Regular Town Council Meeting

Tuesday, February 09, 2021 at 5:00 PM

Electronic Meeting

AGENDA

This meeting can be viewed on the Town of Bluffton's Facebook page

PUBLIC COMMENT

Public comments will be received via conference line provided by the Town Clerk. All requests for public hearing or public comment will be accepted up to two (2) hours prior to the scheduled meeting start time.

I. Call to Order

II. Pledge of Allegiance

III. Invocation

IV. Adoption of the Agenda

V. Adoption of the Minutes

1. Regular Meeting Minutes of January 12, 2021
2. Workshop Meeting Minutes of January 19, 2021

VI. Presentations, Celebrations and Recognitions

1. Beaufort County School District Character Student of the Month – Mayor Sulka

VII. Public Comment

VIII. Communications from Mayor and Council

IX. Workshop Agenda Items

1. Discussion and Direction on Updates to Special Revenue Funds, Accommodations Tax Allocations and Fund Balance Policies – Chris Forster, Director of Finance and Administration
2. Discussion on Amendments to the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 3 – Application Process, Article 4 – Zoning Districts, and Article 9 – Definitions and Interpretations to Amend the Definition of "Contributing Structure", add the "Inventory of Contributing Resources" to the UDO, and Change "Historic Structure" References to "Contributing Structures" - Heather Colin, Director of Growth Management

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X. Public Hearing & Final Reading

1. Consideration of Town of Bluffton Needs Assessment for Housing, Public Facilities, and Economic Development – Michelle Knight, Community and Economic Development Director, Lowcountry Council of Governments
2. Consideration of an Ordinance to Amend the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 3 – Application Process, Article 5 – Design Standards, Sec.5.10 Stormwater Management, and Article 9 – Definitions and Interpretations Related to Adopting the Southern Lowcountry Post Construction Stormwater Ordinance and Stormwater Design Manual – Public Hearing and Final Reading – Bryan McIlwee, Director of Engineering

XI. Formal Agenda Items

1. Consideration of Amendments to the Town of Bluffton Code of Ordinances, Chapter 19 – Flood Damage Protection, Specifically as it Relates to the Updates to the National Floodplain Insurance Program Regulations and FEMA's Re-evaluation of Flood Hazards in the Town of Bluffton Reflected in Updated Flood Insurance Rate Maps – Final Reading – Heather Colin, Director of Growth Management
2. Consideration of an Ordinance Amending the Town of Bluffton FY 2021 Budget to Provide for the Expenditures of Certain Funds and to Allocate Sources of Revenue for the Said Funds – First Reading – Chris Forster, Director of Finance and Administration
3. Consideration of an Emergency Ordinance of the Town of Bluffton, South Carolina, Extending the Requiring of Individuals to Wear Face Coverings in Light of the COVID-19 Pandemic; and Matters Related Thereto; and Severability – Scott Marshall, Interim Town Manager
4. Consideration of an Emergency Ordinance of the Town of Bluffton to Authorize the Town Manager to Develop and Enact Such Plans and Policies Needed to Ensure Continuity in the Delivery of Government Services in Light of the COVID-19 Pandemic- Scott Marshall, Interim Town Manager
5. Consideration of an Ordinance Amending the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 5 – Design Standards Related to Building Types, Maximum Building Footprint and Height – First Reading- Heather Colin, Director of Growth Management

XII. Consent Agenda Items

1. Monthly Department Reports: Police, Finance and Administration, Municipal Court, Engineering, Don Ryan Center for Innovation, and Growth Management
2. Town Manager's Monthly Report
3. Consideration of a Resolution to Adopt the May River Watershed Action Plan Update as a Supporting Document to the Comprehensive Plan – Bryan McIlwee, Director of Engineering
4. Consideration of a Resolution to Adopt the Southern Lowcountry Stormwater Design Manual as a Supporting Document to Unified Development Ordinance, Article 5 – Design Standards, Sec. 5.10 Stormwater Management – Bryan McIlwee, Director of Engineering

5. Consideration of a Proposed Lighting Agreement with Palmetto Electric for the Law Enforcement Center – Bryan McIlwee, Director of Engineering
6. Consideration of an Extension for the Memorandum of Understanding between the Town of Bluffton and Beaufort Jasper Water and Sewer Authority Regarding Collaboration on Projects and Capacity Fee Credits - Chris Forster, Director of Finance and Administration
7. COVID-19 Pandemic Update – Scott Marshall, Interim Town Manager

XIII. Executive Session

1. Contractual Matters Relating to a Public Private Partnership to Develop Workforce and Affordable Housing on Town Owned Property (Pursuant to SC Freedom of Information Act 30-4-70[a][5])
2. Contractual Matters Relating to the Palmetto Bluff Planned Unit Development Agreement (Pursuant to SC Freedom of Information Act 30-4-70[a][2])

XIV. Action from Executive Session

XV. Adjournment

"FOIA Compliance – Public notification of this meeting has been published and posted in compliance with the Freedom of Information Act and the Town of Bluffton policies."

In accordance with the requirements of Title II of the Americans with Disabilities Act of 1990 ("ADA"), the Town of Bluffton will not discriminate against qualified individuals with disabilities on the basis of disability in its services, programs, or activities. The Town of Bluffton Council Chambers are ADA compatible. Any person requiring further accommodation should contact the Town of Bluffton ADA Coordinator at 843.706.4500 or adacoordinator@townofbluffton.com as soon as possible but no later than 48 hours before the scheduled event.

**Please note that each member of the public may speak at one public comment session and a form must be filled out and given to the Town Clerk. Public comment must not exceed three (3) minutes.*

BLUFFTON TOWN COUNCIL MEETING MINUTES

ELECTRONIC MEETING
January 12, 2020

Mayor Sulka called the meeting to order at 5 P.M. Council members present were Mayor Pro Tempore Fred Hamilton, Larry Toomer, Bridgette Frazier, and Dan Wood. Town Manager Marc Orlando, Deputy Town Manager Scott Marshall, Chief of Police Stephenie Price, Director of Engineering Bryan McIlwee, Director of Finance and Administration Chris Forster Director of Growth Management Heather Colin, Town Clerk Kimberly Chapman, and Town Attorney Terry Finger were also present.

The pledge and invocation were given by Mayor Sulka.

Adoption of the Agenda

Toomer made a motion to adopt the agenda as presented. Wood seconded. The motion carried unanimously.

Adoption of the Minutes

Town Council Regular Meeting Minutes of December 8, 2020

Frazier made a motion to approve the Regular Meeting Minutes of December 8, 2020. Wood seconded. The motion passed unanimously.

Presentations, Celebrations and Recognitions

Mayor Sulka acknowledged the Beaufort County School District Character Student of the Month, Mia Zito from May River High School. Mia was honored for the character trait "Respect/Gratitude".

Mayor Sulka read the Martin Luther King Jr. Proclamation aloud.

Palmetto Bluff and New Riverside Development Agreement Annual Update – David O'Donoghue, President, Palmetto Bluff

Public Comment

Shantel Richardson, 7 Albert Green Lane, Bluffton – Stated that Bridgette Frazier should not have to defend herself or her actions in regard to her actions that recently took place on social media regarding events at the Capitol. Stated that he supports Councilwoman Bridgette Frazier staying on Town Council regardless of the petition.

Justin Jarrett, 279 Station Parkway, Bluffton – Stated that he supports Councilwoman Bridgette Frazier staying on Town Council regardless of the petition that originated on social media requesting that she be removed from Council as a result of recent social media dialogue between Frazier and others regarding events that took place at the Capitol. Also stated that his friend, Donna Fonseca had signed up for public comment but was not able to make it to the meeting, however Jarrett said that she echoed his support for Councilwoman Frazier.

Candace Harnett, 21 Cobblestone Court, Savannah – Stated that she understands that there are citizens who are requesting that Frazier be removed from Town Council but feels that Frazier should be hailed a hero and commended for reporting criminal activity. She stated removing her would send a message of condoning this type of behavior. Stated that Frazier displays bravery that we should all want in our government officials.

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Jodie Srutek, 431 Gardners Circle, Bluffton – Stated that due to the current political climate of our country that elected officials are tasked with communicating with the public effectively and setting an example of integrity. Requested that Town Council be an example and show the Bluffton does not tolerate hate or bigotry. Stated that she supports Bridgette Frazier staying on Town Council, regardless of the petition that originated on social media requesting that she be removed from Council as a result of recent social media dialogue between Frazier and others regarding events that took place at the Capitol. Stated that Bridgette exemplifies leadership for our community.

Sherry Lee, 20 Dawn Sky Court, Bluffton – Spoke in support of Bridgette Frazier staying on Town Council regardless of the petition that originated on social media requesting that she be removed from Council as a result of recent social media dialogue between Frazier and others regarding events that took place at the Capitol. Asked that other Town Council take a stand to keep Councilwoman Frazier on Town Council.

Sharron Brown, 163 Buck Island Road, Bluffton – Spoke in reference to Simmonsville and Buck Island Road Neighborhood program; also stated that she was confused as to why the Town of Bluffton sent out a media release regarding the petition about Bridgette Frazier and that the Town of Bluffton needs to streamline what goes out in a media release and what does not.

Communications from Mayor and Council

Wood stated that he would like to discuss the golf cart ordinance soon. Mayor Sulka asked that staff reach out to Representative Herbkersman to have the letter written to get this started.

Mayor Sulka stated requested that staff respond to the questions regarding the Buck Island Simmonsville Neighborhood Plan. Sulka stated that she had made a public statement regarding the role of Town Council and that all five members sit as a Council to do better for Bluffton as a result of recent dialogue surrounding the petition for removal of Councilwoman Frazier.

Frazier stated she was thankful for those that have supported her through the attacks. She stated that she will always be an advocate for all things right in Bluffton and she will never be silent for any type of injustice that would undermine the work that has been done for Bluffton, which is one Bluffton that works for everyone.

