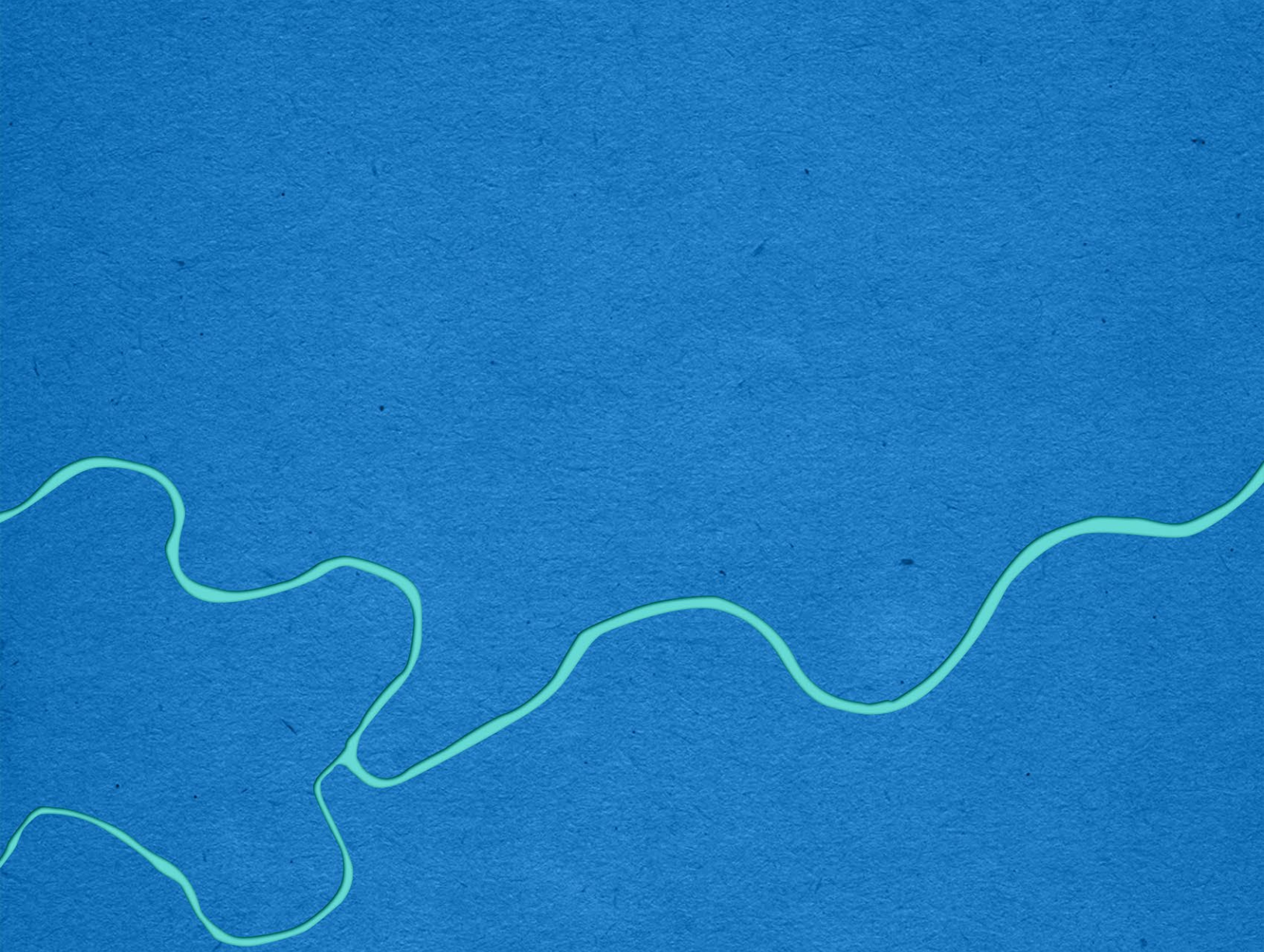


GREEN STORMWATER INFRASTRUCTURE MANUAL

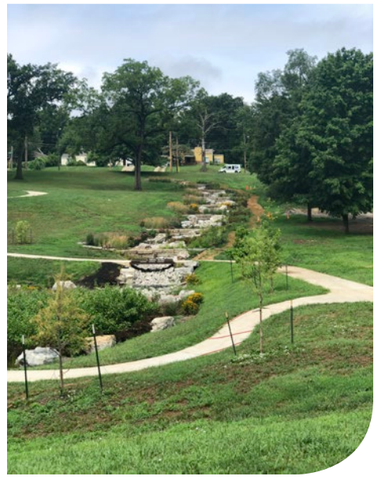
GREEN

CITY OF KCMO

DRAFT AUGUST 2018

TABLE OF CONTENTS

INTRODUCTION



THE FUTURE OF STORMWATER MANAGEMENT

Strategies for stormwater management have expanded in recent years, with an emphasized focus on capturing rainwater where it falls rather than moving it away as quickly as possible. We are letting go of the ***out of sight, out of mind*** mentality of yesterday and moving forward with thinking of stormwater as a resource rather than a waste product. As a community, we are exploring infrastructure through a fresh lens, and asking ourselves:

HOW IS KANSAS CITY INVESTING DOLLARS IN INFRASTRUCTURE?

WHAT BENEFIT DOES IT PROVIDE TO THE COMMUNITY?

WHAT BENEFIT DOES IT PROVIDE TO ME?

When it rains streets shed hundreds of millions of gallons of runoff into an underground pipe system. Once this runoff is in the underground pipes it can cause downstream problems such as basement flooding and combined sewer overflows. If we don't manage runoff differently these problems will continue to require expensive infrastructure projects to solve them.

Green stormwater infrastructure (GSI) is a range of technologies that help our communities collect and store rainwater, and can provide an immediate visual, aesthetic benefit to the community. The City of Kansas City, Missouri has been piloting many of these technologies to better understand and define how green stormwater infrastructure fits into our community of tomorrow. The **Green Stormwater Infrastructure Manual** pulls many of the technologies and the lessons learned from these pilot initiatives into a resource for designers and reviewers. GSI supplements more traditional infrastructure found within and adjacent to the street right-of-way, and provides a visible benefit for our community as it anticipates and prepares for a sustainable infrastructure future.

Green stormwater infrastructure (GSI) supplements traditional stormwater inlet, or catch basin, and pipe systems with the primary goal of collecting the most frequent rainfall events, catching stormwater runoff before it reaches the pipe systems. GSI facilities can take on varying looks and functions, each designed specifically for the stormwater drainage reaching it, and to integrate within the surrounding area. GSI is unique to each area because of the surface runoff conditions, subsurface materials, and surrounding landscapes.

The purpose of the **Green Stormwater Infrastructure Manual** is to provide an integrated framework for design and construction of GSI, city-wide. This is a platform to build GSI per a consistent design and construction criteria, ultimately setting the stage for more consistent and efficient long-term maintenance practices. While GSI has a primary stormwater benefit that is the focus of this manual, it continues to be a catalyst for community enhancements, stimulating other improvements. Many of these benefits include improvement of highly visible infrastructure systems, from replacement of sidewalks to expanding the tree canopy. Other benefits are less visible, but critical for long term public health, including integrated sewer and water supply rehabilitation.

These multi-benefit solutions to the community are highly dependent on focused coordination and collaboration between city departments to meet and understand objectives and visions for a project area. It is the infrastructure vision for the future of Kansas City – integrated improvements that meet community needs and regulatory objectives, while anticipating the infrastructure of the next generation. Elements discussed in this manual can be implemented throughout the city - from capital project improvements to private development opportunities - to provide these multicommunity benefits and meet city regulatory obligations. Working together, this manual strives to provide the tools to effectively use stormwater as a resource that provides tangible, visible public benefits.

WHEN TO USE THIS MANUAL:

To design and construct GSI facilities, with the goal of reducing the volume of stormwater reaching the storm sewer systems.

The designer should pay particular attention to:

- Requirements for stormwater collection in **combined sewer areas.**
- Capacity of the downstream sewer system that stormwater is discharging to.
- Project design criteria variances required because of limited downstream capacity and/or limitations of the existing **combined sewer.**
- Integration of the tools provided by this Manual with GSI construction on both capital projects and private development.

Designers should not limit themselves by the stormwater management tools defined in this manual; however, variances from this manual should be approved during design by a designated City official.

WHAT TOOLS ARE INCLUDED IN THIS MANUAL

Approaching GSI Design: GSI is built by assembling GSI Components. GSI Components are introduced in this section, with the goal of identifying appropriate GSI Components for different GSI design types. Considerations and integration of other infrastructure and community benefit improvements are discussed as part of holistic design.

Using the GSI Specifications: A high-level overview to build a designer's and a contractor's understanding of the technical contents and the expectation for use. This section includes discussion on when to use the GSI Specifications and how to integrate these into city contract documents.

GSI Component Design Guidelines: For each GSI Component, the building blocks of GSI, a design guideline is provided in this manual. This guideline includes an overview, a description of where to use the GSI Component, design considerations, and a design deliverable checklist, providing the designer a baseline expectation as to the level of detail to include with the construction documents. The purpose of the guideline is to provide design guidance, not criteria, to assist in the planning and design of constructible GSI.

GSI Component Design Detail: A design detail for each GSI Component is provided with the guideline. Note that the intent is for the designer to take the detail and tailor it to each respective GSI design. The detail shows the minimum level of information that needs to be provided with the design. The designer is expected to modify the detail and include on the construction plans. The designer is expected to consider the constructability of the detail during the design process in the project specific GSI setting.

GSI Establishment & Maintenance: Regular maintenance is critical to maintaining the long-term vitality and sustainability of the GSI. This section provides descriptions of maintenance tasks required to sustain the design function of the GSI with photo examples and typical task frequencies.

Recommended Plant List & Characteristics: Plants that have successfully grown in KCMO projects are listed in a table containing characteristics and are provided with photo examples. This tool can be found in Appendix A.

Site Activity Plan Instructions: A detailed instruction to the development of the Site Activity Plan per the GSI specification including examples of required forms and submittals. These instructions and template forms can be found in Appendix B.

GSI Construction Specifications: Construction specifications for GSI projects to be included with the city's Project Manual. The GSI construction specifications can be found in Appendix C.

APPROACHING GREEN STORMWATER INFRASTRUCTURE DESIGN

While each GSI is site specific, there are features of the GSI that are common between facilities. These features, or GSI Components are designed to bring stormwater in and out of the facility, protect the GSI, and promote its overall function. Components are the building blocks of a GSI facility, regardless of its size. GSI Components include:

GSI Inlets: A collection point of stormwater, from an opening in the curb line to a traditional inlet.

GSI Permeable Pavement: A Large Area Thin Infiltration System (LATIS) that reduces impervious area, or, can function as a stormwater collection point.

GSI Landscaping: Provides a highly visible GSI function with benefits at and below the surface. Includes trees, shrubs, grasses, perennials, and native wildflower seeding and sodding.

GSI Energy Dissipation and Pretreatment: Features to decrease the velocity of stormwater to prevent erosion and scouring of surface materials, and, to collect sediment, trash and debris.

GSI Soil and Aggregate Media: The primary means of storage and filtration, allowing stormwater to move downward within the GSI facility. Finer and coarser graded media provide filtration and storage. Soil media supports plant growth, from grasses to trees.

GSI Piping: To convey stormwater to or away, provide access or observation to the subsurface, and protect utilities within the GSI.

GSI Above Grade Barriers: Physical or visual barriers at the edge of the GSI.

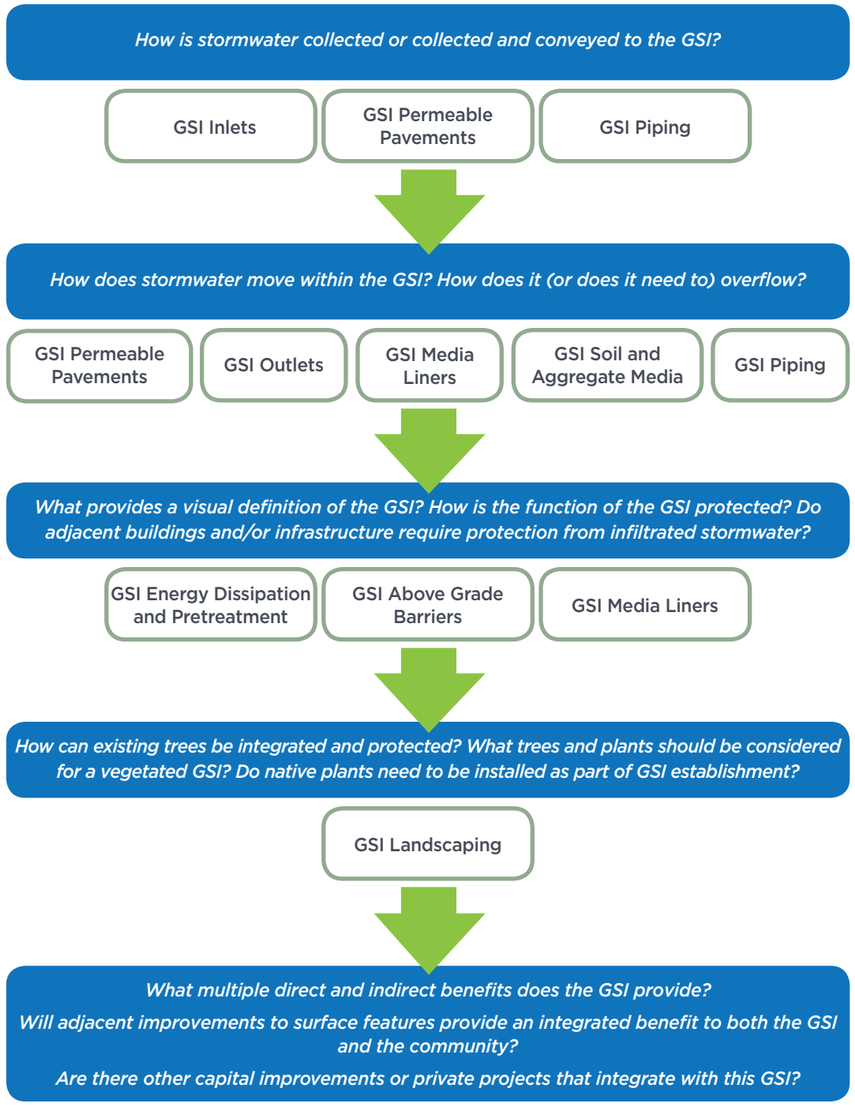
GSI Outlets: A discharge point of excess stormwater volume, either above or below grade.

GSI Media Liners: Permeable or impermeable synthetic fabric liners used to provide stabilization and/or separation.

GSI "practices" represent the full installation of the GSI including all applicable components required to provide the desired function of the facility. GSI practice terminology varies significantly across the globe, though the primary functions of the practice are the same: provide stormwater collection, treatment, and storage. This manual is intended to be used in conjunction with the Mid-America Regional Council Manual (MARC) of Best Management Practices Manual for Stormwater Quality (MARC BMP Manual). To be consistent with these regional standards, this manual references the same GSI practice terminology as the MARC BMP Manual. While each GSI site and design is unique, it is recommended that the following GSI Components be evaluated at a minimum for applicability for each of the GSI practices.

GSI Practice	Inlets	Energy Dissipation & Pretreatment	Above Grade Barriers	Permeable Pavement	Soil & Aggregate Media	Media Liners	Landscaping	Piping	Outlets
Rain Garden	●	●	●		●		●		
Bioretention Basin	●	●	●		●	●	●	●	●
Porous Asphalt		●	●	●	●	●		●	
Pervious Concrete		●	●	●	●	●		●	
Permeable Pavers		●	●	●	●	●		●	
Bioswale/Native Vegetation Swale	●	●	●		●	●	●	●	●
Non-Structural Native Vegetation	●	●	●		●		●		
Infiltration Trench	●	●	●		●	●		●	●
Wetland/Extended Detention Wetland	●	●	●		●	●	●	●	●
Sand Filter	●	●	●		●	●		●	●
Extended Wet Detention Basin	●	●	●		●	●	●	●	●
Extended Dry Detention Basin	●	●	●		●	●	●	●	●
Proprietary Media Filtration	●	●							
Green Roof					●	●	●	●	●

Regardless of the GSI practice, designers define the design of a GSI facility by assembling GSI Components. This can be described by thinking through the function of the final GSI and how stormwater can be managed and used for community benefit. For example:



How is stormwater collected and conveyed to the GSI?

Let's walk through centralized, neighborhood, and distributed GSI examples constructed by the city and discuss how GSI Components were assembled together for a functional GSI.

A designer should consider how stormwater will get to the GSI facility. In some cases, this may be overland; in others, curb and gutter systems may collect and convey stormwater to traditional catch basins, or curb cuts in combination with piping systems. GSI Permeable Pavement can also function to collect stormwater, where at-surface grades preclude stormwater from reaching other types of GSI Inlets. The designer should consider the unique nature of the GSI site, and how to use the natural drainage paths to bring water to a place where it can be infiltrated and/or stored.

Centralized GSI: Wetland at E 81st St and Troost Ave

- GSI Inlets. Traditional Catch Basins collect stormwater in swales and the street cross section and connect to Traditional Pipes bringing stormwater in at the surface of the GSI.
- GSI Permeable Pavements. Permeable pavers collect stormwater and connect to an Underdrain.
- GSI Piping. A Utility Sleeve protects waterline and sewer line crossings. Traditional Pipes convey stormwater collected at Traditional Catch Basins to the GSI.

Neighborhood GSI: Bioretention at Arleta Park

- GSI Inlets. Traditional Catch Basins collect stormwater and connect to Traditional Pipes, bringing stormwater in at the surface of the GSI.
- GSI Piping. A Utility Sleeve protects waterline and sewer line crossings. Traditional Pipe conveys stormwater collected at Traditional Catch Basins to the GSI.

Distributed GSI: Bioretention at E 81st St and Lydia Ave

- GSI Inlets. Traditional Catch Basins collect stormwater and connect to distribution pipes bringing stormwater in below the surface of the GSI. Reverse roll-back curb was used to bring overland flow into the GSI.
- GSI Piping. A Utility Sleeve protects waterline and sewer line crossings. A Distribution Pipe brings water into the GSI below grade.

How does stormwater infiltrate within the GSI? How does it (or does it need to) overflow?

The designer considers how stormwater moves through the GSI facility itself. Once stormwater is collected by the facility, the designer must consider how the water is stored, how it infiltrates, and how it can leave the GSI. Typical GSI Components considered include GSI Soil and Aggregate Media, GSI Outlets, and GSI Piping.

Centralized GSI: Wetland at E 81st St and Troost Ave

- GSI Soil and Aggregate Media. Growing Media within a playing field area stores and infiltrates stormwater. Storage Aggregate Media below the Permeable Pavers and Growing Media, stores stormwater and provides bedding for Underdrains. An Aggregate Media Barrier between the Storage Aggregate Media and Growing Media prevents migration of media between transitional layers.
- GSI Outlets. Large multi-stage structures to control release of stormwater for multiple rainfall events.
- GSI Piping. An Underdrain drains water from the Permeable Pavers and from a playing field. A Cleanout provides an access point for cleaning the underdrain.

Neighborhood GSI: Bioretention at Arleta Park

- GSI Soil and Aggregate Media. Growing Media promotes infiltration within a series of bioretention areas. Storage Aggregate Media promotes infiltration and storage below Growing Media. Aggregate Media Barrier between the Storage Aggregate Media, Growing Media, and subgrade prevents migration of media between transitional layers.
- GSI Outlets. An Overflow Riser with elevated bee-hive risers and internal adjustable weir.
- GSI Piping. An Underdrain drains water from the bioretention GSI. A Cleanout provides an access point for cleaning the underdrain.

Distributed GSI: Bioretention at E 81st St and Lydia Ave

- GSI Soil and Aggregate Media. Growing Media promotes infiltration in two bioretention areas. Storage Aggregate Media promotes infiltration and storage below Growing Media and can also be bedding for Distribution Pipe and Underdrain. Aggregate Media Barrier between the Storage Aggregate Media, Growing Media, and subgrade prevents migration of media between transitional layers.
- GSI Outlets. An in-line Overflow Riser structure with adjustable weir to control overflow elevation.
- GSI Piping. An Underdrain drains water from the GSI. A Cleanout provides an access point to underdrains and distribution pipes for cleaning.

What provides a visual definition of the GSI?

How is the function of the GSI protected?

Do adjacent buildings and/or infrastructure require protection from infiltrated stormwater?

It is important to protect the GSI from erosive stormwater velocities and provide a means for flows that exceed the design to bypass. But there is also a need to visually designate the extents of the GSI facility for vehicles, pedestrians, and for maintenance crews.

Centralized GSI: Wetland at E 81st St and Troost Ave

- GSI Energy Dissipation and Pretreatment. In-line hydrodynamic separator provides capture of trash and sediment immediately upstream of the wetland. Armored forebay and stone cascade reduces velocity of stormwater entering GSI
- GSI Above Grade Barriers. Ribbon curb extends around the perimeter of the wetland plantings. Decorative metal railing separates forebay area and pedestrian overlook
- GSI Media Liners. Impermeable liner is installed where the Pervious Pavers meet the street pavement. Permeable liner installed along bottom of Pervious Pavers to provide structural stability to pavement.

Neighborhood GSI: Bioretention at Arleta Park

- GSI Energy Dissipation and Pretreatment. Stone splash pads were used at Traditional Pipe discharge points to the bioretention GSI. Stone weirs used to slow velocity of stormwater moving through bioswale GSI.
- GSI Above Grade Barriers. Boulders were used to define the edge of the bioretention GSI.

Distributed GSI: Bioretention at E 81st St and Lydia Ave

- GSI Energy Dissipation and Pretreatment. Surface stones were installed adjacent to the reverse roll-back curb to dissipate overland flow stormwater velocity. Catch basin inserts used to capture trash and floatables and protect the distribution pipe
- GSI Above Grade Barriers. Wood fencing was installed to designate the GSI at the street pavement edge. Ribbon curb delineates the GSI boundary with adjacent mowed area.
- GSI Media Liners. Impermeable liner is installed at the street edge of the bioretention GSI. Permeable liner installed between media barrier and storage aggregate prevents migration of media between transitional layers.

How can existing trees be integrated and protected?

What trees and plants should be considered for a vegetated GSI?

Does native seed need to be installed as part of GSI establishment?

The designer should consider what types of landscape integrates with the surrounding neighborhood, how to promote the landscape's health as it establishes, as well as what maintenance practices will be needed for the landscape to thrive.

Centralized GSI: Wetland at E 81st St and Troost Ave

GSI Landscaping

- Trees, shrubs, grasses and perennials are planted throughout the GSI site. Perennial wetland plants are included.
- Fescue sod specified around maintenance path
- Fescue seed mix specified on the areas surrounding the wetland. A challenge for this GSI site was grass establishment on the side slopes into the wetland/ detention area. It was critical to the health of the wetland and to prevent sedimentation of the new GSI facility.

Neighborhood GSI: Bioretention at Arleta Park

GSI Landscaping

- Trees, shrubs, grasses and perennials are planted throughout the GSI site.
- This existing park area also had several trees that required protection during construction.
- A challenge to landscape establishment was diverting overland stormwater flow for larger rainfall events to allow the vegetation to root and establish.

Distributed GSI: Bioretention at E 81st St and Lydia Ave

GSI Landscaping

- Shrubs, grasses and perennials are planted through these two bioretention GSI.
- Plant establishment must consider the natural stormwater flow paths.
- For this location, the Overflow Riser was adjusted to allow stormwater to flow through rather than pond during the plant establishment period.

What direct and indirect benefits does the GSI provide?

Will adjacent improvements to surface features provide an integrated benefit to both the GSI and the community?

Are there other capital improvements or private projects that integrate with this GSI?

It is critical for a designer to approach the design of GSI holistically. Its successful function is directly tied to adjacent infrastructure features, both above and below the surfaces. In addition, the total area draining to the GSI should be considered, as rainfall will pick up sediment and debris and bring these constituents overland through stormwater flow paths to the GSI facility. Weigh the importance of the community's input on these infrastructure improvements, and consider the benefits of integrating these features into one project instead of multiple projects that may be constructed over a lengthier period of time. Communication with the community to establish expectations and build trust are key to the success of infrastructure improvements.

Centralized GSI: Wetland at E 81st St and Troost Ave

- The centralized wetland provides a wet feature that anchors a surrounding park.
- Trails around the wetland and detention area were installed to provide community access in and around the GSI and to promote walkability.
- Infrastructure below grade was improved, including construction of new storm sewer, rehabilitation of combined/sanitary sewer, and replacement of water supply lines.
- Infrastructure above grade was improved, including street resurfacing, curb and sidewalk replacement.

Neighborhood GSI: Bioretention at Arleta Park

- A new playground facility and basketball court was integrated into the GSI features.
- Trails around and within the GSI were installed to provide community access and promote walkability.
- Infrastructure above grade was improved, including installation of a ribbon curb and sidewalk on the adjacent streets.
- Infrastructure below grade was improved, including new storm sewer, rehabilitation of combined/sanitary sewer, and replacement of water supply lines.

Distributed GSI: Bioretention at E 81st St and Lydia Ave

- Infrastructure below grade was improved, including promoting infiltration of stormwater in a natural low area, and replacement of water supply lines.
- Infrastructure above grade was improved, including street resurfacing, curb and sidewalk replacement.
- Landscape was enhanced, including new street trees and integration of plants to enhance the neighborhood.

USING THE GSI CONSTRUCTION SPECIFICATIONS

Specifications in combination with construction drawings make a project constructible. They are the nuts and bolts that hold a project together, and provide the necessary details to build a project. For a designer, it is critical to understand the details provided in the specifications, and how these details supplement and work with the construction drawings.

The purpose of this section is to provide a high-level overview of the GSI Construction Specifications to build a designer's and a contractor's understanding of the technical contents and the expectation for use. For every project where the GSI Construction Specifications are incorporated into the contract documents, the expectation is for both the designer and the contractor to comprehensively understand the specifications, and apply them to all aspects of the project.

WHEN TO USE GSI SPECIFICATIONS

Construction specifications included with this manual should be used on city projects that include any of the GSI Components defined by this manual. These specifications **work in conjunction with** respective department specifications; **they do not replace** these specifications. Existing specifications commonly used on projects constructed within the city include:

- Public Works Department. The base of these specifications is Kansas City Metro Chapter, American Public Works Association (APWA) Standard Specifications and Design Criteria, however the City has amended and made exceptions to these. The most current version is available on the City's Public Works Department website.
- Parks and Recreation Department (KC Parks). For work within the City's Board of Parks and Recreation Commissioner's jurisdictional right-of-way or property, standard design details per KC Parks should be incorporated into the construction documents. This applies to right-of-way and property listed in the City's most current version of the Kansas City, Missouri Parks and Recreation Reference Book.
- Water Services Department (KC Water). Within the Water Services Department, a designer is required to request the most current version of the construction technical specifications. Wastewater, water, stormwater, and facilities specifications are available.
- Kansas City Metro Chapter, American Public Works Association (APWA). The APWA specifications are regionally used as a comprehensive base of construction specifications for public works construction projects. The most recent version of these specifications is posted on the Chapter's website.

The GSI Construction Specifications provide the technical parameters for construction of the GSI Components included with this manual. In addition, they provide definition for protecting and maintaining the GSI during construction and through the establishment period. Infiltration testing protocols are also included.

It is the designer's responsibility to incorporate the GSI Construction Specifications and identify other technical specifications that are needed to construct the GSI.

WHAT IS INCLUDED IN THE GSI CONSTRUCTION SPECIFICATIONS

For each GSI Component, a standard GSI Construction Specification is provided.

- Inlets
- Energy Dissipation and Pretreatment
- Porous Asphalt
- Permeable Pavers
- Existing Tree Protection
- Plants
- Selective Vegetation Removal
- Pervious Concrete
- Above Grade Barriers
- Soil and Aggregate Media
- Topsoil
- Media Liners
- Native & Wildflower Seeding & Sodding
- Non-Native Seeding and Sodding
- Piping
- Outlets

The following GSI Construction Specifications do not have an associated GSI Component; however, the inclusion of these specifications is **required** on all GSI projects to fully define expectations during and following construction.

- Site Activity Plan
- Control and Protection
- Earthwork
- In-Situ Infiltration Testing
- Establishment

The standard GSI Construction Specifications are considered just that – standard – with only portions of the specification editable by the designer. The GSI Construction Specifications are available in a SpecsIntact file format, which is available on request. Within this file, the designer will find 'decision points'. These are designated by text in [brackets], and are opportunities for the designer to select or include direction as appropriate for the GSI design.

The GSI Construction Specifications reference the Kansas City Metro Chapter APWA Specifications (2017 version) exclusively, to provide applicability throughout the city to a wide array of project integration. In general, each specification follows this format:

Part 1: General	Part 2: Products	Part 3: Execution
1.1 Purpose 1.2 Measurement and Payment 1.3 Related Sections 1.4 Reference Standards 1.5 Submittals 1.6 Quality Assurance 1.7 Quality Control 1.8 Delivery, Storage and Handling	• Specific to each GSI Component • Materials required to build each GSI Component • Included as decision points so designer can choose material applicable to the project	3.1 Preparation 3.2 Installation 3.3 Tolerances 3.4 Disposal of Material 3.5 Protection 3.6 Maintenance 3.7 Post-Construction Testing 3.8 Warranty

HOW TO INTEGRATE WITH CITY STANDARDS

For complete contract documents, it is important for the GSI Construction Specifications to fully integrate with the standard city specification front-end sections. The designer is responsible for reviewing the comprehensive Project Manual, which includes all of the technical specifications and what is commonly known as the front-ends.

The following modifications must be incorporated into the Project Manual for full integration of the GSI Construction Specifications:

- 00800 Supplementary Conditions
  - Add definition for Green Stormwater Infrastructure (GSI) to **SC-1.01.A, Article 1, Paragraph 1.01**
    - Green Stormwater Infrastructure (GSI): Elements of the Work that are designed and constructed with the purpose of stormwater management. GSI augments traditional catch basin and pipe systems by collecting and infiltrating rainfall, and may include but is not limited to, rain gardens, bioretention, bioswales, infiltration trenches, permeable pavement, wetlands, detention basins, retention basins, green roofs, and manufactured systems."
  - Modify "Correction Period" in **SC-13.07 Article 13, Paragraph 13.07, Correction Period, Subparagraph A is amended as follows:**
    - Correction Period is three (3) years instead of one (1) year
    - The Correction Period for items designated as Green Stormwater Infrastructure (GSI) as set forth in Paragraph 13.07 A shall be three (3) years instead of one (1) year, which longer period of time shall also be applicable to the Correction Period set forth in Paragraph 13.07 C. All other provisions of Paragraph 13.07 remain unchanged except as necessary to accommodate the revised length of the Correction Period. Elements of the Work include the following:
      - [Designer to list GSI Components on Project]
      - [Designer to list GSI Components on Project]
      - [Designer to list GSI Components on Project]
  - Modify "Performance and Maintenance Bond" period in **SC-5.01 A. Article 5, Paragraph 5.01, Performance, Payment and Other Bonds, Subparagraph A, second sentence is amendment as follows:**
    - Bonds shall remain in effect at least **three (3) years** from the date of **Substantial Completion and/or Achievement of Full Operation**

UNDERSTANDING GSI CONSTRUCTION SPECIFICATIONS NOT ASSOCIATED WITH A GSI COMPONENT

There are five (5) GSI Construction Specifications that are not directly associated with a GSI Component. These specifications assist in further construction direction related to GSI construction planning, construction execution, testing protocols, and maintenance requirements from the time of install of the first GSI Component through the Establishment Period.

02937 GREEN STORMWATER INFRASTRUCTURE SITE ACTIVITY PLAN

The purpose of the Site Activity Plan is to thoroughly plan construction sequencing, site preparation (including control of stormwater within the site and protection of GSI), installation, stabilization of all disturbed area, and establishment of GSI facilities. The Site Activity Plan shall be submitted by the contractor and approved by the city prior to the commencement of any field activities. The contractor can work directly with the designer to develop the material required for the Site Activity Plan. Standard forms have been created to assist both designer and contractor with development of the Site Activity Plan, and are included in Appendix B along with instructions on how to use the forms. The items required in the Site Activity Plan supplement those required in city standard section 00700, with an emphasis on proactively constructing with the integrity of the GSI in mind. The following items are the major submittal requirements of the Site Activity Plan:

Green Stormwater Infrastructure Construction Schedule. The GSI Construction Schedule shall be included as part of the overall project construction schedule required per the contract documents. The GSI Construction Schedule shall include additional detail on GSI phasing with an emphasis on protecting the GSI facility, including GSI preparation, installation, and post-construction measures. The following items shall be included as part of the GSI Construction Schedule:

- Procurement of GSI materials, including planting materials, lead times, and storage requirements;
- Installation of GSI Components, as defined in this manual;
- Sequence for bypassing/diverting stormwater runoff from GSI facility for establishment of landscape;
- Sequence for site stabilization activities of areas upstream of GSI;
- Inclusion of GSI Establishment, including landscaping.

Appendix B includes a template for the GSI construction schedule as well as instructions for both the designer and contractor on how to fill out the form.

Stormwater Runoff Management Plan. The stormwater runoff management plan includes a plan view sheet with appropriate existing and proposed topographic information to fully illustrate drainage patterns on the site throughout construction, and the impact of these drainage patterns on the GSI installation sequence and establishment. Development of the stormwater runoff management plan should integrate protection measures to protect the integrity of the GSI. The following items shall be included as part of the stormwater runoff management plan:

- Means and methods to control stormwater runoff and protect the GSI, including installation and maintenance plan.
- GSI shall not be used for collection or conveyance of stormwater during construction unless approved by the City.
- Sedimentation within the footprint of the GSI during construction shall be removed immediately by the contractor, and the GSI repaired as needed to fully functioning capacity.
- Contributing drainage area to the GSI must be fully stabilized and approved by the designer prior to the installation of the GSI.
- Stormwater runoff shall not discharge in the GSI facility until authorized by the designer.

Site Access and Utilization Plan. The site access plan shall include a plan view sheet with existing and proposed topographic information to fully illustrate traffic patterns during construction. This includes site access, haul roads, delivery of materials, and any temporary access facilities. The city and designer will evaluate site access plan for compaction and sedimentation impact to the GSI facilities. Where compaction is anticipated, the contractor will provide a plan for decompaction and/or removal and replacement of any soils. The following items shall be included as part of the site utilization plan:

- A plan for protecting existing trees and vegetation during construction;
- A plan for maintaining utilities on site during construction;
- Identification of material storage, laydown/equipment staging, and temporary facility areas;
- A description of how stored materials will be protected, including maximum storage durations, and a description of how materials will be disposed of (if applicable);
- A description of the equipment and methods used to backfill with respective materials, in a manner that does not put the function of the GSI at risk.

Green Stormwater Infrastructure Maintenance Plan. The GSI maintenance plan shall include specific maintenance activities to be performed by the contractor during the GSI Establishment Period (discussed in 02957). Specific activities and proposed frequency of the activities shall be included. The City may choose to direct the contractor to use a standard or project specific maintenance manual, if available, and ultimately will approve maintenance plan. Appendix B includes a template for the GSI maintenance plan that auto-populates standard tasks associated with each GSI Component used in the design. Instructions are also provided in Appendix B to assist both the designer and contractor in filling out the form. The tasks identified in this form should be reflected in the contractor's bid for completion during the GSI Establishment Period.

02938 GREEN STORMWATER INFRASTRUCTURE CONTROL AND PROTECTION

The purpose of the GSI control and protection specification is to provide control of stormwater collection, conveyance and runoff to the GSI installation(s) within a project area, and to protect the GSI during construction and through establishment. The function of the GSI is most commonly compromised by failure to protect it during construction activities. Therefore, proactively planning for the control of stormwater within the contributing drainage area to the GSI, as well as how to protect the GSI facility itself, can maintain the function of the GSI, reducing the need for repairs after construction which will save the city time and money.

This specification supplements the GSI Site Activity Plan specification. The requirements of this specification are applicable to any project that incorporates GSI Components, regardless of disturbed land area. The Kansas City Metro Chapter APWA 2150 is a key reference for designers and contractors for materials and methods that could be applicable. It is the intent that the designer will provide clear direction on the drawings as to the area of GSI to protect, contributing drainage area to the GSI for reference, and a proposed phasing plan. The following minimum measures for control of stormwater runoff and protection of GSI need to be included with the GSI Site Activity Plan to meet the requirements of this specification:

- Stormwater flow control at GSI Inlets, including protection of entire boundary of a GSI facility for those facilities accepting overland stormwater flow;
- Stormwater flow control at GSI Outlets;
- Sediment, debris, and dust control within and near the GSI.

02939 GREEN STORMWATER INFRASTRUCTURE EARTHWORK

The purpose of the GSI earthwork specification is to provide site preparation, excavation, and grading requirements for GSI facilities. This specification is intended to work with standard specifications for earthwork outside of the designated GSI or areas requiring compaction. Items unique to this specification include:

- Definitions for backfill, clearing/grubbing, excavation, finished grade, settlement, and subgrade, specific to GSI construction;
- Discussion of equipment and method requirements for limiting compaction within the GSI;
- Requirement for finished grade elevation of GSI to be surveyed and elevations submitted for review and approval. A tolerance for this surveyed elevation is defined in the specification. The intent is for the grade to be verified prior to landscaping activities.

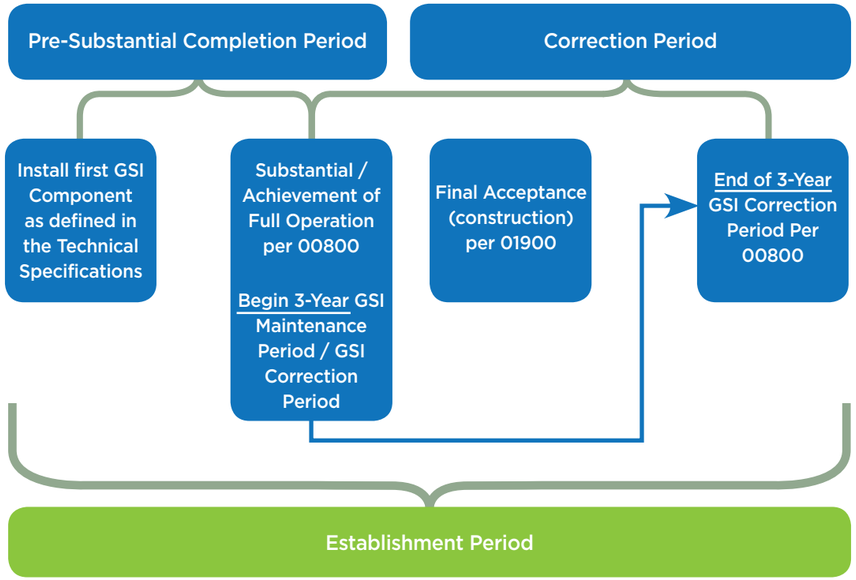
02956 GREEN STORMWATER INFRASTRUCTURE IN-SITU INFILTRATION TESTING

The purpose of the GSI in-situ infiltration testing specification is to provide consistent infiltration testing methods to confirm desired and/or designed drainage of GSI using a double-ring infiltrometer test, a percolation test, or a permeable pavement infiltration test. The type of test for use on a respective project is a decision point within the specification. Key items of consideration related to this specification include:

- The double-ring infiltrometer test follows the requirements as defined in ASTM D3385.
- Requirements for the percolation test are included in the specification.
- Requirements of infiltration test on porous asphalt or pervious concrete as defined in ASTM C10701/C1701M and permeable pavers as defined in ASTM C1781/C1781M.
- No test may be completed within 24 hours of rainfall exceeding one (1) inch in depth.
- Requirements for implementing the testing is referenced in other GSI Construction Specifications.

02957 GREEN STORMWATER INFRASTRUCTURE ESTABLISHMENT

The purpose of the GSI establishment is to define the service and maintenance expectations and activities from the time that the first GSI Component is installed (Pre-Substantial Completion Period) through the end of the defined Correction Period. It should be noted that the contractor is responsible for the integrity of each GSI Component from the instant that it is installed. The contractor is responsible for proper establishment of all landscaping as specified for each GSI installation. That responsibility includes maintenance activities to preserve the integrity and function of each GSI component. The contractor is responsible for the integrity and function of the GSI from Pre-Substantial Completion Period through the defined Correction Period.



This specification provides a minimum level of maintenance service performance expectation for the GSI. This includes minimum service and maintenance performance expectations for the GSI's appearance, handling weeds, pests, and disease, handling mulch and erosion, and maintaining the integrity of drainage within the system. The contractor should reference these performance expectations when developing the GSI maintenance plan required by 02937 Green Stormwater Infrastructure Site Activity Plan.

The contractor is required to complete a final inspection with the City within 60 days of the end of the establishment period. This inspection shall identify any deficiencies of the GSI related to the performance expectation and design function. The contractor is responsible for correcting identified deficiencies prior to the end of the establishment period.

GSI COMPONENT DESIGN GUIDELINES & DETAILS

GSI - 1 INLET

AN INLET IS THE COLLECTION POINT OF STORMWATER. AN INLET TYPICALLY COLLECTS STORMWATER RUNOFF AND DISCHARGES THIS RUNOFF EITHER TO THE SURFACE OR BELOW THE SURFACE OF THE GSI. AN INLET COMPONENT CAN RANGE FROM SIMPLE OPENINGS IN THE CURB LINE, TO MANUFACTURED STORMWATER STRUCTURES, TO TRADITIONAL INLET BOXES.

DESIGN DELIVERABLE CHECKLIST

- ☐ Plan view of GSI indicating location of inlet structure(s) including northing/easting points.
- ☐ Spot elevations to show drainage path towards the inlet structure(s) as well as major overland flow paths and bypass for storm events that exceed the design capacity of the GSI.
- ☐ Detail/Section view of inlet structure(s) specifying recommended product/manufacturer, size, dimensions, and elevations (as applicable).
- ☐ Detail of anchoring design to prevent flotation (as applicable).
- ☐ Inlet capacity calculations.

1.1 INFILTRATION INLET

Description:

The infiltration inlet is a modification to a stormwater inlet box that promotes infiltration by directing stormwater to an aggregate storage media layer over native soil subgrade. A distribution pipe component can be added for increased storage and infiltration capacity. Stormwater flows in excess of the design can be controlled with an overflow weir to a downstream conveyance system.

Where to use:

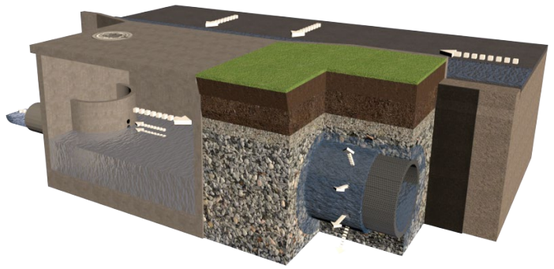
The infiltration inlet can be used where stormwater inlet boxes are typically used to promote infiltration at a stormwater collection point for frequent rainfall events.

Design Considerations:

The following are recommendations and considerations for designing an infiltration inlet. Refer to Section 02940 GSI Inlets for construction and material specific requirements.

- Street tree placement requirements should be considered when siting and sizing infiltration inlets.
- Infiltration inlet should be sized to capture the design storm for the tributary drainage area to that location. Adjustments to distribution pipe length and aggregate storage bed dimensions may be necessary.
- Impermeable liner is required adjacent to street pavement to impede water from encroaching into pavement subgrade.
- Maintenance access should be considered when placing the inlet. If the inlet is located more than 20 feet from an existing vehicular access point, a maintenance access path should be included with the design.

Infiltration Inlet Rendering

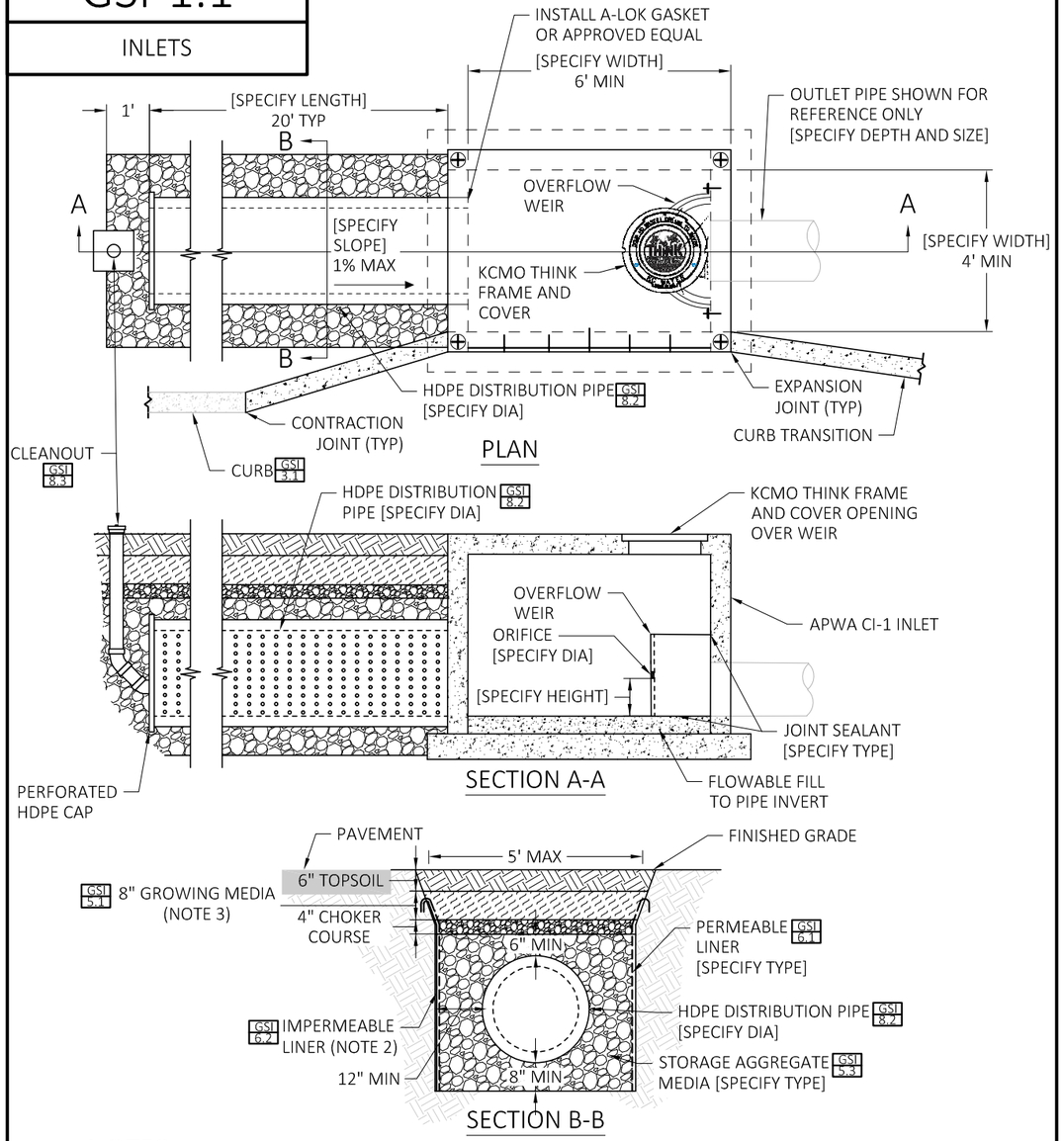


KCMO "THINK Protect Your Water Protect Your Home" Manhole Lid

Infiltration inlet designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-1.1

INLETS



NOTES:

1. INFILTRATION INLET SHALL BE PER 02940.
2. IF INFILTRATION INLET IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

INFILTRATION INLET

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

1.2 CURB CUT

Description:

Curb cuts are openings that route stormwater from the curb line to the surface of the GSI.

GSI 1.2 **Curb Cuts** are poured in place concrete into a new curb line or as a new section of an existing curb line.

Curb Cut

Where to use:

Curb cuts can be used along any curb application to collect stormwater from pavement areas and direct toward a specific location in a GSI feature. Curb cuts are not recommended for use on curb radii and should be located at or beyond the end of a curb return. Impacts to ADA ramps should be considered when placing curb cuts.

Design Considerations:

The following are recommendations and considerations for designing GSI with curb cuts. Refer to Section 02940 GSI Inlets for construction and material specific requirements.

A curb cut should be designed with inlet capacity sufficient to intercept the design flow for the GSI practice. On sloped applications, multiple curb cuts may be needed. Curb cut inlet capacity should limit the maximum inflow to the GSI facility to the design storm, allowing for larger stormwater flows to bypass the facility.

A curb cut should be used in conjunction with an energy dissipation component (GSI-2.1) to limit erosion of GSI surface materials.

The invert of the curb cut should be lower than or equal to the invert of the pavement or gutter line. Gutter aprons (GSI-1.3) may be used in conjunction with curb cuts to maximize capture capacity of the curb cut.

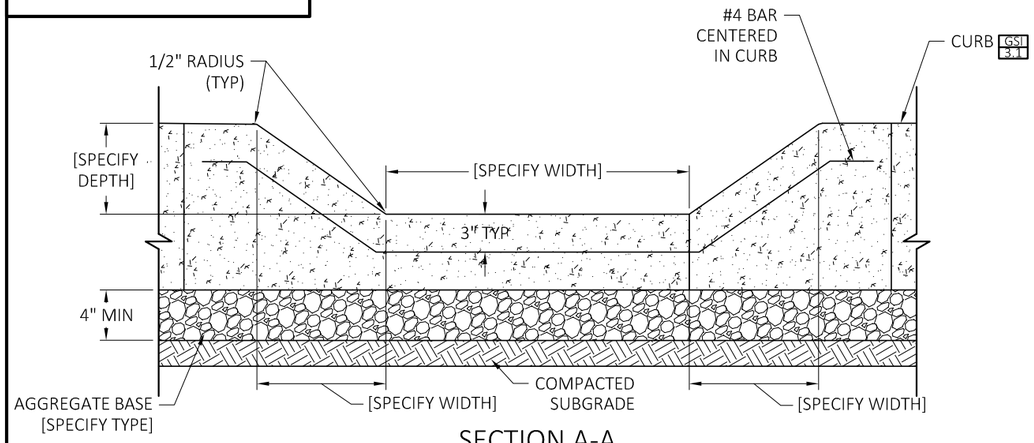
A curb guard (GSI-3.5) can extend the curb line over a curb cut at the designer's discretion.

Maintenance access should be considered when placing the inlet. If the inlet is located more than 20 feet from an existing vehicular access point, a maintenance access path should be included with the design.

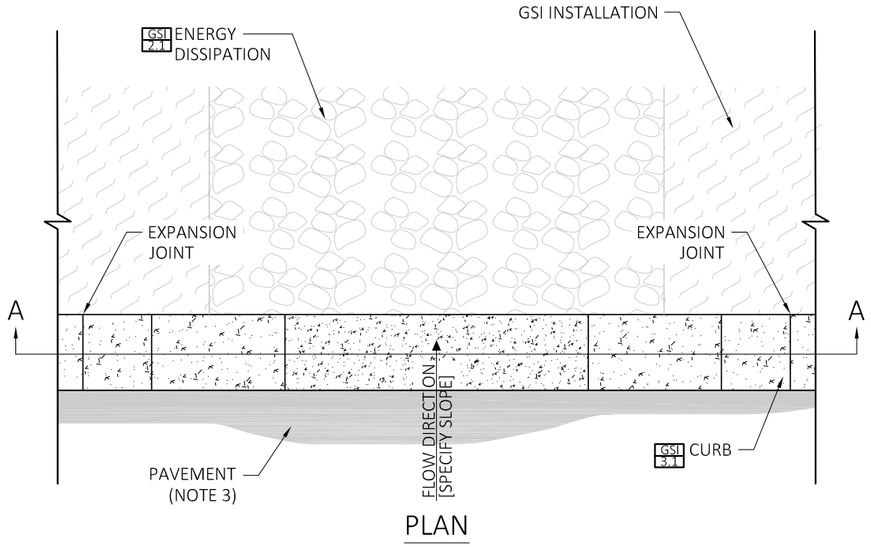
A curb cut design outside of the parameters of this guideline should be submitted for review and approval.

GSI-1.2

INLETS



SECTION A-A



PLAN

NOTES:

1. CURB CUT SHALL BE PER 02940.
2. TRANSITION TO TYPICAL CURB SECTION PER GSI-3.1.
3. ADJACENT GRADE MUST HAVE POSITIVE SLOPE TOWARDS THE GSI INLET.

CURB CUT

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

1.3 GUTTER APRON

Description:

A gutter apron is a depression in the gutter line at a stormwater collection point to a GSI facility. The depression of the gutter apron is characterized by a steeper cross slope that can increase inlet capacity to maximize the volume of stormwater collected.

Gutter Apron

Where to use:

A gutter apron can be used on any pavement section where spacing between the pavement edge and the GSI practice allow. A gutter apron may be setback, or extended, behind the curb line to avoid conflict with traffic lanes. To avoid slip hazards for passengers exiting vehicles, gutter aprons are not recommended adjacent to on-street parking areas.

Design Considerations:

The following are recommendations and considerations for designing GSI with a gutter apron component. Refer to Section 02940 GSI Inlets for construction and material specific requirements.

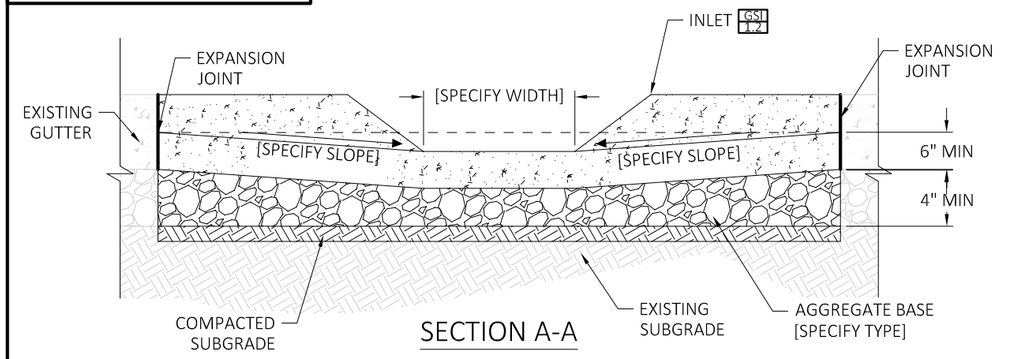
Gutter apron cross slope should be specified by designer based on stormwater collection design and desired entrance velocity. Maximum gutter cross slope should consider hazard to off-course vehicles. Gutter cross slope within a gutter apron should not exceed 3:1 (H:V) along roadway applications.

The use of directional veins within a gutter apron can provide some means of energy dissipation and assist in the collection of stormwater.

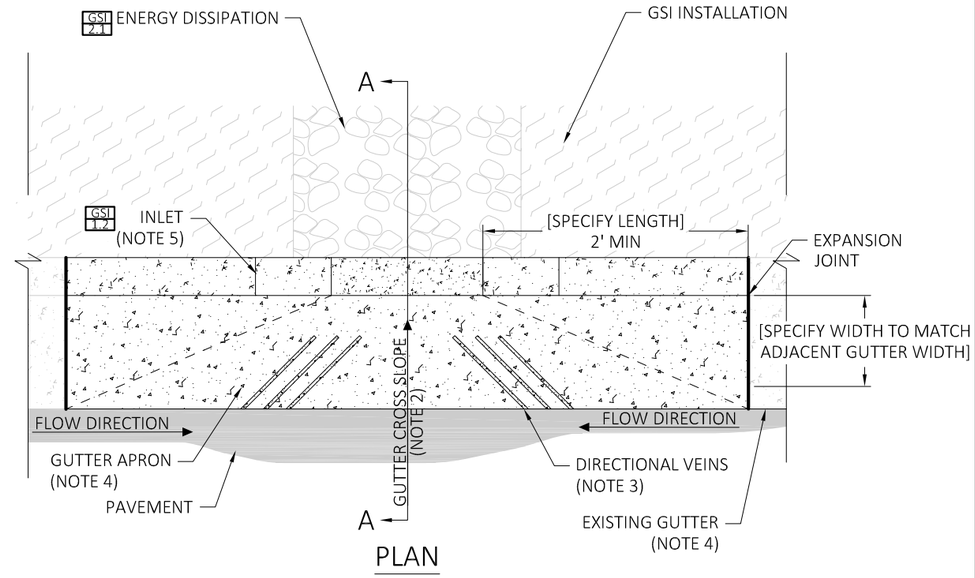
A gutter apron design outside of the parameters of this guideline should be submitted for review and approval.

GSI-1.3

INLETS



SECTION A-A



PLAN

NOTES:

1. GUTTER APRON SHALL BE PER 02940.
2. CROSS SLOPE SHALL BE SPECIFIED BY DESIGN PROFESSIONAL TO MEET REQUIRED INLET CAPACITY.
3. DIRECTIONIAL VEINS SHALL BE ANGLED SUCH THAT UPSTREAM END INTERCEPTS FLOW FROM STREET AND DIRECTS TOWARDS INLET (GSI-1).
4. REINFORCEMENT IN GUTTER APRON SHALL MATCH THAT OF THE ADJACENT GUTTER. TRANSITION TO TYPICAL CURB AND GUTTER SECTION PER GSI 3.1.
5. INLET CURB AND GUTTER APRON SHALL BE CAST MONOLITHICALLY.

GUTTER APRON

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

1.4 TRENCH DRAIN

Description:

A trench drain is a solid or grated cover over a shallow concrete or metal trench that collects stormwater. Typical applications either collect stormwater runoff from an adjacent paved surface at-grade through a grated cover, or, collect flow through an opening at one end of the trench. A trench drain often is used to collect stormwater without impacting the pedestrian or vehicular use of the surrounding area. Shallower invert elevations associated with a trench drain can provide greater flexibility than standard curb or grate inlets.

Where to use:

A trench drain can be used in pedestrian or vehicular applications where stormwater collection is needed at-grade. A trench drain is commonly used to collect stormwater from the curb line and convey it across a walking surface without creating a hazard to pedestrians. A trench drain may also be used at street or driveway entrances to collect stormwater across the pavement section where a lack of elevation change may preclude other means of stormwater collection.

Trench Drain

Design Considerations:

The following are recommendations and considerations for designing GSI with a trench drain component. Refer to Section 02940 GSI Inlets for construction and material specific requirements.

A trench drain should be rated for pedestrian or vehicular loading, as needed for the site-specific design application. H-20 loading is required for trench drains.

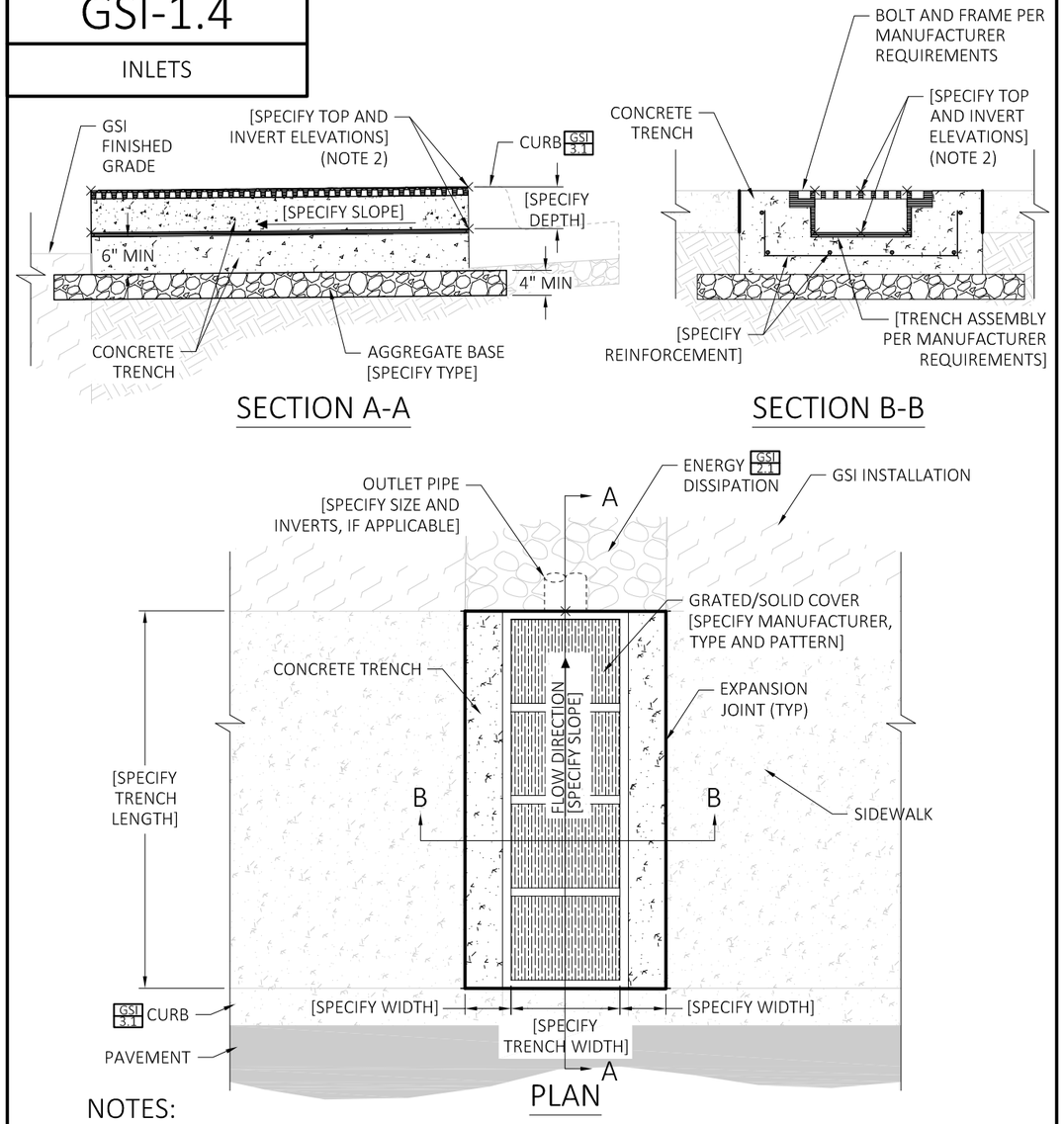
When a trench drain is designed for a pedestrian application, grate spacing in the trench cover should not exceed 1/2 inch per ADA Standards for Accessible Design. Designer should verify that selected product complies with ADA requirements.

Maintenance access should be considered when placing the inlet. If the inlet is located more than 20 feet from an existing vehicular access point, a maintenance access path should be included with the design.

A trench drain design outside of the parameters of this guideline should be submitted for review and approval.

GSI-1.4

INLETS



NOTES:

1. TRENCH DRAIN SHALL BE PER 02940.
2. PROVIDE INVERT ELEVATIONS, TOP ELEVATIONS, CROSS SLOPE AND LONGITUDINAL SLOPE OF TRENCH CHANNEL.
3. GRATES LOCATED IN PEDESTRIAN WALKWAYS SHALL HAVE A MAXIMUM GRATE OPENING OF 1/2" IN ONE DIRECTION PER SECTION 302 OF THE 2010 ADA STANDARDS FOR ACCESSIBLE DESIGN.
4. BOLT DOWN GRATE AND FRAME IS REQUIRED. ALL BOLTS SHALL BE FLUSH WITH EXISTING GRADE OF THE SIDEWALK.
5. TRENCH DRAIN AND GRATE/COVER SHALL BE AASHTO H-20 LOAD RATED.

TRENCH DRAIN

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

1.5 MANUFACTURED INLET

Description:

A manufactured inlet is a proprietary inlet structure that typically provides a pretreatment function in addition to stormwater collection. Some manufactured inlets can accomplish dual-purpose objectives that otherwise would require multiple GSI components.

Where to use:

A manufactured inlet may be used in stormwater collection applications. Designer should consult manufacturer requirements and recommendations when determining where to use a specific manufactured inlet.

Manufactured Inlet

Manufactured Inlet

Manufactured inlet pretreatment designs outside of the parameters of this guideline should be submitted for review and approval.

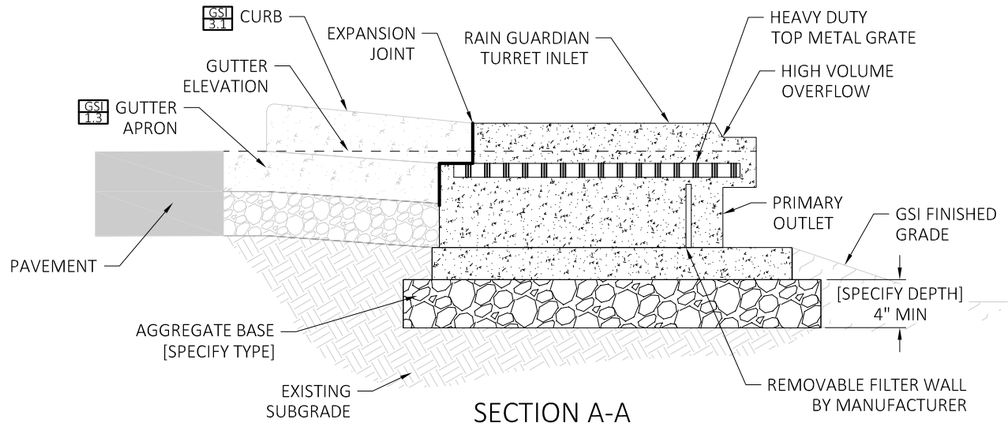
Design Considerations:

The following are recommendations and considerations for designing GSI with a manufactured inlet component. Refer to Section 02940 GSI Inlets for construction and material specific requirements.

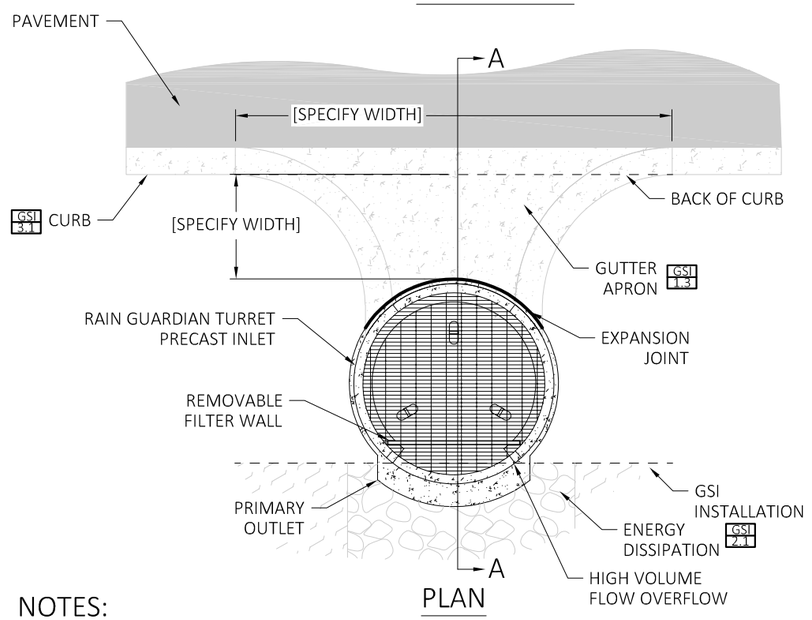
- A manufactured inlet design detail is often provided by the manufacturer. Designer should review detail and provide additional information as needed for construction.
- Inlets adjacent to vehicular application should be traffic rated.
- Design should be per manufacturer instructions. Product should provide adequate information to calculate inlet capacity.
- If applicable, designer should provide an anchoring design for a manufactured inlet to mitigate flotation of the structure.
- Maintenance access should be considered when placing the inlet. If the inlet is located more than 20 feet from an existing vehicular access point, a maintenance access path should be included with the design.

GSI-1.5

INLETS



SECTION A-A



PLAN

NOTES:

1. MANUFACTURED INLET SHALL BE PER 02940.
2. POSITION MANUFACTURED INLET SO PRIMARY OUTLET ALIGNS WITH TOE OF GSI SIDE SLOPE TO AVOID SOIL INTERFERENCE WITH FILTER.

MANUFACTURED INLET
(RAIN GUARDIAN TURRET EXAMPLE)

AUGUST 2018

GSI – 2 ENERGY DISSIPATION & PRETREATMENT

ENERGY DISSIPATION COMPONENTS ARE USED TO DECREASE THE VELOCITY OF STORMWATER TO PREVENT EROSION AND SCOURING OF GSI SURFACE MATERIALS. PRETREATMENT COMPONENTS CAPTURE SEDIMENT, TRASH, AND DEBRIS PRIOR TO ENTERING THE GSI TO ASSIST WITH MAINTENANCE OF THE FACILITY. ENERGY DISSIPATION CAN ALSO SERVE AS PRETREATMENT BY COLLECTING DEBRIS WHERE STORMWATER ENTERS THE GSI.

DESIGN DELIVERABLE CHECKLIST

- ☐ Plan view of GSI indicating location of energy dissipation/pretreatment device including northing/easting points for extents of component (as applicable).
- ☐ Detail/Section view of energy dissipation including aggregate and/or surface stone/brick size, depth, extents, and elevations (as applicable).
- ☐ Detail/Section view of pretreatment device including recommended product/ manufacturer, size, dimensions, and elevations (as applicable).
- ☐ GSI designed maximum entrance velocity, permissible shear stress, and aggregate and/or stone size calculations (as applicable).

2.1 SPLASH PADS

Description:

A splash pad uses surface stone or brick to dissipate stormwater energy. The roughness of the surface material reduces the velocity of the stormwater. Surface material for a splash pad can be installed over an aggregate bedding and media liner, or, may be embedded in concrete.

GSI 2.1.1 **Concrete Embedded Splash Pad:** splash pad in which the surface stone or brick is embedded in concrete.

Concrete Embedded Splash Pad

GSI 2.1.2 **Surface Stone Splash Pad:** splash pad in which the surface stone is placed over a graded aggregate base.

Surface Stone Splash Pad

Where to use:

Energy dissipation should be used in GSI applications where stormwater is channelized to an inlet (GSI-1). Splash pads may embed surface stone/brick in concrete for designs with a higher stormwater velocity, that require anchoring of the surface material. Splash pads with loose surface stone are preferred for stormwater sheet flow design applications. Both loose stone and concrete embedded splash pads may be used for either application, provided the size of the surface material and anchoring/base design is appropriate for the velocity of stormwater entering the GSI.

Table 2.1 Surface Stone Permissible Shear Stress

Average Stone Size (in)	Permissible Shear Stress (lbs/ft^2)
1	0.33
2	0.67
3	0.87
4	1.36
6	2.00
10	3.46
12	4.00
18	6.17
20	6.77
30	10.15
39	13.53

Permissible shear stress value derived from APWA 5600 Table 5607-1 and critical shear stress values from Table 5605-2. Permissible shear stress is assumed to be critical shear stress with a 1.5 factor of safety applied.

Applied shear stress is calculated based on hydraulic radius of inflow at the inlet, surface slope, and specific weight of water, per APWA 5605.5, Part E.1.

Design Considerations:

The following are recommendations and considerations for designing GSI with surface stone splash pads. Refer to Section 02941 GSI Energy Dissipation and Pretreatment for construction and material specific requirements.

The flow path of stormwater exceeding the design capacity of the GSI should be considered during the design process. It is recommended that GSI be designed to only intercept design capacity flows, and to allow larger flows to bypass the facility. Preventing larger flows from being routed through the GSI reduces the risk for washout of the surface material during larger storm events.

Energy dissipation should be sized to withstand maximum shear stress for stormwater flow entering the GSI. Maximum shear stress should consider flows for all storms allowed to pass through the GSI, regardless of the design storm the GSI is designed to control. Surface stone material should be sized to prevent movement of the stone such that the design shear stress of the stormwater inflow is less than the permissible shear stress, per APWA 5600. Table 2.1 shows permissible shear stress for a variety of stone sizes.

For surface stone sizes outside of the range provided, designer should provide gradation requirements of the stone material and shear stress used for calculation.

Side slopes towards the growing media are recommended to be 4:1 (horizontal:vertical) or shallower to mitigate erosion potential. Slopes should not exceed 3:1 (horizontal:vertical).

Energy dissipation should be designed with sufficient length, width, and thickness to prevent and/or minimize scouring of the GSI surface media beyond the extents of the splash pad.

The following are minimum recommendations for splash pad geometries:

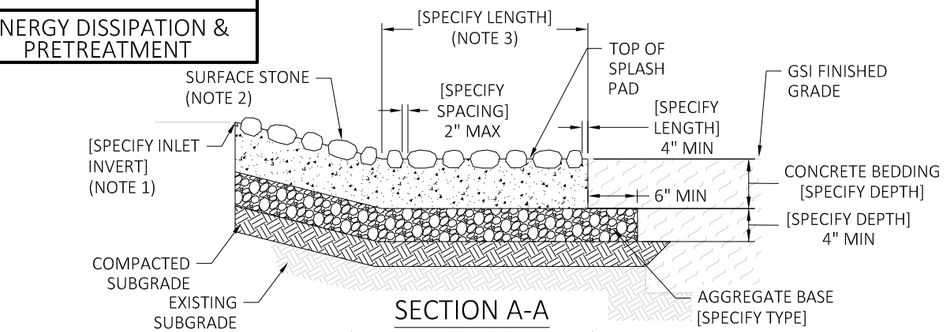
- Width: The splash pad should extend behind the GSI inlet a minimum of twice the width of the opening.
- Length: The splash pad should extend beyond the GSI side slope onto the flat surface of the GSI a minimum of 3 times the thickness of the total splash pad.
- Thickness: The thickness of the surface material is recommended to be a minimum of twice the D_{50} stone.

Concrete Embedded Splash Pad

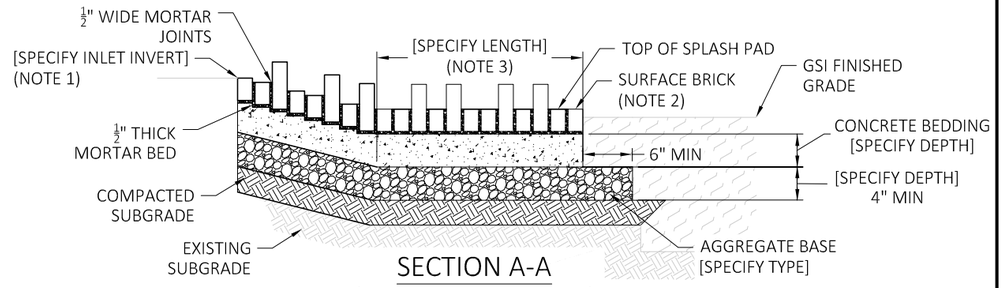
Surface stone splash pad designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-2.1.1

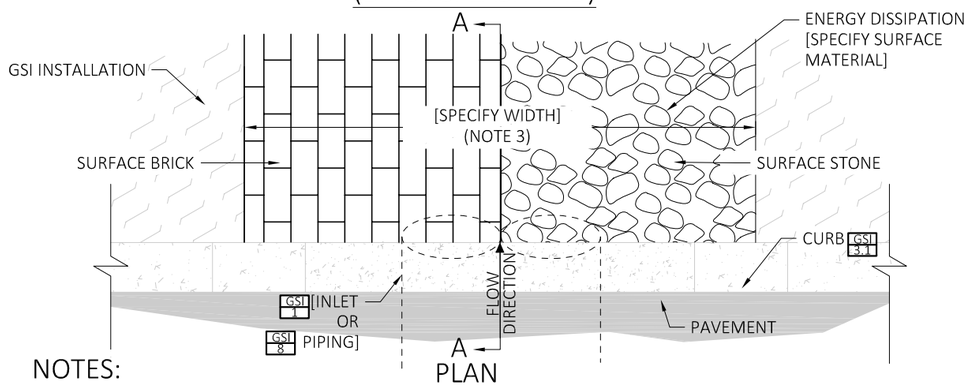
ENERGY DISSIPATION & PRETREATMENT



SECTION A-A
(STONE SPLASH PAD)



SECTION A-A
(BRICK SPLASH PAD)



PLAN

NOTES:

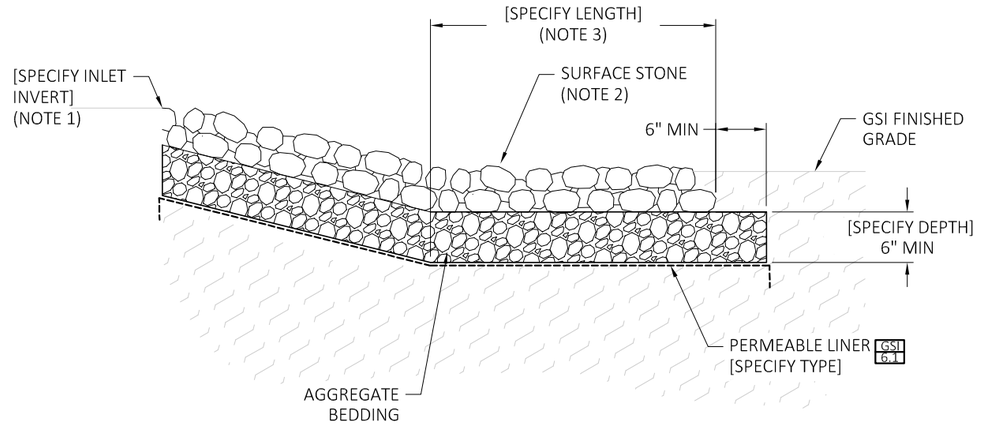
1. CONCRETE EMBEDDED SPLASH PAD SHALL BE PER 02941.
2. TOP OF SPLASH PAD ELEVATION SHALL NOT EXCEED THE HEIGHT OF THE INLET INVERT. DESIGNER TO SPECIFY TOP OF STONE OR BRICK ELEVATION, AND MINIMUM AND MAXIMUM HEIGHT VARIATION BETWEEN SURFACE MATERIAL AND DEPTH OF EMBEDMENT IN CONCRETE BEDDING. SURFACE MATERIAL SHOULD BE EMBEDDED A MINIMUM OF ⅓ TO ½ OF THE HEIGHT OF THE STONE/BRICK. DESIGNER TO SPECIFY SURFACE MATERIAL TYPE, SIZE AND PATTERN OF SURFACE MATERIAL.
3. SPLASH PAD WIDTH SHALL BE MINIMUM TWICE INLET OPENING WIDTH OR PIPE DIAMETER. SPLASH PAD LENGTH SHALL BE A MINIMUM OF 3 TIMES THE THICKNESS OF THE SURFACE STONE AND CONCRETE BEDDING.

