1. INTRODUCTION

The City of Savannah Stormwater Management Local Design Manual (LDM) has been developed to serve as a comprehensive guide to implementing stormwater management facilities, controls and systems in the City of Savannah. Additionally, the City of Savannah LDM has been developed to supplement the technical guidance information contained in the Georgia Stormwater Management Manual (GSMM) first Edition (August 2001) and the Coastal Stormwater Supplement (CSS) to the GSMM, latest edition. The City's MS-4 permit requires that the City adopt a local design manual that implements the use of either the Georgia Stormwater Management Manual or an equivalent local design manual, and that, as a part of Chatham County, that the adopted manual should include the Coastal Supplement. Therefore, the Local Design Manual serves as the required manual, and the GSMM and the CSS serve as technical reference guidance for the design, construction, and maintenance of stormwater management systems within the City. Any conflicts or issues that may arise pertaining to information contained in the GSMM and the CSS should be addressed at the onset of the project through correspondence with the appropriate City Staff.

1.1 Stormwater Management Compliance Process

The following outlines the step by step process for complying with the applicable provisions of the City of Savannah Stormwater Management LDM and the City of Savannah Stormwater Management Ordinance. All projects differ with regard to the pertinent site-specific design and construction related issues and details. To that end, the step by step process outlined herein should be used as a general guide with the understanding that some variation to the process may be necessary to successfully complete a particular project.

1.1.1 Stormwater Management Site Planning and Design Criteria Process

<u>Concept Design Phase</u>

Step 1: Review applicable local, state, and federal requirements and guidelines

Step 2: Schedule and attend a Site Plan Review (SPR) meeting with the City

Step 3: Conduct natural resources inventory.

Step 4: Assess potential application of green infrastructure practices

Step 4A: Apply post-construction stormwater management criteria

- Criteria #1: Stormwater runoff reduction

- Criteria #2: Stormwater quality protection
- Criteria #3: Aquatic resource protection
- Criteria #4: Overbank flood protection
- Criteria #5: Extreme flood protection

Step 4B: For redevelopment projects seeking off-site post-development stormwater management credit, complete and submit application, Appendix H. Credit for off-site stormwater management is only available within city right-of-way or city-owned property.

Step #5: Prepare a stormwater management concept plan and submit to City for review and approval.

Step #6: Schedule and attend concept plan and consultation meeting with City Staff to review concept plan.

Step #6A: Revise concept plan (if necessary)

(Projects of less than 1.0 acre in size may request a waiver of concept plan submittal. In lieu of the concept submittal, the items become due with the Detailed Stormwater Management Design Phase submittal below. Attendance at the SPR meeting is encouraged in lieu of the submittal.

<u>Detailed Stormwater Management Design Phase</u>

Step 7: Prepare stormwater management design plan

Step 7A: Perform downstream hydrologic analysis

Step 7B: Prepare stormwater management system inspection and maintenance plan (A copy of the agreement is attached as Appendix A)

Step 7C: Prepare erosion and sedimentation control plan and planting plan

Step 8: Submit plans to City with engineer's certification (copy attached as Appendix E) and completed Stormwater Checklist (copy attached as Appendix F.)

Step 9: Address City comments and re-submit for approval.

Step 10: Where off-site stormwater management within city right-of-way or city-owned property credit is to be purchased for redevelopment projects, submit payment and provide documentation of payment prior to project's final inspection.

Step 11: Upon acceptance of Stormwater Management Design Plan by the City Owner executes and submits stormwater inspection and maintenance plan.

Construction Phase

Step 11: Obtain land disturbance activity (LDA) permit from City Development Services

Step 12: Obtain site development permit

Step 13: Attend Site Development administered pre-construction meeting on project site

Step 14: Install and maintain site erosion and sedimentation controls

Step 15: Commence site construction activities

Step 16: Coordinate field inspections with City staff

Step 17: Complete final site inspection and project completion. Before the issuance of a certificate of occupancy, the applicant is responsible for certifying that the project has been completed in accordance with the approved stormwater management design plan (certification statement is attached as Appendix B) and for submitting the engineer's certification of completeness by a Georgia licensed professional engineer (engineer's certification statement is attached as Appendix C). A final inspection shall be conducted by the staff or representatives of the City of Savannah to confirm the accuracy of the as built plans. A final inspection is required before any performance bond or other guarantee can be released.

Post-Construction Phase

Step 18: Show all stormwater management units in private and common areas on the final plat. Include notations that such units will be maintained in accordance with Article B of the Stormwater Management Ordinance.

Step 19: Record the stormwater management inspection and maintenance agreement. (A copy of the agreement is attached as Appendix A.)

Step 20: Post maintenance bond, letter of credit (LOC), escrow amount or certified check for the period required. Bonded items shall include 100% of the construction cost of the project until as-builts are provided; 150% of any items not 100% complete at the time of C. O.; 150% bonding for any stormwater system and green infrastructure system subject to construction sediment due to uncompleted site stabilization to plans; and 150% bonding for any surface improvement constructed above any underground bonded structure, along with reasonable construction limits necessary for access.

Step 21: Secure certificate of occupancy (CO)/final plat

Step 22: Prepare as-built survey and as-built design certification.

2. Post-Construction Stormwater Management and Site Planning and Design Criteria

The following post-construction stormwater management and site planning and design criteria shall be applied to all new development and redevelopment activities that are subject to the provisions of this ordinance. The criteria have been designed to protect valuable local natural resources from the negative impacts of the land development process.

If local natural resource protection and stormwater management goals and objectives warrant greater protection than that provided by the post-construction stormwater management and site planning and design criteria outlined below, the City of Savannah may impose additional requirements on new development and redevelopment activities that it has determined are necessary to protect local aquatic and terrestrial resources from the negative impacts of the land development process.

2.1 Natural Resources Inventory

Prior to the start of any land disturbing activities, including any clearing and grading activities, the SAGIS land cover maps, acceptable site reconnaissance, and biological and traditional land surveying techniques should be used to complete a thorough assessment of the natural resources, both terrestrial and aquatic, found on a development site. The natural resources inventory shall be completed in general accordance with Section 4.3.1 and Table 4.2 of the CSS to the GSSM, or using a comparable methodology as approved by the Stormwater Director.

The preservation and/or restoration of the natural resources found on a development site, may, at the discretion of the City of Savannah be assigned quantifiable stormwater management “credits”. Credits can be used to meet the post-construction stormwater management criteria outlined in the applicable sections of the City of Savannah Stormwater Management Ordinance. The green infrastructure practices provided in the latest edition of the CSS to the GSSM can be used as well to satisfy stormwater management criteria outlined in the City of Savannah Stormwater Management Ordinance.

2.2 Use of Green Infrastructure Practices

Green infrastructure/Low Impact Development (GI/LID) practices shall be used to the maximum extent practical during the creation of a stormwater management concept plan for a proposed development project. Green infrastructure practices can be used to not only help protect local terrestrial and aquatic resources from the direct impacts of the land development process, but also to help maintain pre-development site hydrology and reduce post-construction stormwater runoff rates, volumes and pollutant loads.

All GI/LID practices shall be selected, designed, constructed, and maintained in general accordance with the information presented in the latest edition of the CSS to the GSMM and the LDM. Applicants are referred to the latest edition of CSS to the GSMM, and the LDM, for guidance on selecting GI/LID practices that can be used to satisfy the post–construction stormwater management criteria outlined in the applicable sections of the City of Savannah Stormwater Management Ordinance.

For (GI/LID) practices that are not included in the CSS to the GSMM, or for which pollutant and runoff reduction rates have not been provided, the effectiveness of the GI/LID must be documented through prior studies, literature reviews or other means, and receive approval from the Stormwater Director, or his designee, before being included in a stormwater management system.

2.3 Stormwater Runoff Reduction

2.3.1 Development Criteria

The stormwater runoff volume generated by the first 1.2" of rainfall is called the runoff reduction storm event (RR_v), in Section 4.4.1 of the latest edition of the CSS to the GSMM. The RR_v shall be captured on-site. A stormwater management system is presumed to comply with these criteria if, according to the following criteria:

(1) It includes green infrastructure practices that provide for the interception, evapotranspiration, infiltration or capture and reuse of stormwater runoff, that have been selected, designed, constructed and maintained in accordance with the information presented in the latest edition of the CSS to the GSMM and the LDM; and,

(2) It is designed to provide the amount of stormwater runoff reduction specified in the latest edition of the CSS to the GSMM.

The Stormwater Director or his designee **may** reduce the amount of stormwater runoff reduction needed to satisfy the RR_v on development sites that are considered to be stormwater hotspots, or that have site characteristics or constraints, such as high groundwater, impermeable soils, contaminated soils or confined groundwater aquifer recharge areas, that prevent the use of GI/LID.

When seeking a reduction in RR_v, applicants shall provide adequate documentation to the City of Savannah to show that GI/LID practices have been used on the development site to the maximum extent practicable.

2.4 Stormwater Quality Management and Protection

In order to protect local aquatic resources from water quality degradation, post-construction stormwater runoff shall be adequately treated before it is discharged from a development site. Applicants can satisfy this criterion by satisfying the stormwater runoff reduction

criteria. However, if any of the stormwater runoff volume generated by the runoff reduction storm event, as defined in the latest edition of the CSS to the GSMM, cannot be reduced on the development site, due to site characteristics or constraints, it shall be intercepted and treated in one or more stormwater management practices that provide at least an 80 percent reduction in total suspended solids loads and that reduce nitrogen and bacteria loads to the maximum extent practical. When seeking to satisfy this criteria through the use of one or more stormwater management practices, applicants shall:

(1) Intercept and treat stormwater runoff in stormwater management practices that have been selected, designed, constructed and maintained in accordance with the information presented in the latest edition of the CSS to the GSMM and the LDM; and,

(2) Provide adequate documentation to the Stormwater Director or his designee to show that total suspended solids, nitrogen and bacteria removal were considered during the selection of the stormwater management practices that will be used to intercept and treat stormwater runoff on the development site.

2.5 Aquatic Resource Protection and Energy Dissipation

In order to protect local aquatic resources from several other negative impacts of the land development process, including complete loss or destruction, stream channel enlargement and increased salinity fluctuations, applicants shall provide aquatic resource protection in accordance with the with the information provided in the latest edition of the Coastal Stormwater Supplement to the Georgia Stormwater Management Manual.

2.5.1 Primary Conservation Areas

The following drainage areas are considered primary conservation areas for the aquatic resource protection criteria in Savannah:

Salt Creek
Hayners Creek
Hoover Creek
Little Ogeechee River
Vernon River
Wilmington River, and
All marsh buffers,

Applicants for stormwater discharges to these drainage basins shall submit a demonstration of use of better site planning techniques as presented in the latest edition of the CSS to the GSMM. Direct discharges to primary conservation areas as defined above shall require aquatic resource protection as described in the CSS of the GSMM.

2.5.2 Energy dissipation

Velocity control and energy dissipation measures shall be installed at all stormwater outfalls in accordance with the criteria and guidance provided in Section 4.5 of the GSMM (Volume 2) and the applicable sections of the CSS.

2.6 Overbank Flood Protection

All stormwater management systems shall be designed, constructed, and maintained to control the peak discharge generated by the overbank flood protection storm event, as defined in the latest edition of the *Coastal Stormwater Supplement to the Georgia Stormwater Management Manual*, to prevent an increase in the duration, frequency and magnitude of downstream overbank flooding. A stormwater management system is presumed to comply with this criterion if it is designed to assure that the peak flow rate for the one year frequency 24 hour duration, 5 year 24 hour, 10 year 24 hour, and 25 year 24 hour storms do not exceed their pre development conditions. The design shall assure that the peak flows do not exceed pre development flows for construction conditions.

The Stormwater Director or his designee ***may*** modify or waive this criteria on development sites where both the on-site and downstream stormwater conveyance systems are designed to safely convey the peak discharge generated by the overbank flood protection storm event to a receiving stream, tidal creek or other aquatic resource without causing additional downstream flooding or other environmental impacts, such as stream channel enlargement or degradation of habitat.

2.7. Extreme Flood Protection

All stormwater management systems shall be designed, constructed, and maintained to control the peak discharge generated by the extreme flood protection storm event, as defined in the latest edition of the *Coastal Stormwater Supplement to the Georgia Stormwater Management Manual*, to prevent an increase in the duration, frequency and magnitude of downstream extreme flooding and protect public health and safety. Development sites shall be designed, constructed, and maintained such that all GI/LID practices that impound stormwater runoff can safely pass the 100-year storm without overtopping or creating damaging or dangerous downstream conditions.

Demonstration of safe passage of the 100 year 24 hour storm shall include a stage storage analysis of the system, an inflow/outflow comparison of the system, and construction of a table showing peak stage elevations in comparison to safe freeboards to structures of the system and adjacent buildings/structures/infrastructure.

Flood mitigation capacity in accordance with City Code Part 8 Article D must come from below the flood elevation determined from the latest FEMA maps for the project site. Such capacity is to be determined separate from overbank flood or aquatic resource protection detention capacity.

