animal infestations to owner/operator.

Special Considerations

- Chemical pest control shall be performed during dry weather with little to no wind (no more than 24 hours before or after rain).
- Temperature restrictions may apply depending on given pesticide type.
- Prior to pesticide application, the following information shall be submitted to owner/operator 24 hours prior:
  - Date of application and hour of completion.
  - Name and address of given application site.
  - Brand name, EPA registration number, amount, and rate/dosage of each pesticide used.
  - Size and identification of area treated.
  - Names and certification numbers of all persons involved, restricted reentry interval.
- All pesticides applied must follow label-specific safety instructions and manufacturer's directions.
- All personnel must comply with directions on all pesticide label sheets, Material Safety Data Sheets (MSDS) sheets, and all other applicable sources, codes, and regulations.
- Anyone listed on the Pennsylvania Pesticide Hypersensitivity Registry located within a 500-foot radius must be notified at least twelve (12) but no more than 72 hours in advance. Notification must be made via email, telephone answering device, or by contact of an adult per any listed phone numbers.
- The following hypersensitivity notification information must be included: date, time, application location, EPA registration number, common name of active ingredients, business name, BU number, business number, and a copy of the label per request.
- Personnel performing pest management shall include at minimum:
  - Pennsylvania Certified Pesticide Applicator or Registered Technician who is under supervision of a Pennsylvania Certified Pesticide Applicator that can be on site within five (5) hours.
  - If necessary, a Noncertified Applicator under the direct supervision of a Pennsylvania Certified Pesticide Applicator who is physically present and within site of application.

B.17 PHOTO DOCUMENTATION

Description

This section describes procedures and requirements for recording proper photo documentation of BMP components and projects. Photo documentation shall be recorded prior to and following system maintenance.

Applicability

Bioinfiltration and Bioretention	Porous Pavement
Green Roof	Subsurface Infiltration and Detention
Cistern	Naturalized Basin

Equipment

Camera	Rake
Disposal bag	Pen & paper
Gloves	Flashlight
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Inspect the site prior to maintenance effort to assess maintenance needs.
- Write up the BMP system ID, date, and maintenance task, and take a photo of the label.
- Take a photo of the BMP component(s) or specific focus area(s) that will undergo maintenance prior to any work being done.
- Perform maintenance task(s).
- Take a photo of the BMP component(s) or specific focus area(s) that underwent maintenance, matching the photos taken prior to work as best as possible.

Special Considerations

- Use of cameras with wrist straps are preferred to prevent the possibility of a camera falling into a BMP component.
- Avoid shadows in photos when possible. Use a flashlight when appropriate.
- Be cautious of traffic when taking photos near active roadways and sites.

B.18 PIPE JETTING

Description

This section describes procedures and requirements for pipe jet cleaning subsurface features. Pipe jetting should be performed when 30% or more of the cross-sectional area of a pipe is blocked or when specified by the owner/operator.

Applicability

- Bioinfiltration and Bioretention
- Green Roof
- Naturalized Basin
- Porous Pavement
- Subsurface Infiltration and Detention

Equipment

- Crowbar
- Jetter hoses, fittings, clamps, nozzles (sizes TBD before arrival to site)
- Measuring wheel
- High pressure pumping system
- Hand tools
- Shovel/spade
- Manhole hooks
- Ladder
- Gloves
- Flashlight
- CCTV equipment
- Safety cones
- Push broom
- Safety vest
- Safety glasses

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Pre-maintenance inspections should have been performed to determine which structures require maintenance so that the appropriate equipment can be brought to the site.
- Sweep area surrounding the structure that may be collecting trash/debris/sediment.
- Remove any trash/sediment/debris that is restricting access or flow control.
- Remove pre-treatment device if not permanently attached to the structure (clean if needed).
- Position jet system so that the reel is adjacent to the selected access structure (inlet, manhole, riser, cleanout, etc.). Utilize an inlet, manhole, or control structure as the primary maintenance access point.
- Insert jetter hose into pipe through the flexible hose guard. Insert hose guard into the pipe to guide the jetter hose and prevent wear from friction.
- Ensure a vacuum tube is present within the structure to vacuum jetted waste material—following approved vacuum cleaning protocols.
- Start high-pressure pump after ensuring the nozzle is fully inserted and secured.
- Jet-rod the conveyance pipe structures to move trash, sediment, and organic debris toward the access point. Perform as many passes as needed to clean the structure. Pipe jetting is complete once the jetted water is clear.

- Stop maintenance immediately if structural damage or failure are observed. Report observation to owner/operator.
- Prior to closing access point, inspect structures to ensure that all traps are closed, and pretreatment screens are latched/correctly installed.
- Complete a post-maintenance inspection of pipes with a closed-circuit television (CCTV) camera. If possible, attempt access through a cleanout or riser before attempting access through other structures such as inlet, control structure, or manhole.
    - Move camera at a steady pace, not to exceed 30 feet per minute from entry point.
    - Stop the camera if structural or construction defects are observed. Re-position camera to better view defects and capture still shots if possible.
    - At the completion of the inspection, retract the camera to the entry point, recoding the CCTV data.

Special Considerations

- Based on typical design drain down times, vacuuming should not be performed within 48 hours of a significant (> 1 inch) precipitation event.
- Determination of appropriate equipment (hoses, fittings, etc.) for maintenance shall be made prior to arrival so that the appropriate equipment is transported to the site.
- Confirm that the jetter equipment waste storage tank is free of debris from another site/project. If required by owner/operator, take a time stamped photograph of empty storage tanks.
- When using hydraulically propelled cleaning tools, precautions shall be taken to ensure that the water pressure does not damage or cause flooding to nearby property.
- When using hydraulically propelled cleaning tools, all access structures that are not used as entry points must be closed, secured by screws, screw caps, or weighted bags (minimum 40 lbs.)

B.19 PLANT REMOVAL

Description

This section describes procedures and requirements for various types of vegetation and organic debris removal. Any dead or diseased vegetation should be removed within the BMP area.

Applicability

Bioinfiltration and Bioretention	Green Roof
Naturalized Basin	

Equipment

Handsaw	Small chainsaw
Digging spade	Digging fork
Garden Mattock	Stump puller
Shovel	Pruners
Gloves	Top soil
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- To remove large shrubs:
    - Use pruners, handsaw, or small chainsaw to cut through thick branches and brush.
    - Use digging spade and digging fork to dig around perimeter of the root zone to loosen and cut roots, then cut roots at base of stump with a garden mattock.
    - Use digging spade and digging fork to dislodge stump from the ground. If a stump puller is available, clamp stump to puller's vice and rock stump puller back and forth until the stump may be pulled away from the ground.
    - Backfill open trench with surrounding soil.
- To remove trees:
    - Identify expected fall pattern by observing growth pattern and tree angle. Remove any possible obstacles and prepare escape routes. Place temporary barriers to warn pedestrians and vehicles.
    - Select an appropriate saw depending on diameter at breast height (DBH). A small chainsaw can be used in most cases to increase speed and efficiency.
    - Depending on size of crown, use the 1-cut or 2-cut method to cut down tree. The 2-cut method allows greater control and typically used on larger trees.
    - Roots may be left or removed at discretion of operator. Backfill open trench with surrounding soil.
- To remove herbaceous vegetation and small shrubs:
    - Cut base of vegetation using hand saw or pruners.
    - Dig roots using a shovel, make sure to avoid disturbance of nearby plants.
    - Backfill area with top soil.

Special Considerations

- If targeted site is not under optimal tree removal conditions, contact a specialty tree removal service for assistance. Inform the owner/operator.
- Work must be performed consistent with the following standards:
    - International Society of Arboriculture (ISA) – All applicable standards
    - ANSI A300 (Part 9) – 2011 Tree Risk Assessment
    - OSHA Standard 1901.266: Logging Operations

B.20 PLOWING

Description

This section describes procedures and requirements of plowing. Plowing should be performed to remove snow from the surface of porous pavement after any snow event greater than two (2) inches.

Applicability

Porous Pavement

Equipment

Rubber snow plow	Boots
Shovel	Deicer/Beet Heet
Gloves	Safety vest
Safety glasses	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Plow porous pavement with rubber plow blade set to one (1) inch above the pavement surface.
- Repeat as requested by owner/operator for the duration of the storm.

Special Considerations

- Any deicers should be used in moderation.
- Sand or cinders should not be applied on or adjacent to the porous pavement.

B.21 POROUS PATCHING

Description

This section describes procedures and requirements for patching damage to porous pavement. Porous patching should be performed as needed when damage is observed on porous pavement areas.

Applicability

Porous Pavement

Equipment

Pressure washer	Plate compactor
Shovel	Wheelbarrow
Gloves	Push broom
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Inspect the site prior to maintenance effort to assess maintenance needs.
- Sweep the area of concern to clear any debris and sediment.
- Pressure wash the area of concern.
- Sweep away any remaining standing water from the area of concern.
- Mix and apply porous patch material in accordance with the vendor specifications.

Special Considerations

- After patch application, secure the area to prevent any disturbance to the resealing process.

B.22 PRUNING

Description

This section describes procedures and requirements for maintenance pruning. Damaged, diseased, or dead branches should be removed and height of dense vegetation adjacent to walkways or street intersections should be maintained to keep safe lines of sight for pedestrians and vehicles.

Applicability

Bioinfiltration and Bioretention	Subsurface Infiltration and Detention
Naturalized Basin	

Equipment

Chain saw	Hand saw, pruning pole saws, pole clips
Tarp	Pruning shears and loppers
Lift with dump box	Push broom
Gloves	Chipper trailer (disc or drum)
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Use sharp, sterilized pruning tools.
- Make clean even cuts using proper tool for size of branch.
- Remove low limbs as needed to maintain safe overhead and line of sight clearances for pedestrians and vehicles.
- Remove all dead, damaged, diseased, or dying branches back to the nearest branching point, taking care to avoid damage to the branch collar.
- Carefully cut as close to the branch collar without cutting the branch collar itself. Preserve the branch collar for proper healing.
- Cut branches into pieces than can be easily carried and remove any material to be disposed at an approved off-site location.