Workshop Agenda Items:

FY21 Consolidated Budget Update – Chris Forster, Director of Finance and Administration

Forster stated that on June 9, 2020 Town Council approved the FY 2021 Town of Bluffton Budget of $34,223,867. This reflected a budget reduction of -8.3%. The General Fund, which is the Town's main operating fund was approved at $19, 363,015 or a reduction of -4.1%. Budget reductions were carefully estimated in response to the impacts of the COVID-19 pandemic.

Through the month of November, General Fund revenues total almost $2.9 million. This reflects a 9% increase over the same period of FY 2020. This increase is primarily due to better than expected permit revenue as a result of an approximate 36% increase in new residential building permits compared to the same timeframe last year.

Sixty percent of General Fund revenue is made up of property taxes, business licenses and building permits. According to the most recent County billing estimates, property taxes for fiscal year 2021 should come in approximately 3% higher than expected. As a result of the COVID-19 pandemic business licenses are expected to meet but not exceed initial projections which reflect a -12.6% reduction compared to fiscal year 2020 actuals. Based on current trends, building permit revenue is expected to exceed expectations by approximately 24%.

In total, the General fund revenue is estimated to be $403,917 (2%) higher than initially budgeted. In December 2020 the Town issued $5,080,000 in a general obligation bond. With these proceeds, the consolidated results of all budget funds are estimated to add $0.5 million to fund balance. The bond proceeds excluded; the Town is estimated to spend down fund balance by $4,464,684. This is primarily in the CIP fund as previously started projects are completed.

Formal Agenda Items:

Acceptance of the Presentation of the Town of Bluffton FY 2020 Audit by Mauldin and Jenkins, LLC – Chris Forster, Director of Finance and Administration

Forster stated that on April 4, 2018, the Town of Bluffton solicited a Request for Proposal (RFP) for Financial Audit Services. As a result, Town Council authorized the Town Manager to execute a contract with Mauldin & Jenkins, LLC for audit services for fiscal years ending June 30, 2018, 2019 and 2020 during the June 13, 2018 Town Council meeting. This is the third year Mauldin & Jenkins has audited the Town of Bluffton's financial records and assisted in the preparation of the Comprehensive Annual Financial Report (CAFR).

Forster introduced Trey Scott from Mauldin and Jenkins to present the results of the audit.

Scott stated that the Town of Bluffton received an unmodified and clean opinion. This is the highest level of assurance and that this is a testament that the Town of Bluffton is doing the right thing.

The governmental fund financial statements give the reader a detailed short-term view that helps determine if there are more or less financial resources available to finance the Town's programs. These funds focus on how assets can readily be converted into cash flow in and out, and what monies are left at year-end that will be available for spending in the next year.

Revenues have increased over prior year for consolidated budgeted funds. The Town continues to see larger than anticipated revenues with the strength in business licenses and franchise fees. Property Taxes have increased 8.3% from prior year in the General Fund along with a (1.2%) decrease in the Licenses and Permits category with a slight decrease in permit revenue.

Expenditures are approximately $400,000 less than the prior year for the consolidated funds due to the completed Capital Improvements Program Fund project expenditures of approximately $6.5 million in the prior year and $5.2 million in the current year. General Fund expenditures have increased approximately $0.8 million from prior year due to additional expenses for Community Safety and Policing with the addition of staff and equipment.

General Fund Balance remains strong and had an increase of $1,395,980 in FY 20, due to the strong performance of revenues and conservative spending. At June 30 the Town's General Fund had an unassigned (unrestricted) fund balance of approximately $12.3 million or 71% of FY 20 expenditures.

Toomer made a motion to accept the Fiscal Year 2020 Audit for the Town of Bluffton presented by Mauldin & Jenkins, LLC and its inclusion in the Comprehensive Annual Financial Report for the year ending June 30, 2020. Hamilton seconded. Roll call was taken, and the motion passed unanimously.

Consideration of Amendments to the Town of Bluffton Code of Ordinances, Chapter 19 – Flood Damage Protection, Specifically as it Relates to the Updates to the National Floodplain Insurance Program Regulations and FEMA's Re-evaluation of Flood Hazards in the Town of Bluffton Reflected in Updated Flood Insurance Rate Maps – First Reading – Heather Colin, Director of Growth Management

Colin stated that FEMA recently completed a reevaluation of flood hazards in the community. On June 30, 2017 and August 9, 2019, FEMA provided the Town with preliminary and revised preliminary copies of the Flood Insurance Study (FIS) and FIRM that identify existing flood hazards. Both the required publication and appeals periods have been met and the FIRM for Bluffton will become effective on March 23, 2021.

Because the FIS report establishing the flood hazard determinations has been completed, certain additional requirements must be met under the National Flood Insurance Act of 1968 as amended no later than March 23, 2021.

The proposed amendments incorporate the required amendments identified the Flood Mitigation Specialist from the South Carolina Department of Natural Resources and included in attachment 4. In addition to the minimum amendments required by FEMA for eligibility in the NFIP, staff is proposing that the current requirement of a one foot freeboard be increased to a three foot freeboard for all construction. Freeboard is defined as the factor of safety usually expressed in feet above a flood level for purposes of flood plain management.

The purpose of freeboard is as follows:

- Reduces flood losses in the habitable portion of homes so that citizens can return home faster;

Benefits citizens as they will receive improved flood insurance rates:

- Most of Bluffton's construction located in the special hazard flood zones are new construction areas with no unregulated areas affected; and
- With the additional 2 feet of freeboard recommended there should be less drastic height deviations between new and existing construction.

The Town of Bluffton currently has multiple elevation requirements varying from 12 to 16 feet depending on the location. The current base flood elevation (BFE) required on the current maps (FIRM) is 11 to 15 feet. The FIRM's effective March 23, 2021 varies from five to nine feet. Currently, approximately five percent of the land area in Bluffton is located within a special flood zone. Upon the effective date of the FIRM, it will decrease approximately three percent.

Wood made a motion to approve the Ordinance Amending the Town of Bluffton Code of Ordinances, Chapter 19- Flood Damage Protection, Specifically as it Relates to the Updates to the National Floodplain Insurance Program Regulations and FEMA's Reevaluation of Flood Hazards in the Town of Bluffton Reflected in the Updated Flood Insurance Rate Maps. Frazier seconded. Roll call was taken, and the motion carried unanimously.

Consideration of the Acceptance of Huggins Hollow, LLC's One Hundred Percent (100%) Annexation Petition to Annex Certain Real Properties Contiguous to the Town of Bluffton's Corporate Boundaries Consisting of a Total of 36.265 Acres, More or Less, and Bearing Beaufort County Tax Map Nos. R600 036 000 0001 0000, R600 036 000 001D 0000, R600 036 000 001F 0000, R600 036 000 001H 0000, R600 036 000 0364 0000, and R600 036 000 0439 0000 – Heather Colin, Director of Growth Management

Colin stated that on August 28, 2020 in accordance with Section 5-3-150 of the Code of Laws of South Carolina and the *Town of Bluffton Annexation Policy and Procedure Manual* ("Annexation Manual"), Josh Tiller, of J.K. Tiller Associates, Inc., on behalf of the property owner Huggins Hollow, LLC, submitted a 100% Annexation Petition Application for six parcels totaling 36.265 acres adjacent to Gibbet Road on Huggins Hollow Lane and Jade Stone Court ("Properties") into the Town of Bluffton's municipal boundary.

Pursuant to the Annexation Manual, the Applicant also submitted a concurrent Zoning Map Amendment application requesting the Properties zoning designation as Agriculture (AG) subject to the Town of Bluffton Unified Development Ordinance which permits limited uses.

Per the revision to the Annexation Manual approved by Town Council Resolution on October 13, 2020, the initial step in the public review process is an initial briefing, or "intent to annex", to Town Council for general discussion of the request and its associated applications such as the appropriate zoning classification and possible negotiation items. At the conclusion of the discussion, Town Council takes action to accept or decline to accept the proposed Annexation Petition by majority vote.

In the event Town Council accepts the petition, additional action by majority vote is necessary to either refer or forgo the referral of request to the Town of Bluffton Negotiating Committee if deemed necessary.

The Properties contains approximately 36.265 acres located within Unincorporated Beaufort County as shown on the Location Map provided in the application submittal. The Properties currently contain a single-family home, manufactured homes, campers, and accessory structures.

The Properties and a majority of the adjacent parcels are zoned as T2 - Rural pursuant to the Beaufort County Community Development Code.

A majority of the immediately adjacent properties are also within Unincorporated Beaufort County and are similarly zoned as T2 - Rural. The exception is the adjacent property to the north-east which established the required contiguity as it is within the Town of Bluffton's Municipal Boundary and zoned as Buckwalter Planned Unit Development and part of the development known as Lawton Station.

The Applicant does not have a specific plan for the Properties to-date; however, they have considered possible future use as an RV Park which is permitted within the requested Agriculture (AG) District.

After Council discussion regarding the petition, there was not a motion to approve the annexation. *The motion died due to lack of a motion.*

Consent Agenda Items

1. Monthly Department Reports: Police, Finance & Administration, Municipal Court, Engineering, Don Ryan Center for Innovation, and Growth Management
2. Town Manager Monthly Report
3. Consideration of a Proposed Contractual Agreement Relating to Rewriting of the Comprehensive Plan – Heather Colin, Director of Growth Management
4. Consideration of a Resolution Amending the Town of Bluffton Employee Handbook for Process Changes and Clarity – Katherine Robinson, Director of Human Resources
5. Development Agreement Annual Update – Heather Colin, Director of Growth Management
6. Don Ryan Center for Innovation Annual Update – Mike Levine, CEO, Don Ryan Center for Innovation
7. Consideration of a Proposed Contractual Agreement Relating to Engineering Services for Calhoun Street and Boundary Street Streetscape Projects – Bryan McIlwee, Director of Engineering
8. COVID-19 Pandemic Update – Scott Marshall, Deputy Town Manager

Frazier made a motion to approve the consent agenda as presented. Wood seconded. The motion carried unanimously.