The Stormwater Director ***may*** modify or waive this criteria on development sites where both the on-site and downstream stormwater conveyance systems are designed to safely convey the peak discharge generated by the extreme flood protection storm event to a receiving stream, tidal creek or other aquatic resource without causing additional downstream flooding or other environmental impacts, such as stream channel enlargement or degradation of habitat.

2.8 Redevelopment Criteria

Redevelopment activities that are not exempt from Stormwater Management for Development Activities requirements shall meet at least one of the following criteria to meet the runoff reduction volume and the Stormwater Quality Protection criteria of the Stormwater Management Ordinance:

1. **Reduce Impervious Cover:** Reduce existing site impervious cover by at least 20%, unless otherwise approved by the Stormwater Director or his designee.
2. **Provide Post-Development Stormwater Management:** Manage the stormwater runoff from the site's existing impervious cover and any new impervious cover in accordance with the post-development stormwater management criteria outlined in the applicable sections of the City of Savannah Stormwater Management Ordinance. The green infrastructure and stormwater management practices used to comply with the these criteria shall be selected, designed, constructed and maintained in accordance with the information presented in the latest edition of the CSS to the GSMM and the LDM.
3. **Provide Off-Site Stormwater Management:** Provide, through the use of off-site stormwater management practices, a level of stormwater quality and quantity control that is equal to or greater than that which would be provided by satisfying the post-construction stormwater management criteria outlined in the applicable sections of the City of Savannah Stormwater Management Ordinance.
4. **Provide Off-Site Stormwater Management Within City Right-Of-Way Or City-Owned Property Where GI/LID Structural Practices are in Place at Completion of Redevelopment**: When GI/LID is provided within the City ROW or property owned by the City in the same drainage basin as the redevelopment, equivalent runoff reduction volume (RRv) can be applied as credit to meet the redevelopment criteria. Application for this credit must be made through use of the form in Appendix H.
5. **Combination of Measures:** Any combination of (1) through (4) above that is acceptable to the City of Savannah.

Redevelopment activities shall meet the Aquatic Resource Protection, Overbank Flood Protection, and Extreme Flood Protection criteria of the CSS of the GSMM.

3. APPROVED HYDROLOGIC & HYDRAULIC METHODS

3.1. Hydrologic Methods

3.1.1 Rational method

The rational method **may** be used with the approval of the Stormwater Director or his designee to develop peak runoff flows for culverts or stormwater drainage systems with contributing drainage areas that are less than 10 acres in size and that are described by a single runoff coefficient. No prorating of runoff coefficients shall be acceptable. Rational method shall not be used for estimating runoff for detention sizing. All rational method calculations shall be made in accordance Appendix A-3 of the GSMM (Volume 2 Appendix A-3) and applicable sections of the CSS.

The use of the rational method, or any other method than the TR-55 method, described below, requires prior approval by the Stormwater Director or his designee. Plans submitted without prior approval may not be reviewed until calculations are confirmed by the permittee utilizing approved methods. (Please note that Sections 4 and 5 of Volume 2 (Appendix A-1) of the GSMM are not part of Section 3.1.2 below.)

3.1.2 SCS TR-55 Method

The Soil Conservation Service (SCS) method is the accepted runoff method of the City and must be utilized to size detention. All computations shall be in accordance with Section 2 of the GSMM, (Volume 2-Appendix A-1). Rainfall intensities shall be derived from Table A2-10 to A2-13 (Savannah) of Appendix A-2 of the GSMM (Volume 2). Please note that intensities vary by location within Chatham County. A peaking factor of 323 is acceptable for the Savannah area. Type III storms should be used east of I-95. Type II storms must be used west of I-95.

Time of concentration methods shall be according to pages 3-1 thru 3-4 of Volume 2 (Appendix A-1) of the GSMM. Triangular shaped hydrographs are not acceptable. Time of concentration must be calculated taking into account the condition of the site soil. If roughened by tire ruts, local depressions, poor drainage, or silvicultural practice, adjust roughness values accordingly. Maximum length of any sheet flow calculation shall be 300 feet.

3.1.3 Other methods

Prior approval by the Stormwater Management Director is required for use of any other runoff calculation method, (i.e., TR-20, XP-SWMM, etc.) The determination as to whether another method may be approved is determined by both the method's ability to accurately

determine information required, and to be able to be checked by the Department. Use of ICPR, XP-SWMM, or other dynamic model must include adequate documentation of input parameters, to afford checking of the calculation.

4. CONVEYANCE LEVEL OF SERVICE (LOS) STANDARDS

4.1 General

The designer shall endeavor to meet the applicable stormwater management design criteria outlined herein to the maximum extent possible for each design project. Successful incorporation of these criteria into the overall design process should: (1) help maintain pre development site hydrology; (2) protect natural resources; and (3) minimize the impacts of post construction stormwater runoff.

4.2 Stormwater Runoff Detention and Discharge Rate Requirements

Chapter 3.0 of the GSMM and the applicable sections of the CSS should be consulted with regard to the design of stormwater runoff detention and discharge rate requirements for new development and redevelopment projects.

4.2.1 Discharge Rates for New Development and Redevelopment Projects

Development plans including site grading and drainage plans should be developed to mimic existing site conditions, and to minimize disruption of natural site infiltration, retention and drainage patterns. Additionally, no increases in stormwater runoff rates shall be allowed at any discharge point from the site unless approved by the City. The baseline or pre-developed site is defined as the hydrologic conditions that exist on a development site prior to the commencement of any land disturbing activities and at the time that plans for the land development project are approved by the local development review authority, and shall model any depression storage and/or detention storage. The development shall be analyzed for the following storm events at a minimum:

- 1-year return frequency, 24 hour duration design storm
- 5-year return frequency, 24 hour duration design storm
- 10-year return frequency, 24 hour duration design storm
- 25-year return frequency, 24 hour duration design storm
- 50-year return frequency, 24 hour duration design storm
- 100-year return frequency, 24 hour duration design storm

Where downstream conditions indicate that the conveyance and/or storage capacity of existing infrastructure could be impacted by the post development conditions, a more stringent standard may be required. For example, if the project site drains into an existing

detention pond within the study area, then the designer will be required to demonstrate that the discharge rates from the proposed development will still allow the detention pond to operate at a level commensurate with the site in an undeveloped state. Detention facilities should be designed upon the basis of known or projected developments (proposed by the developer) for the contributing drainage basin. Although, the developer is only required to construct the facility with sufficient volume to provide detention for the proposed development, a design shall be provided to the City demonstrating the ultimate configuration of the proposed detention facility at full site build-out. Additionally, the proposed site plan should have sufficient land around the facility reserved to construct the ultimate configuration without significant demolition.

If a proposed development activity discharges stormwater runoff into a substandard stormwater conveyance system that is a part of the City of Savannah municipal storm sewer system (MS4), the submittal must demonstrate at least one of the following options:

- No increase in the development site's peak rate and total volume discharged to the substandard system; and
- The site stormwater management plan should provide other engineering solutions that are designed to mitigate adverse impacts on the conveyance system. The proposed solutions must be submitted for review and approval by the City prior to implementation.

When the development site's stormwater peak and/or total volume discharge has increased to an adjacent property, written approval of the neighboring property owner shall be provided. The private stormwater easement and agreement shall be provided for neighboring property.

4.3 Drainage Stormwater Conveyance Practices

Stormwater conveyance practices, which may include, but are not limited to, storm drain pipes, culverts, catch basins, drop inlets, junction boxes, headwalls, gutters, ditches, open channels, swales and energy dissipaters, shall be provided when necessary to convey post-construction stormwater runoff and protect private properties adjoining development sites and/or public rights-of-way. Stormwater conveyance practices that are used to convey post-construction stormwater runoff on development sites shall meet the following requirements:

1. Methods used to calculate stormwater runoff rates and volumes shall be in accordance with the information presented in the latest edition of the GSMM, the CSS and the City of Savannah LDM;
2. All culverts, pipes systems, and open channel flow systems shall be sized in accordance with the information presented in the latest edition of the GSMM, the CSS, and the City of Savannah LDM; and

3. Planning and design of stormwater conveyance practices shall be completed in accordance with the information presented in the latest edition of the GSMM, the CSS, and the City of Savannah LDM.
4. Adequate easements or right-of-ways for maintenance access shall be provided and recorded with required public documents.

4.3.1 Bridges

All bridges that will serve as an evacuation route shall be designed to accommodate the 100 year 24 hour storm with no overtopping of the roadway/street. A bridge that serves as ingress/egress to a critical facility as described in the City's Flood Protection Ordinance shall be designed to accommodate the 500 year 24 hour storm with no overtopping of the roadway/street.

4.3.2 Streets

All streets must be built at a centerline elevation so that the registered professional engineer demonstrates to the stormwater management director, or his/her designated representative's satisfaction that the water surface elevation will not exceed the height of the curb for the 50-year, 24-hour storm event. In all cases, all streets shall have a minimum street centerline elevation of 6.5 (NAVD88)

4.3.3 Culverts and Pipe Systems

Table 2: Culvert & Pipe LOS Criteria

Roadway Classification/Use	Minimum Allowable Design LOS
Arterial/Emergency Evacuation Route	25-year
Collector Roads	25-year
Neighborhood Roads	10-year
Roads with no other outlet	25-year
Parking lots/material storage areas/landscape areas	10-year

Culverts with contributing drainage areas greater than 10 acres shall be designed using the SCS TR-55; 24-hour storm. If a proposed culvert system will connect to an existing culvert system that does not achieve the design storm event LOS depicted in the Table 2 above, then the proposed system shall be designed with an equivalent LOS to the existing system, but the LOS shall not be less than the minimum allowable shown in Table 2 unless approved by the Stormwater Director, or his designee. In situations where emergency evacuation issues arise during the Concept Design Phase, the City may require that the conveyance LOS for both the proposed culvert system and the existing culvert system be increased. The designer should consult with the City during the Concept Design Phase of the project to ascertain the applicable design and LOS requirements.

4.3.4 Inlets (Catch basins, yard inlets, drop inlets, hooded grate inlets, and flumes)

Inlets collecting stormwater runoff from street surfaces and area inlets shall be sized to capture the storm event specified for the pipe system to which it drains and a maximum depth as determined by the following table:

Table 3

Roadway Classification/Use	Allowable Flooding LOS
Arterial/Emergency Evacuation Route	One Lane Width Open
Collector Roads	One Lane Width Open
Neighborhood Roads	8.0 Ft Lane Width Open
Roads with No Other Outlet	One Lane Width Open
Parking Lots	Maximum 0.5 ft Depth
Detention areas utilized for other purposes (i.e., parking lot detention, etc.) with flood warning sign	Maximum 1.5 ft Depth
Material Storage Areas/Landscape Areas	Maximum 2.0 ft Depth

Note: *The Stormwater Director or his designee can modify these requirements if the designer demonstrates that an alternate design criteria is acceptable.*

Inlets and grading adjacent to habitable structures shall be designed to prevent stormwater runoff from entering the structure during the 100-year design storm.

4.3.5 Inlets (Headwalls, Flared End Sections, Etc.)

Inlets that utilize the opening for the pipe as the inlet, (i.e., headwalls, flared end sections, etc.) shall be sized to capture the storm event specific for the pipe system to which it drains and a maximum flooded depth that will not result in bypass of the inlet or cause structural flooding. The headwater conditions induced by the inlet should minimize impacts to any upstream drainage structures. The designer should consult the City during the Concept Phase to determine if any unacceptable flooding will occur and if such a condition is acceptable/allowable.

4.3.6 Roadside Ditches

Roads constructed without curb and gutter shall incorporate ditches that are designed to the specific design storms as shown in the following table:

Table 4: Roadside Ditch LOS Criteria

Roadway Classification/Use	Minimum Allowable Design LOS
Arterial/Emergency Evacuation Route	25-year
Collector Roads	25-year
Neighborhood Roads	10-year
Roads with No Other Outlet	25-year

Note 1: *Drainage structures internal to the proposed land development activity will be designed for no less than the 10-year, 24 hour storm event.*

Note 2: *The Stormwater Director, or his designee, can modify these requirements if the designer demonstrates that an alternate design criterion is acceptable.*

If a proposed roadside ditch system will connect to an existing drainage system (i.e., open ditch, pipe, etc.) that does not achieve the design storm LOS depicted in Table 4 above, then the proposed ditch system may be designed with an equivalent LOS to the existing system to which it will connect, but the LOS shall not be less than the minimum allowable shown in Table 4 unless approved by the Stormwater Director, or his designee. In situations where emergency evaluation issues arise during the Concept Design Phase, the City may require that the conveyance LOS of both the proposed ditch system and the existing culvert system be improved. This may require that the conveyance capacity of the proposed ditch system be increased to provide storage of rainfall to minimize flooding. Or the existing pipe system conveyance LOS may need to be increased or a combination of these stormwater runoff management measures may be required. The designer should consult with the City during the Concept Design Phase of the project to ascertain the applicable design requirements.