Special Considerations

- The owner/operator shall make arrangements with the utility company for removal of any limbs or branches in conflict with electrical distribution lines. Tree pruning near or within electrical wires shall only be conducted by a qualified line clearance arborist. Electric utilities warn to keep 10 feet from all primary/distribution power lines.
- All pruning efforts should intend to protect clear sight lines, ensure that branches and limbs are not impeding with street traffic, pedestrian traffic, or structures. Ideal clearances may not be practical in all cases, particularly for young trees.

B.23 SANITIZING

Description

This section describes procedures and requirements of sanitizing a cistern. Cisterns should be sanitized if trash, sediment, or organic debris is present within the BMP, the BMP has just been installed, or a bacteria test result is positive.

Applicability

Cistern

Equipment

Screwdrivers	Crowbar
Wrenches	Unscented liquid household bleach
Pliers	Pressure washer
Mallet	Manhole hooks
Gloves	Metal/Plastic brush
Brush	Detergent
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Drain and clean any surface contaminated cisterns, tanks, and rain barrels or any contaminated subsurface systems.
    - Empty any water using approved vacuum cleaning and waste disposal protocols.
    - Clean and scrub all internal surfaces using a brush or high pressure washer and a mixture of detergent and water.
    - Wash all internal surfaces using a pressure washer or fill the tank with water and let stand for a few hours. Drain all water using approved waste disposal protocols
- Sanitize any surface contaminated cisterns, tanks, and rain barrels.
    - Fill 25% of the tank with clean water.
    - Add 3 cups of 5%-8.25% unscented liquid household bleach for every 100 gallons of water (a chlorine concentration of about 100 ppm or mg/L).
    - Mix the solution in the tank and fill to full capacity with clean water.
    - Let the solution stand in the tank for 24 hours with all covers and valves closed.
    - Empty the tank using approved waste disposal protocols.
- Check the tank for residual chlorine concentration.
    - Refill the tank with clean water and let stand for 30 minutes.
    - Test the residual chlorine levels. The tank is safe for use if the chlorine concentration is 0.5 mg/L or less.
    - If the concentration is higher, empty the tank using approved waste disposal protocols and repeat above steps until the tested chlorine concentration is 0.5 mg/L or less.
- Sanitize any associated piping or hoses using the same procedures as described above.

Special Considerations

- If the tank is required for use urgently, the bleach concentration can be doubled, and the standing time can be reduced from 24 hours to 8 hours.
- Contaminated water must be disposed of using approved waste disposal protocols.

B.24 SEDIMENT REMOVAL

Description

This section describes procedures and requirements for removal of sediment from BMP surfaces, inflow or outflow areas, and pretreatment devices. Sediment can damage plants by burying the stems and coating the leaves. Sediment can also clog the gravel elements and soil beds, leading to less infiltration of stormwater and reduce the storage capacity of the BMP.

Applicability

Bioinfiltration and Bioretention

Naturalized Basin

Subsurface Infiltration and Detention

Equipment

Broom	Leaf blower
Digging fork	5 gallon bucket
Scoop shovel	Flathead shovel
Gloves	Trash bags
Brush	Safety vest
Safety glasses	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Collect and remove sediment using shovels, trash bags, and disposal containers as appropriate.
- Remove sediment from BMP surfaces:
    - Remove sedimentation from BMP surfaces.
    - Separate sediment from engineered soil by gently scraping the top surface (1-3 inches) of the BMP with a small rake, shovel, and/or trowel, taking care not to damage plants or remove the filter media.
    - Any bare areas within vegetated SMPs that result from sediment removal shall be immediately stabilized/repaired.
- Remove sediment from inflow and outflow areas including sidewalk/paved areas adjacent to any grates and curb openings.
    - Sweep sediment 4-5 feet from either side of curb cut openings, the gutter line adjacent to the BMP and up gradient of the inflow area.
    - For trench drains, use a leaf blower. In some cases, covers may have to be removed to fully access the inflow areas.

- Remove sediment from pretreatment devices (such as forebays, filter strips, or inlet filter fabric device):
    - Occasionally, a scrub brush or pressure washer should be used to scrub filter fabric pretreatment devices in order to remove fine sediment from fabric pores, taking care not to tear or damage the material.
    - A tarp may be used to contain and collect sediment for bagging and removal.
- When damage or tear/rip to filter fabric pretreatment devices is greater than three (3) inches then the device must be replaced

Special Considerations

- Sediment is composed of finer materials than engineered soil and normally found in small mounds within inlet areas and areas where water pools in the BMP.
- Although sediment loads may be heavier during late winter after snow melts, it should be removed year-round whenever it is present.
- In early spring it is important to remove deicing salts that may have accumulated over the winter time.
- Removal of sediment from subsurface inlets, pipes, and culverts, or other structures is detailed in the Pipe Jetting and Vacuum Cleaning sections.
- If sediment is present in large quantities, or in hard-to-access or permanently wet locations, then mechanized equipment such as a mini excavator or portable vacuum excavator may be used as an option at the discretion of the on-site foreman to promote safe and efficient sediment removal.

B.25 SEEDING/SODDING

Description

This section describes procedures and requirements for various seeding techniques and proper seed-bed preparation.

Applicability

Bioinfiltration and Bioretention	Naturalized Basin
Green Roof	

Equipment

Cultipacker	Hydroseed tank, hoses, nozzles
Spreader	Seed mix
Bonded Fiber Matrix	Straw mulch/ Tackifier
Small Rototiller/ Rake	Biodegradable erosion control blanket
Gloves	Sod pallets
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Seedbed preparation:
    - Areas to be seeded shall be well graded and cleaned of all weeds, trash, debris, brush, loose stones, and any other foreign material with the potential to interfere with seeding.
    - All gullies or disturbed areas shall be repaired, and seedbed shall be scarified prior to seeding.
    - If seedbed is within the vicinity of existing plants or woodland opening, avoid damage to existing trunks and roots by using a hand rake or small rototiller.
- Seeding (general):
    - Seeding is to be performed after all preparation work is complete.
    - No fertilizer or lime shall be applied to any seeded areas without explicit approval.
    - Hydro-seeding and hand broadcast are the preferred methods, an alternative method must be approved prior to start of work.
    - All seeding equipment shall be calibrated prior to application to ensure accuracy and even distribution. Seed installed by equipment shall be capable of seeding at the specified rate.
- Seeding (hand broadcast):
    - Seed is to be applied uniformly through seedbed and shall be applied in two different directions.
    - Firm the soil with a Cultipacker, or other equivalent equipment. Do not cover seed with more than ¼ inch of soil.
    - Immediately after initial seeding, water seeded areas evenly and thoroughly.

- Mulch and tack all seeded areas within 12 hours. Place weed-free hay or straw uniformly, in a continuous blanket, approximately 3/4 to 1 1/2-inch loose layers, at a minimum rate of two (2) tons per acre. If directed, the Contractor shall increase the rate of application, depending upon the material used, season, soil conditions, or method of application. Anchor mulch with tackifier.

- Seeding (hydro-seed):
  - Seed is to be uniformly distributed across the entire disturbed area.
  - Seed-water mixture within the hydro-seeder tank shall be applied no later than one (1) hour after seed is added to the tank.
  - Follow equipment manufacturer's installation instructions and recommendations. Use approved hydro-spraying machines with fan-type nozzle.
  - Hydro-seed shall be applied using the two-step process to ensure success:

    Step 1: The first coat shall be distributed uniformly from opposing directions to the soil surface. The mix shall contain only the specified seed mixtures at specified rates, hydro-seed mulch at 500 lb. per acre and tackifier at manufacturer recommended rates.

    Step 2: The second coat shall be distributed uniformly on top of the first coat, covering the entire seeded area with an erosion resistant coating of mulch. This mix shall contain water, hydro-seed mulch at 1,500 lb. per acre and tackifier at manufacturer recommended rates.

- Sodding:
  - If soil is dry, lightly moisten the soil just before laying sod. Soil is to be lightly moistened, taking care not to cause muddy conditions.
  - Lay sod pieces in a staggered fashion, as if laying brick, to avoid long-lined strips across the turf and enhance root establishment at the jointing points.
  - Be sure the edges are in contact with each other, taking care not to overlap or stretch pieces.
  - When laying sod on slopes, start placing strips from the lowest point to the highest point. If slope is greater than 10%, it may be necessary to peg the sod strips with wooden stakes or sod staples for security.

- Site clean-up:
  - After hydro-seed application: thoroughly flush the tank, pumps and hoses to remove all material. Wash all material from the exterior of the machine and remove any slurry spills.
  - Do not allow seeded areas to be trafficked or subjected to grazing.

Special Considerations

- Seeding shall only be performed during spring (March 1 - May 15) or fall (August 15 – October 15).
- No seeding, tilling, regrading or soil work shall be performed when the soil is frozen or saturated.
- Personnel are responsible for replacing any plantings that die due to improper or insufficient water during the first year.

B.26 SIGNAGE CARE

Description

This section describes procedures and requirements for maintaining signs within the BMP area.

Applicability

- Bioinfiltration and Bioretention
- Green Roof
- Cistern
- Porous Pavement
- Subsurface Infiltration and Detention
- Naturalized Basin

Equipment

- Rags
- Gloves
- Safety glasses
- Utility knife
- Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Wipe down signage.
- Remove tags and strings on signage.
- Remove expired no-parking signage.

Special Considerations

- Remove graffiti (see Graffiti Removal protocol) to the maximum extent possible. Report graffiti that could not be removed.

B.27 SINKHOLE AND SETTLING REPAIR

Description

This section describes procedures and requirements for repairing areas with minor to moderate settling.

Applicability

Bioinfiltration and Bioretention	Subsurface Infiltration and Detention
Naturalized Basin	

Equipment

Engineered soil	Jackhammer
Shovel	Wheelbarrow
Tamper	Clean fill (2A modified subbase)
Gloves	Topsoil
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- If area is unstable immediately stop and contact the owner/operator.
- If settling has caused a visible depression/sinkhole:
    - Remove surface material (turf, soil, plants, asphalt etc.) and dispose of offset.
    - Clear settled area and excavate to the bottom of the depression using hand tools.
    - Fill excavated area with clean fill material and compact with tamper.
    - For softscape areas – cover excavation with topsoil and replace plants and mulch. Replacements should match the conditions prior to excavation.
    - For hardscape areas – replace hardscape subbase and asphalt/concrete/pavers covering to match existing grade.
- If settling has caused a minor depression:
    - Pack problematic area with 2A modified subbase.
    - Replace existing soil with new topsoil and mulch as needed.