Executive Session

1. Contractual Matters Relating to Buckwalter Place Multi County Industrial Park (MCIP) (Pursuant to SC Freedom of Information Act 30-4-70 [a][5])
2. Personnel Matters Relating to the Town Manager Contract and Discussion Regarding Appointment of Interim Town Manager (Pursuant to SC Freedom of Information Act 30-4-70 [a][1][2])
3. Personnel and Security Matters and Receipt of Legal Advice Involving a Sitting Town Council Member (pursuant to Section 30-4-70[a][1][2] and [3])

Toomer made a motion to move into Executive Session at 6:56 PM to discuss the aforementioned items. Frazier seconded. The motion was unanimous.

Town Council exited Executive Session at 8:48 PM. No motions were made, and no votes were taken during Executive Session.

Toomer made a motion to appoint Deputy Town Manager Scott Marshall as interim town manager as of January 20, 2021 for a salary of $142,311 with the continuation of his current benefits. Wood seconded. Roll call was taken, and the motion passed unanimously.

Frazier made a motion to adjourn 8:50 p.m. Toomer seconded. The motion carried unanimously.

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Lisa Sulka, Mayor Kimberly Chapman, Town Clerk

BLUFFTON TOWN COUNCIL
QUARTERLY CIP WORKSHOP MEETING MINUTES

ELECTRONIC MEETING
January 19, 2021

Mayor Sulka called the meeting to order at 5:00 P.M. Council members present were Mayor Pro Tempore Fred Hamilton, Bridgette Frazier, and Dan Wood. Councilman Larry Toomer was not present. Town Manager Marc Orlando, Deputy Town Manager Scott Marshall, Director of Engineering Bryan McIlwee, and Town Clerk Kimberly Chapman, and Town Attorney Terry Finger were also present.

Public Comments – There were none.

Workshop Items:

Oyster Factory Park Master Plan Update

McIlwee stated that at the July 21, 2020 CIP Quarterly Workshop, staff presented an update to the 2015 Master Plan for Town Council to review.

Staff believes that the proposed updates are consistent with the terms of the Conservation Easement and has submitted plans to the Open Land Trust for review and approval.

Updated features are generally the same as the 2015 Master Plan with more detail provided including:

- Cookout Area Improvement
- Parking Improvements
- Playground Improvements
- Pathway Improvements
- Treehouse and Other Improvements
- Bulkhead, Boardwalk and Crabbing Dock

Council feedback from the July 21, 2020 Workshop was as follows:

- Relocate playground and tree house from behind the pavilion
- Update and increase power service at the cookout area
- Consult with Beaufort County and Rural and Critical Land Preservation Program to verify that proposed updates are consistent with existing agreements
- Upgrade ground surface and drainage inside cookout area (crushed oyster shell, plantation mix, coral stone, etc.)
- Provide convenient access points for loading and unloading to the event area but restrict vehicular traffic through the park space.
- Proposed northern parking lot to accommodate passenger vehicles rather than more boat trailer parking.

McIlwee stated that staff has suggested the following for discussion:

- Passive recreation located to western side of the park.
- Treehouse relocated to specimen tree near stage.
- Food truck and service delivery area defined with bollards to restrict access into event area.

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- Incorporated Bottle Cap Mural into Master Plan.
- Proposed durable and pervious surface throughout the event area.
- Power service updates to be incorporated into FY22 improvements.
- Provided loading zone off Wharf Street to allow for pull in and delivery offloads.

Next steps are as follows:

- FY 2021 – Design of the next phase of Development as directed by Town Council.
- FY 2022 – Construction of selected improvements and design of remaining phases of development.
- FY 2023 and beyond – Phased construction of the remaining Master Plan Improvements.

Sulka stated that she loves the passive swings versus the past idea of a playground, not to take up too much of the area to the east of the park towards the Garvin/Garvey House, as it used for weddings, and she suggested that oyster shell not be installed in high traffic areas where people are walking and running to avoid injury.

In regard to the proposed three-point turn for food trucks, Frazier stated that there should be consideration given designating a specific area for the trucks to park so that easy entry and exit will be allowed. McIlwee stated that staff will investigate alternate accommodations for the food trucks regarding maneuvering in the small space to provide ease.

<u>Bottle Cap Art Project Update</u>

McIlwee stated that Palmetto Ocean Conservancy approached Town Staff to discuss the installation of a bottle cap mural on Town owned property. The proposed project proposes to recycle plastic bottle caps into community art to promote conservation awareness around the health of our waterways.

The Palmetto Ocean Conservancy has commissioned Amos Hummell to design eight 4'wide x 8' tall panels depicting ocean wildlife scenes. Panels can be configured into an octagon or linear configuration, single or double sided.

Previous mural locations considered and discusses included Buckwalter Place, Oyster Factory Park, 184 Bluffton Road and Oscar Frazier Park. The initial preferred location was next to Buckwalter Park playground, but it was determined that there was not enough space remaining after the playground was constructed to accommodate the mural.

Oyster Factory Park is now being considered due to available space as well as its proximity to the May River.

Frazier stated that she likes the proposed location near the existing restrooms due to it being an open space. After some conversation regarding the location near the crosswalk and its close proximity to the road and concerns with oncoming traffic, all Council was in consensus that the location near the existing restrooms was the most desirable.

<u>May River Watershed Action Plan Update</u>

Kim Jones gave the following overview in regard to the development and background of the May River Watershed Action Plan:

- 2007: SCDHEC reported increasing fecal coliform levels in the May River headwaters
- 2009: SCDHEC shellfish harvesting classification change

- DRAFT 2018: May River on the SCDHEC State 303(d) list of impaired waterbodies with >1,000 sites in SC; 1,250 Total Impairments in SC; 116 Bacteria Impairments for Shellfish Waters in SC
- May River Watershed Action Plan
  - Goal to restore & protect shellfish harvesting throughout the May River
  - Developed from Dec 2010 – Nov 2011 with public/stakeholder input; Adopted by Town Council in November 2011
- Coordinated proactive approach:
  - Strategies include Policies, Programs, Projects & Partnerships with WAPAC guidance
  - Provide measurable goals
  - Dynamic & adaptable document
- Restoration & Prevention Measures:
  - Engineering-based solutions
  - Planning-based solutions

Jones stated the following policies, programs and projects:

Policies:

- Unified Development Ordinance – Stormwater Water Quality Volume Control requirement (2011)
- Transfer of Development Rights of 1,300 residential units (equivalent of 146 acres impervious surface) out of the May River headwaters (2012)
- Sewer Connection Ordinance (2015; amended 2018)
- Sewer Connection & Extension Policy (2017)
- Stormwater Utility (SWU) Fee Rate Model Update (2019), Revised SWU Fee and implemented new Stormwater Plan Review and Inspection Fees (2020), and $5.25 million GO Bond (2020)

Programs:

- Neighborhood Assistance Program – Septic Maintenance Assistance Program (2009)
- Microbial Source Tracking added to Water Quality Sampling Programs (2017) to identify sources and develop appropriate management strategies
- Neighborhood Assistance Program – Septic to Sewer Conversion Program (2018)
- Capital Improvement Program projects incorporate water quality treatment, eg. Dr. Mellichamp Drive Streetscape; Oyster Factory, Wright Family, Martin Family Parks; May River Road Streetscape

Projects:

- Sanitary Sewer Extension both within and beyond May River Watershed
  - Completed – Buck Island/Simmonsville Road Phases 1 – 4; Toy Fields; Jason/Able Streets; Poseys Court
  - Current – Buck Island/Simmonsville Road Phase 5; Historic District Phases 1 & 2

- EPA Clean Water Act Section 319 grant projects as awarded by SC DHEC
  - Phase 1, 2009 – $483,500 New Riverside Pond to reduce fecal bacteria concentrations; septic system maintenance assistance throughout the watershed; rain barrels and rain gardens
  - Phase 2, 2011 – $290,000 Pine Ridge Stormwater Reuse for Irrigation Pond Retrofit to reduce stormwater volume
  - Phase 3, 2016 – $231,350 Town Hall Campus Retrofit to reduce impervious surface
  - Phase 4, 2019 – $365,558.36 Sewer lateral line connection construction in support of Poseys Court and Historic District Phases 1 &2
  - Phase 5, 2020 – $179,700 Bridge Street Streetscape Retrofit to provide stormwater runoff treatment
  - May River Watershed Action Plan intended to be a "living document" revised as needed based upon an adaptive management framework
  - 10 years since original Action Plan was developed and implemented.

Key Components of the Action Plan Assessment & Update accomplished by:

1. Assessment of current conditions – "Historical Analysis of Water Quality, Climate Change Endpoints, and Monitoring of Natural Resources in the May River" (Montie et al. 2019)
2. State of Knowledge for Stormwater Best Management Practices (BMPs) – Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual (2020)
3. Water Quality Model – Develop XPSWMM Water Quality Model for 2002 Baseline Conditions and 2018 Current Conditions for the Headwaters sub-basins (1. Rose Dhu, 2. Stoney Creek, 3. Duck Pond, and 4. Palmetto Bluff), and evaluate potential impact of current Action Plan proposed BMPs and suggest up to 11 alternatives, as needed

Jones discussed the strategic plan fiscal years 2019-2020 May River Watershed Action Plan Update and stated that the project team of McCormick Taylor, Moffatt and Nichol, and Noble Lab, LLC completed:

1. Water Quality Modeling Report summarizing the data, processes, and assumptions the Project Team utilized to construct the XPSWMM water quality model, and a summary of the results; and
2. Provided recommendations on policies, programs, projects and potential strategic partnerships intended to restore and protect shellfish harvesting throughout the length of the May River as the May River Watershed Action Plan Update.

Water Quality Model – Develop XPSWMM Water Quality Models (2002 & 2018 conditions) and evaluate 2011 Action Plan's proposed BMPs and suggest up to eleven (11) alternatives as needed.