4.3.7 Drainage Canals

For a proposed drainage channel designed to convey stormwater runoff either from or to an existing culvert system, the proposed channel should be designed to the LOS established for the existing pipe system, unless directed otherwise by the City.

4.3.8 Easements and Right-of-Ways

Minimum Right-of-Way and Easement widths for stormwater ditches, swales, canals, etc. shall be determined as follows:

A. For ditches 1-5 ft, the easement/right-of-way width shall be 20-ft. plus top width of the ditch. The 20-ft. access maintenance shall be provided on one side of the ditch within the easement//R-O-W.

B. For ditches 5-25 ft., the easement/right-of-way width shall be 10-ft on one side and 20-ft on the other side of the ditch plus the top width of the ditch.

C. For ditches greater than 25-ft., the easement/right-of-way width shall be 20-ft. on both sides of the ditch plus top width.

D. If any building foundation(s) exist, 5 feet additional right of way or easement width shall be provided on the building side of the ditch.

Minimum Right-of-Way and Easement widths for underground stormwater sewers shall be determined as follows:

A. For pipe depths 5.0 feet and less from pipe invert to proposed finished grade, the easement or right-of-way width is to be 10 feet on each side from the edge of the pipe to the edge of the right of way or easement.

B. For pipe depths between 5.1 feet and 10.0 feet from pipe invert to proposed finished grade, the easement or right-of-way is to be 12.5 feet on each side from the edge of the pipe to the edge of the right of way or easement.

C. For pipe depths 10.1 feet and greater from pipe invert to proposed finished grade, the easement width is to be 15 feet on each side from the edge of the pipe to the edge of the right of way or easement.

D. If any building foundation(s) exist, 5 feet additional right of way or easement width shall be provided on the building side of the pipe.

Drainage easements may be used for other easements with the written approval of the City Engineer and Stormwater Management Director and with consent of the easement holders. Nothing shall be constructed which prohibits the use of drainage easements for access to various properties and other compatible uses without the written authorization of the Stormwater Management Director and City Engineer.

All stormwater drainage easements shall be recorded in the Chatham County Courthouse and two (2) copies shall be submitted to the City Engineer and one (1) copy to the Stormwater Management Director. Copies shall be chronoflex mylar.

A developer may be required to provide adequate easements downstream from his proposed discharge if adequate public or private facilities do not exist to carry the proposed discharge.

4.3.9 Flood Elevation Impacts

All design work should be performed in strict conformance with applicable local, state, and federal government agency requirements pertaining to floodplain management. All development activity shall be designed to maintain the flooding capacity of the flood hazard area, unless:

1. It can be demonstrated that there is no increase, either upstream or downstream in the base flood elevation after the proposed improvement; and,
2. Compensating storage is provided for all flood volume displaced by the proposed development or redevelopment activities below the base flood elevation.

It is the policy of the City of Savannah that raising the flood water elevation on an adjacent property is not acceptable. As such, the LOS standards outlined in the City of Savannah LDM shall be considered minimum standards. Where flood elevation(s) on an adjacent property will increase due to the development and/or construction of a drainage system, the LOS may be increased by the City in an effort to minimize impacts to the adjacent property.

This requirement may be waived at the City's discretion if the adjacent property owner provides a permanent drainage easement between the two property owners. The easement shall provide that the owner of the impacted property acknowledges that an increase in flood elevations will occur on their property as a result of the proposed development. Additionally, the easement shall include at a minimum a map showing the extent of the pre-development and post-development 100-year floodplains the party responsible for causing the impacts to the floodplain shall address any applicable FEMA or other regulatory requirements as part of the design and permitting effort.

Finally, the easement must be recorded with the City as an attachment to the affected property's land deed and shall be binding on all future property owners. Long term maintenance of the easement shall be the responsibility of the private property owners in accordance with the provisions outlined in the easement.

5 CONSTRUCTION MATERIALS

5.1 Conveyance Structures

5.1.1 Pipes under Roads and Pavement

All pipes under roadways, parking lots and other surfaces designed for vehicular traffic shall be constructed of reinforced concrete pipe (RCP) meeting Georgia Department of Transportation (GDOT) standards. Joints shall be wrapped with a double layer of non-woven geotextile with a minimum weight of 16 ounces per yard. Installation shall follow manufacturer's standards, or the City of Savannah Stormwater Specification 02400, whichever is more stringent.

5.1.2 Pipes Not Under Roads and Pavement

Pipes not under roadways, parking lots and other surfaces meant for vehicular traffic shall be constructed of RCP or high density polyethylene (HDPE) pipe meeting GDOT standards. HDPE pipe, if selected, must be approved by the Stormwater Director, or his designee, and be installed in accordance with manufacturer's standards. HDPE pipes shall be installed with a minimum of one pipe diameter of cover over the crown of the pipe.

5.1.3 Channels

All channels must be protected from erosion through the use of rip-rap, concrete, erosion control matting or similar method acceptable to the Stormwater Director or his designee. All channel side slopes shall have a 3 foot horizontal to 1 foot vertical (3:1) slope, or less, unless otherwise approved by the Stormwater Director, or his designee.

5.1.4 Inlets

All inlets shall be constructed of materials and methods approved the by the Georgia Department of Transportation (GDOT) and designs pre-approved by the Stormwater Director, or designee.

5.2 Detention Ponds

All stormwater management and detention facilities constructed in accordance with the requirements of the LDM shall be constructed on subdivided parcels deeded to the property owner (for non-residential parcels) or the homeowners association (for residential parcels). No stormwater management or detention facility for residential subdivisions shall be constructed in whole or part on a parcel intended for future sale or use as a residential property.

Detention ponds built to serve residential subdivisions with public rights-of-ways shall have City access easements to all pond inlets and outlets. A flow through easement shall be dedicated to the City for all detention ponds, granting the City access to all outlet structures.

The post developed peak rate of runoff cannot exceed the pre-developed rate of runoff for the 1-year, 5-year, 10-year, or 25-year, 24 hour storms. The principal spillway system/outlet must be capable of discharging the calculated peak flow rate without use of the emergency overflow spillway. The emergency overflow spillway should be designed to safely handle the 100-year, 24 hour storm event. In no case will stormwater stored in road/street rights of way or on residential lots be counted toward the required storage volume of the detention facility unless right-of-way storage is part of the project's CSS design criteria.

5.2.1 Dry Earthen Detention Ponds

Dry detention ponds shall be designed to provide for positive drainage to the outlet of the pond. Side slopes shall be designed to be no steeper than 3-feet horizontal to 1-foot vertical (3:1) slopes. If the 100-year maximum water surface depth is equal to or greater than four feet, then a standard four foot high chain link fence shall be constructed around the detention pond with a 20 foot gate provided to allow access. A chain link fence may not be required when the site in which the pond is to be constructed is zoned non-residential and is a sufficient and safe distance from properties zoned residential or publicly owned property (excluding right-of-way). The city should be consulted on any waiver regarding erection of fence around the detention pond.

Acceptable backfill and fill materials shall consist of suitable soils for earthen embankment construction. The material shall be free of rock or gravel larger than three inches in any dimension, debris, waste, vegetation, and other deleterious matter. Backfill and fill materials shall not be placed in layers thicker than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers. Each layer should be uniformly moistened

or aerated before compaction to achieve optimum moisture and density per ASTM D698. All backfill and fill materials should be placed evenly to required elevations, and uniformly along the full length of the embankment. Additionally, soils should be compacted to at least 95% maximum dry unit weight per ASTM D698.

5.2.2 Dry Underground Stormwater Detention

No underground detention ponds shall be constructed on residential development projects. Underground detention ponds may be considered on non-residential development projects after the designer has sufficiently demonstrated to the Stormwater Director, or his designee that above ground detention is not feasible.

5.2.3 Wet Detention Ponds

Wet detention ponds may be constructed if the facilities are designed to the criteria outlined in Section 3.2.1.5 of the GSMM (volume 2) and Section 8.0 of the CSS. Ponds with submerged inlet or outlet piping shall be provided with a means of isolating all submerged pipes individually for maintenance.

5.3 Water Quality Best Management Practices (BMP's)

5.3.1 Green Infrastructure Practices

The designer is encouraged to review and consult the information contained in Section 7.0 of the CSS and the Green Growth Guidelines (http://www.coastalgadnr.org/cm/green/guide) regarding the recommended green infrastructure practices.

5.3.2 Recommended Stormwater Management Practices

The designer is encouraged to review and consult Section 8.0 of the CSS for guidance regarding the recommended stormwater management practices and selection of appropriate stormwater management practices.

5.3.3 Proprietary Stormwater Management Practices

The Stormwater Director or his designee may at their discretion allow proprietary stormwater management controls. Prior to specification of such a device, the designer shall consult the Stormwater Director or his designee to determine whether the control will be acceptable. Proof of performance history including active references is expected.

5.3.4 Infiltration Practices

Infiltration BMPs must demonstrate compliance through a certified test according to the Soil Infiltration Testing Protocol in Appendix I.

6 CRITICAL WATER RESOURCE AREAS

The City Manager or his designee may establish special design criteria for select areas based on the findings of watershed assessments, hydrologic and hydraulic reports, known flooding issues, geographic-specific service delivery considerations or State 303(d) water quality impairment listings. The designer should consult with the Stormwater Director or his designee to determine if any special drainage districts exist within the City of Savannah.

At this time, the only special districts are those which drain to a Section 305(b)/Section 303(d) "not supporting designated uses" impaired waters as follows:

Casey Canal from headwaters to Vernon River

Harmon Canal from headwaters to Hayners Creek

Chippewa Canal from headwaters to Hayners Creek

Salt Creek from headwaters to Hardin Canal

Pipemakers Canal, from unnamed tributary upstream of Dean Forest Road to Savannah River.

Savannah Harbor, from Hwy 25 Bridge (old Hwy 17) to Elba Island Cut

7 PROCEDURES AND REQUIREMENTS

7.1 Engineering Controls – Design Standards

All hydraulic calculations shall be made in accordance with good engineering practice.

All reports shall include adequate narrative to describe the design theory, basis, inputs, and results in comparison to standards. Raw computer generated data outputs without adequate description will not be reviewed. Assure that reports of computer inputs are adequately described relating to design standards. Similarly, assure that computer outputs are adequately described and compared to standards to prove compliance with design requirements.

All culverts, pipe systems, and open channel flow systems shall be sized in accordance with the information presented in the latest edition of the GSMM, the CSS and the City of Savannah LDM. Assure that reports of computer inputs are adequately described relating to design standards. Similarly, assure that computer outputs are adequately described and compared to standards to prove compliance with design requirements.

Planning and design of stormwater conveyance practices shall be completed in accordance with the latest edition of the GSMM, the CSS and the City of Savannah LDM.

All bridges that will serve as an evacuation route shall be designed to accommodate the 100 year 24 hour storm with no overtopping of the roadway/street. A bridge that serves as ingress/egress to a critical facility as described in the City's Flood Protection Ordinance shall be designed to accommodate the 500 year 24 hour storm with no overtopping of the roadway/street.

Culverts and pipe systems serving contributing drainage areas greater than 10 acres shall be designed using the SCS TR 55, 24 hour storm. Culverts shall be sized such that minimum conveyance level of service (LOS) standards are maintained during the 25-yr, 24-hr storm.

Utilize a tailwater hydrograph for analysis of flow. Sources of tailwater conditions include FEMA FIS, U S Army COE basin studies, or other engineering study. Describe the tailwater evaluation in a narrative, citing sources and assumptions. If a tailwater cannot be determined, calculate the project utilizing alternate worst case scenarios: 1) with no tailwater throughout the evaluation, assure no increase in peak runoff rates for the 1 thru 100 year 24 hour storms; then, 2) assume the FEMA FIRM BFE tailwater condition, or some greater value based upon conditions between the outfall and the nearest FEMA FIRM BFE throughout the model run, checking peak hydraulic grade lines conditions against adjacent structures and infrastructure; and, then design for the worst conditions in each scenario.

In a situation where pre and post evaluations may be performed downstream from the project limit, evaluate all conveyance between the project and the evaluation point, using adherence to the overbank flood protection and extreme flood protection criteria, and determine if additional infrastructure work is required. If so, include the additional infrastructure work in the design.

The detention facilities required for overbank flood protection shall be designed such that they drain no more than ½ the 25-yr, 24-hr storm design volume in 24 hours .

The detention facilities required for extreme flood protection shall be designed such that they are ready for another design storm (100 year frequency 24 hour duration) within 60 hours following the end of a design storm.

7.2 Engineering Report Deliverable Requirements

The Engineering Report shall provide a demonstration of the use of Better Site Planning Techniques and Better Site Design Techniques as described in the CSS of the GSMM.

If a computer program is used for site hydrology design, assure that key input parameters are provided. These parameters include tailwater condition, beginning water levels, friction coefficients, and if overbank situations are encountered, the topographic and friction

parameters for the overbank area. If standard computer output does not provide adequate clarity, annotations may be applied to increase identify required data. Provide the tailwater hydrograph for the outfall.