Special Considerations

- No regrading or soil work shall be performed when the soil is frozen or saturated.

B.28 SOIL AMENDMENT

Description

This section describes procedures and requirements of amending soil in areas of erosion and compaction or areas of sedimentation and contamination.

Applicability

Bioinfiltration and Bioretention	Green Roof

Equipment

Engineered soil	Bucket
Shovel	Trash bags
Hard rake	Spading fork
Tamper	Pitch fork
Gloves	Wheelbarrow
Water tank and hose	Safety vest
Safety glasses	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Replace soil on eroded slopes, in flow paths and areas of compaction.
- Where necessary, collect and remove 1-3 inches of sediment/contaminated soil and transfer in to disposal containers.
- Alert supervisor if new soil has any issues, or if significant re-grading is necessary to fix eroded slopes.
- Rake and shovel soil to conform to slopes specified by the design. Gently tamp into place – do not compact.
- Replant and water any vegetation that was distributed by soil replenishment.
- Clean any excess soil that may have been blown/sept into surrounding (non-soil) areas.

Special Considerations

- Be sure to observe sediment deposits or compacted soil and alert field supervisor if necessary. Excessive sedimentation and soil compaction can greatly hinder BMP functionality.
- It is recommended to conduct soil tests to forcast soil amendment frequency.

B.29 STRUCTURAL PRUNING

Description

This section describes procedures and requirements for structural pruning and training of young trees.

Applicability

- Bioinfiltration and Bioretention
- Naturalized Basin
- Subsurface Infiltration and Detention

Equipment

- Chain saw
- Tarp
- Shovel
- Rake
- Lift with dump box
- Gloves
- Safety glasses
- Hand saw, pruning pole saws, pole clips
- Pruning shears and loppers
- Push broom
- Power blower
- Chipper trailer (disc or drum)
- Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Structural tree pruning work shall be performed under direction and on-site supervision of a certified arborist.
- Structural pruning promotes proper growth patterns and train the growth of young trees to achieve target clearances.
- Do not remove more than 25% annually of total tree foliage or foliage of any single branch or limb when it is cut back to a lateral.
- Use sharp, sterilized pruning tools.
- Remove all rubbing and crossing limbs.
- Remove competing leaders, if tree is single-stemmed species.
- Carefully cut as close to the branch collar without cutting the branch collar itself. Preserve the branch collar for proper healing.
- Cut branches into pieces than can be easily carried and remove any material to be disposed at an approved off-site location.

Special Considerations

- Personnel shall not prune any trees located near or within electrical wires. Tree pruning near or within electrical wires shall only be conducted by a qualified line-clearance arborist, an individual who, through related training and on-the-job experience, is familiar with the equipment and hazards in line clearance and has demonstrated the ability to perform the special techniques involved. This individual may or may not be currently employed by a line-clearance contractor.
- Structural pruning shall only be done annually in the winter.

B.30 TARGET PERENNIAL – CUTTING BACK

Description

This section describes procedures and requirements of cutting back dead perennials from the previous growing season.

Applicability

Bioinfiltration and Bioretention	Naturalized Basin

Equipment

Garden shears	Trash bags
Scissors	Trash receptacle
Tarp	Arbor twine
Gloves	Safety vest
Safety glasses	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Different perennials require different cutting back methods depending on several factors including plant type and season:
    - Dead heading
        - Cut back dead flowers and seed heads to allow for new growth during the warm season.
        - Applies to basal rosette plant forms.
    - Dead leafing
        - Cut back diseased, dead, and/or damaged leaves during the warm season.
        - Applies to strappy leaved, stalky leaved and basal rosette plant forms.
    - Pinching back
        - Cut back a section of the plant (2/3 – 3/4 of height). This will promote compact growth.
        - Applies to stalky leaved and branches or bushy leaved plant forms.
    - Renovation
        - Cut weak, struggling stems to the base during the warm season.
        - Cut stems with dead blossoms back to flowering branches.
        - Cut back any stems with diseased leaves.
        - This method applies to all plant forms.

Special Considerations

- Not all perennials thrive with trimming. If unsure, only remove dead parts of plants.

B.31 TARGET PERENNIAL – DIVIDING AND TRANSPLANTING

Description

This section describes procedures and requirements of dividing and transplanting perennials. Target perennials may need to be divided and transplanted every 3-5 years to prevent overcrowding and mildew.

Applicability

Bioinfiltration and Bioretention	Naturalized Basin

Equipment

Hand trowel	Utility knife
Flat spade	Tarp
Shovel	Trash bags
Gloves	Safety vest
Safety glasses	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Assess perennial plantings for signs that they should be divided:
    - Dead centers with growth appearing only on the outer edges.
    - Blooming smaller than usual.
    - Fewer flowers or weaker growth than usual.
    - Aggressive spreaders that are overtaking space.
- To divide target perennials:
    - Select the healthiest sections of plantings to divide and transplant.
    - Dig deep into the soil in a circle, at least 6" from the crown of the plant, with a hand trowel and lift the plant, root ball, and soil.
    - Gently remove as much soil away as possible without damaging the roots.
    - Carry the plant to the tarp to prevent damage to other plantings.
    - Cut apart the crown into 3-4 sections using a flat spade or utility knife. Each section should include several stems and a clump of roots.
    - Repeat with any perennial plantings that need to be divided. Protect newly dug and/or divided plants from the wind and sun while working on other plantings.
- To transplant the divided plants:
    - Prepare the new planting location by turning the soil at least 8-inches deep and remove any rocks, roots, or debris.
    - Dig a hole at least 1.5 times as deep and wide as the transplanted plant's roots.
    - Build a firm mound of soil in the middle of the hole and place the planting on the mound.
    - Spread the roots out and down over the mound.
    - Fill the hole with soil just below the crown or to the depth it was originally planted. Add mulch to the surface around the plant up to the crown.
    - Water the plant consistently for the next 2-3 weeks.

Special Considerations

- Perennials should be divided approximately 4-6 weeks before a hard frost.
- Foliage on tall perennials may need to be cut back prior to dividing.

B.32 TRASH REMOVAL

Description

This section describes procedures and requirements for removal of trash from BMP elements. Trash should be removed year-round wherever it is present. At some sites, trash may need frequent removal. High trash amounts can damage plants or block the flow of water, and in some cases even become a health hazard.

Applicability

Bioinfiltration and Bioretention	Green Roof
Subsurface Infiltration and Detention	Cistern
Naturalized Basin	

Equipment

Broom	Trash bags
Shovel	Disposal container
Trash picker	Rake
Gloves	Safety vest
Safety glasses	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Remove trash from BMP elements:
    - Collect and remove trash and debris from all BMP elements using a trash picker, broom, shovel, and/or dust pan whenever possible.
    - Collect and remove trash and debris from adjacent gutter line within 4 feet of inflow and outflow points as applicable.
    - Dispose of trash at approved disposal facility.

Special Considerations

- The accumulation of trash can create negative perceptions of facilities from nearby residents, businesses, and communities.
- It is important to wear personal protective equipment as necessary to avoid contact with unknown substance. Trash that washes off the streets may contain toxic chemicals or biological contaminants.
- Any illegal dumping activity, toxic spills, and health hazards (such as hypodermic needles or chemicals) should be reported to the field supervisor and the appropriate agency.
- Remove graffiti to the maximum extent possible. Report graffiti that could not be removed.

B.33 VACUUM CLEANING

Description

This section describes procedures and requirements for vacuum cleaning debris from subsurface access and flow control/conveyance structures.

Applicability

Bioinfiltration and Bioretention	Porous Pavement
Cistern	Subsurface Infiltration and Detention

Equipment

Vacuum or Vac truck	Crowbar
Hand tools	Shovel/Spade
Manhole hooks	Ladder
Gloves	Measuring wheel
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Pre-maintenance site checks should be performed to determine which structures require maintenance so that the appropriate equipment can be brought to the site.
- Sweep or vacuum area surrounding the structure that may be collecting trash/debris/sediment.
- Remove any trash, sediment or debris that is restricting access or flow control.
- Remove pre-treatment device if not permanently attached to the structure (clean if needed).
- Insert vacuum tube into the structure or the most downstream access point.
- Vacuum all debris and water from structure.
- While vacuuming, avoid placing large equipment on the surface of the media storage area or concrete sidewalks.
- Prior to closing access point, inspect structures to ensure that all traps are closed, and pretreatment screens are latched/correctly installed.

Special Considerations

- Based on typical design drain down times, vacuuming should not be performed within 48 hours of a significant (> 1 inch) precipitation event.
- Dispose of waste in proper manner in an approve location in accordance with local regulation.

B.34 VACUUM SWEEPING

Description

This section describes procedures and requirements for vacuum sweeping. Vacuum sweeping should occur monthly as part of routine surface maintenance for porous pavement.

Applicability

Porous Pavement

Equipment

Regenerative air sweeper/ Power washer component	Contractor bags
Shovel	Measuring wheel
Gloves	Push broom
Safety glasses	Safety vest
Water tank	

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- Inspect the site prior to maintenance effort to assess maintenance needs.
- Manually remove large trash/sediment/debris from surfaces.
- When using the sweeper, clean from the upstream end of the porous pavement towards the downstream end.
- Use power washer component, if applicable, to dislocate particles stuck in the porous surface and immediately vacuum so the material does not reenter the pores.
- If dust becomes excessive, use water as needed.
- Sweep surface until all visible material has been removed.
- Refer to Gravel Joint Filling protocol to replace any gravel removed while using the sweeper.
- There are several tasks that should be avoided on or near pervious pavement systems:
    - Sanding, re-sealing, re-surfacing.
    - Storage of mulch/soil materials or snow piles (with sand).
    - Construction staging.