Key Findings included:

1. Need to integrate tidal creek research (Holland et al. 2004; Sanger et al. 2008; Sanger and Blair et al. 2015; Sanger and Tweel et al. 2015; Montie et al. 2019) findings with current State of Knowledge of fecal coliform fate and transport with stormwater BMP efficacy.

2. In the Headwaters, ponds have increased from 22 in 2002 to 262 in 2018.

3. Headwaters impervious surface increase from 2002 to 2018 in Table 1.

Table 1: Change in Impervious Area in May River Headwaters

Subwatershed	Total Area (Acres)	2002 Impervious*		2018 Impervious*	
		Acres	%	Acres	%
Duck Pond	683.10	18.90	2.77%	18.90	2.77%
Palmetto Bluff	1,925.53	117.24	6.09%	186.24	9.67%
Rose Dhu Creek	4,168.06	342.00	8.21%	822.60	19.74%
Stoney Creek	5,480.16	229.79	4.19%	848.71	15.49%
TOTAL	12,256.85	707.93	5.78%	1,876.44	15.31%

*calculated from Town of Bluffton GIS files and referencing historic aerial imagery

Action Plan Update Recommendations:

1. Policies to protect and improve water quality in the May River watershed include:
   a. Adopt proposed regional Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual.
   b. Eliminate clear cutting approach within developed areas.
   c. Increase buffer areas and requirements.
   d. Increase conservation and open space requirements and require recorded conservation easements.
   e. Reduce planned density/re-zone.
   f. Increase tree protection/conservation areas and requirements.
   g. Offer incentives to renegotiate existing land development agreements to reduce density and meet current environmental objectives.
   h. Develop strategies to effectively execute public/private partnerships.
2. Programs to continue and new program recommendations:
   a. Continue to support the Municipal Separate Storm Sewer System (MS4) program in the Town and County as they work to achieve the six (6) Minimum Control Measures.
   b. Continue Neighborhood Assistance Program
      - Septic Assistance
      - Septic to Sewer Conversion
   c. Establish an Impervious Area Restoration/Retrofit Program in areas where development pre-dated stormwater management requirements or failed to meet on-site retention of the 95th percentile storm. The purpose of this Program is to target large impervious areas to be retrofitted to meet 95th percentile storm retention of impervious surfaces with infiltration/filtration BMP to the maximum extent possible.
   d. Modify Water Quality Monitoring Program to include:

- Developing in-house microbial source tracking
- Recommendations for future bacteria monitoring locations
- Recommendations for future water flow monitoring locations

4. **Partnerships –** Continue to seek and establish key partnerships to protect and improve water quality especially with Beaufort-Jasper Water & Sewer Authority, Beaufort County, Beaufort County School District, and public-private partnerships for retrofit projects.
5. **Projects –** In contrast to 2011 Action Plan, ponds and ditches are not recommended as new projects as they do not promote infiltration
   a. Four (4) septic to sewer conversion projects (Stoney Creek, Gascoigne, Pritchardville, and Cahill) from the May River Watershed Sewer Master Plan
   b. Eleven (11) Impervious Area Restoration/Stormwater Retrofit Program, prioritized via an evaluation matrix
   c. Additional future projects include:
      - Impervious Surface Rehabilitation/Retrofit
      - On-site Volume Reduction
      - Modifications to Make Ponds Bacteria Neutral (Pond Retrofit)
      - Proprietary Products to Eliminate Bacteria
      - Nature-Based Solutions

Jones stated that the next steps will be to bring a Resolution to adopt the Action Plan at the February 9th Town Council Meeting.

<u>Wright Family Park Rental and Fee Schedule</u>

McIlwee stated that every year when the budget is adopted, a master fee schedule adopted as well. The current master fee schedule does not include rental fees for the newly completed Wright Family Park.

The following chart was displayed for reference:

Oyster Factory Park	Basis	Fee
Reservation of Park East of Wharf Street		
Rental Fee	Per Day	$300.00
Less than Full Day (6 hr Reservation: 1 hr Setup, 4 hr Event, 1 hr Cleanup)	4-Hour Block	$150.00
Rental Fee – Non-Profit	Per Day	$150.00
Less than Full Day (6 hr Reservation: 1 hr Setup, 4 hr Event, 1 hr Cleanup)	4-Hour Block	$75.00
Security Deposit	Per Rental	$100.00
Reservation of Park West of Wharf Street		$100.00
Rental Fee	Per Day	
Less than Full Day (6 hr Reservation: 1 hr Setup, 4 hr Event, 1 hr Cleanup)	4-Hour Block	$50.00
Rental Fee – Non-Profit	Per Day	$50.00
Less than Full Day (6 hr Reservation: 1 hour Setup, 4 hr Event, 1 hr Cleanup)	4-Hour Block	$25.00
Security Deposit	Per Rental	$100.00
Martin Family Park and Public Park @ Buckwalter Place Commerce Park	**Basis**	**Fee**
4 Hour Access (6 hr Reservation; 1 hr Setup, 4 hr Event, 1 hr Cleanup)	Per Event	$100.00
All Day Access	Per Day	$150.00
Security Deposit	Per Event	$150.00

McIlwee stated the below as a fee recommendation:

Wright Family Park	Basis	Fee
4 Hour Access (6 hr Reservation; 1 hr Setup, 4 hr Event, 1 hr Cleanup)	Per Event	$100.00
All Day Access	Per Day	$150.00
Security Deposit	Per Event	$150.00

Additional Notes:

- **The Town Manager or designee may waive any or all fees if it is deemed in the best interests of the Town.**
- **All fees will be collected at the Customer Service Center at Town Hall.**
- **Security Deposit may be refunded provided the park, facilities, and equipment are clean and returned to the condition that existed prior to the rental.**
- **A full refund of the Rental Fee and Security Deposit will be granted with cancellation notice at least 48-hours prior to the scheduled rental start or if an event is rained out and the part not utilized.**

Frazier asked if the fee schedule is set, if it can be amended once access to the Squire Pope Cottage is allowed.

Wood asked the rest of Council if the Town should rent the park out. Hamilton stated that he has reservations about renting the park out, due to lack of parking and how close the park is to churches in the area.

Sulka asked what interest the Town has received thus far. McIlwee stated that the Town has had requests for weddings (even though alcohol is not allowed). Sulka stated that she is in agreement with Hamilton with the lack of parking for large events. Wood concurred as well, and said he was somewhat opposed to renting the park. Frazier stated that she agreed in regard for the parking concerns, but that she felt that citizens would really want to have events at the park. She asked that a survey be conducted for input from stakeholders to see what the park's purpose is for the community.

Orlando stated that past conversations were that wedding ceremonies could take place at the park, but the receptions would need to take place elsewhere.

Sulka asked that staff inquire what the waterfront park in Beaufort did for special events such as Symphony Under the Stars, etc. Marshall stated that the park is rented in sections and that it rents for $200 -$2200 for one section to the entire park, in four-hour blocks.

McIlwee stated that he can have staff track the number of requests the Town is receiving and what type of events are being requested.

Hamilton and Wood stated that they would like staff to speak to the church and to residents on parking and traffic concerns.

Frazier stated that the Town needs to be considerate of the church, but also residents that want to use the park as well.

Sulka asked that everyone put on their creative hats and rethink the rental of the park and what events will be permitted. Sulka stated that the proposed fees seem a bit too low.

Marshall stated that there is plenty of time to solicit feedback from residents before the first reading of the budget.

Sulka acknowledged that this meeting is outgoing Town Manager Marc Orlando's last Council meeting. Orlando stated that he is proud of the entire Town of Bluffton team and Council's high attention to details. He thanked Mayor and Council on behalf of staff for their leadership.

Wood made a motion to adjourn. The meeting adjourned at 6:32 p.m.

__________________________________ __________________________________

Lisa Sulka, Mayor Kimberly Chapman, Town Clerk

TOWN COUNCIL
STAFF REPORT
Department of Finance & Administration

MEETING DATE:	February 9, 2021
PROJECT:	Discussion and Direction on Updates to Special Revenue Funds, Accommodations Tax Allocations and Fund Balance Policies
PROJECT MANAGER:	Chris Forster, MPA, CPFO, CGFM, Director of Finance & Administration

OVERVIEW:

As part of the strategic plan, the Finance department took on the initiative to evaluate Special Revenue Funds; the types that can be levied and how they may be used compared to how other similar communities are allocating Accommodations Tax (ATAX) Funds. Additionally, the Finance department assessed the Town's fund balance policy for its sufficiency and appropriateness compared to best practices and applicable risks.

Special Revenue Funds and allocations

The State of South Carolina governs what kinds of taxes and fees a local jurisdiction may approve. Currently the Town of Bluffton leverages every legally authorized revenue source in some manner. Local changes can be made to the rates at which taxes and fees may be set and the types of operational fees that may be approved.

Special revenues include State and Local Accommodations taxes and Hospitality taxes. These revenues must be used for tourism related expenditures or the promotion of tourism. The first $25 thousand plus 5% of State Accommodations revenue must be allocated to the general fund. The next 30% must be allocated to an organization promoting tourism known as the Designated Marketing Organization (DMO). For the Town of Bluffton that is the Hilton Head Island-Bluffton Chamber. The Town currently allocates the next $190,000 to the Bluffton Historical Foundation, BHF (formerly Bluffton Historical Preservation Society). The remaining amount can be granted to non-profits for tourism and cultural related events. Use of State ATAX dollars are more restrictive and can only support tourism related operations expense if not normally provided by the municipality.

Local accommodations tax can be used for Tourism related CIP, operations and maintenance, including advertising and promotional expenses. Current Town Ordinance allows an allocation up to 8% to the DMO, up to 10% for operations and maintenance and up to 1% to the reserve fund. As part of the budget ordinance the Town has traditionally allocated 51% of local ATAX to the CIP fund.

Hospitality tax must be used for tourism related CIP and expenses, drainage improvements, advertising and promotion. There are no other Town restrictions on the use of Hospitality taxes. The Town has traditionally transferred $500,000 to General Fund and a significant amount to support specific projects within the CIP.