Similarly, assure that output parameters are provided. Provide hydraulic grade lines for the 25 year and the 100 year storms on pipe or ditch profiles. If a spreadsheet is used, identify peak elevations, alarm levels, and how they pertain to nearby structures. If standard computer output does not provide adequate clarity, annotations may be applied to increase identification of required data. Assure that reports of computer inputs are adequately described relating to design standards. Similarly, assure that computer outputs are adequately described and compared to standards to prove compliance with design requirements.

Summarize calculations with narratives and tables. Reference tables with calculation locations. Provide well planned and communicated information in order to facilitate efficient and timely review. Assure that reports of computer inputs are adequately described relating to design standards. Similarly, assure that computer outputs are adequately described and compared to standards to prove compliance with design requirements.

Provide stage area storage analysis of detention pond performance for the required storm passage. Utilize inflow/outflow analysis to compute peak elevations and discharge flows. Clearly denote the freeboard of the bank, and describe freeboard to nearby structures (adjacent buildings or infrastructure) that may be adjacent or downstream.

Tables showing predevelopment peak flows, total quantities, and peak discharge elevations for each outfall and in total shall be compared to post development flows, total quantities, and peak discharge for each outfall and in total.

8 Green Infrastructure and Stormwater Management Practices

All GI/LID practices shall be selected, designed, constructed and maintained in accordance with the information presented in the latest edition of the *Coastal Stormwater Supplement to the Georgia Stormwater Management Manual* and any relevant local addenda. Applicants are referred to the latest edition of the *Coastal Stormwater Supplement to the Georgia Stormwater Management Manual*, and any relevant local addenda, for guidance on selecting GI/LID practices that can be used to satisfy the post-construction stormwater management criteria outlined in Section 4 of this ordinance.

For green infrastructure or stormwater management practices that are not included in the *Coastal Stormwater Supplement to the Georgia Stormwater Management Manual*, or for which pollutant removal and runoff reduction rates have not been provided, the effectiveness of the green infrastructure or stormwater management practice must be

documented through prior studies, literature reviews or other means, and receive approval from the Stormwater Management Director before being included in a stormwater management system.

9 Stormwater Conveyance Practices

Stormwater conveyance practices, which may include, but are not limited to, storm drain pipes, culverts, catch basins, drop inlets, junction boxes, headwalls, gutters, ditches, open channels, swales and energy dissipaters, shall be provided when necessary to convey post-construction stormwater runoff and protect private properties adjoining development sites and/or public rights-of-way. Stormwater conveyance practices that are used to convey post-construction stormwater runoff on development sites shall meet the following requirements:

1) Methods used to calculate stormwater runoff rates and volumes shall be in accordance with the information presented in the latest edition of the *Georgia Stormwater Management Manual* and any relevant local addenda;

(2) All culverts, pipe systems and open channel flow systems shall be sized in accordance with the information presented in the latest edition of the *Georgia Stormwater Management Manual* and any relevant local addenda; and,

(3) Planning and design of stormwater conveyance practices shall be completed in accordance with the information presented in the latest edition of the *Georgia Stormwater Management Manual* and any relevant local addenda.

10 Stormwater Hot Spots

The Concept Design Phase of development plans for parking garages, vehicle storage lots, vehicle fueling areas and gas stations, auto repairs shops, golf courses, marinas and transportation equipment repair facilities are required to submit plans with best management practices for stormwater hotspots. Fuel and vehicle maintenances areas must provide oil/water separators for stormwater that comes into contact with these operations. The stormwater inspection and maintenance plan must specifically address maintenance and inspection of oil/water separators or other devices used for hotspots.

11 As-built Documentation and Plat

Within 60 days of issuance of the Certificate of Occupancy, the applicant is responsible for submitting as built plans for all green infrastructure and stormwater management practices

shown on the approved stormwater management design plan. The as built plans must show the following items:

- the final design specifications for all green infrastructure and stormwater management practices,
- the final stormwater system elevations based on the North American Vertical Datum 1988,
- the final stormwater system volumes where they were provided as a part of the system design, and
- the as-built elevations at elevation breaks, along curbing, and at changes in grade for pavement, at top and bottom of ditch banks, top and bottom of pond slopes, and each orifice or opening on pond discharge structures.

As-built survey field work shall collect adequate numbers of spot shots to mirror design info given on the approved paving grading and drainage drawing.

As-built drawings shall illustrate the difference between design and as-built by marking though the design elevation (leaving the result legible).

As built information for stormwater management systems shall be supplied for both design and as-built for verification on both drawings and the Record Drawing Stormwater Management Inventory Data sheet (see Appendix F).

Definitions

"Applicant" means a property owner or agent of a property owner who has submitted an application for a post-construction stormwater management permit.

"Aquatic Buffer" means an area of land located around or near a stream, wetland, or waterbody that has intrinsic value due to the ecological services it provides, including pollutant removal, erosion control and conveyance and temporary storage of flood flows.

"Aquatic Resource Protection" means measures taken to protect aquatic resources from several negative impacts of the land development process, including complete loss or destruction, stream channel enlargement and increased salinity fluctuations.

"Better Site Design Techniques" means site design techniques that can be used during the site planning and design process to minimize land disturbance and the creation of new impervious and disturbed pervious cover. Better site design techniques include reducing clearing and grading limits, reducing roadway lengths and widths and reducing parking lot and building footprints.

"Better Site Planning Techniques" means site planning techniques that can be used during the site planning and design process to protect valuable aquatic and terrestrial resources from the direct impacts of the land development process. Better site planning techniques include protecting primary and secondary conservation areas.

"Building" means any structure, either temporary or permanent, having walls and a roof, designed for the shelter of any person, animal or property and occupying more than 100 square feet of area.

"Channel" means a natural or artificial watercourse with a definite bed and banks that conducts continuously or periodically flowing water.

"Conservation Areas" means permanently protected areas of a site that are preserved, in perpetuity, in an undisturbed, natural state.

"Conservation Easement" means a legal agreement between a land owner and a local, state or federal government agency or land trust that permanently protects conservation areas on the owner's land by limiting the amount and type of development that can take place within them but continues to leave the conservation areas in private ownership.

"Dedication" means the deliberate appropriation of property by its owner for general public use.

"Detention" means the temporary storage of stormwater runoff in a stormwater management practice for the purpose of controlling the peak discharge rates and providing gravitational settling of pollutants.

"Developer" means a person who undertakes a land development project.

"Development Project" means a new development or redevelopment project.

"Development Site" means a parcel of land where land disturbing activities have been or will be initiated to complete a land development project.

"Drainage Easement" means a legal right granted by a land owner to a grantee allowing the grantee to convey, treat or manage stormwater runoff on the private land subject to the drainage easement.

"Easement" means a legal right granted by a land owner to a grantee allowing the use of private land for conveyance, treatment and management of stormwater runoff and access to green infrastructure and stormwater practices.

"Erosion and Sediment Control Plan" means a plan that is designed to minimize and control the accelerated erosion and increased sediment loads that occur at a site during land disturbing activities.

"Evapotranspiration" means the loss of water to the atmosphere through both evaporation and transpiration, which is the evaporation of water from the aerial parts of plants.

"Existing Site Conditions" means site building footprint and impervious surface area in place no earlier than five years prior to the date of development application.

"Extended Detention" means the temporary storage of stormwater runoff in a stormwater management practice for an extended period of time, typically 24 hours or greater.

"Extreme Flood Protection" means measures taken to protect downstream properties from dangerous extreme flooding events and help maintain the boundaries of the existing 100-year floodplain.

"Fee in Lieu Contribution" means a payment of money in place of meeting all or part of the stormwater management criteria required by a post-construction stormwater management ordinance.

"Flooding" means a volume of stormwater runoff that is too great to be confined within the banks of a stream, river or other aquatic resource or walls of a stormwater conveyance feature and that overflows onto adjacent lands.

"Green Infrastructure Practices" means a strategically planned and managed network of natural lands, working landscapes, and other open spaces that conserves ecosystem values and functions and provides associated benefits to human populations.

In the context of the LDM, they are a combination of better site planning, design techniques and low impact development practices that are used to protect valuable terrestrial and aquatic resources from the direct impacts of the land development process, maintain pre-development site hydrology and reduce post-construction stormwater runoff rates, volumes and pollutant loads.

"Hotspot" shall mean the same as Stormwater Hotspot, described elsewhere in these definitions.

"Hydrologic Soil Group (HSG)" means a Natural Resource Conservation Service classification system in which soils are categorized into four runoff potential groups. The groups range from group A soils, with high permeability and little runoff produced, to group D soils, which have low permeability rates and produce much more runoff.

"Impaired Waters" means those streams, rivers, lakes, estuaries and other water bodies that currently do not meet their designated use classification and associated water quality standards under the Clean Water Act.

"Impervious Cover" means a surface composed of any material that greatly impedes or prevents the natural infiltration of water into the underlying native soils. Impervious surfaces include, but are not limited to, rooftops, buildings, sidewalks, driveways, streets and roads. Any pavement material and compacted soil used for driveways, roads and parking lots are considered impervious cover.

"Industrial Stormwater Permit" means a National Pollutant Discharge Elimination System (NPDES) permit issued to an industry or group of industries that regulates the pollutant levels associated with industrial stormwater discharges or specifies on-site pollution control strategies.

"Infill Development" means land development that occurs within designated areas based on local land use, watershed and/or utility plans where the surrounding area is generally developed, and where the site or area is either vacant or has previously been used for another purpose.

"Infiltration" means the process of allowing stormwater runoff to percolate into the underlying native soils.

"Infiltration Practice" means a green infrastructure or stormwater management practice designed to provide infiltration of stormwater runoff into the underlying native soils. These stormwater management practices may be above or below grade.

"Inspection and Maintenance Agreement and Plan" means a written agreement and plan providing for the long-term inspection and maintenance of all green infrastructure practices, stormwater management practices, stormwater conveyance features and stormwater drain infrastructure on a development site.

"Jurisdictional Wetland" means an area that is inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions, commonly known as hydrophytic vegetation.

"Land Development" means any project undertaken to change or improve a site that involves one or more land disturbing activities.

"Land Disturbing Activity" means any activity that changes stormwater runoff rates, volumes and pollutant loads on a site. These activities include, but are not limited to, the grading, digging, cutting, scraping, or excavating of soil, the placement of fill materials,

paving, construction, substantial removal of vegetation and any activity that bares soil or rock or involves the diversion or piping of any natural or man-made watercourse.

"Land Owner" means the legal or beneficial owner of land, including those holding the right to purchase or lease the land, or any other person holding proprietary rights in the land. **"Low Impact Development Practice"** means small-scale stormwater management practices that are used to disconnect impervious and disturbed pervious surfaces from the storm drain system and reduce post-construction stormwater runoff rates, volumes and pollutant loads. Low impact development practices include soil restoration, site reforestation/revegetation, green roofs, vegetated filter strips and rain gardens.

"National Pollutant Discharge Elimination System (NPDES) Stormwater Discharge Permit" means a permit issued by the EPA, or by a State under authority delegated pursuant to 33 USC § 1342(b), that authorizes the discharge of pollutants to waters of the State, whether the permit is applicable on an individual, group, or general area-wide basis.

"New Development" means a land development project undertaken on a previously undeveloped or unimproved site.

"Nonpoint Source Pollution" means pollution from any source other than from a discernible, confined and discrete conveyance, such as a wastewater treatment plant or industrial discharge. Sources of nonpoint source pollution include, but are not limited to, agricultural, silvicultural, mining and construction activities, subsurface disposal and urban stormwater runoff.

"Nonstructural Stormwater Management Practice" means any natural resource protection or stormwater management practice or technique that uses natural processes and natural systems to intercept, convey, treat and/or manage stormwater runoff. Nonstructural stormwater management practices include, but are not limited to, protecting primary and secondary conservation areas, reducing clearing and grading limits, reducing roadway lengths and widths, reducing parking lot and building footprints, soil restoration, site reforestation/revegetation, green roofs, vegetated filter strips and rain gardens.

"Off-Site Stormwater Management Practice" means a green infrastructure or stormwater management practice located outside the boundaries of a development site.

"On-Site Stormwater Management Practice" means a green infrastructure or stormwater management practice located within the boundaries of a development site.

"Overbank Flood Protection" means measures taken to protect downstream properties from damaging overbank flooding events.

"Owner" means the legal or beneficial owner of a piece of land, including, but not limited to, a mortgagee or vendee in possession, receiver, executor, trustee, lessee or other person, firm, or corporation in control of the site.

"Permanent Stormwater Management Practice" means a green infrastructure or stormwater management practice that will be operational after the land disturbing activities

are complete and that is designed to become a permanent part of the site for the purposes of managing post-construction stormwater runoff.

"Permit" means the permit issued by a local development review authority to an applicant, which is required for undertaking any land development project or land disturbing activities.

"Person" means any individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, utility, cooperative, city, county or other political subdivision, any interstate body, or any other legal entity.

"Post-Development Hydrology" refers to the set of hydrologic conditions that may reasonably be expected to exist on a development site, after the completion of all land disturbing and construction activities.