Special Considerations

- To determine if more intensive maintenance is necessary, spray water over the entire surface and identify areas of ponding. Mark these areas and alert field supervisor.

B.35 WATERING

Description

This section describes procedures and requirements for watering trees and plants.

Applicability

Bioinfiltration and Bioretention	Porous Pavement
Green Roof	Subsurface Infiltration and Detention
Cistern	Naturalized Basin

Equipment

Hydrant key/Wrench	Watering tank(s)
Backflow Preventer	Watering wand/nozzles
¾-inch hose	Water pump
Gloves	Gator bags
Safety glasses	Safety vest

Instructions

- Observe the site to ensure no hazardous materials or unsafe conditions are present.
- If watering off of hydrant, be sure to install hydrant backflow preventer as needed, and use caution to only open hydrants permitted to be opened with the proper equipment and trained personnel. Attach hoses and adapters to backflow preventers to water directly from hydrants.
- If watering from tanks mounted in trucks or trailers, use either gravity or mechanical pumps to provide adequate water, and attach hoses and adapters to this equipment.
- Soak the top 6-8 inches of soil evenly by constantly spraying water across the surface rather than concentrating the spray in one place,
- Water trees by placing and filling gator bags. Remove gator bags at the end of watering season.

Special Considerations

- Watering is to be conducted from April through November.
- If a state of drought is being observed by government at any level for the area, watering is not permissible.
- Watering is triggered by a period of 4 days without rain of 1/3 inch or greater for herbaceous or 7 days without rain of 1/3 inch or greater for trees.
- There are times when judgement calls will need to be made by inspectors during inspections to determine supplemental watering needs for any plants or trees at a site. Inspectors will need to observe and take into account forecasts and temperatures to make best efforts in determining watering needs.

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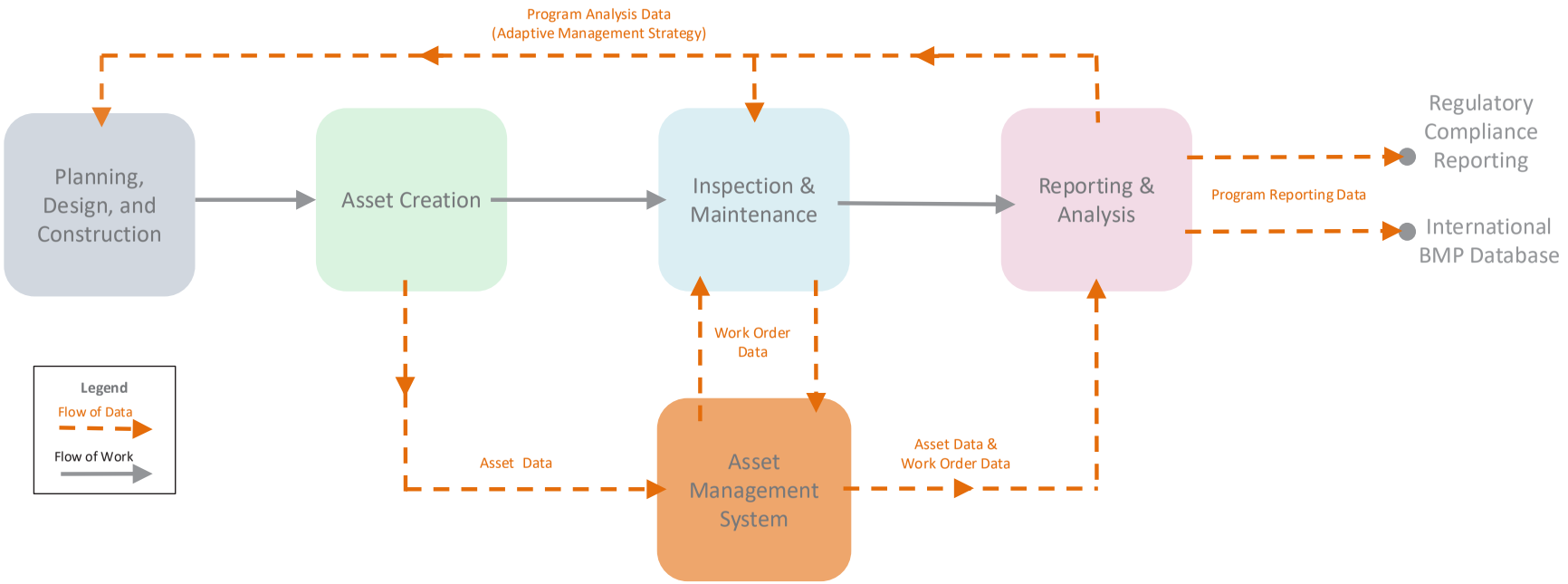
APPENDIX C – COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM WORKFLOW CHARTS