Considerations for Discussion:

- Does the Town want to do more Town managed tourism promotion and advertising?
- Should Town consider adjusting local ATAX and HTAX allocations to designate funds for town advertising and promotion?
- Should there be adjustments to the 8% local ATAX allocation to the DMO?
- Should HBF receive a percent allocation of State ATAX like the DMO, rather than a flat dollar amount?

Fund Balance Policy

The current Town Fund Balance Policy has four main components. The Emergency Recovery Fund which is calculated as 15% of General Fund budgeted expenditures. The unassigned Fund Balance reserve which is 25% of budgeted General Fund expenditures. The Vehicle & Equipment Replacement Reserve which is capped at $1 million but is equal to 115% of designated assets depreciation cost.

The Government Finance Officers Association (GFOA), who's mission is to advance excellence in public finance, provide advisories and recommended practices on municipal financial policies and procedures. The two major best practices released by the GFOA on fund balance include the "Fund Balance Guidelines for the General Fund" and "Strategies for Establishing Capital Asset Renewal and Replacement Reserve Policies."

The GFOA recommends that a municipality maintain an unrestricted fund balance of "no less than" two months' worth (17%) of budgeted expenditures. But they qualify that with a recommendation that the adequacy of minimum unrestricted fund balance "should be based on risks unique to each municipality." All GFOA's recommendations regarding fund balance reserves seek to identify the bare minimum a municipality should maintain in unrestricted reserves and do not attempt to identify actual needs since each jurisdiction is unique. In April of 2020 GFOA released a Risk Based Reserve Assessment tool for municipalities to gauge risks and identify a minimum reserve threshold more appropriate for a jurisdiction's needs. Town Finance completed this assessment and determined the Town faced a moderate to high level of risk to retain through reserves and the assessment recommends adopting an amount of reserves significantly higher than the recommended minimum. Best practice recommends that the Town benchmark to similar communities and analyze most significant risks to make sure the Town is adequately covered compared to the unique financial costs of such risks. In addition, they recommend assessing the impact of reserves on the Town's bond rating.

The other major reserve recommended by the GFOA is the Capital Asset Renewal and Replacement Reserve. The current Town Vehicle and Equipment Reserve is limited in scope and capped at $1M. In the past ten years the Town's depreciable assets have increased 88%. They have increased 56% in just the past 5 years. The Town's CIP projects have grown significantly and large capital investments are planned to be completed over the next few years, including parks, facilities and infrastructure. Recommended practice is to maintain a reserve for all capital asset renewals and replacements. The GFOA recommends a minimum balance equal to a percentage of the Five-year average of an entity's capital budget and base annual contributions on a percentage of the annual depreciation of an entity's assets.

Considerations for Discussion:

- Adjust emergency reserves to be based on a percent of all budgeted funds rather than just General Fund.
- Consider adjusting emergency reserve to align with potential disaster recovery costs? Or commit more unassigned reserves to maintain flexibility in the use of reserves?
- Consider updating equipment reserve to a capital asset reserve?
- Define appropriate uses of excess reserves as one-time unexpected, nonrecurring costs.

TOWN COUNCIL

STAFF REPORT
Department of Growth Management

MEETING DATE:	February 9, 2021
PROJECT:	Amendments to the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 3 – Application Process and Article 9 – Definitions and Interpretations to Amend the Definition of "Contributing Structure", add the "Inventory of Contributing Resources" to the UDO, and Change "Historic Structure" References to "Contributing Structures – Workshop
PROJECT MANAGER:	Heather Colin, AICP Director of Growth Management

BACKGROUND: As part of the FY 21/22 Strategic Plan, Town Council sought to "more closely align" the boundaries of the local historic district (Old Town Bluffton Historic District) and the National Register Historic District (Bluffton Historic District), which is a small portion of Old Town Bluffton as shown on Attachment 2.

To determine the possibility of a closer alignment, an updated historic resource survey was conducted by Brockington and Associates, Inc. in 2019. Based on this survey, some additional properties in Old Town appear eligible to be included in a nomination to expand the National Register Historic District. The possible expansion area is shown in Attachment 2. Related to this, a review of the existing Unified Development Ordinance (UDO) requirements for designation and review of contributing structures was undertaken by Town Staff.

Based on the review of the UDO, highlights of the amendments proposed by Town Staff include:

- Updating the term for and definition of "Contributing Structure": The term would become "contributing resource" and the definition would be expanded to include structures, buildings, objects, and sites. Two of the Town's coves (Heyward and Huger), for example, are contributing sites rather than structures.

- Establishing the list of contributing resources in the UDO for easier accessibility. Presently, the most recently adopted historic resource survey must be consulted; however, not all surveyed properties are contributing resources. All existing contributing resources would be included in the list, with no new resources proposed (nor are any existing resources proposed to be eliminated). If the list is adopted, any resource on the list approved for de-listing or demolition by Town Council at a later date would be removed from the list, not the historic resource survey.

- Refining the review criteria for Certificates of Appropriateness-Historic District (COFA-HD), which are required for new construction in Old Town Bluffton, as well as for certain modifications to existing contributing and non-contributing structures, as well as for demolition of a contributing structure.

- "Housekeeping" items, such as replacing the term "contributing structure" for "contributing resource," where necessary in the UDO, is also proposed.

Previously, Town Staff presented a workshop on Pro-Active Preservation and Maintenance of Contributing Structures. The ordinance proposes to re-establish what was previously titled the "Maintenance of Contributing Structures" ordinance but did not carry over into the UDO.

The next steps for these amendments are provided in the below timeline and acknowledge the property owner and public notification process for both the Planning Commission and Town Council.

No action by Town Council is required on this item at this time.

NEXT STEPS:

Steps	Anticipated Dates
Step 1. Town Council Workshop	February 9
Step 2. Historic Preservation Commission Workshop	March 3
Step 3. Public Notice (Certified Letter / Property Posting)	Send March 15; Allow 30 days for pick-up by property owner
Step 4. Planning Commission Public Hearing and Recommendation	May 26
Step 4. Town Council – 1st Reading	July 13
Step 5. Town Council Meeting – Final Reading and Public Hearing	August 10 [Note: Notice must be provided 30 days before this meeting]

ATTACHMENTS:

1. Presentation
2. Old Town Bluffton and National Register Historic District Map

Workshop - Amendments to the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 3 – Application Process and Article 9 – Definitions and Interpretations to Amend the Definition of "Contributing Structure," add an"Inventory of Contributing Resources" to the UDO, and Change "Historic Structure" References to "Contributing Structures"

Presentation to Town Council

February 9, 2021

Department of Growth Management

Heather Colin, AICP, Director of Growth Management

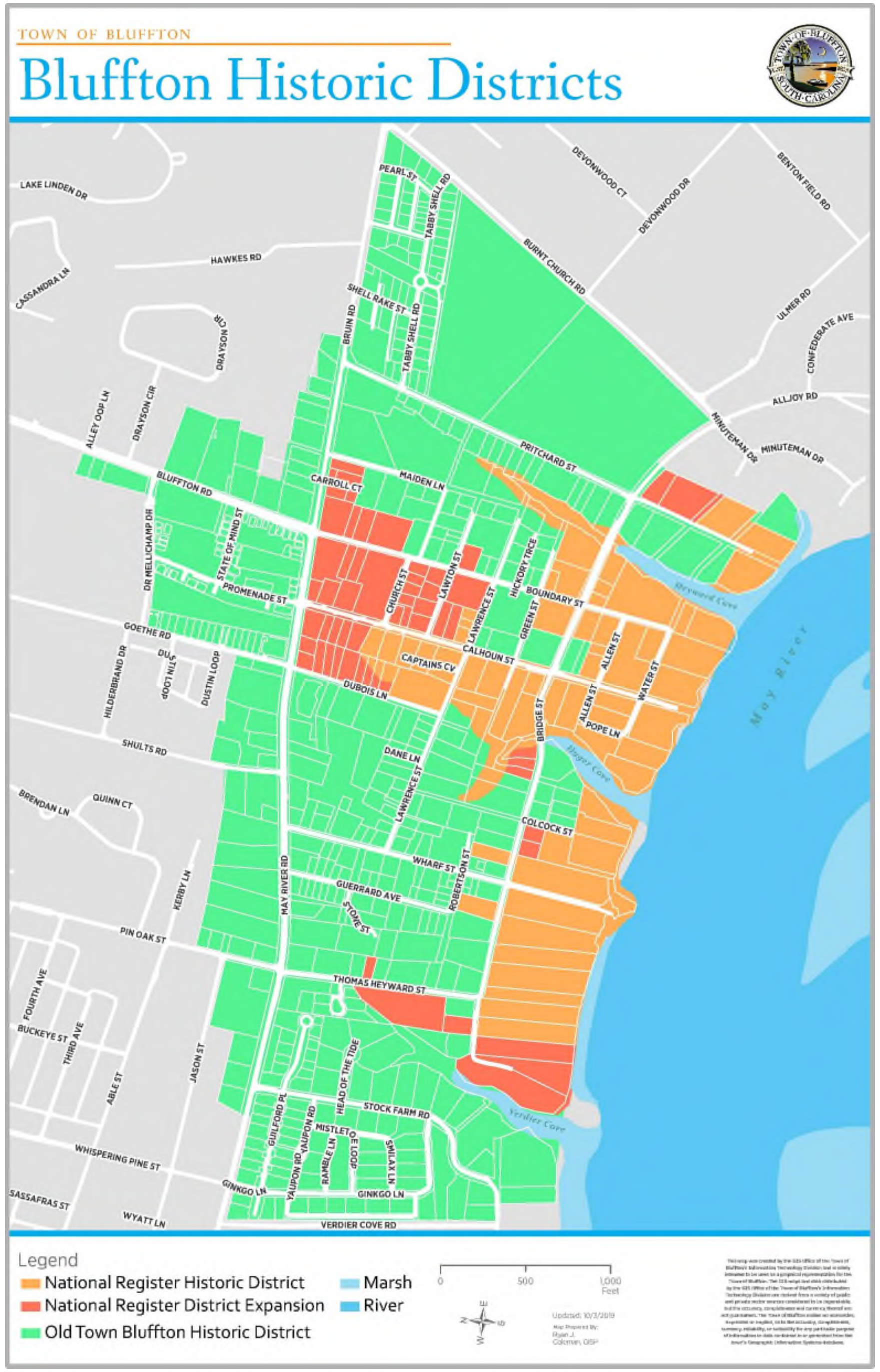
Strategic Plan

The proposed amendments have a relationship to the desire of Town Council to "more closely align" the boundaries of the local historic district (Old Town Bluffton) and the National Register Historic District, which is a small portion of Old Town Bluffton as shown on the Historic District Map. *[See Slide 3]*

An updated historic resource survey was conducted in 2019. Based on the survey, some additional properties in Old Town appear eligible to be included in a nomination to expand the National Register District. Based on this possibility, a review of the existing UDO requirements for designation and review of contributing structures was undertaken. The definition of 'contributing structure' was also examined. This workshop provides an overview of possible UDO amendments.