CONCRETE EMBEDDED SPLASH PAD

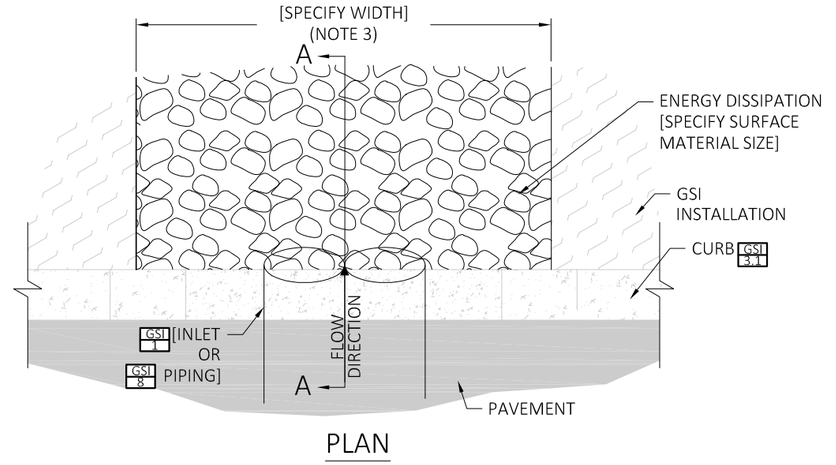
AUGUST 2018

GSI-2.1.2

ENERGY DISSIPATION & PRETREATMENT



SECTION A-A



PLAN

NOTES:

1. SURFACE STONE SPLASH PAD SHALL BE PER 02941.
2. TOP OF SPLASH PAD ELEVATION SHALL NOT EXCEED THE HEIGHT OF THE INLET INVERT. DESIGNER TO SPECIFY SIZE OF SURFACE STONE AND SPLASH PAD ELEVATION.
3. SPLASH PAD WIDTH SHALL BE MINIMUM TWICE INLET OPENING WIDTH OR PIPE DIAMETER. SPLASH PAD LENGTH SHALL BE A MINIMUM OF 3 TIMES THE THICKNESS OF SURFACE STONE AND AGGREGATE BEDDING.

SURFACE STONE SPLASH PAD

AUGUST 2018

2.2 PRETREATMENT

Description:

Pretreatment consists of at and below grade components upstream of the GSI that collect trash, sediment, and debris. Manufactured pretreatment devices are available in various sizes and applications, ranging from small capacity inlet catch baskets to larger structures with trash racks and settling chambers. Pretreatment can also be achieved by installing grass or clean aggregate buffer strips between the tributary drainage area and the GSI. Adequate pretreatment reduces maintenance needs within the GSI, improves aesthetics of the facility, and increases the sustainability of the overall function of the practice.

Where to use:

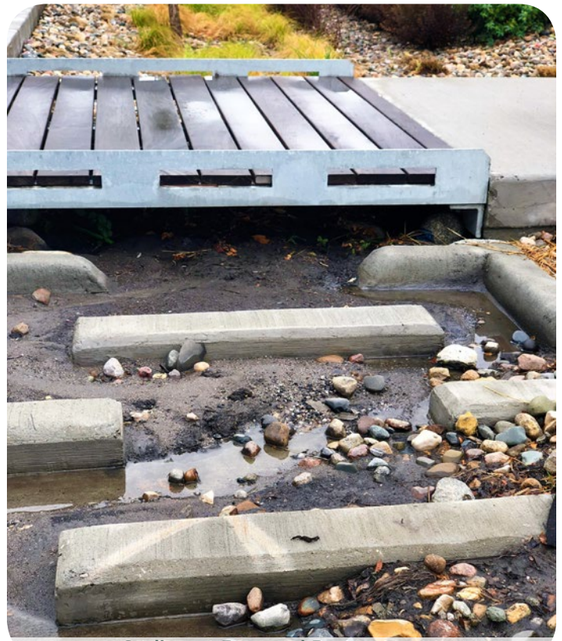
Pretreatment should be considered on all GSI practices. Size, type and extent of pretreatment needs vary by GSI design. Energy dissipation, grass buffer strips and inlet catch baskets may be adequate for smaller scale GSI. Larger scale, centralized GSI require more robust pretreatment devices to limit sediment loading and collect trash.

Design Considerations:

The following are recommendations and considerations for designing GSI with pretreatment. Refer to Section 02941 Energy Dissipation and Pretreatment for construction and material specific requirements.

- Designer should specify pretreatment component device/manufacturer for each GSI facility.
- Designer should consider maintenance access and frequency of maintenance activities when selecting pretreatment measures. Pretreatment measures that require cleaning by a vehicle-mounted unit, such as a vacuum truck, must be within 10 feet of pavement that can accommodate the vehicle's size and weight.

Inlet Catch Basket



Sediment Removal Pretreatment

Pretreatment designs outside of the parameters of this guideline should be submitted for review and approval.

GSI - 3 ABOVE GRADE BARRIERS

ABOVE GRADE BARRIERS ARE PHYSICAL OR VISUAL BARRIERS PLACED AT THE EDGE OF THE GSI TO PROTECT THE FACILITY FROM TRAFFIC, PEDESTRIANS, AND IMPROPER MAINTENANCE ACTIVITIES. ABOVE GRADE BARRIERS ALSO INCREASE SAFETY FOR THE PUBLIC BY PROVIDING A VISUAL DELINEATION BETWEEN PEDESTRIAN/VEHICULAR SPACE AND THE PRIMARY GSI PRACTICE. BARRIERS MAY ALSO OFFER AN AESTHETIC BENEFIT BY PROVIDING A DECORATIVE AND DEFINED EDGE TO THE FACILITY. ABOVE GRADE BARRIERS SHOULD BE USED ANYTIME THERE IS A SIGNIFICANT CHANGE IN GRADE OR ELEVATION BETWEEN THE GSI FACILITY AND SURROUNDING PEDESTRIAN OR VEHICULAR AREA.

DESIGN DELIVERABLE CHECKLIST

- ☐ Plan view of GSI indicating location of above grade barrier(s) including northing/easting points and elevations.
- ☐ Detail/Section view of above grade barrier(s) specifying recommended product/ manufacturer, size, and dimensions (as applicable).

3.1 CURBS

Description:

Curb is a reinforced concrete barrier that surrounds the GSI practice and provides a defined edge to the facility. Curbing can be constructed above grade, serving as a physical vertical barrier, which supports collection and conveyance of stormwater. Curbing can also be flush with the surrounding grade, functioning primarily as a visual barrier and allowing for distributed sheet flow of stormwater into the facility.

Where to use:

Curbing can be applied directly adjacent to roadways or other pavements as well as in vegetated areas. Curbing is traditionally used as part of the roadway cross section to collect and convey stormwater and to promote structural stability of adjoining flexible pavements. Curbing may also be applied in vegetated areas to define and differentiate maintenance boundaries for the GSI facility and surrounding vegetation. There are five curb types typically used in GSI that can be designed to meet multiple and varying purposes.

GSI 3.1.1 **Straight Curb** is a vertical barrier that provides area separation.

Straight Curb

GSI 3.1.2 **Straight Curb and Gutter** is a vertical barrier that collects and conveys stormwater and directs it to a designated point. This is also commonly known as a “high back” curb.

Straight Curb and Gutter

GSI 3.1.3 **Roll Back Curb and Gutter** is a mountable curb that collects and conveys stormwater and directs it to a designated point. This is also commonly known as a “lazy back” curb.

Roll Back Curb and Gutter

GSI 3.1.4 **Reverse Roll Back Curb and Gutter** encourages stormwater drainage away from pavements while defining an edge. Reverse roll back curb is geometrically the same as a roll back curb and gutter, but is situated in the opposite direction with the top of curb set flush with the adjoining pavement, and the gutter line sloped away from the pavement and towards the GSI.

Reverse Roll Back Curb and Gutter

GSI 3.1.5 **Ribbon Curb** is a curb located flush with adjacent grade that designates a defined edge. Ribbon curb can be used in both pavement and non-pavement applications to create a defined edge.

Ribbon Curb

Curb designs outside of the parameters of this guideline should be submitted for review and approval.

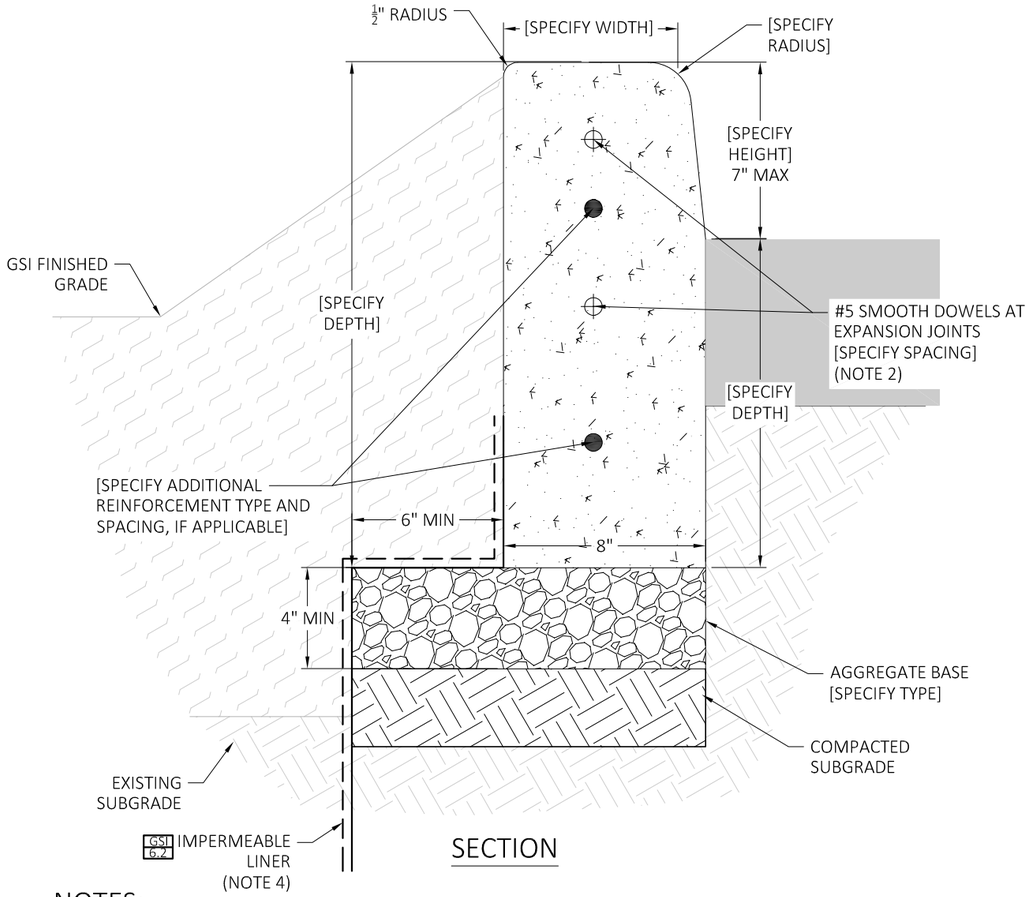
Design Considerations:

The following are recommendations and considerations for designing GSI with curb components. Refer to Section 02942 GSI Above Grade Barriers for construction and material specific requirements.

- Curbing exceeding 7 inches in height above grade should be structurally designed and reinforced to withstand expected loading and lateral earth pressures.
- When curbing is applied in a pedestrian area and extends above the grade of the pavement, a minimum 48-inch clear width in the path of travel must be maintained per US Access Board Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way. 60-inch wide passing spaces must also be provided at maximum intervals of 200 feet.
- Designer should consult the applicable City department for specifying additional requirements on curb dimensions and reinforcing.

GSI-3.1.1

ABOVE GRADE BARRIERS



SECTION

NOTES:

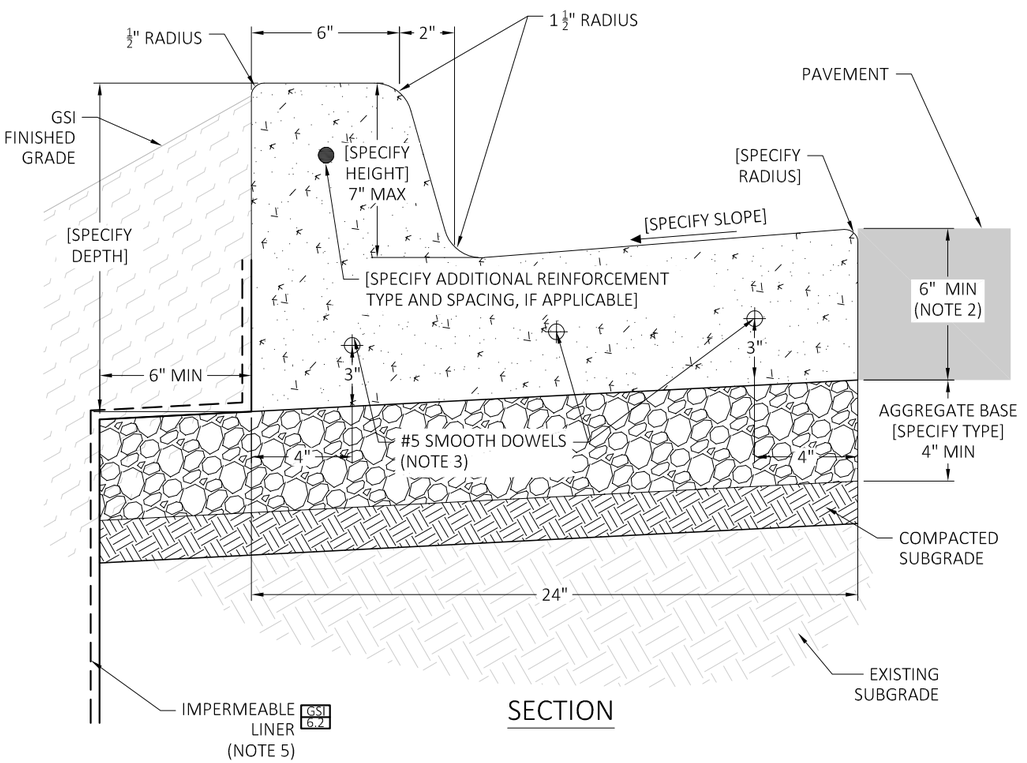
1. CURBING SHALL BE PER 02942.
2. 1/2" WIDE EXPANSION JOINTS WITH 2' DOWELS SHALL BE PLACED AT RADIUS POINTS AND AT 100' INTERVALS. THESE DOWELS SHALL BE GREASED AND WRAPPED ON ONE END WITH EXPANSION TUBES. PREMOLDED NON-EXTRUDING FILLER HOMEX-300 (1/2" THICK) OR APPROVED EQUAL. JOINT SEALER (1" DEEP) SHALL BE AS ONE COMPONENT, GUN-GRADE, MOISTURE CURED EPOXY OR URETHANE SUCH AS "VULCUM 45" OR EQUAL AS APPROVED BY THE DESIGN PROFESSIONAL.
3. 1" DEEP CONTRACTION JOINTS SHALL BE INSTALLED AT APPROXIMATELY 10' INTERVALS. THESE JOINTS SHALL PASS ACROSS THE ENTIRE CURB SECTION.
4. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

STRAIGHT CURB

AUGUST 2018

GSI-3.1.2

ABOVE GRADE BARRIERS



SECTION

NOTES:

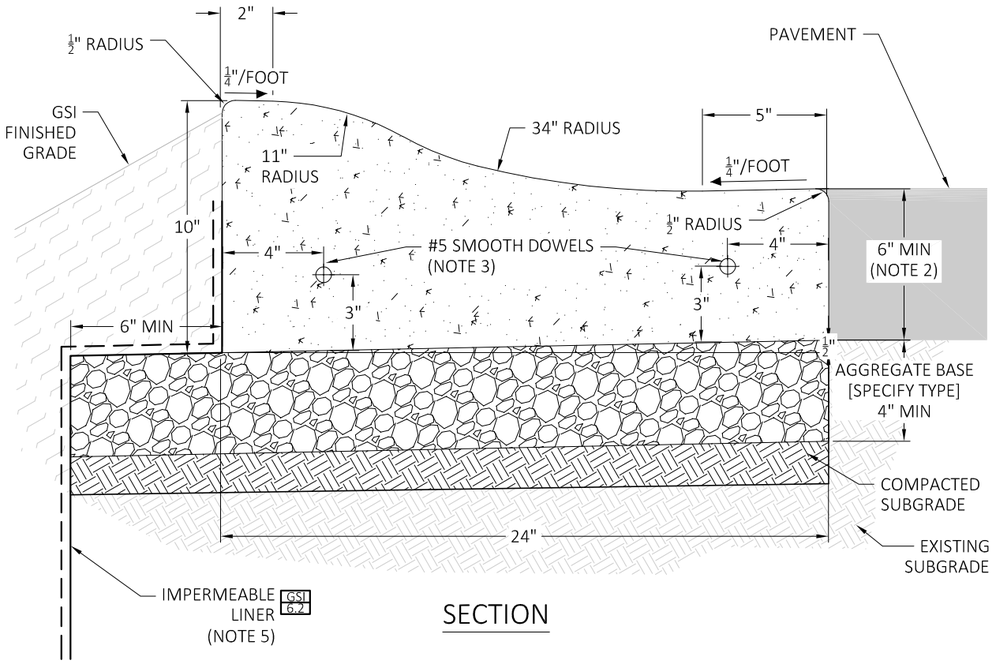
1. CURBING SHALL BE PER 02942.
2. DEPTH OF CURB SHALL BE MINIMUM OF 8" THRU HANDICAP ACCESS RAMPS.
3. 1/2" WIDE EXPANSION JOINTS WITH 2' DOWELS SHALL BE PLACED AT RADIUS POINTS AND AT 100' INTERVALS. THESE DOWELS SHALL BE GREASED AND WRAPPED ON ONE END WITH EXPANSION TUBES. PREMOLDED NON-EXTRUDING FILLER HOMEX-300 (1/2" THICK) OR APPROVED EQUAL. JOINT SEALER (1" DEEP) SHALL BE AS ONE COMPONENT, GUN-GRADE, MOISTURE CURED EPOXY OR URETHANE SUCH AS "VULCUM 45" OR EQUAL AS APPROVED BY THE DESIGN PROFESSIONAL.
4. 1" DEEP CONTRACTION JOINTS SHALL BE INSTALLED AT APPROXIMATELY 10' INTERVALS. THESE JOINTS SHALL PASS ACROSS THE ENTIRE CURB SECTION.
5. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

STRAIGHT BACK CURB & GUTTER

AUGUST 2018

GSI-3.1.3

ABOVE GRADE BARRIERS



SECTION

NOTES:

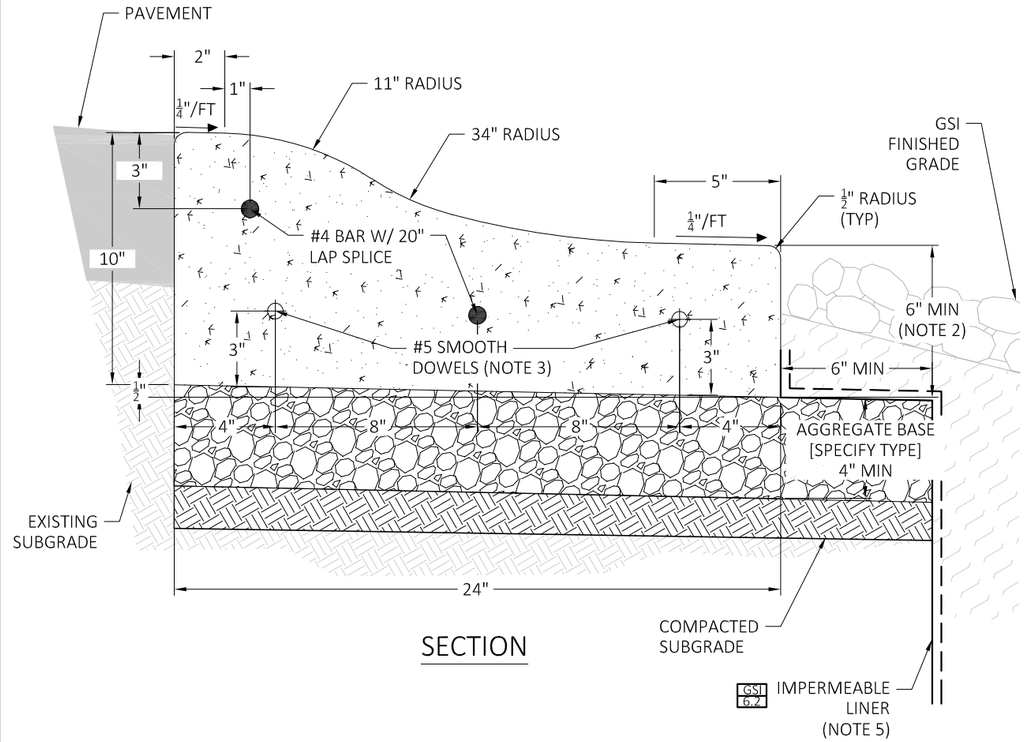
1. CURBING SHALL BE PER 02942.
2. DEPTH OF CURB SHALL BE MINIMUM OF 8" THRU HANDICAP ACCESS RAMPS.
3. 1/2" WIDE EXPANSION JOINTS WITH 2' DOWELS SHALL BE PLACED AT RADIUS POINTS AND AT 100' INTERVALS. THESE DOWELS SHALL BE GREASED AND WRAPPED ON ONE END WITH EXPANSION TUBES. PREMOLDED NON-EXTRUDING FILLER HOMEX-300 (1/2" THICK) OR APPROVED EQUAL. JOINT SEALER (1" DEEP) SHALL BE AS ONE COMPONENT, GUN-GRADE, MOISTURE CURED EPOXY OR URETHANE SUCH AS "VULCUM 45" OR EQUAL AS APPROVED BY THE DESIGN PROFESSIONAL.
4. 1" DEEP CONTRACTION JOINTS SHALL BE INSTALLED AT APPROXIMATELY 10' INTERVALS. THESE JOINTS SHALL PASS ACROSS THE ENTIRE CURB SECTION.
5. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

ROLL BACK CURB & GUTTER

AUGUST 2018

GSI-3.1.4

ABOVE GRADE BARRIERS



SECTION

NOTES:

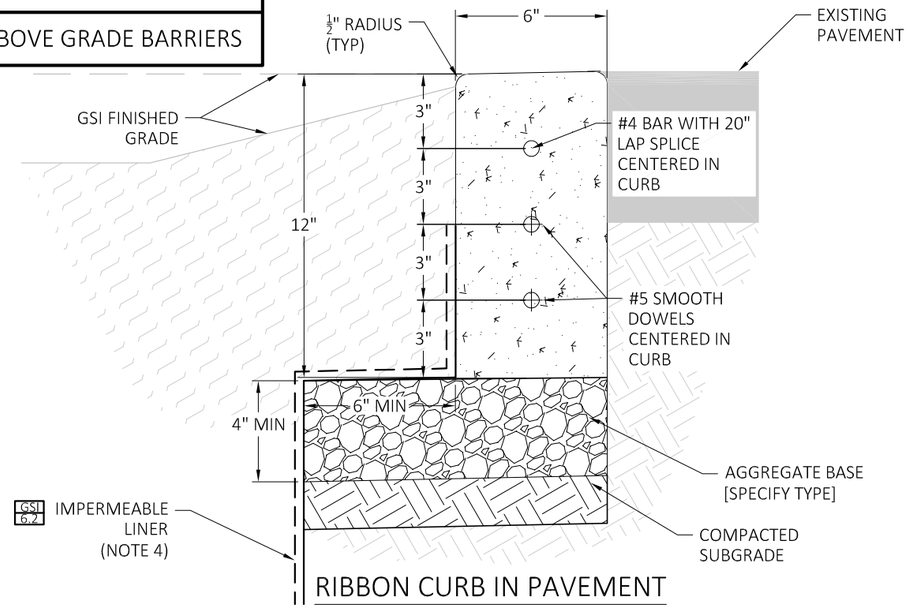
1. CURBING SHALL BE PER 02942.
2. DEPTH OF CURB SHALL BE MINIMUM OF 8" THRU HANDICAP ACCESS RAMPS.
3. 1/2" WIDE EXPANSION JOINTS WITH 2' DOWELS SHALL BE PLACED AT RADIUS POINTS AND AT 100' INTERVALS. THESE DOWELS SHALL BE GREASED AND WRAPPED ON ONE END WITH EXPANSION TUBES. PREMOLDED NON-EXTRUDING FILLER HOMEX-300 (1/2" THICK) OR APPROVED EQUAL. JOINT SEALER (1" DEEP) SHALL BE AS ONE COMPONENT, GUN-GRADE, MOISTURE CURED EPOXY OR URETHANE SUCH AS "VULCUM 45" OR EQUAL AS APPROVED BY THE DESIGN PROFESSIONAL.
4. 1" DEEP CONTRACTION JOINTS SHALL BE INSTALLED AT APPROXIMATELY 10' INTERVALS. THESE JOINTS SHALL PASS ACROSS THE ENTIRE CURB SECTION.
5. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

REVERSE ROLL BACK CURB & GUTTER

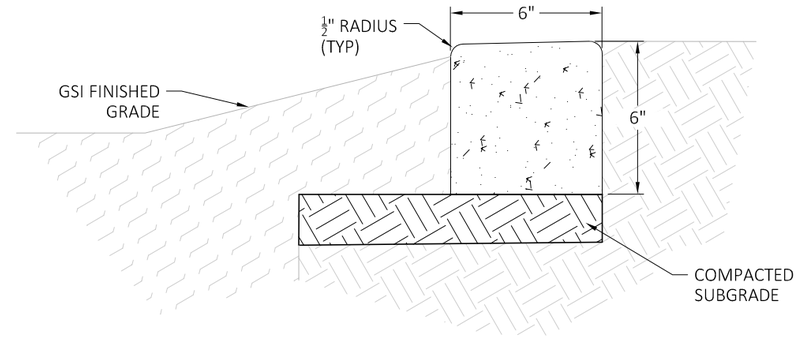
AUGUST 2018

GSI-3.1.5

ABOVE GRADE BARRIERS



RIBBON CURB IN PAVEMENT



RIBBON CURB IN SOIL

NOTES:

1. CURBING SHALL BE PER 02942.
2. 1/2" WIDE EXPANSION JOINTS WITH 2' DOWELS SHALL BE PLACED AT RADIUS POINTS AND AT 100' INTERVALS. THESE DOWELS SHALL BE GREASED AND WRAPPED ON ONE END WITH EXPANSION TUBES. PREMOLDED NON-EXTRUDING FILLER HOMEX-300 (1/2" THICK) OR APPROVED EQUAL. JOINT SEALER (1" DEEP) SHALL BE AS ONE COMPONENT, GUN-GRADE, MOISTURE CURED EPOXY OR URETHANE SUCH AS "VULCUM 45" OR EQUAL AS APPROVED BY THE DESIGN PROFESSIONAL.
3. 1" DEEP CONTRACTION JOINTS SHALL BE INSTALLED AT APPROXIMATELY 10' INTERVALS. THESE JOINTS SHALL PASS ACROSS THE ENTIRE CURB SECTION.
4. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE TRENCH AND SHALL EXTEND 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

RIBBON CURB

AUGUST 2018

3.2 FENCING & RAILINGS

Description:

Fencing is a vertical boundary that can delineate GSI extents while providing an aesthetic decorative barrier. Railings provide this same function but are intended for areas where pedestrian safety is a concern, usually due to significant elevation changes. Common fencing and railing types used with GSI include:

GSI 3.2.1 Wood Fencing

GSI 3.2.2 Metal Fencing

Where to use:

Fencing and railings are primarily used within pedestrian walking surfaces to designate GSI boundaries and discourage public access. Fencing or railings should be used any time the change in grade between the GSI and the adjacent surface exceeds 30 inches, when adjacent slopes exceed 2:1 (horizontal: vertical), or to meet the site specific safety requirements.

Wood Fencing

Metal Fencing

Design Considerations:

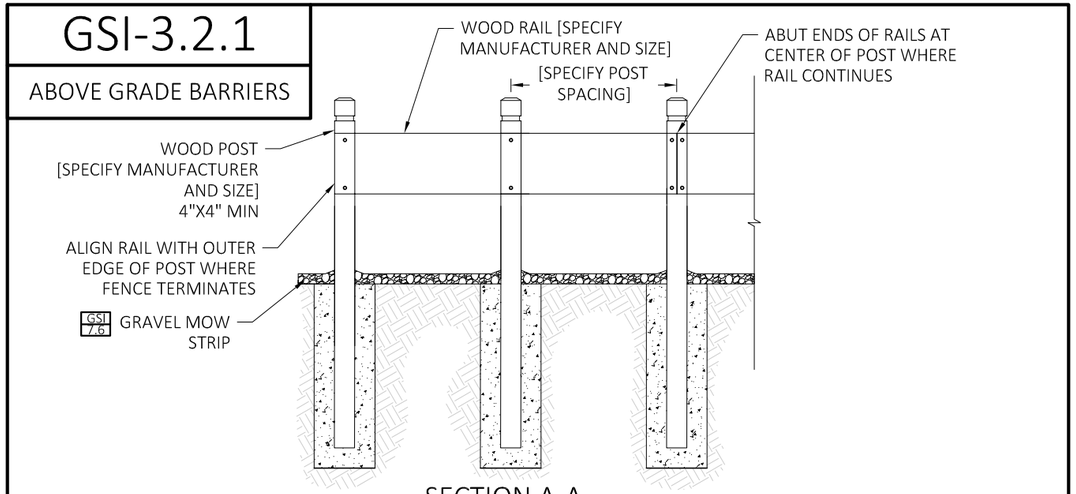
The following are recommendations and considerations for designing GSI with fencing and/or railing components. Refer to Section 02942 GSI Above Grade Barriers for construction and material specific requirements.

- Fencing and railings adjacent to roadways should not infringe on line-of-site requirements. A minimum 2-foot clear zone should be maintained between the roadway edge and the fence or railing.
- When fencing or railing is applied in a pedestrian area, a minimum 48-inch clear width in the path of travel must be maintained per US Access Board Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way. 60-inch wide passing spaces must also be provided at maximum intervals of 200 feet.
- Fencing and railing should have a minimum height of 36 inches. When vertical drop between the pedestrian area and the GSI exceeds 30 inches, minimum fencing/railing height should be 42 inches, or per the requirements of the International Building Code.
- Fencing and railing should have a minimum clear distance of 1 inch between bottom elevation of bottom rail and top of finished grade beneath the fence. When applied as protection against a significant drop, the bottom rail must be a maximum 15 inches above the ground surface per Public Rights-of-way Accessibility Guidelines.
- Fencing and railing placement should consider access for maintenance. When the barrier extends around the entire facility, include a gate for access.

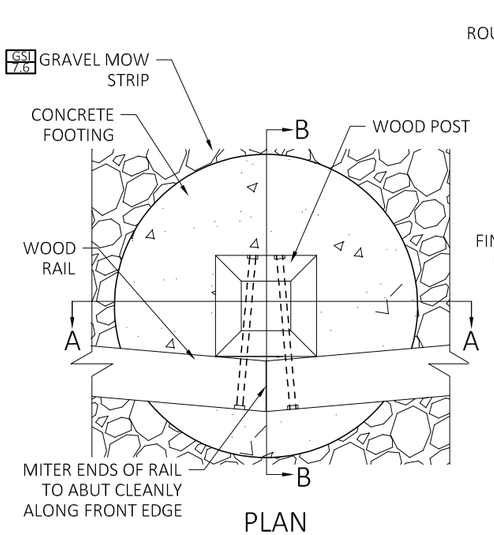
Fencing and railing designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-3.2.1

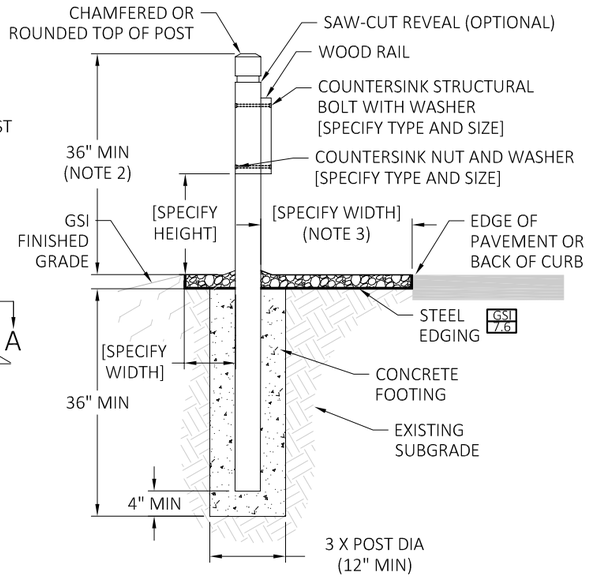
ABOVE GRADE BARRIERS



SECTION A-A



PLAN



SECTION B-B

NOTES:

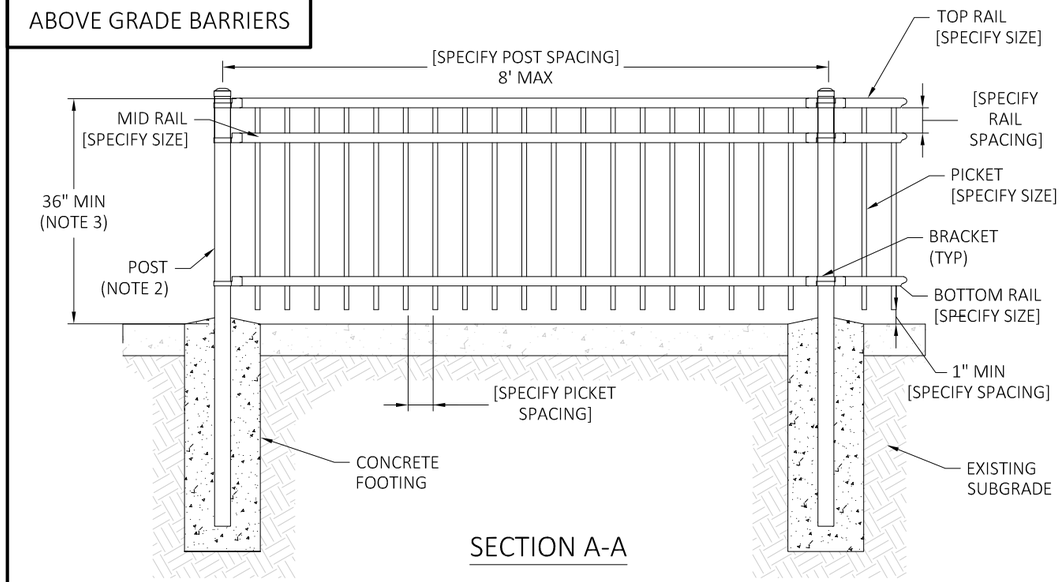
1. WOOD FENCING SHALL BE PER 02942.
2. WHEN VERTICAL DROP BETWEEN PEDESTRIAN AREA AND GSI EXCEEDS 30 INCHES, MINIMUM FENCE HEIGHT OF 42 INCHES IS REQUIRED. DESIGNER TO SPECIFY FENCE HEIGHT.
3. WHEN FENCING IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED.

WOOD FENCING

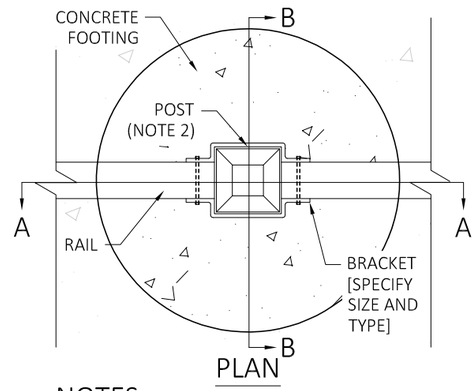
AUGUST 2018

GSI-3.2.2

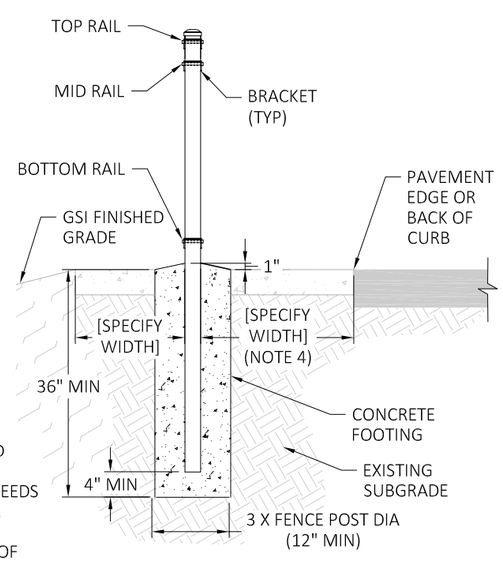
ABOVE GRADE BARRIERS



SECTION A-A



PLAN



SECTION B-B

NOTES:

1. METAL FENCING SHALL BE PER 02942.
2. POST SIZE DEPENDS ON FENCE HEIGHT, EXPECTED LOADING, AND WIND FORCE. DESIGNER TO SPECIFY POST SIZE AND HEIGHT.
3. WHEN VERTICAL DROP BETWEEN PEDESTRIAN AREA AND GSI EXCEEDS 30 INCHES, MINIMUM FENCE HEIGHT OF 42 INCHES IS REQUIRED.
4. WHEN FENCING IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED.
5. DIMENSIONS SHOULD BE STANDARD PER MANUFACTURER REQUIREMENTS.

METAL FENCING

AUGUST 2018

3.3 BOLLARDS

Description:

Bollards provide vertical demarcation to bring attention to the GSI location. Bollards may be metal, wood, or concrete material with a reflector to provide enhanced visibility.

GSI 3.3.1 Wood Bollard

GSI 3.3.2 Metal Bollard

GSI 3.3.3 Concrete Bollard

GSI 3.3.4 Removable Bollard

Specialty bollards may also be used to incorporate a more artistic element to the above grade barrier design.

Where to use:

Bollards should be used roadside to provide a visual demarcation of the GSI. Bollards may also be used at the entrance to plazas or trails to prevent vehicular traffic from entering the pedestrian areas, or to provide a visual notice in the change of use between two spaces. Removable bollards can be utilized where maintenance access is needed, but other vehicular traffic is not permitted.

Metal Bollard

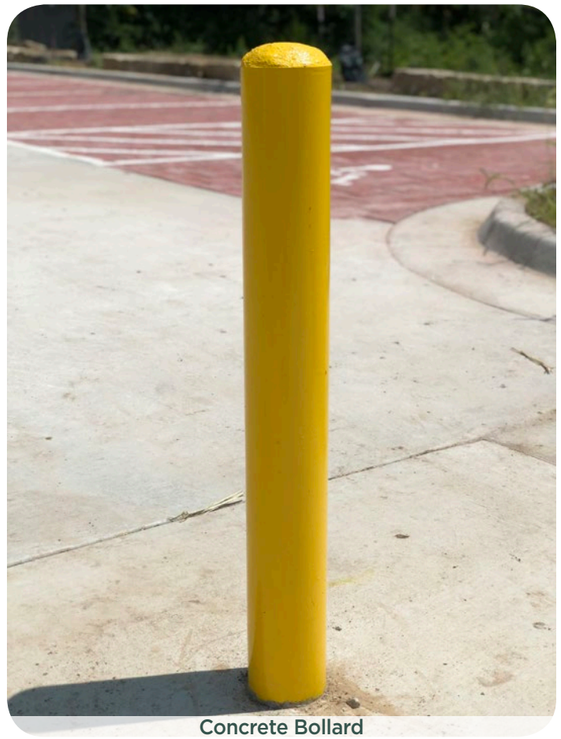
Removable Bollard

Wood Bollard

Design Considerations:

The following are recommendations and considerations for designing GSI with bollards. Refer to Section 02942 GSI Above Grade Barriers for construction and material specific requirements.

- Bollards adjacent to roadways should consider line-of-site requirements. A minimum 2-feet clear zone should be maintained between the roadway edge and the bollard.
- For pedestrian applications of bollards, a minimum 48-inch clear width in the path of travel and between adjacent bollards must be maintained per US Access Board Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way.
- Bollards should include reflectors to increase visibility.
- Break-away bollards are preferred in the vicinity of vehicular areas for ease of replacement. Bollards in trailhead or maintenance path applications where vehicles will need to access must be removable.



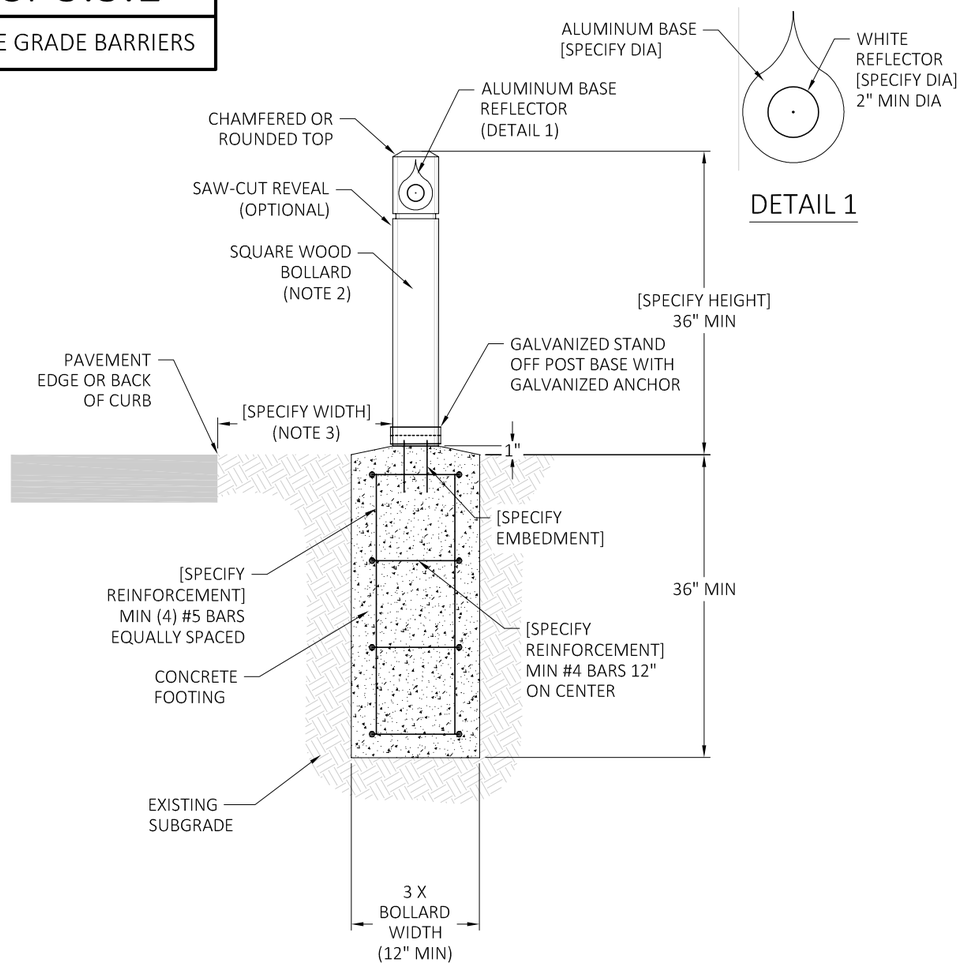
Concrete Bollard

Specialty Bollard

Bollard designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-3.3.1

ABOVE GRADE BARRIERS



SECTION

NOTES:

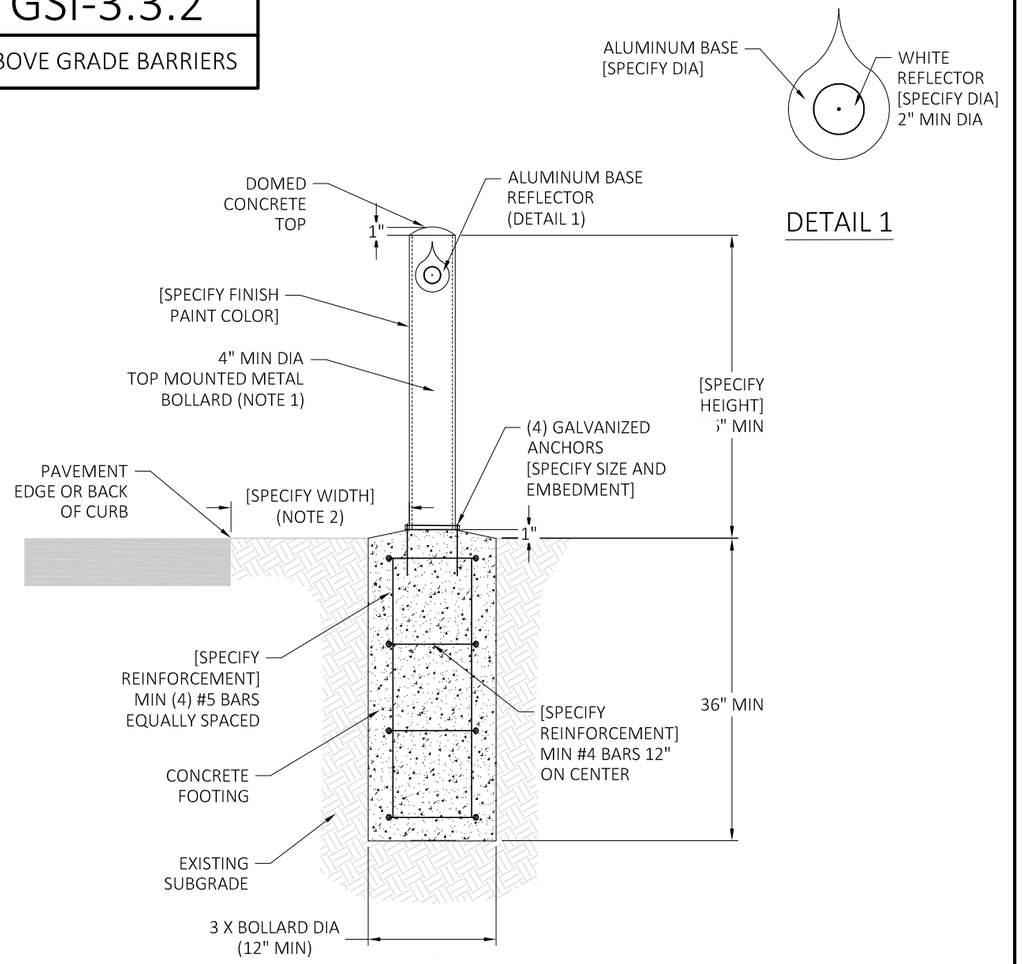
1. WOOD BOLLARD SHALL BE PER 02942.
2. DESIGNER TO SPECIFY SIZE AND FINISH.
3. WHEN BOLLARD IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED.

WOOD BOLLARD

AUGUST 2018

GSI-3.3.2

ABOVE GRADE BARRIERS



SECTION

NOTES:

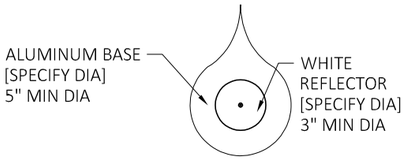
1. METAL BOLLARD SHALL BE MINIMUM SCHEDULE 40 STEEL AND CONCRETE FILLED PER 02942.
2. WHEN BOLLARD IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED

METAL BOLLARD

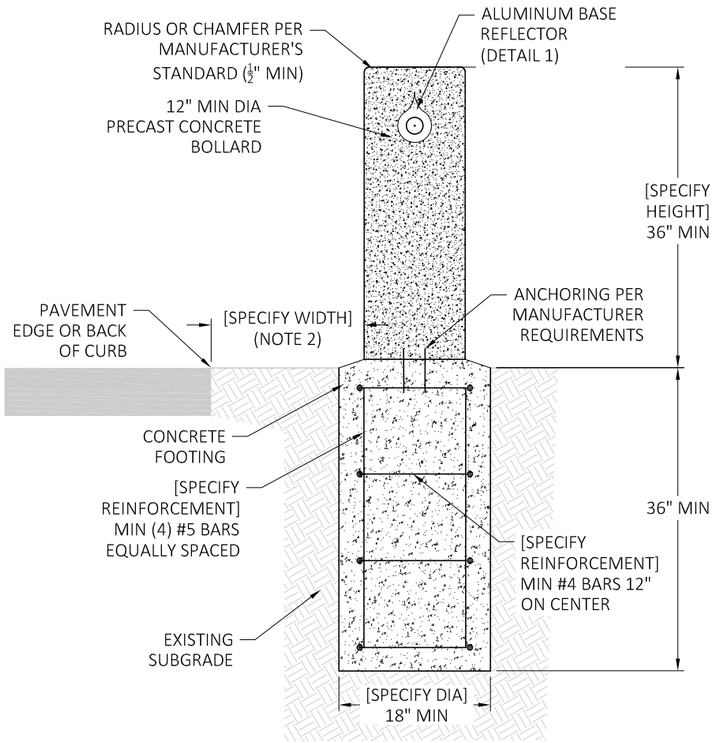
AUGUST 2018

GSI-3.3.3

ABOVE GRADE BARRIERS



DETAIL 1



SECTION

NOTES:

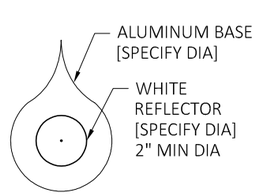
1. PRECAST CONCRETE BOLLARD SHALL BE PER 02942.
2. WHEN BOLLARD IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED

PRECAST CONCRETE BOLLARD

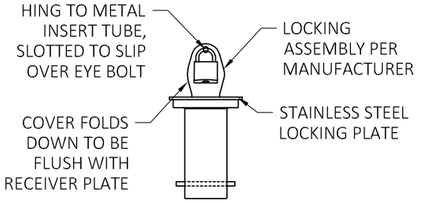
AUGUST 2018

GSI-3.3.4

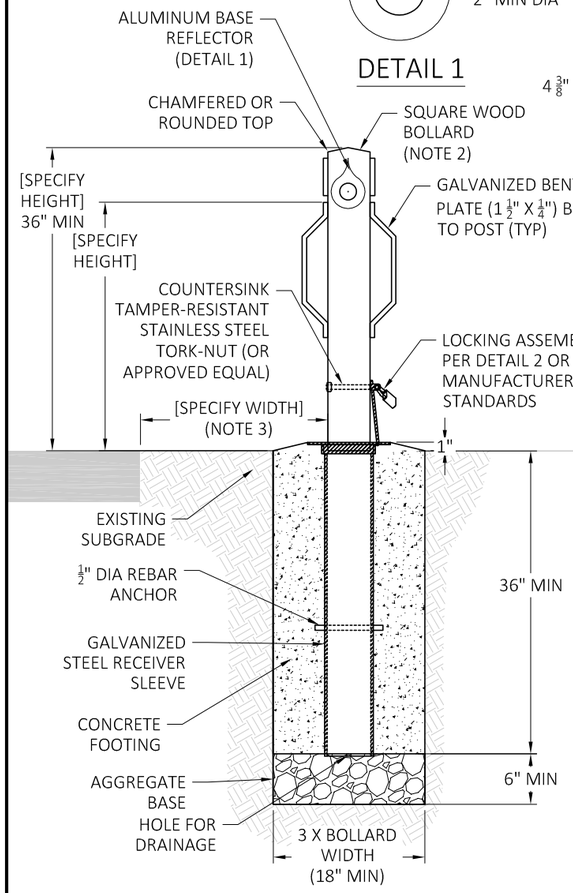
ABOVE GRADE BARRIERS



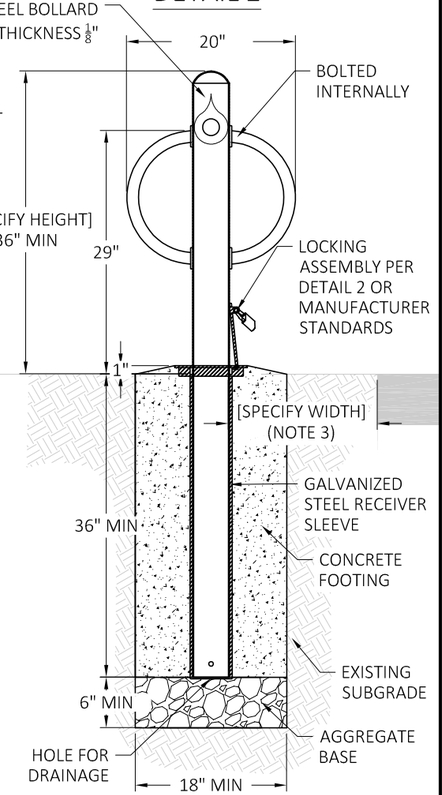
DETAIL 1



DETAIL 2



WOOD REMOVABLE BOLLARD SECTION



METAL REMOVABLE BOLLARD SECTION

NOTES:

1. REMOVABLE BOLLARD SHALL BE PER 02942.
2. DESIGNER TO SPECIFY SIZE AND FINISH.
3. WHEN BOLLARD IS APPLIED ADJACENT TO STREET PAVEMENT, A MINIMUM 2 FOOT OFFSET FROM THE FENCE POST TO THE EDGE OF PAVEMENT IS REQUIRED

REMOVABLE BOLLARD

AUGUST 2018

3.4 STONE BARRIERS

Description:

Stone barriers include both stone boulders and ledgestone walls, both providing a vertical barrier with a more natural edge. Ledgestone can also function as a wall to provide greater flexibility with grade changes.

Common types of stone barriers include but are not limited to:

GSI 3.4.1 Stone Boulder

GSI 3.4.2 Ledgestone

Where to use:

Stone boulders should be used in areas with large open spaces, such as parks or wide medians, to provide a visual boundary. Stone boulders are not recommended for areas directly adjacent to traffic and should follow clear zone design requirements in this application. Ledgestone may be used in steeper slope applications to allow for increased changes in grade while providing structural stability for the adjacent slope.

Design Considerations:

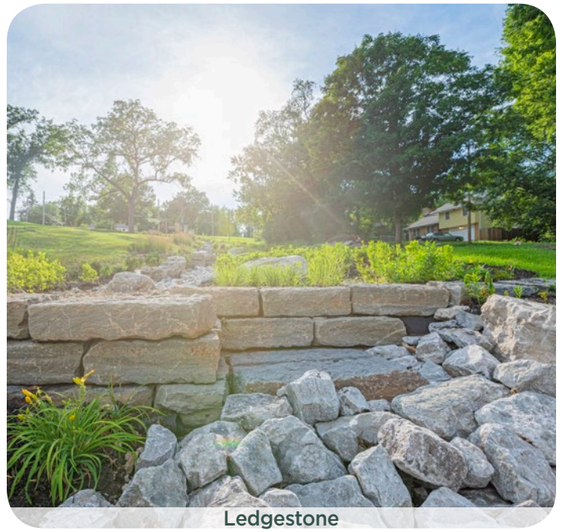
The following are recommendations and considerations for designing GSI with stone barriers. Refer to Section 02942 GSI Above Grade Barriers for construction and material specific requirements.

Designer should specify desired size and spacing of stone boulders. Height and spacing of boulder should not impede visibility of other GSI aesthetics or maintenance access.

A minimum of one maintenance access point is required for each GSI site. Spacing of stone boulders should consider access for maintenance.

- Where vehicular access is needed between stone boulders, a minimum width of 14 feet should be maintained between boulders.
- Where pedestrian access is required between stone boulders, a minimum width of 4 feet should be maintained between adjacent boulders.

In retaining wall applications, ledgestone should be structurally designed to withstand the anticipated loading and provide sufficient reinforcement for adjacent slope. Provisions for drainage shall be provided to relieve hydrostatic pressure buildup behind the wall.



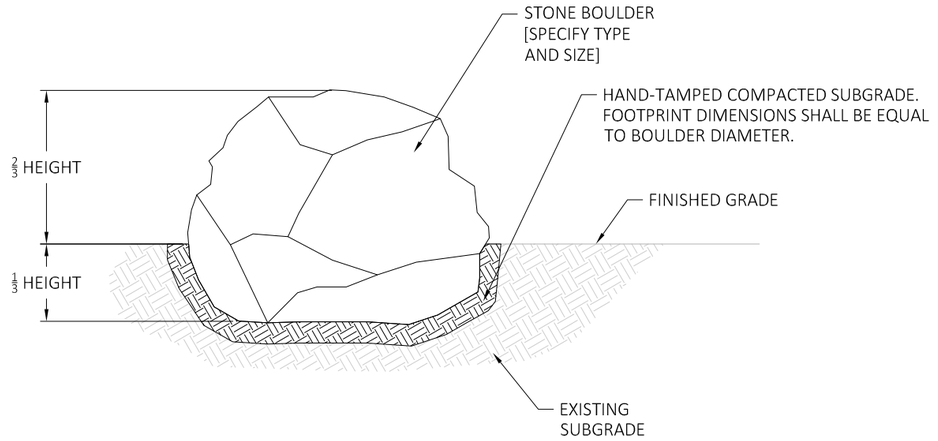
Ledgestone

Stone Boulder

Stone barriers outside of the parameters of this guideline should be submitted for review and approval.

GSI-3.4.1

ABOVE GRADE BARRIERS



SECTION

NOTES:

1. STONE BOULDER SHALL BE PER 02942.
2. SIZE OF BOULDER SHALL BE DETERMINED BY MEASURING HORIZONTALLY AT WIDEST SECTION OF STONE AT 1/3 HEIGHT

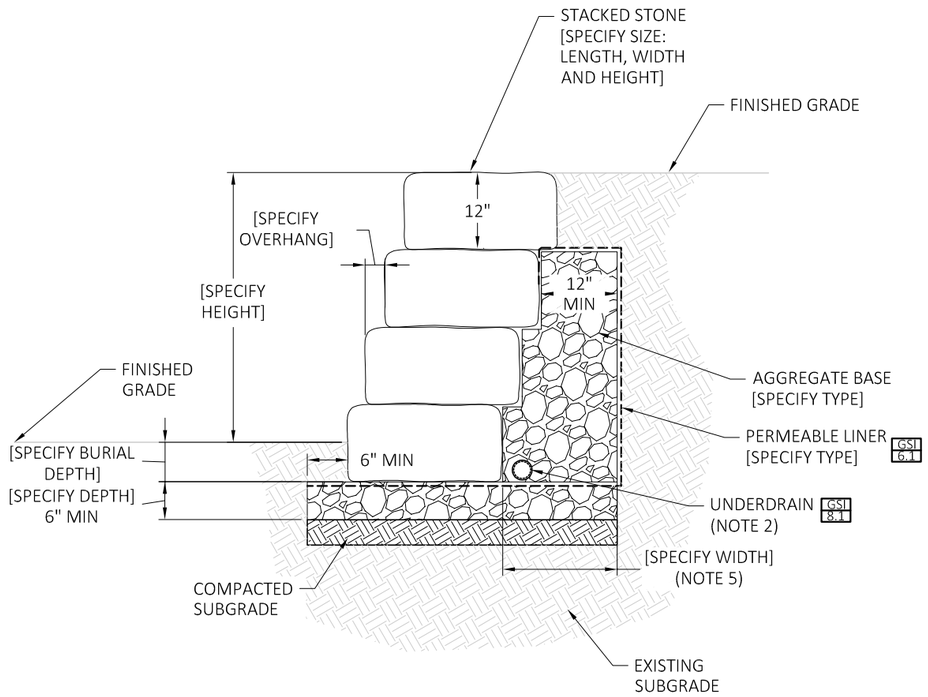
STONE BOULDER

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

GSI-3.4.2

ABOVE GRADE BARRIERS



SECTION

NOTES:

1. STACKED STONE SHALL BE PER 02942.
2. UNDERDRAIN SHALL HAVE A MINIMUM SLOPE OF 0.5% ALONG THE WALL AND DAYLIGHT AT THE END OF THE WALL, OR TO WEEP HOLES AT THE BOTTOM OF THE WALL.
3. STONES SHALL BE STACKED IN A RUNNING BOND PATTERN.
4. STACKED STONE WALLS SHALL BE DESIGNED TO WITHSTAND THE ANTICIPATED SOIL PRESSURE AND PROVIDE SUFFICIENT REINFORCEMENT FOR ADJACENT SLOPE.
5. WIDTH OF AGGREGATE BASE FROM BACK OF BOTTOM STONE SHALL BE EQUAL TO THE TOTAL HEIGHT OF THE WALL.

LEDGESTONE

AUGUST 2018

3.5 CURB GUARDS

Description:

A curb guard is a steel plate that covers an opening in the curb line, providing a consistent curb elevation. A curb guard protects the curb and provides an extension of the vertical barrier.

Where to use:

A curb guards extends over a curb cut (GSI-1.2) to provide an extension of the curb line.

Design Considerations:

The following are recommendations and considerations for designing GSI with a curb guard. Refer to Section 02942 GSI Above Grade Barriers for construction and material specific requirements.

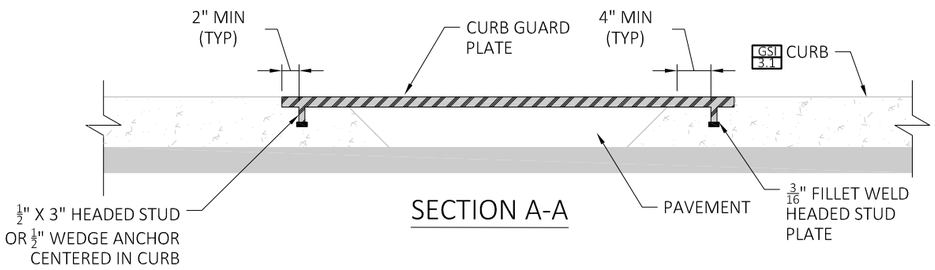
- Designer to specify thickness of curb guard plate based on span of curb opening.
- Manufactured products such as Neenah R-3262 Curb Opening or approved equals may be used in place of a curb guard.

Curb Guard

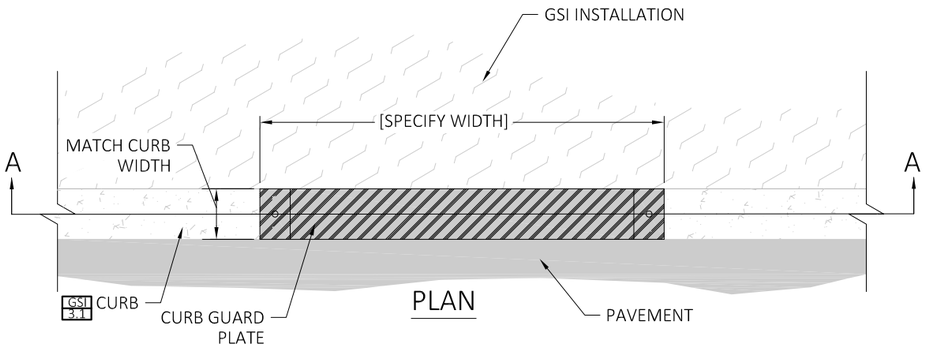
Curb guard designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-3.5

ABOVE GRADE BARRIERS



SECTION A-A



PLAN

NOTES:

1. CURB GUARD SHALL BE PER 02942.

CURB GUARD

AUGUST 2018

GSI – 4 PERMEABLE PAVEMENT

PERMEABLE PAVEMENT ALLOWS FOR INFILTRATION OF STORMWATER THROUGH VOIDS OR PORES IN THE PAVEMENT MATERIAL. PERMEABLE PAVEMENT FUNCTIONS PRIMARILY AS AN INLET, COLLECTING STORMWATER RUNOFF AT THE SURFACE AND INFILTRATING INTO THE SUBSURFACE AGGREGATE STORAGE MEDIA. USE OF PERMEABLE PAVEMENT IN PLACE OF STANDARD PAVEMENT EFFECTIVELY REDUCES THE VOLUME OF STORMWATER RUNOFF BY REDUCING IMPERVIOUS AREA AND INFILTRATING STORMWATER AT THE SOURCE.

DESIGN DELIVERABLE CHECKLIST

- ☐ In-situ infiltration test results for all GSI sites. Reference Section 02956 Green Stormwater Infrastructure In-situ Infiltration Testing for recommended test methodology.
- ☐ Plan view of GSI specifying extents of permeable pavement with northing/easting points, and elevations.
- ☐ Detail/Section view of GSI specifying type of permeable pavement, with type and depth of aggregate media layers, referencing material specifications.
- ☐ Grading plan should identify Survey Verification Points along the boundaries of the permeable pavement and spot elevations within the finished grade of the pavement for contractor verification during construction.

4.1 PERVIOUS CONCRETE

Description:

Pervious concrete is a specialty concrete mix consisting of approximately 20 to 25% voids. Pervious concrete functions as the surface material in a permeable pavement GSI allowing water to pass through the voids in the surface as opposed to ponding and running off the pavement. A storage aggregate media layer is located below the pervious concrete, which allows for the temporary storage of stormwater and serves as the structural subbase.

Where to use:

Pervious concrete can be used in lieu of traditional pavement. It is primarily used in settings with minimal shear stress such as trails, sidewalks, alleyways, parking lots, and parking stalls. Pervious concrete should not be used in high truck traffic areas, nor in drive lanes where the pervious concrete surface will be exposed to excessive shear stress. The potential for eroding adjacent slopes and other vegetation should be considered when locating pervious concrete applications. Pervious concrete should not be used within the right-of-way without an operation and maintenance agreement in place. Use of permeable pavement within the right-of-way requires City Engineer's approval.

Pervious Concrete

Design Considerations:

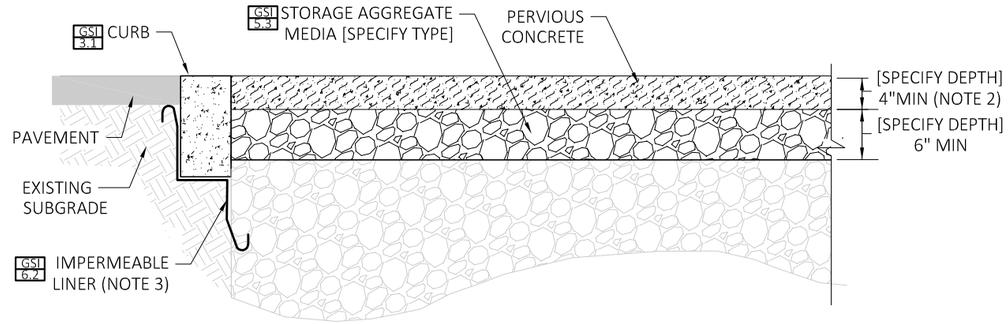
The following are recommendations and considerations for designing pervious concrete components. Refer to Section 02943 Green Stormwater Infrastructure Pervious Concrete for construction and material specific requirements.

- For applications bringing stormwater runoff from upstream drainage area to the pervious concrete, it is recommended that runoff be loaded as distributed sheet flow.
- Pervious concrete may be used in place of a traditional impermeable surface, to reduce impervious area, and therefore reduce stormwater runoff.
- Depth of pervious concrete pavement depends on desired vehicular loading requirements for the application. Designer should specify pervious concrete pavement depths on the Construction Plans. Recommended pavement depths for pervious concrete applications:
  - Sidewalks = 4 to 5 inches
  - Parking Areas = 6 to 8 inches
- Depth of storage aggregate media depends on designed storage volume for the GSI practice per GSI-5.3. No. 57 aggregate is recommended directly below the pervious concrete surface.
- It is recommended that designer specify pre- and post-construction infiltration testing per Section 02956 on all permeable pavement applications.

Pervious concrete designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-4.1

PERMEABLE PAVEMENT



SECTION

NOTES:

1. PERVIOUS CONCRETE SHALL BE PER 02943.
2. DESIGNER TO SPECIFY DEPTH OF PERVIOUS CONCRETE. DEPTH SHALL BE DESIGNED TO WITHSTAND ANTICIPATED STRUCTURAL LOADING.
3. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE GSI AND SHALL EXTEND A MINIMUM OF 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

PERVIOUS CONCRETE

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

4.2 POROUS ASPHALT

Description:

According to NAPA guidelines, porous asphalt is a specialized hot mix asphalt consisting of 16 to 22% voids. Porous asphalt allows water to pass through the voids in the asphalt surface as opposed to ponding and running off the pavement surface. A storage aggregate media layer is located below the porous asphalt to stabilize the surface and provide temporary stormwater storage.

Where to use:

Porous asphalt can be used in lieu of traditional pavement in many applications. It is primarily used in applications with minimal vertical loads and shear stresses such as trails, sidewalks, alleyways, parking lots, and parking stalls. Porous asphalt should not be used in high truck traffic areas with excessive vertical loads, nor in drive lanes where the porous asphalt surface will be exposed to excessive shear stress. The potential for eroding adjacent slopes and other vegetation should be considered when locating porous asphalt installations. Porous asphalt should not be used within the right-of-way.

Porous Asphalt

Design Considerations:

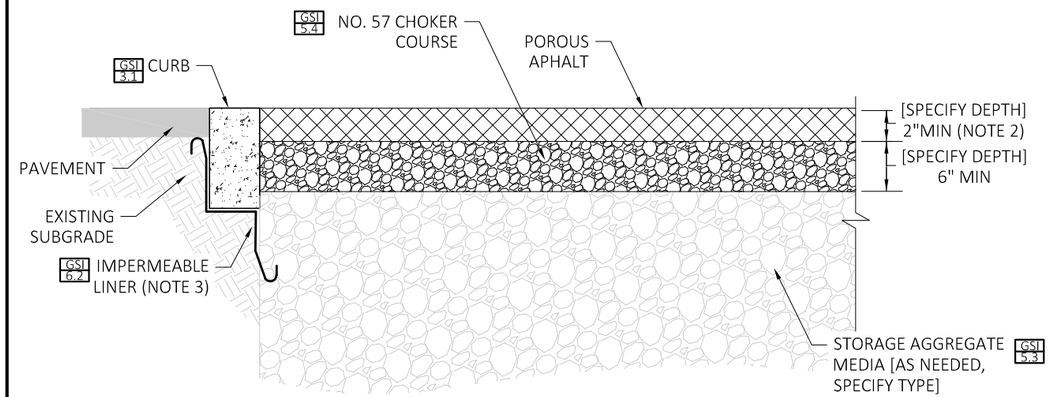
The following are recommendations and considerations for designing porous asphalt components. Refer to Section 02944 Green Stormwater Infrastructure Porous Asphalt for construction and material specific requirements.

- For applications bringing stormwater runoff from upstream drainage area to the porous asphalt, it is recommended that stormwater runoff be loaded as distributed sheet flow.
- Porous asphalt may be used in place of another traditional impermeable surface, to reduce impervious area, and therefore reduce stormwater runoff.
- Depth of porous asphalt pavement depends on desired vehicular loading requirements for the application. Recommended pavement depths for porous asphalt applications typically range from 2 to 5 inches, but may vary based on site specific requirements.
- Depth of storage aggregate media depends on designed volume for the GSI practice, per GSI-5.3, and structural stability requirements for the pavement. No. 57 aggregate is required immediately below the porous asphalt surface.
- It is recommended that designer specify pre- and post-construction infiltration testing per Section 02956 on all permeable pavement applications.

Porous asphalt designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-4.2

PERMEABLE PAVEMENT



SECTION

NOTES:

1. POROUS ASPHALT SHALL BE PER 02944.
2. DESIGNER TO SPECIFY DEPTH OF POROUS ASPHALT. DEPTH SHALL BE DESIGNED TO WITHSTAND ANTICIPATED STRUCTURAL LOADING.
3. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE GSI AND SHALL EXTEND A MINIMUM OF 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION. SPECIFY TYPE.

POROUS ASPHALT

AUGUST 2018

4.3 PERMEABLE PAVERS

Description:

Permeable pavers are unit paver systems that allow water to pass through the joints or openings between the individual pavers. Permeable pavers typically incorporate a choker course and a storage aggregate media layer beneath the paver surface that allows for the temporary storage of stormwater. Permeable pavers may also incorporate jointing and bedding material.

Where to use:

Permeable pavers can be used in lieu of traditional pavement in most applications. Designer should consult the paver manufacturer for appropriate design loads for the material. The potential for eroding adjacent slopes and other vegetation should be considered when locating permeable paver installations. Permeable pavers should not be used within the right-of-way without an operation and maintenance agreement in place. Use of permeable pavement within the right-of-way requires City Engineer's approval.

Permeable Pavers

Permeable Pavers

Design Considerations:

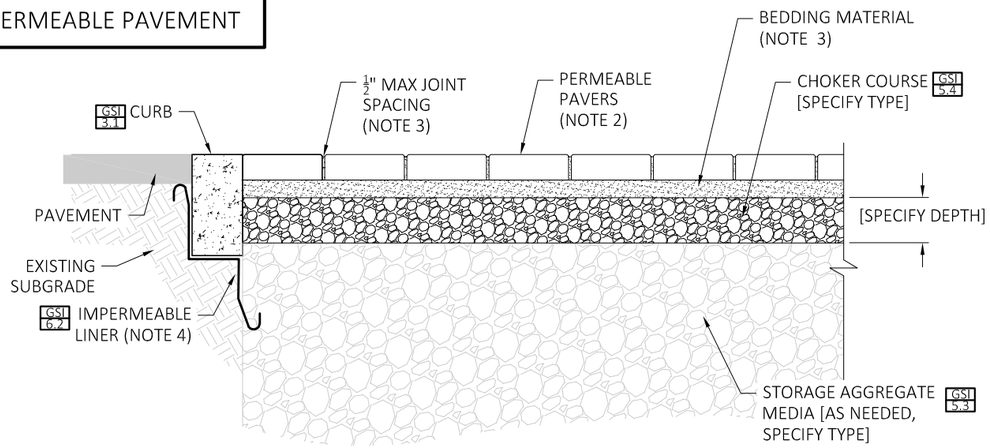
The following are recommendations and considerations for designing permeable paver components. Refer to Section 02945 Green Stormwater Infrastructure Permeable Pavers for construction and material specific requirements.

- For applications bringing stormwater runoff from upstream areas to the permeable pavers, it is recommended that stormwater runoff be loaded as distributed sheet flow.
- Permeable pavers may be used in place of another traditional impermeable surface, to reduce impervious area, and therefore reduce stormwater runoff.
- Depth of permeable paver, choker course, jointing and bedding material, and paver spacing depends on the manufactured paver product. Designer should specify paver manufacturer or approved equal. When pavers are applied in a pedestrian area, joint spacing should not exceed 1/2 inch per ADA Standards for Accessible Design.
- Depth and type of storage aggregate media depends on required storage volume for the GSI practice, per GSI-5.3.
- It is recommended that designer specify pre- and post-construction infiltration testing per Section 02956 on all permeable pavement applications.

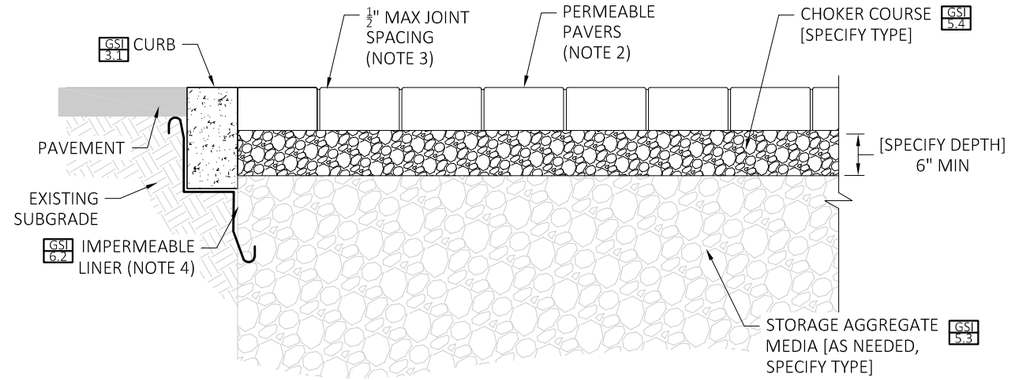
Permeable paver designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-4.3

PERMEABLE PAVEMENT



PERMEABLE PAVERS WITH JOINTING MATERIAL



PERMEABLE PAVERS WITHOUT JOINTING MATERIAL

NOTES:

1. PERMEABLE PAVERS SHALL BE PER 02945.
2. DESIGNER TO SPECIFY MANUFACTURER AND TYPE OF PERMEABLE PAVERS. THICKNESS OF PERMEABLE PAVERS PER MANUFACTURER REQUIREMENTS DEPENDENT ON APPLICATION. PERMEABLE PAVERS SHALL HAVE CHAMFERED EDGES.
3. PERMEABLE PAVER JOINTS SHALL BE SPACED AND FILLED PER MANUFACTURER RECOMMENDATIONS. DESIGNER TO SPECIFY JOINTING AND BEDDING MATERIAL TYPE, DEPTH, AND REQUIRED SPACING.
4. IF GSI IS ADJACENT TO STREET PAVEMENT, AN IMPERMEABLE LINER IS REQUIRED ALONG THE STREET SIDE OF THE GSI AND SHALL EXTEND A MINIMUM OF 30" BELOW THE BOTTOM ELEVATION OF THE PAVEMENT SECTION.

PERMEABLE PAVERS

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

GSI – 5 SOIL & AGGREGATE MEDIA

SOIL AND AGGREGATE SERVE AS THE PRIMARY STORAGE AND FILTRATION MEDIA IN A GSI FACILITY. VOIDS IN THE MEDIA ALLOW FOR STORMWATER TO MOVE, PROVIDING FILTRATION, INFILTRATION AND STORAGE FUNCTIONS WITHIN THE GSI. STORAGE CAPACITY IS PRIMARILY RECOGNIZED IN THE COARSER AGGREGATE STORAGE MEDIA MATERIALS. FINER GRADED MEDIA PROVIDE A FILTRATION FUNCTION FOR THE GSI IN ADDITION TO SOME STORAGE. SOIL MEDIA IS ALSO DESIGNED TO SUPPORT PLANT GROWTH, WHICH IMPROVES INFILTRATION AND UPTAKE CAPACITY, AS WELL AS OVERALL PERFORMANCE OF THE GSI.

DESIGN DELIVERABLE CHECKLIST

- ☐ In-situ infiltration test results for all GSI sites. Reference Section 02956 Green Stormwater Infrastructure In-situ Infiltration Testing for recommended test methodology.
- ☐ Storage capacity calculations including tributary drainage area, impervious area percentage, target water quality volume, soil and aggregate component storage volume, and GSI total storage volume including any ponding depth if applicable.
- ☐ Plan view of GSI specifying extents of grading and GSI media with northing/easting points and elevations.
- ☐ Detail/Section view of GSI specifying depths of each soil and aggregate media layer, referencing material specifications.
- ☐ Grading plan should identify Survey Verification Points along the top and bottom of the side slope, finished surface, and spot elevations of the GSI for contractor verification during construction.