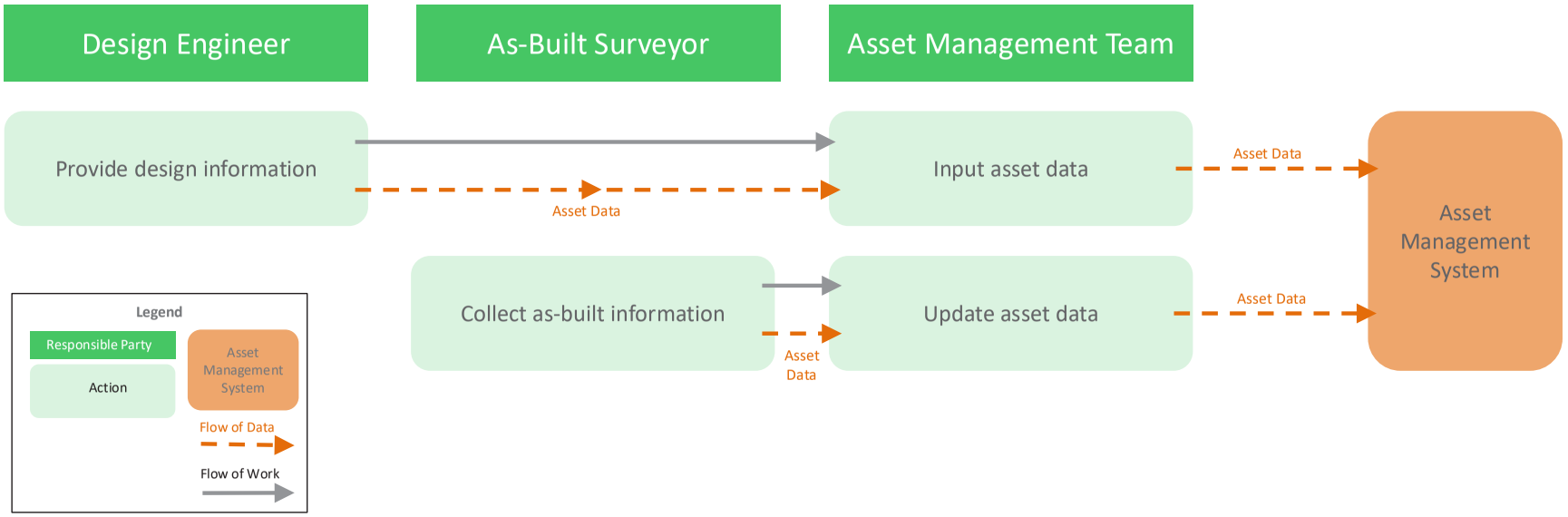
C.1 GREEN INFRASTRUCTURE PROGRAM – OVERALL DATA MANAGEMENT WORKFLOW



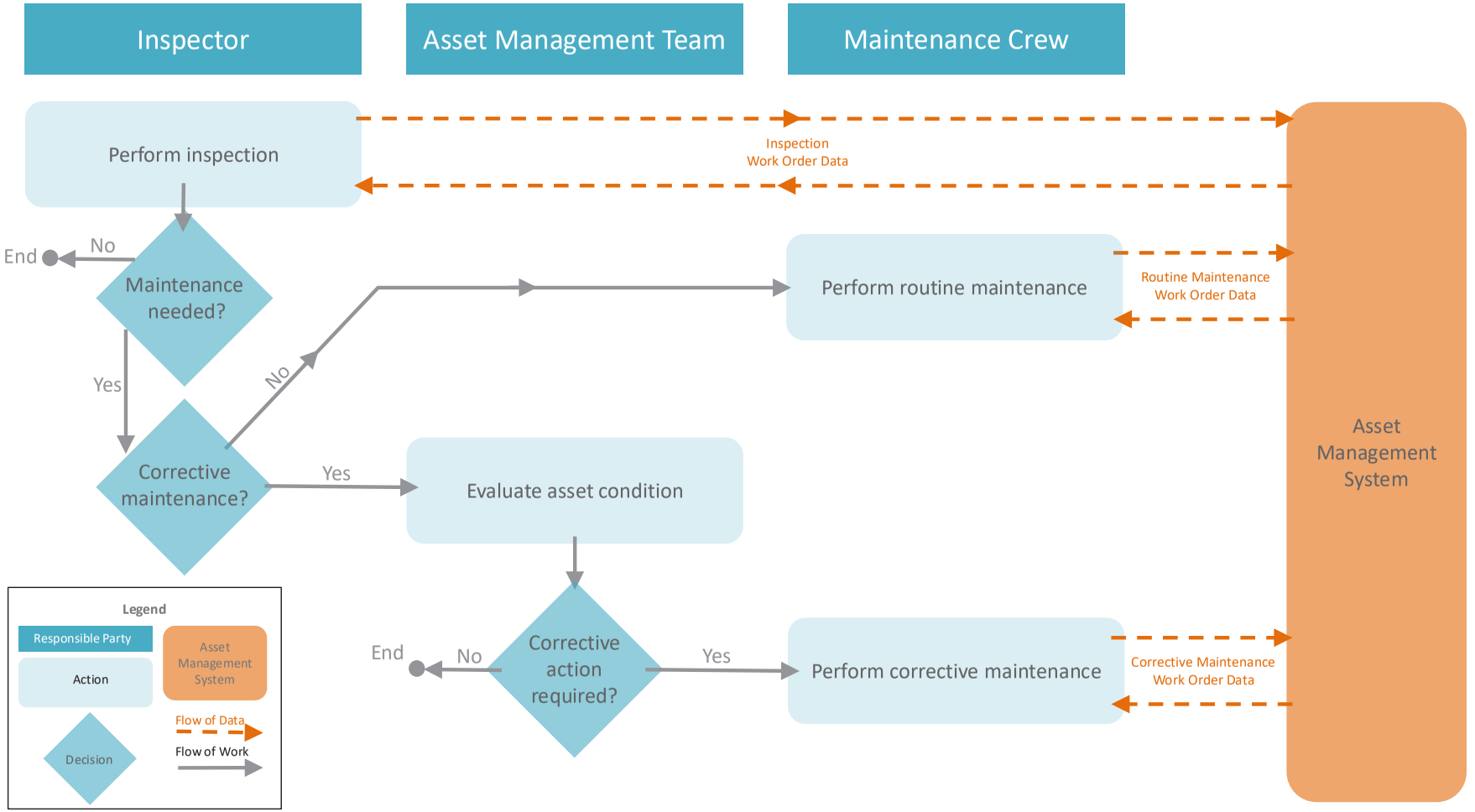
Appendix C

Appendix C

C.2 ASSET CREATION WORKFLOW



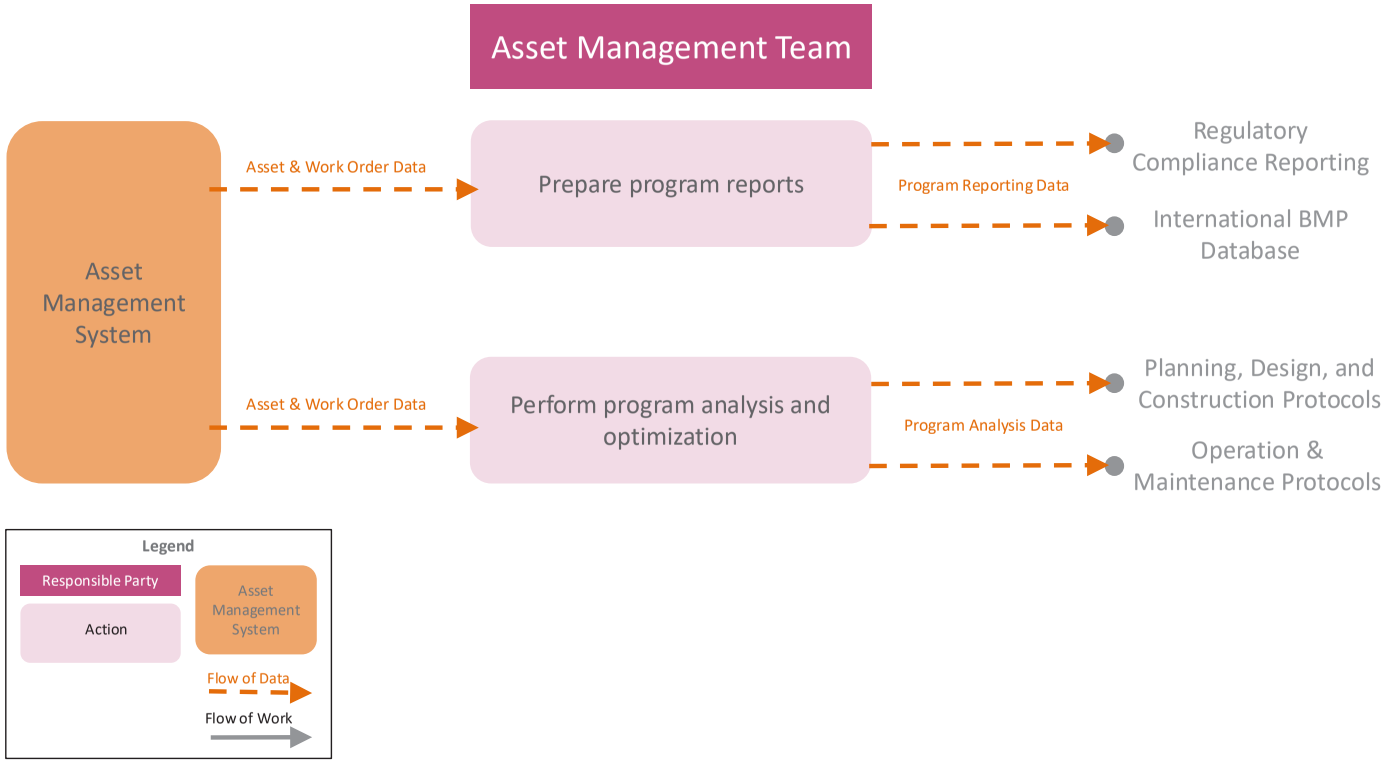
C.3 INSPECTION & MAINTENANCE WORKFLOW



Appendix C

Appendix C

C.4 REPORTING & ANALYSIS WORKFLOW



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APPENDIX D – COMPUTERIZED MAINTENANCE MANAGEMENT SYSTEM ASSET INPUTS

Assets to Input into the City's CMMS

Key:

Yellow highlighted items are fields in the International BMP Database data tables provided by DPW. They are highlighted in the Asset columns to avoid overlapping green highlighted items in the Schema columns. These are highlighted in all the tables.
Green highlighted items are existing fields in the City of Lancaster GIS Database and are highlighted in the Project and BMP Level Assets tables only. They are highlighted in the Schema column to avoid overlapping yellow highlighted items in the Asset column.
* Indicates Dependent Field. Depending on data entry from others fields within the data table, these fields will toggle results between N/A and user input.

Data Table Name:

Project Level Assets

Data Field	Data Type
Organization	Text
Project ID	Text
Count of BMPs in Project	Number
City	Text
State	Text
Zip	Number
Installation Date	Date/Time
Project Level Total Tributary Land Area (ac)	Number
Project Level Impervious Tributary Area (ac)	Number
Project level Pervious Tributary Area (ac)	Number
Project Status	Text
Project Sewer Type	Text
Project Construction Cost	Number
Project Design Cost	Number
Project Cost Estimate	Number

BMP Level Assets

Data Field	Data Type
Unique Asset ID	Text
Owner	Text
Project ID	Text
BMP ID	Text
BMP Type	Text
Decimal Latitude	Number
Decimal Longitude	Number
Installation Date	Date/Time
BMP Level Total Tributary Land Area (ac)	Number
BMP Level Impervious Tributary Area (ac)	Number
BMP Level Pervious Tributary Area (ac)	Number
Treatment Volume or Flow Rate	Number
Treatment Volume or Rate Units	Text
Surface Area	Number
Surface Area Units	Text
*Vegetative Footprint (sf)	Number
Total Footprint (sf)	Number
Hydraulic Loading Ratio	Number
BMP Function	Text
*Soil Media Type	Text
*Soil Media Depth (ft)	Number
*Soil Media Area (sf)	Number
*Storage Depth (ft)	Number
BMP Max Depth (ft)	Number
Storage Area (sf)	Number
Storage Volume (cf)	Number
Storage Type	Text
*Liner	Text
*Ponding Area (sf)	Number
*Ponding Depth (ft)	Number
*Freeboard (ft)	Number
*Underdrain	Text
*Control Structure Type	Text
*Control Structure Height (ft)	Number
*Pretreatment Device(s)	Text
Release Rate (cfs/ac)	Number
*Drawdown Time (hr)	Number
*Soil Group	Text
*Wind Erosion Control	Text
*Waterproof Type	Text
*Side Slopes (%)	Number
In Lucity	Text
Lucity Link	Text
*Dissipator	Text
*Surface Slope (%)	Number
*Choker Depth (ft)	Number
*Forebay Area (sf)	Number
*Forebay Depth (ft)	Number
Comments	Text

BMP Pipe Runs

Data Field	Data Type
Unique Asset ID	Text
BMP ID	Text
BMP Type	Text
Pipe Run ID	Text
Material	Text
Perforation	Text
Diameter (in)	Number
Number of Bends	Number
Minimum Bend Angle (degrees)	Number
Outflow Orifice Diameter (in)	Number

BMP Structures

Data Field	Data Type
Unique Asset ID	Text
BMP ID	Text
BMP Type	Text
Structure ID	Text
Pretreatment Type	Text
Structure Type	Text
Outlet Release Rate	Number
Upstream Pipe Run ID	Text
Downstream Pipe Run ID	Text

BMP Trees

Data Field	Data Type
Unique Asset ID	Text
BMP ID	Text
BMP Type	Text
Tree ID	Text
Planted DBH (in)	Number
Genus	Text
Species	Text
Cultivar	Text

Infiltration Data

Data Field	Data Type
Unique Asset ID	Text
Project ID	Text
BMP ID	Text
BMP Type	Text
Infiltration Test Date	Date/Time
Infiltration Design Test Type	Text
Infiltration Boring Depth (ft)	Number
Infiltration Design Depth to Groundwater (ft)	Number
Infiltration Design Depth to Bedrock (ft)	Number
Infiltration Design Rate (in/hr)	Number
Infiltration Footprint Area (sf)	Number
Infiltration Construction Test Type (ft)	Number
Infiltration Construction Rate (in/hr)	Number

Assets to Input into the City's CMMS

Surface Inspection WO

	Data Field	Data Type
	Unique Asset ID	Number
	BMP ID	Text
	BMP Type	Text
	BMP Address	Text
	Event Record Type	Text
	Work Order ID	Number
	Work Order Type	Text
	Scheduled Date	Date/Time
	Start Date	Text
	Start Time	Date/Time
	End Time	Date/Time
	Inspection Comments	Text
	Attached Files	File
Inflow Area(s) Inspection	Flow Obstruction	Text
	Erosion	Text
	Sedimentation	Text
	Structural / Settling	Text
	Comments	Text
Infiltration/ Filtration/Storage Area(s) Inspection	Erosion	Text
	Sedimentation	Text
	Structural / Settling	Text
	Drainage	Text
	Comments	Text
Outflow Area(s) Inspection	Flow Obstruction	Text
	Erosion	Text
	Sedimentation	Text
	Structural / Settling	Text
	Comments	Text
Vegetation Inspection	Cover	Text
	Condition	Text
	Soil	Text
	Tree(s)	Text
	Non Target	Text
	Comments	Text
Drainage Area Inspection	Erosion / Sedimentation	Text
	Spills / Contamination	Text
	Comments	Text
	Routine Surface Maintenance Needed	Text
	Routine Watering Needed	Text
	Corrective Maintenance Needed	Text