Historic District Map

- Green, Red and Orange Areas: The entire Old Town Bluffton Historic District
- Orange Area: Existing National Register Historic District
- Red Area: Properties eligible to be included in a nomination for an expanded National Register Historic District



Overview of UDO Amendments

Amendments are proposed to the following sections of the Unified Development Ordinance (UDO):

- Sec. 9.2 (Defined Terms): Revising the definition of "Contributing Structure"
- Sec. 3.18 (Certificate of Appropriateness – Historic District): Streamlining review criteria
- Sec. 3.19 (Site Feature) – "Housekeeping" items, including revising terminology
- Sec. 3.25 (Designation of a Contributing Structure): Streamlining the criteria to be applied for designating contributing resources and for the de-listing or demolition of existing contributing resources
- Sec. 3.26 (Pro-active Preservation): To create an intervention process for maintenance of contributing structures (discussed at a previous workshop)

Sec. 9.2: Current UDO Definition of “Contributing Structure”

“Any property, structure, or architectural resource which was designated as “contributing” in the Bluffton Historic District’s 1996 nomination to the National Register of Historic Places, or in the most recent Bluffton Historic Resource Survey[*], or any other structure designated as a Contributing Structure as provided for in Section 3.25. The complete demolition of a ‘Contributing Structure’ or removal of a ‘Contributing Structure’ from the Bluffton Historic Resource Survey shall cause the structure to no longer be considered ‘contributing’.”

[*] The 2008 Historic Resources Survey

Why is an Updated Definition Proposed?

- To change "Contributing Structure" to "Contributing Resource" to be a more encompassing term that includes buildings, structures, objects and sites (e.g., the coves)

- To reference the list of contributing resources in the UDO, which will provide for easier accessibility (i.e., adopted historic resource survey will not have to be consulted to determine contributing status). Not all resources in a historic resource survey are contributing.

- If contributing status is removed or demolition approved, the resource would be removed from the resource list appearing in the UDO (and not the resource survey).

Current Contributing Structure Map

- All Contributing Structures shown on ‘Historic Resource Map’
- Resources include buildings, structures, objects and sites
- 84 total resources: 82 structures; 2 sites (Huger and Heyward Coves)
- 5 lots shown where a contributing structure previously existed (*does not include all contributing structures that have been demolished*)
- Map is available on the Town’s website

Working Definition

- **Contributing Resource: “**Any building, structure, object, site or property which meets the criteria for a Contributing Resource, as outlined in Section 3.25 (Designation of Contributing Resource), and that is designated as a “contributing resource” in Table 9.7, Town of Bluffton Contributing Resources.”

Note: Table 9.7 would be a new addition to the UDO and include the address and a resource number for each of the Town’s 84 resources. As new resources are designated, or existing resources de-listed or demolished, the resource would be removed from this Table.

Sec. 3.18: Review Criteria

- The Certificate of Appropriateness-Historic District or COFA-HD review criteria is proposed to be revised to refine the following: 1) the ‘Applicability’ language; and 2) the application review criteria for new construction, alterations and demolition.

Sec. 3.19: Site Features

- Site Features are site elements not related to a structure (except for minor exterior alterations that do not affect the architectural character). Features include but are not limited to signage, and modifications to site elements like parking, landscaping and lighting.

- Proposed changes relate to ‘housekeeping’ items, such as rewording “historic structures” to “contributing resources.” No substantive changes are proposed.

Sec. 3.25: Designation of Contributing Structure

Proposed revisions include:

- Changing “Structure” to “Resource”

- The designation criteria are refined and less redundant (See next slide - Slide 12)

Sec. 3.25: Designation of Contributing Structure

Possible Criteria for Designation:

1. The resource is at least 50 years old unless Town Council determines that a resource less than 50 years old is of exceptional significance; and

2. The quality of significance to the Town, Region, State or National history, architecture, archeology, engineering, and culture is present in resource that possesses integrity of location, design, setting, materials, workmanship, feeling, and association; and

3. The resource meets at least one of the following, as applicable to the Town, Region, State or Nation:
   a. Associated with events that have made a significant contribution to the broad patterns of our history; or
   b. Associated with lives of persons significant in our past; or
   c. Embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
   d. Have yielded, or may be likely to yield, information important in prehistory or history.

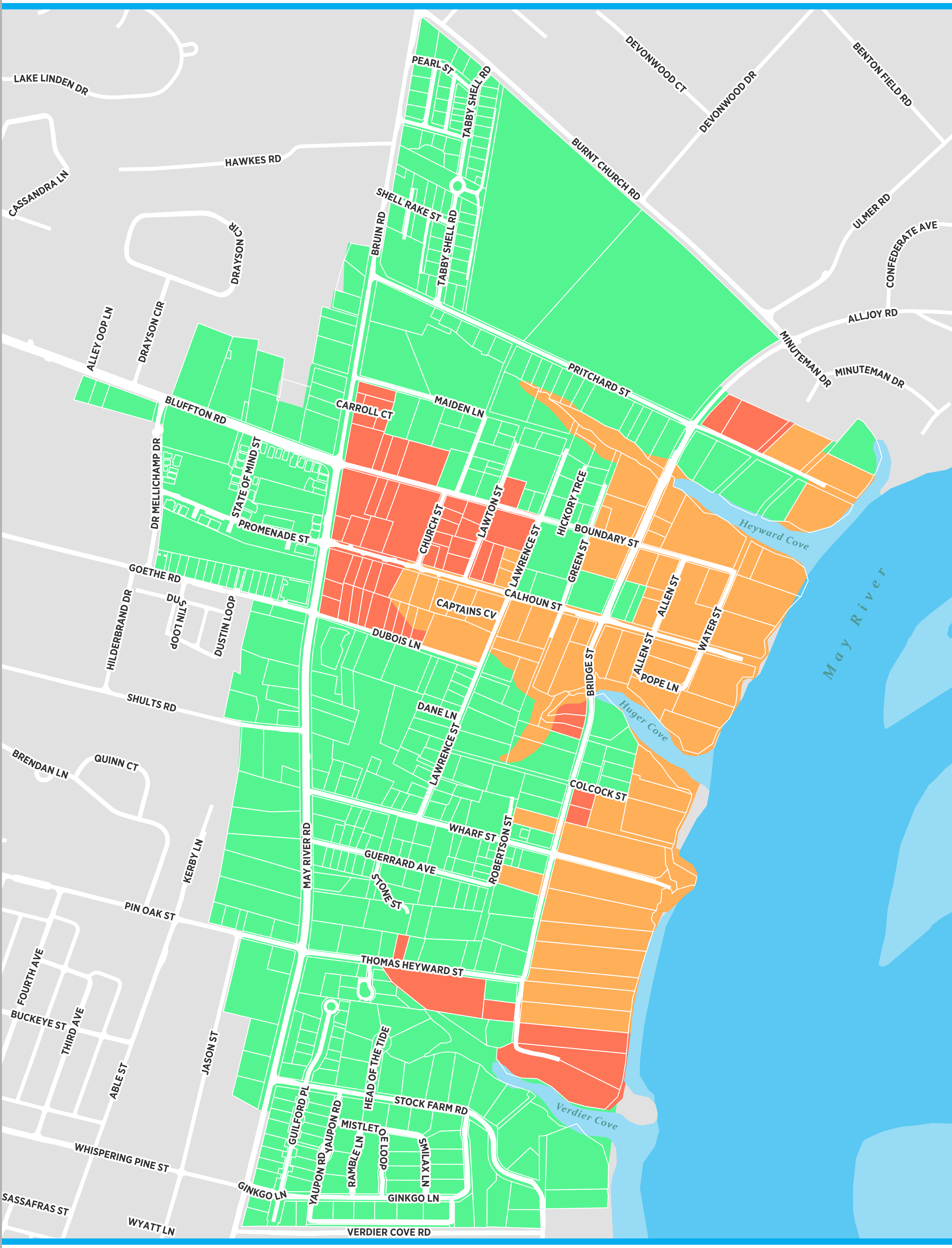
Possible Next Steps

Steps	Anticipated Dates
Step 1. Town Council Workshop	February 9
Step 2. Historic Preservation Commission Workshop	March 3
Step 3. Public Notice (Certified Letter / Property Posting)	Send March 15; Allow 30 days for pick-up by property owner
Step 4. Planning Commission Public Hearing and Recommendation	May 26
Step 4. Town Council – 1st Reading	July 13
Step 5. Town Council Meeting – Final Reading and Public Hearing	August 10 [Note: Notice must be provided 30 days before this meeting]

QUESTIONS

TOWN OF BLUFFTON

Bluffton Historic Districts



Legend

- National Register Historic District
- National Register District Expansion
- Old Town Bluffton Historic District
- Marsh
- River

0 500 1,000 Feet

N E S W

Updated: 10/3/2019

Map Prepared By:
Ryan J. Coleman, GISP

This map was created by the GIS Office of the Town of Bluffton's Information Technology Division and is solely intended to be used as a graphical representation for the Town of Bluffton. The GIS maps and data distributed by the GIS Office of the Town of Bluffton's Information Technology Division are derived from a variety of public and private sector sources considered to be dependable, but the accuracy, completeness and currency thereof are not guaranteed. The Town of Blu[illegible]ties, expressed or implied, as to the [illegible]s, currency, reliability, or suitability [illegible]ose of information or data containe[illegible]he town's Geographic Information Systems database.