5.1 GROWING MEDIA

Description:

Growing media is a well-mixed blend of soil, organic, and aggregate medias designed to improve soil performance to better suit the application and environment within a GSI practice. Bioretention soil media, amended native soil, and structural soil are all types of growing media.

Topsoil is the uppermost layer of the soil that contains a majority of the soil's organic matter and microorganisms, making the soil more amenable to sustaining plant life.

Bioretention Soil Media consist of topsoil, sand, and compost that aids in plant growth and stormwater management. Bioretention soil media promotes infiltration, filters pollutants, and provides an organic, moisture-retentive, and chemically suitable growing media for vegetation.

Amended Native Soil Media consists of native topsoil mixed with compost to serve the same function as bioretention soil media.

Structural Soil is composed of narrowly graded crushed stone mixed with clay loam and hydrogel to provide structural support for pavement systems while promoting infiltration, moisture, and nutrients for plant growth.

Where to use:

Growing media can be used in any GSI practice intended to promote infiltration, provide stormwater storage and sustain vegetation. Bioretention and amended native soil media are typically used in vegetated GSI. Structural soil media can be used where adjacent pavement requires structural stability, with the intent of promoting vegetation growth.

Bioretention Soil Media

Design Considerations:

The following are recommendations and considerations to be taken when designing growing media. Refer to Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media for construction and material specific requirements.

- Bioretention or amended native soil media should not extend under adjacent paved areas requiring compaction or structural stability, such as curbs, sidewalks or streets. In instances where growing media is desired to extend under pavement, structural soil media should be used.
- Depth of growing media depends on application and designed storage volume for the GSI practice. Growing media layer must maintain a minimum depth of 30 inches to allow for adequate root establishment. GSI practices with trees must consider additional minimum depth requirements per GSI-7.3 Trees.
- Recommended porosity assumptions for storage capacity calculations of growing media:
  - Bioretention soil = 0.30
  - Amended native site soils = porosity should be defined by the designer, based on testing of native site soils
  - Structural soil = 0.40
- It is recommended that designer specify pre- and post-construction infiltration testing per Section 02956 on all permeable pavement applications.
- Side slopes towards the growing media are recommended to be 4:1 (horizontal:vertical) or shallower to mitigate erosion potential. Slopes should not exceed 3:1 (horizontal:vertical).

Growing media designs outside of the parameters of this guideline should be submitted for review and approval.

5.2 SAND

Description:

Sand is a fine aggregate that primarily serves to improve infiltration and filtration functions in GSI facilities. Sand media can be applied as the primary GSI media layer, as a media transition layer, or as a constituent in other GSI media mixes.

Where to use:

Sand is typically found in three primary applications in GSI. Sand can be used in sand filters, as a choker course, and as a constituent of bioretention soil media. The primary function of the sand component in each of these applications is as follows:

1. Sand as the primary media in sand filter GSI promotes infiltration and/or filtration.
2. Sand as a choker course (GSI-5.4) is a thin layer of sand between GSI media layers that acts as a transition layer between finer and courser media. It is primarily used to prevent migration of finer media to subsurface layers.
3. Sand as one of three constituents in bioretention soil media (GSI-5.1), encourages infiltration and storage.

Sand

Design Considerations:

The following are recommendations and considerations when designing sand media components. Refer to specification 02946 Green Infrastructure Soil and Aggregate Media for construction and material specific requirements.

- Sand should not extend under adjacent paved areas requiring compaction or structural stability, such as curbs, sidewalks or streets.
- Depth of sand layer depends on application of the media. The following are recommendations for sand media depths and compositions for typical applications:
  - Sand Filters: sand media depth varies per contributing drainage area, plan area of sand filter, and designed storage volume for the GSI practice. Recommended minimum depth of 18 inches.
  - Choker Course (GSI-5.4): sand media depth for a choker course typically ranges from 2 to 4 inches.
  - Bioretention Soil Media (GSI-5.1): sand typically is between 50% and 65% of the total mix design as a combination of two components: (1) the required composition of sand, and, (2) the sand portion of the required composition of topsoil.
- Recommended porosity assumption for storage capacity calculations of sand media is 0.30.
- All aggregate should be clean, double-washed and free of fines as required in the specifications to prevent clogging of the media.

Sand media designs outside of the parameters of this guideline should be submitted for review and approval.

5.3 STORAGE AGGREGATE MEDIA

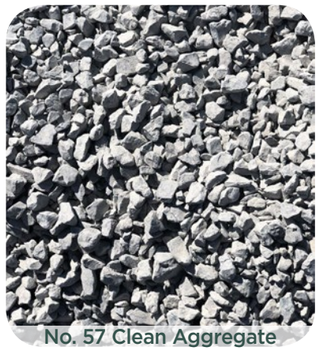
Description:

Storage aggregate media is a coarser graded stone that can be placed in GSI to provide stormwater storage capacity in the void space. Storage aggregate materials include No. 2, No. 3, No. 56, No. 57, and No. 67 aggregate (approximately ¾-inch to 2.5-inch diameter stone).

Where to use:

Storage aggregate media has a variety of applications in GSI. No. 57 aggregate can be used as the primary storage aggregate layer of the GSI, as well as the bedding for the underdrain or distribution piping (GSI-8) to mitigate clogging of the perforated pipe system. No. 2 and No. 3 aggregate is typically used below the primary storage aggregate layer to provide additional stormwater storage.

No. 2 Clean Aggregate



No. 57 Clean Aggregate

Design Considerations:

The following are recommendations and considerations to be taken when designing storage aggregate media components. Refer to specification 02946 Green Infrastructure Soil and Aggregate Media for construction and material specific requirements.

Depth of storage aggregate media depends on application of media. The following are recommendations for aggregate media depths for typical applications:

- Storage Aggregate Layer: aggregate storage media depth varies per contributing drainage area, plan area of GSI, and designed storage volume for the GSI practice.
- Aggregate Bedding: aggregate bedding depths for underdrain systems will vary based on diameter of underdrain or distribution piping and configuration within the GSI section. A minimum 4-inch offset from the outside diameter of the pipe is recommended. See GSI-8.1 and GSI 8.2 for pipe bedding design considerations.

Recommended porosity assumption for storage capacity calculations of storage aggregate media is 0.40.

All aggregate should be clean, double-washed and free of fines as required in the specifications to prevent clogging of the media.

Storage aggregate media designs outside of the parameters of this guideline should be submitted for review and approval.

5.4 CHOKER COURSE

Description:

A choker course is a horizontal transition layer of aggregate media that acts as a media barrier to prevent the migration of finer GSI media layers to the coarser storage aggregate media layers. The choker coarse typically includes sand, No. 7, No. 8, No. 89, or No. 9 aggregates (approximately 1/4-inch to 1.0-inch diameter stone). Sand used as a choker course is the same material as the sand used in bioretention soil media or sand filters (GSI-5.2), though functions as a thin filter layer rather than a constituent of the primary GSI media. No. 57 aggregate as described in GSI-5.3 can also be used as a choker course for permeable pavement systems requiring increased designed structural stability.

Where to use:

A choker course may be used in a GSI system to control the movement of media between transitioning layers while allowing for stormwater to infiltrate the system. A choker course is typically used between overlying soil or sand layers and the subsurface coarser storage aggregate media layers. A choker course can also function as jointing or bedding material for permeable pavers (GSI-4.2) and other permeable pavements.

Choker Course

Design Considerations:

The following are recommendations and considerations to be taken when designing storage aggregate media components. Refer to specification 02946 Green Infrastructure Soil and Aggregate Media for construction and material specific requirements.

Depth of choker course depends on material and the design. The following are recommendations for media depths:

- Sand: depth typically ranges from 4 to 6 inches.
- No. 7, No. 8, No. 89, and No. 9 Aggregate: depth typically ranges from 2 to 6 inches.

All aggregate should be clean, double-washed and free of fines as required in the specifications to prevent clogging of the media.

Choker course designs outside of the parameters of this guideline should be submitted for review and approval.

GSI – 6 MEDIA LINERS

MEDIA LINERS ARE SYNTHETIC FABRIC LINERS USED TO PROVIDE STABILIZATION AND/OR SEPARATION OF SOIL AND AGGREGATE MEDIA WITHIN A GSI, AND TO LIMIT MIXING OF MEDIA LAYERS. MEDIA LINERS CAN BE PERMEABLE OR IMPERMEABLE, TO ALLOW OR PREVENT STORMWATER INFILTRATION AND TO PROTECT ADJACENT INFRASTRUCTURE, AS NEEDED.

DESIGN DELIVERABLE CHECKLIST

- ☐ Detail/Section view of GSI: specify media liner type, horizontal and vertical extents within the section, and category/class or manufacturer.
- ☐ Anchoring detail for media liner.

6.1 PERMEABLE LINER

Description:
A permeable liner is a non-woven geotextile fabric that allows for the infiltration of stormwater within GSI while providing separation between varying media. Permeable liners may also be used below gravel, mow strips, or other landscaping materials to limit weed growth within the GSI landscaped edging area. In some applications, permeable liners may be used to provide increased structural stability, particularly in pavement applications.

Where to use:
Permeable liners are used in a variety of GSI to provide support and separation of media layers. Permeable liners are primarily utilized for vertical applications on the sides of the GSI to prevent mixing of surrounding subgrade with GSI media layers. Permeable liners are also sometimes specified for use horizontally in pavement applications, though are not typically recommended between horizontal media layers due to susceptibility to clogging. When media separation is needed on horizontal applications, a choker course (GSI-5.4) is recommended.

Design Considerations:
The following are recommendations and considerations to be taken when designing GSI with a permeable liner. Refer to Section 02948 Green Stormwater Infrastructure Media Liners for construction and material specific requirements.

Designer should specify required class of media liner meeting the minimum property requirements needed for the given application. Designer may instead specify a preferred manufacturer and product, or approved equal.

The following permeable liners are recommended for the given applications:

- Media layer separation: minimum of Class 3, Mirafi 140N, or approved equal.
- Permeable pavement stabilization: minimum Class 2, Mirafi RS380i, or approved equal.

Permeable Liner

Permeable Liner

Permeable liner designs outside of the parameters of this guideline should be submitted for review and approval.

6.2 IMPERMEABLE LINERS

Description:
An impermeable liner is an impermeable membrane, or geomembrane, that prevents water from migrating away from the GSI and repels water with no absorption.

Where to use:
Impermeable liners should be used in GSI practices directly adjacent to traditional pavements and buildings to prevent damage to the infrastructure from infiltrated stormwater migrating from the GSI. The Kansas City, Missouri Department of Public Works requires the use of impermeable liners for GSI adjacent to roadways.

Design Considerations:
The following are recommendations and considerations to be taken when designing GSI with an impermeable liner. Refer to Section 02948 Green Stormwater Infrastructure Media Liners for construction and material specific requirements.

If the GSI is adjacent to traditional pavement within the public right-of-way or a building, an impermeable liner should be placed along the side of the GSI adjacent to the pavement or building. The impermeable liner should extend 30 inches below the existing grade of the traditional pavement section, or the building footprint.

Impermeable liner designs outside of the parameters of this guideline should be submitted for review and approval.

GSI - 7 LANDSCAPING

WITH THOUGHTFUL SELECTION AND PLACEMENT, A VARIETY OF PLANT TYPES CAN BE SUCCESSFULLY USED IN GSI. THIS SECTION HIGHLIGHTS SOME OF THE UNIQUE CHALLENGES ASSOCIATED WITH THE LANDSCAPING OF GSI SITES AND OFFERS SUGGESTIONS AND GUIDANCE USEFUL IN DEVELOPING A THRIVING, HEALTHY GSI FACILITY.

DESIGN DELIVERABLE CHECKLIST

- ☐ Tree protection plan per the requirements outlined in GSI-7.1.
- ☐ Existing tree protection detail GSI-7.1
- ☐ Planting plan per the requirements outlined in GSI-7.2
- ☐ Planting details per GSI-7.3, GSI-7.4 and GSI-7.5.
- ☐ Preliminary and final renderings (as applicable to the scope of the project) per the requirements outlined in GSI-7.2.

7.1 EXISTING TREE PROTECTION

Description:

Existing trees represent an important asset in the urban forest and should be protected wherever possible. When properly applied, protection measures minimize the negative effects of construction work on trees.

Where to use:

Tree protection measures should be used around trees that are desired to remain in place after construction. The City may approve removal of the existing trees during the design process if there are conflicts between existing trees and sidewalk replacement, utility installation or repair, new construction, or infrastructure installation. The designer should prepare a Tree Protection Plan that annotates all existing trees surveyed to identify necessary tree protection measures required during the construction process.

Table 7.1 Tree Replacement Schedule

Size of Tree Removed (DBH)	Rate of Replacement (2-inch Caliper)
2 - 5 inches	1:1
6 - 10 inches	2:1
11 - 16 inches	3:1
17 - 23 inches	4:1
24 - 31 inches	5:1
32+ inches	6:1

Replacement recommendations developed from the "Tree Removal Policy" under City of Kansas City, Missouri Parks and Recreation Department, Forestry Operations

Designer should consider impact to existing trees when developing grading plan. Any improvements that require digging, excavating, trenching, changing of grade, or other actions within the tree protection zone should be avoided, if possible. Alternative methods to trenching, such as boring, should be considered to avoid damage to existing trees. If improvements are required within the tree protection zone, designer should specify removal and replacement of the existing tree per Table 7.1.

Design Considerations:

The following are recommendations and considerations for preparing the Tree Protection Plan. Refer to 02949 Green Stormwater Infrastructure Existing Tree Protection for construction and material specific requirements.

All existing trees within the project extents should be surveyed including northing, easting, and diameter breast height (DBH).

Assess surveyed trees and provide tree species, size (DBH and tree canopy diameter), overall health and location documented. Tree protection plan should identify if existing tree direction should be to protect or to remove:

- Mark trees for removal with a bold (X)
- All trees not marked for removal are to be protected per the requirements of Section 02949.

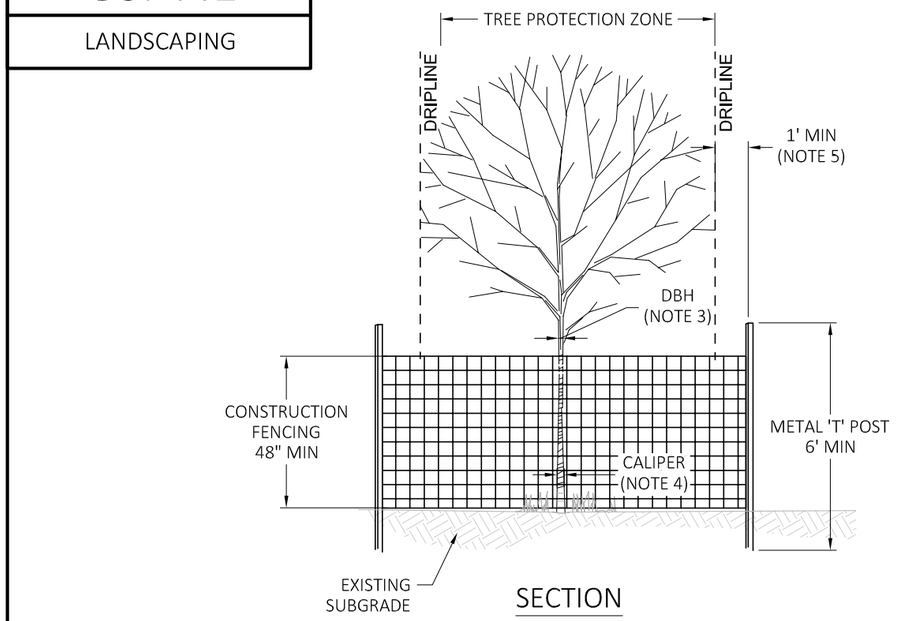
Tree symbols for existing trees to protect should be scaled to show tree canopy size equal to the tree protection zone for the surveyed tree.

Designer should work with the City during the design process to identify opportunities to incorporate required tree replacements into the overall landscape plan.

Existing Tree Protection

GSI-7.1

LANDSCAPING



NOTES:

1. TREE PROTECTION SHALL BE PER 02948.
2. CONSTRUCTION FENCE SHALL BE INSTALLED PRIOR TO CONSTRUCTION OPERATIONS
3. DIAMETER BREAST HEIGHT (DBH) SHALL BE MEASURED AS THE OUTSIDE BARK DIAMETER 4'-6" ABOVE THE GROUND ON THE UPHILL SIDE OF THE TREE.
4. FOR TREES UP TO 4.5" IN DIAMETER, CALIPER SHALL BE MEASURED 6" ABOVE GROUND LEVEL. IF CALIPER MEASURED AT 6" ABOVE GROUND LEVEL EXCEEDS 4.5", THE CALIPER SHALL BE MEASURED AT 12" ABOVE GROUND LEVEL.
5. LOCATE TREE PROTECTION FENCE 1' OUTSIDE DRIPLINE.

EXISTING TREE PROTECTION

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

7.2 PLANTING PLAN

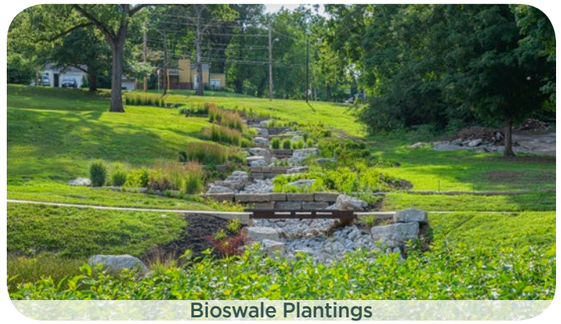
Description:

Planting plans accompanied with the appropriate specifications provide the detail needed to install the vegetation within a GSI facility. The intent of a planting plan is to provide clear and consistent direction to the contractor. The Example Planting Plan (GSI-7.2) is intended to show the detailed information that should be included on planting plans for GSI projects.

Where to use:

Plants are integral to the functionality of all vegetated GSI. Planting plans are required for any project that incorporates vegetation. Specific considerations for siting trees, shrubs, groundcovers, grasses, and perennials are included in GSI-7.3 through -7.6.

When selecting plants, consider other GSI components, location within the GSI facility, and the range of site conditions that will be experienced at that location. Consider how the public and surrounding residents will view the site. Planting patterns can provide structure to the planting plan and aid in maintenance and visual interest.



Bioswale Plantings

Place plants so the site is visually pleasing to residents or visitors, access around the planting is not obstructed by overhanging plant material, and to allow workers to easily maintain and care for plants. Consider form, shape, and geometry within the site.

Design Considerations:

Important considerations when selecting the right type of vegetation include sight line requirements; the type of microclimate, tolerance to drought and inundation; resistance to insects and disease; resistance to vehicular emissions and salt; the ability to remediate pollutants; and the type and frequency of maintenance tasks required. Design considerations for selection of planting material are based on lessons learned during design, installation and maintenance of existing City GSI, and from public response to other GSI projects in the City.

Edges, or above grade barriers (GSI-3), to the GSI provide a sense of structure and order to make the planted area look intentional and well maintained. Depending on design and materials used, they can also provide protection to plants by deterring pedestrian and vehicular traffic.

During plant selection, avoid varieties that may pose a risk to site users such as thorns, poisonous plant parts, and low hanging branches.

At intersections consider sight lines for both pedestrians and drivers. Plants within the 40-foot sight triangle should be no taller than 18 inches from the top of curb. This guidance excludes trees that follow KCMO Parks and Recreation Department Forestry Operations street tree planting guidelines.

Plant diversity reduces the overall plant community's vulnerability to insect attacks and disease, and is a significant factor in overall site health. However, a large variety in plant selection can be difficult to maintain. Planting plans should offer a balance between diversity and strong aesthetic design.

Basic parameter recommendations for shrubs, perennials, and grasses related to sites near pedestrian areas or walkways are maximum 3' height and 2' away from the edge.

PLANTING PLAN REQUIREMENTS

General:

North arrow, scale, legend and sealed by a registered landscape architect in the State of Missouri.

Existing Conditions:

- Existing grade information, including labeled contours.
- Location, size (shown as DBH), and common name of all existing trees. Clearly indicate those trees to be protected (GSI-7.1) and those existing trees to be removed as part of the project.
- Location, size, and type of all above-ground and underground utilities and structures within landscaping extents. Include proper notation, where appropriate, as to any safety hazards to avoid during installation of landscaping.
- Identification of all hardscape elements, including but not limited to above grade barriers (GSI-3), street, sidewalks or other pedestrian areas within the vicinity of the landscaping extents.

Plant Schedule:

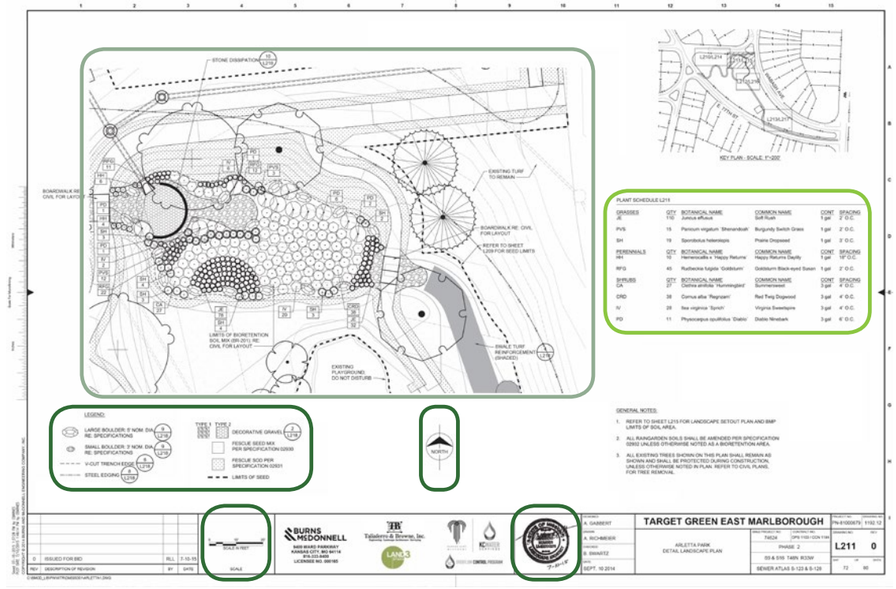
Table formating including type of vegetation (tree, shrub, grass, perennial, groundcover) labeled by plant code, quantity, botanical and common names, size and spacing.

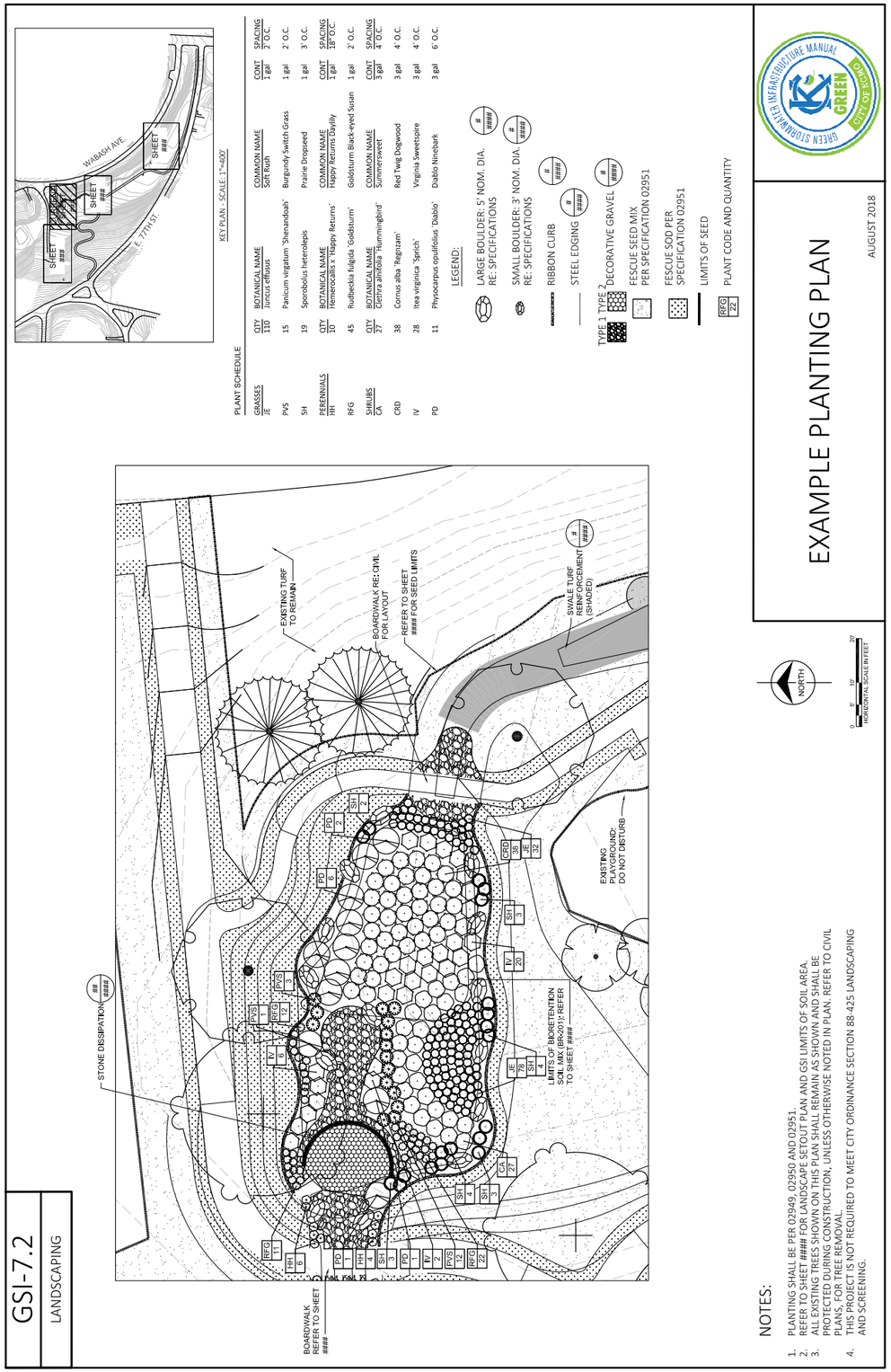
Planting Plan:

- Location of all landscape materials including but not limited to above grade barriers (GSI-3), landscape edging, light fixtures (pole mounted, wall mounted, and ground mounted), hardscape, and plant installation details.
- Plant materials labeled using plant code and legend with quantity of plant type. Plant symbols should be shown at 3/4 mature size when individual symbols are used. Groups of shrubs or smaller plants may be shown as hatched areas where appropriate.
- Finished grade information including labeled contours and spot elevations. Slope protection boundaries of erosion control blanket or other erosion prevention measures needed during plant establishment.
- A table showing landscaping needed to meet City ordinance Section 88-425 Landscaping and Screening, where applicable. If City ordinance Section 88-425 is not required for the project, include a statement which says, "This project is not required to meet City ordinance Section 88-425 Landscaping and Screening."

PLANTING PLAN EXAMPLES:

- General
- Existing Conditions & Planting Plan
- Plant Schedule





7.3 TREES

Description:

Trees are valuable assets that help to collect and store stormwater runoff and improve the quality of air, soil, and public health. The use of trees is encouraged, if space allows, as part of a GSI project. Tree canopies intercept rainfall before it reaches the ground while roots absorb water and improve soils to allow for increased infiltration.

Where to use:

Trees should be used in thoughtful compositions that respect the overall street context, local environment and adjacent land uses. Trees can be used to serve a variety of design functions. Based upon their location, arrangement and spacing, trees can:

- Frame, define and accentuate spaces.
- Add texture and human scale.
- Provide shade and filtered light.

GSI Trees

Consider the soil volume needs to support healthy root growth based on the estimated mature size of the tree. Although the use of proprietary products like soil cells under sidewalk, parking lots, or roads may add to the initial project costs, the lifetime cost and community benefit is likely to be well worth the initial investment. An alternative to cellular type systems to retain adequate soil volumes is use of a structural soil (GSI-5.1). To support good tree health a minimum 600 cubic feet of soil for all street trees in the right-of-way should be provided.

Design Considerations:

Tree selection needs to address the ability of the tree to mature in each microclimate, as well as its ability to meet design objectives. Scale and form are key design considerations. The following are recommendations and consideration to be taken when designing GSI with trees. Refer to section 02951 Green Stormwater Infrastructure Plants for construction and material specific requirements.

Any trees planted in City rights-of-way or on City parcels need to meet the KCMO Parks Forestry guidelines.

Trees should be placed to avoid utility conflicts where possible. Shallow rooted species should be considered near sewer or drain pipes. Open form trees should be considered near overhead wires. Designer should coordinate with the appropriate utility owner for utility specific requirements.

Trees with deeper roots and small trunk flares should be used adjacent to pavements.

When planting on a slope (GSI-7.3.3), the roots and trunk should be vertical and the ground modified so water is directed to the plant's roots, rather than allowing to run straight off.

Aesthetic perspective, spring flowers, fall color, the quality of light and shade, and the abundance of fruit, nuts, and leaf litter should be considered.

Consider soil aeration and adequate water flow to tree roots when including features like hardscape or curbs in the site. If the GSI asset will experience temporary inundation, select tree species that either withstand or thrive under those conditions.

TREES FOR GSI FACILITIES

The trees listed below, when properly sited, are acceptable for use in GSI projects outside street rights-of-way. For sites within street rights-of-way, trees from the KCMO Parks and Recreation Approved Street Tree list shall be used. The list does not prohibit use of other plants.

A full plant characteristics table for the recommended trees plant list can be found in Appendix A and includes the following:

- Plant Code
- Botanical Name
- Common Name
- Missouri Native/Cultivar
- Height
- Spread
- Watering Requirements
- Inundation Tolerance
- Drought Tolerance
- Sunlight Requirements
- Salinity Tolerance

- ***Acer rubrum***
  Red Maple
- ***Acer saccharum 'Bailsta'***
  Fall Fiesta Sugar Maple
- ***Aesculus glabra***
  Ohio Buckeye
- ***Amelanchier x grandiflora***
  'Autumn Brilliance' Serviceberry
- ***Betula nigra***
  River Birch (Single Trunk)
- ***Betula nigra 'Cully'***
  Heritage Birch
- ***Carpinus caroliniana***
  American Hornbeam
- ***Cercis canadensis***
  Eastern Redbud
- ***Chionanthus virginicus***
  White Fringetree
- ***Cladrastis kentukea***
  American yellowwood
- ***Gymnocladus dioica 'Espresso'***
  Espresso Kentucky Coffeetree
- ***Heptacodium miconioides***
  Seven-Son Flower
- ***Juniperus virginiana 'Canaertii'***
  Canaert Eastern Red Cedar
- ***Maclura pomifera 'White Shield'***
  White Shield Osage Orange
- ***Magnolia virginiana 'Jim Wilson'***
  Moonglow Sweet Bay Magnolia
- ***Nyssa sylvatica***
  Blackgum
- ***Ostrya virginiana***
  Hop Hornbeam
- ***Quercus bicolor***
  Swamp White Oak
- ***Quercus macrocarpa***
  Bur Oak
- ***Quercus shumardii***
  Shumard Red Oak
- ***Salix exigua***
  Sandbar Willow
- ***Styphnolobium japonicum***
  Japanese Pagoda Tree
- ***Taxodium distichum***
  Bald Cypress
- ***Tilia americana***
  American Linden

EXAMPLES OF CITY APPROVED TREES

Large Trees:

Used for larger scale areas and along streets. Provides the greatest amount of stormwater performance and mitigation for urban heat island effect. Typical form is spreading to create a continuous canopy.

Medium Trees:

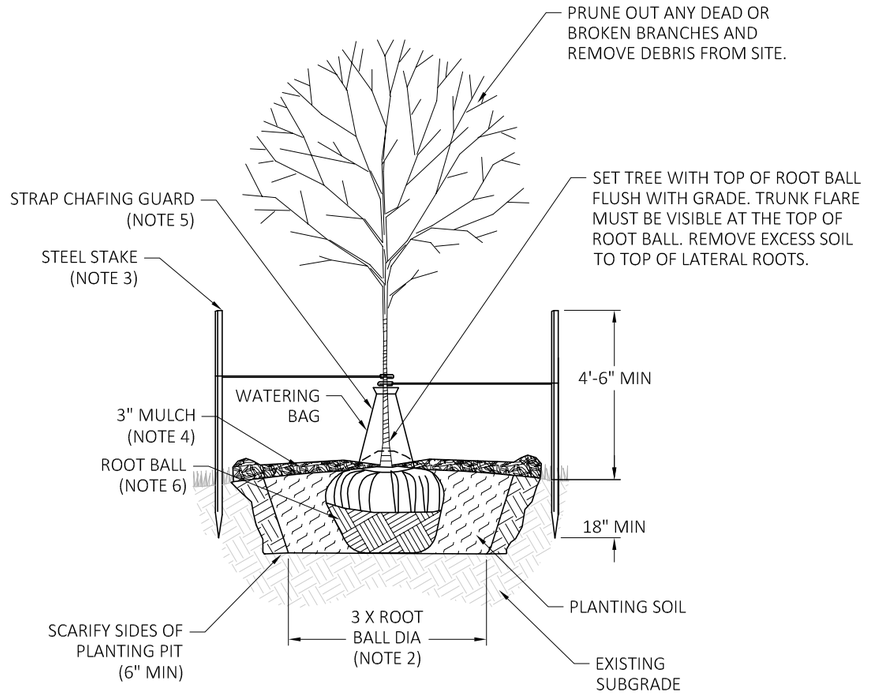
Used for smaller scale areas and streets. Provide variation and some shade. Typical form is spreading or columnar to accommodate for the designated planting area.

Small/Ornamental Trees:

Used for smaller scale areas, especially with utility wires. Provide accents and variation to the landscape. Typical form is spreading or columnar.

GSI-7.3.1

LANDSCAPING



SECTION

NOTES:

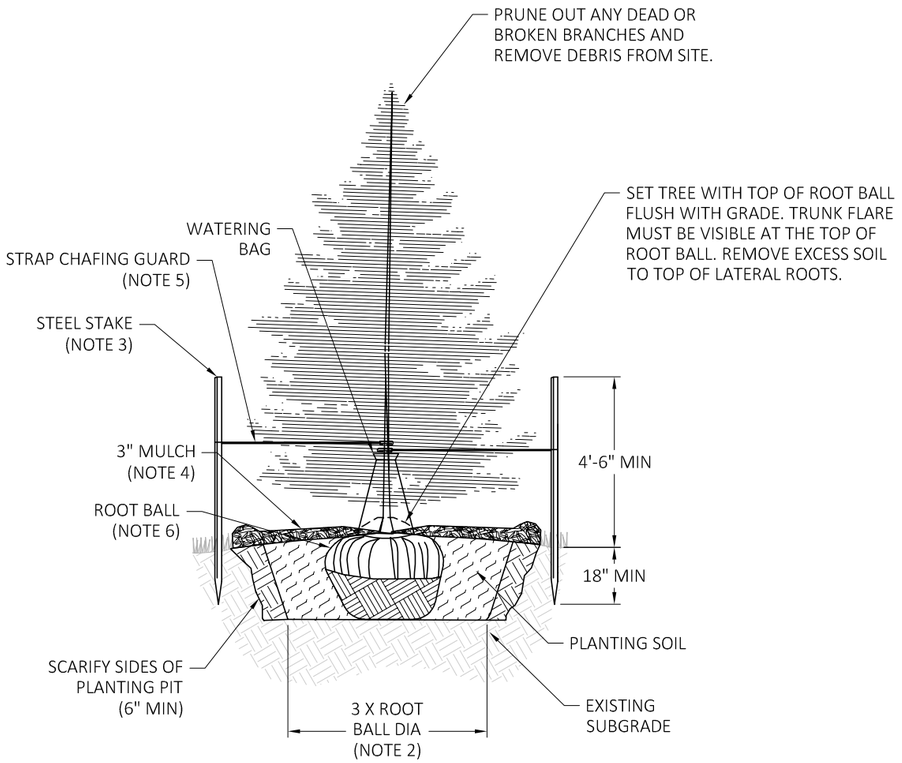
1. TREE PLANTING SHALL BE PER 02949.
2. PLANTING PIT SHALL BE AT LEAST 3 TIMES WIDER THAN THE ROOT BALL DIAMETER, BUT NOT DEEPER. PLACE ROOT BALL ON UNDISTURBED SOIL WITH ROOT FLARE EVEN WITH OR 1" ABOVE GRADE.
3. MINIMUM OF 2 STEEL STAKES SHALL BE SECURED INTO UNDISTURBED SOIL. PLACE STAKES NORTH AND SOUTH OF TREE. ALTERNATIVE STAKING MAY BE APPROVED.
4. DESIGNER TO SPECIFY TYPE OF MULCH. DO NOT PLACE MULCH ON TRUNK OR TRUNK FLARE. BERM AT OUTER EDGES OF RING TO CREATE A SAUCER FORM. MULCH EXTENTS SHALL BE EQUAL TO PLANTING PIT DISTURBANCE AREA.
5. SECURE TREE TO STAKES WITH STRAPS. STRAPS SHALL BE LOOSE ENOUGH TO ALLOW SOME MOVEMENT OF THE TRUNK WITH THE WIND.
6. PLACE TREE WITHIN THE PLANTING HOLE, STRAIGHTEN IT, STABILIZE AND REMOVE A MINIMUM OF $\frac{1}{3}$ OF ROOTBALL BURLAP AND WIRE OR TWINE CAGE.
7. TREES THAT DO NOT MEET THE SIZE REQUIREMENT AS DEFINED IN THE PLANTING PLAN (GSI-7.2) WILL BE REJECTED.

DECIDUOUS TREE PLANTING

AUGUST 2018

GSI-7.3.2

LANDSCAPING



SECTION

NOTES:

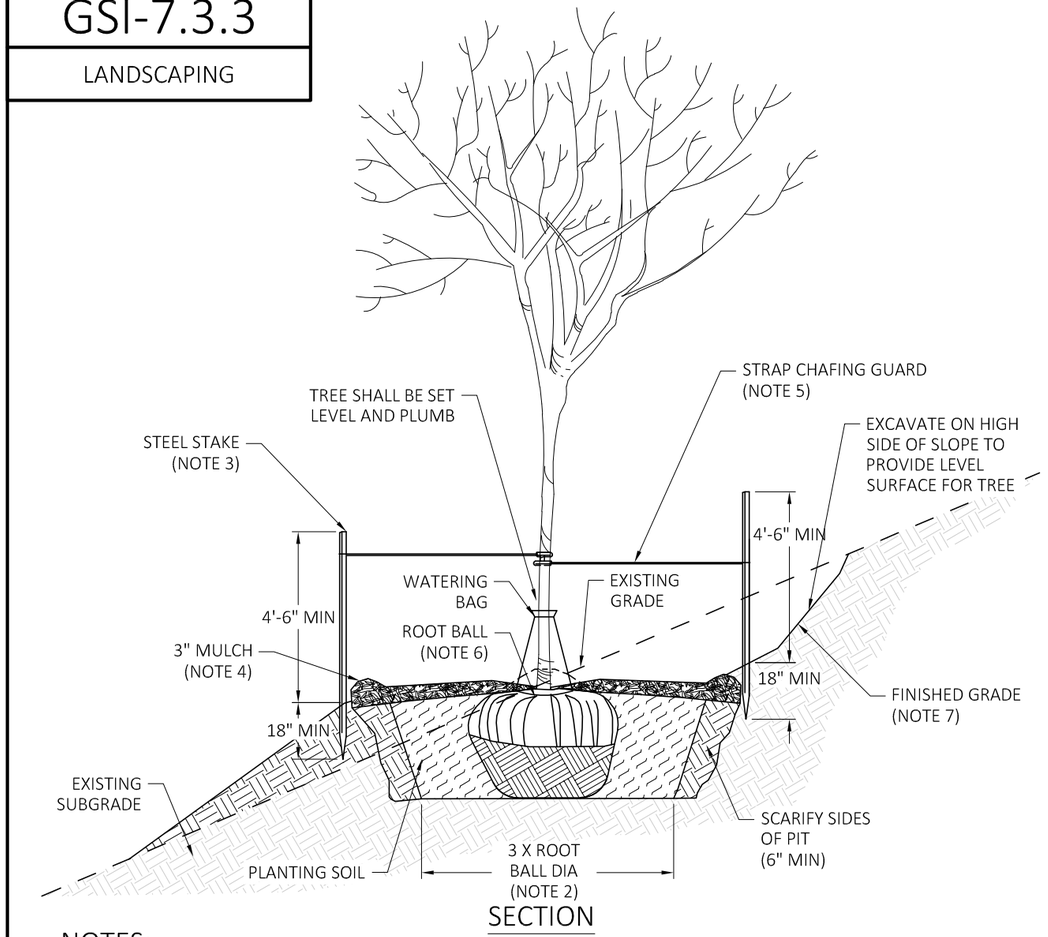
1. TREE PLANTING SHALL BE PER 02949.
2. PLANTING PIT SHALL BE AT LEAST 3 TIMES WIDER THAN THE ROOT BALL DIAMETER, BUT NOT DEEPER. PLACE ROOT BALL ON UNDISTURBED SOIL WITH ROOT FLARE EVEN WITH OR 1" ABOVE GRADE.
3. MINIMUM OF 2 STEEL STAKES SHALL BE SECURED INTO UNDISTURBED SOIL. PLACE STAKES NORTH AND SOUTH OF TREE. ALTERNATIVE STAKING MAY BE APPROVED.
4. DESIGNER TO SPECIFY TYPE OF MULCH. DO NOT PLACE MULCH ON TRUNK OR TRUNK FLARE. BERM AT OUTER EDGES OF RING TO CREATE A SAUCER FORM. MULCH EXTENTS SHALL BE EQUAL TO PLANTING PIT DISTURBANCE AREA.
5. SECURE TREE TO STAKES WITH STRAPS. STRAPS SHALL BE LOOSE ENOUGH TO ALLOW SOME MOVEMENT OF THE TRUNK WITH THE WIND.
6. PLACE TREE WITHIN THE PLANTING HOLE, STRAIGHTEN IT, STABILIZE AND REMOVE A MINIMUM OF $\frac{1}{3}$ OF ROOTBALL BURLAP AND WIRE OR TWINE CAGE.
7. TREES THAT DO NOT MEET THE SIZE REQUIREMENT AS DEFINED IN THE PLANTING PLAN (GSI-7.2)WILL BE REJECTED.
8. USE OF EVERGREEN TREES SHALL BE RESERVED FOR AREAS OUTSIDE THE GSI PONDING AREAS.

EVERGREEN TREE PLANTING

AUGUST 2018

GSI-7.3.3

LANDSCAPING



SECTION

NOTES:

1. TREE PLANTING SHALL BE PER 02949.
2. PLANTING PIT SHALL BE AT LEAST 3 TIMES WIDER THAN THE ROOT BALL DIAMETER, BUT NOT DEEPER. PLACE ROOT BALL ON UNDISTURBED SOIL WITH ROOT FLARE EVEN WITH OR 1" ABOVE GRADE.
3. MINIMUM OF 2 STEEL STAKES SHALL BE SECURED INTO UNDISTURBED SOIL. PLACE STAKES ON OPPOSITE SIDES OF TRUNK WITH DOWNHILL STAKE SET IN EXISTING GRADE. ALTERNATIVE STAKING MAY BE APPROVED.
4. DESIGNER TO SPECIFY TYPE OF MULCH. DO NOT PLACE MULCH ON TRUNK OR TRUNK FLARE. BERM AT OUTER EDGES OF RING TO CREATE A SAUCER FORM. MULCH EXTENTS SHALL BE EQUAL TO PLANTING PIT DISTURBANCE AREA.
5. SECURE TREE TO STAKES WITH STRAPS. STRAPS SHALL BE LOOSE ENOUGH TO ALLOW SOME MOVEMENT OF THE TRUNK WITH THE WIND.
6. PLACE TREE WITHIN THE PLANTING HOLE, STRAIGHTEN IT, STABILIZE AND REMOVE A MINIMUM OF $\frac{1}{3}$ OF ROOTBALL BURLAP AND WIRE OR TWINE CAGE. ROOT BALL SHALL BE SET LEVEL; PLACE TOP OF ROOT BALL AT EXISTING GRADE
7. DESIGNER TO SPECIFY MAXIMUM SLOPE FOR FINISHED GRADE. PROVIDE NECESSARY EROSION CONTROL MEASURES TO ENSURE SOIL STABILITY ON FINISHED GRADE.
8. TREES THAT DO NOT MEET THE SIZE REQUIREMENT AS DEFINED IN THE PLANTING PLAN (GSI-7.2) WILL BE REJECTED.

TREE PLANTING ON SLOPE

AUGUST 2018

7.4 SHRUBS

Description:

Shrubs are a key foundation planting for many planting plans. They offer structure and organizing points and support phytoremediation – the use of plants to clean, remove and stabilize contaminates in stormwater flows.

Where to use:

In a planting plan, shrubs are the bones of the design, and the location, height, spread, and color of woody shrub species can drive the design for the rest of the landscape plan.

GSI Shrubs

GSI Shrubs

Integrate at least 50% native shrub species into the design and balance diversity by not using more than 25% of a single species on the overall project planting plan.

Design Considerations:

Successful use of shrubs in planting plans is dependent on selecting the correct plant for its location and purpose. The following are recommendations and consideration to be taken when designing GSI with shrubs. Refer to section 02951 Green Stormwater Infrastructure Plants for construction and materials specific requirements.

Shrub species can be used to provide accent, screening, color, and textural interest in the landscape. Considering a shrub's function can play a key role in creating order in the landscape.

Match plant growth requirements to site growing conditions. Healthy plant growth requires adequate space both horizontally and vertically for plants to reach their mature height and width.

Plant form is an important factor in determining the planting space needed and in siting a shrub relative to the positions to other plants in the plan. Different plant forms can add variety and interest to the landscape.

Shrubs have specific requirements for light and may fail to thrive when these conditions are not provided. Location in the planting plan should be considered to meet individual species light requirements.

If the shrub will experience temporary inundation, select a species that can either withstand or thrive under those conditions.

Group shrubs in clusters of 5 to 7 so the group of shrubs can be easily maintained when other plants in the site are annually trimmed back.

SHRUBS FOR GSI FACILITIES

The shrubs listed below, when properly sited, are acceptable for use in GSI projects. The list does not prohibit use of other plants.

A full plant characteristics table for the recommended shrubs plant list can be found in Appendix A and includes the following:

- Plant Code
- Botanical Name
- Common Name
- Missouri Native/Cultivar
- Height
- Spread
- Watering Requirements
- Inundation Tolerance
- Drought Tolerance
- Sunlight Requirements
- Salinity Tolerance

- ***Aronia melanocarpa 'Morton'***
  Iroquois Beauty Black Chokeberry
- ***Callicarpa dichotoma 'Early Amethyst'***
  Beautyberry
- ***Caryopteris x clandonensis 'Dark Knight'***
  Blue Mist Shrub
- ***Cephalanthus occidentalis***
  Button Bush
- ***Clethra alnifolia 'Hummingbird'***
  Hummingbird Summersweet
- ***Corylus americana***
  American Hazelnut
- ***Hesperaloe parviflorahe***
  Red Yucca
- ***Hibiscus moscheutos***
  Rose Mallow
- ***Hypericum kalmianum 'Ames'***
  Kalm's St. John's Wort
- ***Itea virginica 'Little Henry'***
  Little Henry Virginia Sweetspire
- ***Physocarpus opulifolius 'Diablo'***
  Diablo Ninebark
- ***Prunus virginiana***
  Choke Cherry
- ***Rhus aromatica 'Gro-Low'***
  Gro-Low Fragrant Sumac
- ***Rhus copallina latifolia 'Morton'***
  Prairie Flame Shining Sumac
- ***Rhus glabra***
  Smooth Sumac
- ***Rhus typhina 'Baltiger'***
  Tiger Eyes Sumac
- ***Viburnum dentatum 'Ralph Senior'***
  Autumn Jazz Viburnum

EXAMPLES OF CITY APPROVED SHRUBS

Large Shrubs:

Used for larger areas where visibility wont be hindered. Provides screening for utilities or privacy. Forms should be considered for site limitations.

Medium Shrubs:

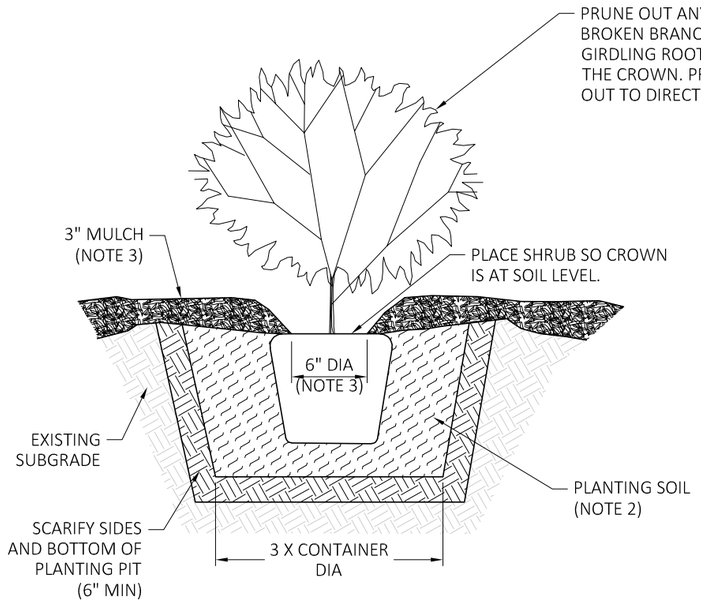
Used for smaller areas and streets. Can be planted in clusters to create a continuous screen. Forms should be considered for site limitations.

Small Shrubs:

Used for smaller areas and streets. Can be planted in clusters to create a continuous screen and not block the eye level. Forms should be considered for site limitations.

GSI-7.4

LANDSCAPING



SECTION

NOTES:

1. SHRUB PLANTING SHALL BE PER 02949.
2. FILL PLANTING PIT WITH PLANTING SOIL. CONSTRUCT RING AROUND PLANTED SHRUB TO FORM SAUCER.
3. INSTALL 3" MULCH THROUGHOUT PLANTING BED. LEAVE A 6" BARE CIRCLE AT BASE OF PLANT. DESIGNER TO SPECIFY TYPE OF MULCH.
4. CONTRACTOR TO WATER THOROUGHLY AFTER PLANTING.

SHRUB PLANTING

AUGUST 2018

7.5 GRASSES, PERENNIALS & GROUNDCOVERS

Description:

Grasses, perennials, and groundcovers play a significant role in green stormwater infrastructure vegetation. Their fibrous root systems anchor soil, slow down water flow, and increase infiltration. They help remove pollutants and offer native species that are well adapted to the demands of GSI features.

Where to use:

In a planting plan, grasses, perennials, and groundcovers offer opportunities for diversity, color, and texture. Integrating these plants with woody shrubs and tree species creates a balanced landscape.

GSI Grasses and Perennials

Consider tolerance to vehicular emissions and salt. A two-foot clearance between outer edge of planting bed and adjacent roadway, parking lot, and parking median pavement is recommended.

Integrate at least 50% native shrub species into the design and balance diversity by not using more than 25% of a single species on the project planting plan.

Design Considerations:

Successful use of grass, perennial, and groundcover varieties in the GSI landscape is dependent on selecting the appropriate plant for its location and purpose. The following are recommendations and consideration to be taken when designing GSI with grasses, perennials and groundcovers. Refer to section 02951 Green Stormwater Infrastructure Plants for construction and materials specific requirements.

Plant species can be used to provide color and textural interest in the landscape. When designing with perennials, grasses, and groundcovers consider the plant form in the winter months.

Matching plant growth requirements to site growing conditions. Healthy plant growth requires adequate space both horizontally and vertically for plants to reach their mature height and width.

Plant form is an important factor when selecting the grasses, perennials, and groundcover. Many perennial species and shrubs can be a bit leggy at the base and can benefit from lower form plants to define layers in the landscape.

Consider all maintenance requirements to maintain plant health. Low maintenance native species are preferred.

If the plant will experience temporary inundation, select species that either withstand or thrive under those conditions.

Plant material should be installed to provide a minimum one-foot clearance between outer edge of mature plant and pedestrian paths.

GRASSES, PERENNIALS AND GROUNDCOVERS FOR GSI FACILITIES

The grasses, perennials, and groundcovers listed below, when properly sited, are acceptable for use in GSI projects. The list does not prohibit use of other plants.

A full plant characteristics table for the recommended grasses, perennials and groundcovers plant list can be found in Appendix A and includes the following:

- Plant Code
- Botanical Name
- Common Name
- Missouri Native/Cultivar
- Height
- Spread
- Watering Requirements
- Inundation Tolerance
- Drought Tolerance
- Sunlight Requirements
- Salinity Tolerance

Grasses, Sedges & Rushes

- ***Bouteloua curtipendula***
  Sideoats Grama
- ***Bouteloua gracilis***
  Blue Grama
- ***Calamagrostis x acutiflora 'Karl Forester'***
  Feather Reed Grass
- ***Calamagrostis x acutiflora 'Overdam'***
  Overdam Feather Reed Grass
- ***Carex bicknellii***
  Prairie Sedge
- ***Carex flacca***
  Blue Sedge
- ***Carex grayi***
  Gray's Sedge
- ***Carex muskingumensis***
  Palm Sedge
- ***Carex pensylvanica***
  Pennsylvania Sedge
- ***Carex radiata***
  Star Sedge
- ***Chasmanthium latifolium***
  Northern Sea Oats
- ***Elymus virginicus***
  Virginia Wildrye
- ***Eragrostis spectabilis***
  Purple Love Grass
- ***Juncus effusus***
  Soft Rush
- ***Panicum virgatum 'Cloud Nine'***
  Tall Switch Grass
- ***Panicum virgatum 'Northwind'***
  Northwind Switchgrass
- ***Panicum virgatum 'Shenandoah'***
  Shenandoah Switch Grass
- ***Schizachyrium scoparium 'Blaze'***
  Blaze Little Bluestem
- ***Schizachyrium scoparium 'Carousel'***
  Carousel Little Bluestem
- ***Schizachyrium scoparium 'Prairie Munchkin'***
  Prairie Munchkin Little Bluestem
- ***Schizachyrium scoparium 'The Blues'***
  The Blues Little Bluestem
- ***Sporobolus heterolepis***
  Prairie Dropseed

Perennials

- ***Amsonia illustris***
  Shining Bluestar
- ***Asclepias incarnata***
  Swamp Milkweed
- ***Asclepias purpurascens***
  Purple Milkweed
- ***Asclepias tuberosa***
  Butterfly Milkweed
- ***Baptisia australis***
  Blue Wild Indigo
- ***Echinacea purpurea***
  Purple Coneflower
- ***Gaillardia x grandiflora***
  Blanket Flower
- ***Hemerocallis 'Baja'***
  Baja Daylily
- ***Hemerocallis 'Happy Returns'***
  Happy Returns Daylily
- ***Iris fulva***
  Copper Iris
- ***Iris sibirica 'Butter and Sugar'***
  Butter and Sugar Siberian Iris
- ***Iris sibirica 'Caesar's Brother'***
  Caesar's Brother Siberian Iris
- ***Iris virginica***
  Blue Flag Iris
- ***Liatris pycnostachya***
  Prairie Blazing Star
- ***Liatris spicata***
  Marsh Blazing Star
- ***Liriope muscari 'Big Blue'***
  Big Blue Lilyturf
- ***Liriope muscari 'Variegata'***
  Variegated Lilyturf
- ***Monarda bradburiana***
  Eastern Beebalm
- ***Physostegia virginiana***
  Obedient Plant
- ***Pycnanthemum tenuifolium***
  Slender Mountain Mint
- ***Rudbeckia fulgida 'Goldsturm'***
  Goldsturm Black-Eyed Susan
- ***Sedum 'Autumn Joy'***
  Autumn Joy Sedum
- ***Solidago speciosa***
  Showy Goldenrod
- ***Symphyotrichum oblongifolium***
  Aromatic Aster
- ***Tradescantia ohiensis***
  Ohio Spiderwort

Groundcovers

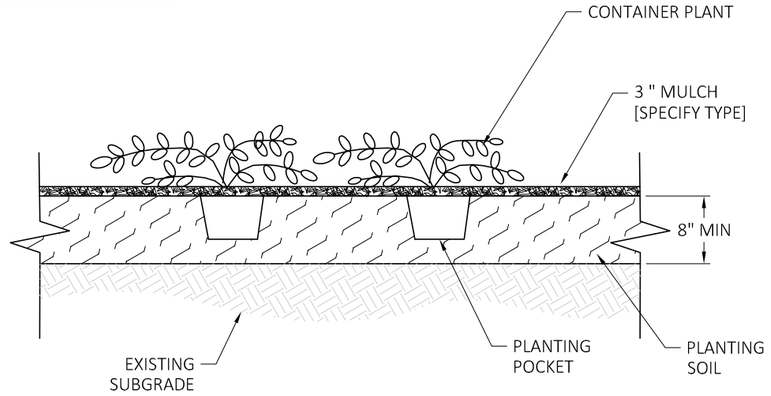
- ***Anemone canadensis***
  Windflower
- ***Callirhoe involucrata***
  Purple Poppy Mallow
- ***Glandularia canadensis***
  Rose Verbena
- ***Oenothera macrocarpa***
  Missouri Evening Primrose
- ***Oenothera speciosa or 'Siskiyou'***
  Pink Evening Primrose
- ***Stachys byzantina 'Helen Von Stein'***
  Helen Von Stein Lamb's Ear

EXAMPLES OF CITY APPROVED GRASSES, PERENNIALS AND GROUNDCOVERS

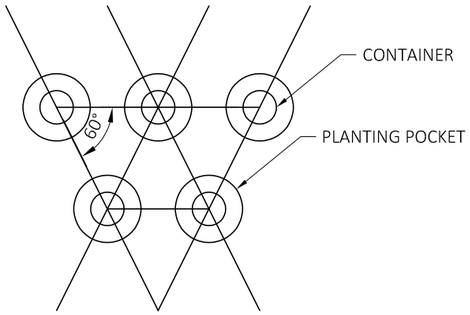
Used for establishing a planting area. Can be grouped in clusters to create interesting color and texture combinations or for screening of utilities. Forms should be considered for site limitations.

GSI-7.5

LANDSCAPING



SECTION



PLAN

NOTES:

1. CONTAINER PLANT SHALL BE PER 02949.
2. CONTRACTOR TO WATER THOROUGHLY AFTER PLANTING.

CONTAINER PLANTING
(GRASSES, PERENNIALS, & GROUNDCOVERS)

AUGUST 2018

7.6 LANDSCAPE EDGING

Description:

Landscape edging provides stabilization and defines the edge of a landscape area. It creates a tidy look that is easier to maintain and can act as a weed barrier.

Where to use:

Edging should be used between a landscape bed and lawn or to separate a transition of loose materials, such as gravel or wood mulch, in a clean fashion.

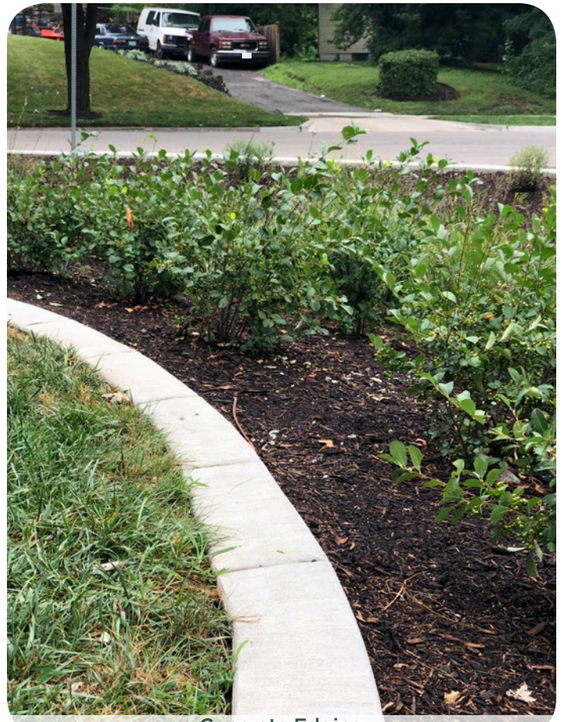
Design Considerations:

The following are recommendations and considerations for designing landscape areas with edging. Refer to 02951 Green Stormwater Infrastructure Plants for construction and material specific requirements.

The use of edging can emphasize a planting bed and maintains a clear pathway.

Edging should be set firmly in place to prevent unsettlement of materials.

Consider what type of material should be used to coincide with the overall planting design and not be a distraction.



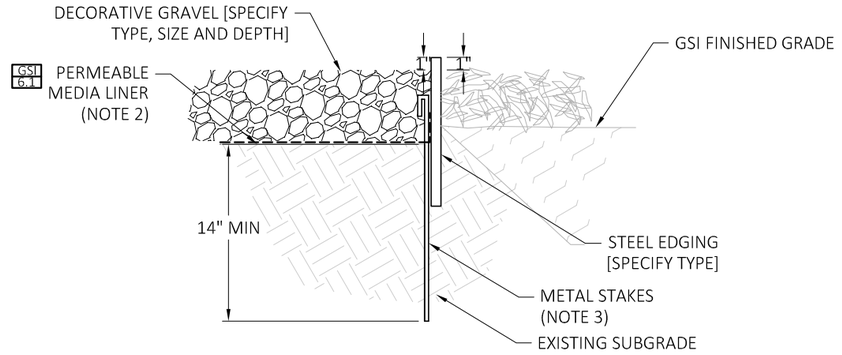
Concrete Edging

Steel & Gravel Edging

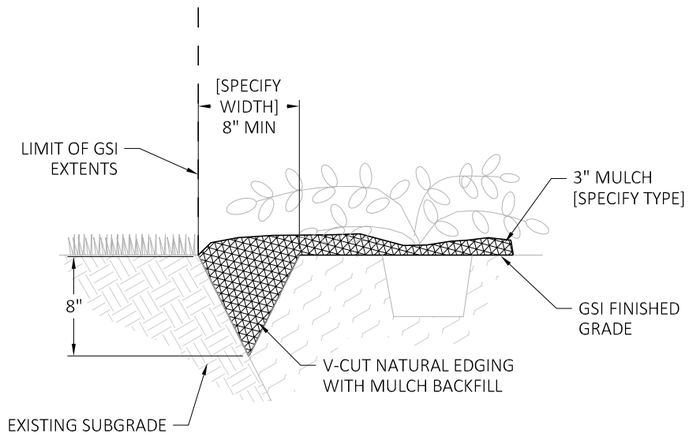
Landscape edging designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-7.6

LANDSCAPING



STEEL EDGING AND DECORATIVE GRAVEL MOW STRIP



V-CUT EDGING

NOTES:

1. LANDSCAPE EDGING SHALL BE PER 02949
2. PERMEABLE LINER SHALL NOT BE VISIBLE AT THE COMPLETION OF DECORATIVE ROCK INSTALLATION. DESIGNER TO SPECIFY TYPE OF PERMEABLE LINER.
3. STAKE EDGING WITH METAL STAKES PER MANUFACTURER REQUIREMENTS.

LANDSCAPE EDGING

AUGUST 2018

7.7 RENDERINGS

Description:

A drawing or computer-generated image that shows the colors, texture, patterns, and material layout of GSI components.

Where to use:

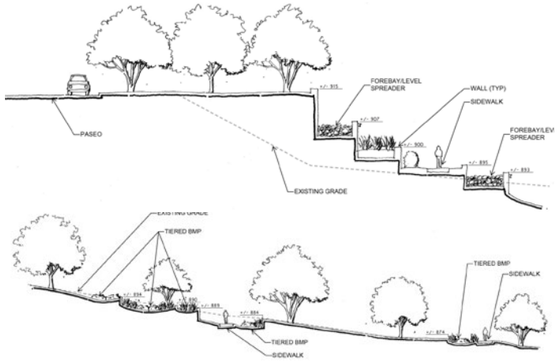
During the design process rendered plans, perspectives, and detail concepts may be required to support design intent.

Design Considerations:

Preliminary Renderings: Hand drawn renderings are preferred during the early project phases to convey the conceptual nature of the design.

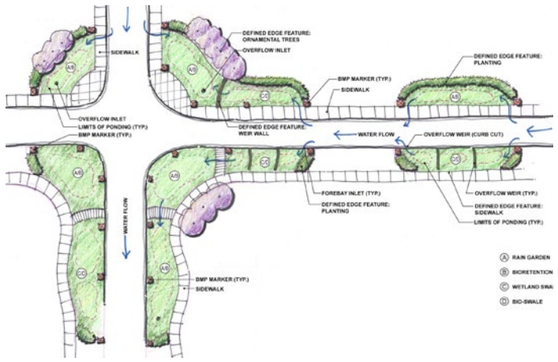
General examples and major descriptions of the level of detail to include on preliminary renderings are as follows:

- Black lines with color added digitally or by hand.
- Text CAPITALIZED in a black sans-serif font or legible, traditional hand lettering.
- Leaders and arrows, dimensions, and/or a legend (as applicable) preferably shown in black.
- Plain, white background.

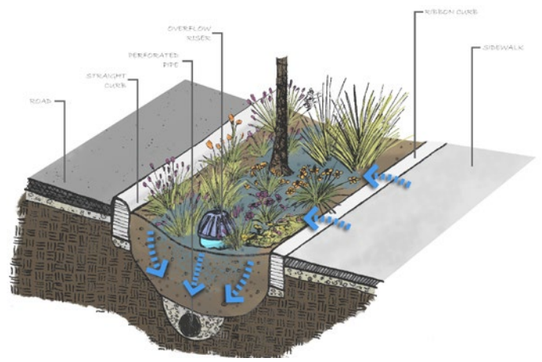


Section Sketch: Black & white section drawing exploring GSI grade changes on a site. (Rendering by Burns & McDonnell)

Section Sketch: Hand colored section drawing showing textures and site relation. (Rendering by Burns & McDonnell)



Preliminary Plan: Hand drawn and colored plan showing conceptual site layout and materials. (Rendering by Land3)



Axonometric Diagram Sketch: Mixed media drawing showing a typical bioretention section. (Rendering by Burns & McDonnell)

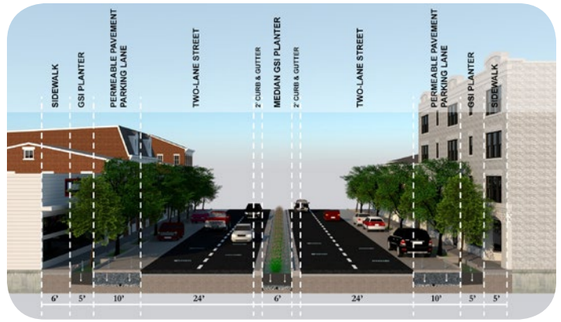
Final Renderings: Computer generated, final renderings are recommended at around 90% design completion to provide a realistic representation of the project. It is critical that final renderings represent what can actually be achieved and maintained to avoid over-promising and under-delivering. Final renderings of the project should include the following features:

- Plan view shown on aerial photograph background or a white background.
- Photo-realistic perspective renderings shown on a photograph background. Perspectives should show accurate representations of grade and elevation variations. Seasons should match between rendering backgrounds and rendered graphics, as well as for before and after renderings. A spring rendering on a winter background is not acceptable.
- Photo-realistic section renderings shown on a photograph or white background.
- Show plant materials at year 2 or 3 after installation.
- Text CAPITALIZED in black sans-serif font
- Leaders and arrows, dimensions and/or a legend (as applicable) preferably shown in black.

Final Site Diagram: Digital drawing showing site GSI layout and context. (Rendering by Burns & McDonnell)

Final Plan: Digital plan showing vegetation and site layout with topographic information. (Rendering by Burns & McDonnell)

Final Perspective: Digital drawing visualizing project materials and layout. (Rendering by Vireo)



Final Section: Digital section drawing showing a typical commercial green street. (Rendering by Burns & McDonnell)

GSI - 8 PIPING

GSI PIPING CONSISTS OF ALL PIPING AND APPURTENANCES WITHIN A GSI FACILITY. PIPING IS PRIMARILY INTENDED TO CONVEY STORMWATER TO OR AWAY FROM THE GSI FACILITY, AND TO PROVIDE ACCESS OR OBSERVATION TO THE SUBSURFACE OF THE GSI. PIPING IS ALSO USED TO PROTECT UTILITIES WITHIN THE FOOTPRINT OF THE GSI FROM WATER DAMAGE WHEN THESE UTILITIES CANNOT BE RELOCATED, AS WELL AS TO PROTECT THE GSI ITSELF FROM CONTAMINATION FROM THE UTILITY.

DESIGN DELIVERABLE CHECKLIST

- ☐ In-situ infiltration test results for all GSI sites. Reference Section 02956 Green Stormwater Infrastructure In-situ Infiltration Testing for recommended test methodology.
- ☐ Plan view of GSI indicating location of all piping components including northing/easting, invert elevations, and stationing (as applicable).
- ☐ Profile view of pipe lengths, size, material, and installed surface and invert elevations (as applicable).
- ☐ Pipe capacity, design flow rates, maximum velocity calculations, and hydraulic grade line elevations (as applicable).
- ☐ Detail of anchoring design to prevent flotation (as applicable).
- ☐ Detail of connection to GSI outlet or downstream drainage system (as applicable).

8.1 UNDERDRAIN

Description:

An underdrain is a perforated plastic pipe, usually polyvinyl chloride (PVC) or high-density polyethylene (HDPE), that conveys stormwater from the subsurface of the GSI facility. While typically perforated, portions of the underdrain can be designed as solid pipe when needed, with applicable fittings. An underdrain provides for dewatering of the GSI storage areas while still allowing for infiltration into the existing subgrade.

Where to use:

An underdrain should be used in GSI sites with limited infiltration capacity that require dewatering of subsurface media. An underdrain should be installed in the storage aggregate media (GSI-5.3) of the GSI.

PVC Underdrain Pipe

HDPE Underdrain Pipe

Design Considerations:

The following are recommendations and considerations to be taken when designing an underdrain system. Refer to Section 02954 Green Stormwater Infrastructure Piping for construction and material specific requirements.

- Underdrain should be no less than 6 inches in diameter for maintenance considerations. Underdrain material should be specified considering loading requirements based on application and location.

- Storage aggregate media for underdrain bedding should extend a minimum of 4 inches beyond the outside diameter of the underdrain. No. 57 aggregate per GSI-5.3 is recommended for bedding aggregate material. At a minimum, storage aggregate media gradation should be larger than the perforation diameter specified.

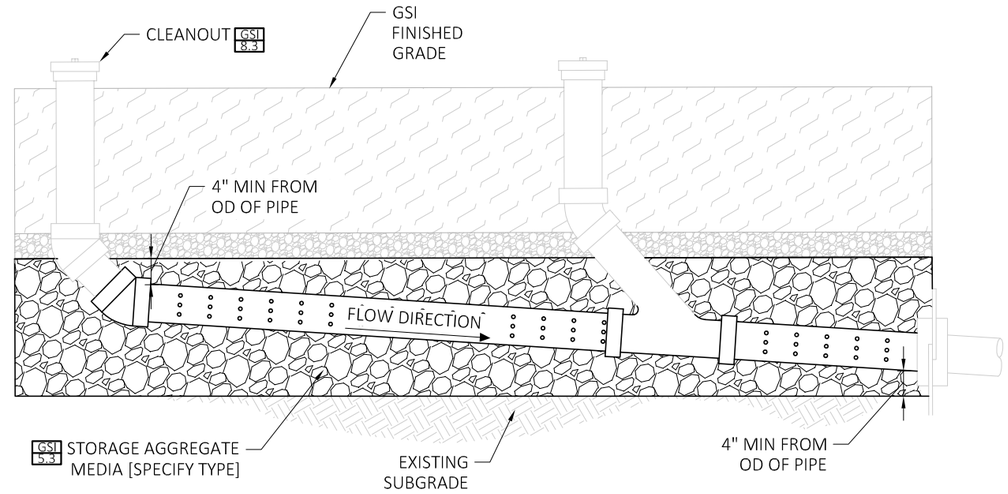
- It is recommended that underdrain be designed with an adjustable flow control mechanism such as a valve, upturned elbow, or manufactured outlet control structure with inline weir (GSI-9.2). Flow control mechanisms maximize GSI storage and infiltration capacity.

- For portions of the underdrain that are not perforated, anti-flotation design should be considered.

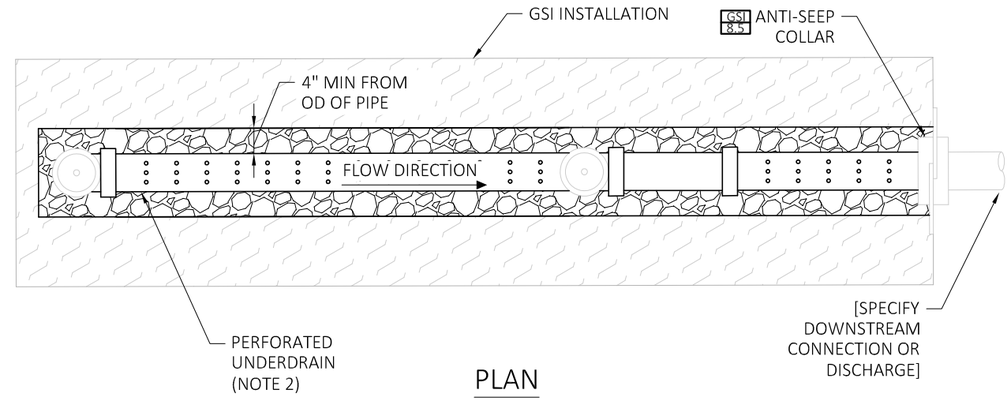
Underdrain designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-8.1

PIPING



PROFILE



PLAN

NOTES:

1. UNDERDRAIN SHALL BE PER 02952.
2. DESIGNER TO SPECIFY TYPE AND DIAMETER OF UNDERDRAIN. UNDERDRAINS SHALL BE A MINIMUM OF 6" DIAMETER.

UNDERDRAIN

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

8.2 DISTRIBUTION PIPE

Description:

A distribution pipe is a perforated plastic pipe, usually polyvinyl chloride (PVC) or high-density polyethylene (HDPE), that conveys stormwater from an upstream collection point into the subsurface of the GSI. While typically perforated, portions of the distribution pipe can be design as solid pipe when needed, with applicable fittings. A distribution pipe allows for introduction of stormwater to the subsurface of the GSI when existing site and infrastructure elevations prevent introducing stormwater flows at the surface of the GSI. The perforated pipe distributes stormwater through the subsurface of the GSI.

Where to use:

A distribution pipe can be used in GSI applications where stormwater cannot be introduced at the surface of the GSI due to grade restrictions or other constraints. A distribution pipe is commonly used to convey stormwater from an inlet or storm sewer system, where depth is constrained, and discharge below grade is necessary.

Distribution Pipe

For portions of the distribution pipe that are not perforated, anti-flotation design should be considered, when appropriate.

Design Considerations:

The following are recommendations and considerations to be taken when designing a distribution pipe. Refer to Section 02954 Green Stormwater Infrastructure Piping for construction and material specific requirements.

Total calculated outflow through distribution pipe perforations should exceed the designed inflow to the GSI. The capacity of the upstream inlet should be considered, to prevent hydraulic backup of the connected upstream system for the design flow. Use of distribution piping should consider the upstream head on the pipe. Designer should provide hydraulic grade line elevations for the design flow and up to the capacity of the upstream contributing system.

Distribution pipe is recommended to be no less than 6 inches in diameter for maintenance considerations. Distribution pipe material should be specified considering loading requirements based on application and location.

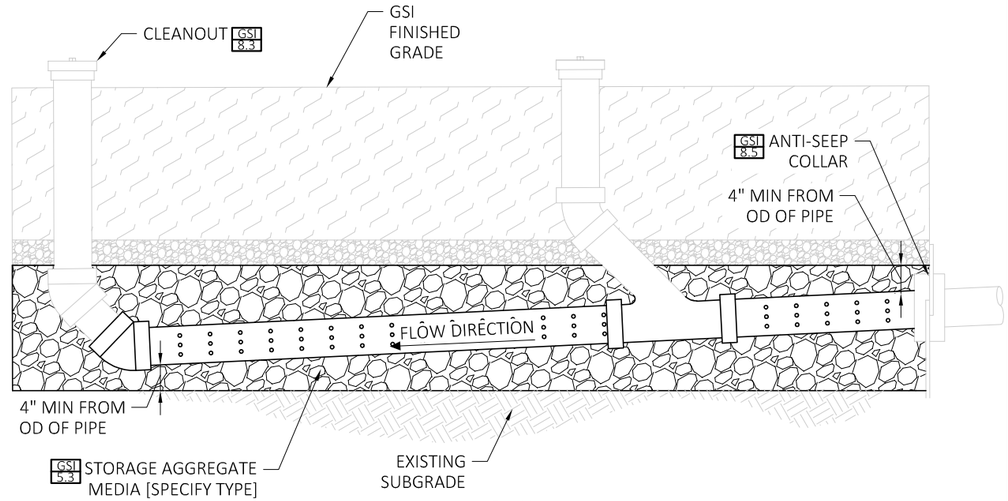
Distribution piping should extend through the length of the GSI facility and have a minimal slope toward the GSI. Designer should consider perpendicular extensions off the primary distribution pipe to adequately distribute flow within the subsurface of the GSI when appropriate.

Storage aggregate media for distribution pipe bedding should extend a minimum of 4 inches beyond the outside diameter of the underdrain. No. 57 aggregate per GSI-5.3 is recommended for bedding aggregate material. At a minimum, storage aggregate minimum gradation sieve should be larger than the perforation diameter specified.