"Pre-Development Hydrology" refers to the set of hydrologic conditions that exist on a development site prior to the commencement of any land disturbing activities and at the time that plans for the land development project are approved by the local development review authority.

"Receiving Stream" or **"Receiving Aquatic Resource"** means the body of water or conveyance into which stormwater runoff is discharged.

"Recharge" means the replenishment of groundwater aquifers.

"Redevelopment" means a change to previously existing, improved property, including but not limited to the demolition or building of structures, filling, grading, paving, or excavating, but excluding ordinary maintenance activities, remodeling of buildings on the existing footprint, resurfacing of paved areas and exterior changes or improvements that do not materially increase or concentrate stormwater runoff or cause additional nonpoint source pollution.

"Regional Stormwater Management Practice" means a stormwater management practice designed to control stormwater runoff from multiple properties, where the owners or developers of the individual properties may participate in providing land, financing, design services, construction services and/or maintenance services for the practice.

"Responsible Party" means any individual, partnership, co-partnership, firm, company, corporation, association, joint stock company, trust, estate, governmental entity, or any other legal entity; or their legal representatives, agents, or assigns that is named on a stormwater inspection and maintenance agreement and plan as responsible for the long-term operation and maintenance of one or more green infrastructure or stormwater management practices.

"Site" means development site.

"Stop Work Order" means an order issued that requires that all land disturbing activity on a site be stopped.

"Stormwater Hotspot" means an area where land use or pollution generating activities have the potential to generate highly contaminated runoff, with concentrations of pollutants in excess of those typically found in stormwater runoff. Stormwater hotspots include, but are not limited to, fueling stations (including temporary fueling stations during construction), golf courses, public works yards and marinas.

"Stormwater Management" means the interception, conveyance, treatment and management of stormwater runoff in a manner that is intended to prevent increased flood damage, channel erosion, habitat degradation and water quality degradation and to enhance and promote the public health, safety and general welfare.

"Stormwater Management Plan" means a written document that details how stormwater runoff will be managed on a development site and that shows how the stormwater management criteria that apply to the development project have been met.

"Stormwater Management Practice" means a practice or technique, either structural or nonstructural that is used to intercept stormwater runoff and change the characteristics of that runoff. Stormwater management practices are used to control post-construction stormwater runoff rates, volumes and pollutant loads to prevent increased flood damage, channel erosion, habitat degradation and water quality degradation.

"Stormwater Management System" means the entire suite of green infrastructure and stormwater management practices and stormwater conveyance features that are used to intercept, convey, treat and manage stormwater runoff on a development site.

"Stormwater Retrofit" means a green infrastructure or stormwater management practice designed for an existing development site that previously had no green infrastructure or stormwater management practice in place or had a practice that was not meeting local stormwater management criteria.

"Stormwater Runoff" means surface water resulting from precipitation.

"Stormwater Runoff Reduction" means providing for the interception, evapotranspiration, infiltration, or capture and reuse of stormwater runoff to help maintain pre-development site hydrology and help protect aquatic resources from several indirect impacts of the land development process, including decreased groundwater recharge, decreased baseflow and degraded water quality.

"Subdivision" means the division of a parcel of land to create one or more new lots or development sites for the purpose, whether immediately or in the future, of sale, transfer of ownership, or land development, and includes divisions of land resulting from or made in connection with the layout or construction of a new street or roadway or a change in the layout of an existing street or roadway.

"Watercourse" means a permanent or intermittent stream or other body of water, either natural or man-made, which gathers or carries surface water.

"Watershed Management Plan" or **"Subwatershed Management Plan"** means a document, usually developed cooperatively by government agencies and other stakeholders,

to protect, restore and/or otherwise manage the water resources found within a particular watershed or subwatershed. Watershed or subwatershed management plans commonly identify threats, sources of impairment, institutional issues and technical and programmatic solutions or projects to protect and/or restore water resources.

"Water Quality Protection" means adequately treating stormwater runoff before it is discharged from a development site to help protect downstream aquatic resources from water quality degradation.

"Wetland Hydroperiod" means the pattern of fluctuating water levels within a wetland caused by the complex interaction of surface water, groundwater, topography, soils and geology within a wetland.

APPENDICES

A Stormwater Facility Inspection & Maintenance Agreement

B Applicant completion certification

C Engineer's project completion certification

D Engineer's as built certification

E Designer's Certification Statement

F Stormwater Checklist

G Record Drawing Stormwater Management Inventory Data

H Application for Redevelopment Runoff Reduction Volume Credit

I Soil Infiltration Testing Protocol

Appendix A: Stormwater Facility Inspection & Maintenance Agreement

This AGREEMENT, made and entered into this ___ day of _____, 20_____, by and between _____, his/her successors and assigns, including but not limited to any homeowners association, commercial developer, holder of any portion of the below described property, and/or similar (hereinafter called the "Landowner"), and the City of Savannah, Georgia; hereinafter called the "City", as required by state and local regulation and ordinances.

WITNESSETH, that WHEREAS, the Landowner is the owner of certain real property described as _____ and recorded by deed in the land records of Chatham County, Georgia, Deed Book ____Page ___, hereinafter called the "Property".

WHEREAS, the Landowner is proceeding to develop the property and/or build upon the property; and

WHEREAS, the Stormwater Management and Operations and Maintenance (O&M) Plan; hereinafter called "the Plan", which is expressly made a part hereof, as approved or to be approved by the City, provides for management of stormwater runoff for the property; and

WHEREAS, the Landowner, its successors and assigns, agree that the health, safety, and welfare of the residents of Savannah, Georgia, require that stormwater management facilities be constructed and maintained on the Property and in accordance with the Plan; and

WHEREAS, the City requires that stormwater management facilities as shown within the Plan be constructed and adequately maintained by the Landowner, its successors and assigns.

NOW, THEREFORE, in consideration of the foregoing premises, the mutual covenants contained herein, and the following terms and conditions, the parties hereto agree as follows:

1. The stormwater management facilities shall be constructed and/or upgraded as well as maintained by the Landowner, its successors and assigns, in accordance with the specifications identified in the Plan.

2. The Landowner, its successors and assigns, shall adequately maintain the stormwater management facilities and perform the work necessary to keep those facilities in good working order at all times, as described in the Plan. This includes all pipes, channels or other conveyances built to convey stormwater to the facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater runoff. Adequate maintenance is herein defined as good working condition so that these facilities are performing their approved design functions.

3. The Landowner, its successors and assigns, shall inspect the stormwater management facility annually and maintain an inspection report on site that will be available for review by the City. The purpose of the inspection is to ensure safe and proper functioning of the stipulated facilities. The inspection shall cover all applicable stormwater management facilities, including but not limited to, conveyance measures, berms, outlet structures, pond areas, etc. Deficiencies shall be noted in the inspection report along with a schedule for repair. The inspection procedures, frequency and report shall follow the procedures established and approved in the Plan.

4. The Landowner, its successors and assigns, hereby grant permission to the City, its authorized agents and employees, to enter upon the Property and to inspect the stormwater management facilities whenever the City deems necessary and with reasonable notice having been given to the Landowner. The City shall provide the Landowner, its successors and assigns, copies of the inspection findings and a directive to commence with the repairs if necessary.

5. In the event the Landowner, its successors and assigns, fails to maintain the stormwater management facilities in good working condition acceptable to the City, the City may issue citations to the Landowner for resulting, continuing ordinance violations (as set forth in the Savannah City Code of Ordinances), until such time as the issues are satisfactorily resolved. Additionally, the City may enter upon the Property and implement the necessary measures to correct deficiencies identified in the inspection report and to recover the costs of such repairs from the Landowner, its successors and assigns through the appropriate means. This provision shall not be construed to allow the City to erect any structure of permanent nature on the land of the Landowner outside of the easement for the stormwater management facilities. It is expressly understood and agreed that the City is under no obligation to routinely maintain or repair said facilities, and in no event shall this AGREEMENT be construed to impose any such obligation on the City.

6. Landowner, its successors and assigns, will perform the work necessary to keep these facilities in good working order as appropriate. In the event a maintenance schedule for the stormwater management facilities (including sediment removal) is outlined on the approved plan, the schedule will be followed.

7. In the event the City, pursuant to this AGREEMENT, performs work of any nature, or expends any funds in performance of said work for labor, use of equipment, supplies, materials, and the like, the Landowner, its successors and assigns, shall reimburse the City upon demand, within thirty (30) days of receipt thereof for all actual costs incurred by the City hereunder. Work will not commence without written notice from the City to the owner.

8. This Agreement imposes no liability of any kind whatsoever on the City and the Landowner agrees to hold the City harmless from any liability in the event the stormwater management facilities fail to operate properly.

9. This AGREEMENT shall constitute a covenant running with the land, and shall be binding on the Landowner, its administrators, executors, assigns, heirs and any other successors in interests, including any homeowners association.

CERTIFICATION

OWNER:

WITNESS the following signatures and seals:

_____
Company/Corporation/Partnership Name (Seal)

By: _____

_____
(Type Name and Title)

The foregoing AGREEMENT was acknowledged before me this ____ day of _____, 20___, by

_____.

_____
NOTARY PUBLIC

My Commission Expires: _____

Appendix B Applicant completion certification

I, _____(print name here)

am the Owner, Applicant, or _____(circle appropriate title or print in blank)

of the site devel0pment known as _____(fill name of development)
located at _____(fill in street address) _____Savannah
(fill in post office city or circle Savannah)

Georgia, zip code _____(fill in the blank)

Under the laws of the state of Georgia pursuant to water quality, flood management, stormwater management, erosion, sediment and pollution control, and City ordinances that may apply to this development, the construction of this development has progressed to the point of completion as measured by accomplishing completion of all of the required components of the approved site development plans. Further, the site will be operated and maintained throughout its life according to the Stormwater Maintenance and Operations Plan as approved for the facility and required by the executed Stormwater Inspection and Maintenance Agreement on file for the facility. I understand that failure to follow, undertake and complete tasks stipulated by the Inspection and Maintenance Agreement on file for the facility may cause others to be assigned to complete the required tasks at my cost, as per the terms detailed in the City's Stormwater Management Ordinance and the approved Stormwater Inspection and Maintanence Agreement for the facility.

I understand my responsibilities and faithfully agree to carry out the responsibilities as required.

Signature_____

Name_____

Address_____

City, State, Zip_____

Provide mailing address to which you wish permanent legal correspondence to be addressed

Daytime Telephone Number_____

Email Address_____

Cell Phone Number _____

Appendix C Engineer's project completion certification

I, _____(print name here)

am a professional engineer registered in the State of Georgia, and am familiar with the requirements of the City of Savannah Stormwater Management Ordinance, the City of Savannah Local Design Manual, hydraulic engineering principles, and the approved design plans for the site devel0pment known as _____(fill name of development) located at _____(fill in street address) _____Savannah (fill in post office city or circle Savannah)

Georgia, zip code _____(fill in the blank)

I have personally compared the approved design plans entitled:_____

_____dated: _____

for which a pre construction meeting / plan approval issuance date was _____

to the conditions of the completed site and make the following certification:

Based upon my personal inspection of the condition of the constructed site in comparison to the approved plans, I find that the site is constructed in substantial compliance with the approved plans.

Name_____

Address_____

City, State, Zip_____

Daytime Telephone Number_____

Email Address_____

Cell Phone Number _____

_____(signature)

Date_____ Seal

Appendix D Engineer's as built certification

I, _____(print name here)

am a professional engineer registered in the State of Georgia, and am familiar with the requirements of the City of Savannah Stormwater Management Ordinance, the City of Savannah Local Design Manual, hydraulic engineering principles, the approved Operations Maintenance Plan, and the approved design plans for the site devel0pment known as _____(fill name of development) located at _____(fill in street address) _____Savannah (fill in post office city or circle Savannah)

Georgia, zip code _____(fill in the blank)

I have personally compared the approved design plans entitled:_____

_____dated: _____

for which a pre-construction meeting / plan approval issuance date was _____

to the as built survey undertaken on _____(fill in date) and make the following certification:

Based upon my personal inspection of the condition of the constructed site and the surveyed results of construction materials, locations, elevations, and capacities of the constructed site in comparison to the approved plans, I find that the site is constructed in compliance with the approved plans, and will function in compliance with the City's Stormwater Management Ordinance, provided requirements of the Stormwater Operations and Maintenance Plan are implemented.

Name_____

Address_____

City, State, Zip_____

Daytime Telephone Number_____

Email Address_____

Cell Phone Number _____

_____(signature)

Date _____ Seal

Appendix E Designer's certification statement

I, _____(print name here)

am a professional engineer registered in the State of Georgia, and am familiar with the requirements of the City of Savannah Stormwater Management Ordinance, the City of Savannah Local Design Manual, the City Flood Protection Ordinance, the City Subdivision Ordinance, the City Erosion and Sediment Control Ordinance, hydraulic engineering principles, and low impact design/green infrastructure design practices.