Subsurface and Sweeping Inspection WO

	Data Field	Data Type
	Unique Asset ID	Number
	BMP ID	Text
	BMP Type	Text
	BMP Address	Text
	Event Record Type	Text
	Work Order ID	Number
	Work Order Type	Text
	Scheduled Date	Date/Time
	Start Date	Text
	Start Time	Date/Time
	End Time	Date/Time
	CCTV	Text
	CCTV Files	File
	Inspection Comments	Text
	Attach File	File
Pipes	Sedimentation, Blockage	Text
	Comments	Text
Structures	Sedimentation, Blockage	Text
	Comments	Text
Porours Surfaces	Sedimentation, Blockage	Text
	Comments	Text
	Routine Subsurface Maintenance Needed	Text
	Routine Sweeping Maintenance Needed	Text
	Corrective Maintenance Needed	Text

Assets to Input into the City's CMMS

Maintenance WO (All BMP Types)

	Data Field	Data Type
	Associated Inspection WO ID	Number
	Inspection Comments	Text
	Inspection Files	File
	Unique Asset ID	Number
	BMP ID	Text
	BMP Type	Text
	BMP Address	Text
	Event Record Type	Text
	Work Order Type	Text
	Work Order ID	Number
	Scheduled Date	Date/Time
	Priority	Number
	Work Order Status	Text
	Assigned Crew	Text
	Start Date	Date/Time
	Start Time	Date/Time
	End Time	Date/Time
	Maintenance Comments	Text
	Attached Files	File
Maintenance Narrative	Photo Documentation	Text
Maintenance Narrative	Signage Care	Text
Maintenance Narrative	Graffiti Removal	Text
Maintenance Narrative	Sediment Removal	Text
Maintenance Narrative	Trash Removal	Text
Maintenance Narrative	Organic Debris Removal	Text
Maintenance Narrative	Mulch Amendment	Text
Maintenance Narrative	Mulch Replacement	Text
Maintenance Narrative	Soil Amendment	Text
Maintenance Narrative	Sinkhold and Settling Repair	Text
Maintenance Narrative	Erosion Repair	Text
Maintenance Narrative	Pest Management	Text
Maintenance Narrative	Manual Weed Control	Text
Maintenance Narrative	Pruning	Text
Maintenance Narrative	Structural Pruning	Text
Maintenance Narrative	Target Perennial - Cutting Back	Text
Maintenance Narrative	Target Perennial - Dividing and Transplanting	Text
Maintenance Narrative	Plant Removal	Text
Maintenance Narrative	Mowing	Text
Maintenance Narrative	Seeding/Sodding	Text
Maintenance Narrative	Inlet Pretreatment Maintenance	Text
Maintenance Narrative	Concrete Repair	Text
Maintenance Narrative	Pipe Jetting	Text
Maintenance Narrative	Vacuum Cleaning	Text
Maintenance Narrative	Sweeping	Text
Maintenance Narrative	Deicing	Text
Maintenance Narrative	Plowing	Text
Maintenance Narrative	Gravel Joint Filling	Text
Maintenance Narrative	Porous Patching	Text
Maintenance Narrative	BMP Shutdown	Text
Maintenance Narrative	BMP Startup	Text
Maintenance Narrative	Inlet Pretreatment Clearing	Text
Maintenance Narrative	Sanitizing	Text
Maintenance Narrative	Chamber Clearing	Text
Maintenance Narrative	Surface Media Cultivation	Text
Maintenance Narrative	Watering	Text
Materials	Material	Text
Materials	Cost/Unit	Text
Materials	Units	Number
Effort	Crew Rate	Number
Effort	Time	Number
Effort	Effort Cost	Number
	Total Maintenance Cost	Number

Watering WO

	Data Field	Data Type
	Associated Inspection WO ID	Number
	Inspection Comments	Text
	Inspection Files	File
	Unique Asset ID	Number
	BMP ID	Text
	BMP Type	Text
	BMP Address	Text
	Event Record Type	Text
	Work Order Type	Text
	Work Order ID	Number
	Scheduled Date	Date/Time
	Priority	Number
	Work Order Status	Text
	Assigned Crew	Text
	Start Date	Date/Time
	Start Time	Date/Time
	End Time	Date/Time
	Attached Files	File
	Hydrant Opened	Text
	Hydrant ID	Text or Number
	Hydrant Open Time	Date/Time
	Hydrant Close Time	Date/Time
Maintenance Narrative	Supplemental Watering	Text
Materials	Material	Text
Materials	Cost/Unit	Text
Materials	Units	Number
Effort	Crew Rate	Number
Effort	Time	Number
Effort	Effort Cost	Number
	Total Watering Cost	Number

Corrective WO

	Data Field	Data Type
	Associated Inspection WO ID	Number
	Inspection Comments	Text
	Inspection Files	File
	Unique Asset ID	Number
	BMP ID	Text
	BMP Type	Text
	BMP Address	Text
	Event Record Type	Text
	Work Order Type	Text
	Work Order ID	Number
	Scheduled Date	Date/Time
	Priority	Number
	Work Order Status	Text
	Assigned Crew	Text
	Start Date	Date/Time
	Start Time	Date/Time
	End Time	Date/Time
	Attached Files	File
Maintenance Narrative	Corrective Maintenance	Text
Maintenance Narrative	Comments	Text
Materials	Material	Text
Materials	Cost/Unit	Text
Materials	Units	Number
Effort	Crew Rate	Number
Effort	Time	Number
Effort	Effort Cost	Number
	Total Maintenance Cost	Number

Assets to Input into the City's CMMS

Project Level Reporting

Reporting Field
Number of Assets
Number of Assets per Type
Total Annual Maintenance Cost
Increase in Total Maintenance Cost from Prior Year
Increase in Total Number of Assets from Prior Year
Average Design Cost per Asset
Average Design Cost per Asset Type
Average Design Cost per Project Total Tributary Area
Average Design Cost per Project Impervious Tributary Area
Average Design Cost per Project Pervious Tributary Area
Average Construction Cost per Asset
Average Construction Cost per Asset Type
Average Construction Cost per Project Total Tributary Area
Average Construction Cost per Project Impervious Tributary Area
Average Construction Cost per Project Pervious Tributary Area
Average Maintenance Cost per Asset
Average Maintenance Cost per Asset Type
Average Maintenance Cost per Project Total Tributary Area
Average Maintenance Cost per Project Impervious Tributary Area
Average Maintenance Cost per Project Pervious Tributary Area

BMP Level Reporting

Reporting Field
Number of Maintenance Visits
Number of Routine Surface Maintenance Visits
Number of Routine Subsurface Maintenance Visits
Number of Corrective Maintenance Visits
Number of Watering Maintenance Visits
Total Cost
Total Effort Cost
Total Materials Cost
Total Routine Surface Maintenance Cost
Total Routine Subsurface Maintenance Cost
Total Corrective Maintenance Cost
Total Watering Maintenance Cost
Cost per SF of Vegetated Area
Cost per LF of Piping
Cost per SF of Tributary Area
Cost per SF of Impervious Tributary Area
Cost per SF of Pervious Tributary Area
Cost per Volume Managed

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APPENDIX E – REPORTING FORMS AND LOGS

Best Management Practice (BMP) Maintenance Form
E.1 Data Schema Key

Schema:
Form Subheader Text
Form Text
Lucity Generated Input
Maintenance Crew/Inspector User Input
Data Types:
Verified Text - Drop Down List
Text
Time
Date
Number
Yes/No

Best Management Practice (BMP) Maintenance Form
E.2 Data Schema

Work Order Information

BMP ID:	Verified Text	Work Order Type:	Verified Text
BMP Type:	Verified Text	Work Order ID:	Number
BMP Address:	Verified Text	Scheduled Date:	Date
Associated Inspection WO ID:	Number		
Inspection Comments:	Text		
Inspection Files:	File		

General

Priority:	Verified Text	Start Date:	Date
Work Order Status:	Verified Text	Start Time:	Time
Assigned Crew:	Verified Text	End Time:	Time
Maintenance Comments:	Text		
Attach File:	File		

Maintenance Checklist

Task	*Completed by Maintenance Crew*	*Notes/Comments*
Concrete Repair	Yes/No	Text
Manual Weed Control	Yes/No	Text
Mowing	Yes/No	Text
Mulch Amendment	Yes/No	Text

Best Management Practice (BMP) Maintenance Form
E.2 Data Schema

Plant Removal	Yes/No	Text
Sediment Removal	Yes/No	Text
Target Perennial - Cutting Back	Yes/No	Text
Target Perennial - Dividing and Transplanting	Yes/No	Text

Equipment & Materials List

Item	*Units*	*Quantity*
Verified Text	Verified Text	Number
Verified Text	Verified Text	Number
Verified Text	Verified Text	Number
Verified Text	Verified Text	Number
Verified Text	Verified Text	Number
Verified Text	Verified Text	Number
Verified Text	Verified Text	Number
Verified Text	Verified Text	Number
Verified Text	Verified Text	Number

Associated Cost

Item	*Units*	*Quantity*	*Unit Cost*	*Total*
Verified Text	Verified Text	Number	Number	Number
Verified Text	Verified Text	Number	Number	Number
Verified Text	Verified Text	Number	Number	Number
Verified Text	Verified Text	Number	Number	Number
Verified Text	Verified Text	Number	Number	Number
Verified Text	Verified Text	Number	Number	Number
Verified Text	Verified Text	Number	Number	Number
Verified Text	Verified Text	Number	Number	Number
Verified Text	Verified Text	Number	Number	Number
Verified Text	Verified Text	Number	Number	Number
Verified Text	Verified Text	Number	Number	Number
			TOTAL	Number

Best Management Practice (BMP) Maintenance Form
E.3 Bioinfiltration and Bioretention Example Form

Work Order Information

BMP ID:	Brandon Park 04	Work Order Type:	Surface WO
BMP Type:	Bioretention/Bioinfiltration	Work Order ID:	110402002
BMP Address:	757 Wabank Street	Scheduled Date:	7/27/2018

Associated Inspection WO ID: 110400001

Inspection Comments: Bare spots along the rain garden slope, install 4x 1 gallon Ilex Glabra. Mulch top perimeter of rain garden slope

Inspection Files: PIC_0804.jpg ; PIC_0805.jpg ; 20180719_BrandoPark04.pdf

General

Priority:	Routine	Start Date:	7/27/2018
Work Order Status:	Complete	Start Time:	10:14:56 AM
Assigned Crew:	DPW_3person_1	End Time:	1:21:26 PM

Maintenance Comments: Ilex Glabra and Mulch added. New plantings have been watered.