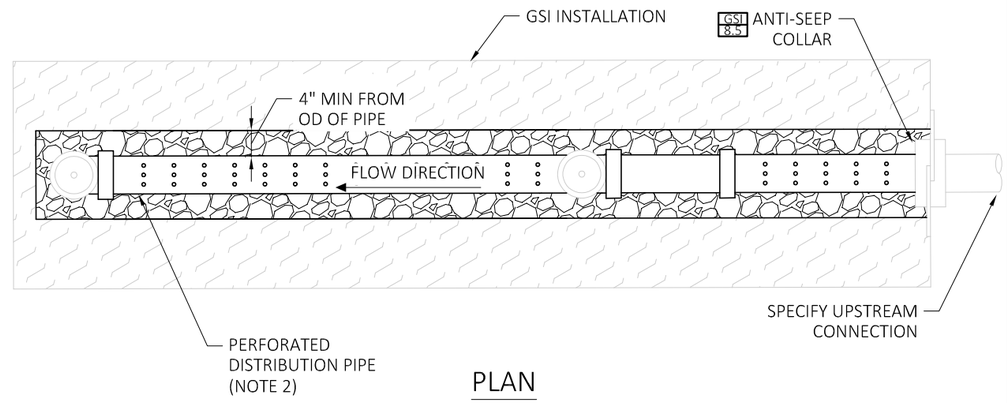
Distribution pipe designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-8.2

PIPING



PROFILE



PLAN

NOTES:

1. DISTRIBUTION PIPE SHALL BE PER 02952.
2. DESIGNER TO SPECIFY TYPE AND DIAMETER OF DISTRIBUTION PIPING. DISTRIBUTION PIPE SHALL BE A MINIMUM OF 6" DIAMETER.

DISTRIBUTION PIPE

AUGUST 2018

8.3 CLEANOUT

Description:

A cleanout is a plastic vertical piping application, usually polyvinyl chloride (PVC) or high-density polyethylene (HDPE), that extends from the surface of a GSI facility and connects to the underdrain or distribution pipe to provide inspection and maintenance access.

Where to use:

A cleanout should be used with all underdrain (GSI-8.1) and distribution pipe (GSI-8.2) components. A cleanout should be located at the upstream end of all subsurface piping, at junctions or bends, or intermittently to provide access at a maximum spacing interval of 100 feet.

Cleanout in Soil

Cleanout in Pavement

Design Considerations:

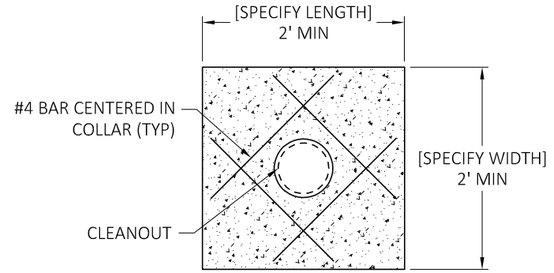
The following are recommendations and considerations to be taken when designing a cleanout. Refer to Section 02954 Green Stormwater Infrastructure Piping for construction and material specific requirements.

- Cleanout should be no less than 6 inches in diameter. Cleanout diameter should match the diameter of the subsurface pipe it is accessing.
- Cleanout in pavement applications should be flush with adjacent grade to prevent trip hazards, with a HS-25 traffic-rated frame and cover, such as Neenah R-1976 product or similar.
- Cleanout in soil should extend above finished grade to remain accessible over time. Height of cleanout above finished grade should consider aesthetic visibility of piping component.
- Cleanout should consist of two 45˚ elbow fittings connected to subsurface piping. Two 45˚ elbow fittings may be replaced with 90˚ elbow or tee fitting when constrained by depth.
- Anchoring of the cleanout should be provided to prevent flotation, as appropriate.
- Designer should consider aesthetics of the portion of the pipe that is exposed above grade. It is recommended that exposed pipe be black in color or consider specifying decorative rock around the exposed pipe.

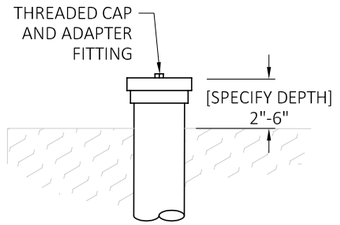
Cleanout designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-8.3

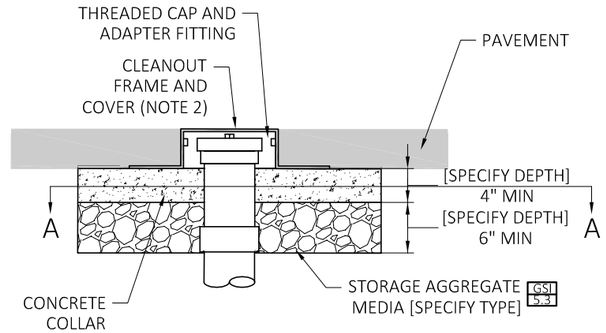
PIPING



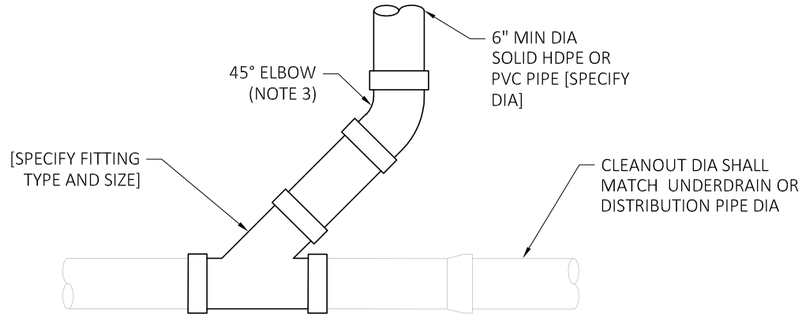
SECTION A-A



CLEANOUT IN SOIL



CLEANOUT IN PAVEMENT



CLEANOUT

NOTES:

1. CLEANOUT SHALL BE PER 02952.
2. CLEANOUT FRAME AND COVER SHALL BE NEENAH R-1976 OR APPROVED EQUAL FOR PAVEMENT APPLICATIONS. COVER SHALL BE CLEARLY MARKED WITH A UNIQUE IDENTIFIER PROVIDED BY OWNER. FRAME SHALL BE SECURED IN CONCRETE COLLAR IF NOT SECURED IN PAVEMENT SURFACE. COVERS IN PAVEMENT SHALL BE FLUSH WITH FINISHED GRADE.
3. FITTINGS OF 45° ELBOWS CAN BE REPLACED WITH 90° ELBOW OR TEE FITTING WHEN CONSTRAINED BY DEPTH.
4. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM $\frac{1}{3}$ DRIVEN INTO THE GROUND.

CLEANOUT

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

8.4 OBSERVATION WELL

Description:

An observation well is a vertical application of slotted well screen that penetrates the GSI media layers, allowing viewing and measurement of the water elevation in the GSI subsurface. Measuring the drawdown of water levels in the GSI facility monitors the overall function of the GSI.

Where to use:

Observation wells can be used in GSI with an aggregate storage media (GSI-5.3) storage layer where monitoring is desired or required.

Design Considerations:

The following are recommendations and considerations to be taken when designing an observation well. Refer to Section 02954 Green Stormwater Infrastructure Piping for construction and material specific requirements.

Observation Well

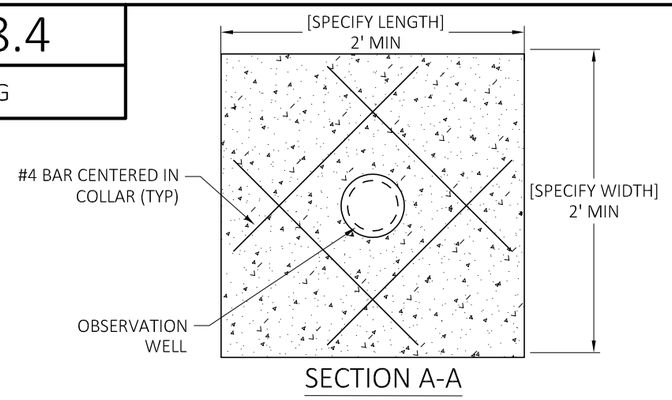
Observation Well

- Observation well diameter should consider proposed data monitoring equipment to be installed. Observation wells should not be smaller than 2” in diameter for ease of access.
- Slotted portion of the observation well should be located within aggregate media of the GSI to prevent clogging of the observation well.
- Observation well in pavement applications should be flush with adjacent grade with a traffic-rated frame and cover, such as Neenah R-1976 product or approved equal.
- Designer should consider aesthetics of the portion of the pipe that is exposed above grade. It is recommended that exposed pipe be black in color or consider specifying decorative rock around the exposed pipe.

Observation well designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-8.4

PIPING



OBSERVATION WELL IN PAVEMENT

NOTES:

1. OBSERVATION WELL SHALL BE PER 02952.
2. OBSERVATION WELL FRAME AND COVER SHALL BE NEENAH R-1976 FOR PAVEMENT APPLICATIONS. COVER SHALL BE CLEARLY MARKED WITH A UNIQUE IDENTIFIER PROVIDED BY OWNER. FRAME SHALL BE SECURED TO CONCRETE COLLAR IF NOT SECURED IN PAVEMENT SURFACE. COVERS IN PAVEMENT SHALL BE FLUSH WITH FINISHED GRADE.
4. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM 3/4 DRIVEN INTO THE GROUND.

OBSERVATION WELL

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

8.5 ANTI-SEEP COLLAR

Description:

An anti-seep collar reduces the preferential flow of stormwater from GSI to adjacent subgrade or laterally along a pipe and/or utility. An anti-seep collar generally consists of a plastic collar with sealant around the outside diameter of a pipe and/or utility.

Where to use:

An anti-seep collar is installed at either end of a utility sleeve (GSI-8.6) or at the edge of the GSI where an impermeable barrier is used to reduce a lateral flow from the extents of GSI facility. Anti-seep collars should be considered in urban areas or where GSI is directly adjacent to buildings.

Design Considerations:

The following are recommendations and considerations to be taken when designing an anti-seep collar. Refer to Section 02954 Green Stormwater Infrastructure Piping for construction and material specific requirements.

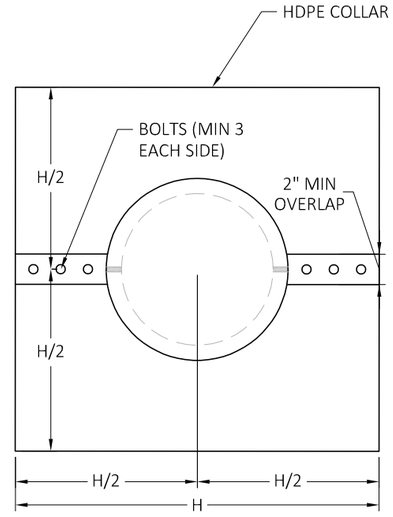
The anti-seep collar should be a minimum of 3 times the diameter of the utility service, utility sleeve, or pipe around which the anti-seep collar is installed.

Designer should consult the utility owner for protection requirements of utility within the vicinity of stormwater infrastructure. Relocation of the utility outside the extents of the GSI facility is preferred.

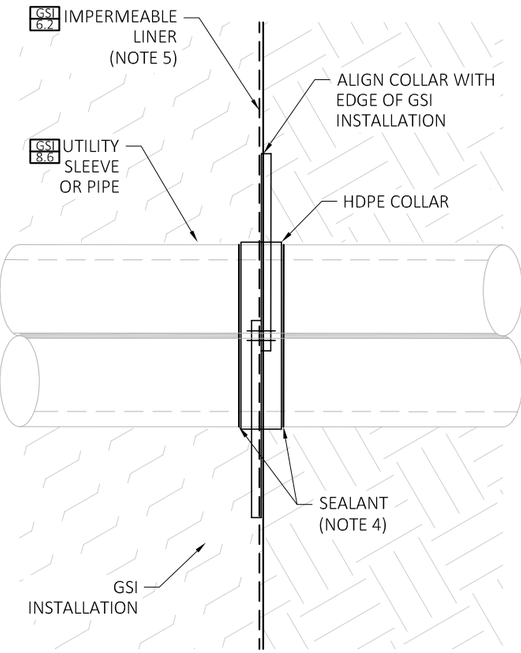
Anti-seep collar designs outside of the parameters of this guideline should be submitted for review and approval.

GSI-8.5

PIPING



SECTION



PROFILE

NOTES:

1. ANTI-SEEP COLLAR SHALL BE PER 02952.
2. ANTI-SEEP COLLAR SHALL BE USED IN CONJUNCTION WITH UTILITY SLEEVE OR AS SPECIFIED BY DESIGN PROFESSIONAL.
3. DIMENSION 'H' SHALL BE A MINIMUM OF 3X THE DIAMETER OF THE UTILITY SERVICE, UTILITY SLEEVE OR PIPE.
4. SEAL SURFACE OF UTILITY SLEEVE AND ANTI-SEEP COLLAR WITH WATER-TIGHT SEALANT, AS RECOMMENDED BY MANUFACTURER
5. IMPERMEABLE LINER SHALL BE INSTALLED ON INSIDE FACE OF ANTI-SEEP COLLAR UNLESS OTHERWISE NOTED BY THE DESIGN PROFESSIONAL.

ANTI-SEEP COLLAR

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

8.6 UTILITY SLEEVE

Description:

A utility sleeve protects a utility service or pipe from stormwater infiltration when relocation of the utility or pipe is not viable. A utility sleeve also protects the GSI facility from the utility service or pipe.

Where to use:

A utility sleeve may be installed on a utility service or pipe that passes through, under, or adjacent to a GSI installation. Utility sleeves are also used in pipe crossing or utility crossing situations to prevent cross-contamination.

Design Considerations:

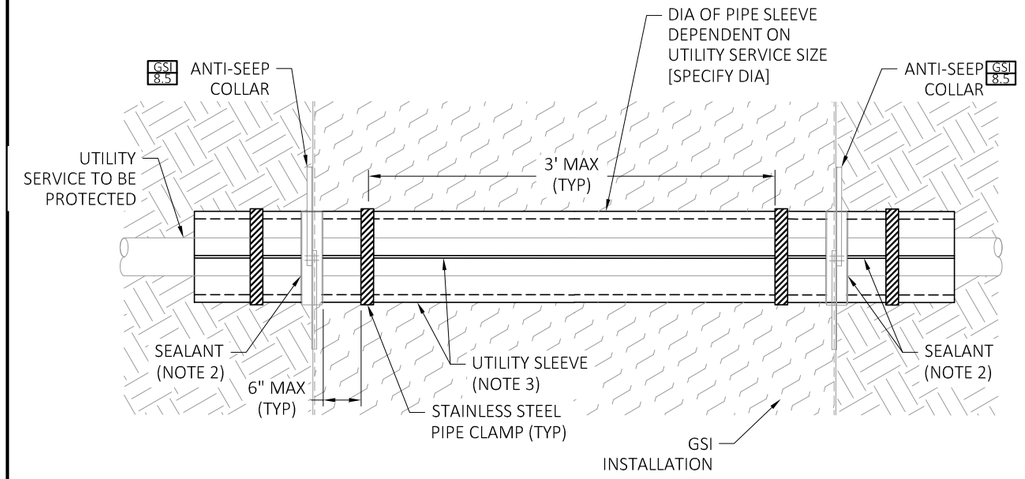
The following are recommendations and considerations to be taken when designing a utility sleeve. Refer to Section 02954 Green Stormwater Infrastructure Piping for construction and material specific requirements.

- A utility service and/or pipe should be relocated outside the extents of the GSI installation, when possible.
- Designer should consult the utility owner for protection requirements of utility within the extents and/or vicinity of stormwater infrastructure.
- Anti-seep collar should be installed at either end of a utility sleeve.

A utility sleeve design outside of the parameters of this guideline should be submitted for review and approval.

GSI-8.6

PIPING



SECTION

NOTES:

1. UTILITY SLEEVE SHALL BE PER 02952.
2. SEAL SURFACE OF UTILITY SLEEVE AND ANTI-SEEP COLLAR WITH WATER-TIGHT SEALANT, AS RECOMMENDED BY MANUFACTURER
3. APPLY WATERTIGHT SEALANT BETWEEN TWO HALVES OF UTILITY SLEEVE.

UTILITY SLEEVE

AUGUST 2018

GREEN STORMWATER INFRASTRUCTURE MANUAL GREEN CITY OF KCMO

GSI – 9 OUTLETS

GSI OUTLETS ARE DESIGNED TO ALLOW EXCESS STORMWATER FLOWS TO EXIT THE GSI WHEN THE CAPACITY OF THE FACILITY IS EXCEEDED. THE OUTLET STRUCTURE CAN BE DESIGNED TO CONTROL WATER LEVELS BOTH AT THE SURFACE AND IN THE SUBSURFACE OF THE GSI. STORMWATER ABOVE THE FINISHED GRADE OF THE GSI IS CONTROLLED WITH AN OVERFLOW RISER THAT IS OVERTOPPED ONCE THE PONDING ELEVATION IN THE FACILITY IS EXCEEDED. OUTLETS CAN BE DESIGNED WITH ADDITION FLOW CONTROL MECHANISMS TO CONTROL OUTFLOW FROM THE STORAGE AGGREGATE MEDIA OR UNDERDRAIN COMPONENTS, TO MAXIMIZE THE STORAGE CAPACITY OF THE GSI.

DESIGN DELIVERABLE CHECKLIST

- ☐ Plan view of GSI indicating location of outlet structure(s) including northing/easting points and RIM elevations.
- ☐ Spot elevations to show positive drainage path towards the outlet structure(s) as well as major overland flow paths and bypass for storm events that exceed the design capacity of the GSI.
- ☐ Detail/Section view of outlet structure (s) specifying recommended product/ manufacturer, structure size, dimensions, and elevations of overflow mechanisms including structure top, flow control weir/orifice/valve, and inverts (as applicable).
- ☐ Detail of anchoring design to prevent flotation (as applicable).
- ☐ Maximum outflow rate and drawdown time calculations.
- ☐ Detail of outlet structure connection to downstream drainage system.

9.1 OVERFLOW RISER

Description:

An overflow riser consists of solid plastic pipe and fittings or manufactured structure with a grated cover that extends above the finished grade of the GSI to collect stormwater from the GSI surface. When the design ponding elevation in the facility is exceeded, the riser conveys flows away from the GSI to a downstream conveyance system. Overflow risers typically consist of the following types:

GSI 9.1.1 **Overflow Riser:** Consists of a solid plastic pipe, usually polyvinyl chloride (PVC) or high-density polyethylene (HDPE) with a domed or flat grated top.

GSI 9.1.2 **Manufactured Overflow Riser:** Consists of prefabricated outlet structure, it should be noted that manufactured outlets are often referred to by the manufacturer as "inlets" due to their stormwater collection function.

Where to use:

Overflow risers should be used in GSI applications with the potential for stormwater inflow greater than the design capacity and ponded elevation should be controlled to prevent flooding of adjacent areas, such as GSI adjacent to private property, buildings, or streets. Overflow risers are most commonly used to control the ponded water surface elevation within the GSI facility.

Manufactured Overflow Riser

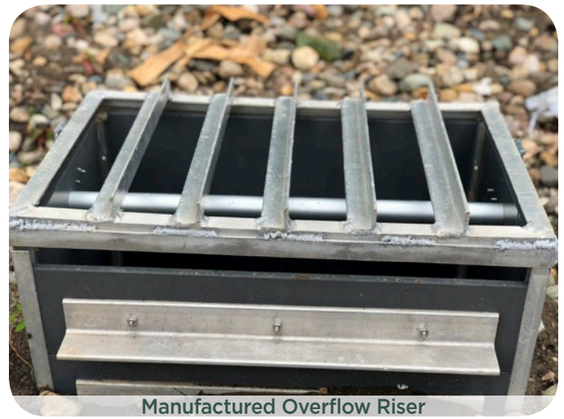
Overflow riser designs outside of the parameters of this guideline should be submitted for review and approval.

Design Considerations:

The following are recommendations and considerations to be taken when designing overflow risers. Refer to Section 02955 Green Stormwater Infrastructure Outlets for construction and material requirements.

- Overflow elevations should be set at the design ponding height. Ponding volume above the overflow elevation is not recognized as storage volume in the GSI, as it is assumed to discharge through the outlet and bypass the facility.
- Overflow risers should typically consist of two 45˚ elbow fittings to connect to outlet piping, when feasible. Two 45˚elbow fittings may be replaced with a 90˚elbow or tee fitting when constrained by depth.
- Manufactured overflow riser standard detail is often provided by the manufacturer. Designer should review detail and provide additional information as needed to define water level control function of the GSI facility.
- Designer is required to evaluate the impact of the outflow from the GSI to the downstream drainage system by providing existing and proposed hydraulic grade line elevations.
- Designer should provide an anchoring design for the overflow riser to mitigate flotation of the structure, as needed.
- Designer should consider specifying a catch basket or strainer product within in the outlet structure to minimize debris exiting the facility.
- Designer should consider aesthetics of the portion of the pipe that is exposed above grade. It is recommended that exposed pipe be black in color or consider specifying decorative rock around the exposed pipe.
- Designer should take measures to minimize standing water in structure sumps to mitigate mosquito habitat.

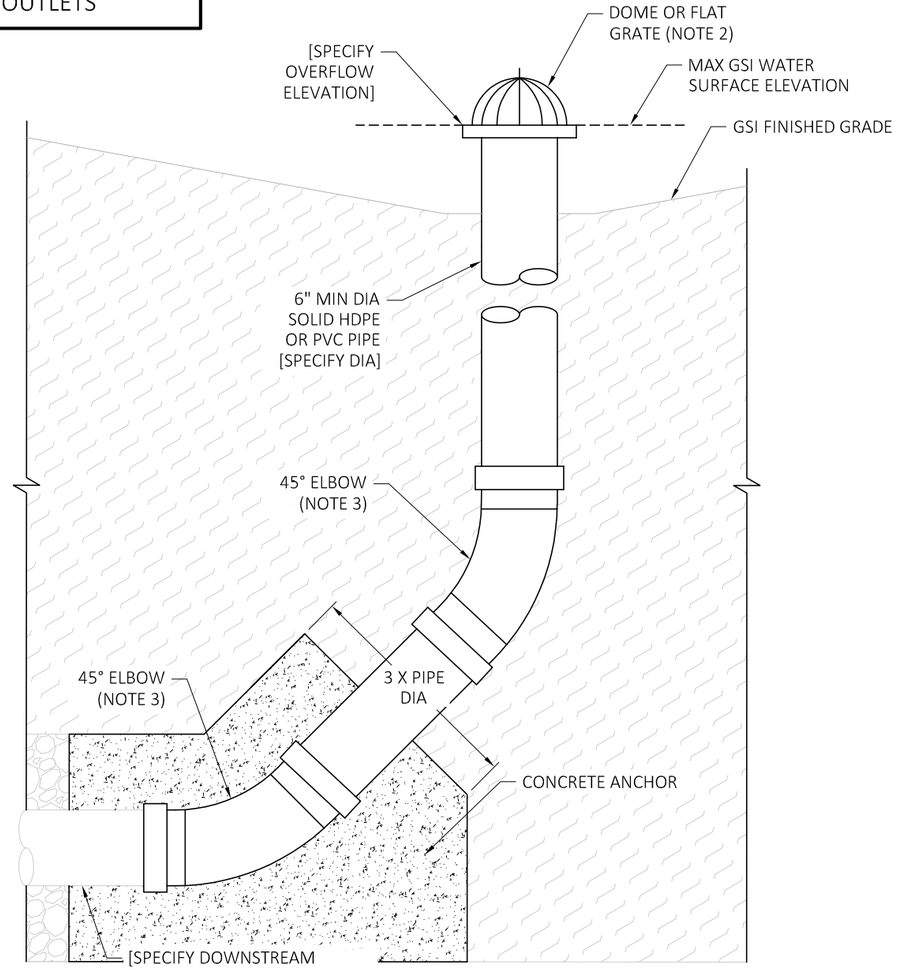
Manufactured Overflow Riser



Manufactured Overflow Riser

GSI-9.1.1

OUTLETS



SECTION

NOTES:

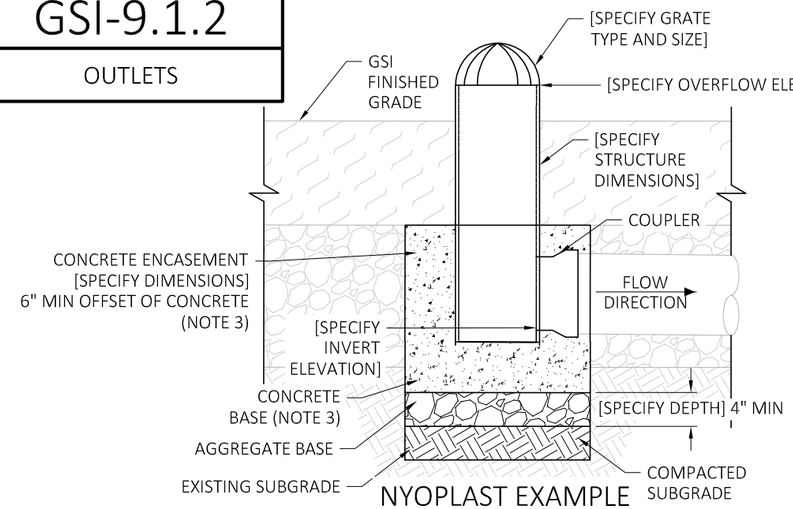
1. OVERFLOW RISER SHALL BE PER 02953.
2. FRAMES, GRATES AND COVERS SHALL BE SPECIFIED BY THE DESIGN PROFESSIONAL. DOMED GRATE SHOWN FOR REFERENCE ONLY.
3. FITTINGS OF 45° ELBOWS CAN BE REPLACED WITH 90° ELBOW OR TEE FITTING WHEN CONSTRAINED BY DEPTH.
4. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM $\frac{1}{3}$ DRIVEN INTO THE GROUND.

OVERFLOW RISER

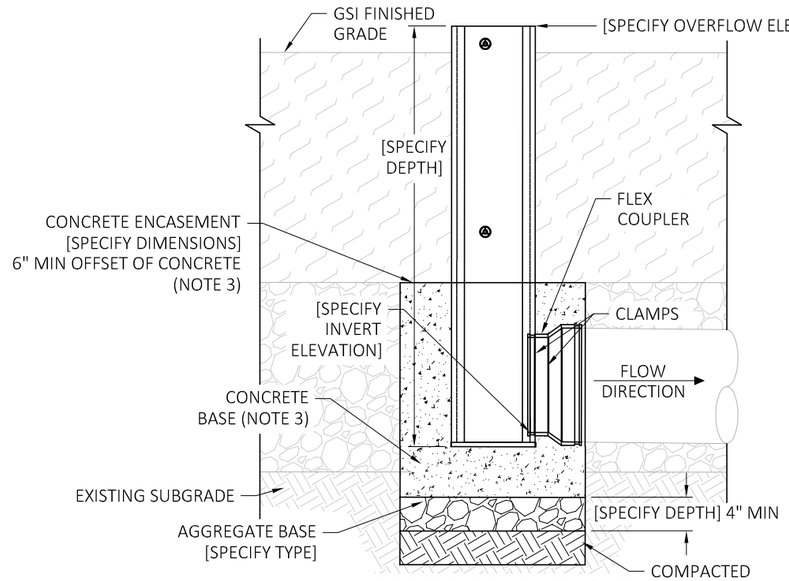
AUGUST 2018

GSI-9.1.2

OUTLETS



NYOPLAST EXAMPLE



AGRIDRAIN EXAMPLE

NOTES:

1. OUTLET STRUCTURE SHALL BE PER 02953.
2. DESIGNER TO SPECIFY MANUFACTURER AND PRODUCT.
3. OVERFLOW RISER AND CONCRETE BASE SHALL BE DESIGNED TO RESIST BUOYANCY. DESIGNER TO SPECIFY DIMENSIONS AND REINFORCEMENT OF BASE AND ENCASEMENT (IF APPLICABLE). CONCRETE ENCASEMENT OPTION SHOWN FOR REFERENCE ONLY.
4. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM $\frac{1}{3}$ DRIVEN INTO THE GROUND.

MANUFACTURED OVERFLOW RISER

(NYOPLAST & AGRIDRAIN EXAMPLES)

AUGUST 2018

9.2 OUTLET CONTROL STRUCTURE

Description:

Outlet control structures include overflow risers with internal control mechanisms, such as weirs, valves, or orifices, that provide controlled release of stormwater flows from both the surface and the subsurface of the GSI. Manufactured outlet control structures are pre-fabricated control structures that can be designed with internal water level control features.

Where to use:

Outlet control structures should be used in GSI outlet applications with below grade storage to maximize storage and infiltration capacity by controlling the water level in both the surface and subsurface of the facility.

Weir Outlet Control

Design Considerations:

The following are recommendations and considerations to be taken when designing outlet control structures. Refer to Section 02955 Green Stormwater Infrastructure Outlets for construction and material specific requirements.

- Designer should specify control mechanism type size, and configuration, as applicable. Designer should consider blinding potential of valves and orifices that impact rate of stormwater release from the GSI facility.
- Manufactured outlet control structure standard detail is often provided by the manufacturer. Designer should review detail and provide additional information as needed to define water level control function of the GSI facility.
- Control mechanism (weir, orifice, or valve) elevations internal to the outlet control structure should consider the designed elevations within the GSI storage media. It is recommended that these elevations are set no higher than the top of the storage aggregate media.
- Overflow elevations should be set at the design ponding height. Ponding volume above the overflow elevation is not recognized as storage volume in the GSI as it is assumed to discharge through the outlet and bypass the facility.

Outlet control structure designs outside of the parameters of this guideline should be submitted for review and approval.

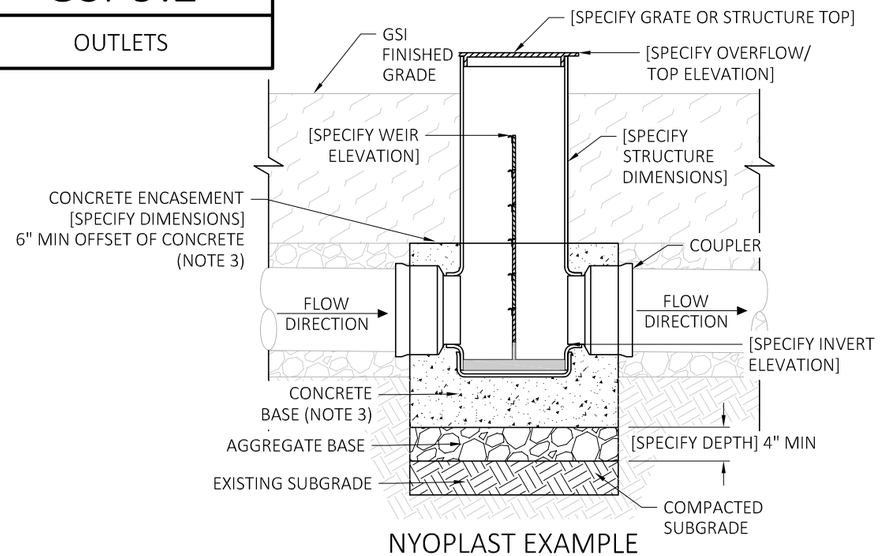
- Designer is required to evaluate the impact of the outflow from the GSI to the downstream drainage system by providing existing and proposed hydraulic grade line elevations.
- Designer should provide an anchoring design for the outlet control structure to mitigate flotation of the structure, as applicable.
- Designer should consider specifying a catch basket or strainer product within in the outlet structure to minimize debris exiting the facility.

Outlet Control Structure

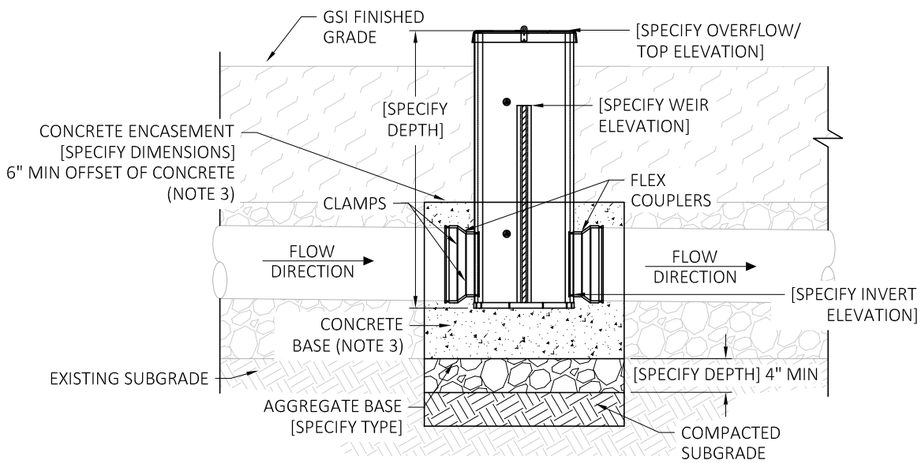
Outlet Control Structure

GSI-9.2

OUTLETS



NYOPLAST EXAMPLE



AGRIDRAIN EXAMPLE

NOTES:

1. OUTLET STRUCTURE SHALL BE PER 02953.
2. DESIGNER TO SPECIFY MANUFACTURER AND PRODUCT.
3. OVERFLOW RISER AND CONCRETE BASE SHALL BE DESIGNED TO RESIST BUOYANCY. DESIGNER TO SPECIFY DIMENSIONS AND REINFORCEMENT OF BASE AND ENCASEMENT (IF APPLICABLE). CONCRETE ENCASEMENT OPTION SHOWN FOR REFERENCE ONLY.
4. A WOODEN 2 INCH X 2 INCH DEMARCATION STAKE IS REQUIRED AT ALL STRUCTURE LOCATIONS. THE STAKE SHALL BE PAINTED WHITE AND A MINIMUM OF 4 FEET LONG WITH THE BOTTOM $\frac{1}{3}$ DRIVEN INTO THE GROUND.

MANUFACTURED OUTLET CONTROL STRUCTURE

(NYOPLAST & AGRIDRAIN EXAMPLES)

AUGUST 2018

GSI ESTABLISHMENT & MAINTENANCE

Establishment & Maintenance Introduction

Tools in this Section

Service Levels of Performance Standards

Rating Indices

Maintenance Activity Guidance

Maintenance Tasks & Typical Frequencies

Troubleshooting Guidance

ESTABLISHMENT & MAINTENANCE: INTRODUCTION

The purpose of the Green Stormwater Infrastructure Manual is to improve the overall success of green stormwater infrastructure in Kansas City, Missouri. Tracking maintenance activities performed through the life of each GSI component provides a complete picture of the long-term effort required to sustain a site. This record may highlight components or designs that were faulty or failed to meet expectations, facilitating better designs in the future. A design approach based on data gathered by the field crews empowers the city to select options that require fewer maintenance manpower hours and avoid those that are prone to operating issues.

This section is intended to be used by contractors installing or establishing City projects with GSI components, city crews that take over the maintenance of established GSI sites, or other groups that work with the city to provide maintenance services. Tools have been developed to streamline scheduling, standardize establishment inspection and maintenance tasks, and to track those tasks.

TOOLS IN THIS SECTION

Service Levels of Performance Standards provides the service level expectations to be met during the establishment and maintenance phases. Any frequencies recommended as part of this document are intended to assist in meeting the required service level, but do not take precedent over the service levels.

There are three maintenance rating indexes to be used during the inspection of green stormwater infrastructure. The **Litter Index** was developed by "Keep America Beautiful" and provides a tool to rate litter density. The **Appearance Index** and the **Function Index**, as published in the Seattle "Green Stormwater O&M Manual" (2009), help guide inspection using pictures to describe conditions ranging from poor to excellent. These indexes should be used to document the litter and appearance of the GSI feature before each regularly scheduled field visit begins. Each site should achieve a level one rating (no litter/excellent appearance) by completing maintenance tasks per GSI component.

Maintenance Guidance is provided for regular tasks per design component. Pictures show various GSI features and describe the tasks that should be completed for each. Each task is accompanied by a task code and title that correlates to the tasks provided in the Site Activity Plan **Maintenance Schedule Forms** included in Appendix B. These forms are intended to be used by design professionals and contractors for scheduling and reporting maintenance efforts. The forms are also accompanied by instructions to guide both contractors and designers on how to use the forms. Some projects may use computerized maintenance management systems (CMMS) in lieu of forms, but similar content is recommended for computerized forms.

The **Maintenance Tasks and Typical Frequencies** section summarizes the list of individual GSI component maintenance tasks provided in the Maintenance Guidance section, and provides typical frequencies for each task. The frequencies are intended to be used as references only, and may need to be adjusted based on site-specific needs to meet the required Service Levels of Performance.

Troubleshooting Guidance provides considerations for situations that may be encountered at GSI features that are not functioning properly. These go above and beyond standard routine maintenance tasks. Potential causes of these larger-scale issues are discussed and solutions are suggested.

SERVICE LEVELS OF PERFORMANCE STANDARDS

Within this table are listed the performance standards that should be met during the establishment period. In several of the other tools in this document, tasks and frequencies have been provided to aid in performing all the necessary maintenance activities. However, they are solely meant to provide a guide and do not replace the performance standards or absolve the contractor from meeting them.

For additional information regarding the contractor responsibilities related to the Establishment period, review the KCMO GSI Specifications, in particular Specification 02955 Green Stormwater Infrastructure Establishment Period.

Service Levels of Performance Standards

Appearance	Weeds, Pests, Disease	Mulch, Erosion	Drainage
Vegetation healthy with tidy appearance Vegetation watered during dry periods over two (2) weeks in length Vegetation confined to planted areas Clean, distinct planting bed edges Litter/trash removed Fallen/blown foliage removed (leaves, nuts, sticks, lawn clippings, fallen branches) little to no sediment or silt on surface No cracking, settling, or damage to of GSI Components	Weeds are not acceptable, every effort should be made to control and eliminate all weeds Pests or diseases that threaten vegetation should be removed with gentlest method possible. If problem is limited to less than 5% of plants, remove infected plants and replace with different species Mosquito larvae removed	Mulch evenly distributed, two (2) inches to four (4) inches deep No evidence of erosion Little to no sediment or silt on mulch surface Finished grade location and elevation tolerances shall not exceed the following: -Horizontal = 0.1 feet -Vertical = 0.1 feet	Zero ponding depth observed 48 hours following a rain event Clear, open flow paths for water (inlet, outlet, overflow)

RATING INDICES

LITTER INDEX
(Rating developed by "Keep America Beautiful")

1: No Litter
- Virtually no litter
- Generally neat and tidy

2: Slightly Littered
- Small amount of litter
- It may take a few people a little bit of time to pick up the litter

3: Littered
- It may take a group of people some time to pick up the litter
- Considerable effort to clean

4: Extremely Littered
- Continuous amount of litter
- It may take a group a lot of time and equipment to pick up the litter

APPEARANCE INDEX
(From Seattle "Green Stormwater O&M Manual", 2009)

1: Excellent
- Healthy vegetation, excellent appearance
- No weedy species present

2: Good
- Mostly healthy vegetation, good appearance
- Occasional weed species (5-10%)

3: Moderate
- Mostly healthy vegetation, neglected appearance
- Lots of weedy species (10-20%)

4: Poor Effort
- Unhealthy vegetation, neglected appearance
- Weedy species predominate (more than 20%)

FUNCTION INDEX

(From Seattle "Green Stormwater O&M Manual", 2009)

1: Excellent

- No erosion or bare spots, sediment, or flow obstructions

2: Good

- Some erosion and bare spots (0-5%)
- Some sediment and some flow obstructions

3: Moderate

- Substantial erosion and bare spots (5-10%)
- Significant build-up of sediment, some flow obstructions

4: Poor Effort

- Erosion and bare spots (more than 10%)
- Significant build-up of sediment, significant flow obstructions

MAINTENANCE ACTIVITY GUIDANCE

GSI-1: INLET

Inspect for standing water (1.1.A)

If there is standing water, note it on the inspection form. Report any observation of mosquito larvae to Owner's attention within 24 hours of observation. Immediately install mosquito Bti (Bacillus thuringiensis) mosquito dunk in location of observed larvae following manufacturer's recommended application rate and instructions. Larger chemical dunks may be allowable for sites with bigger sumps not within public's reach, but must be approved by the owner prior to application.

Inspect structural integrity (1.1.B)

Inspect structural conditions of inlet. Check for loose or damaged inlets, grates or screens. Check for damaged or broken curbing or concrete structures. Report any observed damage to the Owner.

Remove sediment, debris and trash (1.2.A)

Remove all sediment and debris, including fallen or blown foliage and other trash, accumulated in inlet structures.

Remove blockages (1.2.B)

Remove any blockages within the structure. Clean or replace filter bag/basket, as necessary. Follow manufacturer's maintenance instructions, as applicable.

Remove sediment for open flow paths (1.2.C)

Stiff broom inlet structure and twenty feet of curb/ gutter upstream of inlet structures, if applicable. Ensure open flow paths to and through the structure.

Remove accumulated sediment (1.2.D)

Remove sediment accumulation along perimeter of GSI if sediment is blocking water from entering. Check for erosion along perimeter and immediately upstream of component.

GSI-2: ENERGY DISSIPATION & PRETREATMENT

Inspect and record debris depth (2.1.A)

Perform visual inspection on pretreatment devices to verify functionality. Quantify trash and measure accumulated sediment with ruler or dipstick.

Remove sediment, debris and trash (2.2.A)

Remove all sediment and debris, including fallen or blown foliage and other trash, from pretreatment structures. Remove any blockages within the structure. Completely remove accumulated sediment and debris. Follow manufacturer's maintenance instructions, as applicable. If necessary, jet vacuum the pretreatment chambers within a week of observed blockages to prevent stormwater from bypassing around the GSI.

Repair erosion (2.R2.A)

Verify the integrity of cascading weirs or berms. Repair erosion near weirs/berms, when applicable.

GSI-3: ABOVE GRADE BARRIERS

Inspect structural integrity (3.1.A)

Inspect conditions of surrounding above grade barriers and/or reflective devices. Check for loose or damaged base or stand for bollards/fencing. Check for damaged or broken curbing. Report any observed damage to the Owner.

Repair structural damage (3.R2.A)

Repair, replace or tighten any necessary pieces.

Repair erosion (3.R2.B)

Inspect for and repair any erosion or undermining of or around above grade barrier by replacing displaced media in like kind.

GSI-4: PERMEABLE PAVEMENT

Inspect pavement for clogging (4.1.A)

Inspect entire surface area for standing water. Check infiltration by pouring water on surface to verify water readily soaks away and note locations where ponding occurs. If pavement is clogged, follow manufacturer instructions for unclogging the surface.

Inspect pavement condition (4.1.B)

Inspect pavement condition. Note and report any observed cracking, spalling, and noticeable surface wear.

Repair pavers (4.R2.A)

Remove and replace any pavers that have broken or cracked; lift and regrade base for any pavers that have sunk.

Repair pavement (4.R2.B)

Remove any pavement that has excessive spalling; replace with new porous pavement, if possible, or replace with conventional pavement, with approval from the Owner.

Redress joints (4.R2.C)

If joints are designed to be dressed, dress all joints with original jointing material where the joint filler has washed away or settled to ½-inch or more from surface. Ensure jointing material is free from fines.

Remove debris and trash (4.2.A)

Remove trash and litter from all pavement surfaces. Report observations of dumped large items such as furniture, tires, bags of trash, etc. to Owner immediately. Provide street address where dumping was observed.

Remove sediment from pavement and pavers (4.2.B)

Vacuum surface to remove accumulated sediment that has migrated onto and into pavement. Follow manufacturer instructions for pavement with jointing material, so as not to permanently displace the material. If joints are designed to be open, verify that joints are not filled with debris or sediment; remove debris if it is found.

Remove weeds (4.3.A)

Remove weeds. For permeable pavers, use a weed torch or approved herbicide; avoid hand pulling weeds so that subsurface gravel is not displaced.

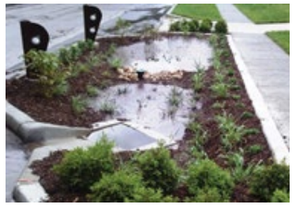
Remove stains and other markings (4.4.A)

Use stain removal agents to remove caked-on dirt or other surface markings.

GSI-5: SOIL & AGGREGATE MEDIA

Inspect site after 3-inch rain in 24-hour period (5.1.A)

Complete a review of the project area after cumulative rainfall of 3 inches or more in 24 hours per the nearest USGS or City rain gauge. Revisit in another 24 hours, if no additional rainfall occurs, to inspect that the water has drained. If the GSI did not drain, report to Owner. Owner will provide direction on maintenance activities to restore its performance.



Record standing water depth (5.1.B)

During every site visit, observe and record the depth in inches of any standing water, if present, on the inspection log.

Inspect for erosion (5.1.C)

Check for erosion gullies to see if water is entering GSI in undesirable area. Replace displaced material in like kind. Report recurring gullies to the Owner.

Inspect for snow or snow removal damage (5.1.D)

Inspect after major snow storms for general damage from snow removal equipment or blockage from sand or road debris. Remove blockages, as applicable. Report any permanent damage to the Owner.

Report utility excavation (5.1.E)

Report to Owner any observed utility excavations that occur within the maintained areas (digging for telecommunications, water main replacement or repairs, etc.) or upstream of the GSI feature.

Remove sediment, debris, and trash (5.2.A)

Remove buildup of sediment, trash, and litter from landscaped areas. Report observations of dumped large items such as furniture, tires, bags of trash, etc. to Owner. Provide street address where dumping was observed.

Replace settled materials (5.R2.A)

Inspect for signs of soil or gravel settlement. Replace and stabilize surface material as needed to bring to original grade. Report any observation of animal burrows larger than 1-inch to Owner.

Repair erosion (5.R4.A)

Fill small gullies with mulch or surface material. If erosion occurs in the same place more than one time, contact Owner. Fill larger gullies with decorative rock, appropriately sized for the permissible shear stress of stormwater entering the GSI, as directed by the Owner (see Green Stormwater Infrastructure Manual GSI-2.1). Check for mulch or soil slumping. Rake back into place.

GSI-7: LANDSCAPING

Remove debris and trash (7.2.A)

Remove fallen/blown foliage (leaves, nuts, sticks, clippings from adjacent lawnmowers, fallen branches, etc.)

Apply pre-emergent herbicide (7.3.A)

Rake leaves and litter from GSI surface before applying pre-emergent herbicide. Apply pre-emergent herbicide granules as product instructions indicate. Avoid use of herbicide if GSI discharges to separate sewer system, or directly to streams.

Remove weeds (7.3.B)

Maintain GSI components so they are free of weeds at all times. Weeds are defined as plants that were not installed as part of the project. If plants are found that were not originally installed but are identified as beneficial plants, consult Owner for direction prior to removal. Identify weed species to determine the appropriate Integrated Vegetative Management techniques. Hand-pull all annual and biennial weed species, unless alternative methods have been previously approved. For perennial weed species use the mildest effective measures to remove the weed and prevent its return. Any person applying pesticides for weed management must be Missouri-State Certified Pesticide Applicators. Blue marker dye is recommended in all liquid pesticides before use. Pesticides shall not be applied within 24 hours of a forecasted rain event, and shall be applied per product label.

Manage disease and pests (7.3.C)

Follow Integrated Pest Management principles to manage diseases and pests that could threaten plant or human health as well as to manage weeds. Review Integrated Pest Management information available from the University of Missouri Extension.

Manage landscape edges (7.5.A)

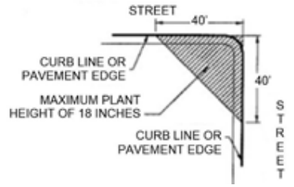
Landscape edging (metal landscape edge, concrete edge, cultivated edge, etc.) should be clean, distinct, and visible. If plants are covering edges, streets, or surrounding pavement, properly prune or reposition the plants to uncover those surfaces. If edging material has sunken, raise it up to original grade.

Prune for compact growth (7.5.B)

Prune plantings as needed in a manner appropriate to species type and to encourage compact growth habit. Maintain vegetation so that it is confined to intentionally planted areas. Conduct cosmetic pruning as needed for dead or broken stems and branches.

Trim plant near intersection (7.5.C)

Trim plants at intersections within 40 feet of the street corner so they do not exceed 18 inches in height from the top of curb or pavement elevation. This does not apply to intersections where residential driveways and streets meet unless a specific request is received from resident.



Spring pruning of perennials and grasses (7.5.D)

In early spring (February and early March), cut back perennials and grasses to 1-inch height and remove all cuttings from site. This is supplemental to ongoing pruning. DO NOT cut back shrubs to 1-inch height.

Mow buffer around GSI perimeter (7.5.E)

Mow or neatly string-line trim to a height of 2 inches, a 3-foot buffer around GSI perimeters and lawn areas contained within the GSI. Broom or blow resulting grass clippings into the mowed grass area(s). Do not leave clippings on paved, gravel, or mulched surfaces. Do NOT mow non-lawn vegetation within the GSI footprint. Immediately contact Owner and request written clarification if mowing extents are unclear.

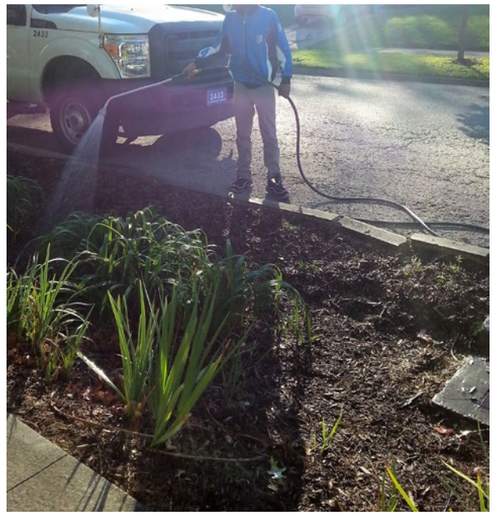
Mow grass swales (7.5.F)

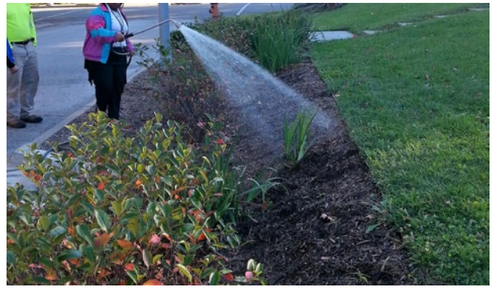
Mow or neatly string trim grass swales to height of 3 to 5 inches. Broom or blow grass clippings into the grass. Do not leave clippings on paved, gravel, or mulched surfaces.

Water vegetated areas (7.6.A)

Water newly installed plants weekly until the first freeze of the planting season occurs. The replacement plants need to be watered every other day for the first two weeks after planting. After that, they should be watered on a weekly basis. Water vegetated areas to completely saturate soil to a depth of 4 inches until the end of the growing season (after the first frost).

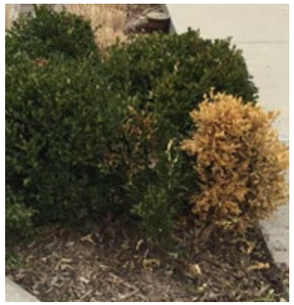
If no rain falls for two consecutive weeks anytime between April 1st to November 30th, water vegetated areas to completely saturate soil to a depth of 4 inches. Water vegetated areas to completely saturate soil to the 4-inch depth every two weeks until rainfall resumes.





Remove dead plants and replace (7.R3.A)

If any tree, plant, shrub, seed or sod is more than 75% dead, photograph vegetation in place and immediately remove. Record the dead plants on the inspection log. Contact Owner before installing replacement plants; replace removed dead plants as recommended by the Owner. Replacement plant should be planted either in April or September, to minimize heat stress to plants.



Refresh mulch (7.R4.A)

Refresh mulch as needed to maintain a 3-inch depth of mulch. Rake mulch if it has washed around. Sweep mulch from tops and sides of grates. If netting is present, remove or bury any loose ends that could create a tripping hazard. Cover with mulch or turn down and staple with sod anchor.

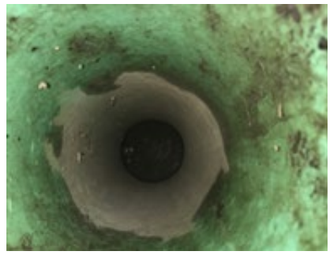
GSI-8: PIPING

Verify safe, secure access points (8.1.A)

Verify that access points to underground features are present and secured in their proper place. If guards, covers or lids are missing, notify Owner.

Inspect for standing water (8.1.B)

Check cleanouts for visible standing water or blockages in subsurface piping to confirm piping is functioning properly.



Inspect and record debris depth (8.1.C)

Visually inspect the underground features and measure and record the accumulated sediment and debris.

Inspect structural integrity (8.1.D)

Inspect structural condition of pipe components. Check for damaged or broken pipes, pipe connections, or other underground features. Report any observed damage to the Owner.

Remove blockages (8.2.A)

Remove and dispose of any blockages obstructing flow. If necessary, remove outlet control mechanism to remove blockages. Follow manufacturer's maintenance instructions, as applicable.

Remove sediment, debris and trash (8.2.B)

Access the underground features at all clean-out risers and remove all accumulated sediments in all underground features. If necessary, clean and flush piping to remove debris.

GSI-9: OUTLETS

Verify open flow paths (9.1.A)

Verify open flow pathways for water to GSI outlet. Verify clear flow path from overflow to downstream drainage system.

Inspect structural integrity (9.1.B)

Inspect conditions of outlets. Check for loose or damaged outlets, outlet pipes, grates or screens. Check for damaged or broken curbing or concrete structures. Report any observed damage to the Owner.

Remove sediment, debris and trash (9.2.A)

Empty sediment and debris from outlet structures. Follow manufacturer's maintenance instructions, as applicable. Schedule for vacuum truck to remove accumulated sediment and debris from the sump of outlet structures.

Inspect outlet control mechanism (9.4.B)

Inspect, clean, and exercise outlet control mechanism to assure it is properly functioning and that stormwater can enter pipe/manhole freely. If necessary, remove outlet control mechanism and remove any blockage in the pipe. Follow manufacturer's maintenance instructions, as applicable.

MAINTENANCE TASKS & TYPICAL FREQUENCIES

The following table summarizes the individual GSI component maintenance tasks discussed in detail in the previous sections. Frequency of maintenance is highly dependent on the individual site, surrounding area, and weather conditions. Maintenance frequencies may need to be adjusted to maintain the required service levels of performance and accommodate all external factors. The typical frequencies listed below are intended to be used as guidance only, and do not take precedence over the service levels of performance.

GSI-1

Task Code	Short Name	Typical Frequency
1.1.A	Inspect for standing water	Weekly
1.1.B	Inspect Structural integrity	Quarterly
1.2.A	Remove sediment, debris and trash	Bi-weekly
1.2.B	Remove blockages	Bi-weekly
1.2.C	Remove Sediment for open flow paths	Bi-weekly
1.2.D	Remove accumulated sediment	Bi-weekly

GSI-2

Task Code	Short Name	Typical Frequency
2.1.A	Inspect and record debris depth	Bi-weekly
2.2.A	Remove sediment, debris and trash	Bi-weekly
2.R2.A	Repair erosion	Quarterly

GSI-3

Task Code	Short Name	Typical Frequency
3.1.A	Inspect structural integrity	Quarterly
3.R2.A	Repair structural damage	Quarterly
3.R2.B	Repair erosion	Quarterly

GSI-4

Task Code	Short Name	Typical Frequency
4.1.A	Inspect pavement for clogging	Quarterly
4.1.B	Inspect pavement condition	Quarterly
4.R2.A	Repair pavers	Semi-annually
4.R2.B	Repair pavement	Semi-annually
4.R2.C	Redress joints	Semi-annually
4.2.A	Remove debris and trash	Weekly
4.2.B	Remove sediment from pavement and pavers	Quarterly
4.3.A	Remove weeds	Quarterly
4.4.A	Remove stains and other markings	Quarterly

GSI-5

Task Code	Short Name	Typical Frequency
5.1.A	Inspect site after 3-inch rain in 24 hour period	Seasonally
5.1.B	Record standing water depth	As needed
5.1.C	Inspect for erosion	Quarterly
5.1.D	Inspect for snow or snow removal damage	Seasonally
5.1.E	Report utility excavation	As needed
5.2.A	Remove sediment, debris and trash	Bi-weekly
5.R2.A	Replace settled materials	Quarterly
5.R4.A	Repair erosion	Quarterly

GSI-7

Task Code	Short Name	Typical Frequency
7.2.A	Remove debris and trash	Weekly
7.3.A	Apply pre-emergent herbicide	Quarterly
7.3.B	Remove weeds	Weekly
7.3.C	Manage disease and pests	Weekly
7.5.A	Manage landscape edges	Weekly
7.5.B	Prune for compact growth	Quarterly
7.5.C	Trim plants near intersection	Monthly
7.5.D	Spring pruning of perennials and grasses	Annually
7.5.E	Mow buffer around GSI perimeter	Monthly
7.5.F	Mow grass swales	Monthly
7.6.A	Water vegetated areas	As needed
7.R3.A	Remove dead plants and replace	Semi-annually
7.R4.A	Refresh mulch	Monthly

GSI-8

Task Code	Short Name	Typical Frequency
8.1.A	Verify safe, secure access points	Weekly
8.1.B	Inspect for standing water	Weekly
8.1.C	Inspect and record debris depth	Monthly
8.1.D	Inspect structural integrity	Quarterly
8.2.A	Remove blockages	Semi-annually
8.2.B	Remove sediment, debris and trash	Bi-weekly

GSI-9

Task Code	Short Name	Typical Frequency
9.1.A	Verify open flow paths	Weekly
9.1.B	Inspect structural integrity	Quarterly
9.2.A	Remove sediment, debris and trash	Bi-weekly
9.4.B	Inspect outlet control mechanism	Semi-annually

TROUBLESHOOTING GUIDANCE

GSI design continues to evolve as lessons are learned from each project. We can use these **"lessons learned"** to evaluate GSI features that are not functioning properly and find potential solutions that go above and beyond standard preventative maintenance tasks. Potential causes of problems may extend into the upstream drainage area. This section is not meant to include all potential inspection observations; instead, the intent is to walk the user through the **troubleshooting process** as it could be applied to a GSI site. Through a thorough evaluation, next steps toward a solution can be identified.

FUNCTIONAL ISSUE: Water is not entering the GSI.

- Observe and Evaluate: How is stormwater draining to the GSI facility? Compare desktop design data to actual field conditions during a rain event.
- Check opening. Sediment, leaf or other debris, and litter can block openings to the inlet or build up around the edge of the GSI, blocking flow.
- Elevation of at-grade inlet. At-grade inlets should be at an elevation at or above the downstream GSI to allow water to move into the facility unobstructed. For example: if sod is higher than ribbon curb or other inlet, it may be necessary to remove the sod, lower the grade and replace the sod. Additionally, if the inlet gutter or apron is higher than the adjacent pavement such that water is bypassing the inlet, the inlet and gutter apron may need to be lowered.

FUNCTIONAL ISSUE: Erosion in the GSI facility.

- Observe and Evaluate: Are GSI Energy Dissipation components included at the facility? If so, are they located at points where stormwater is draining to the GSI facility? Compare desktop design data to actual field conditions during a rain event.
- Observe and Evaluate: Is the GSI facility inline or offline? For inline GSI facilities all rainfall runoff is designed to infiltrate and/or flow through, with no bypass. For offline GSI facilities, rainfall runoff is diverted from the main drainageway, with excess runoff following the main drainageway and bypassing the GSI.
- Observe and Evaluate: How much did it rain, and at what intensity? GSI facilities are typically designed to store stormwater runoff from between one and two inches of rainfall that falls in less than 24 hours. More intense rainfall may impact the GSI, especially inline facilities.
- Check drainageways. Are there obstructions to the drainageway? Observe how water is entering GSI. The design may have assumed overland sheet flow would occur; is flow concentrating instead?
- Observe vegetation density, health, and maturity. Established vegetation helps hold soil in place. Are there missing or dead plants that should be replaced? Erosion control measures, such as an erosion control blanket, will help prevent erosion while new plants are established.

FUNCTIONAL ISSUE: Standing water in the GSI facility for more than 48 hours.

- Observe and Evaluate: How much did it rain over the previous three days? GSI facilities are typically designed to store stormwater runoff from between one and two inches of rainfall. If it has rained more than two inches, it may take more time for the runoff to infiltrate or discharge from the GSI system. Continue to inspect daily, and note the interval time between inspections and the ponding depth of water.
- Check maturity of vegetation. For the first growing season, lower the elevation of or open the outlet control structure to allow water to flow through the GSI facility rather than pond, allowing vegetation to establish. As vegetation matures, the facility can handle increased stormwater ponding.
- Check outlet. Sediment, leaf or other debris, and litter can block openings to the outlet.
- Observe site conditions. Accumulated sediment at the surface can prevent stormwater from draining. The growing media or permeable pavement can be clogged by sediment, leaves, grass clippings or other materials that may have accumulated. Identify the source of the sediment and/or debris by observing stormwater paths from the drainage area to the site, and surrounding property conditions.
- Observe surrounding conditions. Are there construction sites within the drainage area? The GSI should be protected from sediment loads due to construction activity. What is the condition of the pavement in the drainage area? As asphalt degrades, the fine particles can be carried by stormwater runoff.
- Evaluate GSI Pretreatment components. In some cases, the pretreatment devices may not be functioning properly. They may be clogged or stopped in such a way that is allowing water to flow past into the feature.

FUNCTIONAL ISSUE: Vegetation in poor health or dead.

- Check maturity of vegetation. For the first growing season, lower the elevation or open the outlet control structure to allow water to flow through the GSI facility rather than pond, allowing conditions for the vegetation to establish. As vegetation matures, the facility will handle increased stormwater ponding.
- Observe vegetation density, health, and maturity. Established vegetation helps hold soil in place. Are there missing or dead plants that should be replaced? Erosion control measures, such as an erosion control blanket, will help prevent erosion while new plants are established. Is vegetation species selection appropriate for planted location within the GSI facility?
- Understand site maintenance activities. Were herbicides or other chemicals administered as part of maintenance activities? If so, where? Has utility work been present in the area (excavations or at-grade)? Utility excavations as part of emergency and/or planned repairs can impact immediately adjacent vegetation health.
- Engage a landscape professional for assistance. Plant death can result from a variety of conditions, including but not limited to: poor establishment practices, too much or too little sunlight or moisture, nutrient imbalance, pest infestation, excess herbicides, etc.

APPENDIX A: RECOMMENDED PLANT LIST & CHARACTERISTICS

Recommended Green Stormwater Infrastructure Tree Plant List & Characteristics

Use this plant list as a guideline for plant material selections. As needed, offer suggestions of better plant alternatives for consideration. Aim for 75% minimum native plants (or native cultivars) when possible.

Plant Code	Botanical Name	Common Name	Missouri Native/ Native Cultivar	Height (ft)	Spread (ft)	Water	Inundation Tolerance	Drought Tolerance	Light	Salinity Tolerance
Trees										
AR	*Acer rubrum*	Red Maple	Yes	40 to 70	30 to 50	Med to Wet	High	Low	Full Sun to Part Shade	No
AS	*Acer saccharum 'Bailsta'*	Fall Fiesta Sugar Maple	Yes	40 to 80	30 to 60	Med	Med	Med	Full Sun to Part Shade	No
AG	*Aesculus glabra*	Ohio Buckeye	Yes	20 to 40	20 to 40	Med	Med	Med	Full Sun to Part Shade	No
AG2	*Amelanchier x grandiflora*	Autumn Brilliance' Serviceberry	Yes	15 to 25	15 to 25	Med	Med	Med	Full Sun to Part Shade	No
BN	*Betula nigra*	River Birch	Yes	40 to 70	20 to 30	Dry to Wet	High	Med	Full Sun to Part Shade	Yes
BN	*Betula nigra 'Cully'*	Heritage Birch	Yes	40 to 70	40 to 60	Med to Wet	Med	Med	Full Sun to Part Shade	No
CC	*Carpinus caroliniana*	American Hornbeam	Yes	20 to 35	20 to 35	Med	Med	Med	Full Sun to Part Shade	No
CC2	*Cercis canadensis*	Eastern Redbud	Yes	20 to 30	25 to 35	Med	Med	Med	Full Sun to Part Shade	No
CV	*Chionanthus virginicus*	White Fringetree	Yes	12 to 20	12 to 20	Med	Med	Med	Full Sun to Part Shade	No
CK	*Cladrastis kentukea*	American yellowwood	Yes	30 to 50	40 to 55	Med	Med	Med	Full Sun to Part Shade	No
GD	*Gymnocladus dioica 'Espresso'*	Espresso Kentucky Coffeetree	Yes	60 to 80	40 to 55	Med	Med	High	Full Sun	No
HM2	*Heptacodium miconioides*	Seven Sons Flower	Yes	15 to 20	8 to 10	Med	Med	Med	Full Sun	No
JC	*Juniperus virginiana 'Canaertii'*	Canaertii Eastern Red Cedar	Yes	20 to 35	8 to 15	Med	Med	Med	Full Sun	No
MP	*Maclura pomifera 'White Shield'*	White Shield Osage Orange	No	20 to 35	20 to 35	Dry to Wet	Med	Med	Full Sun to Part Shade	No
MM	*Magnolia virginiana 'Jim Wilson'*	Moonglow Sweet Bay Magnolia	Yes	15 to 35	10 to 20	Med to Wet	Med to High	Med	Full Sun to Part Shade	No
NS	*Nyssa sylvatica*	Blackgum	Yes	30 to 50	20 to 30	Med to Wet	High	Med	Full Sun to Part Shade	Yes
OV	*Ostrya virginiana*	Hop Hornbeam	Yes	25 to 40	20 to 30	Med	Med	Med	Full Sun to Part Shade	No
QB	*Quercus bicolor*	Swamp White Oak	Yes	50 to 60	50 to 60	Med to Wet	Med	High	Full Sun	No
QM	*Quercus macrocarpa*	Burr Oak	Yes	60 to 80	60 to 80	Dry to Med	Low to Med	Med	Full Sun	No
QS	*Quercus shumardii*	Shumard Red Oak	Yes	40 to 60	30 to 40	Dry to Med	Low to Med	Med	Full Sun	Yes
SE	*Salix exigua*	Sandbar Willow	Yes	2 to 6	2 to 4	Med to Wet	High	Med	Full Sun to Part Shade	No
SJ	*Styphnolobium japonicum*	Japanese Pagoda Tree	Yes	50 to 75	50 to 75	Med	Med	High	Full Sun to Part Shade	No
TD	*Taxodium distichum*	Baldcypress	Yes	40 to 50	20 to 30	Dry to Wet	High	Med	Full Sun	Yes
TA	*Tilia americana*	American Linden	Yes	50 to 80	30 to 50	Med	Med	Med	Full Sun to Part Shade	No

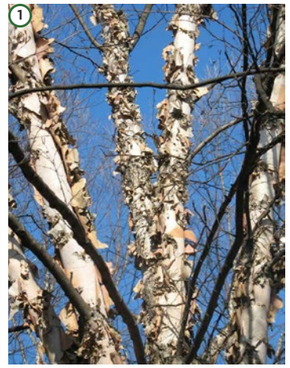
RECOMMENDED TREES

Large Shade Trees:

Acer rubrum - Red Maple

Acer saccharum - 'Bailsta' Fall Fiesta Sugar Maple

Betula nigra - River Birch



Betula nigra - 'Cully' Heritage Birch

Gymnocladus diocia - 'Espresso' Kentucky Coffeetree

Quercus bicolor - Swamp White Oak

Quercus macrocarpa - Bur Oak

Quercus shumardii - Shumard Red Oak

Styphnolobium japonicum - Japanese Pagoda Tree

Tilia americana -American Linden

Taxodium disthichum - Bald Cypress

RECOMMENDED TREES

Medium Shade Trees:

Aesculus glabra - Ohio Buckeye

Carpinus caroliniana - American Hornbeam

Cercis canadensis - Eastern Redbud

Cladrastis kentukea - American Yellowwood

Ostrya virginiana - Hop Hornbeam

Juniperus virginiana - 'Canaertii Canaert Eastern Red Cedar

Maclura pomifera - 'White Shield' Osage Orange

Nyssa sylvatica - Black Gum

RECOMMENDED TREES

Small/Ornamental Trees:

Amelanchier x grandiflora- 'Autumn Brilliance' Serviceberry

Chionanthus virginicus - White Fringetree

Heptacodium miconioides - Seven-Son Flower

Magnolia virginiana - 'Moon Glow' Sweet Bay Magnolia

Salix exigua - Sandbar Willow

Recommended Green Stormwater Infrastructure Shrub Plant List & Characteristics

Use this plant list as a guideline for plant material selections. As needed, offer suggestions of better plant alternatives for consideration. Aim for 75% minimum native plants (or native cultivars) when possible.

Plant Code	Botanical Name	Common Name	Missouri Native/ Native Cultivar	Height (ft)	Spread (ft)	Water	Inundation Tolerance	Drought Tolerance	Light	Salinity Tolerance
Shrubs										
AM	*Aronia melanocarpa 'Morton'*	Iroquois Beauty Black Chokeberry	Yes	2 to 3	4 to 5	Med	Med	Low	Full Sun to Part Shade	Yes
CD	*Callicarpa dichotoma 'Early Amethyst'*	Beautyberry	Yes	3 to 4	4 to 5	Med	Med	Med	Full Sun to Part Shade	No
CX	*Caryopteris x clandonensis 'Dark Knight'*	Blue Mist Shrub	Yes	2 to 3	2 to 3	Med	Med	Med	Full Sun	No
CO	*Cephalanthus occidentalis*	Button Bush	Yes	5 to 12	4 to 8	Med to Wet	High	Med	Full Sun to Part Shade	No
CA	*Clethra alnifolia 'Hummingbird'*	Hummingbird Summersweet	Yes	2 to 4	3 to 5	Med to Wet	High	Low to Med	Full Sun to Part Shade	Yes
CA	*Corylus americana*	American Hazelnut	Yes	10 to 16	8 to 13	Med	Med	Med	Full Sun to Part Shade	No
HP	*Hesperaloe parviflorahe*	Red Yucca	No	2 to 3	2 to 3	Dry	Low	High	Full Sun	Yes
HM	*Hibiscus moscheutos*	Rose Mallow	Yes	3 to 8	3 to 8	Med to Wet	High	Low	Full Sun to Part Shade	Yes
HK	*Hypericum kalmianum 'Ames'*	Kalm's St. John's Wort	No	2 to 3	2 to 3	Med	Med	Med	Full Sun to Part Shade	Yes
IVL	*Itea virginica 'Little Henry'*	Little Henry Virginia Sweetspire	Yes	1.5 to 2	2 to 2.5	Med to Wet	High	Med	Part Shade to Shade	Yes
PO	*Physocarpus opulifolius 'Diablo'*	Diablo Ninebark	Yes	4 to 8	4 to 8	Dry to Med	Med	Med	Full Sun to Part Shade	No
PV	*Prunus virginiana*	Choke Cherry	Yes	20 to 30	15 to 20	Dry to Med	Med	Med	Full Sun to Part Shade	No
RA	*Rhus aromatica 'Gro-Low'*	Gro-Low Fragrant Sumac	Yes	1.5 to 2	6 to 8	Dry to Med	Low	High	Full Sun to Part Shade	Yes
RC	*Rhus copallina latifolia 'Morton'*	Prairie Flame Shining Sumac	No	5 to 7	6 to 10	Dry to Med	Med	Med	Full Sun to Part Shade	No
RG	*Rhus glabra*	Smooth Sumac	Yes	9 to 15	9 to 15	Dry to Med	Med	Med	Full Sun to Part Shade	No
RT	*Rhus typhina 'Baltiger*	Tiger Eyes Sumac	Yes	3 to 6	3 to 6	Dry to Med	Med	Med	Full Sun to Part Shade	No
VD	*Viburnum dentatum 'Ralph Senior'*	Autumn Jazz Viburnum	No	6 to 10	8 to 12	Med	Med	Med	Full Sun to Part Shade	No

RECOMMENDED SHRUBS

Large Shrubs:

Corylus americana -American Hazelnut

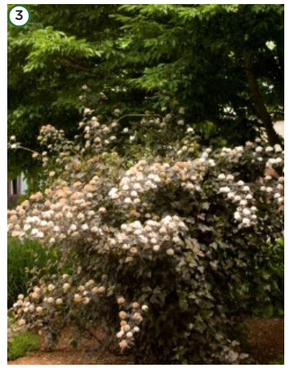
Cephalanthus occidentalis - Buttonbush

Prunus virginiana - Chokecherry

Rhus glabra - Smooth Sumac

Medium Shrubs:

Hibiscus moscheutos - Rose Mallow



Physocarpus opuliflius - 'Diablo' Ninebark

Rhus copallina latifolia-'Morton' Prairie Flame Shining Sumac

Rhus typhina - 'Baltiger' Staghorn Sumac

Viburnum dentatum - 'Ralph Senior' Autumn Jazz Viburnum

RECOMMENDED SHRUBS

Small Shrubs:

Aronia melanocarpa - Iroquois Beauty Black Chokeberry

Clethra alnifolia - 'Hummingbird' Summersweet

Callicarpa dichotoma - 'Early Amethyst' Beautyberry

Caryopteris x clandonensis - 'Dark Knight' Blue Mist Shrub

Hypericum kalmianum - 'Ames' Kalm's St. John's Wort

Hesperaloe parviflora - Red Yucca

Itea virginica - 'Little Henry' Virginia Sweetspire

Rhus aromatica - 'Gro-Low' Fragrant Sumac

Recommended Green Stormwater Infrastructure Grasses, Perennials, and Groundcovers Plant List & Characteristics

Use this plant list as a guideline for plant material selections. As needed, offer suggestions of better plant alternatives for consideration. Aim for 75% minimum native plants (or native cultivars) when possible.