The attached design plans, Stormwater Management Report, and Stormwater Management Operations and Maintenance Plan for the site devel0pment known as _____(fill name of development) located at _____(fill in street address) _____Savannah (fill in post office city or circle Savannah)

Georgia, zip code _____(fill in the blank) are designed in compliance with the Local Design Manual of the City of Savannah, the City of Savannah Stormwater Management Ordinance, the City of Savannah Local Design Manual, the City Flood Protection Ordinance, the City Subdivision Ordinance, and the City Erosion and Sediment Control Ordinance. Further, when constructed according to the design plans, and operated according to the facility Stormwater Operations and Maintenance Plan, the facility will function in compliance with the Local Design Manual of the City of Savannah, the City of Savannah Stormwater Management Ordinance, the City of Savannah Local Design Manual, the City Flood Protection Ordinance, the City Subdivision Ordinance, and the City Erosion and Sediment Control Ordinance.

Name_____

Address_____

City, State, Zip_____

Daytime Telephone Number_____

Email Address_____

Cell Phone Number _____

_____(signature)

Date_____ Seal

Appendix F

Stormwater Checklist

STORMWATER MANAGEMENT SITE DEVELOPMENT PLAN REVIEW CHECKLIST

This checklist must be completed, signed, and submitted by the Consultant with the design phase submittal. The purpose of this checklist is not only to facilitate an efficient review, but also to assist the Consultant in planning their site design work flow, to aid in QA/QC of complete submittal packages, and ultimately to assist in achieving faster permitting. To complete the form, circle the appropriate response, "Y, N, or N/A", for each item, to designate if performed, and documentation included in submittal. Under "note", include location within submittal package (sheet number, and location or detail number, or page number and paragraph of report, etc.) for Y items. Alternately, include why N or N/A is acceptable for the site, based upon the Stormwater Management Ordinance and the Local Design Manual. Feel free to contact the City of Savannah Stormwater Management Department at 912-650-7855 if you have any questions.

Concept Design Phase

	Circle one	Note
1. Procure and provide site mapping to illustrate the layout of the proposed development project and show in general how post construction stormwater runoff will be managed on the development site. Mapping for concept may be based on preliminary survey information such as enlarged USGS map, GIS data, deed plots, or old field survey, etc.	Y N N/A	
2. Provide a thorough assessment of the Natural Resources including both terrestrial and aquatic found on the development site by acceptable site reconnaissance and surveying techniques.	Y N N/A	
3. Show the site at adequate scale to demonstrate location within the City limits. Including, at minimum, the following details in a conceptual proposal, using appropriate tables, plans, and narratives as required:	Y N N/A	
A) Project acreage	Y N N/A	
B) Building location, area (foot print) and finish floor elevations	Y N N/A	
C) Most current FEMA flood zone delineation, include the Flood Insurance Rate Map, Community map number and the effective date.	Y N N/A	
D) Impervious area (pre and post development condition)	Y N N/A	
E) Stormwater unit area, parking and tree area delineation	Y N N/A	

F) Wetland delineations. Clearly note on plan if there are or aren't any wetland areas found in and/or within 200 feet of the project area.	Y N N/A
G) Waters of the State within 200 feet of the project area.	Y N N/A
H) A presentation of proposed phasing plan(s) if the project will be divided into several phases.	Y N N/A
4. Assess potential application of green infrastructure practices in the form of better site planning and design techniques. Low impact development practice should be used to the maximum extent practicable during the creation of a stormwater management concept plan. A demonstration of better site planning is required. At a minimum, the following site information and practices shall be considered, utilizing available information instead of field exploration for concept development. Check all that apply:	Y N N/A
A) Soil type (from Soil Study)	Y N N/A
B) Depth of ground water on site	Y N N/A
C) Whether the type of development proposed is a hotspot as defined by the Ordinance and Design Manual. If yes, address how this influences the concept proposal?	Y N N/A
D) Protection of primary and secondary conservation areas	Y N N/A
E) Reduced clearing and grading limits	Y N N/A
F) Reduced roadway lengths and widths	Y N N/A
G) Reduced parking lot and building footprints to minimize impervious surface	Y N N/A
H) Soil restoration	Y N N/A
I) Site reforestation/revegetation	Y N N/A
J) Impervious area disconnection	Y N N/A
K) Green roof	Y N N/A
L) Pervious pavement	Y N N/A
5. Provide preliminary calculation to verify the site is suitable for the proposed project scale and layout to satisfy the Post-construction Stormwater Management Design Criterias and requirements of the current City of Savannah Stormwater Ordinance.	Y N N/A
6. Briefly summarize in separate report the stormwater management strategy to be utilized for the proposed site design. This report shall be signed and sealed by the GA Registed PE.	Y N N/A

Detailed Design Phase

	Circle One	Note
1. Provide site survey plan with the drainage submittal. The site survey plan shall include but is not limited to the following:	Y N N/A	
A) Date(s) of survey and revisions	Y N N/A	
B) Bench mark with elevation, the bench mark shall have coordinates based on the Georgia State Plane Coordinate System, East Zone, North American Datum of 1983 (NAD 83). Elevation shall be based on the North American Vertical Datum of 1988 (NAVD 88).	Y N N/A	
C) Existing and proposed right of way, easements and set backs	Y N N/A	
D) Adjacent structures and names of property owners	Y N N/A	
E) Property identification number (PIN)	Y N N/A	
F) Gross acreage of property	Y N N/A	
G) Show environmental features, including landfills	Y N N/A	
H) Topographic contours in 1 foot intervals	Y N N/A	
I) Property line bearings and distances	Y N N/A	
J) North arrow and scale.	Y N N/A	
K) Professional stamp and signature	Y N N/A	
L) Location of all existing utilities, structures above ground and underground (pipe, manholes/catch basins with top and invert elevations, drive, walkway, fence, etc.), information on downstream system which the proposed storm system is connecting to. At least two (2) downstream manholes shall be surveyed.	Y N N/A	
M) Most current FEMA flood zone delineation, include the Flood Insurance Rate Map, Community map number and the effective date.	Y N N/A	
N) Wetland delineations. Clear note on plan if there are or aren't any wetland areas found in and within 200 feet of the project area.	Y N N/A	
O) Water of the state within 200 feet of the project area.	Y N N/A	

2. Provide a thorough assessment of the Natural Resource Inventory including both terrestrial and aquatic found on the development site by acceptable site reconnaissance and surveying techniques if Concept Design phase was not exercised.	Y N N/A
3. Assess potential application of green infrastructure practices in a detailed manner. Better site planning and design techniques and low impact development practice shall be used to the maximum extend practical. The following site information shall be considered:	Y N N/A
A) Soil type.	Y N N/A
B) Depth of ground water on site.	Y N N/A
C) Whether the type of development proposed is a hotpot as defined by the Ordinance and Design Manual. How does this influence site design?	Y N N/A
4. Provide a summary narrative/report of how the post-construction stormwater runoff will be managed on the development site meeting the five (5) post-construction stormwater management criteria as described in City of Savannah Stormwater Management LDM.	Y N N/A
A) Meeting Stormwater Runoff Reduction	Y N N/A
B) Meeting Stormwater Quality Protection	Y N N/A
C) Meeting Aquatic Resource Protection	Y N N/A
D) Meeting Overbank Flood Protection	Y N N/A
E) Meeting Extreme Flood Protection	Y N N/A
F) Provide soil maps; boring locations with geotechnical report if needed.	Y N N/A
G) Hydrology: provide runoff curve number determinations, time of concentration, and hydrograph generation (SCS methods) for pre- and post-developed conditions with worksheets.	Y N N/A
H) Hydraulics: Specify assumptions and coefficients used; Provide stage-storage table and curve. Provide pond routing of post-development hydrographs for appropriate design storms as defined in the City of Savannah Stormwater Management Ordinance; Provide riser/outlet structure analysis and emergency spillway adequacy/capacity analysis.	Y N N/A
I) Provide pipe size calculations.	Y N N/A

5. The detention facility Design shall meet Georgia Stormwater Management Manual, and Coastal Supplement requirements.	Y N N/A
A) Tail water condition elevation is documented by a reasonable resource and/or analysis.	Y N N/A
B) The pond has been designed to provide Overbank Flood Protection Volume. One foot of free board has been provided above the 100 year peak water elevation. A soil survey may be required within the proposed detention facility which demonstrates that the designed storage volume is above the seasonal ground water elevation.	Y N N/A
C) Minimum 15' wide maintenance access has been provided around the pond and from the publicly accessed road, and necessary easement has been provided.	Y N N/A
D) A sediment fore-bay has been designed Per GA Blue Book if the pond is also used for Water Quality purpose.	Y N N/A
6. Match pipe crown elevations, at minimum where possible.	Y N N/A
7. Show drainage pattern, property ridge line(s), and building finish elevation on the grading plan.	Y N N/A
8. Clearly note on plans:	Y N N/A
A) A Right of Way Permit shall be obtained prior to performing construction activity in the City's R.O.W	Y N N/A
B) Chlorinated disinfected water shall not be discharged into the stormwater system.	Y N N/A
C) Call before you dig note.	Y N N/A
9. Provide downstream and surrounding neighborhood area analysis to identify any existing capacity shortfalls or drainage blockages based on the 10% rule in the GSMM.	Y N N/A
10. Direct connection of a building's downspouts into a City system shall be discouraged.	Y N N/A
11. When the development site's stormwater peak and/or total volume discharge has increased to the adjacent property written approval of the neighboring property owner shall be provided. The private stormwater easement and agreement shall be provided for neighboring property.	Y N N/A
12. Provide stormwater pipe profiles with 25 and 100 year HGL. Show all existing and proposed utility crossings on profiles.	Y N N/A
13. Note on plans the City's right to always allow access property to inspect stormwater facilities.	Y N N/A

14. Include note on plans requiring compliance with video tape procedures for stormwater facilities as prescribed in the City's document titled "New Construction Televising Procedures Manual" as prepared by the Water and Sewer Department.	Y N N/A
15. Prepare Stormwater management system inspection and maintenance plan.	Y N N/A
16. Provide Soil Erosion/Sedimentation Control plan to include the following information:	Y N N/A
A) Description of site activity and amount/degree of disturbance.	Y N N/A
B) Existing site conditions (topography, vegetation, drainage)	Y N N/A
C) Soil type, description, and boundary	Y N N/A
D) Name and 24 hour number of local contact responsible for erosion and sedimentation control	Y N N/A
E) Methods to be used in Erosion and Sedimentation Control plan	Y N N/A
F) Permanent site stabilization, establishment and maintenance	Y N N/A
G) Provisions for use of onsite detention pond as temporary sediment basin with clean out schedule & instructions for conversion to a permanent facility.	Y N N/A
H) Calculations needed to assure adequacy of basin and structures	Y N N/A
I) Construction schedule (graph or table), including a note in **Bold Letter**: "**The escape of sediment from the site shall be prevented by the installation of erosion and sediment control measures and practices prior to, or concurrent with, land disturbing activities**."	Y N N/A
J) Maintenance statement note: "Erosion control measures will be maintained at all times. If full implementation of the approved plan does not provide for effective erosion control, additional erosion and sediment control measures shall be implemented to control or treat the sediment source."	Y N N/A
K) Note: "Any disturbed area left exposed for a period greater than 14 days shall be stabilized with mulch or temporary seeding."	Y N N/A
L) Tree locations and protection fences on demolition plans.	Y N N/A

17. All plans and reports shall be signed and sealed by registered Georgia Professional Engineer	Y N N/A	
18. Provide signed and sealed Engineer Certification Letter	Y N N/A	
19. After the project has been constructed, As-builts (Record Drawings) must be submitted to the City of Savannah Development Services Office as required by City of Savannah Procedure for handling Close-out Documents for Private Development Projects. The size of the drawings shall be 24" x 36". As-builts shall have a coordinate system based on the Georgia State Plane Coordinate System, East Zone, North American Datum of 1983 (NAD 83). Elevations shown shall be based on the North American Vertical Datum of 1988 (NAVD 88). All measurements and coordinates shown shall use the U.S. Survey Foot definition. Coordinates shall be shown on all drainage structures, detention outlet control structures, manholes. It is suggested that this data format be used at the beginning of the project in the site design phase.	Y N N/A	
20. Acknowledge the responsibilities and costs which are associated with the necessary items as part of the close out documents in order to obtain a final Certificate of Occupancy. These items are listed in Appendix "B" as a reminder in the City's Stormwater Management Development's Acceptance Letter for development.	Y N N/A	

The above checklist shall be used as a minimum guideline for drainage development requirements and must be completed and signed by the engineer proposing the development with his/her plans to the Development Service Office. As the developer's engineer completes an item, he/she shall document the fact of completion by circling the appropriate 'Y, N, or N/A' in the box for that particular item. The box at the right of the form is for explanation of where to find items included for each Y response. Alternately, the box is for explaining why N or N/A is appropriate, based upon the City's Stormwater Ordinance and/or Local Design Manual. Please ensure that the portion below is filled out in its entirety:

Name of Development:	
<u>Developer's Engineer Name:</u>	
Developer's Engineering Firm:	
Developer's Engineer Signature:	
Date City Reviewer Received:	
Date City Review Comments Issued:	

Appendix G:

Record Drawing Stormwater Management Inventory Data

Record Drawing Stormwater Management Unit Inventory Data

The Inventory is intended to be completed and provided to the Stormwater Management Department with the first as-built drawing submittal to the City Engineer.