TOWN COUNCIL

STAFF REPORT
Engineering Department

MEETING DATE:	February 9, 2021
PROJECT:	Consideration of an Ordinance to Amend the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 3 – Application Process, Article 5 – Design Standards, Sec. 5.10 Stormwater Management, and Article 9 – Definitions and Interpretation Related to Adopting the Southern Lowcountry Post Construction Stormwater Ordinance and *Southern Lowcountry Stormwater Design Manual* – Second and Final Reading (Public Hearing)
PROJECT MANAGER:	Bryan McIlwee, P.E., Director of Engineering

RECOMMENDATION:

Approve Second and Final Reading (Public Hearing) of an Ordinance to amend the Town of Bluffton Code of Ordinances Chapter 23 – Unified Development Ordinance, Article 3 – Application Process, Article 5 – Design Standards, Section 5.10 Stormwater Management, and Article 9 – Definitions and Interpretation Related to Adopting the Southern Lowcountry Post Construction Stormwater Ordinance and *Southern Lowcountry Stormwater Design Manual*.

No changes were made as a result of Town Council's approval of the Ordinance at First Reading on December 8, 2020.

BACKGROUND/DISCUSSION:

Southern Lowcountry Regional Board
Elected officials from the Towns of Bluffton, Ridgeland and Hilton Head Island, City of Hardeeville, and Beaufort and Jasper Counties re-established the Southern Lowcountry Regional Board (SoLoCo) on August 29, 2017. The Mission of SoLoCo is "to create a regional think tank that will identify the problems and opportunities that face the entire southern Lowcountry, as defined by the members and regardless of municipal or county boundaries; to discuss the zoning, housing, employment, quality of life and social issues; and to propose action plans to the appropriate legislative bodies."

SoLoCo prioritized the need for a uniform set of stormwater standards and design guidelines to meet the goal of protecting the region's sensitive environment, residents' quality of life, and future economic development opportunities. Seven (7) jurisdictions (Town of Bluffton, Beaufort County, City of Hardeeville, Jasper County, City of Beaufort, Town of Port Royal, and Town of Yemassee, referred to as the "Project Partners") agreed to work with a consultant team of Center for Watershed Protection and McCormick Taylor to draft a regional model stormwater ordinance and design manual.

The consultant team and the Project Partners received local stakeholder input from the project's outset and garnered feedback from the professional design community during local, statewide, regional, and national presentations as well as three (3) local Public Meetings in early 2020, and a formal Public Review and Comment period of the Final Draft documents.

Upon completion of the Public Meetings and Public Comment period, comments were reviewed and evaluated by the consultant team and the Project Partners resulting in the final version the model

Southern Lowcountry Post Construction Stormwater Ordinance (SoLoCo Stormwater Ordinance) and *Southern Lowcountry Stormwater Design Manual* (*Design Manual*), as presented for adoption today.

Town of Bluffton Strategic Plan

On May 8, 2018, the Town of Bluffton Town Council approved a Resolution adopting the Strategic Plan for Fiscal Years 2019-2020 ("Strategic Plan"). Updating the Town's stormwater design standards was a priority project relating to Strategic Focus Areas of May River & Surrounding Rivers and Watersheds and Community Quality of Life, which includes updating policies and ordinances to sustain the Town's "unique and authentic" character, as well as preserving its natural resources, culture, and history.

The proposed stormwater regulatory amendments to Town of Bluffton Municipal Code Chapter 23 Unified Development Ordinance (UDO), Article 5 (Design Standards), Section 10 (Stormwater) are intended to incorporate the SoLoCo Stormwater Ordinance to provide a consistent set of regulations across the southern Lowcountry region to manage stormwater on a watershed basis to protect water quality and natural resources. Section 10 amendments also include proposed requirements for a grading plan to ensure proper lot drainage, protection of topography, and protection of vegetative resources. Further stormwater design detail guidance is provided in the *Design Manual*. Additional amendments in Article 3 (Application Process) and Article 9 (Definitions and Interpretation) are proposed to provide consistency with the proposed Article 5, Section 10 amendments.

MAY RIVER WATERSHED ACTION PLAN ADVISORY COMMITTEE and PLANNING COMMISSION RECOMMENDATIONS:

As part of the Town's formal code amendment and document adoption process, additional public review has included:

- Planning Commission Workshop on August 26, 2020;
- May River Watershed Action Plan Advisory Committee review and formal recommendation for adoption on August 27, 2020;
- Town Council Workshop on October 13, 2020; and
- Planning Commission Public Hearing and formal recommendation for adoption of the ordinance amendments and *Design Manual* on October 28, 2020; and
- Town Council First Reading on December 8, 2020.

PROPOSED AMENDMENTS:

The proposed changes are in line with best practices and will allow Town Staff to better regulate stormwater drainage system standards. If the Second and Final Reading is approved by Town Council it is proposed that the effective date of the ordinance be March 1, 2021.

Because of length, the proposed amendments are provided in detail in Attachment 2, Exhibit A. Below is a summary of the sections of the UDO proposed to be amended as part of the SoLoCo Stormwater Ordinance and Design Manual adoption process.

- UDO Article 3 – Application Process
  Changes proposed relate to the stormwater permit and process to establish a stormwater surety,
  - Section 3.10 – Development Plan
  - Section 3.13 – Development Surety and Stormwater Surety
- UDO Article 5 – Design Standards
  - Section 5.10 – Stormwater
    For clarity and consistency with partner jurisdictions, the proposed SoLoCo Stormwater Ordinance elements have been incorporated into existing UDO Article 5.10 Stormwater with reference to the regional Design Manual.
- UDO Article 9 – Definitions and Interpretation

Proposed new and refined Definitions relating to the proposed incorporation of the SoLoCo Stormwater Ordinance and Design Manual into the UDO.

TOWN COUNCIL ACTIONS:

As granted by the powers and duties set forth in Section 2.2.6.C.4 of the UDO, Town Council has the authority to take the following actions with respect to this application:

1. Approve the application as submitted;
2. Approve the application with amendments; or
3. Deny the application as submitted.

NEXT STEPS:

UDO Text Amendment Procedure	Date	Complete
Step 1. SoLoCo – Recommendation to Adopt by Partner Organizations	July 28, 2020	✓
Step 2. Planning Commission – Workshop	August 26, 2020	✓
Step 3. May River Watershed Action Plan Advisory Committee – Recommendation to Adopt	August 27, 2020	✓
Step 4. Town Council – Workshop	October 13, 2020	✓
Step 5. Planning Commission – Public Hearing and Recommendation to Town Council	October 28, 2020	✓
Step 6. Town Council – 1st Reading	December 8, 2020	✓
Step 7. Town Council Meeting – Final Reading and Public Hearing* *(Anticipated)* ****Effective date would be March 1, 2021.***	February 9, 2021	✓

SUMMARY:

The adoption of the *Southern Lowcountry Stormwater Design Manual* is consistent with the Comprehensive Plan and supports the May River and Surrounding Rivers and Watersheds Focus Area as a priority within the Strategic Action Plan for Fiscal Years 2019 - 2020. Thus, Town Staff recommends that Town Council approve a Resolution to adopt the *Southern Lowcountry Stormwater Design Manual* as a supporting document to the Unified Development Ordinance, Article 5 – Design Standards, Sec. 5.10 Stormwater Management.

ATTACHMENTS:

1. Presentation
2. Proposed Ordinance
   a. Exhibit A – UDO edits
3. Recommended Motion

Southern Lowcountry Post Construction Stormwater Ordinance and *Southern Lowcountry Stormwater Design Manual* – Second and Final Reading (Public Hearing)

Presentation to Town Council
February 9, 2021
Department of Engineering
Bryan McIlwee, P.E., Director of Engineering

Proposed Amendments

- Amendments to the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 3 – Application Process, Article 5 – Design Standards, Section 5.10 Stormwater Management, and Article 9 – Definitions and Interpretations Related to Adopting the Southern Lowcountry Post Construction Stormwater Ordinance and *Southern Lowcountry Stormwater Design Manual*

Proposed Amendments

UDO ARTICLE 3 – APPLICATION PROCESS

- Section 3.10 – Development Plan
- Section 3.13 – Development Surety and Stormwater Surety

Changes are required related to the Stormwater Permit and process to establish a Stormwater Surety.

UDO ARTICLE 5 – DESIGN STANDARDS

- Section 5.10 – Stormwater

For clarity and consistency with partner jurisdictions, the proposed SoLoCo Stormwater Ordinance elements have been incorporated into existing UDO Article 5.10 Stormwater with reference to the regional *Southern Lowcountry Stormwater Design Manual.*

UDO ARTICLE 9 – DEFINITIONS AND INTERPRETATION

- Proposed new and refined Definitions relating to the proposed incorporation of the SoLoCo Stormwater Ordinance and *Southern Lowcountry Stormwater Design Manual* into the UDO.