Plant Code	Botanical Name	Common Name	Missouri Native/ Native Cultivar	Height (ft)	Spread (ft)	Water	Inundation Tolerance	Drought Tolerance	Light	Salinity Tolerance
Grasses, Perennials, and Groundcovers										
AI	*Amsonia illustris*	Shining Bluestar	Yes	2 to 3	1 to 1.5	Med to Wet	Med	Med	Full Sun to Part Shade	No
AC	*Anemone canadensis*	Windflower	Yes	1 to 2	2 to 2.5	Med to Wet	High	Med	Full Sun to Part Shade	No
AI2	*Asclepias incarnata*	Swamp Milkweed	Yes	2 to 5	2 to 3	Med to Wet	High	Med	Full Sun	No
AP	*Asclepias purpurascens*	Purple Milkweed	Yes	2 to 3	1 to 3	Dry to Med	Med	Med to High	Full Sun	No
AT	*Asclepias tuberosa*	Butterfly Milkweed	Yes	1 to 2.5	1 to 1.5	Dry to Med	Dry to Med	Med to High	Full Sun	No
BA	*Baptisia australis*	Blue Wild Indigo	Yes	3 to 4	3 to 4	Dry to Med	Dry to Med	Med to High	Full Sun to Part Shade	No
BC	*Bouteloua curtipendula*	Sideoats Grama	Yes	1 to 1.5	1 to 1.5	Dry	Med	High	Full Sun	Yes
BG	*Bouteloua gracilis*	Blue Grama	Yes	1 to 2	1 to 2	Dry to Med	Low	Med	Full Sun	No
CK2	*Calamagrostis x acutiflora 'Karl Forester'*	Feather Reed Grass	Yes	3 to 5	1.5 to 2.5	Med to Wet	High	Med	Full Sun	No
CO2	*Calamagrostis x acutiflora 'Overdam'*	Overdam Feather Reed Grass	Yes	2.5 to 3	1.5 to 2.0	Med to Wet	High	Med	Full Sun	No
CI	*Callirhoe involucrata*	Purple Poppy Mallow	Yes	.5 to 1.0	.5 to 3	Dry to Med	Med	Med to High	Full Sun	No
CB	*Carex bicknellii*	Prairie Sedge	Yes	1 to 1.5	1 to 1.5	Dry to Wet	Med	Med	Full Sun to Part Shade	No
CF	*Carex flacca*	Blue Sedge	Yes	1 to 1.5	1 to 1.5	Med to Wet	High	Med	Full Sun to Part Shade	No
CG	*Carex grayi*	Gray's Sedge	Yes	2 to 3	2 to 3	Med to Wet	High	Low	Full Sun to Shade	Yes
CM	*Carex muskingumensis*	Palm Sedge	Yes	2 to 3	2 to 3	Med to Wet	High	Med	Full Sun to Shade	Yes
CS2	*Carex pensylvanica*	Pennsylvania Sedge	Yes	.5 to 1.0	.5 to 1.0	Dry to Med	Med to High	Med	Full Sun to Part Shade	No
CR	*Carex radiata*	Star Sedge	Yes	1 to 1.5	1 to 1.5	Med to Wet	Med to High	Med	Part shade to Shade	No
CL	*Chasmanthium latifolium*	Northern Sea Oats	Yes	2 to 5	1 to 2.5	Med to Wet	Med	Med	Full Sun to Part Shade	No
EP	*Echinacea purpurea*	Purple Coneflower	Yes	3 to 5	1 to 2	Dry to Med	Low	High	Full Sun to Part Shade	No
EV	*Elymus virginicus*	Virginia Wildrye	Yes	2 to 4	1 to 2	Med	Med	Med to High	Full Sun to Part Shade	No
ES	*Eragrostis spectabilis*	Purple Love Grass	Yes	1 to 2	1 to 2	Dry to Med	Med	High	Full Sun	No
GB	*Gaillardia x grandiflora*	Blanketflower	Yes	2 to 3	1 to 2	Dry to Med	Med	Med to High	Full Sun to Part Shade	No
GC	*Glandularia canadensis*	Rose Verbena	Yes	.5 to 1.5	1 to 2	Dry to Med	Low	Med to High	Full Sun	No
HB	*Hemerocallis 'Baja'*	Baja Daylily	No	2 to 2.5	1.5 to 2	Med	Med	Med	Full Sun to Part Shade	Yes
HH	*Hemerocallis 'Happy Returns'*	Happy Returns Daylily	No	1 to 1.5	1 to 1.5	Med	Med	Med	Full Sun to Part Shade	Yes
IB	*Iris sibirica 'Butter and Sugar'*	Butter and Sugar Siberian Iris	Yes	2 to 2.5	2 to 2.5	Med to Wet	High	Med	Full Sun to Part Shade	No
IF	*Iris fulva*	Copper Iris	Yes	2 to 3	1 to 2	Med to Wet	High	Med	Full Sun to Part Shade	No
ISC	*Iris sibirica 'Caesar's Brother'*	Caesar's Brother Siberian Iris	No	3 to 4	2.5 to 3	Med to Wet	Med	Low	Full Sun to Part Shade	Yes
IV	*Iris virginica*	Blue Flag Iris	Yes	1 to 3	1 to 3	Med to Wet	High	Med	Full Sun	Yes
JE	*Juncus effusus*	Soft Rush	Yes	2 to 4	2 to 4	Wet	High	Low	Full Sun	Yes
LP	*Liatris pycnostachya*	Prairie Blazing Star	Yes	2 to 5	1 to 2	Dry to Med	Med	Med to High	Full Sun	No
LS	*Liatris spicata*	Marsh Blazing Star	Yes	2 to 4	1 to 2	Med	Med	High	Full Sun	Yes
LMB	*Liriope muscari 'Big Blue'*	Big Blue Lilyturf	No	1 to 2	1 to 2	Med	Med	Med to High	Full Sun to Part Shade	Yes
LMV	*Liriope muscari 'Variegata'*	Variegated Lilyturf	No	1 to 1.5	1 to 2	Med	Med	Med	Full Sun to Part Shade	Yes
MB	*Monarda bradburiana*	Eastern Beebalm	Yes	1 to 2	1 to 2	Dry to Med	Low	Med	Full Sun to Part Shade	No
OM	*Oenothera macrocarpa*	Missouri Evening Primrose	Yes	0.75 to 1	1 to 1.5	Dry to Med	Low	High	Full Sun	Yes
OS	*Oenothera speciosa or 'Siskiyou'*	Pink Evening Primrose	Yes	0.75 to 2	1 to 1.5	Dry to Med	Low	High	Full Sun	Yes
PC	*Panicum virgatum 'Cloud Nine'*	Tall Switch Grass	Yes	5 to 7	2 to 3	Med to Wet	High	Med to High	Full Sun to Part Shade	No
PVN	*Panicum virgatum 'Northwind'*	Northwind Switchgrass	Yes	4 to 6	2 to 2.5	Med to Wet	Med	Med	Full Sun to Part Shade	Yes
PS3	*Panicum virgatum 'Shenandoah'*	Switch Grass	Yes	3 to 5	3 to 4	Med to Wet	High	Med to High	Full Sun to Part Shade	No
PV	*Physostegia virginiana*	Obedient Plant	Yes	2 to 3	2 to 3	Med	Med	Med	Full Sun	No
PT	*Pycnanthemum tenuifolium*	Slender Mountain Mint	Yes	2 to 3	2 to 3	Dry to Med	Med	Med	Full Sun to Part Shade	Yes
RF	*Rudbeckia fulgida 'Goldsturm'*	Goldsturm Black-Eyed Susan	Yes	2 to 3	1 to 2	Dry to Med	Low	Med	Full Sun	No
SSB	*Schizachyrium scoparium 'Blaze'*	Blaze Little Bluestem	Yes	2 to 3	1 to 1.5	Dry	Low to Med	Med	Full Sun	Yes
SC	*Schizachyrium scoparium 'Carousel'*	Carousel Little Bluestem	Yes	2 to 2.5	2 to 2.5	Dry to Med	Dry to Med	Med to High	Full Sun	No
SSP	*Schizachyrium scoparium 'Prairie Munchkin'*	Prairie Munchkin Little Bluestem	No	1.5 to 2	1 to 1.5	Dry	Low to Med	Med	Full Sun	Yes
ST	*Schizachyrium scoparium 'The Blues'*	Little Bluestem	Yes	2 to 2.5	2 to 2.5	Dry to Med	Med	Med to High	Full Sun	No
SAJ	*Sedum 'Autumn Joy'*	Autumn Joy Sedum	Yes	1 to 1.5	1 to 1.5	Dry to Med	Low	High	Full Sun	Yes
SS	*Solidago speciosa*	Showy Goldenrod	Yes	2 to 3	2 to 3	Dry to Med	Med	Med to High	Full Sun	No
SH	*Sporobolus heterolepis*	Prairie Dropseed	Yes	2 to 3	2 to 3	Dry to Med	Low	High	Full Sun	No
SB	*Stachys byzantina 'Helen Von Stein'*	Helen Von Stein Lamb's Ear	No	0.5 to 1	1 to 2	Dry to Med	Low	High	Full Sun	No
SO	*Symphyotrichum oblongifolium*	Aromatic Aster	Yes	1 to 3	1 to 3	Dry to Med	Low	High	Full Sun	No
TO	*Tradescantia ohiensis*	Ohio Spiderwort	Yes	1.5 to 3	2 to 3	Med to Wet	Med	Med	Part Shade to Shade	No

RECOMMENDED GRASSES, PERENNIALS & GROUNDCOVERS


Amsonia illustris - Shining Bluestar


Asclepias tuberosa - Butterfly Milkweed


Calamagrostis x acutiflora- 'Karl Forester' Feather Reed Grass


Anemone canadensis - Windflower


Baptisia australis - Blue Wild Indigo


Calamagrostis x acutiflora- 'Overdam' Feather Reed Grass


Asclepias incarnata - Swamp Milkweed


Bouteloua curtipendula- Sideoats Grama


Callirhoe involucrata -Purple Poppy Mallow


Asclepias purpurascens - Purple Milkweed


Bouteloua gracilis - Blue Grama


Carex bicknellii - Prairie Sedge

RECOMMENDED GRASSES, PERENNIALS & GROUNDCOVERS

Carex flacca - Blue Sedge

Carex grayi - Gray's Sedge

Carex muskingumensis- Palm Sedge

Carex pensylvanica - Pennsylvania Sedge

Carex radiata - Star Sedge

Chasmanthium latifolium - Northern Sea Oats

Echinacea purpurea - Purple Coneflower

Elymus virginicus - Virginia Wildrye

Eragrostis spectabilis - Purple Love Grass

Gaillardia x grandiflora - Blanketflower

Glandularia canadensis - Rose Verbena

Hemerocallis - 'Baja' Daylily

RECOMMENDED GRASSES, PERENNIALS & GROUNDCOVERS

Hemerocallis - 'Happy Returns' Daylily

Iris fulva - Copper Iris

Iris sibirica - 'Butter and Sugar' Iris

Iris sibirica - 'Caesar's Brother' Iris

Iris virginica - Blue Flag Iris

Juncus effusus - Soft Rush

Liatris pycnostachya - Prairie Blazing Star

Liatris spicata- Marsh Blazing Star

Liriope muscari- 'Big Blue' Lilyturf

Liriope muscari - 'Variegata' Lilyturf

Monarda bradburiana - Eastern Beebalm

Oenothera macrocarpa - Missouri Evening Primrose

RECOMMENDED GRASSES, PERENNIALS & GROUNDCOVERS

Oenothera speciosa - 'Siskiyou' Pink Evening Primrose

Panicum virgatum - 'Cloud Nine' Tall Switch Grass

Panicum virgatum - 'Northwind' Switch Grass

Panicum virgatium - 'Shenandoah' Switch Grass

Physostegia virginiana - Obedient Plant

Pycnanthemum tenuifolium - Slender Mountain Mint

Rudbeckia fulgida - 'Goldsturm' Black-Eyed Susan

Schizachyrium scoparium - 'Blaze' Little Bluestem

Schizachyrium scoparium - 'Carousel' Little Bluestem

Schizachyrium scoparium - 'Prairie Munchkin' Little Bluestem

Schizachyrium scoparium - 'The Blues' Little Bluestem

Sedum - 'Autumn Joy' Sedum

RECOMMENDED GRASSES, PERENNIALS & GROUNDCOVERS

Solidago speciosa - Showy Goldenrod

Sporobolus heterolepis - Prairie Dropseed

Stachys byzantina- 'Helen Von Stein' Lamb's Ear

Symphyotrichum oblongifolium- Aromatic Aster

Tradescantia ohiensis - Ohio Spiderwort

PLANT IMAGE SOURCES

1. Missouri Botanical Garden. Retrieved from: *https://www.missouribotanicalgarden.org/plantfinder/plantfindersearch*
2. United States Department of Agriculture (USDA) Fire Effects Information System (FEIS). Retrieved from: *https://www.fs.fed.us/database/feis/plants*
3. Monrovia Plant Catalog. Retrieved from: *https://www.monrovia.com/plant-catalog*
4. Illinois Wildflowers Grasses, Sedges, Rushes, & Non-Flowering Plants in Illinois. Retrieved from: *https://www.illinoiswildflowers.info/grasses/grass_index.htm*
5. Dave's Garden Plant Files. Retrieved from: *https://davesgarden.com/guides/pf*

APPENDIX B: SITE ACTIVITY PLAN INSTRUCTIONS

GSI SITE ACTIVITY PLAN TEMPLATE INSTRUCTIONS

Included in this Appendix are standard forms to be used for the Site Activity Plan, as required in Section 02937 as well as instructions for how to use the forms. The instructions are divided by steps that should be taken by the Design Professional to generate the project-specific forms when compiling the Project Manual, and steps that should be taken by the Contractor to complete the forms. PDFs of the forms are included for informational purposes only; editable digital versions of the forms are available by request from the City Project Manager. Steps listed below are broken into tasks for each responsible party. Information about spreadsheet functions that may be helpful is included in italicized text.

DESIGN PROFESSIONAL

Upon completion of the following steps, the Design Professional should create PDFs of the forms and include them as attachments to Section 02937 Green Stormwater Infrastructure Site Activity Plan, so they become part of the contract documents. The template forms are provided with the baseline GSI specifications only, and should be modified per specific project requirements. When forms are modified, care should be taken ensure all information is visible once printed.

GSI Sites & Components (Tab 1):

1. Fill in the project header information at the top of the form: Project title, project number, and date of project advertisement for bid.

GREEN STORMWATER INFRASTRUCTURE
SITE COMPONENTS

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

2. GSI Sites (columns B-C): Under the GSI Locations column insert the GSI site designation and location description. Site names should be representative of each individual GSI, plan identifier and location. Under the GSI Type column select the applicable GSI practice type from the drop down menu. The GSI practices are described in the Approaching Green Stormwater Infrastructure Design section of this manual

The GSI Site Names (Tab 1) will auto-populate the GSI Sites column in the GSI Construction Schedule (Tab 2, column B).

GSI SITES	
GSI Location	GSI Type
(R1) - 1400 Main St	*Rain Garden*
(B1) - 1425 Main St	*Bioretention Basin*
(PP1-PP8) - W 13th St	*Permeable Pavers*

GSI COMPONENTS	
☑	GSI-1 Inlets
☑	GSI-2 Energy Dissipation & Pretreatment
☑	GSI-3 Above Grade Barriers
☑	GSI-4 Permeable Surfaces
☑	GSI-5 Soil & Aggregate Media
☑	GSI-6 Media Liners
☑	GSI-7 Landscaping
☑	GSI-8 Piping
☑	GSI-9 Outlets
☑	*(Insert Additional Component)*
☑	*(Insert Additional Component)*

3. GSI Components (columns E-F): select all applicable GSI Components for the entire project by clicking the checkmark boxes. If there are any additional components that are not listed (for example, proprietary features or a new technology type) add those components to the list.

4. Once completed, delete all *red italicized text*.

Information entered on this tab including project header, GSI SITES, and GSI COMPONENTS will auto-populate options on subsequent tabs as described in further detail in the following sections.

5. Once complete, it is recommended that the design professional lock the GSI Sites and GSI Component cells (columns B,C,E, and F) to avoid any future unintentional changes by the Contractor.

GSI Construction Schedule (Tab 2):

Project header information at the top of the form should auto-populate from information entered in GSI Sites & Components tab (Tab 1).

GSI Site (column B): column should be auto-populated from the GSI SITES entered and GSI COMPONENTS selected in the GSI Sites & Components (Tab 1)

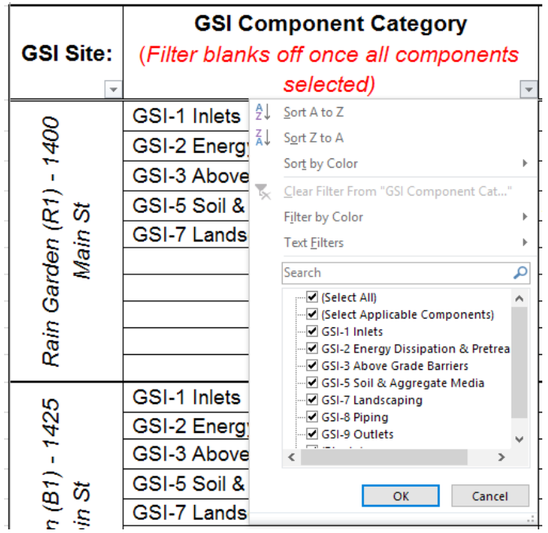
1. GSI Component Category (column C): for each GSI Site, use the drop-down list to select the applicable features for each GSI Site.

   If a component is not listed in the drop-down list, go back to the GSI Sites & Components tab (Tab 1) to make sure the selection box was marked in the GSI Component list. If an additional component needs to be added to the list, type it into the list and checkmark the selection box.

2. GSI Component Description/Project (column D): For each component provide a brief description of the component for each individual site. If a proprietary product is being used, provide the product name that is specified on the plans. The GSI Component Description/Product should correlate with the Schedule of Values per Section 00700 Construction General Conditions.

GSI Site:	GSI Component Category *(Filter blanks off once all components selected)*	GSI Component Description/ Product
Rain Garden (R1) - 1400 Main St	GSI-1 Inlets	Rain Guardian Turret
	GSI-2 Energy Dissipation & Pretreatment	Rock Splash Pad
	GSI-3 Above Grade Barriers	Ribbon Curb
	GSI-5 Soil & Aggregate Media	Amended Native Soil
	GSI-7 Landscaping	Native Plants
Bioretention (B1) - 1425 Main St	GSI-1 Inlets	Rain Guardian Turret
	GSI-2 Energy Dissipation & Pretreatment	Rock Splash Pad
	GSI-3 Above Grade Barriers	Straight Curb & Gutter
	GSI-5 Soil & Aggregate Media	BSM, No. 57, No. 8
	GSI-7 Landscaping	Native Plants
	GSI-8 Piping	PVC Underdrain
	GSI-9 Outlets	Agridrain WCS

3. Once all GSI Component Categories are entered, select the drop down arrow in the header of GSI Component Category (column C) and uncheck the “Blanks” box to filter off any unused rows. Once complete, delete all red italicized text.



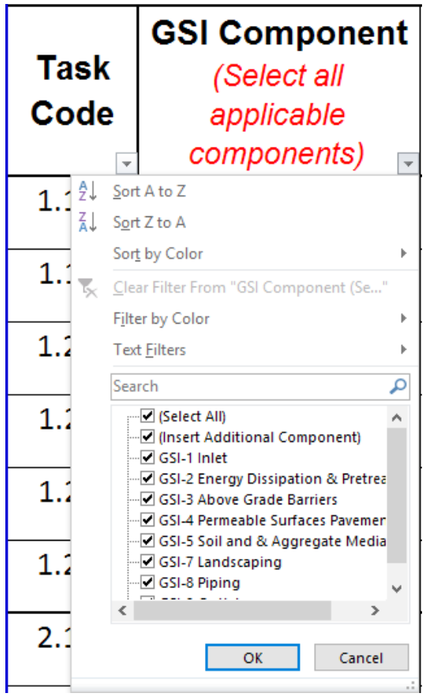
4. Once complete, it is recommended that the design professional lock the GSI Site and GSI Component Category cells (column B and C) to avoid any future unintentional changes by the Contractor.

GSI Maintenance Schedule (Tab 3):

Project header information at the top of the form should auto-populate from information entered in GSI Sites & Components tab (Tab 1).

1. GSI Component (column C): select the project's applicable GSI Components from the filter window (this should match the components selected on GSI Sites & Components, Tab 1).

   The selections made on the GSI Sites & Components tab (Tab 1) are populated to the right side of the form to assist in the selection.



Applicable GSI Components
(From 'GSI Sites & Components' Sheet)

GSI-1 Inlets

GSI-2 Energy Dissipation & Pretreatment

GSI-3 Above Grade Barriers

GSI-4 Permeable Surfaces

GSI-5 Soil & Aggregate Media

GSI-6 Media Liners

GSI-7 Landscaping

GSI-8 Piping

GSI-9 Outlets

(Insert Additional Component)

(Insert Additional Component)

2. Required Tasks (column D): review standard maintenance task lists and remove any tasks that do not apply to the project specific components. Add additional maintenance tasks for specialty products or components outside of the standard GSI components list. Once complete, select the drop down arrow in the header of the Required Tasks column and uncheck the "Blanks" box to filter off any unused rows.

3. GSI Sites Included (column J): add the name of the different GSI sites that utilized each GSI Component. This will indicate the location that each required task should be taking place.

   The selections made on the GSI Sites & Components tab (Tab 1) are populated to the right side of the form to assist in the entry.

Task Code	GSI Component *(Select all applicable components)*	Required Tasks	Frequency *(Select Frequency of Maintenance)*	Time of Year *(if frequency < Monthly)*	Responsible Party	GSI Sites Included
1.1.A	GSI-1 Inlet	Inspect for standing water	Weekly			Rain Garden (R1) - 1400 Main St Bioretention (B1) - 1425 Main St
1.1.B		Inspect structural integrity	Quarterly			
1.2.A		Remove sediment, debris and trash	Bi-weekly			
1.2.B		Remove blockages	Bi-weekly			
1.2.C		Remove sediment for open flow paths	Bi-weekly			
1.2.D		Remove accumulated sediment	Bi-weekly			

GSI Sites
(From 'GSI Sites & Components' Sheet)

Rain Garden (R1) - 1400 Main St

Bioretention (B1) - 1425 Main St

Permeable Pavement Parking (PP1-PP8) - W 13th St

4. Delete the *red italicized "(Select all applicable components)" text* in the GSI Component column (column C)

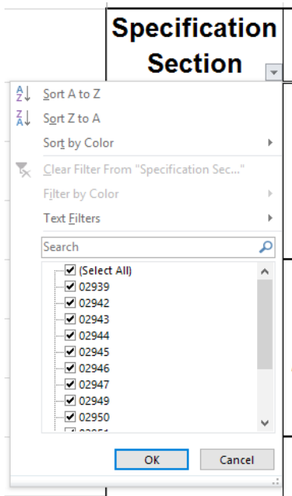
5. Once complete, it is recommended that the design professional lock the GSI Component, Required Tasks, and GSI Site cells (columns C,D, and J) to avoid any future unintentional changes by the Contractor.

GSI Quality Assurance (Tab 4):

Project header information at the top of the form should auto-populate from information entered in GSI Sites & Components tab (Tab 1).

1. Specification Section (column B): select the project's applicable GSI Specifications. This should match the project manual Table of Contents for all GSI specifications

2. If additional specifications are included in the project, add the specification number and the experience requirement to the bottom of the table.



Specification Section	Experience Requirement	Reference Number	Project Location
	Landscaping/GSI experience, within previous 3 years	1	
		2	
		3	
	ACI Certified Flatwork Finisher and Technician	1	
		2	
		3	
02942	*5 years experience with type of above grade barrier specified*	1	
		2	
		3	

3. Once complete, it is recommended that the design professional lock the Specifications Section cells (column B) to avoid any future unintentional changes by the Contractor.

CONTRACTOR

Prior to the start of the project, the Contractor should request the editable digital version of the attached Site Activity Plan forms. The forms should include all GSI design specific information, as provided by the Design Professional. The Contractor should modify the forms per specific project requirements. When forms are modified, care should be taken ensure all information is visible once printed.

GSI Sites & Components (Tab 1):

1. Fill in project header information at the top of the form: enter Contractor name and revise date to be Site Activity Plan submittal/revision date.

Project Title: Main Street GSI

Project Number: 81000222

Contractor: 123 Construction Company

Date: 2/1/2018

Information entered on this tab including project header, GSI SITES, and GSI COMPONENTS will auto-populate options on subsequent tabs as described in further detail in the following sections.

GSI Construction Schedule (Tab 2):

1. Material Procurement Lead Time (column E): enter estimated procurement time based on product manufacturer/ material producer coordination.

2. Begin Installation Date (column F): enter date the Contractor intends to start construction for the component, including any site prep or excavation necessary for the Work.

3. End Installation Date (column G): enter date intended to complete install of the component, including any backfilling or post-construction testing required.

4. Notes (Column H): add any applicable notes, regarding the components and associated construction schedule.

GSI Site:	GSI Component Category *(Filter blanks off once all components selected)*	GSI Component Description/ Product	Material Procurement Lead Time	Begin Installation Date	Complete Installation Date	Notes
Rain Garden (R1) - 1400 Main St	GSI-1 Inlets	Rain Guardian Turret	2 weeks	2/19/2018	2/23/2018	
	GSI-2 Energy Dissipation & Pretreatment	Rock Splash Pad	1 week	3/12/2018	3/23/2018	
	GSI-3 Above Grade Barriers	Ribbon Curb	2 weeks	2/26/2018	3/9/2018	
	GSI-5 Soil & Aggregate Media	Amended Native Soil	2 months	3/12/2018	3/23/2018	
	GSI-7 Landscaping	Native Plants	3 months	3/16/2018	3/21/2018	

GSI Construction Schedule (Tab 3):

Project header information at the top of the form should auto-populate from information entered in GSI Sites & Components tab (Tab 1).

1. Frequency (column G): the task list is populated with standard tasks associated to their respective GSI components. For each of the tasks, select the frequency of maintenance from the drop down options.

Task Code	GSI Component *(Select all applicable components)*	Required Tasks	Frequency *(Select Frequency of Maintenance)*	Time of Year *(if frequency < Monthly)*
1.1.A	GSI-1 Inlet	Inspect for standing water	Weekly	
1.1.B		Inspect structural integrity		
1.2.A		Remove sediment, debris and trash		
1.2.B		Remove blockages		
1.2.C		Remove sediment for open flow paths	Bi-weekly	

Weekly
Bi-Weekly
Monthly
Quarterly
Semi-Annually
Annually
Following 3" Rain Event in 24 ho
Seasonally

Minimum Annual Frequency (column F) will automatically update based on the Frequency selected in column F. This frequency will be used to auto-populate options in subsequent tabs, discussed further in the following sections, but can otherwise stay hidden from view.

2. Time of Year (column H): if the frequency is greater than monthly, select the correct Time of Year information. If the frequency is less than monthly, leave this cell blank.

3. Responsible Party (column I): add the responsible party information. If a subcontractor and contractor are responsible for providing different tasks, put the name of the firm responsible for each individual task.

GSI Component *(Select all applicable components)*	Required Tasks	Frequency *(Select Frequency of Maintenance)*	Time of Year *(if frequency < Monthly)*	Responsible Party	GSI Sites Included
GSI-7 Landscaping	Remove debris and trash	Weekly		123 Constr Co	Rain Garden (R1) - 1400 Main St Bioretention (B1) - 1425 Main St
	Apply pre-emergent herbicide	Quarterly	Mar, Jul, Oct	ABC Landscaping	
	Remove weeds	Weekly		ABC Landscaping	
	Manage disease and pests	Weekly		ABC Landscaping	
	Manage landscape edges	Weekly		123 Constr Co	
	Prune for compact growth	Quarterly	Mar, Jul, Oct	ABC Landscaping	
	Trim plants near intersections	Monthly		ABC Landscaping	
	Spring pruning of perennials and grasses	Annually	Mar	ABC Landscaping	
	Mow buffer around GSI perimeter	Monthly		123 Constr Co	
	Mow grass swales	Monthly		123 Constr Co	
	Water vegetated areas	As needed		ABC Landscaping	
	Remove dead plants and replace	Semi-annually	Mar, Oct	ABC Landscaping	
	Refresh mulch	Monthly		ABC Landscaping	

4. Once completed, delete all *red italicized text.*

5. The maintenance schedule is intended to be updated regularly with the Site Activity Plan, as needed to maintain the required Service Levels of Performance.

Information entered on this tab including maintenance task frequency and time of year will auto-populate options in the Contractor Maintenance Activity Forms discussed further in the following section.

GSI Quality Assurance Qualifications (Tab 4):

Project header information at the top of the form should auto-populate from information entered in GSI Sites & Components tab (Tab 1).

1. For each specification included in the Project Manual, the Contractor shall provide 3 references to demonstrate compliance with the experience requirements summarized in column C, and described in detail in Part 1.06 of each specification.

2. Fill in project location (Project Area, City and State), project owner name, contact number, project completion date and total dollar value of the project in columns E through I.

Specification Section	Experience Requirement	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02939	*Landscaping/GSI experience, within previous 3 years*	1					
		2					
		3					
02942	*ACI Certified Flatwork Finisher and Technician*	1					
		2					
		3					
02942	*5 years experience with type of above grade barrier specified*	1					
		2					
		3					

Suggested Maintenance Inspections/Activities Forms

The remaining sheets (Tabs 5 through 10) are optional templates for the contractor to use to document maintenance work and inspection activities that occur at each site. A separate sheet should be used for each individual site. These sheets are broken into frequency of maintenance work and are based on the selections entered in the GSI Maintenance Schedule (Tab 3). Some projects may use Computerized Maintenance Management Systems (CMMS) in lieu of forms, but similar content is recommended for computerized forms.

Project Title, Project Number, and Contractor should update automatically from the GSI Sites and Components (Tab 1).

1. Fill in the date the activities were performed. Use the same GSI Site name or description that was used on the form in the GSI Site & Component sheet (Tab 1). Add the name of the inspector and/or maintenance supervisor names and contact information.

2. **PRIOR TO EACH USE: The maintenance schedule is intended to be updated any time the Site Activity Plan is updated, to maintain the required Service Levels of Performance. Each frequency tab must also be updated to reflect any changes made.**

   a. Minimum Annual Frequency (column E): select the applicable frequency from the filter window only, and uncheck any other frequencies listed. The following are the Maintenance tabs and associated frequencies:

      i. Weekly Maintenance Activities (52)

      ii. Bi-weekly Maintenance Activities (26)

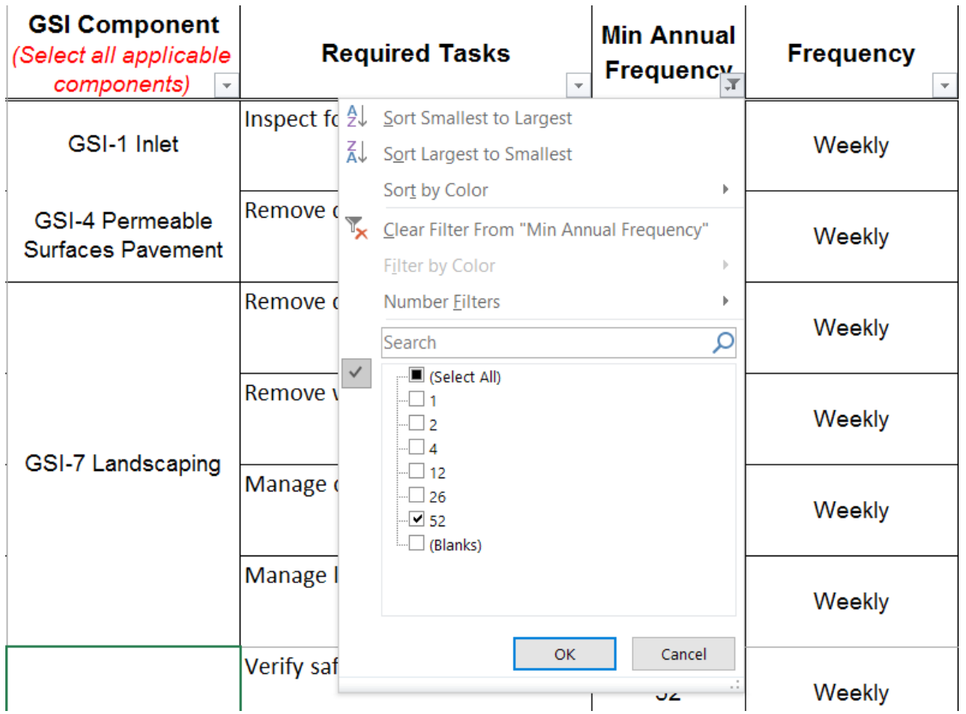
      iii. Monthly Maintenance Activities (12)

      iv. Quarterly Maintenance Activities (4)

      v. Semi-annual Maintenance Activities (2)

      vi. Annual Maintenance Activities (1)

This minimum annual frequency cell and frequency columns are populated based on the frequency that was selected for each task on Tab 3, column F. If a change needs to be made, update to the correct frequency on tab 3, then refilter the Maintenance tab to reflect the change.



3. Appearance and Function Rating: Fill in the GSI Appearance Rating and the GSI Function Rating for each site. These rating systems are explained in the maintenance section of the Green Stormwater Infrastructure Manual with examples provided. A rating should be assigned in the “before” cell based on the condition upon arrival to the site, and in the “after” cell based on the condition once activities are completed. Each site should achieve a level one rating (no litter/excellent appearance) when the regularly scheduled maintenance visit is complete, to meet the Service Levels of Performance requirements.

GSI SITE:	***(Insert GSI Site Name/Description)***		**INSPECTOR:**	***(Insert Inspector/Maintenance Supervisor Name and Contact)***	**HOURS:**
APPEARANCE RATING:	***(Insert Rating)***	Before	**FUNCTION RATING:**	***(Insert Rating)***	Before
	(Insert Rating)	After		***(Insert Rating)***	After

4. Notes (column G): Add any comments or observations made during the site visit. This column may also be used to track material used at each site.

5. Task Completed (column H): Use the “Task Completed” column to indicate which tasks were completed for the reported visit.

6. Once all tasks for that visit are complete, record the total hours. This should be a cumulative total of hours for all the workers at the site. For example, if two workers spent a half hour maintaining the site, record 1.0 hour.

GSI SITES & COMPONENTS FORM

GSI CONSTRUCTION SCHEDULE FORM

GREEN STORMWATER INFRASTRUCTURE SITE COMPONENTS

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

GSI SITES	
GSI Location	**GSI Type**
(Insert GSI Site Name/Description)	
(Insert GSI Site Name/Description)	
(Insert GSI Site Name/Description)	

	GSI COMPONENTS
☑	GSI-1 Inlets
☑	GSI-2 Energy Dissipation & Pretreatment
☑	GSI-3 Above Grade Barriers
☑	GSI-4 Permeable Surfaces
☑	GSI-5 Soil & Aggregate Media
☑	GSI-6 Media Liners
☑	GSI-7 Landscaping
☑	GSI-8 Piping
☑	GSI-9 Outlets
☑	*(Insert Additional Component)*
☑	*(Insert Additional Component)*
☐	
☐	
☐	
☐	
☐	
☐	
☐	
☐	
☐	

GREEN STORMWATER INFRASTRUCTURE CONSTRUCTION SCHEDULE

CITY OF FOUNTAINS HEART OF THE NATION KANSAS CITY MISSOURI

Project Title: ____________________

Project Number: ____________________

Contractor: ____________________

Date: ____________________

GSI Site:	GSI Component Category (*Filter blanks off once all components selected*)	GSI Component Description/ Product	Material Procurement Lead Time	Begin Installation Date	Complete Installation Date	Notes
(Insert GSI Site Name/Description)						
(Insert GSI Site Name/Description)	*(Select Applicable Components)*					
(Insert GSI Site Name/Description)	*(Select Applicable Components)*					

GREEN STORMWATER INFRASTRUCTURE CONSTRUCTION SCHEDULE

GSI Site:	GSI Component Category (*Filter blanks off once all components selected*)	GSI Component Description/ Product	Material Procurement Lead Time	Begin Installation Date	Complete Installation Date	Notes

GSI MAINTENANCE SCHEDULE FORM

CITY OF FOUNTAINS
HEART OF THE NATION
KANSAS CITY
MISSOURI

GREEN STORMWATER INFRASTRUCURE MAINTENANCE SCHEDULE

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

Task Code	GSI Component *(Select all applicable components)*	Required Tasks	Frequency *(Select Frequency of Maintenance)*	Time of Year *(if frequency < Monthly)*	Responsible Party	GSI Sites Included
1.1.A	GSI-1 Inlet	Inspect for standing water	Weekly			*(List all GSI sites that incorporate component)*
1.1.B		Inspect structural integrity	Quarterly			
1.2.A		Remove sediment, debris and trash	Bi-weekly			
1.2.B		Remove blockages	Bi-weekly			
1.2.C		Remove sediment for open flow paths	Bi-weekly			
1.2.D		Remove accumulated sediment	Bi-weekly			
2.1.A	GSI-2 Energy Dissipation & Pretreatment	Inspect and record debris depth	Bi-weekly			*(List all GSI sites that incorporate component)*
2.2.A		Remove sediment, debris and trash	Bi-weekly			
2.R2.A		Repair erosion	Quarterly			
3.1.A	GSI-3 Above Grade Barriers	Inspect structural integrity	Quarterly			*(List all GSI sites that incorporate component)*
3.R2.A		Repair structural damage	Quarterly			
3.R2.B		Repair erosion	Quarterly			

KCMO GREEN STORMWATER INFRASTRUCTURE MANUAL -Appendix B

GREEN STORMWATER INFRASTRUCURE MAINTENANCE SCHEDULE

Task Code	GSI Component *(Select all applicable components)*	Required Tasks	Frequency *(Select Frequency of Maintenance)*	Time of Year *(if frequency < Monthly)*	Responsible Party	GSI Sites Included
4.1.A	GSI-4 Permeable Surfaces Pavement	Inspect pavement for clogging	Quarterly			*(List all GSI sites that incorporate component)*
4.1.B		Inspect pavement condition	Quarterly			
4.R2.A		Repair pavers	Semi-annually			
4.R2.B		Repair pavement	Semi-annually			
4.R2.C		Redress joints	Semi-annually			
4.2.A		Remove debris and trash	Weekly			
4.2.B		Remove sediment from pavement and pavers	Quarterly			
4.3.A		Remove weeds	Quarterly			
4.4.A		Remove stains and other markings	Quarterly			
5.1.A	GSI-5 Soil and & Aggregate Media	Inspect site after 3 inch rain in 24 hour period	Seasonally			*(List all GSI sites that incorporate component)*
5.1.B		Record standing water depth	As needed			
5.1.C		Inspect for erosion	Quarterly			
5.1.D		Inspect for snow or snow removal damage	Seasonally			
5.1.E		Report utility excavation	As needed			
5.2.A		Remove sediment, debris and trash	Bi-weekly			
5.R2.A		Replace settled materials	Quarterly			
5.R4.A		Repair erosion	Quarterly			

GREEN STORMWATER INFRASTRUCURE MAINTENANCE SCHEDULE

Task Code	GSI Component *(Select all applicable components)*	Required Tasks	Frequency *(Select Frequency of Maintenance)*	Time of Year *(if frequency < Monthly)*	Responsible Party	GSI Sites Included
7.2.A	GSI-7 Landscaping	Remove debris and trash	Weekly			*(List all GSI sites that incorporate component)*
7.3.A		Apply pre-emergent herbicide	Quarterly			
7.3.B		Remove weeds	Weekly			
7.3.C		Manage disease and pests	Weekly			
7.5.A		Manage landscape edges	Weekly			
7.5.B		Prune for compact growth	Quarterly			
7.5.C		Trim plants near intersections	Monthly			
7.5.D		Spring pruning of perennials and grasses	Annually			
7.5.E		Mow buffer around GSI perimeter	Monthly			
7.5.F		Mow grass swales	Monthly			
7.6.A		Water vegetated areas	As needed			
7.R3.A		Remove dead plants and replace	Semi-annually			
7.R4.A		Refresh mulch	Monthly			
8.1.A	GSI-8 Piping	Verify safe, secure access points	Weekly			*(List all GSI sites that incorporate component)*
8.1.B		Inspect for standing water	Weekly			
8.1.C		Inspect and record debris depth	Monthly			
8.1.D		Inspect structural integrity	Quarterly			
8.2.A		Remove blockages	Semi-annually			
8.2.B		Remove sediment, debris and trash	Bi-weekly			

KCMO GREEN STORMWATER INFRASTRUCTURE MANUAL -Appendix B

GREEN STORMWATER INFRASTRUCURE MAINTENANCE SCHEDULE

Task Code	GSI Component *(Select all applicable components)*	Required Tasks	Frequency *(Select Frequency of Maintenance)*	Time of Year *(if frequency < Monthly)*	Responsible Party	GSI Sites Included
9.1.A	GSI-9 Outlets	Verify open flow paths	Weekly			*(List all GSI sites that incorporate component)*
9.1.B		Inspect structural integrity	Quarterly			
9.2.A		Remove sediment, debris and trash	Bi-weekly			
9.4.B		Inspect outlet control mechanism	Semi-annually			

GSI QUALITY ASSURANCE QUALIFICATIONS FORM

CITY OF FOUNTAINS
HEART OF THE NATION
KANSAS CITY
MISSOURI

GREEN STORMWATER INFRASTRUCTURE QUALITY ASSURANCE QUALIFICATIONS

Project Title: _____

Project Number: _____

Contractor: _____

Date: _____

Specification Section	Experience Requirement	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02939	*Landscaping/GSI experience, within previous 3 years*	1					
		2					
		3					
02942	*ACI Certified Flatwork Finisher and Technician*	1					
		2					
		3					
02942	*5 years experience with type of above grade barrier specified*	1					
		2					
		3					
02943	*3 years recent pervious concrete experience; CPG or NRMCA credentials*	1					
		2					
		3					

KCMO GREEN STORMWATER INFRASTRUCTURE MANUAL -Appendix B

GREEN STORMWATER INFRASTRUCTURE QUALITY ASSURANCE QUALIFICATIONS

Specification Section	Experience Requirement	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02944	*3 years recent porous asphalt experience*	1					
		2					
		3					
02945	*3 years recent permeable paver experience*	1					
		2					
		3					
02946	*3 years landscaping/GSI experience*	1					
		2					
		3					
02947	*5 years landscaping/GSI experience*	1					
		2					
		3					
02949	*Experienced tree service firm; certified Arborist*	1					
		2					
		3					
02950	*Horticulturist; landscape removal experience; Experienced tree service firm*	1					
		2					
		3					

GREEN STORMWATER INFRASTRUCTURE QUALITY ASSURANCE QUALIFICATIONS

Specification Section	Experience Requirement	Reference Number	Project Location	Owner Name	Contact Number	Completion Date	Dollar Value
02951	*5 years landscaping/GSI experience*	1					
		2					
		3					
02952	*5 years recent native seed install/ establishment experience; B.S. in related field*	1					
		2					
		3					
02953	*Seeding/sodding experience*	1					
		2					
		3					
02956	*Infiltration testing experience*	1					
		2					
		3					

KCMO GREEN STORMWATER INFRASTRUCTURE MANUAL - Appendix B

AUGUST 2018

GSI RECOMMENDED MAINTENANCE ACTIVITY/ INSPECTION FORMS

GREEN STORMWATER INFRASTRUCTURE WEEKLY MAINTENANCE ACTIVITIES

Project Title: _____
Project Number: _____
Contractor: _____
Date of Activity: _____

GSI SITE:	*(Insert GSI Site Name/Description)*		INSPECTOR:	*(Insert Inspector/Maintenance Supervisor Name and Contact)*	HOURS:
APPEARANCE RATING:	*(Insert Rating)*	Before	FUNCTION RATING:	*(Insert Rating)*	Before
	(Insert Rating)	After		*(Insert Rating)*	After

GSI Component *(Select all applicable components)*	Required Tasks	Min Annual Frequency	Frequency	Notes	Task Completed?
GSI-1 Inlet	Inspect for standing water	52	Weekly		
GSI-4 Permeable Surfaces Pavement	Remove debris and trash	52	Weekly		
GSI-7 Landscaping	Remove debris and trash	52	Weekly		
	Remove weeds	52	Weekly		
	Manage disease and pests	52	Weekly		
	Manage landscape edges	52	Weekly		

KCMO GREEN STORMWATER INFRASTRUCTURE MANUAL -Appendix B

GREEN STORMWATER INFRASTRUCTURE WEEKLY MAINTENANCE ACTIVITIES

GSI Component *(Select all applicable components)*	Required Tasks	Min Annual Frequency	Frequency	Notes	Task Completed?
GSI-8 Piping	Verify safe, secure access points	52	Weekly		
	Inspect for standing water	52	Weekly		
GSI-9 Outlets	Verify open flow paths	52	Weekly		

CITY OF FOUNTAINS
HEART OF THE NATION
KANSAS CITY
MISSOURI

GREEN STORMWATER INFRASTRUCTURE
BI-WEEKLY MAINTENANCE ACTIVITIES

Project Title: _____
Project Number: _____
Contractor: _____
Date of Activity: _____

GSI SITE:	*(Insert GSI Site Name/Description)*		INSPECTOR: *(Insert Inspector/Maintenance Supervisor Name and Contact)*		HOURS:
APPEARANCE RATING:	*(Insert Rating)*	Before	FUNCTION RATING:	*(Insert Rating)*	Before
	(Insert Rating)	After		*(Insert Rating)*	After

GSI Component *(Select all applicable components)*	Required Tasks	Min Annual Frequency	Frequency	Notes	Task Completed?
GSI-1 Inlet	Remove sediment, debris and trash	26	Bi-weekly		
	Remove blockages	26	Bi-weekly		
	Remove sediment for open flow paths	26	Bi-weekly		
	Remove accumulated sediment	26	Bi-weekly		
GSI-2 Energy Dissipation & Pretreatment	Inspect and record debris depth	26	Bi-weekly		
	Remove sediment, debris and trash	26	Bi-weekly		

KCMO GREEN STORMWATER INFRASTRUCTURE MANUAL -Appendix B

GREEN STORMWATER INFRASTRUCTURE BI-WEEKLY MAINTENANCE ACTIVITIES

GSI Component *(Select all applicable components)*	Required Tasks	Min Annual Frequency	Frequency	Notes	Task Completed?
GSI-8 Piping	Remove sediment, debris and trash	26	Bi-weekly		
GSI-9 Outlets	Remove sediment, debris and trash	26	Bi-weekly		

GREEN STORMWATER INFRASTRUCTURE
MONTHLY MAINTENANCE ACTIVITIES

Project Title: _____
Project Number: _____
Contractor: _____
Date of Activity: _____

GSI SITE:	*(Insert GSI Site Name/Description)*		INSPECTOR:	*(Insert Inspector/Maintenance Supervisor Name and Contact)*	HOURS:
APPEARANCE RATING:	*(Insert Rating)*	Before	FUNCTION RATING:	*(Insert Rating)*	Before
	(Insert Rating)	After		*(Insert Rating)*	After

GSI Component *(Select all applicable components)*	Required Tasks	Min Annual Frequency	Frequency	Notes	Task Completed?
GSI-7 Landscaping	Trim plants near intersections	12	Monthly		
	Mow buffer around GSI perimeter	12	Monthly		
	Mow grass swales	12	Monthly		
	Refresh mulch	12	Monthly		
GSI-8 Piping	Inspect and record debris depth	12	Monthly		

GREEN STORMWATER INFRASTRUCTURE
QUARTERLY MAINTENANCE ACTIVITIES

Project Title: _____
Project Number: _____
Contractor: _____
Date of Activity: _____

GSI SITE:	*(Insert GSI Site Name/Description)*		INSPECTOR:	*(Insert Inspector/Maintenance Supervisor Name and Contact)*	HOURS:
APPEARANCE RATING:	*(Insert Rating)*	Before	FUNCTION RATING:	*(Insert Rating)*	Before
	(Insert Rating)	After		*(Insert Rating)*	After

GSI Component *(Select all applicable components)*	Required Tasks	Min Annual Frequency	Frequency	Notes	Task Completed?
GSI-1 Inlet	Inspect structural integrity	4	Quarterly		
GSI-2 Energy Dissipation & Pretreatment	Repair erosion	4	Quarterly		
GSI-3 Above Grade Barriers	Inspect structural integrity	4	Quarterly		
	Repair structural damage	4	Quarterly		
	Repair erosion	4	Quarterly		

GREEN STORMWATER INFRASTRUCTURE QUARTERLY MAINTENANCE ACTIVITIES

GSI Component *(Select all applicable components)*	Required Tasks	Min Annual Frequency	Frequency	Notes	Task Completed?
GSI-4 Permeable Surfaces Pavement	Inspect pavement for clogging	4	Quarterly		
	Inspect pavement condition	4	Quarterly		
	Remove sediment from pavement and pavers	4	Quarterly		
	Remove weeds	4	Quarterly		
	Remove stains and other markings	4	Quarterly		
GSI-5 Soil and & Aggregate Media	Replace settled materials	4	Quarterly		
	Repair erosion	4	Quarterly		
GSI-7 Landscaping	Apply pre-emergent herbicide	4	Quarterly		
	Prune for compact growth	4	Quarterly		
GSI-8 Piping	Inspect structural integrity	4	Quarterly		
GSI-9 Outlets	Inspect structural integrity	4	Quarterly		

CITY OF FOUNTAINS
HEART OF THE NATION
KANSAS CITY
MISSOURI

GREEN STORMWATER INFRASTRUCTURE SEMI-ANNUAL MAINTENANCE ACTIVITIES

Project Title: _____
Project Number: _____
Contractor: _____
Date of Activity: _____

GSI SITE:	*(Insert GSI Site Name/Description)*		INSPECTOR:	*(Insert Inspector/Maintenance Supervisor Name and Contact)*	HOURS:
APPEARANCE RATING:	*(Insert Rating)*	Before	FUNCTION RATING:	*(Insert Rating)*	Before
	(Insert Rating)	After		*(Insert Rating)*	After

GSI Component *(Select all applicable components)*	Required Tasks	Min Annual Frequency	Frequency	Notes	Task Completed?
GSI-4 Permeable Surfaces Pavement	Repair pavers	2	Semi-annually		
	Repair pavement	2	Semi-annually		
	Redress joints	2	Semi-annually		
GSI-7 Landscaping	Remove dead plants and replace	2	Semi-annually		
GSI-8 Piping	Remove blockages	2	Semi-annually		
GSI-9 Outlets	Inspect outlet control mechanism	2	Semi-annually		

CITY OF FOUNTAINS
HEART OF THE NATION
KANSAS CITY
MISSOURI

GREEN STORMWATER INFRASTRUCTURE
ANNUAL MAINTENANCE ACTIVITIES

Project Title: _____
Project Number: _____
Contractor: _____
Date of Activity: _____

GSI SITE:	*(Insert GSI Site Name/Description)*		INSPECTOR:	*(Insert Inspector/Maintenance Supervisor Name and Contact)*	HOURS:
APPEARANCE RATING:	*(Insert Rating)*	Before	FUNCTION RATING:	*(Insert Rating)*	Before
	(Insert Rating)	After		*(Insert Rating)*	After

GSI Component *(Select all applicable components)*	Required Tasks	Min Annual Frequency	Frequency	Notes	Task Completed?
GSI-5 Soil and & Aggregate Media	Inspect site after 3 inch rain in 24 hour period	1	Seasonally		
GSI-7 Landscaping	Spring pruning of perennials and grasses	1	Annually		

APPENDIX C: GSI CONSTRUCTION SPECIFICATIONS

02937 GSI Site Activity Plan
02938 GSI Control and Protection
02939 GSI Earthwork
02940 GSI Inlets
02941 GSI Energy Dissipation and Pretreatment
02942 GSI Above Grade Barriers
02943 GSI Pervious Concrete
02944 GSI Porous Asphalt
02945 GSI Permeable Pavers
02946 GSI Soil and Aggregate Media
02947 GSI Topsoil
02948 GSI Media Liners
02949 GSI Existing Tree Protection
02950 GSI Selective Vegetation Removal
02951 GSI Plants
02952 GSI Native Grass and Wildflower Seeding
02953 GSI Non-Native Seeding and Sodding
02954 GSI Piping
02955 GSI Outlets
02956 GSI In-Situ Infiltration Testing
02957 GSI Establishment

SECTION 02937

GREEN STORMWATER INFRASTRUCTURE SITE ACTIVITY PLAN

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02937 Green Stormwater Infrastructure Site Activity Plan is to thoroughly plan construction sequencing, prepare, control and protect the green stormwater infrastructure sites, install the green stormwater infrastructure components (GSI Components) as defined in Section 00800 Supplementary Conditions, stabilize disturbed area, and establish the green stormwater infrastructure facilities.

1.02 MEASUREMENT AND PAYMENT

A. The cost for development and implementation of the Site Activity Plan shall be subsidiary to other project administrative costs.

1.03 RELATED SECTIONS

A. The sections listed below form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

00700 General Conditions

00800 Supplementary Conditions

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

[02940 Green Stormwater Infrastructure Inlets]

[02941 Green Stormwater Infrastructure Energy Dissipation and Pretreatment]

[02942 Green Stormwater Infrastructure Above Grade Barriers]

[02943 Green Stormwater Infrastructure Pervious Concrete]

[02944 Green Stormwater Infrastructure Porous Asphalt]

[02945 Green Stormwater Infrastructure Permeable Pavers]

[02946 Green Stormwater Infrastructure Soil and Aggregate Media]

[02947 Green Stormwater Infrastructure Topsoil]

[02948 Green Stormwater Infrastructure Media Liners]

[02949 Green Stormwater Infrastructure Existing Tree Protection]

[02950 Green Stormwater Infrastructure Selective Vegetation Removal]

[02951 Green Stormwater Infrastructure Plants]

[02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding]

[02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding]

[02954 Green Stormwater Infrastructure Piping]

[02955 Green Stormwater Infrastructure Outlets]

[02956 Green Stormwater Infrastructure In-Situ Infiltration Testing]

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150	Division II Construction and Material Specification, Erosion and Sediment Control

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

SITE ACTIVITY PLAN

GREEN STORMWATER INFRASTRUCTURE CONSTRUCTION SCHEDULE

STORMWATER RUNOFF MANAGEMENT PLAN

SITE ACCESS AND UTILIZATION PLAN

GREEN STORMWATER INFRASTRUCTURE MAINTENANCE PLAN

QUALITY ASSURANCE QUALIFICATIONS

SD-10 Operation and Maintenance Data

SITE ACTIVITY PLAN UPDATES

1.06 QUALITY ASSURANCE

A. Qualifications

1. The Contractor shall develop and control the Site Activity Plan. The Contractor is responsible for installation and establishment of all green stormwater infrastructure components.

2. QUALITY ASSURANCE QUALIFICATIONS; submit qualifications with a minimum of three (3) references for related project work meeting the experience requirements described in Part 1.06 of the following Sections:[02939 Green Stormwater Infrastructure Earthwork,] [02942 Green Stormwater Infrastructure Above Grade Barriers,] [02943 Green Stormwater Infrastructure Pervious Concrete,] [02944 Green Stormwater Infrastructure Porous Asphalt,] [02945 Green Stormwater Infrastructure Permeable Pavers,] [02946 Green Stormwater Infrastructure Soil and Aggregate Media,] [02947 Green Stormwater Infrastructure Topsoil,] [02949 Green Stormwater Infrastructure Existing Tree Protection,][02950 Green Stormwater Infrastructure Selective Vegetation Removal,] [02951 Green Stormwater Infrastructure Plants,] [02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding,] [02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding,] [02956 Green Stormwater Infrastructure In-Situ Infiltration Testing]. Qualifications shall include project location, owner name and contact number, completion date, and dollar value of work.

B. Erosion and Sediment Control

1. The Contractor shall assume that implementation measures specified in the Site Activity Plan are independent of erosion and sediment control as required under the Owner's General Operating Permit with the Missouri Department of Natural Resources (Permit No: MOR100006).

2. The Contractor shall utilize APWA 2150 in conjunction with Section 02938 Green Stormwater Infrastructure Control and Protection as part of this Site Activity Plan, and to the extent necessary to control and protect green stormwater infrastructure.

1.07 QUALITY CONTROL

A. The Contractor shall be responsible for updating the Site Activity Plan during the project at an interval at least as frequent as every 30 days.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Not applicable.

PART 2 PRODUCTS

2.01 MATERIALS AND METHODS

A. Materials and methods identified by Contractor in the Site

Activity Plan are subject to approval by Design ProfessionalOwner prior to Part 3.

2.02 ALTERNATE SITE ACTIVITY PLAN MATERIALS OR METHODS

A. The Contractor may propose alternative methods or materials for implementation of the Site Activity Plan during the project, provided that such methods provide equal or improved measures, as determined by the Design ProfessionalOwner. The Contractor shall submit documentation as requested by the Design ProfessionalOwner to evaluate the alternative.

PART 3 EXECUTION

3.01 PREPARATION

A. A Site Activity Plan is a collection of illustrative plans which identify a detailed green stormwater infrastructure construction schedule, address stormwater runoff during construction, summarize means of access to the Site, and identify the anticipated Site utilization. [The Contractor may combine the Site Activity Plan with requirements of APWA 2150, so long as the information required of both is clearly defined.]

B. All preconstruction submittals per Part 1.05, A. shall be submitted and accepted prior to commencement of Work.

3.02 INSTALLATION

A. The Contractor shall develop and submit a SITE ACTIVITY PLAN within 30 days of Notice to Proceed which shall include but not be limited to the information defined per the following:

B. GREEN STORMWATER INFRASTRUCTURE CONSTRUCTION SCHEDULE: Shall be included and maintained as part of the Project Schedule requirements per Section 00700. The Green Stormwater Infrastructure Construction Schedule shall include additional detail on specific phasing of construction activities for all GSI Components. The Green Stormwater Infrastructure Construction Schedule shall include but not be limited to timelines for all green stormwater infrastructure materials:

1. Procurement of Material including lead times for all green stormwater infrastructure materials to be used onsite;

2. Installation of GSI Components;

3. Bypass/Diversion of Stormwater Runoff;

4. Green Stormwater Infrastructure Establishment, per Section 02957 Green Stormwater Infrastructure Establishment;

5. Site Stabilization Activities

C. STORMWATER RUNOFF MANAGEMENT PLAN: Shall include a markup to a Drawing(s) with appropriate existing and proposed topographic information with notes to fully illustrate drainage patterns on the Site, and the impact of drainage patterns on the green stormwater infrastructure installation and establishment.

Stormwater Runoff Management Plan shall be integrated with control and protection requirements as specified by Section 02938 Green Stormwater Infrastructure Control and Protection to manage stormwater runoff within the Site. Stormwater runoff shall not be allowed to discharge into a green stormwater infrastructure facility until authorized by the Design ProfessionalOwner. Unless approved by the Owner, green stormwater infrastructure shall not be used for collection or conveyance of stormwater during construction. Contractor shall provide means and methods to control stormwater and protect green stormwater infrastructure through the Establishment Period, including installation, inspection, and maintenance. Stormwater Runoff Management Plan shall include but not be limited to the following:

1. Delineation of Green Stormwater Infrastructure Boundaries including all green stormwater infrastructure components;

2. Site Drainage Patterns of stormwater runoff within the Site extents including means and methods to divert stormwater runoff away from green stormwater infrastructure extents;

3. Control of Stormwater Runoff as defined in Section 02938 Green Stormwater Infrastructure Control and Protection;

4. Protection of Green Stormwater Infrastructure as defined in Section 02938 Green Stormwater Infrastructure Control and Protection.

D. SITE ACCESS AND UTILIZATION PLAN: Shall include a markup to a Drawing(s) with appropriate existing and proposed topographic information to fully illustrate access routes and storage locations to limit Site compaction and sedimentation to retain the integrity of the green stormwater infrastructure facility. The Contractor shall coordinate with all trades to prevent vehicle travel across green stormwater infrastructure footprint, as defined in the Drawing(s) and/or within green stormwater infrastructure components. Site Access and Utilization Plan shall include but not be limited to the following:

1. Project Phasing identified graphically with the intent of protecting the green stormwater infrastructure;

2. Delineation of Green Stormwater Infrastructure Protection Boundaries per Section 02938 Green Stormwater Infrastructure Control and Protection;

3. Delineation of Tree Protection Zones including tree protection methods, addressing construction access within tree protection zones per Section 02949 Green Stormwater Infrastructure Existing Tree Protection;

4. Anticipated Site Traffic Patterns including Site access, haul roads, delivery of materials and any temporary facilities;

5. Anticipated Compaction Areas and Contractor's plans for decompaction and/or removal and replacement of any soils not planned for excavation;

6. Maintenance of Utilities on Site during Work, including but not limited to, flow in sewers and water courses;

7. Identification of Storage Areas for material and fuel storage, laydown/equipment staging, material stockpiling, and temporary facility areas;

8. Material Schedule of how stored materials will be protected, including maximum permissible storage durations, and a description of how materials will be disposed of, if applicable;

9. Description of the Equipment and Methods used to for excavation and placement with respective materials within the limits of the green stormwater infrastructure, in a manner that does not put the function of the green stormwater infrastructure facility at risk per Section 02939 Green Stormwater Infrastructure Earthwork.

E. GREEN STORMWATER INFRASTRUCTURE MAINTENANCE PLAN: Shall include specific maintenance activities by green stormwater infrastructure component to be performed by the Contractor during the Establishment Period to meet the service level standards. Maintenance Plan shall include Contractor proposed frequency of activities to meet service level standards defined in Section 02957 Green Stormwater Infrastructure Establishment. Frequencies may include weekly, bi-weekly, monthly, quarterly, semi-annual, and annual maintenance activities, subject to approval by the Design ProfessionalOwner. The Contractor shall submit updated tasks and associated frequencies to meet Section 02957 Green Stormwater Infrastructure Establishment Part 3.06 as part of SITE ACTIVITY PLAN UPDATES for approval by Design ProfessionalOwner. Contractor shall use a standard template provided by Owner for Green Stormwater Infrastructure Maintenance Plan including but not limited to the following items:

1. Maintenance Activities proposed and associated frequency for each activity;

2. Inspection Log will be recorded at the time of the activity and shall include the following:

   a. Project identification including project name, contract number, inspector name and contact, date and time of inspection, and weather conditions at the time of inspection;

   b. Description of Tasks completed including objective of tasks, completion status, and related notes;

   c. Cumulative rainfall during the previous 24 hours and the current week and observed water level in the green stormwater infrastructure footprint;

   d. General inspection notes including but not limited to observed presence of mosquito larvae, animal burrowing, soil loss, sedimentation, invasive species, dying/dead plants, or general damage to the green stormwater infrastructure facility.

3. Material Log including quantities of materials used during inspection and maintenance activities. Material utilization documentation shall be recorded at the time of the activity.

3.03 TOLERANCES

A. Not applicable.

3.04 DISPOSAL OF MATERIAL

A. All debris and excess material shall be disposed of off Site by the Contractor in a manner complying with local ordinances and antipollution laws. Waste shall not be buried on the Site or disposed of into storm drains, sanitary sewers, streams or waterways.

B. Materials may be temporarily stockpiled in an area within the limits of construction that do not disrupt construction activities, create any nuisances or safety hazards, or otherwise restrict access to the Site.

C. Waste materials shall not be stored in areas designated for green stormwater infrastructure.

D. Burning of waste materials shall not be allowed within the Site extents unless Contractor obtains a permit for open burning of trade wastes from the Air Pollution Control Section of Kansas City Health Department. Burning shall not be permitted within green stormwater infrastructure extents or tree protection zones.

3.05 PROTECTION

A. Protection of green stormwater infrastructure facility per Section 02938 Green Stormwater Infrastructure Control and Protection shall be included by Contractor in the Site Activity Plan, through all phases of construction and during the Establishment Period.

B. Areas serviced and/or maintained shall be promptly cleaned up on the same working day as Work is performed to a suitable condition. All equipment or tools used in the performance of this Work shall be removed from the location and any spillage swept and removed from the area the same working day as Work is performed.

C. Protect landscape from damage. Maintain protection during the Work and to meet requirements of Section 02957 Green Stormwater Infrastructure Establishment. Landscape damaged during construction shall be treated, repaired, or replaced within 48 hours by Contractor, weather and planting season permitting and as approved by Design ProfessionalOwner.

3.06 MAINTENANCE

A. SITE ACTIVITY PLAN UPDATES shall be submitted with each Application for Payment at not more than 30-day intervals through Establishment Period. Updates to the Site Activity Plan should reflect any changes to the schedule, stormwater runoff, Site

access and utilization, or maintenance plans provided in previous Site Activity Plan submittals.

B. Maintenance of Site Activity Plan shall be the responsibility of the Contractor until Certificate of Substantial Completion Achievement of Full Operation, as defined in Section 00800 Supplementary Conditions.

C. Green stormwater infrastructure facility shall be maintained per Part 3.02, E. through the duration of the Establishment Period.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall be responsible for maintaining record copies of all material verification forms such as load tickets, invoices, sales receipts, and/or similar items to verify type and quantity of material delivered to the Site. The Owner reserves the right to request verification of any material delivered to the Site throughout the duration of the Establishment Period.

-- End of Section --

SECTION 02938

GREEN STORMWATER INFRASTRUCTURE CONTROL AND PROTECTION

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02938 Green Stormwater Infrastructure Control and Protection is to provide control of stormwater collection, conveyance, and runoff to green stormwater infrastructure installations within the Site, and to protect the green stormwater infrastructure during construction and through the Establishment Period, as defined in Section 02957 Green Stormwater Infrastructure Establishment.

B. This section shall work in conjunction with the Stormwater Runoff Management Plan, as described in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

C. This section does not replace Owner or Contractor erosion and sediment control regulatory responsibilities. [Green stormwater infrastructure for protection shall be identified graphically in the Drawings.]

D. Definitions

1. Control of Stormwater Runoff: Measures, means, and methods of collection and conveyance of stormwater.

2. Protection of Green Stormwater Infrastructure: Measures, means, and methods of preserving the condition, stormwater management capabilities, and general landscape health of green stormwater infrastructure.

1.02 MEASUREMENT AND PAYMENT

A. The cost for development and implementation of green stormwater infrastructure control and protection shall be subsidiary to Work being performed.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless

otherwise indicated by Design ProfessionalOwner.

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150 Division II Construction and Material Specification, Erosion and Sediment Control

1.05 SUBMITTALS

A. Not applicable.

1.06 QUALITY ASSURANCE

A. Not applicable.

1.07 QUALITY CONTROL

A. Temporary Control of Stormwater Runoff measures and temporary Protection of Green Stormwater Infrastructure means and methods shall be evaluated by the Contractor with Site Activity Plan updates, as defined in Section 02937 Green Stormwater Infrastructure Site Activity Plan, through the duration of the Establishment Period.

B. Control and Protection measures evaluation and updates shall be recorded as follows for the specified periods:

1. Stormwater Runoff Management Plan from the Notice to Proceed until Certificate of Substantial CompletionAchievement of Full Operation is issued.

2. Green Stormwater Infrastructure Maintenance Plan from Certificate of Substantial CompletionAchievement of Full Operation through the Establishment Period.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Delivery, storage, and handling of materials associated with temporary Control of Stormwater Runoff and temporary Protection of Green Stormwater Infrastructure shall meet the requirements of APWA 2150, or as identified in the Drawings.

B. Manufactured products shall be delivered, stored and handled per the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MATERIALS

A. Materials used for temporary Control of Stormwater Runoff and temporary Protection of Green Stormwater Infrastructure shall meet the requirements of APWA 2150, or as identified in the Drawings. The Contractor may propose alternative materials, provided that such methods provide equal or improved measures of Control as determined by OwnerDesign Professional.

PART 3 EXECUTION

3.01 PREPARATION

A. Prior to Work, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area.

B. Contractor shall submit a description of measures for Control of Stormwater Runoff and Protection of Green Stormwater Infrastructure proposed for all green stormwater infrastructure components, as identified in the Runoff Management Plan as defined in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.02 INSTALLATION

A. Contractor shall provide all specific temporary Control of Stormwater Runoff measures and temporary Protection of Green Stormwater Infrastructure, means and methods as defined by the Site Activity Plan.

B. Control and protection shall be installed prior to Work performed upstream of any green stormwater infrastructure component per the schedule and sequencing identified in the Site Activity Plan.

C. Control of Stormwater Runoff and Protection of Green Stormwater Infrastructure shall include the following minimum methods for applicable green stormwater infrastructure components:

1. Flow control at green stormwater infrastructure inlets including protection of entire boundary for facilities accepting overland flow;

2. Flow control at green stormwater infrastructure outlets;

3. Sediment, debris and dust control within the green stormwater infrastructure.

3.03 TOLERANCES

A. Not applicable.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Not applicable.

3.06 MAINTENANCE

A. The Contractor shall maintain temporary Control of Stormwater Runoff and Protection of Green Stormwater Infrastructure until the entire upstream area is fully stabilized.

B. The Contractor shall be responsible for removing, replacing, and cleaning of control and protection measures throughout the duration of Work to maintain control and protection of the green stormwater infrastructure facility.

C. Excessive damage or lack of Control of Stormwater Runoff and/or Protection of Green Stormwater Infrastructure will result in not meeting required service level of performance per Section 02957 Green Stormwater Infrastructure Establishment.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. Not applicable.

-- End of Section --

SECTION 02939

GREEN STORMWATER INFRASTRUCTURE EARTHWORK

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02939 Green Stormwater Infrastructure Earthwork is to provide Site preparation, excavation and grading requirements for green stormwater infrastructure infiltration practices that require limited compaction of subgrade.

B. Earthwork for green stormwater infrastructure requiring compaction and areas outside of designated green stormwater infrastructure shall be in accordance with the APWA 2100, or as specified in the Drawings.

C. Definitions

1. Backfill: Placing of approved material in the green stormwater infrastructure facility area(s) to the lines and grades as shown in the Drawings.

2. Clearing: Cutting and disposal of trees, brush, and all other vegetation or combustible material found on or above the existing ground surface inside the limits of disturbance of the green stormwater infrastructure.

3. Excavation: Removal of materials from the construction area to the lines and grades shown in the Drawings. Excavation shall include all materials regardless of nature unless otherwise specified in the Drawings.

4. Finished Grade: Elevation of finished surface of soil media per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

5. Grubbing: Removal and disposal of all tree stumps and roots within the limits of disturbance of the green stormwater infrastructure.

6. Subgrade: Surface or elevation of subsoil remaining after completing excavation.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material and equipment required for green stormwater infrastructure earthwork, depicted in the Drawings and specified herein. Earthwork shall be measured in the units of [Cubic Yards][Each] and shall be paid for by Unit PriceLump Sum Price.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the

text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02946 Green Stormwater Infrastructure Soil and Aggregate Media

[02949 Green Stormwater Infrastructure Existing Tree Protection]

[02951 Green Stormwater Infrastructure Plants]

[02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding]

[02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding]

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

02957 Green Stormwater Infrastructure Establishment Period

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2100	Division II Construction and Material Specifications, Grading and Site Preparation

FEDERAL HIGHWAY ADMINISTRATION (FHWA)

FHWA MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

EXISTING GRADE SURVEY VERIFICATION

SITE INSPECTION

SD-06 Test Reports

PRE-CONSTRUCTION INFILTRATION TEST RESULTS

SD-07 Certificates

COMPLETION OF EXCAVATION

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications

1. Work shall be performed by a qualified installer whose work has resulted in the successful installation of green stormwater infrastructure facilities and establishment of plant life within the last three (3) years, with employees skilled in the landscape trade, and specifically skilled in green stormwater infrastructure.

1.07 QUALITY CONTROL

A. The Contractor shall notify the Design ProfessionalOwner within 48 hours of completion of excavation and prior to placement of all media, as specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

B. Prior to procurement of material and delivery to the Site, the Contractor shall submit all required material to the testing agency and submit required testing results showing material is in conformance with the Contract Documents, as specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. All materials shall be handled and stored in accordance with the respective specification sections.

B. Construction equipment and materials shall not be stored within the footprint of the green stormwater infrastructure facility at any time.

C. The Contractor shall field mark all excavation areas designated for green stormwater infrastructure prior to commencement of Work.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. The Contractor shall submit a description of equipment/methods used for excavation and placement of green stormwater infrastructure materials prior to the commencement of Work per Section 02937 Green Stormwater Infrastructure Site Activity Plan. The Contractor shall be solely responsible for determining the means and methods for meeting the requirements of excavation and placement of materials with the following conditions:

1. The Contractor shall use equipment and methods that minimize compaction of both the base of the green stormwater infrastructure facility as well as the installed materials unless otherwise specified in the Drawings.

2. Low ground-contact pressure equipment shall be used on green stormwater infrastructure facilities to minimize disturbance to established areas adjacent to perimeter of green stormwater infrastructure facility. No heavy equipment shall

be used within the perimeter of the green stormwater infrastructure facility before, during, or after excavation and installation of materials, unless otherwise specified by Design ProfessionalOwner.

3. Contractor shall abide by all compaction requirements as specified in the Drawings. Contractor shall not use equipment with narrow tracks or narrow tires, rubber tires with large lugs, or high-pressure tires within the limits of the green stormwater infrastructure, unless otherwise specified by the Design ProfessionalOwner.

4. Decompaction of the base of the green stormwater infrastructure facility can be completed by using a primary tilling operation of chisel plow, ripper, or sub-spoiler. Additional refracture methods may be substituted at the discretion of the Design ProfessionalOwner.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all green stormwater infrastructure locations and elevations. The contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. EXISTING GRADE SURVEY VERIFICATION; Notify the Design ProfessionalOwner if surveyed stake elevations vary from existing grade identified in the Drawings where proposed grade of green stormwater infrastructure facility ties into the existing grade. Surveyed stake elevations shall be taken at specific point locations identified in the Drawings.

B. Existing Utilities

1. The Contractor shall be responsible for protecting all existing items, utilities and/or structures above and below ground.

2. The Contractor shall contact utility owners and/or make exploratory excavations as necessary to determine the exact location of underground utilities and structures and the limits and character of soil and/or rock prior to construction.

3. If any items require relocation or replacement, the Contractor shall notify the utility or property owner in advance of the Work. The Contractor shall be responsible for all arrangements with the utility and/or property owner for relocation or replacement of the item.

C. Project Conditions

1. Green stormwater infrastructure earthwork shall not be conducted when the ambient temperature is either falling or forecasted to fall below 35 degrees Fahrenheit within 24 hours of proposed placement of media, except by permission of the Design ProfessionalOwner. No material shall be installed on frozen surfaces, nor shall frozen material be placed in green stormwater infrastructure facilities.

2. Excavation permits shall be secured prior to any Work. In all instances, the Contractor agrees to perform all Work in accordance with the permit and to indemnify and hold harmless the Owner from all liability, judgments, costs, expenses and claims growing out of damages or alleged damages, of any nature to any person or property arising out of performance or non-performance of said Work or the existence of facilities and/or appurtenances thereof.

3. SITE INSPECTION: Prior to commencement of Work and delivery of materials, the Contractor and Design ProfessionalOwner shall conduct an inspection of the Site to verify the following is in accordance with Section 02937 Green Stormwater Infrastructure Site Activity Plan:

a. Delineation of boundaries of green stormwater infrastructure excavation extents.

b. Delineation for protection of existing trees and other vegetation per Section 02949 Green Stormwater Infrastructure Existing Tree Protection.

c. Location for stockpiling all soil and aggregated materials and equipment and methods of protection.

d. Location of erosion control measures.

4. The Contractor shall have acceptance on all fill materials and/or media per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media to be used in the green stormwater infrastructure prior to commencement of excavation.

D. Control and Protection: Prior to earthwork activities, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified in the Runoff Management Plan, per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

3.02 INSTALLATION

A. Clearing and Grubbing

1. Contractor shall perform all clearing and grubbing within the limits of construction as required to complete the Work.

2. Clear and grub to a minimum depth of 18 inches within the

footprint of green stormwater infrastructure facility.

3. Trees not specifically marked for removal shall be protected per Section 02949 Green Stormwater Infrastructure Existing Tree Protection.

B. Excavation

1. Excavation of green stormwater infrastructure facility shall be protected from heavy equipment that would result in compaction of soils within the footprint.

2. Excavation shall be to the dimensions, side slopes, elevations, and cross sections specified in the Drawings, as follows:

a. Contractor shall furnish, install and maintain such sheeting, bracing and other components as may be required to support any excavation per APWA 2100, Part 2102.3.

b. Excavation within one (1) foot of finished grade shall not be permitted if the soil is frozen or has been subjected to greater than 0.25 inches of precipitation in the previous 48 hours.

c. The Contractor shall provide dewatering equipment to remove and dispose of all surface water and groundwater entering excavations. Surface water shall be diverted or otherwise prevented from entering excavations, without causing damage to adjacent property.

d. The bottom of the excavation shall be mechanically scarified to a minimum depth of six (6) inches to alleviate any compaction of the facility bottom. Any ponded water shall be removed from the bottom of the facility and the soil shall be friable before mechanical scarification. Mechanical scarification shall not be done along piping alignment(s) and/or in locations where the soil supports the pipe aggregate material.

e. Any sediment deposited within the excavation extents shall be fully removed from the green stormwater infrastructure facility prior to placement of soil and/or aggregate media, per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

f. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of soil and/or aggregate materials. Submit PRE-CONSTRUCTION INFILTRATION TEST RESULTS.

3. Excavation Protection

a. Excavations shall be restored to the level of the adjacent surfaces as soon as practicable. Contractor

shall provide effective protection to the public from any open excavation.

b. Excavations in roadways shall be protected and secured in accordance with existing federal, state and local codes and standards, including, but not limited to, the most current edition of the FHWA MUTCD.

c. A protective cover over an excavation shall be installed so that it can sustain the weight of any persons and/or objects placed upon it. The cover shall be fixed to the ground, so it cannot be moved. Protective covers shall have no opening(s) or protuberance(s) of sufficient size to cause a fall and/or injury. Advance warning devices shall be installed as necessary.

d. Any excavation that is not covered shall be fenced in so that it surrounds the entire excavation area and prevents entry. The fencing shall be a minimum of 42 inches in height. The fence shall be secured and upright at all times.

e. Protective excavation coverings and fences shall be inspected by the Contractor at least daily to assure integrity. Protective excavation coverings and fences in heavy traffic areas shall be inspected more often as necessary.

4. COMPLETION OF EXCAVATION; Notify the Design ProfessionalOwner within 48 hours of completion of excavation and prior to placement of all media as defined in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

C. Subgrade Preparation

1. Clean subgrade and dispose of all debris prior to placement of aggregate or soil media. Remove all large clods, lumps, brush, roots, stumps, litter, trash, and other foreign material three (3) inches in diameter or larger.

2. Verify finished depth of facility and grade of surrounding area with Drawings and are within tolerances specified in Part 3.03.

3. Do not compact subgrade under green stormwater infrastructure facility unless specifically required per the Drawings.

D. Filling and Backfilling

1. Backfill material shall not be placed until PRE-CONSTRUCTION INFILTRATION TEST RESULTS have been accepted.

2. Green stormwater infrastructure facility shall be filled to the dimensions, side slopes, elevations, and cross sections specified in the Drawings.

3. Soil and Aggregate Backfill: Fill and backfill materials

shall be placed in lifts to suit the lines and grades required, making allowances for settlement and placement of cover materials as specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

4. Pipe and Structure Aggregate

a. Aggregate shall be placed to the depth and extents shown in the Drawings.

b. Place aggregate using methods that will not disturb or damage the piping material or the surrounding green stormwater infrastructure facility.

c. Spread aggregate to provide uniform and continuous support beneath pipe or structures. Backfill around the pipe or structure uniformly in maximum six (6) inch lifts.

d. Where required for stability, compaction shall be achieved using small, hand-held or walk behind compactors.

E. Fine Grading

1. Fine grading shall be performed immediately prior to planting operations.

2. Grading shall provide positive drainage to the green stormwater infrastructure facility and/or outlet structure within the facility, unless otherwise specified in the Drawings.

3.03 TOLERANCES

A. The Contractor shall place materials based on the lines and grades specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the Design ProfessionalOwner for review. Survey elevation shall be taken at specific point locations identified in the Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area

is fully stabilized.

B. [Vegetation shall be installed immediately following installation of soil media per Section 02951 Green Stormwater Infrastructure Plants, 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding, or 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding. If Site conditions limit vegetation of facility immediately following installation of soil media, Contractor shall implement additional measures to cover and protect the green stormwater infrastructure facility for duration of exposure.]

C. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain green stormwater infrastructure facility through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. The Contractor shall be responsible for maintaining finished grade of materials within the tolerances defined in Part 3.03 for the duration of the Establishment Period. The Contractor shall make all repairs or replacements necessary to correct changes in finished grade within 30 days of notice from the Owner.

3.07 POST-CONSTRUCTION TESTING

A. Contractor shall verify that finished grade elevations of the facility surface, side slopes, and surrounding area are within tolerances defined in Part 3.03.

3.08 WARRANTY

A. Not applicable.

-- End of Section --

SECTION 02940

GREEN STORMWATER INFRASTRUCTURE INLETS

PART 1 GENERAL

1.01 PURPOSE

A. An inlet is the collection point of stormwater. An inlet typically collects stormwater runoff and discharges this runoff either to the surface or below the surface of the green stormwater infrastructure facility. An inlet can range from simple openings in the curb line, to manufactured stormwater structures, to traditional inlet boxes.

1.02 MEASUREMENT AND PAYMENT

A. Contractor shall provide all labor, material, and equipment required to install the green stormwater infrastructure inlets as shown in the Drawings and as specified herein. Green Stormwater Infrastructure Inlets shall be measured in the units of Each and shall be paid for by Unit PriceLump Sum Price.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937	Green Stormwater Infrastructure Site Activity Plan
02938	Green Stormwater Infrastructure Control and Protection
02939	Green Stormwater Infrastructure Earthwork
02942	Green Stormwater Infrastructure Above Grade Barriers
02946	Green Stormwater Infrastructure Soil and Aggregate Media
02948	Green Stormwater Infrastructure Media Liners
02951	Green Stormwater Infrastructure Plants
02954	Green Stormwater Infrastructure Piping
02957	Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LRFD	AAHSHTO Load-Resistance-Factor Design Bridge Design Standards

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	Specifications for Structural Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM A615/A615M	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A775/A775M	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2208	Division II Construction and Material Specifications, Paving - Portland Cement Concrete Paving
APWA 2604	Division II Construction and Material Specifications, Storm Sewers - Structures

KANSAS CITY METRO MATERIALS BOARD SPECIFICATIONS (KCMMB)

KCMMB	Kansas City Metro Materials Board Specifications

MID-WEST CONCRETE INDUSTRY BOARD CONCRETE SPECIFICATIONS - CONCRETE PAVEMENT (MCIB)

MCIB	Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement

1.05 SUBMITTALS

SD-03 Product Data

MANUFACTURER INFORMATION

SHOP DRAWINGS

SD-06 Test Reports

GRADATION TEST RESULTS

SD-07 Certificates

CONCRETE MIX DESIGN

1.06 QUALITY ASSURANCE

[A. Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment. Manufacturer certified according to the National Ready Mixed Concrete Association (NRMCA) "Certificate of Ready Mixed Concrete Production Facilities."]