Project Name:	**Date of Final Inspection:**
Project Number:	**Project Total Disturbed Area:**
Project Location:	**Project Total Impervious Area:**
Consultant:	**Site APv:**

SW Structure List:	**ID/Name:**		
Wet Pond			
Dry Pond			
Stormwater Wetland			
Vegetated Filter Strip			
Bioretention/Rain Garden			
Underground Storage			
Permeable Pavement			
Green Roof			
Other: _____			

Describe Stormwater Treatment Train: (Attach additional pages if necessary)

Flood Protection Table:								
SWMU ID	Volume(cf) / Elevation (NAVD88)	N/A	1yr-24hr	5yr-24hr	10yr-24hr	25yr-24hr	50yr-24hr	100yr-24hr

Wet Pond:	**SWMU ID:**	*Provide table for each SWMU ID*

<table>
<tr><td colspan="4">Description of unit’s design function in the stormwater management train:</td></tr>
<tr><td>Permanent Pool Volume:</td><td></td><td>Forebay Sediment Volume:</td><td></td></tr>
<tr><td>Side slopes not to exceed:</td><td></td><td>Pond Sediment Volume:</td><td></td></tr>
<tr><td>Outfall structure coordinates (to nearest hundredth):</td><td>X:
Y:</td><td colspan="2" rowspan="2">Aquatic vegetation provided (list/quantity):</td></tr>
<tr><td colspan="2">Outfall Design Detail:</td></tr>
</table>

Dry Pond:	**SWMU ID:**	*Provide table for each SWMU ID*	
Description of unit's design function in the stormwater management train:			
Storage Volume:		Sediment Storage Volume:	
Flow Path Width:		Outfall Design Detail:	
Side slopes not to exceed:			
Outfall structure coordinates (to nearest hundredth):	**X:** **Y:**		

Vegetated Filter Strip:	**SWMU ID:**	*Provide table for each SWMU ID*	
Description of unit's design function in the stormwater management train:			
Flow Path Width:		Sediment Storage Volume:	
Side slopes not to exceed:		Outfall Design Detail:	
Outfall structure coordinates (to nearest hundredth):	**X:** **Y:**		

Grass Channel:	**SWMU ID:**	*Provide table for each SWMU ID*	
Description of unit's design function in the stormwater management train:			
Flow Path Width:		Sediment Storage Volume:	
Side slopes not to exceed:		Outfall Design Detail:	

Outfall structure coordinates (to nearest hundredth):	**X:** **Y:**	

Stormwater Wetlands:	**SWMU ID:**	*Provide table for each SWMU ID*
Description of unit's design function in the stormwater management train:		
Surface Area (at outfall elevation): Depth (max): Volume:		Sediment Volume:
Outfall Structure Coordinates (to nearest hundredth):	**X:** **Y:**	Aquatic Vegetation Provided (list/quantity):
Outfall Design Detail:		

Bioretention Areas and Rain gardens:	**SWMU ID:**	*Provide table for each SWMU ID*
Description of unit's design function in the stormwater management train:		

Depth Of Constructed Soil		Inlet Design:	
Underdrain: Y / N	Size:	Outfall Structure:	Y / N

Outfall Structure Coordinates (to nearest hundredth):	X: Y:	Vegetation Provided (list/quantity):
Outfall Design Detail:		

Underground Detention:	**SWMU ID:**	*Provide table for each SWMU ID*
Description of unit's design function in the stormwater management train:		
Volume:		Diagram of Inlets and Chambers:
Outfall Structure Coordinates (to nearest hundredth):	**X:** **Y:**	
Outfall Design Detail:		

Permeable Pavement:	**SWMU ID:**	*Provide table for each SWMU ID*

Description of unit's design function in the stormwater management train:	
Volume of Storage (cf): Underdrain: Y/N Type: Diameter:	Detail of full depth cross-section:

Green Roof::	**SWMU ID:**	*Provide table for each SWMU ID*
Description of design function in the stormwater management unit train:		
Square feet of green: Media depth: Detention volume: Overflow elevation (height above roof surface):	Detail of full depth cross-section:	
Overflow Storage? Y/N Storage volume:		

Provide flow diagram of green roof overflow detention/reuse system:

Infiltration Trench:	**SWMU ID:**	*Provide table for each SWMU ID*
Description of unit's design function in the stormwater management train:		
Storage Volume:		Inlet design:
SWMU location (to nearest hundredth):	**X:** **Y:**	Cross Section of Trench:

Underdrain: Y/N Pipe Size: Length: Diagram:	

Other Units:	**SWMU ID:**	*Provide table for each SWMU ID*
Description of unit's design function in the stormwater management train:		
Design Capacity/Volume:		Diagram of Unit:
Outfall Coordinates (to nearest hundredth):	**X:** **Y:**	

Instructions for completing Record Drawing Stormwater Management Unit Inventory data sheet:

Project Name, Number, Location and Consultant should be identical to the SPR information for the project.

Provide the date of the final inspection as registered in the SPR data for the project.

Total disturbed and total impervious areas are provided with the project's Hydrology Report but shall be provided as-built to reflect any changes since the design submittal.

Site APv is the project's Aquatic Resource Protection Volume from the accepted project concept plan or stormwater design plan.

Stormwater Structure List is to include the Stormwater Management Units (SWMUs) and a unique identifier for the project. Stormwater structures for the purposes of this form do not include manholes, inlets, ditches (unless provided as a swale), headwalls, pipes (unless provided as underground detention) or pipe flared end sections.

Stormwater treatment train should show in sequence all Stormwater Management practices used to address the Stormwater Management Ordinance. This may include BMPs such as downspout disconnects, reduced pavement area on lots, curb inlet inserts and other engineered methods.

Enter both as-built elevation and volume of design storms for SWMUs that provide overbank flood protection.

For each SWMU provide the description of the unit's design function in the stormwater management train. The description should include how the RRv, APv and/or OFP are addressed with this unit. This information should agree with the stormwater design submittal for the project and may come directly from the CSS Site Planning and Design Worksheet. Provide requested documentation of as-built details for post-construction inspection and maintenance program.

Provide Georgia Professional Engineer's signature, registration number and date as certification of the review and accuracy of this submittal.

Appendix H:

Application for Redevelopment Runoff Reduction Volume Credit

Applicant Information		
Name	Email:	
Primary contact:		Title:
Mailing Address		
City:	State:	Zip code:
Telephone number:		Cell number:

Project Site Information		
Location/Address:		Property size (acres)
Project name:		Plan number in ETRACK: _____- _____- Plan
Watershed/Downstream discharge point:		
Application is for off-site RRv _____ or impervious area off-set _____ (check one)		
Credit for off-site stormwater management is only available within city right-of-way or city-owned property.		

Eligibility of off-site Compliance: Documentation of Infeasibility of On-site Compliance

Please check each eligibility criterion that applies to this site

- ☐ Too small/no an area outside of the building foot print
- ☐ Soil contamination or other subsurface or geologic condition that creates risks or hazards to infiltration of water into the ground
- ☐ Site use that is inconsistent with capture and reuse of storm water (explain below)
- ☐ A physical condition that prohibits use of storm water infiltration practice (like seawall, slip piles, walls)
- ☐ Other significant site constraints (explain below):

(explain)

Water Volume Calculations

Off-site RRv Calculation		**Off-site Pervious Surface Calculation**
Total off-site Runoff Reduction credit applied for: (cuft)		Total off-site pervious surface credit applied for: (sf)
RRC(off-site) [sf] = RRC (onsite) / 0.42		
Total off-site Runoff Reduction required:		Total off-site pervious surface required:
RRC(total) = RRC(off-site) + 0.20(RRC(off-site))		RRC(total) = RRC(off-site) + 0.20(RRC(off-site))
Total Cost of purchased Run-off Reduction Volume to be managed off-site = $_____		

Appendix I:

Soil Infiltration Testing Protocol[i]

Soil Infiltration Testing Protocol

Purpose of this Protocol

The soil infiltration testing protocol describes evaluation and field testing procedures to determine if infiltration BMPs are suitable at a site, as well as to obtain the required data for infiltration BMP design.

When to Conduct Testing

The Site Design Process for LID, outlined in Chapter 5 of this manual, describes a process for site development and application of nonstructural and structural BMPs. It is recommended that soil evaluation and investigation be conducted following development of a concept plan or early in the development of a preliminary plan.

Who Should Conduct Testing

Soil evaluation and investigation may be conducted by soil scientists, local health department sanitarians, design engineers, professional geologists, and other qualified professionals and technicians. The stormwater designer is *strongly* encouraged to directly observe the testing process to obtain a first-hand understanding of site conditions.

Importance of Stormwater BMP Areas

Sites are often defined as unsuitable for infiltration BMPs and soil-based BMPs due to proposed grade changes (excessive cut or fill) or lack of suitable areas. Many sites will be constrained and unsuitable for infiltration BMPs. However, if suitable areas exist, these areas should be identified early in the design process and should *not* be subject to a building program that precludes infiltration BMPs. Full build-out of site areas otherwise deemed to be suitable for infiltration should not provide an exemption or waiver for adequate stormwater volume control or groundwater recharge.

Safety

As with all field work and testing, attention to all applicable Occupational Safety and Health Administration (OSHA) regulations and local guidelines related to earthwork and excavation is required. Digging and excavation should never be conducted without adequate notification through the Michigan One Call system (Miss Dig www.missdig.net or 1-800-482-7171). Excavations should never be left unsecured and unmarked, and all applicable authorities should be notified prior to any work.

Infiltration Testing: A Multi-Step Process

Infiltration testing is a four-step process to obtain the necessary data for the design of the stormwater management plan. The four steps include:

1. Background evaluation
   - Based on available published and site specific data
   - Includes consideration of proposed development plan
   - Used to identify potential BMP locations and testing locations
   - Prior to field work (desktop)
2. Test pit (deep hole) observations
   - Includes multiple testing locations
   - Provides an understanding of sub-surface conditions
   - Identifies limiting conditions
3. Infiltration testing
   - Must be conducted onsite
   - Different testing methods available
4. Design considerations
   - Determine suitable infiltration rate for design calculations
   - Consider BMP drawdown
   - Consider peak rate attenuation

Step 1. Background evaluation

Prior to performing testing and developing a detailed site plan, existing conditions at the site should be inventoried and mapped including, but not limited to:

- Existing mapped soils and USDA Hydrologic Soil Group classifications.
- Existing geology, including depth to bedrock, karst conditions, or other features of note.
- Existing streams (perennial and intermittent, including intermittent swales), water bodies, wetlands, hydric soils, floodplains, alluvial soils, stream classifications, headwaters, and first order streams.
- Existing topography, slope, drainage patterns, and watershed boundaries.
- Existing land use conditions.
- Other natural or man-made features or conditions that may impact design, such as past uses of site, existing nearby structures (buildings, walls), abandoned wells, etc.
- A concept plan or preliminary layout plan for development should be evaluated, including:
  - Preliminary grading plan and areas of cut and fill,
  - Location of all existing and proposed water supply sources and wells,
  - Location of all former, existing, and proposed onsite wastewater systems,
  - Location of other features of note such as utility rights-of-way, water and sewer lines, etc.,
  - Existing data such as structural borings, and
  - Proposed location of development features (buildings, roads, utilities, walls, etc.).

In Step 1, the designer should determine the potential location of infiltration BMPs. The approximate location of these BMPs should be on the proposed development plan and serve as the basis for the location and number of tests to be performed onsite.

Important: If the proposed development is located on areas that may otherwise be a suitable BMP location, or if the proposed grading plan is such that potential BMP locations are eliminated, the designer is ***strongly*** encouraged to revisit the proposed layout and grading plan and adjust the development plan as necessary. Full build-out of areas suitable for infiltration BMPs should ***not*** preclude the use of BMPs for runoff volume reduction and groundwater recharge.

Step 2. Test pits (deep holes)

A test pit (deep hole) allows visual observation of the soil horizons and overall soil conditions both horizontally and vertically in that portion of the site. An extensive number of test pit observations can be made across a site at a relatively low cost and in a short time period. The use of soil borings as a substitute for test pits is strongly discouraged, as visual observation is narrowly limited in a soil boring and the soil horizons cannot be observed in-situ, but must be observed from the extracted borings.

A test pit (deep hole) consists of a backhoe-excavated trench, 2½-3 feet wide, to a depth of 6-7½ feet, or until bedrock or fully saturated conditions are encountered. The trench should be benched at a depth of 2-3 feet for access and/or infiltration testing.