Attach File: 00080054.jpg ; 00080055.jpg

Maintenance Checklist

Task	*Completed by Maintenance Crew*	*Notes/Comments*
Concrete Repair	☐	
Erosion Repair	☐	
Graffiti Removal	☑	Graffiti on sign
Inlet Pretreatment Clearing	☐	

Best Management Practice (BMP) Maintenance Form
E.3 Bioinfiltration and Bioretention Example Form

Inlet Pretreatment Maintenance	☑	
Manual Weed Control	☐	
Mowing	☐	
Mulch Amendment	☐	
Mulch Replacement	☑	4 CY added to perimeter
Organic Debris Removal	☑	
Pest Management	☐	
Photo Documentation	☑	
Pipe Jetting	☐	
Plant Removal	☐	
Pruning	☐	

Best Management Practice (BMP) Maintenance Form
E.3 Bioinfiltration and Bioretention Example Form

Sediment Removal	☑
Seeding/Sodding	☐
Signage Care	☑
Sinkhole and Settling Repair	☐
Soil Amendment	☐
Structural Pruning	☑
Target Perennial - Cutting Back	☐
Target Perennial - Dividing and Transplanting	☐
Trash Removal	☑
Vacuum Cleaning	☐
Watering	☐

Equipment & Materials List

Item	*Units*	*Quantity*

Mulch	Cubic Yards	4.0
1Gal Shrub	Each	4.0

Associated Cost

Item	*Units*	*Quantity*	*Unit Cost*	*Total*
3 Person Crew	Hours	3.1	$ 145.00	$ 449.50
Mulch	Cubic Yards	4.0	$ 42.00	$ 168.00
1Gal Shrub	Each	4.0	$ 32.00	$ 128.00
		TOTAL		$ 745.50

Best Management Practice (BMP)
E.4 Surface Inspection Form

Work Order Information

BMP ID:
BMP Type:
BMP Address:

Work Order Type:
Work Order ID:
Scheduled Date:

Inspection Information

Start Date:
Start Time:
End Time:

Inspection Comments:

Attach File:

Inspection Checklist

Category	*Observation*	*Need for Maintenance*			*Notes/Comments*
		No Maintenance Needed	*Routine Maintenance Needed*	*Priority or Corrective Maintenance Needed*	
Inflow Area(s)	Flow Obstruction	☐	☐	☐	
Inflow Area(s)	Erosion	☐	☐	☐	
Inflow Area(s)	Sedimentation	☐	☐	☐	
Inflow Area(s)	Structural / Settling	☐	☐	☐	
Infiltration, Filtration, Storage Area(s)	Erosion	☐	☐	☐	
Infiltration, Filtration, Storage Area(s)	Sedimentation	☐	☐	☐	
Infiltration, Filtration, Storage Area(s)	Structural / Settling	☐	☐	☐	
Infiltration, Filtration, Storage Area(s)	Drainage	☐	☐	☐	

Best Management Practice (BMP)
E.4 Surface Inspection Form

Outflow Area(s)	Flow Obstruction	☐	☐	☐
Outflow Area(s)	Erosion	☐	☐	☐
Outflow Area(s)	Sedimentation	☐	☐	☐
Outflow Area(s)	Structural / Settling	☐	☐	☐
Vegetation	Cover	☐	☐	☐
Vegetation	Condition	☐	☐	☐
Vegetation	Soil	☐	☐	☐
Vegetation	Tree(s)	☐	☐	☐
Vegetation	Non Target	☐	☐	☐
Drainage Area	Erosion / Sedimentation	☐	☐	☐
Drainage Area	Spills / Contamination	☐	☐	☐

Best Management Practice (BMP)
E.4 Surface Inspection Form

	Yes	No
Routine Surface Maintenance Needed:	☐	☐
Routine Watering Needed:	☐	☐
Corrective Maintenance Needed:	☐	☐

Inspection Effort

Crew	*Date*	*Effort Cost*	*Total*
		Total	

Best Management Practice (BMP)
E.5 Subsurface and Sweeping Inspection Form

Work Order Information

BMP ID:
BMP Type:
BMP Address:

Work Order Type:
Work Order ID:
Scheduled Date:

Inspection Information

Start Date:
Start Time:
End Time:

CCTV:
CCTV File(s):

Inspection Comments:

Attach File:

Inspection Checklist

Category	*Observation*	*Need for Maintenance*			*Notes/Comments*
		No Maintenance Needed	*Routine Maintenance Needed*	*Priority or Corrective Maintenance Needed*	
Pipes	Sedimentation, Blockage	☐	☐	☐	
Structures	Sedimentation, Blockage	☐	☐	☐	
Porous Surfaces	Sedimentation, Blockage	☐	☐	☐	

	Yes	No
Routine Subsurface Maintenance Needed:	☐	☐
Routine Vacuum Sweeping Maintenance Needed:	☐	☐
Corrective Maintenance Needed:	☐	☐

Inspection Effort

Crew	*Date*	*Effort Cost*	*Total*
		Total	

Best Management Practice (BMP) Maintenance Form
E.6 Bioinfiltration and Bioretention

Work Order Information

BMP ID:
BMP Type:
BMP Address:

Work Order Type:
Work Order ID:
Scheduled Date:

Associated Inspection WO ID:
Inspection Comments:

Inspection Files:

General

Priority:
Work Order Status:
Assigned Crew:

Start Date:
Start Time:
End Time:

Maintenance Comments:

Attach File:

Maintenance Checklist

Task	*Completed by Maintenance Crew*	*Notes/Comments*
Concrete Repair	☐	
Erosion Repair	☐	
Graffiti Removal	☐	
Inlet Pretreatment Clearing	☐	
Inlet Pretreatment Maintenance	☐	

Best Management Practice (BMP) Maintenance Form
E.6 Bioinfiltration and Bioretention

Manual Weed Control	☐
Mowing	☐
Mulch Amendment	☐
Mulch Replacement	☐
Organic Debris Removal	☐
Pest Management	☐
Photo Documentation	☐
Pipe Jetting	☐
Plant Removal	☐
Pruning	☐
Sediment Removal	☐
Seeding/Sodding	☐

Best Management Practice (BMP) Maintenance Form
E.6 Bioinfiltration and Bioretention

Signage Care	☐
Sinkhole and Settling Repair	☐
Soil Amendment	☐
Structural Pruning	☐
Target Perennial - Cutting Back	☐
Target Perennial - Dividing and Transplanting	☐
Trash Removal	☐
Vacuum Cleaning	☐
Watering	☐

Best Management Practice (BMP) Maintenance Form
E.6 Bioinfiltration and Bioretention

Equipment & Materials List

Item	*Units*	*Quantity*

Associated Cost

Item	*Units*	*Quantity*	*Unit Cost*	*Total*
			TOTAL	

Best Management Practice (BMP) Maintenance Form
E.7 Cistern

Work Order Information

BMP ID:
BMP Type:
BMP Address:

Work Order Type:
Work Order ID:
Scheduled Date:

Associated Inspection WO ID:
Inspection Comments:

Inspection Files:

General

Priority:
Work Order Status:
Assigned Crew:

Start Date:
Start Time:
End Time:

Maintenance Comments:

Attach File:

Maintenance Checklist

Task	*Completed by Maintenance Crew*	*Notes/Comments*
Photo Documentation	☐	
BMP Shutdown	☐	
BMP Startup	☐	
Chamber Clearing	☐	

Best Management Practice (BMP) Maintenance Form
E.7 Cistern

Graffiti Removal	☐
Organic Debris Removal	☐
Sanitizing	☐
Signage Care	☐
Trash Removal	☐
Vacuum Cleaning	☐

Equipment & Materials List

Item	*Units*	*Quantity*

Associated Cost

Item	*Units*	*Quantity*	*Unit Cost*	*Total*
			TOTAL	

Best Management Practice (BMP) Maintenance Form
E.8 Green Roof

Work Order Information

BMP ID:
BMP Type:
BMP Address:

Work Order Type:
Work Order ID:
Scheduled Date:

Associated Inspection WO ID:
Inspection Comments:

Inspection Files:

General

Priority:
Work Order Status:
Assigned Crew:

Start Date:
Start Time:
End Time:

Maintenance Comments:

Attach File:

Maintenance Checklist

Task	*Completed by Maintenance Crew*	*Notes/Comments*
BMP shutdown	☐	
BMP startup	☐	
Concrete Repair	☐	
Graffiti Removal	☐	

Best Management Practice (BMP) Maintenance Form
E.8 Green Roof

Manual Weed Control	☐
Organic Debris Removal	☐
Pest Management	☐
Photo Documentation	☐
Pipe Jetting	☐
Plant Removal	☐
Seeding/Sodding	☐
Sediment Removal	☐
Signage Care	☐
Soil Amendment	☐
Trash Removal	☐
Watering	☐

Best Management Practice (BMP) Maintenance Form
E.8 Green Roof

Equipment & Materials List

Item	*Units*	*Quantity*

Associated Cost

Item	*Units*	*Quantity*	*Unit Cost*	*Total*
			TOTAL	

Best Management Practice (BMP) Maintenance Form
E.9 Naturalized Basin

Work Order Information

BMP ID:
BMP Type:
BMP Address:

Work Order Type:
Work Order ID:
Scheduled Date:

Associated Inspection WO ID:
Inspection Comments:

Inspection Files:

General

Priority:
Work Order Status:
Assigned Crew:

Start Date:
Start Time:
End Time:

Maintenance Comments:

Attach File:

Maintenance Checklist

Task	*Completed by Maintenance Crew*	*Notes/Comments*
Concrete Repair	☐	
Erosion Repair	☐	
Graffiti Removal	☐	
Manaul Weed Control	☐	
Mowing	☐	

Best Management Practice (BMP) Maintenance Form
E.9 Naturalized Basin

Organic Debris Removal	☐
Pest Management	☐
Photo Documentation	☐
Pipe Jetting	☐
Plant Removal	☐
Pruning	☐
Seeding/Sodding	☐
Sediment Removal	☐
Signage Care	☐
Structural Pruning	☐
Target Perennial - Cutting Back	☐

Best Management Practice (BMP) Maintenance Form
E.9 Naturalized Basin

Target Perennial - Dividing and Transplanting	☐
Trash Removal	☐
Watering	☐

Best Management Practice (BMP) Maintenance Form
E.9 Naturalized Basin

Equipment & Materials List

Item	*Units*	*Quantity*

Associated Cost

Item	*Units*	*Quantity*	*Unit Cost*	*Total*
			TOTAL	

Best Management Practice (BMP) Maintenance Form
E.10 Porous Pavement

Work Order Information

BMP ID:
BMP Type:
BMP Address:

Work Order Type:
Work Order ID:
Scheduled Date:

Associated Inspection WO ID:
Inspection Comments:

Inspection Files:

General

Priority:
Work Order Status:
Assigned Crew:

Start Date:
Start Time:
End Time:

Maintenance Comments:

Attach File:

Maintenance Checklist

Task	*Completed by Maintenance Crew*	*Notes/Comments*
Concrete Repair	☐	
Deicing	☐	

Best Management Practice (BMP) Maintenance Form
E.10 Porous Pavement

Graffiti Removal	☐
Gravel Joint Filling	☐
Inlet Pretreatment Clearing	☐
Inlet Pretreatment Maintenance	☐
Photo Documentation	☐
Pipe Jetting	☐
Plowing	☐
Porous Patching	☐
Signage Care	☐
Vacuum Cleaning	☐
Vacuum Sweeping	☐

Best Management Practice (BMP) Maintenance Form
E.10 Porous Pavement

Equipment & Materials List

Item	*Units*	*Quantity*

Associated Cost

Item	*Units*	*Quantity*	*Unit Cost*	*Total*
			TOTAL	

Best Management Practice (BMP) Maintenance Form
E.11 Subsurface Infiltration and Detention

Work Order Information

BMP ID:
BMP Type:
BMP Address:

Work Order Type:
Work Order ID:
Scheduled Date:

Associated Inspection WO ID:
Inspection Comments:

Inspection Files:

General

Priority:
Work Order Status:
Assigned Crew:

Start Date:
Start Time:
End Time:

Maintenance Comments:

Attach File:

Maintenance Checklist

Task	*Completed by Maintenance Crew*	*Notes/Comments*
Concrete Repair	☐	
Erosion Repair	☐	
Graffiti Removal	☐	
Inlet Pretreatment Clearing	☐	

Best Management Practice (BMP) Maintenance Form
E.11 Subsurface Infiltration and Detention

Inlet Pretreatment Maintenance	☐
Manual Weed Control	☐
Organic Debris Removal	☐
Pest Management	☐
Photo Documentation	☐
Pipe Jetting	☐
Pruning	☐
Sediment Removal	☐
Signage Care	☐
Sinkhole and Settling Repair	☐
Structural Pruning	☐
Trash Removal	☐

Best Management Practice (BMP) Maintenance Form
E.11 Subsurface Infiltration and Detention

Vacuum Cleaning ☐

Watering ☐

Equipment & Materials List

Item	*Units*	*Quantity*

Associated Cost

Item	*Units*	*Quantity*	*Unit Cost*	*Total*

TOTAL

Best Management Practice (BMP) Maintenance Form
E.12 Supplemental Watering

Work Order Information

BMP ID:		Work Order Type:	
BMP Type:		Work Order ID:	
BMP Address:		Scheduled Date:	
Associated Inspection WO ID:			
Inspection Comments:			
Inspection Files:			

General

Priority:		Start Date:	
Work Order Status:		Start Time:	
Assigned Crew:		End Time:	
Hydrant Opened:			
Hudrant ID:			
Hydrant Open Time:			
Hydrant Close Time:			
Maintenance Comments:			
Attach File:			

Best Management Practice (BMP) Maintenance Form
E.12 Supplemental Watering

Maintenance Checklist

Task	*Completed by Maintenance Crew*	*Notes/Comments*
Supplemental watering	☐	

Equipment & Materials List

Item	*Units*	*Quantity*

Associated Cost

Item	*Units*	*Quantity*	*Unit Cost*	*Total*
			TOTAL	

Best Management Practice (BMP) Maintenance Form
E.13 Corrective Maintenance

Work Order Information

BMP ID:
BMP Type:
BMP Address:

Work Order Type:
Work Order ID:
Scheduled Date:

Associated Inspection WO ID:
Inspection Comments:

Inspection Files:

General

Priority:
Work Order Status:
Assigned Crew:

Start Date:
Start Time:
End Time:

Maintenance Comments:

Attach File:

Maintenance Checklist

Task	*Completed by Maintenance Crew*	*Notes/Comments*
Corrective Maintenance	☐	

Best Management Practice (BMP) Maintenance Form
E.13 Corrective Maintenance

Equipment & Materials List

Item	*Units*	*Quantity*

Associated Cost

Item	*Units*	*Quantity*	*Unit Cost*	*Total*
			TOTAL	

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APPENDIX F – PERSONNEL CLASSIFICATIONS

Various aspects of GI maintenance require the use of specialized personnel. The following personnel classifications are required to carry out one or more stormwater system O&M tasks:

Asset Management

Title: Green Infrastructure Asset Manager

Position: GI Asset Coordinator

Description:

- The Asset Manager oversees the database of GI assets, including assets within LUCITY and the Geographic Information System (GIS).
- The Asset Manager oversees the workflow of collected O&M data within LUCITY and makes program-level decisions to optimize operation and maintenance costs based on collected data.
- The Asset Manager coordinates and generates year-end reports, and regulatory deliverables.
- The Asset Manager makes decisions and resolves issues elevated to them by the GI Asset Specialist.

Title: Green Infrastructure Asset Management Specialist

Position: GI Asset Technician (vacant)

Description:

- The GI Asset Specialist generates new assets within GIS and LUCITY, and commits changes to existing assets as needed.
- The GI Asset Specialist works within LUCITY to initiate, assign, and review completed work orders.
- The GI Asset Specialist oversees the schedule of GI services and dispatches inspection and maintenance personnel through the use of work orders.
- The GI Asset Specialist communicates issues related to the schedule or corrective maintenance with the Asset Manager.

Inspection

Title: Green Infrastructure Inspector

Position: NEW POSITION NEEDED

Description:

- The GI Inspector conducts visual assessments of vegetative and structural components during routine inspections.
- The GI Inspector is experienced with vegetation identification and health assessment, and GI maintenance requirements.
- The GI Inspector conducts post construction inspections, to assure that new systems are not entering the program with outstanding issues.

Title: CCTV Inspector

Position: TV Technician I

Description:

- The CCTV Inspector is experienced with the inspection and maintenance of storm sewer systems, operation of CCTV equipment, and has NASSCO PACP certification.
- The CCTV Inspector conducts remote assessments of subsurface infrastructure such as pipes, inlets, and riser structures and codes any identified defects according to the NASSCO guidelines.
- The CCTV Inspector is familiar with traffic control and certified in OSHA confined space entry.

Surface Maintenance

Title: Green Infrastructure Maintenance Foreman

Position: Maintenance Worker I

Description:

- The GI Maintenance Foreman manages GI Maintenance Laborers and assures that they perform routine landscape maintenance of GI effectively.
- The GI Maintenance Foreman understands the functionality of different types of GI assets and the role they play in a combined sewer system.
- The GI Maintenance Foreman understands how to use LUCITY to find work order requests and fulfill work orders while performing maintenance.
- GI Maintenance Foreman is familiar with vegetation identification and health assessment, experienced in landscape care, and is able to provide GI maintenance services to ensure the system performs as intended.

Title: Green Infrastructure Maintenance Laborer

Position: Laborer I

Description:

- The GI Maintenance Laborer understands the functionality of different types of GI assets and the role they play in a combined sewer system.
- The GI Maintenance Laborer understands the fundamentals of landscape care and provides GI maintenance services to ensure the system performs as intended.

Subsurface and Porous Pavement Maintenance

Title: Jetter Vacuum Operator

Position: Equipment Operator I

Description:

- The Jetter Vacuum Operator is experienced with the maintenance of storm sewer systems and the operation of vacuuming and jetting equipment.
- The Jetter Vacuum Operator understands the functionality of different types of GI assets and the role they play in a combined sewer system.
- The Jetter Vacuum Operator is familiar with traffic control and OSHA confined space entry.

Title: Jetter Vacuum Technician

Position: Equipment Technician I

Description:

- The Jetter Vacuum Technician is able to perform the maintenance of storm sewer systems and GI BMPs using vacuuming and jetting equipment.
- The Jetter Vacuum Technician is familiar with traffic control and OSHA confined space entry.

Title: Street Sweeping Operator

Position: Equipment Operator I

Description:

- The Street Sweeping Operator is experienced with the operation of regenerative air sweepers and maintenance requirements for various types for porous pavement and permeable pavers.

Title: Street Sweeping Technician

Position: Equipment Technician I

Description:

- The Street Sweeping Technician is familiar with the use of regenerative air sweepers and maintenance requirements for various types for porous pavement and permeable pavers.

Title: Snow Plow Operator

Position: Equipment Operator I

Description:

- The Snow Plow Operator experienced with the operation of snow plows and de-icing spreader equipment.
- The Snow Plow Operator understands special precautions necessary to performing snow plowing operations on porous pavement and permeable pavers.

Title: Snow Plow Technician

Position: Equipment Technician I

Description:

- The Snow Plow Technician is experienced with the use of snow plows and de-icing spreader equipment.

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