[B. Installer Qualifications: Design Professional to insert additional manufacturer/installer qualifications as applicable.]

[C. Testing Agency Qualifications

1. An independent agency, acceptable to the authorities having jurisdiction, qualified according to ASTM C1077 for testing indicated.

2. Personnel performing tests shall be ACI Concrete Strength Testing Technician and ACI Concrete Laboratory Testing Technician - Level 1. Testing Agency laboratory supervisor shall be an ACI Concrete Laboratory Testing Technician - Level 2.

3. Concrete Field Testing: Personnel conducting concrete field tests shall be qualified as ACI Concrete Field Testing Technician - Grade I.]

1.07 QUALITY CONTROL

A. Inspection and testing shall be performed by the Contractor/manufacturer in conformance with applicable standards. All material delivered to the Site shall have quality control certificates certifying the materials conform to specifications.

[B. Field testing of concrete shall be performed by the Contractor once for every 50 cubic yards of concrete placed and shall conform to the requirements of APWA 2208.]

C. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the Design ProfessionalOwner. Such inspection may be made at the place of manufacture or on the Site after delivery.

D. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

E. All materials which have been damaged after delivery will be rejected and corrected at the Contractor's expense. If materials are rejected after installation, they shall be repaired as accepted by the Design ProfessionalOwner, or removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Materials shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

[B. Manufactured products shall be delivered, stored and handled per manufacturer's recommendations.]

PART 2 PRODUCTS

[2.01 INFILTRATION INLET

A. Media Liner: Shall be the type specified in the Drawings and meet the requirements specified in Section 02948 Green Stormwater Infrastructure Media Liners.

B. Perforated Underdrain: Shall be the type specified in the Drawings and meet the requirements specified in Section 02954 Green Stormwater Infrastructure Piping.

C. Cleanout: Shall be the type specified in the Drawings and meet the requirements specified in Section 02954 Green Stormwater Infrastructure Piping.

D. Storage Aggregate Media: Shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

E. Choker Course: Shall be the type specified in the drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

F. Growing Media: Shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

G. Topsoil: Shall meet the requirements specified in Section 02947 Green Stormwater Infrastructure Topsoil.

H. Precast Inlet: Shall be the type specified in the Drawings and shall conform to APWA 2604.

I. Overflow Weir: Shall consist of a 24-inch solid wall HDPE pipe per Section 02954 Green Stormwater Infrastructure Piping, cut in half so that the cross-sectional shape is a semi-circle. Length of piping for overflow weir shall be equal to the specified depth of the weir per the Drawings. Stainless steel straps one-eighth

(1/8) inch thick by two (2) inch wide shall be used at the top of HDPE pipe to anchor weir to precast inlet. Anchor with one-half (1/2) inch diameter by three (3) inch stainless steel adhesive anchors with HILTI HIT-RE500 epoxy or approved equal.]

[2.02 CURB CUT

A. Curb cuts shall be cast-in-place openings of new curb.

B. Concrete and reinforcement used with curb cuts shall meet the requirements for curbs specified in Section 02942 Green Stormwater Infrastructure Above Grade Barriers.]

[2.03 TRENCH DRAIN

[A. Design Professional to specify recommended product or approved equal.]

B. Trench drain shall be H-20 wheel rated per AASHTO LRFD Bridge Design Specifications. Grate material shall be [ductile iron] [gray iron] [stainless steel].

[C. Concrete Trench: Concrete mix shall be 4,500 psi conforming to [MCIB] [KCMMB] or approved equal. Contractor shall submit CONCRETE MIX DESIGN prior to procurement of material including certification that mix design meets the requirements of the specified mix.

D. Reinforcement: Non-epoxy coated bars shall conform to ASTM A615/A615M. Epoxy coated bars shall conform to ASTM A775/A775M.

E. Aggregate Base: Concrete base shall have an underlying aggregate base, which shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media. Contractor shall submit GRADATION TEST RESULTS of aggregate base prior to procurement of material.]]

[2.04 MANUFACTURED INLET

[A. Design Professional to specify recommended product or approved equal.]

B. MANUFACTURER INFORMATION; Submit manufacturer information for product data and instruction for each product, including but not limited to structure type, size, material, effective open area, fabrication, delivery and handling, placement, installation, and protection.

[C. SHOP DRAWINGS; Submit shop drawings with a minimum of the following information, if applicable:

1. Suppler name, address and phone;

2. Structure dimensions (exterior and interior) including open area for inlet capacity;

3. Pipe connections and sizes;

4. Flow lines/flow directions.]

[D. Concrete Base: Concrete mix shall be 4,000 psi conforming to [MCIB] [KCMMB] or approved equal. Contractor shall submit CONCRETE MIX DESIGN prior to procurement of material including certification that mix design meets the requirements of the specified mix.]

E. Aggregate Base: Concrete base shall have an underlying aggregate base, which shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media. Contractor shall submit GRADATION TEST RESULTS of aggregate base prior to procurement of material.]]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking: All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all structure locations and elevations. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

[B. Project Conditions

[1. Conditions for concrete placement shall comply with ACI 301. Hot weather placement shall comply with ACI 305R, and cold weather placement shall comply with ACI 306R.]]

C. Control and Protection

1. Prior to installation of in green stormwater infrastructure inlets, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Prior to connecting inlets to downstream drainage systems, temporary erosion control measures shall be in place.

3. Stormwater bypass and/or dewatering measures shall be in place to keep the Site clean and dry for the duration of installation.

3.02 INSTALLATION

A. Excavation

1. Excavation methods used shall conform to the requirements of Section 02939 Green Stormwater Infrastructure Earthwork.

2. Excavation shall extend to a depth such that the specified invert elevation and top of structure elevation, once fully

installed, is located at the elevation shown in the Drawings. If an invert elevation or top of structure elevation is not specified, the Contractor is to consult the Design ProfessionalOwner to verify control elevations for the structure prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the structure at the grades shown.

[B. Infiltration Inlet

1. Media Liner: Shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners.

2. Perforated Underdrain: Shall be installed per Section 02954 Green Stormwater Infrastructure Piping.

3. Cleanout: Shall be installed per Section 02954 Green Stormwater Infrastructure Piping.

4. Storage Aggregate Media: Shall be installed per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

5. Choker Course: Shall be installed per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

6. Growing Media: Shall be installed per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

7. Topsoil: Shall be installed per Section 02947 Green Stormwater Infrastructure Topsoil.

8. Precast Inlet: Structure shall be per APWA 2604.

9. Overflow Weir: Shall be affixed to the wall of the precast structure using stainless steel straps and adhesive anchors so that the top elevation of the overflow weir matches the elevation of the crown of the perforated underdrain pipe.]

[C. Curb Cut

1. Curb cuts shall be cast-in-place, installed as concrete curb per Section 02942 Green Stormwater Infrastructure Above Grade Barriers with opening dimensions as specified in the Drawings.

2. If modifying an existing curb line, the existing curb shall be removed to the nearest contraction or expansion (isolation) joint and the curb cut shall be cast-in-place with a throat and directional veins to divert flows through the curb cut as opposed to running parallel with the curb line.

3. Concrete shall be poured such that the finished grade of the inlet is flush with the adjacent pavement and shall have positive drainage toward the green stormwater infrastructure facility, as specified in the Drawings.]

[D. Trench drain shall be installed per manufactuerer's requirements.]

[E. Manufactured Inlet

1. Concrete Base, Aggregate Base and Anchoring

a. Unless otherwise specified by the manufacturer/Design ProfessionalOwner, all manufactured inlets require a concrete base and aggregate base for stability.

b. Aggregate base shall be placed to the depth and extents shown in the Drawings/recommended by the manufacturer. Place aggregate using methods that will not disturb or damage the structure itself or the surrounding piping/green stormwater infrastructure facility.

c. Compaction shall be achieved using small, hand-held or walk behind compactors to prevent damage to the structure or over-compaction of the surrounding areas intended for infiltration.

d. Concrete base size and thickness shall be as specified in the Drawings/by manufacturer. Concrete base shall be constructed per APWA 2208, Part 2208.4. Concrete must be cured seven (7) days prior to placement of inlet.]

2. Manufactured Inlet Structure Placement

a. Place manufactured inlet on concrete base and level vertically. Verify critical elevations, including but not limited to top of structure, inverts in/out and [overflow][weir] elevations.]

F. Backfill

1. Prior to backfilling, cover inlet opening(s) to protect from material deposition inside the structure during placement. Provide protection of inlet per Section 02938 Green Stormwater Infrastructure Control and Protection.

2. Backfill around inlet and compact uniformly in maximum six (6) inch lifts by hand using small, hand-held or walk behind compactors to prevent damage to the inlet or over-compaction of surrounding areas intended for infiltration.

3. Install soil and/or aggregate media around structure to finished grade per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media and as shown in the Drawings. All green stormwater infrastructure media shall be in place including mulch per Section 02951 Green Stormwater Infrastructure Plants prior to removal of protective covering and installation of grated cover.

3.03 TOLERANCES

A. Inlet structure installed elevation shall not deviate from design elevation by more than 0.1 feet. Verify all elevations specified in the Drawings, including but not limited to invert elevations, top of structure elevation, and [weir][overflow] elevations.

B. Horizontal placements shall be within 0.1 feet of the alignment depicted in Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the inlet structure until the entire upstream tributary area is fully stabilized.

B. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain green stormwater infrastructure inlets through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the inlet. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.

-- End of Section --

SECTION 02941

GREEN STORMWATER INFRASTRUCTURE ENERGY DISSIPATION AND PRETREATMENT

PART 1 GENERAL

1.01 PURPOSE

A. Energy dissipation is used to decrease the velocity of stormwater to prevent erosion and scouring of green stormwater infrastructure facility surface materials. Pretreatment captures sediment, trash, and debris prior to entering the green stormwater infrastructure facility.

1.02 MEASUREMENT AND PAYMENT

A. Contractor shall provide all labor, material, and equipment required to install the [energy dissipation][and][manufactured pretreatment device] as shown in the Drawings and as specified herein. [Energy dissipation][and][manufactured pretreatment device] shall be measured by Unit PriceLump Sum Price as follows:

Energy Dissipation and Pretreatment Measurement and Payment Units

Item	Unit
[Surface Stone]	[Cubic Yards or Tons]
[Surface Brick]	[Each]
[Concrete Base]	[Cubic Yards]
[Manufactured Pretreatment Device]	[Each]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02948 Green Stormwater Infrastructure Media Liners

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to

the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	Specifications for Structural Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM A615/A615M	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A775/A775M	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM C33/C33M	Standard Specification for Concrete Aggregates
ASTM C270	Standard Specification for Mortar for Unit Masonry
ASTM C902	Standard Specification for Pedestrian and Light Traffic Paving Brick
ASTM D5519	Standard Test Methods for Particle Size Analysis of Natural and Man-Made Riprap Materials

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2208	Division II Construction and Material Specifications, Paving - Portland Cement Concrete Paving

KANSAS CITY METRO MATERIALS BOARD SPECIFICATIONS (KCMMB)

KCMMB	Kansas City Metro Materials Board Specifications

MID-WEST CONCRETE INDUSTRY BOARD CONCRETE SPECIFICATIONS - CONCRETE PAVEMENT (MCIB)

MCIB	Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

PLACEMENT NOTIFICATION

SD-03 Product Data

MANUFACTURER INFORMATION

SURFACE MATERIAL LAYOUT

SHOP DRAWINGS

SD-04 Samples

SURFACE MATERIAL

SD-06 Test Reports

GRADATION TEST RESULTS

SD-07 Certificates

CONCRETE MIX DESIGN

1.06 QUALITY ASSURANCE

[A. Manufacturer Qualifications

[1. A qualified manufacturer or supplier of specified [stone][brick] units similar to those specified in the Drawings with adequate production capacity to manufacture required units.]

[2. A qualified manufacturer or supplier of specified manufactured pretreatment device similar to those specified in the Drawings with adequate production capacity to manufacture required units.]]

[B. Installer Qualifications

[1. Manufactured pretreatment device installation shall be completed by the manufacturer or an installer certified by the manufacturer to install the product.]

[2. Design Professional to insert additional manufacturer/installer qualifications as applicable.]]

[C. Testing Agency Qualifications: Personnel conducting concrete field tests shall be qualified as ACI Concrete Field Testing Technician - Grade I.]

1.07 QUALITY CONTROL

A. Inspection and testing shall be performed by the Contractor/manufacturer in conformance with applicable standards. All material delivered to the Site shall have quality control certificates certifying the materials conform to specifications.

[B. Field testing of concrete shall be performed by the Contractor once for every 50 cubic yards of concrete placed and shall conform to the requirements of APWA 2208, Part 2208.3.]

C. The quality of all materials, the process of manufacture, and the

finished products shall be subject to inspection and acceptance by the Design ProfessionalOwner. Such inspection may be made at the place of manufacture or on the Site after delivery.

D. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

E. All materials which have been damaged after delivery will be rejected and corrected at the Contractor's expense. If materials are rejected after installation, they shall be repaired as accepted by the Design ProfessionalOwner, or removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Material shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

[B. Manufactured pretreatment devices shall be delivered, stored and handled per manufacturer's recommendations.]

PART 2 PRODUCTS

[2.01 ENERGY DISSIPATION

[A. Permeable Liner: Permeable liner shall be per Section 02948 Green Stormwater Infrastructure Media Liners.]

[B. Aggregate Bedding

1. Aggregate bedding shall be meet the quality requirements of ASTM C33/C33M and shall be reasonably well graded within the following limits:

Aggregate Bedding Gradation Requirements

Sieve Size	Passing (Percent by Weight)
75 mm (3 inch)	100
37.5 mm (1-1/2 inch)	75 - 95
12.5 mm (1/2 inch)	40 - 60
4.75 mm (No. 4)	5 - 25

2. GRADATION TEST RESULTS; Submit gradation test results of aggregate bedding prior to procurement of material.]

[C. Aggregate Base

1. Aggregate base shall be per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

2. GRADATION TEST RESULTS; Submit gradation test results of aggregate base prior to procurement of material.]

[D. Concrete Base

1. Concrete mix shall be 4,500 psi conforming to [MCIB] [KCMMB] or approved equal.

2. CONCRETE MIX DESIGN; Submit certification that concrete mix design for concrete base meets the requirements of the specified mix prior to procurement of material.]

[E. Reinforcment: Shall be No. 4 rebar. Non-epoxy coated bars shall conform to ASTM A615/A615M. Epoxy coated bars shall conform to ASTM A775/A775M. Dowels shall be five-eighths (5/8) inch diameter by two (2) feet smooth dowels.]

[F. Surface Material

1. SURFACE MATERIAL; Submit sample surface [stone][brick] to be used for energy dissipation. Include supplier name, address and phone as well as material color, color range, and texture options for surface [stone][brick].

2. SURFACE MATERIAL LAYOUT; Submit proposed surface material layout with a minimum of the following information, if applicable:

a. Approximate dimensions of individual surface [stone][brick];

b. Approximate spacing between individual [stone][brick];

c. Approximate spacing of [stone][brick] from the edge of the of the concrete base.

3. Surface Stone

a. Surface stone shall be of the size, material and dimensions specified in the Drawings.

b. Unless otherwise specified, surface stone shall be hard and angular or subangular with elongation no greater than 3:1 length to width ratio. Stone shall be uniformly graded with an average stone diameter as specified in the Drawings.

c. GRADATION TEST RESULTS; Submit gradation test results of surface stone prior to procurement of material.

[4. Surface Brick

a. Surface brick material shall be Type I Class SX per ASTM C902. Material provided shall consist of a mixture of full and half size bricks, or to the dimensions specified in the Drawings.

b. Brick shall be free of cracks or other imperfections detracting from the appearance. Contractor shall submit samples of all surface brick to be used to the Design ProfessionalOwner.]

[5. Mortar shall be Type S per ASTM C270 or approved equal by Design ProfessionalOwner.]]

[2.02 MANUFACTURED PRETREATMENT DEVICES

[A. Design Professional to specify recommended product and manufacturer or approved equal.]

B. MANUFACTURER INFORMATION; Submit manufacturer information for product data, and instructions for each product, including, but not limited to supplier name, address and phone as well as product fabrication, delivery and handling, placement, installation, and protection.

C. SHOP DRAWINGS; submit shop drawings with a minimum of the following information, if applicable:

1. Supplier name, address and phone;

2. Structure dimensions (exterior and interior);

3. Pipe connections and sizes;

4. Flow lines and flow directions.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking: All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all structure locations and elevations. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

B. Project Conditions

[1. Conditions for concrete placement shall comply with ACI 301. Hot weather placement shall comply with ACI 305R, and cold weather placement shall comply with ACI 306R.]

C. Control and Protection

1. Prior to installation of [energy dissipation][and][manufactured pretreatment device], the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. PLACEMENT NOTIFICATION; Notify the Design ProfessionalOwner at least 48 hours prior to placement of [energy dissipation][and][manufactured pretreatment device].

3.02 INSTALLATION

A. Excavation

[1. Excavation methods used shall conform to the requirements of Section 02939 Green Stormwater Infrastructure Earthwork.]

2. Excavation shall extend to a depth such that the specified invert elevation and top of structure elevation, once fully installed, is located at the elevation shown in the Drawings. If an invert elevation or top of structure elevation is not specified, the Contractor is to consult the Design ProfessionalOwner to verify control elevations for the structure prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the [energy dissipation][and][manufactured pretreatment device].

[B. Concrete Embedded Splash Pad

1. Aggregate base shall be placed to the depth and extents specified in the Drawings. Aggregate base shall extend a minimum of four (4) inches beyond the extends of the concrete base.

2. Concrete base shall be constructed per APWA 2208, Part 2208.4.

3. Surface [stone][brick] shall be placed per the SURFACE MATERIAL LAYOUT. Contractor shall notify the Design ProfessionalOwner at least 48 hours prior to placement of surface material.

[a. Surface stones shall be placed into the plastic concrete base to the specified depths and spacing per the SURFACE MATERIAL LAYOUT. After the concrete base has cured, the surface stone should not be removable.]

[b. After the concrete base has cured for seven (7) days, mortar shall be used to bind the surface brick onto the concrete base per the SURFACE MATERIAL LAYOUT. After the mortar has hardened, the surface brick should not be removable from the concrete base.]]

[C. Surface Stone Splash Pad

1. Permeable liner shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners prior to placement of aggregate bedding and surface stone.

2. Aggregate bedding shall be spread uniformly to depth and extents specified in the Drawings. Aggregate bedding shall be placed using methods which avoid damage to the permeable liner or subgrade.

3. Surface stone shall be placed over aggregate bedding to the depth and extents specified in the Drawings.]

[D. Manufactured Pretreatment Device

1. All manufactured pretreatment devices shall be installed per manufacturer requirements and recommendations.]

3.03 TOLERANCES

A. [Energy dissipation] [and] [manufactured pretreatment device] installed elevation shall not deviate from design elevation by more than 0.1 feet. Verify all elevations specified in the Drawings, including but not limited to invert elevations and top of structure elevation elevations.

B. Horizontal placements shall be within 0.1 feet of the alignment depicted in Drawings.

[C. Surface brick size shall be within one-fourth (1/4) inch of the size specified.]

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the [energy dissipation] [and] [manufactured pretreatment device] until the entire upstream tributary area is fully stabilized.

B. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain [energy dissipation] [and] [manufactured pretreatment device] through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

[A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the [energy dissipation] [and] [manufactured pretreatment device]. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective

products or material.]

[C. The Contractor shall warrant the green stormwater infrastructure energy dissipation materials through the duration of the Establishment Period. If at any time during the Establishment Period the material becomes damaged due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the material and fully restore the green stormwater infrastructure facility and any damaged components as determined by the Design ProfessionalOwner, at no additional cost to the Owner.]

-- End of Section --

SECTION 02942

GREEN STORMWATER INFRASTRUCTURE ABOVE GRADE BARRIERS

PART 1 GENERAL

1.01 PURPOSE

A. Above grade barriers are physical or visual barriers placed at the edge of the green stormwater infrastructure to protect the facility from traffic, pedestrians, and improper maintenance activities. Above grade barriers also increase safety for the public by providing a visual delineation between pedestrian/vehicular space and the green stormwater infrastructure.

1.02 MEASUREMENT AND PAYMENT

A. Contractor shall provide all labor, material, and equipment required to install the barrier as shown in the Drawings and as specified herein. Above grade barriers shall be paid for by Unit PriceLump Sum Price and measured as follows:.

Above Grade Barriers Measurement and Payment Units

Item	Unit
[Concrete Curb]	[Cubic Yard] [Linear Foot]
[Fencing]	[Linear Foot]
[Bollards]	[Each]
[Concrete Footing]	[Cubic Yard]
[Reflector]	[Each]
[Stone Boulder]	[Each] [Ton]
[Ledgestone]	[Each] [Ton]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference

standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	Specifications for Structural Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 318	Building Code Requirements for Structural Concrete
ACI SP66	ACI Detailing Manual

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2200	Division II Construction and Material Specification, Paving

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM A36/A36M	Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A53/A53M	Standard Specification for Carbon Structural Steel
ASTM A123/A123M	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A240/A240M	Standard Specification for Chroumium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
ASTM A500/A500M	Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A615/A615M	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A653/A653M	Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
ASTM A775/A775M	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete

ASTM C97/C97M	Standard Test Method for Absorption and Bulk Specific Gravity of Dimension Stone
ASTM C99/C99M	Standard Test Method for Modulus of Rupture of Dimension Stone
ASTM C170/C170M	Standard Test Method for Compressive Strength of Dimension Stone
ASTM C241/C241M	Standard Test Method for Abrasion Resistance of Stone Subjected to Foot Traffic
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM D1784	Standard Specification for Rigid Poly(Vinyl Chloride)(PVC) Compounds and Chlorinated Poly(Vinyl Chloride)(CPVC) Compounds
ASTM F2408	Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1	Structural Welding Code - Steel
AWS D1.6	Structural Welding Code - Stainless Steel

AMERICAN IRON AND STEEL INSTITUTE (AISI)

AISI	American Iron and Steel Institute

KANSAS CITY METRO MATERIALS BOARD SPECIFICATIONS (KCMMB)

KCMMB	Kansas City Metro Materials Board Specifications

MID-WEST CONCRETE INDUSTRY BOARD CONCRETE SPECIFICATIONS - CONCRETE PAVEMENT (MCIB)

MCIB	Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

LOCATION NOTIFICATION

SD-03 Product Data

MANUFACTURER INSTRUCTIONS

MANUFACTURER DATA SHEET

DESIGN DATA

SHOP DRAWINGS

CONCRETE STEEL REINFORCEMENT SHOP DRAWINGS

REFLECTOR SHOP DRAWINGS

SD-04 Samples

ABOVE GRADE BARRIER VERIFICATION SAMPLES

SD-07 Certificates

CONCRETE MIX DESIGN

STONE BARRIER MATERIAL

1.06 QUALITY ASSURANCE

[A. Manufacturer Qualifications

[1. Concrete Manufacturer: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment. Manufacturer certified according to the National Ready Mixed Concrete Association (NRMCA) "Certificate of Ready Mixed Concrete Production Facilities."]

[2. [Fence] [and] [Bollard] Manufacturer: A firm engaged in the manufacture of products of types and sizes specified, and whose products have been in satisfactory use in similar service for a minimum of three (3) years.]

[3. MANUFACTURER INSTRUCTIONS; Submit manufacturer instructions for each product, including, but not limited to fabrication, delivery and handling, installation and protection.]

[B. Installer Qualifications

[1. Concrete Installer: ACI Certified Flatwork Finisher and Technician.]

[2. Above Grade Barrier Installer: A firm with minimum of five (5) years of successful installation experience with projects utilizing products similar in type and size to that required for this project.]]

[C. Testing Agency Qualifications

[1. Concrete Testing Agency Personnel

a. An independent agency, acceptable to the authorities having jurisdiction, qualified according to ASTM C1077 for testing indicated.

b. Personnel performing tests shall be ACI Concrete

Strength Testing Technician and ACI Concrete Laboratory Testing Technician - Level 1. Testing Agency supervisor shall be an ACI Concrete Laboratory Testing Technician - Level 2.

2. Concrete Field Testing: Personnel conducting concrete field tests shall be qualified as ACI Concrete Field Testing Technician - Grade I.]

[3. Welding: Qualified procedures and personnel according to AWS D1.1 or AWS D1.6.]]

1.07 QUALITY CONTROL

A. Inspection and testing shall be performed by the Contractor/manufacturer in conformance with applicable standards. All material delivered to the Site shall have quality control certificates certifying the materials conform to specifications.

[B. Field testing of concrete shall be performed by the Contractor once for every 50-cubic yard of concrete placed and shall conform to the requirements of APWA 2200, Part 2208.3.]

C. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the Design ProfessionalOwner. Such inspection may be made at the place of manufacture or on the Site after delivery.

D. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site at once.

E. All materials which have been damaged after delivery will be rejected and corrected at the Contractor's expense. If materials are rejected after installation, they shall be repaired as accepted by the Design ProfessionalOwner, or removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Material shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

[B. Manufactured products shall be delivered, stored and handled per manufacturer's recommendations.]

PART 2 PRODUCTS

[2.01 CONCRETE CURBS

A. Concrete: Concrete mix shall be 4,500 psi conforming to [MCIB,] [KCMMB] or approved equal for curbs unless otherwise specified in the Drawings.

B. Reinforcement: Shall be No. 4 rebar. Non-epoxy coated bars shall conform to ASTM A615/A615M. Epoxy coated bars shall conform to ASTM A775/A775M. Dowels shall be five-eighths (5/8) inch diameter by two (2) feet smooth dowels.]

[C. Curb Guard: [Shall be hot dipped galvanized structural steel per ASTM A36/36M or AISI Type 316 stainless steel plate. Headed studs or wedge anchors shall match the material of the curb guard plate. Hot dip galvanizing shall conform to ASTM A123/A123M and stainless steel shall conform to ASTM A240/A240M. Welding shall conform to AWS D1.1 for carbon steel and AWS D1.6 for stainless steel.][Shall be Neenah R3262-4 or approved equal.]]

D. CONCRETE MIX DESIGN; Certification that concrete mix design meets the requirements of the specified mix.

E. CONCRETE STEEL REINFORCEMENT SHOP DRAWINGS; Submit steel reinforcement drawings conforming to ACI SP66 and ACI 318 including but not limited to bar schedules, erection drawings, bar details, concrete protective cover, steel grade, lap splice lengths, and supports for concrete reinforcement.]

[2.02 FENCING

A. The manufactured fence/rail system shall be capable of meeting the vertical load and infill performance requirements for commercial weight fences under ASTM F2408.

B. At a minimum, fencing material shall meet the following parameters:

[1. Metal: Fencing product shall be [Montage Plus All Terrain Flexibility (ATF) Ornamental Steel Majestic design by Ameristar Fence Products or approved equal]. Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections on finished units. Steel material for fence panels and posts shall conform to the requirements of ASTM A653/A653M, with a minimum yield strength of 45,000 pounds per square inch (310 megapascal) and a minimum zinc (hot-dip galvanized) coating weight of 0.60 ounces per square foot (184 grams per square meter), Coating Designation G-60. Fencing sections and panels shall be biasable to follow site slopes.]

[2. Wood: Provide wood timber post with chamfer tops and lumber rail with metered ends to abut cleanly along front edge. All lumber shall be pressure treated for in-ground use. All fasteners shall be hot-dipped galvanized steel. All lumber shall be pressure treated and suitable for in-ground use.]

[3. Plastic: Product shall be poly vinyl chloride (PVC) formulated to resist impact and for Ultra Violet stabilization. Extruded products meet or exceeds ASTM D1784.]

4. Material and size for pickets, fence posts, gate posts, rails shall be as specified in the Drawings and details.

[C. The manufactured panels and posts shall be subjected to an inline electrode position coating process consisting of multistage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be two (2) mils. The coating shall meet performance criteria of ASTM F2408.]

D. Concrete Footing: Concrete mix shall be 4,000 psi conforming to [MCIB,] [KCMMB] or approved equal for curbs unless otherwise specified in the Drawings. Submit CONCRETE MIX DESIGN certification that concrete mix design meets the requirements of the specified mix.

E. MANUFACTURER DATA SHEET; Submit product data for manufacturer product lines assembled from standard components, including, but not limited to:

1. Supplier name, address, and phone;

2. Grout, anchoring cements and paint products;

3. Preparation instructions and recommendations;

4. Storage and handling requirements and recommendations;

5. Installation methods;

6. Available guidelines and instructions on operations and maintenance of materials installed.

[F. DESIGN DATA; For installed fences indicated to comply with certain design loadings, submit structural analysis data signed and sealed by the Professional Engineer licensed in the state for which the work is being performed, who was responsible for their preparation.]

G. SHOP DRAWINGS; Submit shop drawings showing fabrication and installation of fence. Include colors, plans, elevations, sections, details, field conditions and attachments to other Work.

H. ABOVE GRADE BARRIER VERIFICATION SAMPLES; Submit manufacturer's color charts showing the full range of colors available for products. For each type of exposed finish required, prepared on components and of same thickness and metal indicated for the Work. If finish involves normal color and texture variations, include sample sets showing the full range of variations expected.

]

[2.03 BOLLARDS

[A. Wood Bollards

[1. [Southern yellow pine][Cedar] [square][round] bollards treated with Alkaline Copper Quaternary (ACQ) at 0.40 pounds chemical retention. Surface finish shall be stained as approved by the Owner. All lumber shall be pressure treated and suitable for in-ground use. All fasteners shall be [hot-dipped galvanized steel][stainless steel].]

[2. Design Professional to specify recommended product and manufacturer, or approved equal.]

[3. Top Mounted Bollard: Secure wood bollard to post with post installed stand off type bracket [Simpson Strong Tie Product ABA or approved equal] with a galvanized wedge or adhesive

anchor. [Epoxy shall be Hilti Hit-HY 200 or approved equal.]

[4. Removable Bollards: Wood bollard shall insert into a galvanized steel receiver sleeve attached to a stainless steel locking plate.]]

[B. Metal Bollards

1. Metal bollard material shall be a minimum schedule 40 steel pipe per ASTM A53/A53M or ASTM A500/A500M Grade B structural steel.

[2. Top Mounted Bollards: Fabricate bollards with three-eigths (3/8) inch thick steel baseplates for bolting to concrete slab. Drill baseplates at all four corners for concrete anchors. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.]

[3. Removable Bollards: Fabricate sleeves for bollard anchorage from steel pipe or tubing with one-quarter (1/4) inch thick steel plate. Sleeve inner diamter shall not be larger than the bollard outside diameter plus three-quarters (3/4) of an inch. Bollard shall include stainless steel locking plate.]

[4. Concrete-Filled Metal Bollards: Steel pipe shall be filled with a minimum 3,000 psi 28 day design compressive strength concrete.]

5. Color Coating: Prime bollards with zinc-rich epoxy primer. Color coating shall be polyester powder of the color specified in the Drawings.]

[C. Precast Concrete Bollards

1. Concrete bollard shall be precast concrete with a minimum 5,000 psi 28 day design compressive strength.

2. Reinforcing and anchoring shall be per manufacturer requirements.]

[D. Manufactured/Specialty Bollards

[1. Design Professional to specify recommended product and manufacturer, or approved equal.]

[2. Bollards shall be removable.]]

E. Concrete Footing: Concrete mix shall be 4,000 psi conforming to [MCIB,] [KCMMB] or approved equal for curbs unless otherwise specified in the Drawings. Submit CONCRETE MIX DESIGN certification that concrete mix design meets the requirements of the specified mix.

F. MANUFACTURER DATA SHEET; Submit product data for manufacturer product lines assembled from standard components, including, but not limited to:

1. Supplier name, address, and phone;

2. Grout, anchoring cements and paint products;

3. Preparation instructions and recommendations;

4. Storage and handling requirements and recommendations;

5. Installation methods;

6. Available guidelines and instructions on operations and maintenance of materials installed.

[G. DESIGN DATA; For installed bollards indicated to comply with certain design loadings, submit structural analysis data signed and sealed by the Professional Engineer who was responsible for their preparation.]

[H. SHOP DRAWINGS; Submit shop drawings showing fabrication and installation of bollards. Include colors, plans, elevations, sections, details, field conditions and attachments to other Work.
]

I. ABOVE GRADE BARRIER VERIFICATION SAMPLES; Submit manufacturer's color charts showing the full range of colors available for products. For each type of exposed finish required, prepared on components and of same thickness and metal indicated for the Work. If finish involves normal color and texture variations, include sample sets showing the full range of variations expected.
]

[2.04 CONCRETE FOOTING

A. Install [bollards][and][fencing] on concrete footing as detailed in the Drawings or as specified by manufacturer.

B. Contractor shall coordinate installation drawings, diagrams, templates, instructions, and directions for installing anchors, such as sleeves, concrete inserts, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction.

C. CONCRETE MIX DESIGN; Submit certification that concrete mix design meets the requirements of the specified mix.]

[2.05 REFLECTOR

A. Reflectors shall be [water drop][round][square][rectangular] shaped with aluminum base and a round white reflector shall be mechanically fastened or chemically adhered to each [bollard][fence post] or at the locations specified in the Drawings.

B. REFLECTOR SHOP DRAWINGS; Submit shop drawings showing reflector and fastener materials and dimensions.]

[2.06 STONE BARRIERS

[A. Stone Boulder

1. Stone boulder shall be natural limestone materials. Contractor shall provide weathered natural carbonate stone in thicknesses and general dimensions as shown in the Drawings.

2. Provide stone from within 100-mile radius from project Site.

3. Stone material shall meet the following physical characteristics:

Stone Barrier Testing Requirements

Characteristic	Requirement	Test Method (or Approved Equal)
Compressive Strength	4,000 psi (minimum)	ASTM C170/C170M
Modulus of Rupture	700 psi (minimum)	ASTM C99/C99M
Absorption	7.5% (maximum)	ASTM C97/C97M
Abrasive Hardness	10 (minimum)	ASTM C241/C241M

]
[B. Ledgestone

1. Ledgestone shall be solid, sound, unweather limestone without visible voids.

2. Stone units shall exhibit a hard, massive, solid appearance and shall lack the presence of clay seams, solution cavities, and broken, rubble, or weathered rock conditions.

3. Stone units shall be obtained from the same formation or rock unit.

4. Stone units shall be uniform dimension with a minimum unit weight of 140 pounds per cubic foot.]

C. STONE BARRIER MATERIAL; Submit certification that stone material is within the parameters specified including the following:

1. Supplier name, phone and address;

2. Type of Material;

3. Compressive Strength;

4. Modulus of Rupture;

5. Absorption;

6. Abrasive Hardness.

D. ABOVE GRADE BARRIER VERIFICATION SAMPLES; submit photographs depicting size and geometry of stone prior to selection of sample material. Contractor is required to provide a sample of the stone for Owner review and approval.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The contractor shall set construction stakes, establishing all structure locations and elevations. The contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. LOCATION NOTIFICATION; Notify the Design ProfessionalOwner once all above grade barriers are located and staked in the field prior to installation for review and approval.

[B. Project Conditions

1. Conditions for concrete placement shall comply with ACI 301. Hot weather placement shall comply with ACI 305R, and cold weather placement ACI 306R requirements shall apply.]

3.02 INSTALLATION

[A. Concrete Curbs: Shall be constructed in accordance with APWA 2200, Part 2209.4 to the configuration, lines and grades as indicated in the Drawings.]

[B. [Fence][and][Bollards]

1. Install as indicated in the Drawings and per manufacturer recommendations, as applicable.

2. Fit exposed connections together to form tight, hairline joints.

3. Set posts accurately in location, alignment, and elevation measured from established lines and levels and free from rock.

4. Adjust posts before anchoring to ensure alignment at abutting joints. Space posts at interval indicated.

5. Anchor posts to concrete as required by the manufacturer or as specified in the Drawings.

6. Provide isolation as recommended by manufacturer on concealed surfaces of steel that will be in contact with grout, concrete, masonry, wood, or dissimilar metals.

7. Do not weld, cut, or scratch coated or finished material that is intended for field connection by mechanical or other means without further cutting or fitting.

8. Adjustments and Cleaning

a. Touch-Up Painting: Immediately after erection, clean

field welds, bolted connections, and abraded areas of shop paint, and apply same material to exposed areas.

b. Cleaning: Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in field to shop; make required alterations and refinish entire unit, or provide new units.]

[C. Stone Barriers

1. Layout of stone shall be as specified in the Drawings. Location of stone shall be field adjusted by actual stone size and shape, with final approval by the Owner.

2. Stone shall be set in stable conditions with no rocking. Backfill around stone shall be as specified in the Drawings.]

D. Finish: All above grade barriers shall have a light broomed finished.

3.03 TOLERANCES

[A. Concrete Curbs: Locations and elevations shall not exceed of 0.1 foot vertical and 0.1 foot horizontal.]

[B. [Fences] [and] [Bollards]: Align so variations from level or parallel alignment do not exceed one-fourth (1/4) inch in 12 feet.
]

[C. Stone Barriers: Shall have a surface tolerance of 0.1 foot vertical and 0.1 foot horizontal.]

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Contractor shall protect finishes and integrity of fences and bollards from damage during construction period with temporary protective coverings approved by [manufacturer][Design Professional][Owner].

3.06 MAINTENANCE

A. The Contractor shall maintain above grade barrier through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

[A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the above grade barrier. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.]

[C. The Contractor shall warrant the green stormwater infrastructure above grade barrier materials through the duration of the Establishment Period. If at any time during the Establishment Period the material becomes damaged due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the material and fully restore the green stormwater infrastructure facility and any damaged components as determined by the Design ProfessionalOwner, at no cost to the Owner.]

-- End of Section --

SECTION 02943

GREEN STORMWATER INFRASTRUCTURE PERVIOUS CONCRETE

PART 1 GENERAL

1.01 PURPOSE

A. Pervious concrete is a specialty concrete mix consisting of approximately 20 to 25 percent voids. Pervious concrete functions as the surface material in a permeable pavement green stormwater infrastructure facility, allowing water to pass through the voids in the surface as opposed to ponding and running off the pavement. A storage aggregate media layer is located below the pervious concrete, which allows for the temporary storage of stormwater and serves as the structural subbase.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required to install pervious concrete as depicted in the Drawings and specified herein. Pervious concrete shall be measured in the units of [Cubic Yards][Square Yards] and shall be paid for by Unit PriceLump Sum Price.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02948 Green Stormwater Infrastructure Media Liners

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM C33/C33M	Standard Specification for Concrete Aggregates
ASTM C42/C42M	Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete
ASTM C138/C138M	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C150/C150M	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C260/C260M	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C494/C494M	Standard Specification for Chemical Admixtures for Concrete
ASTM C595/C595M	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C989/C989M	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1116/C1116M	Standard Specification for Fiber-Reinforced Concrete
ASTM C1240	Standard Specification for Silica Fume Used in Cementitious Mixtures
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	Standard Test Method for Determining the Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602/C1602M	Standard Specification for Mixing Water Used in Production of Hydraulic Cement Concrete
ASTM C1688/C1688M	Standard Test Method For Density And Void Content Of Freshly Mixed Pervious Concrete
ASTM C1747/C1747M	Standard Test Method for Determining Potential Resistance to Degradation of Pervious Concrete by Impact and Abrasion
ASTM C1754/C1754M	Standard Test Method for Density and Void Content of Hardened Pervious Concrete

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

WEATHER PLACEMENT CURING AND PROCEDURAL PLAN

PERVIOUS CONCRETE PLACEMENT NOTIFICATION

SD-04 Samples

TEST PANEL

SD-06 Test Reports

PRE-CONSTRUCTION INFILTRATION TEST RESULTS

POST-CONSTRUCTION INFILTRATION TEST RESULTS

MORTAR-BAR METHOD TEST RESULTS

SD-07 Certificates

MIX DESIGN

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications

1. Work shall be performed by a qualified installer per Section 02937 Green Stormwater Infrastructure Site Activity Plan, whose work has resulted in the successful installation of pervious concrete with a minimum of three (3) years recent experience, with employees skilled in the pervious concrete trade, and specifically skilled in green stormwater infrastructure.

2. At least one (1) qualified installer with current Concrete Promotional Group (CPG) Pervious Concrete Certification Program Installer credentials and/or National Ready Mixed Concrete Association (NRMCA) Pervious Concrete Contractor Certification Program Installer credentials [or approved equal as determined by Design Professional] shall be on-site for installation.

B. Testing Agency Qualifications

1. The testing agency shall be an independent agency, acceptable to the authorities having jurisdiction, qualified according to ASTM C1077 for testing indicated.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications.

B. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

C. All materials which have been damaged after delivery or installation shall be rejected, removed and replaced at the Contractor's expense.

D. TEST PANEL; Install a test panel on the Site at a location approved by the Design ProfessionalOwner per the material and construction requirements of this specification. [Test panel may be omitted based on contractor experience with written approval of the Design Professional.] Accepted test panels in like new condition, as determined by the Design ProfessionalOwner, may be used in the Work.

1. The test panel shall be a minimum of [100 square feet].

2. Contractor shall test the panel and submit results for fresh unit weight, infiltration rate, hardened density, hardened void content, and potential ravel by impact or abrasion per the following requirements:

a. The fresh unit weight of pervious concrete for the test panel shall be tested per ASTM C1688/C1688M.

b. The infiltration rate of the in-place pervious concrete for the test panel shall be tested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after the seven (7) day curing period at a minimum of [three (3)] locations within the test panel. The infiltration rate at each of the [three(3)] testing locations shall be greater than [350 inches per hour].

c. The test panel shall be cored per ASTM C42/C42M, and the cores shall be tested per ASTM C1754/C1754M after the seven (7) day curing period at a minimum of [three (3)] locations within the test panel for density and

void content of the hardened pervious concrete.

d. The potential raveling made by impact or abrasion for the test panel shall be tested per ASTM C1747/C1747M.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Material shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

B. Manufactured products shall be delivered, stored and handled per manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MEDIA LINER

A. Media liner shall be the type specified in the Drawings and meet the requirements specified in Section 02948 Green Stormwater Infrastructure Media Liners.

2.02 STORAGE AGGREGATE MEDIA

A. Storage aggregate media shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

2.03 PERVIOUS CONCRETE

A. MIX DESIGN; Submit certification that pervious concrete mix design meets the specified parameters prior to procurement of material. Submittal shall include but not be limited to the following:

1. Aggregate type, source, gradation, specific gravity, and adsorption;

2. Supplementary cementitious materials: Supplementary cementitious materials shall not exceed 25 percent replacement by weight of fly ash nor 50 percent total combined replacement by mass of the Portland cement;

3. Water-to-cement ratio: Water-to-cement ratio between 0.30 and 0.34;

4. Void content: Void content between 15 percent and 25 percent per ASTM C138/C138M;

5. Fiber properties;

6. Accelerated mortar-bar method test results demonstrating that alkali silica reaction produces less than 0.10 percent expansion of pervious concrete test specimens at 28 days per ASTM C1567 (Accelerated mortar-bar method).

7. Manufacturer product instructions including supplier name, address and phone for cement, supplementary cementitious material, and admixtures;

B. Aggregate: Aggregate used in pervious concrete mix shall comply with the following:

1. No. 8 aggregate per ASTM C33/C33M;

2. Sand, included in the total combined aggregate gradation, no more than 7 percent of the total gradation;

3. Specific gravity greater than 2.5;

4. Absorption less than 2.5 percent;

5. MORTAR-BAR METHOD TEST RESULTS; Submit test results demonstrating that alkali silica reaction produces less than 0.10 percent expansion of test specimens at 28 days per ASTM C1260 (Mortar-bar method) for No. 8 aggregate and sand tested separately.

C. Cement

1. Portland Cement Type I and Type II shall conform to ASTM C150/C150M. [A local blend of Type I/II Portland cement that meets Type I or Type II requirements per ASTM C150/C150M is permitted.]

2. Blended Hydraulic Cement Type IS or Type IP shall conform to ASTM C595/C595M.

D. Supplementary Cementitious Material

1. Fly Ash: Fly ash shall conform to ASTM C618.

2. Silica Fume: Silica fume shall conform to ASTM C1240.

3. Ground Granulated Blast Furnace Slag: Ground granulated blast furnace slag shall conform to ASTM C989/C989M, Grade 100 or Grade 120, and shall be no more than 15 percent replacement of cementitious materials.

E. Admixtures

1. Air-Entraining Admixtures: Air-entraining admixtures shall conform to ASTM C260/C260M and shall be used in accordance with manufacturer's recommendations.

2. Chemical Admixtures

a. Polycarboxylate Water Reducing Admixtures: Polycarboxylate water reducing admixtures shall conform to ASTM C494/C494M Type A or Type F and shall be used in accordance with manufacturer's recommendations.

b. Extended Control Admixtures/Hydration Stabilizers: Extended control admixtures/hydration stabilizers shall conform to ASTM C494/C494M Type B or Type D. All pervious concrete shall have extended control admixtures/hydration stabilizers, which shall be available at the Site for redosing as needed. Dosage of extended control admixtures/hydration stabilizers shall

be in accordance with manufacturer's recommendations.

[c. Viscosity Modifying Admixtures: Viscosity modifying admixtures are permitted, pending approval of the Design Professional.]

3. Fibers: Fibers shall be used in pervious concrete, conform to ASTM C1116/C1116M, and comply with the following:

a. Polypropylene or cellulose fibers < 1.5 inch fibrillated or micro fiber type;

b. Fiber dosage rate of 1.5 pounds per cubic yard;

c. Fibers shall be removed from bags and distributed in two (2) to three (3) gallons of water before addition to the mix to prevent balling materials and to promote even distribution.

F. Water: Water shall conform to ASTM C1602/C1602M.

2.04 CURING AND SEALING MATERIALS

A. Pervious concrete shall be cured by the placement of a waterproof covering, polyethylene sheeting per ASTM C171, with a minimum thickness of six (6) mils.

B. Soybean oil shall be used for curing, and shall be applied in manner and quantities per manufacturer's recommendation. Soybean oil shall also be used on formwork as a bond breaker and sprayed on roller screed as well as other placement tools and equipment.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing lines, slopes, elevations, and continuous profiles grades. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. Contractor shall submit survey verification per Section 02939 Green Stormwater Infrastructure Earthwork.

B. Project Conditions

1. If the air temperature is forecasted by the National Weather Service to be above 90 degrees Fahrenheit or below 40 degrees Fahrenheit for seven (7) consecutive days after placement at the Site, the Contractor shall not place pervious concrete[, unless approved by the Design ProfessionalOwner]. Pervious concrete shall not be placed on frozen subgrade. Heated water to mitigate cold weather concreting is not permitted for pervious concrete.

2. WEATHER PLACEMENT CURING AND PROCEDURAL PLAN; Submit hot/cold weather placement curing and procedural plan to monitor and protect the pervious concrete when the air temperature is above 90 degrees or below 40 degrees Fahrenheit for seven (7) consecutive days after placement.

3. PERVIOUS CONCRETE PLACEMENT NOTIFICATION; Notify the Design ProfessionalOwner at least 48 hours prior to placement of pervious concrete.

C. Control and Protection: Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

3.02 INSTALLATION

A. Excavation

[1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.]

2. Excavation shall extend to a depth such that the specified finished grade elevations, once fully installed, are located at the elevation shown in the Drawings. If a finished grade elevation is not specified, the Contractor shall consult the Design ProfessionalOwner to verify control elevations prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the pervious concrete.

4. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of media. Submit PRE-CONSTRUCTION INFILTRATION TEST RESULTS.

B. Media Liner: Media liner shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners.

C. Storage Aggregate Media

1. Storage aggregate media shall be installed in uniform lifts not exceeding six (6) inches.

2. Storage aggregate media shall be compacted after each lift with at least two (2) passes in the vibratory mode followed by at least two (2) passes in the static mode with a minimum ten (10) ton vibratory roller until there is no visible movement, while not crushing the aggregate.

D. Pervious Concrete

1. Pervious concrete shall be placed to the lines, grades and depths specified in the Drawings.

2. Mixing and Hauling

a. Production: Pervious concrete shall be manufactured and delivered in accordance with ASTM C94/C94M.

b. Mixing: Pervious concrete shall be central-mixed or truck-mixed concrete that is mixed for the minimum time as specified in ASTM C94/C94M.

c. Transportation: Pervious concrete may be transported to the Site and the discharge of individual loads shall be completed within one (1) hour of the introduction of mix water to the cement. Delivery times may be extended to exceed 90 minutes when dosages of hydration stabilizer are increased to maintain the concrete, as approved by the Design ProfessionalOwner.

d. Adjustments: Each truckload of pervious concrete shall be visually inspected for consistency of pervious concrete mixture. Water addition and re-dosing of hydration stabilizers to adjust the consistency of the pervious concrete is permitted at the point of discharge. Prior to further discharge, a minimum of 70 revolutions at the manufacturer's designated mixing speed shall be counted following the addition of any water to the mix.

3. Placing and Finishing

a. Formwork: Formwork shall consist of wood, steel, or other material sufficient to support placement. Forms shall extend to the full depth of the pervious concrete. Forms shall be of sufficient strength and stability to support mechanical equipment without deformation of plan and profile following spreading, strike off and compaction operations.

b. Sub-Base: Moisten sub-base at the time of placement to ensure no reduction in strength of the pavement.

c. Pervious Concrete

1) Deposit pervious concrete into the forms by mixer truck chute, conveyor or buggy. Pervious concrete shall not be pumped into the forms.

2) Concrete shall be deposited as close to its final position as practical and such that discharged concrete is incorporated into previously placed plastic concrete.

3) Place the pervious concrete with a roller screed properly weighted with water in the roller. [The Contractor may place the pervious concrete with an alternate screed, as approved by Design Professional.]

4) Use a pervious pan skip float to finish the

pervious concrete surface after placement with the roller screed [or approved equal] and prior to curing.

4. Jointing

a. Isolation joints shall be used when abutting driveways, manholes, light poles, signage poles, and maximum 250-foot on center.

[b. Contraction joints may be installed at the Contractor's discretion, as approved by Design Professional. Contraction joints shall be saw cut no more than 24 hours after installation and shall be a minimum one-fourth (1/4) of the pavement thickness. Slurry/dust shall be immediately vacuumed or washed following jointing.]

5. Curing

a. Curing procedures shall begin three (3) to five (5) minutes behind the roller screed [or approved equal] by spraying soybean oil onto the pavement from both sides of the paving operation.

b. The pervious concrete surface shall then be covered with a minimum of six (6) mil thick polyethylene sheeting [or approved equal], following the soybean oil spray. Any holes, tears, or cuts in the sheeting shall be repaired to prevent moisture loss and to prevent air infiltration under the sheeting. The polyethylene sheeting shall be rolled over the fresh pervious concrete and to the width of the forms. There shall be a minimum of 12 inches of overhang on each side of the form, to have sufficient sheeting to properly anchor down the sides.

c. Cross rollers with a maximum weight of 100 pounds shall be used behind the roller screed (and on top of the polyethylene sheeting) to aid in rolling out the ridges left by the roller screed and for final compaction.

d. Curing of pervious concrete shall last seven (7) days. No vehicular traffic shall be permitted on the pavement until curing is complete (seven (7) days) and no truck traffic shall be permitted for at least 14 days.

3.03 TOLERANCES

A. The Contractor shall place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the Design ProfessionalOwner for review. Survey elevation shall be taken at specific point locations

identified in the Drawings.

C. Fresh Unit Weight: Fresh unit weight shall be tested per ASTM C1688/1688M and shall be within three (3) percent of design unit weight.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully established.

B. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility per Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. The Contractor shall conduct post-construction infiltration testing at up to [three (3)] testing locations, as approved by the Design ProfessionalOwner, per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after curing and submit POST-CONSTRUCTION INFILTRATION TEST RESULTS. Contractor shall conduct post-construction infiltration testing within ten (10) days of curing.

B. Average post-construction infiltration rate shall be [between 350 and 1,500 inches per hour] with no single test less than [150 inches per hour].

C. Installed product that fails to meet post-construction infiltration requirements shall be removed and replaced at no additional cost to the Owner, including underlying aggregates. Subsurface preparation shall be redone as recommended by the Design ProfessionalOwner. Re-installed product shall then be retested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. This procedure shall be repeated by the Contractor until the installation meets post-construction infiltration requirements at the discretion of the Design ProfessionalOwner.

3.08 WARRANTY

A. The Contractor shall warrant the pervious concrete through the duration of the Establishment Period as defined in Section 02957

Green Stormwater Infrastructure Establishment.

B. If at any time during the Establishment Period the pervious concrete spalls, settles or fails to meet post-construction infiltration requirements due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the pervious concrete and fully restore the green stormwater infrastructure facility and any damaged components as determined by the Design ProfessionalOwner, at no additional cost to the Owner.

-- End of Section --

SECTION 02944

GREEN STORMWATER INFRASTRUCTURE POROUS ASPHALT

PART 1 GENERAL

1.01 PURPOSE

A. Porous asphalt is a specialized hot mix asphalt consisting of 16 to 22 percent voids. Porous asphalt allows water to pass through the voids in the asphalt surface as opposed to ponding and running off the pavement surface. A storage aggregate media layer is located below the porous asphalt to stabilize the surface and provide temporary stormwater storage.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required to install porous asphalt as depicted in the Drawings and specified herein. Porous asphalt shall be measured in the units of [Cubic Yards][Square Yards] and shall be paid for by Unit PriceLump Sum Price.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02948 Green Stormwater Infrastructure Media Liners

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN ASSOCIATION OF STATE AND HIGHWAY TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T283 Standard Method of Test for

Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM D2172	Standard Test Methods for Quantitative Extraction of Asphalt Binder from Asphalt Mixtures
ASTM D3203	Standard Test Method for Percent Air Voids in Compacted Asphalt Mixtures
ASTM D3666	Standard Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
ASTM D6390	Standard Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
ASTM D7064/D7064M	Standard Practice for Open-Graded Friction Course (OGFC) Mix Design

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

POROUS ASPHALT PLACEMENT NOTIFICATION

SD-06 Test Reports

PRE-CONSTRUCTION INFILTRATION TEST RESULTS

POST-CONSTRUCTION INFILTRATION TEST RESULTS

SD-07 Certificates

MIX DESIGN

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Work shall be performed by a qualified installer whose work has resulted in the successful installation of porous asphalt with a minimum of three (3) years recent experience and specifically skilled in green stormwater infrastructure.

B. Testing Agency Qualifications: The testing agency shall be an independent agency, acceptable to the authorities having jurisdiction, meeting requirements of ASTM D3666, with technicians certified in the discipline of Hot Mix Asphalt (HMA) Plant Technician.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications.

B. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

C. All materials which have been damaged after delivery or installation shall be rejected, removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Material shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

B. Manufactured products shall be delivered, stored and handled per manufacturer's recommendations.

PART 2 PRODUCTS

2.01 MEDIA LINER

A. Media liner shall be the type specified in the Drawings and meet the requirements specified in Section 02948 Green Stormwater Infrastructure Media Liners.

2.02 CHOKER COURSE

A. Choker course media shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

2.03 STORAGE AGGREGATE MEDIA

A. Storage aggregate media shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

2.04 POROUS ASPHALT

A. MIX DESIGN; Submit certification that the porous asphalt mix design meets the specified parameters. Porous asphalt mix shall be tested the greater of twice per day or three (3) times per job. Include material supplier name, address and phone, and the following:

1. Aggregate type, source, and gradation;

2. Content of binder;

3. Content of additives;

4. Void content: Void content between 16 percent and 22 percent per ASTM D3203;

5. Draindown: Draindown less than 0.3 percent per ASTM D6390;

6. Cantabro Abrasion Tests: Cantabro Abrasion Test on unaged samples less than 20 percent per ASTM D7064/D7064M; Cantabro Abrasion Test on seven (7) day aged samples less than 30 percent per ASTM D7064/D7064M;

7. Tensile Strength Ratio (TSR): TSR shall be greater than or equal to 80 percent per AASHTO T283.

B. Aggregate: Aggregate used in porous asphalt mix shall comply with the following gradation:

Porous Asphalt Aggregate Gradation Requirements

Sieve Size	Passing (Percent by Weight)
19.0 mm (3/4 inch)	100
12.5 mm (1/2 inch)	85 - 100
9.5 mm (3/8 inch)	35 - 60
4.75 mm (No. 4)	10 - 25
2.36 mm (No. 8)	5 - 10
75 um (No. 200)	2 - 4

C. Binder

1. Binder content shall be between 6 and 6.5 percent per ASTM D2172/D2172M and shall be tested the greater of once per 500 tons, once per day, or once per job.

2. Rubber solids content by weight of bitumen shall be between 1.5 and 3 percent per ASTM D2172/D2172M.

D. Additives: Fiber content by total mixture mass shall be [0.3 percent cellulose][0.3 percent cellulose or 0.4 percent mineral][0.4 percent mineral].

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing lines, slopes, elevations, and continuous profiles grades. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. Contractor shall submit survey verification per Section 02939

Green Stormwater Infrastructure Earthwork.

B. Project Conditions

1. Porous asphalt shall not be placed when the ambient air temperature is less than 60 degrees Fahrenheit, when the ground temperature is less than 50 degrees Fahrenheit, or when precipitation is forecasted by the National Weather Service at the Site[, unless approved by the Design ProfessionalOwner].

2. POROUS ASPHALT PLACEMENT NOTIFICATION; Notify the Design ProfessionalOwner at least 48 hours prior to placement porous asphalt.

C. Control and Protection: Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

3.02 INSTALLATION

A. Excavation

[1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.]

2. Excavation shall extend to a depth such that the specified finished grade elevations, once fully installed, are located at the elevation shown in the Drawings. If a finished grade elevation is not specified, the Contractor shall consult the Design ProfessionalOwner to verify control elevations prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the porous asphalt.

4. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of media. Submit PRE-CONSTRUCTION INFILTRATION TEST RESULTS.

B. Media Liner: Media liner shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners.

C. Storage Aggregate Media

1. Storage aggregate media shall be installed in uniform lifts not exceeding six (6) inches.

2. Storage aggregate media shall be compacted after each lift with at least two (2) passes in the vibratory mode followed by at least two (2) passes in the static mode with a minimum ten (10) ton vibratory roller until there is no visible movement, while not crushing the aggregate.

D. Porous Asphalt

1. Porous asphalt shall be placed to the lines, grades and depths specified in the Drawings.

2. Mixing and Hauling

a. Production: Mixing plants shall be a Hot Mix Asphalt (HMA) Plant recognized by the State of Missouri.

b. Transportation: Porous asphalt shall be transported in covered, clean dump beds that have been sprayed with a non-petroleum release agent to prevent the porous asphalt mixture from adhering to the dump beds. Mineral filler, fine aggregate, and slag dust shall not be used to dust truck beds. Haul distances shall be limited so that porous asphalt is placed within 90 minutes of loading.

3. Placing and Finishing

a. Place the porous asphalt in lifts up to four (4) inches thick via truck pavers, compacting with up to four (4) passes of the ten (10) ton static roller.

b. No vehicular traffic shall be permitted on the porous asphalt pavement within 48 hours of placement or until the placed porous asphalt has cooled to a temperature below 100 degrees Fahrenheit, whichever is a longer duration.

3.03 TOLERANCES

A. The Contractor shall place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal ToleranceHorizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the Design ProfessionalOwner for review. Survey elevation shall be taken at specific point locations identified in the Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully established.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility per Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. The Contractor shall conduct post-construction infiltration testing at up to [three (3)] testing locations, as approved by the Design ProfessionalOwner, per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after cooling and submit POST-CONSTRUCTION INFILTRATION TEST RESULTS. Contractor shall conduct post-construction infiltration testing within ten (10) days of cooling.

B. Average post-construction infiltration rate shall be [between 250 and 1,500 inches per hour] with no single test less than [150 inches per hour].

C. Installed product that fails to meet post-construction infiltration requirements shall be removed and replaced at no additional cost to the Owner, including underlying aggregates. Subsurface preparation shall be redone as recommended by the Design ProfessionalOwner. Re-installed product shall then be retested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. This procedure shall be repeated by the Contractor until the installation meets post-construction infiltration requirements at the discretion of the Design ProfessionalOwner.

3.08 WARRANTY

A. The Contractor shall warrant the porous asphalt through the duration of the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment.

B. If at any time during the Establishment Period the porous asphalt spalls, settles or fails to meet post-construction infiltration requirements due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the porous asphalt and fully restore the green stormwater infrastructure facility and any damaged components as determined by the Design ProfessionalOwner, at no additional cost to the Owner.

-- End of Section --

SECTION 02945

GREEN STORMWATER INFRASTRUCTURE PERMEABLE PAVERS

PART 1 GENERAL

1.01 PURPOSE

A. Permeable pavers are unit paver systems that allow water to pass through the joints or openings between the individual pavers. Permeable pavers typically incorporate a choker course and a storage aggregate media layer beneath the paver surface that allows for the temporary storage of stormwater. Permeable pavers may also incorporate jointing and bedding material.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required to install permeable pavers as depicted in the Drawings and specified herein. Permeable pavers shall be measured in the units of [Square Feet] and shall be paid for by Unit PriceLump Sum Price.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02948 Green Stormwater Infrastructure Media Liners

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

[A. Design Professional to include reference standards required for paver products selected.

The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Owner.]

[B. Not applicable.]

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

PERMEABLE PAVER PLACEMENT NOTIFICATION

SD-03 Product Data

MANUFACTURER INSTRUCTIONS

SHOP DRAWINGS

SD-04 Samples

PERMEABLE PAVER SAMPLES

SD-06 Test Reports

PRE-CONSTRUCTION INFILTRATION TEST RESULTS

POST-CONSTRUCTION INFILTRATION TEST RESULTS

SD-07 Certificates

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Work shall be performed by a qualified installer per Section 02937 Green Stormwater Infrastructure Site Activity Plan, whose work has resulted in the successful installation of permeable pavers with a minimum of three (3) years recent experience, with employees skilled in green stormwater infrastructure.

B. Testing Agency Qualifications: The testing agency shall be an independent agency, acceptable to the authorities having jurisdiction, qualified for testing indicated.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications.

B. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the Design ProfessionalOwner. Such inspection may be made at the place of manufacture or the Site after delivery.

C. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

D. All materials which have been damaged after delivery or installation will be rejected, removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Material shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

B. Manufactured products shall be delivered, stored and handled per manufacturer recommendations.

[C. Furnish an excess of [100 square feet] of [permeable paver type] to Design ProfessionalOwner. Furnish products from the same production run as installed.]

PART 2 PRODUCTS

2.01 MEDIA LINER

A. Media liner shall be the type specified in the Drawings and meet the requirements specified in Section 02948 Green Stormwater Infrastructure Media Liners.

2.02 STORAGE AGGREGATE MEDIA

A. Storage aggregate media shall be, per the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

[2.03 CHOKER COURSE

A. Choker course media shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.]

[2.04 Jointing and Bedding Material

A. Jointing and bedding material shall be the type specified in the Drawings and meet the requirements specified in Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.]

2.05 PERMEABLE PAVERS

[A. Design Professional to insert recommended product or approved equal.]

B. MANUFACTURER INSTRUCTIONS; Submit manufacturer instructions for each product, including, but not limited to supplier name, address and phone as well as product fabrication, delivery and handling, installation and protection information.

C. PERMEABLE PAVER SAMPLES; Submit photographs depicting size and geometry of permeable pavers prior to selection of sample material. Include physical sample of the permeable pavers for Design ProfessionalOwner.

D. SHOP DRAWINGS; Submit Shop Drawings that indicate the size, location, placement pattern, anchoring details, termination details, and connection details, as applicable. Shop Drawings shall include supplier name, address and phone.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all structure locations and elevations. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. Contractor shall submit survey verification per Section 02939 Green Stormwater Infrastructure Earthwork.

B. Project Conditions

1. Permeable pavers shall not be installed when ambient air temperature and/or ground temperature is less than or equal to 32 degrees Fahrenheit or in the presence of standing water for a minimum of three (3) days prior to installation.

2. PERMEABLE PAVER PLACEMENT NOTIFICATION; Notify the Design ProfessionalOwner at least 48 hours prior to placement of permeable pavers.

C. Control and Protection: Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

3.02 INSTALLATION

A. Excavation

[1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.]

2. Excavation shall extend to a depth such that the specified finished grade elevations, once fully installed, are located at the elevation shown in the Drawings. If a finished grade elevation is not specified, the Contractor shall consult the Design ProfessionalOwner to verify control elevations prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the permeable pavers.

[4. Design Professional to include manufacturer specific subgrade compaction requirements, as applicable.]

5. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of media. Submit PRE-CONSTRUCTION

INFILTRATION TEST RESULTS.

B. Media Liner: Media liner shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners.

C. Storage Aggregate Media

1. Storage aggregate media shall be installed in uniform lifts not exceeding six (6) inches.

2. Storage aggregate media shall be compacted after each lift with at least two (2) passes in the vibratory mode followed by at least two (2) passes in the static mode with a minimum ten (10) ton vibratory roller until there is no visible movement, while not crushing the aggregate.

[D. Choker Course: Choker course media shall be installed per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.]

[E. Jointing and Bedding Material: Jointing and bedding material shall be installed per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.]

F. Permeable Pavers

1. Permeable pavers shall be placed to the lines, grades and depths specified in the Drawings and according to manufacturer instructions.

2. Pavers shall be mixed from [three (3)] pallets or cubes as they are placed to produce a uniform blend of colors and textures as applicable.

3. Pavers shall be cut with a motor-driven masonry saw to provide clean, sharp, unchipped, edges, or by manufacturer instructions, to the extents identified in the Drawings. [Note: Pavers may settle up to one-half (1/2) inch in the first six (6) to twelve months after placement. Obtain Design ProfessionalOwner approval to place pavers at an elevation up to one-half (1/2) inch above desired finished grade elevation if settling tolerance is not dictated in Drawings.

3.03 TOLERANCES

A. The Contractor shall place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Unit-to-Unit Vertical Offset (from Flush): one-sixteenth (1/16) inch

2. Unit-to-Unit Horizontal Offset (Gap): one-fourth (1/4) inch

3. Finished surface of paving whichever is less, one-eighth (1/8) inch in 24 inches and one-quarter (1/4) inch in ten (10) feet from level, or indicated slope.

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the Design ProfessionalOwner for review.

Survey elevation shall be taken at specific point locations identified in the Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully established.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility per Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. The Contractor shall conduct post-construction infiltration testing at up to [three (3)] testing locations, as approved by the Design ProfessionalOwner, per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after installation and submit POST-CONSTRUCTION INFILTRATION TEST RESULTS. Contractor shall conduct post-construction infiltration testing within ten (10) days of installation.

B. Average post-construction infiltration rate shall be [between 250 and 1,500 inches per hour] with no single test less than [150 inches per hour].

C. Installed product that fails to meet post-construction infiltration requirements shall be removed and replaced at no additional cost to the Owner, including underlying aggregates. Subsurface preparation shall be redone as recommended by the Design ProfessionalOwner. Re-installed product shall then be retested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. This procedure shall be repeated by the Contractor until the installation meets post-construction infiltration requirements at the discretion of the Design ProfessionalOwner.

3.08 WARRANTY

[A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the permeable pavers. The Contractor shall be responsible for coordination with the Warrantor for replacement

of any defective products or material.]

[C. The Contractor shall warrant the permeable pavers through the duration of the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment.

D. If at any time during the Establishment Period the permeable pavers settle or fails to meet post-construction infiltration requirements due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the permeable pavers and fully restore the green stormwater infrastructure facility and any damaged components as determined by the Design ProfessionalOwner, at no additional cost to the Owner.]

-- End of Section --

SECTION 02946

GREEN STORMWATER INFRASTRUCTURE SOIL AND AGGREGATE MEDIA

PART 1 GENERAL

1.01 PURPOSE

A. Soil and aggregate serve as the primary storage and filtration media in a green stormwater infrastructure facility. Voids in the media allow for stormwater to move, providing filtration, infiltration and storage functions.

B. Definitions

[1. Topsoil: The uppermost layer of soil that contains a majority of the soil's organic matter and microorganisms, making the soil more amenable to sustaining vegetation.]

[2. Compost: A product resulting from the controlled anaerobic, biological decomposition of biodegradable materials that is beneficial to plant growth.]

[3. Sand: A fine aggregate with particles finer than No. 4 sieve.
]

[4. Growing Media: Soil that has been designed to meet specific engineering properties including, but not limited to infiltration, strength, and nutrient levels.]

[5. Bioretention Soil Media: An engineered soil media with specific proportions of topsoil, compost, and sand, designed to encourage infiltration and promote plant growth.]

[6. Amended Native Soil Media: An engineered soil media where soil from the site has been modified to provide specific engineering properties.]

[7. Structural Soil Media: An engineered soil media that includes crushed stone to meet strength and stability requirements.]

[8. Storage Aggregate Media: Layer of double-washed aggregate, designed for stormwater storage. (In permeable pavement applications, storage aggregate media may also need to be designed for traffic load.)]

[9. Choker Course: Layer of double-washed aggregate, placed above the storage aggregate media, that filters out sediment particles prior to the storage aggregate media. (In permeable pavement applications, the choker course fills some of the surface voids of the larger sized storage aggregate media and stabilizes the surface prior to paving.)]

[10. Jointing Material: Double-washed aggregate, typically used to fill the joints between pavers.]

[11. Bedding Material: Thin layer of double-washed aggregate, typically used to level pavers.]

[12. Aggregate Base: Double-washed aggregate that provides structural support.]

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for soil and aggregate media installation and testing, dictated in the Drawings and specified herein. Soil and aggregate media shall be paid for by Unit PriceLump Sum Price and measured as follows:

Soil and Aggregate Media Measurement and Payment Units

Item	Unit
[Bioretention Soil Media]	[Cubic Yard]
[Topsoil]	[Cubic Yard]
[Compost]	[Cubic Yard]
[Amended Native Soil]	[Cubic Yard]
[Structural Soil]	[Cubic Yard]
[Sand]	[Cubic Yard]
[Storage Aggregate]	[Cubic Yard][Ton]
[Choker Course]	[Cubic Yard][Ton]
[Jointing and Bedding Material]	[Cubic Yard][Ton]
[Aggregate Base]	[Cubic Yard][Ton]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02948 Green Stormwater Infrastructure Media Liners

[02951 Green Stormwater Infrastructure Plants]

[02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding]

[02953 Green Stormwater Infrastructure Non-Native Seeding

and Sodding]

02954 Green Stormwater Infrastructure Piping

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of Contract Documents, unless otherwise indicated by the Design ProfessionalOwner.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO T-99 Standard Method of Test for Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM C33/C33M Standard Specification for Concrete Aggregates

ASTM D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (2700 kN-m/m3)

ASTM D4972 Standard Test Method for pH of Soils

ASTM D5268 Topsoil Used for Landscaping Purposes

ASTM D6913 Standard Specification for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

ASTM D7503 Standard Test Method for Measuring the Exchange Complex and Cation Exchange Capacity of Inorganic Fine-Grained Soils

TESTING METHODS FOR THE EXAMINATION OF COMPOSTING AND COMPOST (TMECC)

TMECC 4.02 Nitrogen

TMECC 4.03 Phosphorus

TMECC 4.04 Potassium

TMECC 4.05	Secondary and Micro-Nutrient Content
TMECC 4.06	Heavy Metals and Hazardous Elements
TMECC 4.07	Other Elements
TMECC 4.10	Electrical Conductivity for Compost
TMECC 4.11	Electrometric pH Determinations for Compost
TMECC 5.02	Indicator Ratios
TMECC 5.07	Loss on Ignition Organic Matter Method
TMECC 5.08	Respirometry

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA)

USDA NRCS	Natural Resources Conservation Service, United States Department of Agriculture, Soil Classification System

CODE OF FEDERAL REGULATIONS (CFR)

40 CFR	Title 40: Protection of Environment

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

COMPLETION OF EXCAVATION NOTIFICATION

COMPLETION OF MEDIA INSTALLATION NOTIFICATION

SD-06 Test Reports

TESTING AGENCY CONTACT

PRE-CONSTRUCTION INFILTRATION TEST RESULTS

POST-CONSTRUCTION INFILTRATION TEST RESULTS

AGGREGATE BASE GRADATION TEST RESULTS

SD-07 Certificates

TOPSOIL CERTIFICATION

COMPOST CERTIFICATION

SAND CERTIFICATION

BIORETENTION SOIL MEDIA CERTIFICATION

AMENDED NATIVE SOIL MEDIA CERTIFICATION

STRUCTURAL SOIL CERTIFICATION

STORAGE AGGREGATE MEDIA CERTIFICATION

CHOKER COURSE CERTIFICATION

JOINTING AND BEDDING MATERIAL CERTIFICATION

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Work shall be performed by a qualified installer whose work has resulted in the successful installation of green stormwater infrastructure facilities and establishment of plant life with a minimum of three (3) years recent experience, with employees skilled in the landscape trade, and specifically skilled in green stormwater infrastructure.

B. Testing Agency Qualifications

1. An independent agency, acceptable to the authorities having jurisdiction, qualified for testing indicated.

2. TESTING AGENCY CONTACT; All testing and analysis shall be at the expense of the Contractor. Submit all material testing results specified including the following contact information for the testing agency used:

a. Testing Agency Name;

b. Testing Agency Address;

c. Testing Agency Phone;

d. Material Tested.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit required testing results showing material is in conformance with this Specification.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Contractor shall prevent mixing of dissimilar materials during unloading, stockpiling, and placement activities.

B. All stockpiled material shall be covered and protected from contaminants, wind and water erosion. [Soil material shall not be stockpiled to a height exceeding four (4) feet, or for greater than 30 days. Where soil is stockpiled for greater than 30 days, the Contractor shall re-sample material and submit for testing per Part 1.05, B.]

[C. The Contractor shall not handle, move, or work growing media or growing media components when saturated or frozen. Any graded aggregate that has been stored shall be remixed prior to delivery to Site to provide sufficient retention of gradation requirements.

]

[D. Structural soil shall not be stockpiled long-term. Any structural soil not installed immediately should be protected by a tarp or other waterproof covering.]

E. After delivery and prior to placement, the Owner reserves the right to collect samples of the soil or aggregate media. If the media is found to be outside the parameters specified in Part 2, or outside the accepted testing submittals, the Contractor shall replace the media at no additional cost to the Owner.

PART 2 PRODUCTS

[2.01 TOPSOIL

A. Topsoil shall be per Section 02948 Green Stormwater Infrastructure Topsoil.

B. TOPSOIL CERTIFICATION; Submit testing agency certification that topsoil is within the parameters specified prior to mixing with other growing media components. At a minimum test report shall include the following:

1. Material supplier name, address and phone;

2. Gradation;

3. Percent by volume composition of sand, silt, clay and organic matter;

4. pH.]

[2.02 COMPOST

A. Compost shall be a locally sourced homogeneous and friable mixture of partially decomposed organic matter, resulting from composting.

B. The Compost shall meet the following requirements:

Compost Testing Requirements

Characteristic	Acceptable Range	Test Method (or Approved Equal)
Carbon-to-Nitrogen Ratio	12:1 - 25:1	TMECC 5.02-A
Oxygen Uptake	< 150 mg O2/kg volatile solids per hour	TMECC 5.08-A
pH	7.0 - 8.0	TMECC 4.11-A or ASTM D4972
Conductivity (Soluble Salts)	< 6.0 mmhos/cm (dS/m)	TMECC 4.10-A

Characteristic	Acceptable Range	Test Method (or Approved Equal)
Particle Size	100 percent (by mass) passing 1/2-inch sieve	ASTM D6913
Organic Matter	50 percent - 70 percent (by mass)	TMECC 5.07-A
Foreign Matter*	< 1 percent (by mass)	Foreign matter is defined as any matter over 2 mm in any dimension that results from human intervention and having organic or inorganic constituents such as metal, glass, clay and synthetic polymers (i.e. plastic and rubber).
Trace Metals	< Ceiling Concentrations	40 CFR 503.13 or TMECC 4.06

C. COMPOST CERTIFICATION; Submit testing agency certification that compost is within the parameters specified prior to mixing with other growing media components. At a minimum test report shall include the following:

1. Material supplier name, address and phone;

2. Carbon-to-Nitrogen Ratio;

3. Oxygen Uptake;

4. pH;

5. Conductivity (Soluble Salts);

6. Gradation;

7. Percent composition by mass of Organic Matter;

8. Percent composition by mass of Foreign Matter;

9. Trace metals.]

[2.03 SAND

A. Sand shall be clean, double washed fine aggregate meeting the following gradation requirements:

Sand Gradation Requirements Based on ASTM C33/C33M

Sieve Size	Passing (Percent by Weight)
9.5 mm (3/8 inch)	100

Sieve Size	Passing (Percent by Weight)
4.75 mm (No. 4)	95 - 100
2.36 mm (No. 8)	80 - 100
1.18 mm (No. 16)	50 - 85
600 um (No. 30)	25 - 60
300 um (No. 50)	5 - 30
150 um (No. 100)	0 - 10
75 um (No. 200)	0 - 3

B. SAND CERTIFICATION; Submit certification that sand is clean, double washed and meeting the specified gradation requirements Submittal shall include material supplier name, address and phone.

]

[2.04 GROWING MEDIA

[A. Bioretention Soil Media

1. Bioretention soil media shall be a mixture of topsoil, compost, and sand. Material tests are required for each individual component of the bioretention media prior to mixing as specified in Parts 2.01 through 2.03.

2. Bioretention soil media mix shall be certified to meet the following mixing composition of each component:

Bioretention Soil Media Components

Component	Composition (Percent by Volume)
Topsoil	25 - 30
Compost	25 - 30
Sand	40 - 50

3. The bioretention soil media shall meet the follow requirements after thorough mixing of all components:

Bioretention Soil Media Testing Requirements

Item	Criteria	Test Method (or Approved Equal)
pH	5.5 - 7.5	ASTM D4972
Total Phosphorus (P2O5)	60 ppm maximum	TMECC 4.03-A

Item	Criteria	Test Method (or Approved Equal)
Total Potassium (K2O)	78 ppm minimum	TMECC 4.04-A
Magnesium	32 ppm minimum	TMECC 4.05-Mg
Conductivity (Soluble Salts)	500 ppm maximum	TMECC 4.10-A

[4. If Design Professional elects to use bioretention soil media mix outside the parameters of this specification, Design Professional to provide mix design and individual component testing and submittal requirements and parameters.]