At each test pit, the following conditions are to be noted and described. Depth measurements should be described as depth below the ground surface:

- Soil horizons (upper and lower boundary),
- Soil texture, structure, and color for each horizon,
- Color patterns (mottling) and observed depth,
- Depth to water table,
- Depth to bedrock,
- Observance of pores or roots (size, depth),
- Estimated type and percent coarse fragments,
- Hardpan or limiting layers,
- Strike and dip of horizons (especially lateral direction of flow at limiting layers), and
- Additional comments or observations.

The Sample Soil Log Form at the end of this protocol may be used for documenting each test pit.

At the designer's discretion, soil samples may be collected at various horizons for additional analysis. Following testing, the test pits should be refilled with the original soil and the topsoil replaced. A test pit should ***never*** be accessed if soil conditions are unsuitable or unstable for safe entry, or if site constraints preclude entry. OSHA regulations should always be observed.

It is important that the test pit provide information related to conditions at the bottom of the proposed infiltration BMP. If the BMP depth will be greater than 90 inches below existing grade, deeper excavation of the test pit will be required. The designer is cautioned regarding the proposal of systems that are significantly deeper than the existing topography, as the suitability for infiltration is likely to decrease. The design engineer is encouraged to consider reducing grading and earthwork as needed to reduce site disturbance and provide greater opportunity for stormwater management.

The number of test pits varies depending on site conditions and the proposed development plan. General guidelines are as follows:

- For single-family residential subdivisions with on-lot infiltration BMPs, one test pit per lot is recommended, preferably within 100 feet of the proposed BMP area.
- For multi-family and high-density residential developments, one test pit per BMP area or acre is recommended.
- For large infiltration areas (basins, commercial, institutional, industrial, and other proposed land uses), multiple test pits should be evenly distributed at the rate of four to six pits per acre of BMP area.

The recommendations above are guidelines. Additional tests should be conducted if local conditions indicate significant variability in soil types, geology, water table levels, depth and type of bedrock, topography, etc. Similarly, uniform site conditions may indicate that fewer test pits are required. Excessive testing and disturbance of the site prior to construction is not recommended.

Step 3. Infiltration tests

A variety of field tests exists for determining the infiltration capacity of a soil. Laboratory tests are not recommended, as a homogeneous laboratory sample does not represent field conditions. Infiltration tests should be conducted in the field. Infiltration tests should not be conducted in the rain, within 24 hours of significant rainfall events (>0.5 inches), or when the temperature is below freezing.

At least one test should be conducted at the proposed bottom elevation of an infiltration BMP, and a minimum of two tests per test pit are recommended. Based on observed field conditions, the designer may elect to modify the proposed bottom elevation of a BMP. Personnel conducting infiltration tests should be prepared to adjust test locations and depths depending on observed conditions.

Methodologies discussed in this protocol include:

- Double-ring infiltrometer tests.
- Percolation tests (such as for onsite wastewater systems).

There are differences between the two methods. A double-ring infiltrometer test estimates the vertical movement of water through the bottom of the test area. The outer ring helps to reduce the lateral movement of water in the soil from the inner ring. A percolation test allows water movement through both the bottom and sides of the test area. For this reason, the measured rate of water level drop in a percolation test must be adjusted to represent the discharge that is occurring on both the bottom and sides of the percolation test hole.

Other testing methodologies and standards that are available but not discussed in detail in this protocol include (but are not limited to):

- Constant head double-ring infiltrometer.
- Testing as described in the *Maryland Stormwater Manual*, Appendix D.1, using five-inch diameter casing.
- ASTM 2003 Volume 4.08, Soil and Rock (I): Designation D 3385-03, Standard Test Method for Infiltration Rate of Soils in Field Using a Double-Ring Infiltrometer.
- ASTM 2002 Volume 4.09, Soil and Rock (II): Designation D 5093-90, Standard Test Method for Field Measurement of Infiltration Rate Using a Double-Ring Infiltrometer with a Sealed-Inner Ring.
- Guelph permeameter.
- Constant head permeameter (Amoozemeter).

Methodology for double-ring infiltrometer field test

A double-ring infiltrometer consists of two concentric metal rings. The rings are driven into the ground and filled with water. The outer ring helps to prevent divergent flow. The drop-in water level or volume in the inner ring is used to calculate an infiltration rate. The infiltration rate is the amount of water per surface area and time unit which penetrates the soils. The diameter of the inner ring should be approximately 50-70 percent of the diameter of the outer ring, with a minimum inner ring size of four inches. Double-ring infiltrometer testing equipment designed specifically for that purpose may be purchased. However, field testing for stormwater BMP design may also be conducted with readily available materials.

Equipment for double-ring infiltrometer test:
Two concentric cylinder rings six inches or greater in height. Inner ring diameter equal to 50-70 percent of outer ring diameter (i.e., an eight-inch ring and a 12-inch ring). Material typically available at a hardware store may be acceptable.

- Water supply,
- Stopwatch or timer,
- Ruler or metal measuring tape,
- Flat wooden board for driving cylinders uniformly into soil,
- Rubber mallet, and
- Log sheets for recording data.

Procedure for double-ring infiltrometer test

- Prepare level testing area.
- Place outer ring in place; place flat board on ring and drive ring into soil to a minimum depth of two inches.
- Place inner ring in center of outer ring; place flat board on ring and drive ring into soil a minimum of two inches. The bottom rim of both rings should be at the same level.
- The test area should be presoaked immediately prior to testing. Fill both rings with water to water level indicator mark or rim at 30-minute intervals for one hour. The minimum water depth should be four inches. The drop in the water level during the last 30 minutes of the presoaking period should be applied to the following standard to determine the time interval between readings:
  - If water level drop is two inches or more, use 10-minute measurement intervals.
  - If water level drop is less than two inches, use 30-minute measurement intervals.
- Obtain a reading of the drop in water level in the center ring at appropriate time intervals. After each reading, refill both rings to water level indicator mark or rim. Measurement to the water level in the center ring should be made from a fixed reference point and should continue at the interval determined until a minimum of eight readings are completed or until a stabilized rate of drop is obtained, whichever occurs first. A stabilized rate of drop means a difference of ¼ inch or less of drop between the highest and lowest readings of four consecutive readings.
- The drop that occurs in the center ring during the final period or the average stabilized rate, expressed as inches per hour, should represent the infiltration rate for that test location.

Methodology for percolation test
Equipment for percolation test

- Post hole digger or auger,
- Water supply,
- Stopwatch or timer,
- Ruler or metal measuring tape,
- Log sheets for recording data,
- Knife blade or sharp-pointed instrument (for soil scarification),
- Course sand or fine gravel, and
- Object for fixed-reference point during measurement (nail, toothpick, etc.).

Procedure for percolation test

This percolation test methodology is based largely on the criteria for onsite sewage investigation of soils. A 24-hour pre-soak is generally not required as infiltration systems, unlike wastewater systems, will not be continuously saturated.

- Prepare level testing area.
- Prepare hole having a uniform diameter of 6-10 inches and a depth of 8-12 inches. The bottom and sides of the hole should be scarified with a knife blade or sharp-pointed instrument to completely remove any smeared soil surfaces and to provide a natural soil interface into which water may percolate. Loose material should be removed from the hole.
- (Optional) Two inches of coarse sand or fine gravel may be placed in the bottom of the hole to protect the soil from scouring and clogging of the pores.
- Test holes should be presoaked immediately prior to testing. Water should be placed in the hole to a minimum depth of six inches over the bottom and readjusted every 30 minutes for one hour.
- The drop in the water level during the last 30 minutes of the final presoaking period should be applied to the following standard to determine the time interval between readings for each percolation hole:
  - If water remains in the hole, the interval for readings during the percolation test should be 30 minutes.
  - If no water remains in the hole, the interval for readings during the percolation test may be reduced to 10 minutes.
- After the final presoaking period, water in the hole should again be adjusted to a minimum depth of six inches and readjusted when necessary after each reading. A nail or marker should be placed at a fixed reference point to indicate the water refill level. The water level depth and hole diameter should be recorded.
- Measurement to the water level in the individual percolation holes should be made from a fixed reference point and should continue at the interval determined from the previous step for each individual percolation hole until a minimum of eight readings are completed or until a stabilized rate of drop is obtained, whichever occurs first. A stabilized rate of drop means a difference of ¼ inch or less of drop between the highest and lowest readings of four consecutive readings.
- The drop that occurs in the percolation hole during the final period, expressed as inches per hour, should represent the percolation rate for that test location.
- The average measured rate must be adjusted to account for the discharge of water from both the sides and bottom of the hole and to develop a representative infiltration rate. The average/ final percolation rate should be adjusted for each percolation test according to the following formula:

Infiltration Rate = (Percolation Rate)/(Reduction Factor)

Where the Reduction Factor is given by**:

$$R_f = \frac{2d1 - \triangle d}{DIA} + 1$$

With:

d_1 = Initial Water Depth (in.)

$\triangle d$ = Average/Final Water Level Drop (in.)

DIA = Diameter of the Percolation Hole (in.)

The percolation rate is simply divided by the reduction factor as calculated above or shown in Table E.1 below to yield the representative infiltration rate. In most cases, the reduction factor varies from about two to four depending on the percolation hole dimensions and water level drop – wider and shallower tests have lower reduction factors because proportionately less water exfiltrates through the sides.

*** The area reduction factor accounts for the exfiltration occurring through the sides of percolation hole. It assumes that the percolation rate is affected by the depth of water in the hole and that the percolating surface of the hole is in uniform soil. If there are significant problems with either of these assumptions then other adjustments may be necessary.*

Step 4. Use design considerations provided in the infiltration BMP.

Table E.1
Sample Percolation Rate Adjustments

Perc. Hole Diameter, DIA (in.)	Initial Water Depth, D_1 (in.)	Ave./Final Water Level Drop, $\triangle$d (in.)	Reduction Factor, R_f
6	6	0.1	3.0
		0.5	2.9
		2.5	2.6
	8	0.1	3.7
		0.5	3.6
		2.5	3.3
	10	0.1	4.3
		0.5	4.3
		2.5	3.9
8	6	0.1	2.5
		0.5	2.4
		2.5	2.2
	8	0.1	3.0
		0.5	2.9
		2.5	2.7
	10	0.1	3.5
		0.5	3.4
		2.5	3.2
10	6	0.1	2.2
		0.5	2.2
		2.5	2.0
	8	0.1	2.6
		0.5	2.6
		2.5	2.4
	10	0.1	3.0
		0.5	3.0
		2.5	2.8

Additional Potential Testing – Bulk Density

Bulk density tests measure the level of compaction of a soil, which is an indicator of a soil's ability to absorb rainfall. Developed and urbanized sites often have very high bulk densities and, therefore, possess limited ability to absorb rainfall (and have high rates of stormwater runoff). Vegetative and soil improvement programs can lower the soil bulk density and improve the site's ability to absorb rainfall and reduce runoff.

Macropores occur primarily in the upper soil horizons and are formed by plant roots (both living and decaying), soil fauna such as insects, the weathering processes caused by movement of water, the freeze-thaw cycle, soil shrinkage due to desiccation of clays, chemical processes, and other mechanisms. These macropores provide an important mechanism for infiltration prior to development, extending vertically and horizontally for considerable distances. It is the intent of good engineering and design practice to maintain these macropores when installing infiltration BMPs as much as possible. Bulk density tests can help determine the relative compaction of soils before and after site disturbance and/or restoration and should be used at the discretion of the designer/reviewer.

Soil Test Pit Log Sheet

Project: _____ **Date:** _____
Name: _____ **Soil Series:** _____
Location: _____ **Other:** _____
Test Pit # _____

Horizon	Depth (In.)	Color	Redox Features	Texture	Notes (if applicable)	Boundary

NOTES:

REDOX FEATURES
Abundance
Few ..... < 2%
Common.. 2 - 20%
Many ..... > 20%
Contrast
faint
hue & chroma of matrix and redox are closely related.
distinct
matrix & redox features vary 1 - 2 units of hue and several unites of chroma & value.
prominent
Matrix & redox features vary several units in hue, value & chroma

COARSE FRAGMENTS (% of profile)

15-35%	35-60%	>60%
gravelly	very gravelly	extremely gravelly
channery	very channery	extremely channery
cobbly	very cobbly	extremely cobbly
flaggy	very flaggy	extremely flaggy
stony	very stony	extremely stony

BOUNDARY
Distinctness
abrupt....< 1" (thick) *gradual*..2.5 - 5"
clear.....1 - 2.5" *diffuse*....> 5
Topography
smooth - boundary is nearly level
wavy - pockets with width > than depth
irregular - pockets with depth > than width

HORIZONS
O - organic layers of decaying plant and animal tissue (must be greater than 12-18% organic carbon, excluding live roots).
A (topsoil) - mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material.
E - mineral horizon which the main feature is loss of silicate clay, iron, aluminum. Must be underlain by a B (alluvial) horizon.
B (subsoil) - mineral horizon with evidence of pedogenesis or Illuviation (movement into the horizon).
C (substratum) - the un-weathered geologic material the soil formed in. Shows little or no sign of soil formation.

[i] *Reference: LID Manual for Michigan-Appendix E*
http://library.semcog.org/InmagicGenie/DocumentFolder/LIDManualWeb.pdf