5. Topsoil shall be per Section 02948 Green Stormwater Infrastructure Topsoil.

6. Compost shall be per Part 2.02.

7. Sand shall be per Part 2.03.

8. BIORETENTION SOIL MEDIA CERTIFICATION; Submit testing agency certification that the bioretention soil media is within the parameters specified after thorough mixing of all components. At a minimum, test report shall include the following:

a. Material supplier name, address and phone;

b. Percent by volume composition of topsoil, compost and sand components;

c. pH;

d. Total Phosphorus;

e. Total Potassium;

f. Magnesium;

g. Conductivity (Soluble Salts).]

[B. Amended Native Soil Media

1. Amended native soil may be used in place of bioretention soil media only when specified by the Design Professional Owner.

2. Amended native soil shall consist of 50 percent native topsoil meeting the requirements of Part Section 02948 Green Stormwater Infrastructure Topsoil.

3. Native topsoil shall be mechanically scarified to the depth specified in the Drawings and thoroughly mixed with compost.

4. AMENDED NATIVE SOIL MEDIA CERTIFICATION; Submit testing agency certification that the amended native soil media was

mixed using specified by volume composition of native topsoil and compost.]

[C. Structural Soil Media

1. Structural soil shall be CU-Structural Soil®, a proprietary material patented by Cornel University (US Patent # 5,849,069), or approved equal. Only licensed producers are allowed to supply this material, meeting the specifications described.

2. Material tests are required for each individual component of the structural soil media prior to mixing as specified in Parts 2.04, C., 5. through 7.

3. Structural soil shall be a uniformly blended mixture of Crushed Stone, Clay Loam and Hydrogel, mixed to the following proportion:

Structural Soil Media Composition Requirements

Material	Composition (Percent by Weight)
Clay Loam	20 units dry weight
Crushed Stone	100 units by dry weight
Hydrogel	0.03 units dry weight
Moisture Content	AASHTO T-99 optimum moisture

4. Structural soil mixing shall be performed at the licensed producer's yard using appropriate soil measuring, mixing and shredding equipment of sufficient capacity and capability to assure proper quality control and consistent mix ratios. No mixing of structural soil at the project Site shall be permitted.

5. Clay Loam

a. Soil shall be a "clay loam" or "loam" based on the USDA NRCS as determined by mechanical analysis per ASTM D5268 and it shall be uniform composition, without admixture of subsoil. Mechanical analysis for the clay loam shall be as follows:

Structural Soil - Mechanical Analysis of Clay Loam

Textural Class (Partical Size)	Composition (Percent by Weight)
Gravel	< 5
Sand (2.0 - 0.05 mm)	20 - 45
Silt (0.05 - 0.002 mm)	20 - 50

Textural Class (Partical Size)	Composition (Percent by Weight)
Clay (<0.002 mm)	20 - 40

b. Clay loam shall be free of stones greater than one-half (1/2) inch, lumps, plants and their roots, debris and other extraneous matter over one (1) inch in diameter or excess of smaller pieces of the same materials as determined by the Design ProfessionalOwner.

c. Clay loam shall be obtained from naturally well-drained areas, which have never been stripped of topsoil before and have a history of satisfactory vegetative growth. Clay loam shall be the product of a commercial processing facility specializing in production of stripped natural topsoil. No topsoil shall come from USDA - classified prime farmland.

d. Clay loam shall contain not less than two (2) percent nor more the five (5) percent organic matter as determined by ASTM D5268.

e. The Contractor shall submit soil testing agency results meeting the following chemical requirements:

Structural Soil - Soil Testing Requirements

Characteristic	Acceptable Range	Test Method (or Approved Equal)
Carbon-to-Nitrogen Ratio	< 33:1	TMECC 5.02-A
pH	5.5 - 6.5	TMECC 4.11-A or ASTM D4972
Conductivity (Soluble Salts)	< 1.0 mmhos/cm	TMECC 4.10-A
Cation Exchange Capacity	> 10	ASTM D7503

f. Contractor shall submit analysis for nutrient levels by parts per million including nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, magnesium, iron, zinc, calcium and extractable aluminum. Nutrient test shall include the testing agency recommendations for supplemental additions to the soil as calculated by the amount of material to be added per volume of soil for the type of plants to be grown in the soil.

g. Contractor shall submit analysis for levels of toxic elements and compounds including arsenic, boron, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, zinc and PCB. Test results shall be cited in milligrams per kilogram.

6. Crushed Stone

a. Stone shall be granite or limestone and angular in shape with dimensions not exceeding 2.5:1.0 for any two (2) dimensions.

b. The Contractor shall submit testing agency certification of the crushed stone gradation meeting the following requirements:

Structural Soil - Crushed Stone Composition Requirements

Sieve Size	Passing (Percent by Weight)
75 mm (3 inch)	100
37.5 mm (1.5 inch)	90
25 mm (1 inch)	20 - 55
20 mm (0.75 inch)	10

7. Hydrogel

a. Hydrogel shall be potassium propenoate-propenamide copolymer Hydrogel.

b. Hydrogel shall be Gelscape® Hydrogel Tackifier as manufactured by Amereq. Corp. (800) 832-8788, or approved equal.

8. STRUCTURAL SOIL CERTIFICATION; Submit testing agency certification that the clay loam, crushed stone and hydrogel used in the structural soil mix is within the parameters specified prior to mixing. At a minimum test report shall include test results for the following:

a. Material supplier name, address and phone;

b. Soil percent by volume composition of sand, silt, clay and organic matter;

c. Soil chemical properties:

1) Carbon-to-Nitrogen Ration;

2) pH;

3) Conductivity (Soluble Salts);

4) Soil absorption ratio;

5) Nutrient and chemical content by parts per million including nitrate nitrogen, ammonium nitrogen, phosphorus, potassium, magnesium, iron, zinc, calcium and extractable aluminum per appropriate TMECC test method;

6) Toxic Element/Compound content in milligrams per kilogram for Arsenic, Boron, Cadmium, Chromium, Copper, Lead, Mercury, Molybdenum, Nickel, Zinc, and Polychlorinated Biphenyls (PCB) per appropriate TMECC test method;

d. Crushed stone gradation;

e. Optimum compaction moisture content per AASHTO T-99 test results for structural soil mix without removing oversized aggregate;

f. Measured dry-weight percentage of stone in mixture;

g. California Bearing Ratio test results for each structural soil sample compacted to peak standard density.}]

[2.05 STORAGE AGGREGATE MEDIA

A. Storage aggregate media shall be No. 67, No. 57, No. 56, No. 3, or No. 2 stone as specified in the Drawings.

B. Storage aggregate media shall be double-washed, hard, durable, rounded, or sub-angular particles of proper size and gradation, and shall be free from sand, silt, clay, excess fines, and other deleterious materials.

C. Storage aggregate media shall meet ASTM C33/C33M grading requirements for coarse aggregates as follows:

Storage Aggregate Gradation Requirements Based on ASTM C33/C33M

Sieve Size	Passing (Percent by Mass)				
	No. 2	No. 3	No. 56	No. 57	No. 67
75 mm (3 inch)	100	-	-	-	-
63 mm (2-1/2 inch)	90 - 100	100	-	-	-
50 mm (2 inch)	35 - 70	90 - 100	-	-	-
37.5 mm (1-1/2 inch)	0 - 15	65 - 70	100	100	-
25 mm (1 inch)	-	0 - 15	90 - 100	95 - 100	100
19 mm (3/4 inch)	0 - 5	-	40 - 85	-	90 - 100
12.5 mm (1/2 inch)	-	0 - 5	10 - 40	25 - 60	-
9.5 mm (3/8 inch)	-	-	0 - 15	-	20 - 55
4.75 mm (No. 4)	-	-	0 - 5	0 - 10	0 - 10

2.36 mm (No. 8)	-	-	-	0 - 5	0 - 5
1.18 mm (No. 16)	-	-	-	-	-

D. STORAGE AGGREGATE MEDIA CERTIFICATION; Submit certification that aggregate is clean, double washed and meeting the specified gradation. Submittal shall include supplier name, address and phone. Gradation reports shall include the following aggregates:

[1. No. 67]

[2. No. 57]

[3. No. 56]

[4. No. 3]

[5. No. 2]]

[2.06 CHOKER COURSE

A. Choker course shall be sand, No. 9, No. 89, No. 8, No. 7 or No. 57 stone as specified in the Drawings.

B. Stone Choker course shall meet ASTM C33/C33M gradation requirements as follows:

Choker Course Gradation Requirements Based on ASTM C33/C33M

Sieve Size	Passing (Percent by Mass)				
	No. 57	No. 7	No. 8	No. 89	No. 9
37.5 mm (1-1/2 inch)	100	-	-	-	-
25 mm (1 inch)	95 - 100	-	-	-	-
19 mm (3/4 inch)	-	100	-	-	-
12.5 mm (1/2 inch)	25 - 60	90 - 100	100	100	-
9.5 mm (3/8 inch)	-	40 - 70	85 - 100	90 - 100	100
4.75 mm (No. 4)	0 - 10	0 - 15	10 - 30	20 - 55	85 - 100
2.36 mm (No. 8)	0 - 5	0 - 5	0 - 10	5 - 30	10 - 40
1.18 mm (No. 16)	-	-	0 - 5	0 - 10	0 - 10
300 um (No. 50)	-	-	-	0 - 5	0 - 5

[C. Sand shall be per Part 2.03.]

D. CHOKER COURSE CERTIFICATION; Submit certification that aggregate is clean, double washed and meeting the specified gradation.

Submittal shall include supplier name, address and phone. Gradation reports shall include the following aggregates:

[1. Sand]

[2. No. 9]

[3. No. 89]

[4. No. 8]

[5. No. 7]

[6. No. 57]]

[2.07 JOINTING AND BEDDING MATERIAL

A. Jointing and Bedding Material shall be sand, No. 9, No. 89, No. 8, or No. 7 stone as specified in the Drawings.

B. Jointing and bedding material shall meet ASTM C33/C33M gradation requirements as follows:

Jointing and Bedding Material Gradation Requirements Based on ASTM C33/C33M

Sieve Size	Passing (Percent by Mass)			
	No. 7	No. 8	No. 89	No. 9
19 mm (3/4 inch)	100	-	-	-
12.5 mm (1/2 inch)	90 - 100	100	100	-
9.5 mm (3/8 inch)	40 - 70	85 - 100	90 - 100	100
4.75 mm (No. 4)	0 - 15	10 - 30	20 - 55	85 - 100
2.36 mm (No. 8)	0 - 5	0 - 10	5 - 30	10 - 40
1.18 mm (No. 16)	-	0 - 5	0 - 10	0 - 10
300 um (No. 50)	-	-	0 - 5	0 - 5

[C. Sand shall be per Part 2.03.]

D. JOINTING AND BEDDING MATERIAL CERTIFICATION; Submit certification that aggregate is clean, double washed and meeting the specified gradation. Submittal shall include supplier name, address and phone. Gradation reports shall include the following aggregates:

[1. Sand]

[2. No. 9]

[3. No. 89]

[4. No. 8]

[5. No. 7]]

[2.08 AGGREGATE BASE

A. Aggregate base shall be No. 8, No. 7, or No. 57 stone as specified in the Drawings.

B. Aggregate base shall meet ASTM C33/C33M gradation requirements as follows:

Aggregate Base Gradation Requirements Based on ASTM C33/C33M

Sieve Size	Passing (Percent by Mass)		
	No. 57	No. 7	No. 8
37.5 mm (1-1/2 inch)	100	-	-
25 mm (1 inch)	95 - 100	-	-
19 mm (3/4 inch)	-	100	-
12.5 mm (1/2 inch)	25 - 60	90 - 100	100
9.5 mm (3/8 inch)	-	40 - 70	85 - 100
4.75 mm (No. 4)	0 - 10	0 - 15	10 - 30
2.36 mm (No. 8)	0 - 5	0 - 5	0 - 10
1.18 mm (No. 16)	-	-	0 - 5
300 um (No. 50)	-	-	-

[C. AGGREGATE BASE GRADATION TEST RESULTS; Submit gradation test results of the following aggregates prior to procurement of material:

[1. No. 8]

[2. No. 7]

[3. No. 57]]]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing lines, slopes, elevations, and continuous profile grades. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for

layout and performance of Work.

2. Contractor shall submit survey verification per Section 02939 Green Stormwater Infrastructure Earthwork.

B. Project Conditions: Project conditions shall be in accordance with Section 02939 Green Stormwater Infrastructure Earthwork.

C. Control and Protection

1. Prior to soil and aggregate media placement activities, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified in the Runoff Management Plan, per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. The footprint of the facility shall be kept reasonably dry and no stormwater shall be routed through the facility throughout the duration of construction.

3. Blocking of curbs, curb cuts, inlets, and other temporary protection and control measures may be necessary to divert stormwater away from the green stormwater infrastructure facility during construction.

3.02 INSTALLATION

A. Excavation

1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.

2. Contractor shall conduct pre-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing after excavation is complete and prior to placement of soil and/or aggregate materials. Submit PRE-CONSTRUCTION INFILTRATION TEST RESULTS.

3. COMPLETION OF EXCAVATION NOTIFICATION; Notify the Design ProfessionalOwner within 48 hours of completion of excavation and prior to placement of all media layers.

[B. [Storage Aggregate Media] [and] [Choker Course] Placement

1. Contractor shall place aggregate media in loose six (6) inch lifts, hand-raked to the lines and grades specified in the Drawings.

2. COMPLETION OF MEDIA INSTALLATION NOTIFICATION; Notify the Design ProfessionalOwner within 48 hours of completion of installation of each media layer and prior to placement of any additional soil or aggregate media layers.]

[C. [Jointing] [and] [Bedding] Material Placement

1. Contractor shall place aggregate media in loose lifts, hand-raked to the lines and grades specified in the Drawings.

2. COMPLETION OF MEDIA INSTALLATION NOTIFICATION; Notify the Design ProfessionalOwner within 48 hours of completion of installation of each media layer and prior to placement of any additional soil or aggregate media layers.]

[D. [Bioretention] [and] [Amended] Soil Media Placement

1. The growing media shall have a moisture content low enough to prevent visible clumping and compaction during placement.

2. Contractor shall place engineered soil media in horizontal lifts not to exceed six (6) inches for the entire green stormwater infrastructure facility. Each lift shall be lightly watered to encourage settling.

3. If the growing media becomes contaminated with undesired materials during construction, the undesired materials shall be removed and replaced with uncontaminated growing media at the Contractor's expense.

4. To account for settling, Contractor shall install a surcharge lift of growing media over the entire green stormwater infrastructure facility. Surcharge lift shall be allowed to settle for a minimum of 14 days prior to bringing green stormwater infrastructure to finished grade. The entire surface of the growing media, shall be roto-tilled to a depth of six (6) inches at final grading.

5. Mechanical compaction of the growing media is not permitted. Compaction of the growing media shall not exceed 85 percent density per ASTM D1557.]

[E. Structural Soil Media Placement

1. Do not proceed with installation of structural soil material until all walls, curb, footings, and utility work in the area have been installed unless Site elements depend on structural soil for foundation support. Do not over-excavate compacted subgrades of adjacent pavement or structures.

[2. Underdrain shall be installed within aggregate media as specified in the Drawings and per Section 02954 Green Stormwater Infrastructure Piping.]

3. Install Structural Soil in six (6) inch lifts and compact each lift. Compact all materials to peak dry density from a standard compaction curve per AASHTO T-99. No compaction shall occur when moisture content exceeds maximum defined in Part 2.04, C. Delay compaction 48 hours if moisture content exceeds maximum allowable and protect Structural Soil during delays in compaction with plastic or plywood.]

3.03 TOLERANCES

A. The Contractor must place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the Design ProfessionalOwner for review. Survey elevation shall be taken at specific point locations identified in the Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Immediately protect the aggregate or soil media from contamination by undesired materials, trash, debris, water containing cement, clay, silt or materials that will alter the composition of the material by covering with plastic or plywood.

B. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until vegetation is fully established.

[C. Vegetation shall be installed immediately following installation of growing media per Section 02951 Green Stormwater Infrastructure Plants, 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding, or 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding. If Site conditions limit vegetation of facility immediately following installation of soil, Contractor shall implement additional measures to cover and protect the growing media for duration of exposure.]

D. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility and adjacent areas disturbed during construction through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. The Contractor shall conduct post-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing at up to [three (3)] testing locations once all soil and aggregate media has been installed and prior to installation of vegetation. Contractor shall conduct testing within ten (10) days of installation of surface media and submit POST-CONSTRUCTION INFILTRATION TEST RESULTS.

B. Average post-construction infiltration rate shall meet or exceed pre-construction infiltration rates and shall be no less than

[0.25 inches per hour] with no single test less than [0.25 inches per hour].

C. Owner reserves the right to collect a sample of the material for independent testing at any time during the Establishment Period.

D. Media that fails to meet post-construction infiltration requirements shall be remediated as recommended by the Design ProfessionalOwner. Amended media shall then be retested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. This procedure shall be repeated by the Contractor until the media meets post-construction infiltration requirements at the discretion of the Design ProfessionalOwner.

3.08 WARRANTY

A. The Contractor shall warrant the green stormwater infrastructure soil and aggregate media through the duration of the Establishment Period.

B. If at any time during the Establishment Period the media fails to meet post-construction infiltration requirements due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the media and fully restore the green stormwater infrastructure facility and any damaged components as determined by the Design ProfessionalOwner, at no additional cost to the Owner.

-- End of Section --

SECTION 02947

GREEN STORMWATER INFRASTRUCTURE TOPSOIL, REMOVAL AND PLACEMENT

PART 1 GENERAL

1.01 PURPOSE

A. Topsoil is the uppermost layer of soil that contains a majority of the soil's organic matter and microorganisms, making it more amenable to sustaining vegetation. Topsoil can be used independently as a native site soil or imported material, or as a component of the growing media per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

B. This section includes topsoil material and testing requirements and provisions for stripping of existing topsoil, removal of soil horizons, materials, substitutions and supplements, storage, redistribution, and fine grading. Approved topsoil shall be placed in all landscape areas to be planted unless otherwise specified in the Drawings.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for topsoil installation and testing, dictated in the Drawings and specified herein. Topsoil shall be paid for by Unit PriceLump Sum Price and measured by Cubic Yard.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02949 Green Stormwater Infrastructure Existing Tree Protection

02950 Green Stormwater Infrastructure Selective Vegetation Removal

02951 Green Stormwater Infrastructure Plants

02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding

02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of Contract Documents, unless otherwise indicated by the Design ProfessionalOwner.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM D5268	Topsoil Used for Landscaping Purposes
ASTM D6913	Standard Specification for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

1.05 SUBMITTALS

SD-06 Test Reports

TESTING AGENCY CONTACT

SD-07 Certificates

IMPORTED TOPSOIL CERTIFICATION

NATIVE TOPSOIL CERTIFICATION

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Work shall be performed by a qualified installer with a minimum five (5) years of experience whose work has resulted in the successful installation of green stormwater infrastructure, grading and shaping of landscape features, planting beds, lakes and wetlands or other comparable amenities.

B. Testing Agency Qualifications

1. An independent agency, acceptable to the authorities having jurisdiction, qualified for testing indicated. The testing agency shall be accredited by the American Association for Laboratory Accreditation and on the USGA preferred labs list.

2. TESTING AGENCY CONTACT; All testing and analysis shall be at the expense of the Contractor. Submit all material testing results specified including the following contact information for the testing agency used:

a. Testing Agency Name;

b. Testing Agency Address;

c. Testing Agency Phone;

d. Material Tested.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit required testing results showing material is in conformance with this Specification.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Contractor shall prevent mixing of dissimilar materials during unloading, stockpiling, and placement activities.

B. On-site native topsoil shall be segregated and stockpiled when it is impractical to redistribute such materials promptly on regraded areas. Stockpiled materials shall:

1. Be selectively placed on a stable area within the Site;

2. Be stockpiled to a height less than or equal to four (4) feet;

3. Be covered and protected from wind and water erosion;

4. Not be moved until required for redistribution, unless approved by the Design ProfessionalOwner.

C. Topsoil shall not be stockpiled for greater than 30 days without approval by the Design ProfessionalOwner. Where topsoil is stockpiled for greater than 30 days, the Contractor shall re-sample material and submit for testing per Part 1.05.

D. Where stockpiling of materials for greater than 30 days is required, the Design ProfessionalOwner may approve the temporary distribution of the soil materials to an approved area within the Site. Such action shall not permanently diminish the capability of the topsoil of the host site. The material will be distributed in a condition more suitable for redistribution than if stockpiled long-term;

E. After delivery and prior to placement, the Design Professional Owner reserves the right to collect samples of the topsoil. If the media is found to be outside the parameters specified in Part 2, or outside the accepted testing submittals, the Contractor shall replace or ammend the media at no additional cost to the Owner.

PART 2 PRODUCTS

2.01 TOPSOIL

A. Topsoil shall be fertile, friable and free of weeds, weed propagules, roots, rock, clay lumps, cinders, concrete, brick, plastics, metals, litter, debris, herbicides, and other

deleterious material.

B. Topsoil gradation shall be per ASTM D6913 or approved equal meeting the following gradation requirements:

Topsoil Gradation Requirements

Sieve Size	Passing (Percent by Weight)
25.0 mm (1 inch)	100
75 micrometers (No. 200)	0 - 25

C. Topsoil requirements shall be consistent with Loam soil properties. Topsoil pH shall be between 5 and 7.5 per ASTM D5268 with composition meeting the following requirements:

Topsoil Composition Requirements

Component (Particle Size)	Composition (Percent by Weight)
Sand (2.0 - 0.05 mm)	30 - 50
Silt (0.05 - 0.002 mm)	30 - 50
Clay (<0.002 mm)	10 - 30
Organic Matter	3 - 10

D. IMPORTED TOPSOIL CERTIFICATION; At least 30 days prior to starting Work, submit testing agency certification that topsoil is within the parameters specified prior to mixing with other growing media components. At a minimum test report shall include the following:

1. Material supplier name, address and phone;

2. Material origin (address);

3. Gradation;

4. Percent by volume composition of sand, silt, clay and organic matter;

5. pH.

2.02 NATIVE TOPSOIL

A. Native site topsoil may be used in lieu of imported topsoil if material meets the specified criteria and/or is deemed acceptable by the Design ProfessionalOwner. Native topsoil may only be obtained from well-draining sites with onsite topsoil depths of four (4) inches or greater.

B. Native topsoil shall be stripped from all grading areas per Part 3.02, B, and stored per Part 1.08.

C. If native topsoil does not meet requirements of Part 2.01, native

topsoil shall be amended at the Contractor's expense by the following per testing agency recommendations:

1. Lime shall be ground agricultural limestone, a minimum of 90 percent passing the 2.36 millimeter (No. 8) sieve and a minimum of 65 percent calcium carbonate equivalent.

2. Sulfur

   a. Sulfur shall be granular and biodegradable, containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through 3.35 millimeter (No. 6) sieve and a maximum of ten (10) percent passing through 425 micrometer (No. 40) sieve.

   b. Iron sulfate shall be granulated ferrous sulfate, containing a minimum of 20 percent iron and a minimum of ten (10) percent sulfur.

   c. Aluminum sulfate shall be commercial grade and unadulterated.

3. Compost: Compost shall be per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

D. If native topsoil is amended, resubmit test results per Part 1.05 after the topsoil mixture has been thoroughly blended. If the material is deemed unsuitable by the Design ProfessionalOwner, the material shall be reconditioned at the Contractor's expense as recommended by the testing agency.

E. NATIVE TOPSOIL CERTIFICATION; At least 30 days prior to starting Work, submit testing agency certification that topsoil is within the parameters specified prior to mixing with other growing media components. At a minimum test report shall include the following:

1. Gradation;

2. Percent by volume composition of sand, silt, clay and organic matter;

3. pH;

4. Amendment product data and mix ratios.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing lines, slopes, elevations, and continuous profile grades. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

2. Contractor shall submit survey verification per Section 02939 Green Stormwater Infrastructure Earthwork.

B. Project Conditions

1. Project conditions shall be in accordance with Section 02939 Green Stormwater Infrastructure Earthwork.

2. When conditions detrimental to the proper growth of plant material are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the Design ProfessionalOwner prior to installation.

C. Control and Protection

1. Prior topsoil placement activities, the perimeter of the Site shall be protected against runoff and sedimentation from contributing drainage area with measures identified in the Runoff Management Plan, per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. The footprint of the Site shall be kept reasonably dry and no stormwater shall be routed through the Site throughout the duration of construction.

3. Blocking of curbs, curb cuts, inlets, and other temporary protection and control measures may be necessary to divert stormwater away from the Site during construction.

4. Protect all trees and vegetation per Sections 02949 Green Stormwater Infrastructure Existing Tree Protection and 02950 Green Stormwater Infrastructure Selective Vegetation Removal.

3.02 INSTALLATION

A. Topsoil that is a component of the growing media shall be mixed as specified per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

B. Stripping of native topsoil shall be as follows:

1. The full depth of topsoil shall be stripped from all grading areas.

2. Topsoil up to a minimum depth of six (6) inches or the entire "A" horizon of the applicable soil series being disturbed as published in the Published County Soil Survey or other detailed soil survey, shall be stripped and stockpiled from all areas to be excavated or filled.

C. Imported or native topsoil to be used independently shall be placed as follows:

1. De-compact the subgrade to a depth of 12 inches using a disc, ripper, subsoiler, roto-tiller, or chisel plow in locations as shown in the Drawings.

2. Place Topsoil to a minimum depth of six (6) inches. Limit

excavation to areas that will be installed within the same day. Contractor shall not leave pits open and will be required to clearly mark or warn the public of their locations. Backfill topsoil with amendments thoroughly mixed to a minimum depth to meet grades as shown in the Drawings. Do not backfill or excavate if fill or sub-grade is frozen.

3. Topsoil Distribution

a. Place topsoil in three (3) inch lifts. Achieve an approximately uniform, stable thickness, finished grading, and surface-water drainage systems. Lightly water topsoil after placement to encourage settling.

b. Prevent excess compaction of the materials. In-place density shall not exceed 85 pounds per cubic foot.

c. Protect the materials from wind and water erosion before and after seeding or planting.

d. Maintain positive surface drainage. Fill low spots with topsoil except where depressions are indicated in the Drawings.

e. Manually spread topsoil around trees, permanent structures, and paving to prevent damage.

3.03 TOLERANCES

A. The Contractor must place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

B. FINISHED GRADE SURVEY VERIFICATION; Submit survey of finished grade elevation to the Design ProfessionalOwner for review. Survey elevation shall be taken at specific point locations identified in the Drawings.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Immediately protect the topsoil from contamination by undesired materials, trash, debris, water containing cement, clay, silt or materials that will alter the composition of the material by covering with media liner, plastic or plywood.

B. Fully clean all non-vegetated areas where topsoil has been deposited, including but not limited to pavement.

C. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure

Control and Protection to protect the Site until vegetation is fully established.

D. Vegetation shall be installed immediately following installation of topsoil per Section 02951 Green Stormwater Infrastructure Plants, 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding, or 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding. If Site conditions limit vegetation of facility immediately following installation of soil, Contractor shall implement additional measures to cover and protect the growing media for duration of exposure.

E. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

3.06 MAINTENANCE

A. Not applicable.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. If at any time during the Establishment Period soil loss occurs due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the topsoil and fully restore the area as determined by the Design ProfessionalOwner, at no additional cost to the Owner.

-- End of Section --

SECTION 02948

GREEN STORMWATER INFRASTRUCTURE MEDIA LINERS

PART 1 GENERAL

1.01 PURPOSE

A. Media liners are synthetic fabric liners used to provide stabilization and/or separation of soil and aggregate media within a green stormwater infrastructure facility, and to limit mixing of media layers. Media liners can be permeable or impermeable, allow or prevent stormwater infiltration, and protect adjacent infrastructure.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required to install media liners as depicted in the Drawings and as specified herein. Media liners shall be measured in the units of [Square Yards][Square Feet] and shall be paid for by Unit Price Lump Sum Price.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM D751	Standard Test Methods for Coated Fabrics
ASTM D1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

ASTM D3786/D3786M	Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method
ASTM D4491/D4491M	Standard Test Method for Water Permeability of Geotextiles by Permittivity
ASTM D4533/D4533M	Standard Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4632/D4632M	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
ASTM D4751	Standard Test Methods for Determining Apparent Opening Size of a Geotextile
ASTM D5884/D5884M	Standard Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes
ASTM D5885/D5885M	Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
ASTM D6241	Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
ASTM D7003/D7003M	Standard Test Method for Strip Tensile Properties of Reinforced Geomembranes
ASTM D7004/D7004M	Standard Test Method for Grab Tensile Properties of Reinforced Geomembranes
ASTM D7238	Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
ASTM E96/E96M	Standard Test Method for Water Vapor Transmission of Materials

GEOSYNTHETIC RESEARCH INSTITUTE (GRI)

GRI GM 22	Standard Specification for Test Methods, Required Properties and Testing Frequencies for Scrim Reinforced Polyethylene Barriers Used in Exposed Temporary Applications

GRI GT 13(a)	Standard Specification for Test Methods and Properties for Geotextiles Used as Separation between Subgrade Soil and Aggregate

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

MEDIA LINER PLACEMENT NOTIFICATION

SD-03 Product Data

MANUFACTURER INFORMATION

SD-07 Certificates

MANUFACTURER QUANTITY CERTIFICATION

MANUFACTURER QUALITY CERTIFICATION

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications

1. The manufacturer shall have previously demonstrated ability to produce the media liner by having at least two (2) years continuous experience in the manufacturing of the media liner and successfully manufactured a minimum of ten (10) million square feet of the media liner.

2. MANUFACTURER QUANTITY CERTIFICATION; Submit manufacturer certification verifying a minimum of 10 million square feet of the media liner being manufactured as of the date of the submittal.

3. MANUFACTURER QUALITY CERTIFICATION; Submit manufacturer certification, verifying that the quality of the resin used to manufacture the media liner meets the requirements specified in Part 2.

1.07 QUALITY CONTROL

A. Quality control certificates, signed by the manufacturer's quality assurance manager, shall be documented for each roll delivered to the Site and shall include the following:

1. Manufacturer Name;
2. Product Identification;
3. Thickness;
4. Roll Dimension;
5. Roll Number;
6. Lot Number;
7. Sampling Procedures;
8. Sampling Frequency;
9. Test Results of conformance sampling.

B. Conformance sampling shall be completed at a minimum frequency of one (1) sample every 50,000 square feet of media liner delivered. If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection shall be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality assurance at no additional cost to the Owner.

C. MANUFACTURER INFORMATION; Submit manufacturer instructions for each product, including, but not limited to fabrication, delivery and handling, installation and protection. Include the following manufacturer information:

1. Supplier name, address and phone;
2. Documents for material warranty;
3. Documents for media liner workmanship, including, but not limited to batch identifications and associated roll numbers;
4. Origin, identification and production information for the resin used in the media liner, including, but not limited to the supplier's name, brand name and production plant for the resin;
5. Media liner properties including but not limited to weight, grab tensile strength, grab tensile elongation, tongue tear, California Bearing Ratio (CBR) puncture, bursting strength, water vapor transmission, high pressure oxidative induction time, and ultraviolet resistance as specified in Part 2.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Materials shall be wrapped with a protective cover to avoid damage due to handling, water, sunlight, and contaminants. The Contractor shall be responsible for replacement of damaged or unacceptable material as identified by the Design Professional Owner at no additional cost to the Owner.

B. During storage, the media liner shall be elevated off the ground and adequately covered to protect them from dirt, grease,

moisture, mud, mechanical abrasions, and excessive heat that may damage the media liner material. The Contractor shall avoid dragging the media liner on rough soil subbase. Media liner shall be stored on a prepared surface (not wooden pallets) and shall not be stacked more than two (2) rolls high.

PART 2 PRODUCTS

2.01 PERMEABLE LINER

A. Permeable liner shall be comprised of non-woven (with elongation greater than or equal to 50 percent) polypropylene staple fibers, conforming to the following property requirements, as specified in GRI GT 13(a).

Permeable Liner Required Properties

Property (unit) (min/max)	**Class 1**	**Class 2**	**Class 3**	**Test Method (or approved equal)**
Grab Tensile Strength (lb) (min)	203	158	113	ASTM D4632/D4632M
Trapezoid Tear Strength (lb) (min)	79	56	41	ASTM D4533/D4533M
CBR Puncture Strength (lb) (min)	440	320	230	ASTM D6241
Permittivity (sec-1) (min)	1.0	1.0	1.0	ASTM D4491/D4491M
Apparent Opening Size (inches) (max)	0.024	0.024	0.024	ASTM D4751
Ultraviolet Stability (% of strength retained at 500 light hours) (min)	80	70	60	ASTM D7238

[B. Design Professional to specify recommended product and manufacturer, or approved equal.]

2.02 IMPERMEABLE LINER

[A. The impermeable liner shall meet the following property requirements, as specified in GRI GM 22.

Impermeable Liner Required Properties

Property (unit) (min/max value)	**Category 1 20 mil**	**Category 2 12 mil**	**Category 3 8 mil**	**Test Method** (or approved equal)
Weight (lb/1000 ft2) (min)	94	53	34	ASTM D751

Property (unit) (min/max value)	**Category 1 20 mil**	**Category 2 12 mil**	**Category 3 8 mil**	**Test Method** (or approved equal)
Grab Tensile Strength (lb)(min)	114	76	59	ASTM D7004/D7004M
Grab Tensile Elongation (%)(min)	14	14	14	ASTM D7004/D7004M
Tongue Tear (lb)(min)	53	40	15	ASTM D5884/D5884M
CBR Puncture (lb)(min)	320	220	150	ASTM D6241
Bursting Strength (lb/in2)(min)	130	85	60	ASTM D3786/D3786M
Water Vapor Transmission (WVT) (g/m2-day)(max)	0.4	0.7	1.7	ASTM E96/E96M
High Pressure Oxidative Induction Time (OIT) (minute)(min)	1000	1000	1000	ASTM D5885/D5885M
Ultraviolet (UV) Resistance (Florescent light method) [% of strength and elongation retained after 10,000 light hours](min)	50	50	50	ASTM D7238 ASTM D7003/D7003M

]

[B. Design Professional to specify recommended product and manufacturer, or approved equal.]

C. The resin from which the impermeable liner is made shall have a density greater than or equal to 0.932 grams per milliliter, and have a melt index value per ASTM D1238 of less than 1.0 grams per ten (10) minutes. Formulated sheet density shall be greater than or equal to 0.94 grams per milliliter.]

[D. Earthen liner shall be compacted, low permeability fill to the depth specified in the Drawings.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking: All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing lines, slopes, elevations, and continuous profile

grades. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

B. Project Conditions

1. Media liner placement shall not proceed at an ambient temperature below 32 degrees Fahrenheit or above 100 degrees Fahrenheit [unless authorized, in writing, by the Design ProfessionalOwner]. Media liner placement shall not be performed during precipitation, in an area of ponded water, or excessive winds that adversely affect the media liner placement.

2. MEDIA LINER PLACEMENT NOTIFICATION; Notify the Design ProfessionalOwner at least 48 hours prior to placement of media liner.

C. Control and Protection: Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

3.02 INSTALLATION

A. Excavation: Facility shall be excavated [per Section 02939 Green Stormwater Infrastructure Earthwork] to the dimensions, side slopes, and elevations specified in the Drawings.

B. Anchor Trench: Anchor trench shall be constructed as shown in the Drawings [or as recommended by the manufacturer].

C. Liner Placement

[1. Permeable Liner

a. Permeable liner shall be placed loosely with no wrinkles or folds, and with no void space between the permeable liner and adjacent surface. Successive sheets of permeable liner shall overlap at a minimum of 12 inches, with the upstream (higher in elevation) sheet overlapping the downstream (lower in elevation) sheet.

[b. All seams and overlaps shall be subject to the approval of the Design ProfessionalOwner.] Prior to covering the permeable liner with materials, the permeable liner shall be inspected for any damage (e.g. holes, tears, rips etc.) incurred during placement. [The inspection shall be performed by the Design ProfessionalOwner.]

c. Damaged permeable liner, as identified by the [Design ProfessionalOwner], shall be repaired or replaced immediately by the Contractor per manufacturer's recommendations at no additional cost to the Owner.]]

[2. Impermeable Liner

[a. Impermeable liner shall be installed in accordance with manufacturer's recommendations. The layout shall have consistent field seams, kept to a minimum.

b. For impermeable liner placed at 4:1 slopes (horizontal:vertical) or steeper, impermeable liner seams shall be oriented in the direction of the slope (e.g. perpendicular to top of slope). [Horizontal seams across the slope must be approved by the Design Professional.]

c. Impermeable liner shall be anchored per manufacturer's recommendations.

d. Edges of impermeable liner shall be properly weighted to avoid uplift due to wind.

e. Damaged impermeable liner, as identified by the Design ProfessionalOwner, shall be repaired or replaced immediately by the Contractor per manufacturer's recommendations at no additional cost to the Owner.]

[f. Earthen liner shall be compacted to 95 percent proctor.]

D. Backfill: [Backfill shall be in accordance with Section 02939 Green Stormwater Infrastructure Earthwork.] Install [soil][and][aggregate media] over media liner to finished grade per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media and as shown in the Drawings.

3.03 TOLERANCES

A. The Contractor shall place product(s) based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully stabilized.

B. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility per Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the media liner. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.

-- End of Section --

SECTION 02949

GREEN STORMWATER INFRASTRUCTURE EXISTING TREE PROTECTION

PART 1 GENERAL

1.01 PURPOSE

A. This Section includes the protection and trimming of existing trees that interfere with, or are affected by, execution of the Work, whether temporary or permanent construction.

B. Definitions

1. Tree Protection Zone: Area surrounding individual trees or groups of trees to remain during Work, and defined by the Drip Line of individual trees or the perimeter Drip Line of groups of trees, unless otherwise indicated.

2. Drip Line: Area defined by the outermost circumference of the tree canopy.

3. Diameter Breast Height (DBH): The outside bark diameter of an existing tree measured 4.5 feet above the ground, on the uphill side of the tree.

4. Caliper: Diameter of the stem or trunk of a tree measured above existing grade. For trees up to 4.5 inches in diameter, Caliper shall be measured six (6) inches above existing grade. If the Caliper measured at six (6) inches is greater than 4.5 inches, the Caliper shall be measured at 12 inches above existing grade.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for protection of existing trees, dictated in the Drawings and specified herein. Existing tree protection shall be paid for by Unit PriceLump Sum Price and measured as follows:

Existing Tree Protection Measurement and Payment Units

Item	Unit
Tree Protection Fencing	Linear Feet
Tree Removal	Each
Tree Replacement	Each 2-inch caliper replacement tree

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02948 Green Stormwater Infrastructure Media Liners

02951 Green Stormwater Infrastructure Plants

02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z60.1	The American Standard for Nursery Stock
ANSI A300	Tree Care Operations: Standard Practices for Tree, Shrub and Other Woody Plant Maintenance

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

TREE REPLACEMENT PLAN

TREE REMOVAL IDENTIFICATION

TREE PROTECTION PRE-CONSTRUCTION CONFERENCE

1.06 QUALITY ASSURANCE

A. Tree Service Qualifications: Work shall be performed by an experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Work and that will assign an experienced, qualified Arborist to the Work. The Arborist shall be certified by the International Society of Arboriculture.

B. Tree Pruning Standards: Comply with ANSI A300 Part 1, "Trees, Shrubs and other Woody Plant Maintenance-Standard Practices (Pruning)."

1.07 QUALITY CONTROL

A. A qualified Arborist as identified in Part 1.06, A. shall be on the Site on a full-time basis during execution of tasks related to tree protection.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Do not store construction materials, debris, or excavated material inside Tree Protection Zone(s).

B. Site utilization shall protect root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials, and, protecting root systems from ponding, eroding, compaction or excessive wetting caused by dewatering operations.

C. Do not permit vehicles or foot traffic within Tree Protection Zone(s).

PART 2 PRODUCTS

2.01 TREE PROTECTION FENCING

A. Tree protection fencing shall be orange in color and minimum 48 inches in height Mesh Construction Fencing by Conweed or approved equal. Fence posts shall be Metal T-Posts.

2.02 TREE REPLACEMENT

A. TREE REMOVAL IDENTIFICATION; Submit any trees to be removed not specifically identified for removal in the Drawings. Tree removal identification submittal shall include the following:

1. Location of tree with northing/easting points;

2. Species of tree;

3. DBH of tree;

4. And purpose for removal.

B. TREE REPLACEMENT PLAN; Contractor shall submit a tree replacement plan for all trees removed not specifically identified for removal in the Drawings. Tree replacement plan shall include the following:

1. Location of replacement tree(s) with northing/easting points;

2. Species of replacement tree(s);

3. And Caliper of replacement tree(s).

C. Replacement trees shall be in accordance with Section 02951 Green Stormwater Infrastructure Plants.

PART 3 EXECUTION

3.01 PREPARATION

A. Trees, tree roots and limbs within the construction limits shall be protected against injury or damage through the duration of the Work. All trees and vegetation shall remain and be protected unless designated otherwise by the Design ProfessionalOwner.

B. Any trees damaged or destroyed during construction due to construction activities shall be treated or removed at the Contractor's expense per Part 3.02, E. and/or F.

C. Construction Access

1. Submit construction access location and duration of temporary access within Tree Protection Zone(s) per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

2. There shall be no construction traffic within the Tree Protection Zone(s). If no other access is obtainable, place four (4) foot by eight (8) foot sheets of three-quarter (3/4) inch plywood atop nine (9) inches of shredded wood pulp or mulch over entire area proposed for vehicular traffic.

3. After removal of mulch and plywood, Contractor shall aerate the surface soil, per Part 3.02, E.

4. All disturbed areas shall be re-sodded per Section 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding or pavement restored in-kind.

D. Project Conditions

1. Tree protection fencing shall be installed prior to construction operations.

2. Proceed with Work only when existing and forecasted weather conditions are suitable for Work.

E. TREE PROTECTION PRE-CONSTRUCTION CONFERENCE: Before tree protection and trimming operations begin, the Contractor shall conduct a meeting with the Design ProfessionalOwner at the Site to review tree protection and trimming procedures and responsibilities. Contractor shall submit tree protection methods to be used during construction.

3.02 INSTALLATION

A. Tree Protection

1. Install tree protection fencing around Tree Protection Zone(s) to protect remaining trees and vegetation from damage due to Work. Maintain tree protection fencing and remove when Work is complete.

2. Preferred Fencing Installation Method: Where trees are located in open areas not constricted by existing pavement, utilities or proposed grading, the tree protection fencing shall be installed a minimum of one (1) foot outside the Drip Line of the tree.

3. Alternative Fencing Installation Method 1: Where trees are located in areas constricted by utilities or proposed grading, the tree protection fencing shall be installed as close to the Drip Line as possible OR as follows:

Alternative Fencing Installation Method 1 by Tree Size

Tree Size (DBH)	Fence Placement Requirement
Small Trees (<9 inches)	Minimum of 5 feet from face of tree along the side of constriction. All other sides shall be 1 foot outside the dripline of the tree.
Medium (10 inches to 15 inches)	Minimum of 10 feet from the face of the tree along the side of constriction. All other sides shall be 1 foot outside the Drip Line of the tree.
Large (>15 inches)	Minimum of 15 feet from the face of the tree along the side of constriction. All other sides shall be 1 foot outside the Drip Line of the tree.

4. Alternative Fencing Installation Method 2: Where trees are located adjacent to existing pavement, install tree protection fencing adjacent to pavement. All other sides shall be a minimum of one (1) foot outside the Drip Line of the tree.

5. Alternative fencing installation method shall be submitted to the Design ProfessionalOwner.

B. Excavation

1. Do not excavate within Tree Protection Zone(s), unless otherwise indicated in the Drawings or approved by the Design ProfessionalOwner.

2. Install shoring or other protective support systems to minimize sloping excavations within the vicinity of the Tree Protection Zone(s). Do not allow soil loss from Tree Protection Zone(s) in instances where the Drip Line is a point of beginning for excavation or grading operations. If soil loss occurs, Contractor shall correct the problem within 24 hours of occurrence.

3. Where excavation is required within the Drip Line of the tree, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks and comb soil to expose roots. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

4. Where utility trenches are required within Tree Protection Zone(s), tunnel under or around roots by drilling, auger boring, pipe jacking, or digging by hand.

5. Roots damaged during excavation or trenching activities

shall be pruned per Part 3.02, D.

C. Regrading

1. Regrading in the vicinity of an existing tree shall be based on lowering, minor and moderate fill conditions, as defined in the following subsections. Roots damaged by regrading activities shall be pruned per Part 3.02, D.

2. Grade Lowering: Where new finished grade is indicated below existing grade around trees, slope grade away from trees as recommended by Arborist, unless otherwise indicated in the Drawings.

3. Minor Fill: Where existing grade is six (6) inches or less below finished grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations. Do not operate equipment within Tree Protection Zone(s) when fine grading topsoil is placed above existing grade.

4. Moderate Fill: Where existing grade is more than six (6) inches but less than 12 inches below finished grade, place storage aggregate media No. 57 stone per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media, permeable liner per Section 02948 Green Stormwater Infrastructure Media Liners, and topsoil per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media on existing grade as follows:

a. Carefully place storage aggregate media No. 57 stone against tree trunk approximately two (2) inches above finished grade and extend not less than 18 inches from tree trunk on all sides. For balance of area within Drip Line, place storage aggregate media No. 57 stone up to six (6) inches below finished grade.

b. Place permeable liner with edges overlapping 6 inches minimum.

c. Place remaining fill layer of topsoil to finished grade. Do not compact storage aggregate media No. 57 stone or topsoil. Hand grade to required finish elevations.

D. Root Pruning

1. Root Pruning shall take place only where the roots of existing trees have been damaged by regrading or trenching operations and as directed by the Arborist.

2. If construction is to occur within the root zone of existing plant material, root pruning and special plant care, including fertilizing and watering, will be required.

3. Do not cut main lateral roots or taproots. Cut only smaller roots that interfere with installation of Work. Do not break or chop.

4. Prior to root pruning, remove all weeds.

5. Root prune using an approved mechanical root pruning saw prior to regrading operations, as directed by the Arborist. Air Spading excavation consisting of hand and/or pneumatic excavation may be required as directed by Arborist.

6. For plant material that is to remain in place, if the roots of that plant material are exposed during construction, the damaged root ends are to be removed by cutting them off cleanly.

7. Initial watering shall be performed on all trees, which are designated for root pruning. Water trees immediately after pruning by thoroughly saturating root balls and continue to keep root balls thoroughly saturated during first three (3) weeks following root pruning. After the first three (3) weeks, water as required, according to weather conditions, to keep root balls in a moist condition during growing seasons, through the duration of the Work. Test root balls for optimal moisture once per week using a soil auger.

8. All pruning shall be overseen by an Arborist. All pruning shall be done according to the National Arborist Association's Pruning Standards.

9. Any damage to the root zone, as determined by the Arborist, will be compensated by pruning an equivalent amount of the top vegetative growth of the material within one (1) week following root damage, fertilization and supplemental watering.

E. Tree Repair

1. Promptly repair trees damaged by construction operations within 24 hours of occurrence. Treat damaged trunks, limbs, and roots according to Arborist's written instructions.

2. If soil within the Tree Protection Zone(s) becomes compacted during construction, aerate the surface soil a minimum of ten (10) feet outside of the Drip Line and no closer than three (3) feet from the tree trunk. Drill holes two (2) inches in diameter a minimum of 12 inches deep at 24 inches on center or use a turf aerator that is approved by the Design ProfessionalOwner. Backfill holes with an equal mix of augered soil and sand.

F. Tree Replacement

1. Contractor shall obtain written approval from the Design ProfessionalOwner prior to removal of trees not specifically indicated for removal in the Drawings.

2. Trees not indicated for removal in the Drawings that die or are damaged during construction operations shall be removed and replaced at the Contractor's expense if the Design ProfessionalOwner determines that the trees are incapable of restoring to normal growth pattern.

3. Trees removed shall be replaced with two (2) inch Caliper tree(s) at a rate based on the DBH of the existing tree, as follows:

Tree Replacement Requirements

Size of Tree Removed (DBH)	Rate of Replacement (2-inch Caliper)
2 inches - 5 inches	1:1
6 inches - 10 inches	2:1
11 inches - 16 inches	3:1
17 inches - 23 inches	4:1
24 inches - 31 inches	5:1
32+ inches	6:1

4. Replacement trees shall be planted per Section 02951 Green Stormwater Infrastructure Plants and maintained per Section 02957 Green Stormwater Infrastructure Establishment.

3.03 TOLERANCES

A. Trees shall be measured according to ANSI Z60.1 with branches and trunks or canes in their normal position.

B. Do not prune to obtain required sizes.

C. Replacement tree Calipers shall measure equal to or greater than size specified in Part 3.02, F.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall maintain tree protection through the duration of Work in the vicinity of the Tree Protection Zone(s) per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.06 MAINTENANCE

A. Remove tall grass or weeds by mowing and pickup all trash within the Tree Protection Zone(s) for the duration of Work.

B. Contractor shall be responsible for the health of the tree(s) identified for protection through the duration of the Establishment Period, as defined in Section 02957 Green Stormwater Infrastructure Establishment.

C. Vegetative maintenance shall be per Section 02957 Green

Stormwater Infrastructure Establishment.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. Trees, tree roots and limbs within the extents of Work shall be protected against injury or damage through the duration of the Establishment Period. Any trees located in the Tree Protection Zone(s) that die or show more than 25 percent canopy dieback shall be removed and replaced at Contractor's expense per Part 3.02, F.

B. Contractor is responsible for installed plant material warranty per Section 02951 Green Stormwater Infrastructure Plants.

-- End of Section --

SECTION 02950

GREEN STORMWATER INFRASTRUCTURE SELECTIVE VEGETATION REMOVAL

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02950 Green Stormwater Infrastructure Selective Vegetation Removal is to manage areas noted in the Drawings as Tree Protection Zones in which no clearing and grubbing activities, construction, or staging areas are to occur. Areas shall be maintained free from invasive species and structural and/or maintenance concerns of existing tree stands. Within these areas, desirable vegetation, including grasses, wildflowers, shrubs, or trees are to be protected from construction activities.

B. Definitions

1. Selective Vegetation Removal: Areas within Tree Protection Zone [designated in the Drawings] outside of normal clearing and grubbing, where the Contractor shall remove selected trees less than 2-inch diameter breast height and invasive plant undergrowth.

2. Diameter Breast Height (DBH): The outside bark diameter of an existing tree measured 4.5 feet above the ground, on the uphill side of the tree.

3. Glyphosate: A non-selective herbicide that absorbs into the plant tissue and is carried to the roots. Caution must be taken to minimize off-target impacts when applying non-selective herbicides.

4. Triclopyr: A selective herbicide for broadleaf plants (forbs, shrubs, and trees).

5. Invasive Species: Shall be determined by the Missouri Department of Conservation Invasive Plant Species List.

6. Wooded Area Cleanup: Work within the Tree Protection Zone where the Contractor shall remove debris, partially dead or broken vegetation, stumps, loose roots, trash and leaf litter.

1.02 MEASUREMENT AND PAYMENT

A. The cost for development and implementation of Selective Vegetation Removal shall be subsidiary to Work being performed.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02949 Green Stormwater Infrastructure Existing Tree Protection

02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding

02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150	Division II Construction and Material Specification, Erosion and Sediment Control

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z60.1	The American Standard for Nursery Stock

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

MEANS/METHODS OF SELECTIVE VEGETATION REMOVAL

SELECTIVE VEGETATION FIELD ASSESSMENT

FIELD HABITAT ASSESSMENT

SD-07 Certificates

MANUFACTURER CERTIFICATIONS

SD-10 Operation and Maintenance Data

SELECTIVE VEGETATION REMOVAL MAINTENANCE REPORT

1.06 QUALITY ASSURANCE

A. Contractor Qualifications: A qualified horticulturist who has completed work similar in material, design, and extent to that indicated for this Work and with a record of successful landscape

removal.

B. Tree Service Qualifications: Work shall be performed by an experienced tree service firm that has successfully completed tree protection and trimming work similar to that required for this Work and that will assign an experienced, qualified Arborist to the Work. The Arborist shall be certified by the International Society of Arboriculture.

1.07 QUALITY CONTROL

A. MEANS/METHODS OF SELECTIVE VEGETATION REMOVAL; Submit means and methods to be used for Selective Vegetation Removal and Wooded Area Cleanup.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Deliver herbicides in manufacturer's original unopened and undamaged containers. They shall be clearly marked to identify brand name, concentration, contents, and order number on each package. Store all materials in a protected, dry location at temperatures in accordance with manufacturer's recommendation. Materials shall be stacked and stored in accordance with manufacturer's recommendation.

B. Additional manufactured products shall be delivered, stored and handled per the manufacturer's recommendations.

PART 2 PRODUCTS

2.01 HERBICIDES

A. Use of chemical treatment for removal or cause of death for Selective Vegetation Removal must be approved by the Design ProfessionalOwner prior to use.

B. Do not use herbicides that could harm existing plant material intended to remain when applied per Contractor's means and methods per Part 1.07. Contractor shall be responsible for removal and replacement of any and all prematurely defoliated trees within six (6) months of observed damage intended.

1. Woody Plants and Cut Stumps: Contractor shall submit suitable herbicide for approval.

2. Ground Covers and Broadleaf Plants (non-woody): Contractor shall submit suitable herbicide for approval.

C. MANUFACTURER CERTIFICATIONS: Contractor shall submit for approval all products being used and/or stored on the Site prior to delivery or use. Submit product certificates signed by manufacturer, certifying that product complies with Selective Vegetation Removal requirements. Include manufacturer certified analysis for standard products.

2.02 SEED

A. Seed operations shall follow Section 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding and/or 02953

Green Stormwater Infrastructure Non-Native Seeding and Sodding as documented per Drawings.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. SELECTIVE VEGETATION FIELD ASSESSMENT; Contractor shall be responsible for performing a Selective Vegetation Field Assessment of the Site with the Design ProfessionalOwner and qualified Arborist to assess the existing vegetation. The Selective Vegetation Field Assessment submittal shall include, but is not limited to, the following:

a. Contractor shall survey and tag trees, as necessary, for selective removal with final approval given by the Design ProfessionalOwner.

b. Provide figure(s), identifying existing vegetation to remain, invasive species for removal, detailing the species, size, condition, and location of vegetation.

c. Coordinate with utility(s) and Design ProfessionalOwner for Work that impacts the existing Tree Protection Zone.

d. Opportunities for vegetation preservation, or selective removal of vegetation as an alternative to standard clearing and grubbing;

e. Construction limits and the anticipated impacts on surrounding vegetation. Tree protection fencing per Section 02949 Green Stormwater Existing Tree Protection shall be installed around all Selective Vegetation Removal areas.

2. SELECTIVE VEGETATION REMOVAL MAINTENANCE REPORT: Submit a written or graphic report for the care and maintenance of the Tree Protection Zone and Selective Vegetation Removal. This Selective Vegetation Removal Maintenance Report shall convey the activities required for the selective removal and preservation of vegetation. Contractor shall be responsible for coordination with a qualified Arborist for the care of the vegetation during construction and during pruning and vegetation removal activities. All removal and maintenance activities must have approval prior to execution of Work.

3. FIELD HABITAT ASSESSMENT; Submit report for Migratory Bird Nests and State Identified Endangered Bat Habitat. Perform 'Field Habitat Assessment for Active Migratory Bird Nests and Northern Long-eared Bat Habitat' prior to proceeding with any site clearing or plant species removal. The Endangered Species Act (ESA) (16 U.S.C. 1531) provides protection to species that are listed as threatened or endangered or have critical habitat designated for the persistence of the species. The Northern Long-eared Bat (NLEB) is protected as a threatened species under the ESA within Final 4(d) Rule for the Northern Long eared Bat (4(d)

rule). The NLEB hibernates in caves or abandoned mines during the winter. During the summer, the NLEB may roost beneath loose bark of live, dead, or dying trees. Roosting or foraging habitat include forests, wooded fence rows, and riparian areas.

4. Delineate areas for herbicide application and obtain Design ProfessionalOwner acceptance of delineated areas prior to herbicide applications. Adjust areas for herbicide application as requested.

5. All trees not designated for removal shall remain in place. The Contractor shall protect and preserve all items designated to remain.

B. Project Conditions

1. Selective Vegetation Removal shall be limited to September 1st through February 15th to discourage migratory birds from nesting within area of construction.

2. Vegetation must be cleared to a height less than 12 inches. Cleared material should be removed by the Contractor prior to February 15th. If Selective Vegetation Removal is performed between February 16th and August 31st, the Contractor shall employ a qualified wildlife biologist or ecologist to conduct survey for migratory bird activity prior to commencing Selective Vegetation Removal operations.

3. Where migratory bird activity is identified, the Contractor shall obtain the required permits under the Federal Migratory Bird Treaty Act prior to commencing activities. If no migratory bird activity is identified, the contractor may commence activities. Selective Vegetation Removal must be completed within seven (7) calendar days after inspection, including removal of all downed vegetation material from the site. If Selective Vegetation Removal is not completed within seven (7) calendar days of inspection, the contractor's qualified wildlife biologist or ecologist must resurvey the site as required above.

4. Selective Vegetation Removal activities in the Tree Protection Zones shall be completed three (3) months prior to Site clearing, grubbing and earthwork activities. After Selective Vegetation Removal activities have been completed, Contractor shall protect the entire area as specified in Sections 02949 Green Stormwater Infrastructure Existing Tree Protection. Contractor shall take care to limit activities that would conflict with the restoration of Tree Protection Zones.

C. Control and Protection

1. This section shall work in conjunction with the Stormwater Runoff Management Plan, as described in Section 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Protect structures, utilities, sidewalks, pavements, and

other facilities, and lawns and existing exterior plants from damage caused by operations.

3. Provide erosion control measures in accordance with APWA 2150, to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways. This section does not replace erosion and sediment control regulatory responsibilities.

4. Examine areas for compliance with requirements and conditions affecting performance of Work. Proceed with Selective Vegetation Removal only after unsatisfactory conditions have been corrected.

5. Temporary roadways shall be located to minimize damage to shrub and tree stands per the requirements of 02937 Green Stormwater Infrastructure Site Activity Plan.

6. Soil stabilization measures shall be located at the limits of clearing to prevent sediment deposition within the Tree Protection Zone per 02938 Green Stormwater Infrastructure Control and Protection.

7. Equipment must be kept away from trees to be preserved to avoid trunk damage caused by equipment nicking or scarring the trunk.

3.02 INSTALLATION

A. Vegetation Removal Methods

1. Preservation of Existing Trees: Work within the Tree Protection Zone shall be by hand clearing and power raking only. Do not use heavy equipment. Do not mechanically scarify the surface.

2. Mechanical Vegetation Removal: Mechanical removal involves use of loppers, hand saws and other hand tools to cut down plants and hand pulling. Caution needs to be taken when manually removing plants so that soil is not highly disturbed leading to erosion. Many invasive plants can spread via rhizomes and thus taking out the entirety of the root is imperative.

3. Chemical Vegetation Removal: Contractor shall use common systemic herbicides (active ingredients either glyphosate or triclopyr) for chemical vegetation removal, or approved equal. Contractor shall use basal bark treatment and/or foliar treatment or other approved control method. Contractor shall apply systemic herbicide during times and/or seasons that minimize risk for translocation in the plant.

B. Selective Vegetation Removal

1. All trees less than 2-inch caliper and species deemed as invasive shall be cleared and removed. Stumps shall be cut to two (2) inches above the ground and treated with approved herbicide to discourage regrowth. Do not excavate root mass

or disturb adjacent tree roots.

2. All woody shrubs, including both invasive and non-invasive, shall be cleared and removed. Hand dig roots or treat with herbicide to discourage regrowth. Contractor shall take caution not to disturb adjacent tree roots.

3. All groundcovers deemed invasive shall be cleared and removed. All non-invasive groundcovers shall remain.

C. Tree Preservation Understory Restoration

1. Contractor shall, by broadcasting, seed all areas that have been cleared during Selective Vegetation Removal within the Tree Protection Zone with seed mixes as denoted in the Drawings.

2. Contractor shall install seed, following applicable Sections 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding and/or 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding, except that it shall be applied by broadcasting.

D. Trees that lose more than fifty percent of their leaves within Establishment Period shall be replaced per Tree Replacement Requirements, described in 02949 Green Stormwater Infrastructure Existing Tree Protection.

3.03 TOLERANCES

A. Trees shall be measured according to ANSI Z60.1 with branches and trunks or canes in their normal position.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Not applicable.

3.06 MAINTENANCE

A. The Contractor shall maintain temporary Tree Protection Zone through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. Not applicable.

-- End of Section --

SECTION 02951

GREEN STORMWATER INFRASTRUCTURE PLANTS

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02951 Green Stormwater Infrastructure Plants is to provide requirements for landscaping vegetation and materials including but not limited to trees, shrubs, groundcovers, grasses and perennials, fertilizer, mulches and landscape edgings.

B. Definitions

1. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they are grown, with ball size not less than sizes as shown in the Drawings; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

2. Container-Grown Stock: Healthy, vigorous, well-rooted Plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container, but free from circling or girdling roots. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of plant required.

3. Finished Grade: Elevation of finished surface of soil and aggregate media per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

4. Plants: As referenced herein is applicable to trees, shrubs, groundcovers, grasses and perennials. Plants producing wood as a structural tissue are categorized as woody plants. Plants that have no persistent woody stem above ground are categorized as herbaceous plants.

5. Root Flare: Place where the topmost root emerges from the trunk.

6. Tree Crown: Mass of foliage and branches growing outward from the trunk of the tree.

7. Caliper: Diameter of the stem or trunk of a tree measured above existing grade. For trees up to 4.5 inches in diameter, Caliper shall be measured six (6) inches above existing grade. If the Caliper measured at six (6) inches is greater than 4.5 inches, the Caliper shall be measured at 12 inches above existing grade.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for Plants, depicted in the Drawings and specified herein. Plants shall be paid for by Unit PriceLump Sum Price and measured as follows:

Plants Measurement and Payment Units

Item	Unit
[Trees]	[Each]
[Shrubs]	[Each]
[Grasses]	[Each]
[Perennials]	[Each]
[Groundcovers]	[Each]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

00700 General Conditions

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02942 Green Stormwater Infrastructure Above Grade Barriers

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02947 Green Stormwater Infrastructure Topsoil

02948 Green Stormwater Infrastructure Media Liners

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI Z60.1	The American Standard for Nursery Stock

ASTM INTERNATIONAL (ASTM)

ASTM A641/A641M	Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

PLANTING LAYOUT

SD-03 Product Data

MISCELLANEOUS PRODUCTS DATA

SD-04 Samples

LANDSCAPE EDGING SAMPLE

MULCH SAMPLE

SD-07 Certificates

PLANT MATERIAL CERTIFICATION

SD-11 Closeout Submittals

AS-BUILT DRAWINGS

1.06 QUALITY ASSURANCE

A. Installer Qualifications

1. Installer: A qualified landscape installer who has completed landscaping work similar in material, design, and extent to that indicated for this Work and with a record of successful landscape establishment.

2. Field Supervisor: Installer's field supervision is required to maintain an experienced full-time supervisor on Site when planting is in progress. Field supervisor shall have at a minimum five (5) years of experience supervising landscaping work similar in material, design, and extent to that indicated for this project and with a record of successful landscape establishment.

1.07 QUALITY CONTROL

A. Contractor shall notify the Design ProfessionalOwner of sources of planting materials a minimum of 30 days in advance of delivery to Site per requirements of Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. Design ProfessionalOwner may observe Plants either at place of growth or at Site before planting for compliance with requirements for genus, species, variety, size, and quality.

C. Design ProfessionalOwner retains right to observe Plants further for size and condition of ball and root systems, insects, injuries, and latent defects, and to reject unsatisfactory or defective material at any time during progress of Work. The Contractor shall remove rejected Plants immediately from Site.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. The Contractor shall notify the Design ProfessionalOwner of the location of plant materials to be used and allow the Design Professional the opportunity to inspect them either at the place of growth or at the site before planting, for compliance with requirements for genus, species, variety, size, and quality. The Design Professional retains the right to further inspect trees and shrubs for size and condition of root balls and root systems, insects, injuries and latent defects, and to reject unsatisfactory or defective material at any time during progress of work.

B. Provide protective covering to prevent wind damage during transportation to Site. Do not drop any plant materials during loading, unloading, transportation, and delivery. Plant materials shall be tightly packed during transportation; if a full load of Plants is not required, packaging substitutes and braces shall be placed in such a way as to prevent any rolling or movement during the transportation period. Acceptable braces include: wood cross members, large stable rocks, shredded landscape mulch, and topsoil.

C. All planting material shall be delivered with certificates of inspection required by USDA and State of Missouri. Comply with regulations applicable to planting material. Deliver Plants freshly dug or well rooted in their containers, to conditions specified in Part 2. All plants delivered to the site must be clearly labeled with botanical and common names for proper identification. A minimum of one (1) label per species or container is required. Trees and shrubs shall be individually labeled.

D. Deliver Plants after preparations for planting have been completed and install immediately. If planting is delayed more than six (6) hours after delivery, set planting materials in a sheltered location, protect from weather and mechanical damage, and keep roots moist.

1. Handle Balled and Burlapped Stock only by root ball; never move stock by gripping stems or foliage.

2. Set balled stock on ground and cover ball with planting soil, wood mulch, or other acceptable material.

3. Do not remove Container-Grown Stock from containers before time of planting.

4. Water plant materials as often as necessary to maintain root systems in a moist condition.

[E. Trees and Shrubs

1. Do not prune trees and shrubs before delivery, except as approved by the Design ProfessionalOwner. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage.

2. Do not bend or bind-tie trees or shrubs in such a manner as

to destroy their natural shape.]

F. Deliver fertilizers, herbicides, fungicides and pesticides in manufacturer's original unopened and undamaged containers. They shall be clearly marked to identify brand name, contents and order number on each package. Store all materials in a protected, dry location at temperatures in accordance with manufacturer's recommendation. Materials shall be stacked and stored in accordance with manufacturer's recommendation.

PART 2 PRODUCTS

2.01 PLANTS

A. Plants shall be of quantity, size, genus, species, and variety shown in the Drawings and in compliance with ANSI Z60.1. Plant material of a larger size may be used (at no additional cost to the Owner) if acceptable to the Owner, with a proportionate increase in size of roots or balls.

B. Furnish nursery-grown Plants complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement. All plant materials shall be grown at recognized nurseries located within the same USDA Plant Hardiness Zone as the project Site.

C. Plant material shall be grown from the project site eco-region per the Missouri Department of Natural Resources office. Resale plant suppliers shall not be used as sources unless the Contractor can certify that the required plant materials are not available from a growing nursery. When utilized, the Contractor shall submit the name and location of the growing nursery from where the trees or shrubs were obtained.

D. Planting materials shall not be substituted unless otherwise approved by the Design ProfessionalOwner. If specified landscape material is not available, Contractor shall submit proof of non-availability together with a request for Substitute Item, per Section 00700 General Conditions.

[E. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.]

F. PLANT MATERIAL CERTIFICATION; Submit product certificates signed by supplier certifying that plant materials comply with specified requirements and at a minimum include the following:

1. Nursery name, address and phone;

2. List of Plants to be supplied including botanical name, common name, and size;

3. Three (3) digital photographs of each plant species containing height reference and identification;

4. Certificates of inspections as required by governmental authorities;

5. Certification that plant materials comply with specified requirements.

[2.02 TREES

A. All trees provided must be balled and burlapped. Contractor shall submit supplier certifications for all trees, shrubs and related material.

[B. Shade Trees: Shade trees shall be single-stem trees with straight trunk, well-balanced Tree Crown, and intact leader, of height and caliper indicated in the Drawings, complying with ANSI Z60.1 for type of trees required. Shade Tree Crowns shall be equal to one-third (1/3) to one-half (1/2) of tree height.]

[C. Small Upright or Spreading Trees: Small upright or spreading trees shall be branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1. See Drawings for stem form type.]

[D. Multistem Trees: Multistem trees shall be branched or pruned naturally according to species and type, with relationship of caliper, height, and branching according to ANSI Z60.1. Multistem trees shall have clump stem form.]

[E. Coniferous Evergreen Trees: Coniferous evergreen trees, including bald cypress, shall comply with ANSI Z60.1. Trees shall be normal-quality, well-balanced, coniferous evergreens, of type, height, spread, and shape required. Contractor shall provide balled and burlapped coniferous evergreen trees.]]

[2.03 SHRUBS

A. Shrubs shall be container grown with the following form and size: deciduous and evergreen shrubs with not less than the minimum number of canes/spread required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.]

[2.04 GROUNDCOVERS

A. Provide groundcovers established and well rooted in removable containers, flats, or integral biodegradable pots as indicated in the Drawings. Refer to schedule in the planting Drawings for type and condition.]

[2.05 GRASSES AND PERENNIALS

A. Provide grasses and perennials established and well rooted in removable containers, flats, integral biodegradable pots, or deep cell plugs as indicated in the Drawings. Refer to schedule in the planting Drawings for type and condition.]

2.06 PLANTING SOIL

A. Planting soil shall be growing media or topsoil material as specified in the Drawings within landscaping areas and in accordance with Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media and 02947 Green Stormwater

Infrastructure Topsoil shall be used.

2.07 FERTILIZER

A. Fertilizer shall be granular fertilizer consisting of nitrogen, phosphorus, potassium, and other nutrients in proportions and amounts recommended in soil reports, as required per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media, from a qualified soil-testing agency.

B. Fertilizer shall be slow release or quick release as per the soil report.

[2.08 MULCH

A. MULCH SAMPLE; Submit small one-fourth (1/4) pound sample of mulch material(s) to be used for all landscaping areas.

[B. Organic Mulch

1. Green Stormwater Infrastructure Planting Beds: Organic mulch shall be double ground aged hardwood, free from deleterious materials, suitable as a top dressing for proposed plant material, and large enough to prevent displacement. Mulch shall be brown to dark brown in color. Size of particles may vary from minimum of three (3) inches to maximum of four (4) inches in length.

2. Adjacent Planting Beds: Organic mulch shall be double ground aged hardwood, free from deleterious materials and suitable as a top dressing for proposed plant material used adjacent to green stormwater infrastructure facilities. Mulch shall be brown to dark brown in color. Size of particles may vary from minimum of one-quarter (1/4) inch to maximum of two (2) inches in length.]

[C. Pine Straw Mulch

1. Pine straw mulch shall be nine (9) inch minimum pine needle sourced from Slash Pine (Pinus Elliottii) or Longleaf Pine (Pinus Palustris). Pine straw shall be fresh, dry, and bright in color, free of weeds, twigs, pine cones, dirt, gravel, and insects.

2. Needles from Loblolly Pine will not be accepted.]

D. Walnut bark or chips are not acceptable.

]

[2.09 MEDIA LINER

A. Permeable liner shall be the type specified in the Drawings and meet the requirements specified in Section 02948 Green Stormwater Infrastructure Media Liners, or approved equal.]

[2.10 STAKES AND GUYS

A. Upright and Guy Stakes: Shall be studded steel T-post, six (6)

feet length minimum.

B. Guy and Tie Wire: Shall be per ASTM A641/A641M, Class 1, galvanized-steel wire, two (2) strand, twisted, 0.106-inch diameter.

C. Strap Chafing Guard: Shall be reinforced Nylon or Canvas at least 1.5 inches with grommets to protect tree trunks from damage.]

[2.11 LANDSCAPING EDGING

[A. Steel Landscape Edging

1. Steel edging shall be standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

2. Steel edging shall meet the following requirements:

a. Edging Size: Three-sixteenths (3/16) inch wide by six (6) inches deep.

b. Stakes: Ten (10) gauge Tapered steel, a minimum of 15 inches long.

c. Accessories: Standard tapered ends, corners, and splicers.

d. Finish: Powder Coat Finish.

e. Color: Green]

[B. Concrete Ribbon Curb Edging:

1. Monolithic concrete curb per dimensions as detailed.

2. Concrete shall meet the requirements of Section 02942 Green Stormwater Infrastructure Above Grade Barriers.]

[C. V-Cut Edging

1. V-Cut edging shall be a natural cut trench backfilled with specified mulch.]

[D. Decorative Gravel

1. Gravel shall be regionally sourced (within 200-mile radius of project location) decorative gravel, [river rock][angular brown cobbles], [three (3) to eight (8) inches in diameter] [of the type and size specified in the Drawings] with an equal gradation of each size, or approved equal.

[2. Steel edging shall be per Part 2.11, A.]]

[E. LANDSCAPE EDGING SAMPLE; Submit landscape edging sample including the following:

1. Supplier name, address and phone;

2. Product name;

[3. One 12-inch section of steel edging with one stake[;][.]]

[4. Five (5) pounds of decorative gravel for each color and texture of stone required, labeled accordingly.]]]

2.12 MISCELLANEOUS PRODUCTS

A. Anti-desiccant: Natural water-insoluble emulsion, permeable moisture retarder, film forming, acting as a protective coating for the leaf or needle of the plant, substantially reducing water loss during high period of stress. Can be used under hot summer conditions and in cold weather conditions for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Trunk-Wrap Tape: Two layers of crinkled paper cemented together with bituminous material, four (4) inches wide minimum, with stretch factor of 33 percent.

C. Plastic Tree Protector: Each tree shall be protected after planting with an 18-inch nominal height, four (4) inch minimum diameter plastic protector. Material shall be vented polyethylene or equivalent and shall be gray in color.

D. Herbicide: Provide a non-selective, systemic herbicide suitable for use with the plant material specified on the Plans. Provide ROUNDUP Weed and Grass Killer, manufactured by the Monsanto Company, Lawn and Garden Products, or approved equivalent.

E. Pre-Emergent Herbicide: Provide pre-emergent herbicide Pre M 60 DG (granular), or approved equivalent.

F. Mycorrhizal Fungi: Dry, granula inoculant containing at least 6,810 spores per pound. (0.45 kilograms) of vesicular-arbuscular mycorrhizal fungi and 60 million spores per pound (0.45 kilograms) of ectomycorrhizal fungi, and a maximum particle size of 2 milimeters. Apply per manufacturer's recommendation.

G. All other materials, not specifically described but required for a complete and proper installation, shall be as selected by the Contractor subject to the approval of the Design ProfessionalOwner.

H. MISCELLANEOUS PRODUCTS DATA; Submit product information for miscellaneous products related to plants including but not limited to anti-desiccant, trunk-wrap tape, fertilizers, pesticides, and herbicides.

2.13 WATER

A. Water used in this Work shall be furnished by the Contractor and will be suitable for irrigation and free from ingredients harmful to plant life.

B. All watering equipment shall be furnished by the Contractor.

C. Water from adjacent fire hydrants, public or private water lines

shall be metered. Written approval from the property owner shall be obtained prior to the use of suitable water from ponds, creeks or private owners.

D. Watering bags shall be used to water trees. Provide slow release, UV stabilized, polyethylene watering bag with black polypro straps and nylon zippers.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. Contractor shall lay out individual plant locations and areas for plantings.

2. PLANTING LAYOUT: Notify the Design ProfessionalOwner once plant locations are staked, and vegetation areas are outlined prior to installation of Plants. Contractor shall adjust locations when requested, and obtain acceptance of layout before planting.

B. Project Conditions

1. Contractor shall coordinate planting per Section 02937 Green Stormwater Infrastructure Site Activity Plan. Planting seasons shall be as follows:

a. Trees and shrubs (woody plants):

1) Spring: February 15th to May 15th

2) Fall: October 15th to November 30th

b. Grasses and perennials (herbaceous plants):

1) Spring: April 15th to May 15th

2) Fall: September 15th to October 30th

2. Proceed with and complete landscape work as rapidly as portions of the site become available, working within seasonal limitations for each kind of landscape work required.

3. Planting dates outside of the specified planting seasons must be approved by the Design ProfessionalOwner. Contractor shall notify the Design ProfessionalOwner in the event of planting discrepancies and if seasonal conditions become abnormal. Planting operations shall not be performed during time of extreme drought, when ground is frozen, or during times of other unfavorable weather. Proceed with planting only when existing and forecasted weather conditions permit. Contractor shall assume full and complete responsibility for all such plantings and operations.

4. Contractor shall examine areas to receive Plants for compliance with requirements and conditions affecting

installation and performance. When unsatisfactory conditions for plant growth are encountered, including, but not limited to rubble fill, adverse drainage conditions, or obstructions, notify the Design ProfessionalOwner before planting. Proceed with installation only after unsatisfactory conditions have been corrected to the satisfaction of the Design ProfessionalOwner.

5. At time of planting, the top six (6) inches of all areas to be planted shall be free of stones greater than one-half (1/2) inch, weeds and foreign matter.

C. Control and Protection

1. Prior to planting activities, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Contractor shall protect structures, utilities, sidewalks, pavements, and other facilities, lawns and existing vegetation from damage caused by planting operations.

3.02 INSTALLATION

A. Fine Grading: Grade planting areas to a smooth, uniform surface plane with a loose, uniformly fine texture.

1. Perform grading to finished grade elevations identified in the Drawings. Roll and rake, remove ridges, and fill depressions to meet finished grade.

2. Limit fine grading to areas that can be planted in the immediate future.

3. Wet surface thoroughly and allow to dry before planting. Do not create muddy soil.

4. Restore areas if soil loss has occurred or planting area has otherwise been disturbed after finished grading, before planting.

B. Planting Pit Excavation

[1. Trees and Shrubs:

a. Excavate circular pits of the dimensions as shown on the tree and shrub details in the Drawings. Scarify sides of plant pit smoothed during excavation.

[b. Trees: Excavate pit one (1) inch shallower than root ball depth.]

[c. Shrubs: Excavate pit two (2) inches shallower than root ball depth.]]

[2. Grasses and Perennials: Dig holes large enough to allow

spreading of roots as shown on the grasses and perennials detail.]

3. Contractor shall notify the Design ProfessionalOwner if the following conditions are encountered:

a. Obstructions: Unexpected rock or obstructions detrimental to trees or shrub placement or growth are encountered in excavations. Where hardpan layer is encountered, drill six (6) inch diameter holes into free-draining strata or to a depth of ten (10) feet from subgrade, whichever is less, and backfill holes with three-quarter (3/4) inch storage aggregate media.

b. Drainage: Subsurface soil conditions reveal unexpected water seepage or retention in tree or shrub pits.

C. Planting

1. Installation shall be per the Drawings.

2. Only as many Plants as can be planted and watered on that same day shall be distributed in a planting area. Do not prune trees and shrubs at time of installation except to remove damaged growth.

[3. Treat entire plant pit or bed with pre-emergent herbicide in accordance with manufacturer's recommendations.]

[4. Tree and Shrub Planting

a. Balled and Burlap Stock: Do not use ball and burlap stock if root ball is cracked or broken before or during planting operations. Locate Root Flare and remove any extra soil prior to placing tree or shrub into pit to locate final elevation.

1) Set root ball plumb and in center of pit or trench with the Root Flare flush above adjacent Finished Grades.

2) Remove burlap twine and cage from top two-thirds (2/3) of root balls and partially from sides after gentle placement in planting holes, but do not remove from under root balls. Remove pallets, if any, before setting.

3) Place planting soil around root ball in layers, tamping to settle mix and eliminate voids and air pockets.

4) When pit is approximately one-half (1/2) backfilled, water thoroughly before placing remainder of backfill.

5) Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil.

b. Container-Grown Stock: Container shall not be removed from Plants prior to Plants being set out in the designated planting area. Plants shall be removed in such a manner that the root ball is not broken. Refer to detail for correct installation.

1) If circling or diving roots are found, shave all sides of the root ball including the bottom to prevent root girdling.

2) Set Plants plumb and hold rigidly in position until planting soil has been tamped firmly around root ball.

3) After the plant has been placed, additional backfill consistent with planting soil shall be added to the hole to cover approximately one-half (1/2) of the height of the root ball. At this stage, water shall be added to the top of the partly filled hole to thoroughly saturate the root ball and adjacent planting soil. Finish filling the hole with planting soil and tamp firmly.

4) All Plants which settle deeper than specified on the planting details shall be raised to the correct level.]

[5. Grasses and Perennial Planting

a. Containers or flats shall not be removed from Plants prior to Plants being set out in the designated planting area as specified in the Drawings.

b. Plant shall be removed in such a manner that the root ball is not broken.

c. Remove Plants from containers with enough soil around roots to form a plug. Do not damage roots.

d. Place plant in hole, and work planting soil around roots to eliminate air pockets. Leave a slight saucer indentation around Plants to hold water.

e. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

f. Protect Plants from hot sun and wind; remove protection if Plants show evidence of recovery from transplanting shock.]

[D. Guying and Staking

1. Installation shall be per the Drawings.

2. Stake trees with a two (2) inch caliper and less.

3. Use a minimum of two (2) stakes of length required to penetrate at least 18 inches below bottom of backfilled

excavation and to extend at least 54 inches above grade.

4. Set stakes vertically and space to avoid penetrating root balls or root masses.

5. Support trees with straps at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.

6. Set stakes in line with, and on opposite sides of the trunk placed in North/South direction so that the line between stakes is perpendicular to the direction of the prevailing wind.]

[E. Mulch

1. [Mulch shall be placed to the lines, grades, and depths specified in the Drawings.][Mulch shall be utilized at a minimum three (3) inch depth.]

2. [Mulch extents shall be equal to planting pit disturbance area. Place mulch away from trunk and trunk flare. Berm outer edges of mulch ring to create a saucer form.]]

[F. Landscaping Edging

[1. Steel Edging Installation

a. Install steel edging where indicated according to manufacturer's installation recommendations.

b. Anchor with steel stakes spaced approximately 48 inches apart, driven below top elevation of edging.

c. Steel edging shall not be visible above sod or organic wood mulch upon completion of plantings and sod installation.]

[2. Concrete Ribbon Curb Edging: Install concrete ribbon curb edging per Section 02942 Green Stormwater Infrastructure Above Grade Barriers.]

[3. V-Cut Edging: Dig or machine cut natural 30 degree bevel cut, [eight (8) inch minimum in width and six (6) inch minimum in depth][to the depths and dimensions detailed in the Drawings].]

[4. Decorative Gravel

a. Install permeable liner a minimum four (4) inches below Finished Grade, with edges wrapped a minimum of four (4) inches.

[b. Install steel edging per Part 3.02, F., 1.]

c. Place decorative gravel to the lines, grades, and depths specified in the Drawings. Decorative gravel shall cover all fabric, fabric shall not be visible through gravel layers.]

G. Installation of Miscellaneous Products

1. As directed by the Owner, apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage to protect during digging, handling, and transportation. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two (2) weeks after planting.

2. If planted in fall, wrap trees of two (2) inch caliper or larger with trunk-wrap tape. Start at base of trunk and spiral cover trunk to height of first branches. Overlap wrap, exposing half the width, and securely attach without causing girdling. Remove trunk-wrap tape in March and dispose of trunk-wrap tape per Part 3.04. Do not use trunk-wrap tape for trees planted in spring.

H. Watering

1. Container Plants: Water container plant materials at the following rate and frequency:

a. First Week: One (1) inch per day, every other day.

b. Second Week: One (1) inch per day, every third day.

c. Third Week: One (1) inch per day, every fourth day.

2. Trees: Water trees at the following rate and frequency:

a. Two (2) inch caliper trees: Fill bag one (1) time per week

b. Greater than two (2) inch caliper to three (3) inch caliper trees: Fill bag two (2) times per week.

c. Greater than three (3) inch caliper to five (5) inch caliper: Fill bag three (3) times per week.

3. After the third week and prior to Certificate of Substantial CompletionAchievement of Full Operation, water as needed to ensure healthy and vigorous plants.

4. Contractor shall adjust watering rate and frequency as necessary to adapt to rainfall and to prevent puddles, ponding, or runoff. Do not water to the point of runoff.

3.03 TOLERANCES

[A. Trees and shrubs shall be measured according to ANSI Z60.1 with branches and trunks or canes in their normal position. Do not prune to obtain required sizes.

1. Tree size shall be greater than or equal to specified caliper. Take caliper measurements six (6) inches above ground for trees up to 4.5-inch caliper size, and 12 inches above ground for larger sizes.

2. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip-to-tip.]

B. Acceptable trees and shrubs shall be in a vigorous, thriving condition as determined by the Owner prior to the end of the Establishment Period. Plants shall be free of dead or dying branches or branch tips, and shall bear foliage of a normal density, size and color.

C. Acceptable perennial and ornamental grass stands will consist of 90 percent coverage over the entire area and contain health mature or developing plants representative of the original species planted prior to the end of the Establishment Period.

D. Plant materials are to be inspected to certify that all Plants have been installed according to the Drawings and are acceptable. Design ProfessionalOwner will inspect Plants upon written request from the Contractor.

E. Any plant that is dead, or is not in satisfactory health as determined by the Design ProfessionalOwner will be replaced by the Contractor at no additional cost to the Owner.

F. AS-BUILT DRAWINGS; During the course of installation, carefully record in red line on a print of the planting drawings all changes made to the planting layout during installations; approved by the Design ProfessionalOwner.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. Clean wheels of vehicles prior to leaving Site to avoid tracking soil onto roads, sidewalks, or other areas.

3.05 PROTECTION

A. Contractor is responsible for protection of Plants from damage due to landscape operations, operations by other contractors and trades, and others.

B. The Contractor shall implement control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection, including temporary seeding, to protect the green stormwater infrastructure facility until vegetation is fully established and the entire upstream tributary area is stabilized.

C. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

D. Erect visible barricades and warning signs as required to protect newly planted areas from traffic. Maintain visible barricades throughout Establishment Period or until substantial and healthy stand of grass is established.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility and adjacent areas disturbed during construction through the Establishment Period as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

[B. Remove tree stakes after one growing season if root system is stable. If root system is not stable enough for tree to remain upright, reattach and adjust connection to accommodate for new growth and leave stakes for one more growing season.]

3.07 POST-CONSTRUCTION TESTING

A. The Design ProfessionalOwner reserves the right to take and analyze samples of materials for conformity to specifications at any time. Rejected materials shall be immediately removed from the Site at the Contractor's expense. The cost of testing of materials not meeting specifications shall be paid by the Contractor.

3.08 WARRANTY

A. The Contractor shall warrant the green stormwater infrastructure Plants through the duration of the Establishment Period.

B. If at any time during the Establishment Period the plantings become damaged due to improper erosion control, administration of maintenance activities, or frequency of maintenance activities, the Contractor shall replace the Plants and fully restore the green stormwater infrastructure facility and any damaged components as determined by the Design ProfessionalOwner, at no additional cost to the Owner.

-- End of Section --

SECTION 02952

GREEN STORMWATER INFRASTRUCTURE NATIVE GRASS AND WILDFLOWER SEEDING

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding is to provide requirements for seeding native grasses and wildflowers.

B. Definitions

1. Dormant Seeding: Seeding in fall time when ground is not frozen but cold enough so that germination of seed will not occur until the following spring.

2. Nurse Crop: Temporary vegetation to help suppress weeds and manage soil erosion when project conditions are outside of the native grass and wildflower seeding planting seasons.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for native and wildflower seed installation, depicted in the Drawings and specified herein. Seed shall be paid for by Unit PriceLump Sum Price and measured as follows:

Native Grass and Wildflower Seeding Measurement and Payment Units

Item	Unit
[Nurse Crop Seed]	[Pounds/Acre][Pounds/Square Foot]
[Native Seed]	[Pounds/Acre][Pounds/Square Foot]
[Wildflower Seed]	[Pounds/Acre][Pounds/Square Foot]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02946 Green Stormwater Infrastructure Soil and Aggregate

02947 Green Stormwater Infrastructure Topsoil

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150	Division II Construction and Material Specification, Erosion and Sediment Control

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA)

USDA FSA	United States Department of Agriculture, Federal Seed Act

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

SEEDING NOTIFICATION

NURSE CROP SEEDING NOTIFICATION

SD-03 Product Data

PRODUCT DATA

SD-07 Certificates

SEED CERTIFICATION

NURSE CROP SEED CERTIFICATION

1.06 QUALITY ASSURANCE

A. Supplier Qualifications; Seed supplier shall have certificates of inspection as required by governmental authorities.

B. Installer Qualifications

1. Work shall be performed by a qualified installer per Section 02937 Green Stormwater Infrastructure Site Activity Plan, specialized in native seed installation and establishment with five (5) years recent experience, whose work has resulted in the successful installation of native seeding, similar in material, design, and extent.

2. The field supervisor shall have a Bachelor of Science Degree in Horticulture, Botany, Soil Physics, Agronomy, General Agriculture, Agricultural or Biological Engineering, or a related field [as determined by the Design ProfessionalOwner]. The field supervisor shall be identified by the Contractor and shall be on the Site during the following Work:

a. Soil preparation for native grass and wildflower seeding;

b. Native grass and wildflower seeding;

c. Native grass and wildflower establishment.

C. Ecological Consultant (Third Party); Contractor shall engage an experienced Ecological Consultant who has successfully completed quality assurance and construction oversight of native seed installation with the Work. The Ecological Consultant shall not be affiliated with the contracted seed installer or the primary landscape Contractor for the Work. The Ecological Consultant shall report directly to the Contractor, shall be present during both onsite and at meetings, and shall issue daily progress reports during preparation and seeding operations to the Design ProfessionalOwner. Ecological Consultant shall provide maintenance recommendations to be implemented by the installation and maintenance Contractor to be included in required submittals per Section 02957 Green Stormwater Infrastructure Establishment.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications.

B. SEED CERTIFICATION; Submit certification from seed vendor for sources of seed blend at least seven (7) days in advance of delivery to Site. Certification shall include:

1. The botanical and common name and percentage by weight of each species and variety;

2. Percentage germination, purity, and weed seed;

3. Master label, year of production, and date of packaging.

C. PRODUCT DATA; Submit product data for the following, including but not limited to product name, product instructions, supplier name, address, and phone:

1. Organic Soil Conditioner;

2. Straw Mulch;

3. Erosion Control Blanket.

D. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the Design ProfessionalOwner. Such inspection may be made at the place of manufacture or the Site after delivery.

E. Seed shipments shall include the following information:

1. State of Origin;
2. Year of Harvest;
3. Genus and Species Identification;
4. Seed Lot Number;
5. Packaged Quantity;
6. Identification of Seed Supplier;
7. Supplier Certification Number;
8. State of Supplier Registration;
9. Percent Pure Live Seed (PLS) Per Seed Lot;
10. Percent Germination;
11. Percent Weed Seed;
12. Percent Hard Seed;
13. Percent Foreign Matter;
14. Identification of Noxious Weed Seed;
15. Date of Seed Testing;
16. Identification of Seed Testing Agency.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Deliver packaged seed materials in original sealed, labeled, and undamaged containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery and while stored at Site.

PART 2 PRODUCTS

2.01 [NATIVE GRASS] [AND] [WILDFLOWER] SEED

A. Seed shall be fresh, clean, dry, pure-live seed, complying with USDA FSA and Missouri Department of Agriculture regulations for purity, germination, and noxious weeds.

B. Seed lots, unblended, shall be provided to Ecological Consultant in original unopened containers for agro-histological determination and re-testing.

C. The Master label shall be produced by the horticulturist, and shall be sealed according to the appropriate laws and regulations.

D. Provide fresh, clean, new-crop seed complying with tolerances for purity and germination as established by Association of Official Seed Analysts.

E. Provide seed composed of grass and wildflower species and

varieties, proportions by weight, minimum percentages of purity, germination, and maximum percentage of weed seed as specified in the Drawings.

2.02 NURSE CROP SEED

A. Seed shall be a nurse crop species of Grain Rye with 80 percent minimum pure live seed.

B. NURSE CROP SEED CERTIFICATION; Submit certification from seed vendor including:

1. The botanical and common name, origin and percentage by weight of each species and variety;
2. Percentage germination, purity, and weed seed;
3. Identity of noxious weeds;
4. Date of seed test.

2.03 PLANTING SOIL

A. Planting soil within landscaping areas shall be growing media or topsoil material as specified in the Drawings and in accordance with Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media and 02947 Green Stormwater Infrastructure Topsoil.

2.04 FERTILIZER

A. Fertilizer shall be slow-release, granular or pelleted fertilizer, consisting of 50 percent water-insoluble nitrogen.

B. Fertilizer shall be commercial fertilizer of neutral character with some elements derived from organic sources, containing:

1. Phosphoric Acid: Not less than four (4) percent
2. Potassium: Not less than two (2) percent
3. Nitrogen: Not less than three (3) pounds of actual Nitrogen per 1,000 square feet of turf area in a form that will be available during initial growth period

C. Do not use fertilizer between May 1st and September 15th.

D. Native seed stands shall not be fertilized for the first one (1) year after planting, as approved by Design ProfessionalOwner.

E. Use of fertilizers shall be based upon soil testing need, as approved by Design ProfessionalOwner.

2.05 EROSION CONTROL BLANKET

A. Erosion control blanket shall be used on seeding areas with slopes exceeding 6:1 (horizontal:vertical). Erosion control blanket shall meet the requirements of APWA 2150 and shall have a biodegradable classification, not a photodegradable classification.

2.06 ORGANIC SOIL CONDITIONER

A. Organic soil conditioner shall be mycorrhizal inoculant for seed bed preparation and used per manufacturer's specifications.

2.07 STRAW MULCH

A. Straw mulch shall be air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley and used where erosion control blanket is not required.

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking

1. Contractor shall lay out seeding areas.

2. SEEDING NOTIFICATION; Contractor shall notify the Design ProfessionalOwner once locations are staked and vegetation areas are outlined. Contractor shall adjust locations when requested, and obtain acceptance of layout before seeding.

B. Project Conditions

1. Contractor shall coordinate seeding per the Site Activity Plan. Fall planting season allows for Dormant Seeding. Planting seasons shall be as follows:

a. Spring: March 15th to May 31st

b. Fall: November 15th to December 30th

2. Seeding dates outside of the specified planting seasons shall be approved by the Design ProfessionalOwner. Contractor shall notify the Design ProfessionalOwner in the event of seeding discrepancies and if seasonal conditions become abnormal. Proceed with seeding only when existing and forecasted weather conditions permit.

3. Contractor shall examine areas to be seeded for compliance with requirements and conditions affecting installation and performance. When unsatisfactory conditions for native plant growth are encountered, including, but not limited to rubble fill, adverse drainage conditions, or obstructions, notify the Design ProfessionalOwner before seeding. Proceed with installation only after unsatisfactory conditions have been corrected to the satisfaction of the Design ProfessionalOwner.

C. Control and Protection

1. Prior to planting activities, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Install erosion control blanket and nurse crop seeding when Site conditions do not allow for timely seeding of native grass and wildflowers and soil in areas to receive native seed may be subject to erosion.

3. Contractor shall protect structures, utilities, sidewalks, pavements, and other facilities, lawns and existing vegetation from damage caused by seeding operations.

3.02 INSTALLATION

A. Soil Preparation

1. Prior to seeding operation in areas with a temporary seeding installation, the Contractor shall mow the nurse crop to two (2) inches in height, remove thatch and any remaining erosion control blanket, and drill seed into the nurse crop with a 'Truax' brand type drill seeder or approved equal.

2. Prior to seeding operations in fine grade areas, the Contractor shall prepare the areas to receive native seed by cultivating the soils to a depth of two (2) inches to produce a fine seed bed. The seed bed shall be smooth, reasonably free of rocks, soil clods, trash, and other debris.

3. Broadcast the organic soil conditioner and inoculants onto the prepared seed bed at the rate of 20 pounds per 1,000 square feet with equipment approved by the Design ProfessionalOwner.

B. Fine Grading: Grade seeding areas to a smooth, uniform surface plane with a loose, uniformly fine texture.

1. Perform grading to finished grade elevations identified in the Drawings. Roll and rake, remove ridges, and fill depressions to meet finished grade.

2. Limit fine grading to areas that can be seeded in the immediate future.

3. Wet surface thoroughly and allow to dry before planting. Do not create muddy soil.

4. Restore areas if eroded or otherwise disturbed after fine grading, before seeding.

C. Nurse Crop Seeding

1. Nurse Crop seeding shall be installed when site and/or seasonal conditions do not allow for seeding or sodding of the type specified.

2. NURSE CROP SEEDING NOTIFICATION; Notify Design Professional Owner when nurse crop seeding is warranted.

3. Nurse crop seeding shall be installed at 30 pounds per acre to produce a nurse crop until the permanent seed per Part

2.01 or sod per Part 2.02 can be installed per Part 3.01.

D. Seeding

1. Drill Seeding: Sow seeds Truax-type seeding machine that accurately meters the seed types and mixes all seeds uniformly during seeding.

a. The seeding machine shall have the following features:

1) Minimum of two (2) seed boxes to separate fine seeds from large/fluffy seeds;

2) Special feed mechanisms and agitators to evenly distribute the native seeds at a uniform depth;

3) Disc furrow openers and packer wheels or a cultipacker roller to cover the seed and firm the soil after seed placement;

4) Scrapers on the disc openers to prevent moist soil from building up;

5) Maximum row spacing of eight (8) inches.

b. Deliver seed from all boxes and place uniformly into the soil to obtain a final planting depth of one-fourth (1/4) inches.

c. The path of the drill seeding shall be done at a right angle to that of the drainage patterns. Contractor shall make two (2) passes over the entire area, 90 degrees to each other for full coverage.

2. Broadcast Seeding: Use broadcast or drop seed methods where restricted by steep slopes or other areas not accessible to a seeding machine.

a. The broadcast seeder shall have the following features:

1) Dual seed compartments for small seed and large/fluffy seed;

2) Auger agitator and picker wheels to handle fluffy seed;

3) Agitator in small seed compartment;

4) Slide control gate to set feeding rate for the small seed compartment;

5) Ten (10) inch diameter disc to sling seed uniformly on the soil surface.

b. After broadcast seeding, incorporate seed into soil by a light dragging, raking, or harrowing.

c. Roll or pack area to press the soil tightly against the seed and firm the seedbed.

E. Seed Protection

1. Protect seeded slopes greater than 6:1 (horizontal:vertical) with erosion control blanket installed and stapled per manufacturer's recommendations.

2. Protect seeded slopes less than 6:1 (horizontal:vertical) by spreading straw mulch as specified in Part 2.07, after completion of seeding operations.

F. Mulching: Mulching shall be done within 24 hours following the seeding operation except in the case of wood cellulose type mulch.

1. Straw mulch shall be spread uniformly in a continuous blanket at a depth of not less than 1.5 inches and not more than two (2) inches loose measurement (approximately 1.5 to 2 tons per acre).

2. Mulch shall be spread by hand or by a blower type mulch spreader.

3. Blower type mulch spreaders shall be adjusted and operated in such a manner as to prevent excessive breakage of the mulch material. If this cannot be accomplished, the mulch shall be spread by hand.

4. Care shall be exercised to ensure that all wire from baled hay is collected as it is removed from the bale.

5. Mulching shall be started at the windward side of relatively flat areas, or at the upper part of a steep slope, and continued uniformly until the area is covered.

6. The mulch shall not be bunched.

7. No mulch shall be spread unless it can be anchored on the same day. The straw mulch shall be anchored in the soil to a depth of 2 to 3 inches be a notched disk set straight or a mulch crimping machine. The machine shall be weighted and operated in such a manner to secure the mulch firmly in the ground to form a soil binding mulch and prevent loss or bunching of the hay by wind. Two (2) or more passes may be required to anchor the mulch to the satisfaction of the Design ProfessionalOwner.

3.03 TOLERANCES

A. Finished Grade: The Contractor shall place materials based on the line and grade specified in the Drawings within 0.1 feet vertical tolerance.

B. Satisfactory Seed Areas

1. Native grass and wildflower stand shall control erosion through root mass development. There shall be no occurrence of rills or gullies.

2. Native grass and wildflower stand shall contain no less than

85 percent healthy mature or developing plants per square foot with a population distribution per 10,000 square feet representative of ratios in the original blend.

3. Weeds shall be controlled through competition with the desired plants, and that mowed bio-mass is not accumulating in such a manner to be detrimental to existing plant materials as determined by the Design ProfessionalOwner.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. Clean wheels of vehicles prior to leaving Site to avoid tracking soil onto roads, sidewalks, or other areas.

3.05 PROTECTION

A. Contractor is responsible for protection of seed from damage due to landscape operations, operations by other contractors and trades, and others.

B. The Contractor shall implement control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully stabilized.

C. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

D. Erect visible barricades and warning signs to protect newly seeded areas from traffic. Maintain barricades throughout Establishment Period and until substantial and healthy stand of specified plants is established.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility and adjacent areas disturbed during construction through the Establishment Period, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall warrant the green stormwater infrastructure [native grass][and][wildflower] seeding through the duration of the Establishment Period.

B. If at any time during the Establishment Period the facility becomes damaged due to improper erosion control, maintenance activities, or frequency of maintenance activities, the Contractor shall restore the green stormwater infrastructure

facility and any damaged components as determined by the Design ProfessionalOwner, at no additional cost to the Owner.

-- End of Section --

SECTION 02953

GREEN STORMWATER INFRASTRUCTURE NON-NATIVE SEEDING AND SODDING

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding is to provide requirements for furnishing and applying limited soil amendments, seeding, sodding, reconditioning existing lawn areas, and replanting unsatisfactory or damaged lawns affected by execution of the Work.

B. Definitions

1. Certified Seed: Progeny of breeder, foundation or registered seed, handled under procedures acceptable to the Department of Agriculture and Forestry to maintain satisfactory genetic purity and identity. Certification color is Blue Tag or Gold Tag.

2. Cover Crop: Temporary vegetation to help suppress weeds and manage soil erosion when project conditions are outside of the non-native seeding and sodding planting seasons.

3. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath topsoil.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for seeding and sodding, depicted in the Drawings and specified herein. Seed and sod shall be paid for by Unit Price Lump Sum Price measured as follows:

Non-Native Seeding and Sodding Measurement and Payment Units

Item	Unit
[Temporary Seed]	[Pounds/Acre] [Pounds/Square Foot]
[Turfgrass Seed]	[Pounds/Acre] [Pounds/Square Foot]
[Turfgrass Sod]	[Square Feet] [Square Yards]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02947 Green Stormwater Infrastructure Topsoil

02951 Green Stormwater Infrastructure Plants

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2150 Division II Construction and Material Specification, Erosion and Sediment Control

TURFGRASS PRODUCERS INTERNATIONAL (TPI)

TPI Guideline Specifications to Turfgrass Sodding

UNITED STATES DEPARTMENT OF AGRICULTURE (USDA)

USDA FSA United States Department of Agriculture, Federal Seed Act

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

TEMPORARY SEEDING NOTIFICATION

SD-03 Product Data

SOIL AMENDMENTS

SD-07 Certificates

TURFGRASS SEED CERTIFICATION

TURFGRASS SOD SEED CERTIFICATION

TEMPORARY SEED CERTIFICATION

1.06 QUALITY ASSURANCE

A. Installer Qualifications

1. Work shall be performed by a qualified installer per Section 02937 Green Stormwater Infrastructure Site Activity Plan, whose work has resulted in the successful installation of

seeding and sodding, similar in material, design, and extent.

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the Design ProfessionalOwner. Such inspection may be made at the place of manufacture or the Site after delivery.

B. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately. All materials which have been damaged after delivery or installation will be rejected, removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Turfgrass Seed: Deliver turfgrass seed in original sealed, labeled, and undamaged containers.

B. Turf Sod: Harvest, deliver, store, and handle turf sod according to requirements of the TPI.

PART 2 PRODUCTS

2.01 TURFGRASS SEED

A. Seed shall be fresh, clean, dry, new-crop seed, complying with the USDA FSA regulations.

B. TURFGRASS SEED CERTIFICATION; Submit certificates and supplier seed label for turfgrass seed including the following:

1. The botanical and common name, origin and percentage by weight of each species and variety;

2. Percentage germination, purity, and weed seed;

3. Identity of noxious weeds;

4. Date of seed test.

C. Seed shall meet the following requirements for germination, purity, and weed seed:

1. Germination: 85 percent (min)

2. Purity: 98 percent (min)

3. Weed Seed: 0 percent (max)

D. Seed shall have Blue Tag certification.

E. Moldy seed or seed that has been damaged in storage shall not be

used.

F. Seeded areas shall be a blend of 90 percent Turf-Type Tall Fescue and ten (10) percent Kentucky Bluegrass fulfilling the following requirements:

1. Blend shall be at least three (3) improved Turf-Type Tall Fescue species combined with at least one (1) Kentucky Bluegrass species.

2. Blend shall not include aggressive Kentucky Bluegrass cultivars.

3. Blend shall not include Forage-Type Tall Fescues.

4. Turf-Type Tall Fescues shall have a 70 percent average endophyte level minimum.

2.02 TURFGRASS SOD

A. Sod shall be certified turfgrass sod complying with TPI specifications for machine-cut thickness, size, strength, moisture content, and mowed height, free of weeds.

B. TURFGRASS SOD SEED CERTIFICATION; Provide certificates and supplier seed label for turfgrass sod seed including:

1. The botanical and common name, origin and percentage by weight of each species and variety;

2. Percentage germination, purity, and weed seed;

3. Identity of noxious weeds;

4. Date of seed test.

C. Sod shall meet the following requirements for germination, purity, and weed seed:

1. Germination: 85 percent (min)

2. Purity: 98 percent (min)

3. Weed Seed: 0 percent (max)

D. Seed used for sod shall have Gold Tag certification. [If Gold Tag certification seed is not available, then seed shall be the highest quality Blue Tag certification seed available, at the discretion of the Design Professional.]

E. Sod shall have uniform density, color, and texture of the turfgrass species, strongly rooted, and capable of vigorous growth and development when planted.

F. Sodded areas shall be a blend of 90 percent Turf-Type Tall Fescue and ten (10) percent Kentucky Bluegrass:

1. Blend shall be at least three (3) improved Turf Type Tall Fescues combined with at least two (2) Kentucky Bluegrass

species.

2. Turf-Type Tall Fescues shall have a 70 percent average endophyte level minimum.

2.03 TEMPORARY SEED

A. Temporary seeding shall be installed when site and/or seasonal conditions do not allow for seeding or sodding of the type specified.

B. TEMPORARY SEEDING NOTIFICATION; Notify Design ProfessionalOwner when temporary seeding is warranted.

C. Temporary seed shall be per APWA 2150, Part 2153.5, A.

D. TEMPORARY SEED CERTIFICATION; Submit certificates and supplier seed label for temporary seed including:

1. The botanical and common name, origin and percentage by weight of each species and variety;

2. Percentage germination, purity, and weed seed;

3. Identity of noxious weeds;

4. Date of seed test.

2.04 TOPSOIL

A. Topsoil shall be per Section 02947 Green Stormwater Infrastructure Topsoil.

B. SOIL AMENDMENTS; Submit product data of the following soil amendments, including but not limited to product name, product instructions, and supplier name, address, and phone:

1. Lime;

2. Sulfur;

3. Herbicides.

2.05 HERBICIDE

A. Herbicides shall be per Section 02951 Green Stormwater Infrastructure Plants.

2.06 SEED COAT

A. Seed Coat shall be cross-linked, modified acrylic polymer (CAS# 71042-87-0) with graphite (CAS#7782-42-5).

2.07 FERTILIZER

A. Fertilizer shall be slow-release, granular or pelleted fertilizer, consisting of 50 percent water-insoluble nitrogen.

B. Fertilizer shall be commercial fertilizer of neutral character

with some elements derived from organic sources, containing:

1. Phosphoric Acid: Not less than four (4) percent

2. Potassium: Not less than two (2) percent

3. Nitrogen: Not less than three (3) pounds of actual Nitrogen per 1,000 square feet of turf area in a form that will be available during initial growth period

C. Do not use fertilizer between May 1st and September 15th.

2.08 MULCH

A. Straw mulch shall be air-dry, clean, mildew and seed free salt hay or threshed straw of wheat, rye, oats or barely.

2.09 WATER

A. Water used in this Work shall be furnished by the Contractor and will be suitable for irrigation and free from ingredients harmful to plant life.

B. All watering equipment shall be furnished by the Contractor.

C. Water from adjacent fire hydrants, public or private water lines shall be metered. Written approval from the property owner shall be obtained prior to the use of suitable water from ponds, creeks or private owners.

PART 3 EXECUTION

3.01 PREPARATION

A. Project Conditions

1. Contractor shall coordinate seeding per the Site Activity Plan. Planting seasons shall be as follows:

a. Seed

1) Spring: March 15th to May 15th (or once temperatures are 60 degrees Fahrenheit and higher)

2) Fall: September 15th to October 15th (or once temperatures are 75 degrees Fahrenheit and lower)

b. Sod: Sod as temperatures allow. Do not sod when ground is frozen or ambient air temperatures are greater than 90 degrees Fahrenheit or less than 50 degrees Fahrenheit.

2. Seeding or sodding dates outside of the specified planting seasons shall be approved by the Design ProfessionalOwner. Contractor shall notify the Design ProfessionalOwner in the event of seeding discrepancies and if seasonal conditions become abnormal. Proceed with seeding only when existing and

forecasted weather conditions permit.

3. Contractor shall examine areas to be seeded or sodded for compliance with requirements and conditions affecting installation and performance. When unsatisfactory conditions for seed or sod growth are encountered, including, but not limited to rubble fill, adverse drainage conditions, or obstructions, notify the Design ProfessionalOwner before seeding or sodding. Proceed with installation only after unsatisfactory conditions have been corrected to the satisfaction of the Design ProfessionalOwner.

B. Control and Protection

1. Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Contractor shall protect structures, utilities, sidewalks, pavements, and other facilities, lawns and existing vegetation from damage caused by seeding and sodding operations.

3.02 INSTALLATION

A. Soil Preparation

1. Newly Graded Subgrades: Limit subgrade preparation to areas that will be planted in the immediate future.

a. Apply fertilizer directly to subgrade before tilling.

b. Mechanically scarify subgrade to a minimum depth of four (4) inches.

c. Remove and dispose of stones larger than one (1) inch in any dimension, sticks, roots, litter, debris, and extraneous matter per Part 3.04.

d. Thoroughly blend topsoil before spreading.

e. Apply soil amendments per Section 02946 and fertilizer on surface, and thoroughly blend topsoil.

f. Spread topsoil to a depth of four (4) inches but not less than required to meet finished grades after light rolling and natural settlement. Do not spread if topsoil or subgrade is frozen, muddy, or excessively wet.

2. Unchanged Subgrades: If areas are to be seeded or sodded in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare soil as follows:

a. Remove and dispose of existing vegetation per Part 3.04.

b. Mechanically scarify native soil to a minimum depth of six (6) inches.

c. Remove and dispose of stones larger than one (1) inch in any dimension, sticks, roots, litter, debris, and extraneous matter per Part 3.04.

d. Apply soil amendments per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media and fertilizers and mix thoroughly into top four (4) inches of soil. Mix soil to a homogeneous mixture of fine texture.

B. Fine Grading: Grade seeding and sodding areas to a smooth, uniform surface plane with a loose, uniformly fine texture.

1. Perform grading to finished grade elevations identified in the Drawings. Roll and rake, remove ridges, and fill depressions to meet finished grade.

2. Limit fine grading to areas that can be planted in the immediate future.

3. Wet surface thoroughly and allow to dry before planting. Do not create muddy soil.

4. Restore areas if eroded or otherwise disturbed after finished grading, before seeding or sodding.

C. Temporary Seeding: Temporary seeding shall be installed per APWA 2150, Part 2153.5, B. to produce a cover crop until the permanent seed per Part 2.01 or sod per Part 2.02 can be installed per Part 3.01.

D. Seeding

1. Sow seed at five (5) to six (6) pounds per 1,000 square feet.

a. Drill Seeding: Sow seed with a Brillion type seeding machine where applicable.

1) Evenly distribute seed by sowing equal quantities in two (2) directions at right angles to each other[, or three (3) directions in high maintenance areas, as directed by Design Professional].

b. Broadcast Seeding: Use broadcast or drop seed methods where restricted by steep slopes or other areas not accessible to a seeding machine.

1) Do not broadcast or drop seed when wind velocity exceeds five (5) miles per hour.

2) Rake seed lightly into top one-eighth (1/8) inch of topsoil, roll lightly, and water with fine spray.

c. Hydroseeding: Apply hydroseeding in a uniform and

consistent manner.

1) Mix seed, fertilizer and pulverized mulch with water, agitating constantly. Do not add seed to water greater than four (4) hours prior to application.

2) On slopes of 2:1 (horizontal:verical) or flatter, apply seed separately from fertilizer. Rake soil over seed to an average depth of one-half (1/2) inch.

3) On slopes steeper than 2:1 (horizontal:verical) apply seed and fertilizer in a single operation.

2. Seed Protection

a. Protect seeded slopes 4:1 (horizontal:vertical) or greater with erosion-control blankets installed and stapled per manufacturer's recommendations.

b. Protect seeded slopes less than 4:1 (horizontal:vertical) by spreading straw mulch as specified in Part 2.09, after completion of seeding operations. Spread uniformly to form continuous cover over seeded areas. Spread by hand, blower, or as approved by Design ProfessionalOwner.

c. Protect seeded areas against hot, dry weather or drying winds by applying compost within 24 hours after completion of seeding operations. Scatter compost uniformly to a depth of one-quarter (1/4) inch thick and roll to a smooth surface. Soak compost after spreading.

E. Sodding

1. Lay sod within 24 hours of harvesting. Do not lay sod if sod is dormant or if subgrade is frozen or muddy.

a. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap.

b. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation.

c. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface.

d. Work sifted topsoil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

2. Lay sod across angle of slopes exceeding 3:1 (horizontal:vertical). Anchor sod on slopes exceeding 4:1 (horizontal:vertical) with steel staples spaced per manufacturer recommendations but not less than two (2)

anchors per sod strip to prevent slippage.

3. Saturate sod with fine water spray within one (1) hour of planting. For first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1.5 inches below sod.

F. Mulching: Mulching shall be done within 24 hours following the seeding operation except in the case of wood cellulose type mulch.

1. Straw mulch shall be spread uniformly in a continuous blanket at a depth of not less than 1.5 inches and not more than two (2) inches loose measurement (approximately 1.5 to 2 tons per acre).

2. Mulch shall be spread by hand or by a blower type mulch spreader.

3. Blower type mulch spreaders shall be adjusted and operated in such a manner as to prevent excessive breakage of the mulch material. If this cannot be accomplished, the mulch shall be spread by hand.

4. Care shall be exercised to ensure that all wire from baled hay is collected as it is removed from the bale.

5. Mulching shall be started at the windward side of relatively flat areas, or at the upper part of a steep slope, and continued uniformly until the area is covered.

6. The mulch shall not be bunched.

7. No mulch shall be spread unless it can be anchored on the same day. The straw mulch shall be anchored in the soil to a depth of 2 to 3 inches be a notched disk set straight or a mulch crimping machine. The machine shall be weighted and operated in such a manner to secure the mulch firmly in the ground to form a soil binding mulch and prevent loss or bunching of the hay by wind. Two (2) or more passes may be required to anchor the mulch to the satisfaction of the Design ProfessionalOwner.

3.03 TOLERANCES

A. Finished Grade: The Contractor shall place materials based on the line and grade specified in the Drawings within 0.1 feet vertical tolerance.

B. Satisfactory Seed and Sod Areas

1. Area shall be uniform and free of weeds, bare spots exceeding five (5) by five (5) inches, and surface irregularities.

2. Reestablish areas that do not comply with requirements and continue maintenance until areas are satisfactory [as determined by the Design Professional].

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. Clean wheels of vehicles prior to leaving Site to avoid tracking soil onto roads, sidewalks, or other areas.

3.05 PROTECTION

A. Contractor is responsible for protection of seed or sod from damage due to landscape operations, operations by other contractors and trades, and others.

B. The Contractor shall implement control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection, including temporary seeding, to protect the green stormwater infrastructure facility until vegetation is fully established and the entire upstream drainage area is stabilized.

C. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

D. Erect visible barricades and warning signs to protect newly seeded or sodded areas from traffic. Maintain barricades throughout Establishment Period, as defined in Section 02957 Green Stormwater Infrastructure Establishment, and until substantial and healthy stand of specified plants is established.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility and adjacent areas disturbed during construction through the Establishment Period and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall warrant the green stormwater infrastructure seeding and sodding through the duration of the Establishment Period.

B. If at any time during the Establishment Period the facility becomes damaged due to improper erosion control, maintenance activities, or frequency of maintenance activities, the Contractor shall restore the green stormwater infrastructure facility and any damaged components as determined by the Design ProfessionalOwner, at no additional cost to the Owner.

-- End of Section --

SECTION 02954

GREEN STORMWATER INFRASTRUCTURE PIPING

PART 1 GENERAL

1.01 PURPOSE

A. Piping consists of all piping and appurtenances within a green stormwater infrastructure facility. Piping is primarily intended to convey stormwater to or away from the green stormwater infrastructure facility and to provide access or observation to the subsurface. Piping is also used to protect utilities from water damage, as well as to protect the green stormwater infrastructure facility from contamination from the utility.

1.02 MEASUREMENT AND PAYMENT

A. The Contractor shall provide all labor, material, and equipment required for piping installation and testing, dictated in the Drawings and specified herein. Piping shall be paid for by Unit PriceLump Sum Price and measured as follows:

Piping Measurement and Payment Units

Item	Unit
[HDPE Piping]	[Linear Feet]
[PVC Piping]	[Linear Feet]
[Reinforced Concrete Pipe (RCP)]	[Linear Feet]
[Ductile Iron Pipe (DIP)]	[Linear Feet]
[Fittings]	[Each]
[Cleanout]	[Each]
[Observation Well]	[Each]
[Anti-Seep Collar]	[Each]
[Utility Sleeves]	[Linear Feet]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02948 Green Stormwater Infrastructure Media Liners

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2208	Division II Construction and Material Specifications, Portland Cement Concrete Pavement
APWA 2500	Division II Construction and Material Specifications, Sanitary Sewers
APWA 2602	Division II Construction and Material Specifications, Storm Sewers - Pipe Sewer Construction

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM A615/A615M	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A775/A775M	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM D3034	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM F758	Standard Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F1760	Standard Specification for Poly(Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content

KANSAS CITY METRO MATERIALS BOARD SPECIFICATIONS (KCMMB)

KCMMB	Kansas City Metro Materials Board Specifications

MID-WEST CONCRETE INDUSTRY BOARD CONCRETE SPECIFICATIONS - CONCRETE PAVEMENT (MCIB)

MCIB	Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

PLACEMENT NOTIFICATION

BACKFILL NOTIFICATION

SD-02 Shop Drawings

SHOP DRAWINGS

SD-03 Product Data

MANUFACTURER INFORMATION

SD-07 Certificates

CONCRETE MIX DESIGN

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

[A. Design Professional to insert manufacturer/installer qualifications as applicable.]

[B. Not Applicable.]

1.07 QUALITY CONTROL

A. Prior to procurement of material and delivery to the Site, the Contractor shall submit quality control certificates, certifying the materials conform to specifications. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the Design ProfessionalOwner. Such inspection may be made at the place of manufacture or the Site after delivery.

B. All materials shall be subject to rejection at any time due to

failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately. All materials which have been damaged after delivery or installation will be rejected, removed and replaced at the Contractor's expense.

C. MANUFACTURER INFORMATION; Submit manufacturer information for each product, including, but not limited to supplier name, address and phone as well as product fabrication, delivery and handling, placement, installation, and protection information.

D. SHOP DRAWINGS; Submit shop drawings with a minimum of the following information, if applicable:

1. Structure dimensions (exterior and interior);

2. Pipe connections and sizes;

3. Flow lines and flow directions.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Piping and appurtenances shall be delivered, stored, and handled such that the material is installed in sound, undamaged condition.

B. Plastic piping and appurtenances shall be protected from direct sunlight and other heat sources to prevent curvature and/or deformation.

C. Manufactured products shall be delivered, stored and handled per manufacturer's recommendations.

PART 2 PRODUCTS

2.01 [UNDERDRAIN] [AND] [DISTRIBUTION] PIPE MATERIAL

[A. Reinforced Concrete Pipe (RCP): RCP, fittings and joints shall conform to APWA 2602, Part 2602.2, A.]

[B. Ductile Iron Pipe (DIP): DIP, fittings and joints shall conform to APWA 2500, Part 2502.2, B.]

[C. High Density Polyethylene (HDPE)

1. All HDPE pipe, fitting and joints shall be provided by manufacturers certified through the Plastic Pipe Institute (PPI) and/or the National Transportation Product Evaluation Program (NTPEP) third party certification program.

[2. Solid Wall HDPE Pipe

a. Solid wall HDPE pipe, fittings and joints shall conform to APWA 2602 Part 2602.2, D.]

[3. Perforated HDPE Pipe

a. Perforated HDPE pipe, fittings and joints shall conform to APWA 2602 Part 2602.2, D. for 12 inch to 60 inch

diameter pipe and AASHTO M252 for three (3) inch to ten (10) inch diameter pipe and shall have AASHTO Class II perforations.]]

[D. Polyvinyl Chloride (PVC) Pipe

1. Plastic pipe, fittings and joints shall contain an ultraviolet inhibitor to provide protection from exposure to direct sunlight per ASTM D3034, ASTM F758, or ASTM F1760.]

[a. Solid Wall PVC Pipe: PVC solid wall gravity pipe shall be Type PSM, PVC minimum SDR [35] with full diameter dimensions and shall conform to ASTM D3034. Straight pipe shall be furnished in lengths per ASTM D3034.]

[b. Perforated PVC Pipe

1) Perforated PVC pipe shall be Type PS-46 PVC and shall conform to ASTM F758. Straight pipe shall be furnished in lengths per ASTM D3034.

2) Alternately, solid PVC pipe per ASTM D3034 or ASTM F1760 may be used with drilled perforations.

3) Perforations shall be two (2) rows of one-half (1/2) inch diameter holes spread longitudinally, maximum six (6) inch spacing and shall be oriented 120 degrees apart (60 degrees either side of the pipe bottom). The top of pipe shall be marked for ease of installation.]

[2. PVC Fittings and Joints

a. Fittings for perforated PVC pipe shall be bell and spigot push-on joints meeting applicable requirements of ASTM D3212 (Exception: Internal pressure test and vacuum test are not required). The bell-end and spigot-end may be unperforated for a length equal to the depth of the socket and/or shoulder.

b. Gasket-type joints shall conform to ASTM D3212. Solvent-cement-type joints shall conform to ASTM F758.]]

[2.02 CLEANOUT

A. Cleanout shall be constructed of HDPE or PVC material.

B. Cleanout cap shall be threaded.

[C. For cleanout in pavement, cleanout frame and cover shall be Neenah R-1976 or approved equal. Cleanout shall be anchored to a minimum four (4) inch thick concrete collar per Part 2.07 atop minimum six (6) inch aggregate base per Part 2.06.]]

[2.03 OBSERVATION WELL

A. Observation well shall be constructed of HDPE or PVC.

B. Slotted well screen shall have 0.01 inch slot size.

[C. Observation well cap shall be threaded.]

[D. For observation well in pavement, observation well frame and cover shall be Neenah R-1976 or approved equal. Observation well shall be anchored to a minimum four (4) inch thick concrete collar per Part 2.07 atop minimum six (6) inch thick aggregate base per Part 2.06.]]

[2.04 ANTI-SEEP COLLAR

A. Anti-seep collar shall be constructed of HDPE material with a minimum thickness of one-fourth (1/4) inch.

B. Bolt shall be stainless steel.

C. Manufacturer shall be [Scheib Drainage Products] or approved equal.]

[2.05 UTILITY SLEEVE

A. Contractor shall coordinate with appropriate Utility Owner to verify special requirements regarding protection of utility. Contractor is responsible for procurement of all necessary materials to provide required utility protection.]

2.06 AGGREGATE BASE

A. Aggregate base shall be of the material specified in the Drawings, and shall meet the requirements of Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

[2.07 CONCRETE COLLAR

A. Concrete mix shall be 3,500 psi conforming to [MCIB,] [KCMMB] or approved equal for concrete collar unless otherwise specified in the Drawings. Submit CONCRETE MIX DESIGN certifying that concrete mix design for concrete collar meets the requirements of the specified mix.

B. Reinforcement: Shall be No. 4 rebar. Non-epoxy coated bars shall conform to ASTM A615/A615M. Epoxy coated bars shall conform to ASTM A775/A775M. Dowels shall be five-eighths (5/8) inch diameter by two (2) feet smooth dowels.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking: All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all structure locations and elevations. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

B. Project Conditions

1. Piping shall be installed only when weather and/or trench conditions are suitable. Water may be removed from pipe trench via sump pumping or other methods as approved by Design ProfessionalOwner.

[2. Design Professional to insert specific requirements.]

C. Control and Protection

1. Prior to installation, the perimeter of the green stormwater infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Prior to installing the underdrain system, temporary erosion control shall be in place to protect any existing downstream drainage system to which the underdrain system connects.

3. Stormwater bypass and/or dewatering measures shall be in place to keep the Site clean and dry for the duration of installation.

3.02 INSTALLATION

A. Excavation

[1. Excavation methods used shall conform to Section 02939 Green Stormwater Infrastructure Earthwork.]

2. Excavation shall extend to a depth such that the specified invert elevations, once fully installed, are located at the elevation shown in the Drawings. If an invert elevation is not specified, the Contractor shall consult the Design ProfessionalOwner to verify control elevations for the structure prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the piping to the lines and grades shown in the Drawings.

B. Permeable Liner: Permeable liner shall be installed per Section 02948 Green Stormwater Infrastructure Media Liners to the lines and grades specified in the Drawings.

C. Aggregate Base

1. Aggregate base shall be installed per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media to the lines, grades and depths specified in the Drawings.

2. Place aggregate base using methods that will not disturb or damage the piping material or the surrounding green stormwater infrastructure facility.

[3. Compaction shall be achieved using small, hand-held or walk

behind compactors to prevent damage to the structure or over-compaction of the surrounding areas intended for infiltration.]

D. Piping

1. Piping materials shall be inspected prior to placement, rejecting any damaged or defective pipe.

2. PLACEMENT NOTIFICATION; Notify the Design ProfessionalOwner at least 48 hours prior to placement of piping materials.

3. Piping shall be installed to the lines, grades and depths specified in the Drawings.

a. Pipe laying shall commence at the lowest point with continuous slope to provide unrestricted flow and eliminate low spots that could retain water.

b. Pipe shall be laid with ends abutting. Bell-and spigot type pipe shall be installed with the bell end upstream.

4. Cutting shall be performed in a manner to provide smooth, straight, cuts at right angles to the pipe axis, without damage to the pipe. Cuts shall be performed with mechanical pipe cutters, or as approved by the Design ProfessionalOwner.

5. The interior of all piping and appurtenances shall be clear of all foreign matter and debris.

6. Surfaces shall be wiped clean, dry, and free from oil and grease prior to jointing. Jointing shall be watertight.

7. Perforated pipe shall be laid as to center the perforations on the bottom of the pipe.

8. Piping materials damaged during installation shall be removed from the Site and replaced per Part 3.04 at the Contactor's expense.

[9. Contractor shall comply with detailed installation requirements as follows:

[a. RCP shall be installed per APWA 2602 Part 2602.3, B., a.]

[b. DIP shall be installed per APWA 2500 Part 2503.3, B.]

[c. HDPE shall be installed per APWA 2602 Part 2602.3, B., b.]

[d. PVC shall be installed per APWA 2500 Part 2503.3, B.]]

[E. Concrete: Shall be constructd per APWA 2208.]

[F. Cleanout

1. Cleanouts shall be installed to the lines, grades and depths specified in the Drawings.

2. Pipe connection shall be made watertight.]

[G. Observation Well: Observation wells shall be installed to the lines, grades and depths specified in the Drawings.]

[H. Anti-Seep Collar

1. Install anti-seep collar as specified in the Drawings.

2. Affix HPDE around pipe using bolts or other manufacturer required products.

3. Anti-seep collar shall be made watertight using appropriate non-shrink grout or other manufacturer required products.]

[I. Utility Sleeve

1. Install utility sleeve as specified in the Drawings.

2. Contractor shall coordinate with appropriate Utility Owner to verify special requirements regarding protection of utility. Contractor is responsible for installation of all necessary materials to provide required utility protection.]

J. Backfill

1. BACKFILL NOTIFICATION; Notify the Design ProfessionalOwner at least 48 hours prior to placement of backfill.

2. Contractor shall receive approval of all in-place pipes from the Design ProfessionalOwner prior to backfilling.

3. Backfill shall be placed to the lines, grades and depths specified in the Drawings.

3.03 TOLERANCES

A. The Contractor shall place materials based on the line and grade specified in the Drawings within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

[B. A maximum tolerance of one-fourth (1/4) inch on hole spacing and size will be allowed.]

C. FINISHED GRADE SURVEY VERIFICATION; Survey finished elevation of green stormwater infrastructure piping and submit to the Design ProfessionalOwner for review. Survey elevation shall be taken at specific point locations identified in the Drawings, including but not limited to invert elevations and top of structure elevations.

3.04 DISPOSAL OF MATERIALS

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site

Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary protection and control measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully stabilized.

3.06 MAINTENANCE

A. The Contractor shall maintain the green stormwater infrastructure facility per Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

[A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the piping. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.]

[C. The Contractor shall warrant the green stormwater infrastructure piping through the duration of the Establishment Period.

D. If at any time during the Establishment Period the piping fail to function due to improper erosion control, maintenance activities or frequencies, the Contractor shall replace the piping and fully restore the green stormwater infrastructure facility and any damaged components as determined by the Design ProfessionalOwner, at no additional cost to the Owner.]

-- End of Section --

SECTION 02955

GREEN STORMWATER INFRASTRUCTURE OUTLETS

PART 1 GENERAL

1.01 PURPOSE

A. Outlets allow excess stormwater to exit the green stormwater infrastructure facility when the capacity of the facility is exceeded. The outlet structure can control water levels both at the surface and in the subsurface of the green stormwater infrastructure facility. Stormwater above the finished grade of the green stormwater infrastructure is controlled with an overflow riser that is overtopped once the ponding elevation in the facility is exceeded.

1.02 MEASUREMENT AND PAYMENT

A. Contractor shall provide all labor, material and equipment required to install the outlet as shown in the Drawings and as specified herein. Outlet shall be paid for by Unit PriceLump Sum Price and measured as follows:

Outlets Measurement and Payment Units

Item	Unit
[PVC Riser Pipe]	[Linear Feet]
[HDPE Riser Pipe]	[Linear Feet]
[Fittings]	[Each]
[Metal Grate]	[Each]
[Manufactured Outlet Structure]	[Each]
[Concrete Base]	[Cubic Yard]
[Aggregate Base]	[Cubic Yard][Ton]

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02939 Green Stormwater Infrastructure Earthwork

02946 Green Stormwater Infrastructure Soil and Aggregate Media

02951 Green Stormwater Infrastructure Plants

02954 Green Stormwater Infrastructure Piping

02957 Green Stormwater Infrastructure Establishment

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN CONCRETE INSTITUTE (ACI)

ACI 301	Specifications for Structural Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 318	Building Code Requirements for Structural Concrete

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM C94/C94M	Standard Specification for Ready-Mixed Concrete
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A615/A615M	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation

KANSAS CITY METROPOLITAN CHAPTER AMERICAN PUBLIC WORKS ASSOCIATION (APWA)

APWA 2208	Division II Construction and Material Specifications, Paving - Portland Cement Concrete Pavement

KANSAS CITY METRO MATERIALS BOARD SPECIFICATIONS (KCMMB)

KCMMB	Kansas City Metro Materials Board Specifications

MID-WEST CONCRETE INDUSTRY BOARD CONCRETE SPECIFICATIONS - CONCRETE PAVEMENT (MCIB)

MCIB	Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement

1.05 SUBMITTALS

SD-03 Product Data

MANUFACTURER INFORMATION

SHOP DRAWINGS

SD-07 Certificates

CONCRETE BASE MIX DESIGN

CONCRETE COLLAR MIX DESIGN

FINISHED GRADE SURVEY VERIFICATION

1.06 QUALITY ASSURANCE

[A. Concrete Manufacturer: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment. Manufacturer certified according to the National Ready Mixed Concrete Association (NRMCA) "Certificate of Ready Mixed Concrete Production Facilities."]

[B. Installer Qualifications: Design Professional to insert additional manufacturer/installer qualifications as applicable.]

[C. Testing Agency Qualifications

1. An independent agency, acceptable to the authorities having jurisdiction, qualified according to ASTM C1077 for testing indicated.

2. Personnel performing tests shall be ACI Concrete Strength Testing Technician and ACI Concrete Laboratory Testing Technician - Level 1. Testing Agency laboratory supervisor shall be an ACI Concrete Laboratory Testing Technician - Level 2.

D. Concrete Field Testing: Personnel conducting concrete field tests shall be qualified as ACI Concrete Field Testing Technician - Grade I.]

1.07 QUALITY CONTROL

A. Inspection and testing shall be performed by the Contractor/manufacturer in conformance with applicable standards. All material delivered to the Site shall have quality control certificates certifying the materials conform to specifications.

[B. Field testing of concrete shall be performed by the Contractor

once for every 50-cubic yard of concrete placed and shall conform to the requirements of APWA 2208.]

C. SHOP DRAWINGS: Submit shop drawings with a minimum of the following information, if applicable:

1. Supplier name, address and phone;

2. Structure dimensions (exterior and interior);

3. Pipe connections and sizes;

4. Flow lines/flow directions;

5. Grate and/or screening details including effective open area for outlet capacity. Approved or equal products must provide grate effective open area that is within an acceptable range to the specified product, as determined by the Design ProfessionalOwner.

D. The quality of all materials, the process of manufacture, and the finished products shall be subject to inspection and acceptance by the Design ProfessionalOwner. Such inspection may be made at the place of manufacture or on the Site after delivery.

E. All materials shall be subject to rejection at any time due to failure to meet any requirements specified herein. Material rejected after delivery to the Site shall be marked for identification and shall be removed from the Site immediately.

F. All materials which have been damaged after delivery will be rejected and replaced at the Contractor's expense. If materials are rejected after installation, they shall be repaired as accepted by the Design ProfessionalOwner, or removed and replaced at the Contractor's expense.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Materials shall be stored away from active grading or earthwork to avoid contamination with soil, sediment or debris.

[B. Manufactured products shall be delivered, stored and handled per manufacturer recommendations.]]

PART 2 PRODUCTS

[2.01 OVERFLOW RISER

A. Plastic Pipe and Fittings: Shall be solid PVC or HDPE pipe per Section 02954 Green Stormwater Infrastructure Piping of the size and depth specified in the Drawings.

B. Metal Frame and Grate: Shall be ductile iron per ASTM A536 Grade 70-50-05 and of the size and shape specified per the Drawings.]

C. Concrete Collar: Concrete mix shall be 4,000 psi conforming to [MCIB,] [KCMMB] or approved equal. Submit CONCRETE COLLAR MIX DESIGN certifying that concrete mix design for concrete collar meets the requirements of the specified mix.

[2.02 MANUFACTURED OUTLET STUCTURE

[A. Design Professional to specify recommended product or approved equal.]

B. Approved manufactured outlet structures include Nyloplast drain basins, Nyloplast water level control structures, Agridrain inline water level control structures, and Agridrain inlet water level control structures.

C. MANUFACTURER INFORMATION; Submit manufacturer information, product data and instructions for each product, including but not limited to structure type, size, material, effective open area, fabrication, delivery and handling, placement, installation, and protection.

[D. Structure Coating Material: All exposed plastic surfaces of structures shall have a black textured rubberized coating applied to the outer surface. Coating shall extend a minimum of 12 inches below the finished grade.]

[E. Concrete Base: Concrete mix shall be 4,000 psi conforming to [MCIB,] [KCMMB] or approved equal. [Reinforcing bars shall be ASTM A615/A615M Grade 60 or approved equal.] Concrete cover requirements shall conform to ACI 318.

1. CONCRETE BASE MIX DESIGN; Submit certification that concrete mix design for concrete base meets the requirements of the specified mix.

F. Aggregate Base: Concrete shall have an underlying aggregate base per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.]

PART 3 EXECUTION

3.01 PREPARATION

A. Surveying and Staking: All construction stakes, lines, and grades for the proper completion of Work shall be the responsibility of the Contractor. The Contractor shall set construction stakes, establishing all structure locations and elevations. The Contractor shall establish all necessary controls, detail dimensions, and measurements required for layout and performance of Work.

[B. Project Conditions

[1. Conditions for concrete placement shall comply with ACI 301. Hot weather placement shall comply with ACI 305R, and cold weather placement shall comply with ACI 306R.]

[2. Design Professional to insert additional requirements.]]

C. Control and Protection

1. Prior to installation of green stormwater infrastructure outlets, the perimeter of the green stormwater

infrastructure facility shall be protected against runoff and sedimentation from contributing drainage area with measures identified per Sections 02937 Green Stormwater Infrastructure Site Activity Plan and 02938 Green Stormwater Infrastructure Control and Protection.

2. Prior to connecting the outlet to downstream drainage systems, temporary erosion control measures shall be in place.

3. Stormwater bypass and/or dewatering measures shall be in place to keep the Site clean and dry for the duration of installation.

3.02 INSTALLATION

A. Excavation

1. Excavation methods used shall conform to the requirements of Section 02939 Green Stormwater Infrastructure Earthwork.

2. Excavation shall extend to a depth such that the specified overflow elevation, once fully installed, is located at the elevation shown in the Drawings. If an overflow elevation is not specified, the Contractor is to consult the Design ProfessionalOwner to verify control elevations for the structure prior to installation.

3. Subgrade shall be prepared to provide uniform and continuous support of the outlet to the lines and grades shown in the Drawings.

[B. Overflow Riser

1. Underdrain and/or outlet piping shall be installed prior to construction of overflow riser. Attach riser piping to underdrain and/or outlet piping using appropriate pipe fittings per Section 02954 Green Stormwater Infrastructure Piping. Cut vertical piping riser to the overflow elevation specified in the Drawings. Backfill piping immediately following installation to prevent damage to the vertical riser pipe.

2. Pour concrete collar at connection of overflow riser piping to connected pipe to seal pipe connections and prevent floating of overflow riser. The collar shall be a minimum of six (6) inches thick on all sides of the pipe and shall be properly supported.]

3. Place grate over top of overflow riser and attach per manufacturer's instructions.

[C. Manufactured Outlet Structure

[1. Concrete Base and Anchoring

a. Unless otherwise specified by the [manufacturer][Design Professional][Owner], all manufactured outlet structures require anchoring to prevent floating during

periods of inundation.

b. Aggregate base shall be placed to the depth and extents shown in the Drawings. Place aggregate using methods that will not disturb or damage the outlet structures the surrounding piping, or the green stormwater infrastructure facility.

c. Compaction shall be achieved using small, hand-held or walk behind compactors to prevent damage to the structure or over-compaction of the surrounding areas intended for infiltration.

d. Concrete base size and thickness shall be as specified [in the Drawings][by manufacturer].

e. Anchoring: Outlet structure shall be encased in concrete or otherwise securely attached to the concrete base to resist buoyancy and flotation. Concrete encasement or other attachments shall not inhibit the function of the structure. If manufactured outlet structure includes aluminum accessories, apply bituminous coating to all aluminum surfaces in contact with concrete. Manufactured outlet structures with stainless steel accessories do not require bitumous coating for concrete encasement.]

2. Manufactured Outlet Structure Placement

a. Place outlet structure on concrete base and level vertically. Verify critical elevations, including but not limited to top of structure, inverts in/out and [overflow][weir][orifice][valve] elevations.

b. Connection of underdrain and/or outlet pipes to outlet structure shall provide watertight connections per [manufacturer's instructions][Section 02954 Green Stormwater Infrastructure Piping].

c. Anchor or encase outlet structure to concrete base.]

D. Backfill

1. Prior to backfilling, cover structure openings to protect from material deposition inside the structure during placement. Provide protection of outlet per Section 02938 Green Stormwater Infrastructure Control and Protection.

2. Backfill around structure and compact uniformly in six (6) inch lifts by hand using small, hand-held or walk behind compactors to prevent damage to the structure or over-compaction of surrounding areas intended for infiltration.

3. Install soil and/or aggregate media around structure to finished grade per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media and as shown in the Drawings. All green stormwater infrastructure media shall be in place including mulch per Section 02951 Green Stormwater

Infrastructure Plants prior to removal of protective covering and installation of grated cover.

3.03 TOLERANCES

A. Outlet structure installed elevation shall not deviate from design elevation by more than 0.1 feet. Verify all elevations specified in the Drawings including but not limited to invert elevations, top of structure elevation and [overflow][weir][orifice][valve] elevations.

B. Horizontal placements shall be within 0.1 feet of the alignment depicted in Drawings.

C. FINISHED GRADE SURVEY VERIFICATION; Survey finished elevation of green stormwater infrastructure outlet and submit to the Design ProfessionalOwner for review. Survey elevation shall be taken at specific point locations identified in the Drawings, including but not limited to invert elevations, top of structure elevation and [overflow][weir][orifice][valve] elevations.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary protection and control measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the outlet until the entire upstream tributary area is fully stabilized.

B. All protection measures shall be submitted to the Design ProfessionalOwner for acceptance.

3.06 MAINTENANCE

A. The Contractor shall maintain outlet through the Establishment Period, as defined in Section 02957 Green Stormwater Infrastructure Establishment, and per the schedule identified in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. The Contractor shall furnish the Owner with a written warranty from the manufacturer/supplier (Warrantor) that shall warrant the material against manufacturing defects and material degradation.

B. Should a defect occur, which is covered under warranty, the Warrantor shall bear all costs for the repair, relocation and replacement of the outlet. The Contractor shall be responsible for coordination with the Warrantor for replacement of any defective products or material.

-- End of Section --

SECTION 02956

GREEN STORMWATER INFRASTRUCTURE IN-SITU INFILTRATION TESTING

PART 1 GENERAL

1.01 PURPOSE

A. The purpose of Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing is to provide specific testing methods to measure performance of a green stormwater infrastructure facility via [Double-ring Infiltrometer Testing] [and] [Percolation Testing] [and] [Infiltration Testing on Permeable Surfaces].

1.02 MEASUREMENT AND PAYMENT

A. Payment will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the Work. Testing shall be measured per testing site and shall be paid for by Unit PriceLump sum price.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

02937 Green Stormwater Infrastructure Site Activity Plan

1.04 REFERENCE STANDARDS

A. The following publications form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only. Comply with reference standards in effect as of date of the Contract Documents, unless otherwise indicated by Design ProfessionalOwner.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) INTERNATIONAL

ASTM C1701/C1701M	Standard Test Method for Infiltration Rate of In Place Pervious Concrete
ASTM C1781/C1781M	Standard Test Method for Infiltration Rate of Permeable Unit Pavement Systems
ASTM D3385	Standard Test Method for Infiltration Rate of Soils in Field Using Double-Ring Infiltrometer

1.05 SUBMITTALS

SD-01 Preconstruction Submittals

TESTING SITE IDENTIFICATION FIGURE(S)

TESTING NOTIFICATION

SD-06 Test Reports

INFILTRATION TEST RESULTS

1.06 QUALITY ASSURANCE

A. Testing shall be completed by a qualified professional per Section 02937 Green Stormwater Infrastructure Site Activity Plan, with experience in infiltration testing.

1.07 QUALITY CONTROL

A. TESTING NOTIFICATION; Notify the Design ProfessionalOwner at least 48 hours prior to scheduled testing.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Not Applicable.

PART 2 PRODUCTS

2.01 TESTING EQUIPMENT

A. Contractor shall provide testing equipment.

1. Contractor utilize alternative equipment, provided that such equipment provides equal testing results, as determined by the Design ProfessionalOwner.

[2. Double-Ring Infiltrometer Testing: Infiltration testing equipment shall meet the requirements of ASTM D3385.]

[3. Percolation Testing: Percolation testing equipment shall fulfill requirements to complete test per Part 3.02.]

[4. Infiltration Testing on Permeable Surfaces: Infiltration testing equipment shall meet the requirements of ASTM C1701/1701M for pervious concrete and porous asphalt, and ASTM C1781/1781M for permeable pavers. The test ring shall be 12 inches in diameter and a minimum of eight (8) inches in height.]

PART 3 EXECUTION

3.01 PREPARATION

A. TESTING SITE IDENTIFICATION FIGURE(S); Submit a figure of proposed sites for both pre-construction and post-construction testing, including a unique identifier for each location tested. Post-construction testing sites shall be as close (in proximity) as possible to the pre-construction testing sites.

B. Site Preparation: Mulch, sediment and other debris that inhibit the installation of the testing equipment shall be brushed aside prior to installation.

C. Project Conditions: Testing shall not be completed within 24 hours of rainfall exceeding one (1) inch in depth or when an irrigation system has been activated. [Infiltration testing on permeable surfaces shall not be conducted when the pavement surface temperature exceeds 100 degrees Fahrenheit.]

3.02 INSTALLATION

[A. Double-Ring Infiltrometer Testing

1. Install infiltration rings per ASTM D3385 driven to a depth of approximately four (4) inches.

2. Perform infiltration test per ASTM D3385.]

[B. Percolation Testing

1. Excavate a round test hole nine (9) inches in diameter and no less than nine (9) inches deep at each percolation testing site.

2. Install a test ring or PVC section with a minimum diameter of six (6) inches and a height no less than the depth of the excavated hole.

3. Measure and record the depth to the bottom of the test ring.

4. Saturate testing site by completely filling the test ring with water and allowing it to drain completely.

5. When the testing site has completely drained and the bottom of the test hole is still saturated (no more than 24 hours after the testing site has drained), completely refill the test ring or PVC section; measure and record the initial depth of water. Record the start time of test.

6. Measure and record drawdown at regular intervals until the test hole has completely drained, reporting percolation test results in inches of drawdown per time.]

[C. Infiltration Testing on Permeable Surfaces: Complete permeable surface infiltration test per ASTM C1701/1701M for pervious concrete and porous asphalt, and ASTM C1781/1781M for permeable pavers.]

D. INFILTRATION TEST RESULTS; Submit test results within ten (10) days of testing. Results shall include site identification figure(s) showing northing and easting points of test sites, photographs of the testing sites (before, during, and after testing), date of test, test start and end times, data points collected, weather conditions from the beginning to end of testing, and conclusive result.

E. Alternative Testing: Contractor may propose alternative methods for testing, provided that such methods provide equal testing results, as determined by the Design ProfessionalOwner.

3.03 TOLERANCES

[A. Double-Ring Infiltrometer Testing

1. Record the volume of liquid infiltrated during a period of at least six (6) hours or until a relatively constant rate of infiltration is obtained. A relatively constant rate of infiltration as it relates to terminating infiltration testing shall be a minimum of four (4) consecutive infiltration rate measurements of the inner ring within ten (10) percent of each other.

2. Volume shall be recorded to the nearest one (1) milliliter at an approximate interval of ten (10) minutes for green stormwater infrastructure.

3. Elapsed time shall be recorded to the nearest second.]

[B. Percolation Testing: Drawdown shall be measured and recorded at regular intervals until the test hole has completely drained. Drawdown shall be measured within 0.1 inch of accuracy.]

[C. Infiltration Testing on Permeable Surfaces: Elapsed time until the test ring has completely drained shall be recorded to the nearest second.]

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. Contractor shall return the testing site to pre-test conditions.

3.06 MAINTENANCE

A. Not applicable.

3.07 POST-CONSTRUCTION TESTING

A. Not applicable.

3.08 WARRANTY

A. Not applicable.

3.09 FINAL ACCEPTANCE

A. If testing results are inconsistent with defined procedures, re-testing shall occur at the discretion of the Design ProfessionalOwner.

-- End of Section --

SECTION 02957

GREEN STORMWATER INFRASTRUCTURE ESTABLISHMENT

PART 1 GENERAL

1.01 PURPOSE

A. Contractor shall provide all equipment, material and labor required for servicing, maintaining, and establishing green stormwater infrastructure facilities and project landscaping, as identified in Green Stormwater Infrastructure Maintenance Plan, submitted per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

B. The Green Stormwater Infrastructure Establishment Period consists of both the Pre-Substantial Completion Period and the Correction Period as defined in Part 1.01, C. Substantial Completion is defined at the time of Owner's issuance of Certificate of Achievement of Full OperationSubstantial Completion per Section 00700 General Conditions.

C. Definitions

1. Establishment Period: Period in which the Contractor shall be responsible for the performance of the green stormwater infrastructure facility and associated green stormwater infrastructure components as defined in Section 00800 Supplementary Conditions to achieve and sustain Service levels of performance defined in Part 3.06. Establishment Period shall commence at the start of Pre-Substantial Completion Period and shall extend through the duration of the Correction Period.

2. Pre-Substantial Completion Period: Portion of the Establishment Period for green stormwater infrastructure components placed in continuous service before Substantial Completion, as specified in Section 00700 General Conditions, Article 13.07, Part B. Period shall commence when green stormwater infrastructure facility construction commences, as defined as when the first green stormwater infrastructure component is installed, and shall extend through issuance of Certificate of Achievement of Full OperationSubstantial Completion, as defined in Section 00700 General Conditions.

3. Correction Period: Period shall commence at issuance of Certificate of Achievement of Full OperationSubstantial Completion and shall extend for a period as defined in Section 00800 Supplementary Conditions.

4. Establishment: Establishment is used to describe the length of time prior to green stormwater infrastructure being fully capable of managing stormwater runoff. During this period of time, means and methods of Service and Maintenance activities are necessary to promote landscape health for plant maturity and full integration of green stormwater

infrastructure components.

5. Service: Service is described as replenishing materials that are deteriorated, lost to erosion, removed or damaged through exposure to elements, or resulting from use, to achieve and sustain Service levels of performance defined in Part 3.06.

6. Maintenance: Maintenance is described as Work that is appropriate and necessary to achieve and sustain Service levels of performance defined in Part 3.06.

1.02 MEASUREMENT AND PAYMENT

A. Payment will constitute full compensation for all labor, equipment, tools, supplies, and incidentals necessary to complete the Work.

B. Contractor shall submit an Application for Payment quarterly. During Correction period, each Application for Payment shall be for one-twelfth (1/12) of the remaining contracted amount for this Work.

C. Each Application for Payment shall include Inspection Log and Material Log per the Green Stormwater Infrastructure Maintenance Plan, as defined in Section 02937 Green Stormwater Infrastructure Site Activity Plan.

1.03 RELATED SECTIONS

A. The following sections form a part of this specification to the extent referenced. The specifications are referred to within the text by the numeric designation only.

00700 General Conditions

00800 Supplementary Conditions

01290.13 Punch List

02937 Green Stormwater Infrastructure Site Activity Plan

02938 Green Stormwater Infrastructure Control and Protection

02946 Green Stormwater Infrastructure Soil and Aggregate Media

[02951 Green Stormwater Infrastructure Plants]

[02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding]

[02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding]

02956 Green Stormwater Infrastructure In-Situ Infiltration Testing

1.04 REFERENCES STANDARDS

A. Not applicable.

1.05 SUBMITTALS

SD-05 Design Data

INSPECTION LOG AND MATERIAL LOG

SD-06 Test Reports

POST-CONSTRUCTION INFILTRATION TEST RESULTS

1.06 QUALITY ASSURANCE

A. Service, Maintenance, and Establishment activities to be performed by the Contractor shall be identified in the Green Stormwater Infrastructure Maintenance Plan.

1.07 QUALITY CONTROL

A. Contractor shall use an Inspection Log per Section 02937 Green Stormwater Infrastructure Site Activity Plan to record and report all inspection activities as part of the Green Stormwater Infrastructure Maintenance Plan.

B. Contractor shall use a Material Log per Section 02937 Green Stormwater Infrastructure Site Activity Plan to maintain a record of all material used as part of the Green Stormwater Infrastructure Maintenance Plan.

1.08 DELIVERY, STORAGE, AND HANDLING (EQUIPMENT)

A. Contractor shall have proper identification while onsite at all times. Identification may include but is not limited to an authorization letter from Owner, business cards, or labeled vehicles or uniforms.

PART 2 PRODUCTS

2.01 MATERIALS AND METHODS

A. This specification includes recording and documentation of Service, Maintenance, and Establishment activities as defined by the Green Stormwater Infrastructure Maintenance Plan. Recording and documentation requires Contractor utilization of an INSPECTION LOG AND MATERIAL LOG.

B. Materials and methods identified in the Green Stormwater Infrastructure Maintenance Plan are subject to approval by Design ProfessionalOwner.

2.02 ALTERNATE MATERIALS OR METHODS

A. Contractor may use alternate materials and methods subject to approval by the Design ProfessionalOwner.

PART 3 EXECUTION

3.01 PREPARATION

A. Not applicable.

3.02 INSTALLATION

A. Not applicable.

3.03 TOLERANCES

A. The Contractor is responsible for maintaining finished grade of green stormwater infrastructure facility within the following tolerances:

1. Horizontal Tolerance: 0.1 feet

2. Vertical Tolerance: 0.1 feet

B. If green stormwater infrastructure finished grade varies from required tolerances, Contractor shall add additional surface material as specified in the Drawings and per Section 02946 Green Stormwater Infrastructure Soil and Aggregate Media.

3.04 DISPOSAL OF MATERIAL

A. Materials no longer in use shall be removed and disposed of by Contractor per Section 02937 Green Stormwater Infrastructure Site Activity Plan.

3.05 PROTECTION

A. The Contractor shall implement temporary control and protection measures per Section 02938 Green Stormwater Infrastructure Control and Protection to protect the green stormwater infrastructure facility until the entire upstream tributary area is fully stabilized.

3.06 MAINTENANCE

A. The Contractor is responsible for Maintenance of green stormwater infrastructure components through the duration of the Establishment Period.

B. Maintenance activities and frequencies shall be defined in the Green Stormwater Infrastructure Maintenance Plan, and shall be sufficient to meet the following Service level of performance standards:

Establishment Period Service Level Performance

Appearance	Weeds, Pests, Disease	Mulch, Erosion	Drainage
Vegetation healthy with tidy appearance Vegetation watered during dry periods over two (2) weeks in length Vegetation confined to planted areas Clean, distinct planting bed edges Litter/trash removed Fallen/blown foliage removed (leaves, nuts, sticks, lawn clippings, fallen branches) Little to no sediment or silt on surface No cracking, settling, or damage to of green stormwater infrastructure components	Weeds are not acceptable Every effort should be made to control and eliminate all weeds Pests or diseases that threaten vegetation should be removed with gentlest method possible. If problem is limited to less than 5% of plants, remove infected plants and replace with different species Mosquito larvae removed	Mulch evenly distributed, two (2) inches to four (4) inches deep No evidence of erosion Little to no sediment or silt on mulch surface	Zero ponding depth observed 48 hours following a rain event Clear, open flow paths for water (inlet, outlet, overflow)

3.07 POST-CONSTRUCTION TESTING

[A. The Contractor shall conduct post-construction infiltration testing per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing at up to [three (3)] testing locations prior to Final Inspection of work as described in Part 3.08, C. Contractor shall conduct testing within ten (10) days of Final Inspection and submit POST-CONSTRUCTION INFILTRATION TEST RESULTS.

B. Post-construction infiltration rates shall meet or exceed pre-construction infiltration rates and shall be no less than [0.25 inches per hour].

C. Media that fails to meet post-construction infiltration

requirements shall be remediated as recommended by the Design ProfessionalOwner. Amended media shall then be retested per Section 02956 Green Stormwater Infrastructure In-Situ Infiltration Testing. This procedure shall be repeated by the Contractor until the media meets post-construction infiltration requirements at the discretion of the Design ProfessionalOwner.]

[D. Not applicable.]

3.08 WARRANTY

A. Service, Maintenance, and Establishment activities shall be for the full duration of the Establishment Period.

B. For vegetative green stormwater infrastructure components, the Contractor shall be responsible for the health of all plants. Contractor shall replace all dead or dying plants within the green stormwater infrastructure facility. All dead plants shall be replaced a maximum of once per year during the Establishment Period, not to exceed three (3) replacements per plant. Replacement plants shall be installed during the appropriate planting season as defined in Sections 02951 Green Stormwater Infrastructure Plants, 02952 Green Stormwater Infrastructure Native Grass and Wildflower Seeding, or 02953 Green Stormwater Infrastructure Non-Native Seeding and Sodding.

C. The Contractor shall complete a Final Inspection of the Work with the Owner to determine Service level performance within 60 days of termination of the Establishment Period. The Owner shall notify the Contractor in writing of any deficiencies in meeting the Service level performance in the final Punch List per Section 01290.13 Punch List. The Contractor shall correct any identified deficiencies and document remedial action taken in the final Punch List. Affidavit for Final Payment shall not be accepted until all deficiencies have been corrected by the Contractor.

-- End of Section --