Background – SoLoCo Board

2017 – Southern Lowcountry Board of elected officials charged respective staff to summarize & compare stormwater standards to protect natural resources and waterways

2017 – Stormwater Technical subcommittee report to SoLoCo:

- **Findings**:
  - Most restrictive/highest criteria stormwater standards are not necessarily "the best"
  - Stormwater runoff does not follow political boundaries
  - Not every watershed is the same (saltwater v. freshwater)
- **Recommendation to SoLoCo:**
  - Partner to develop a **regional** stormwater standard to provide consistent protection of water resources and consistent design requirements that are current "**State of Knowledge**"
  - Procure consultant team to assist staff in drafting a regionally consistent stormwater ordinance and design manual

7 Project Partners:

- Beaufort County – lead and contract administrator
- Jasper County
- City of Beaufort
- Town of Bluffton
- City of Hardeeville
- Town of Port Royal
- Town of Yemassee

Background – Town Strategic Plan

- Fiscal Year 2019-20 included review of May River Watershed Action Plan policies including updating the Town's stormwater regulations and stormwater design manual.
- 12/2018 – Project initiated by Center for Watershed Protection seeking design community input on existing stormwater ordinances.
- 1/6/2020 – 2/27/2020 – Draft SoLoCo Stormwater Ordinance and *Design Manual* available online for Public Review and Formal Comment.
- 1/23/2020 – Jasper County and City of Hardeeville Public Meeting.
- 1/28/2020 – Beaufort County, City of Beaufort, and Town of Port Royal Public Meeting.
- 1/30/2020 – Town of Bluffton Public Meeting.
- 7/28/2020 – Staff update provided to SoLoCo for adoption schedules.
- 8/26/2020 – Planning Commission Workshop
- 8/27/2020 – May River Watershed Action Plan recommendation to Planning Commission
- 10/13/2020 – Town Council Workshop
- 10/28/2020 – Planning Commission recommendation to Town Council
- 12/8/2020 – Town Council First Reading

Town Council Actions

As granted by the powers and duties set forth in Section 2.2.6.C.4 of the UDO, the Town Council has the authority to take any of the following actions:

1. Approve the application as submitted;

2. Approve the application with conditions; or

3. Deny the application as submitted.

Next Steps

UDO Text Amendment Procedure	Date	Complete
Step 1. SoLoCo – Recommendation to Adopt by Partner Organizations	July 28, 2020	✓
Step 2. Planning Commission – Workshop	August 26, 2020	✓
Step 3. May River Watershed Action Plan Advisory Committee – Recommendation to Adopt	August 27, 2020	✓
Step 4. Town Council – Workshop	October 13, 2020	✓
Step 5. Planning Commission – Public Hearing and Recommendation to Town Council	October 28, 2020	✓
Step 6. Town Council – 1st Reading	December 8, 2020	✓
Step 7. Town Council Meeting – Final Reading and Public Hearing* *(Anticipated)* **Effective date would be March 1, 2021.*	February 9, 2021	✓

QUESTIONS?

Recommended Motion

Consideration of an Ordinance to Amend the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 3 – Application Process, Article 5 – Design Standards, Sec. 5.10 Stormwater Management, and Article 9 – Definitions and Interpretation – Second and Final Reading

"I make a motion to approve Second and Final Reading of Amendments to the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 3 – Application Process, Article 5 – Design Standards, Sec. 5.10 Stormwater Management, and Article 9 – Definitions and Interpretation Related to Adoption of the Southern Lowcountry Post Construction Stormwater Ordinance and Southern Lowcountry Stormwater Design Manual."

ORDINANCE NO. 2020-______

TOWN OF BLUFFTON, SOUTH CAROLINA

AN ORDINANCE AMENDING THE TOWN OF BLUFFTON'S MUNICIPAL CODE OF ORDINANCES, CHAPTER 23, UNIFIED DEVELOPMENT ORDINANCE, ARTICLE 3 – APPLICATION PROCESS, ARTICLE 5 – DESIGN STANDARDS, SECTION 5.10 STORMWATER MANAGEMENT AND ARTICLE 9 – DEFINITIONS AND INTERPRETATION, RELATING TO ADOPTING THE SOUTHERN LOWCOUNTRY POST CONSTRUCTION STORMWATER ORDINANCE AND *SOUTHERN LOWCOUNTRY STORMWATER DESIGN MANUAL*

WHEREAS, the Town of Bluffton desires to improve the general safety, welfare, health and properties of the citizens of the Town of Bluffton; and

WHEREAS, to establish the necessary provisions to accomplish the above, the Town of Bluffton has authority to enact resolutions, ordinances, regulations, and procedures pursuant to South Carolina Code of Laws 1976, Section 5-7-30; and,

WHEREAS, the Town of Bluffton's Town Code and Ordinances provide guidance and requirements for development within the Town of Bluffton through regulations set forth to protect and promote the health, safety, and welfare of the Town's citizens, as espoused through the provisions of the Town of Bluffton Comprehensive Plan and as authorized by the South Carolina Local Government Comprehensive Planning Enabling Act of 1994, Title 6, Chapter 29 of the Code of Laws for South Carolina; and

WHEREAS, the Town of Bluffton Town Council adopted the aforementioned standards, which are known as the Unified Development Ordinance (UDO), Chapter 23 of the Code of Ordinances for the Town of Bluffton, South Carolina on October 11, 2011 through Ordinance 2011-15; and

WHEREAS, the UDO unifies the subdivision, land use, development/design regulations including stormwater design standards into a single set of integrated, updated, and streamlined standards; and

WHEREAS, the Town Council shall from time to time examine ordinances to ensure that they are properly regarded, enforced, sufficient and satisfactory to the needs of the community and can further suggest changes as deemed appropriate; and,

WHEREAS, the Town Council last amended UDO "Article 5.10 Stormwater" and the referenced Stormwater Design Manual in 2011; and

WHEREAS, to protect water quality and citizen quality of life, an update of both UDO "Article 5.10 Stormwater" and the Stormwater Design Manual to current stormwater management State of the Knowledge practices were identified in the Fiscal Years (FY) 2019 – 2020 Strategic Plan Focus Area "May River & Surrounding Rivers and Watersheds" as priority initiatives in the May River Watershed Action Plan Update; and

WHEREAS, the May River Watershed Action Plan is intended to restore and protect shellfish harvesting in the May River which is a SC Department of Health and Environmental Control-designated Outstanding Resource Water for its oyster production, aesthetic qualities, and recreational opportunities; and

WHEREAS, research shows that waterways experience water quality degradation when impervious surface in a watershed exceeds 10% due to stormwater runoff water quality and quantity; and

WHEREAS, development within the Town of Bluffton is resulting in changes in land use and topography causing in an increase in impervious surfaces in the May River watershed from 5.78% in 2002 to 15.31% in 2018; and

WHEREAS, similar development rates are causing increases in population and impervious surface rates in most watersheds located in the Southern Lowcountry Region, which is comprised of the Towns of Bluffton, Port Royal, Yemassee, Ridgeland, and Hilton Head Island, Cities of Hardeeville and Beaufort, and Beaufort and Jasper Counties; and

WHEREAS, on August 29, 2017, elected officials from City of Hardeeville, Towns of Bluffton, Ridgeland, and Hilton Head Island, Beaufort County, and Jasper County, known as the Southern Lowcountry (SoLoCo) Regional Board, prioritized and requested a uniform set of stormwater standards and design guidelines to meet the goal of protecting the region's sensitive environment, residents' quality of life, and future economic development opportunities; and

WHEREAS, understanding the importance of a regional, collaborative, watershed-based approach to stormwater management, the Towns of Bluffton, Port Royal and Yemassee, Cities of Hardeeville and Beaufort, and Beaufort and Jasper Counties partnered with a consultant team with stakeholder input to develop a model "Southern Lowcountry Post Construction Stormwater Ordinance" and *Southern Lowcountry Stormwater Design Manual* based on current State of the Knowledge; and

WHEREAS, the model "Southern Lowcountry Post Construction Stormwater Ordinance" and *Southern Lowcountry Stormwater Design Manual* are unique in that they accomplish 1) Regional collaboration for consistent, effective management of stormwater; 2) Unification of the current diversity of stormwater design requirements resulting from Municipal Separate Storm Sewer System permits, community need, and community dynamics; and 3) Protection of water quality by regulating stormwater design standards from a watershed-based approach, not by jurisdiction; and

WHEREAS, incorporation of the model "Southern Lowcountry Post Construction Stormwater Ordinance" language and requirements into the UDO establishes the regulatory framework to preserve, protect, and revitalize the critical watersheds of the May River, Okatie/Colleton Rivers, and New River; and

WHEREAS, the *Southern Lowcountry Stormwater Design Manual* is in conformance with the UDO and shall serve as a supplement to the UDO to provide the standards for design of stormwater management facilities/stormwater systems within the Town; and

WHEREAS, the Town of Bluffton Town Council desires to amend the Unified Development Ordinance, Article 3 – Application Process, Article 5 – Design Standards, Sec. 5.10 Stormwater Management, and Article 9 – Definitions and Interpretation to adopt the model "Southern Lowcountry Post Construction Stormwater Ordinance" and *Southern Lowcountry Stormwater Design Manual*.

NOW, THEREFORE, BE IT ORDERED AND ORDAINED BY THE TOWN COUNCIL OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, in accordance with the foregoing, the Town hereby amends the Code of Ordinances for the Town of Bluffton, Chapter 23, Unified Development Ordinance as follows:

SECTION 1. AMENDMENT. The Town of Bluffton hereby amends the Code of Ordinances for the Town of Bluffton, South Carolina by adopting and incorporating amendments to Chapter 23 – Unified Development Ordinance, Article 3 – Application Process; Article 5 – Design Standards, Section 5.10 Stormwater Management; and Article 9 – Definitions and Interpretation Related to Adopting the "Southern Lowcountry Post Construction Stormwater Ordinance" and *Southern Lowcountry Stormwater Design Manual* as shown On Exhibit A attached hereto and fully incorporated herein by reference.

SECTION 2. REPEAL OF CONFLICTING ORDINANCES. All ordinances or parts of ordinances inconsistent with this Ordinance are hereby repealed to the extent of such inconsistency.

SECTION 3. ORDINANCE IN FULL FORCE AND EFFECT. This entire Ordinance shall take full force and effect February 1, 2021.

DONE, RATIFIED AND ENACTED this _______ day of ______________, 2020.

This Ordinance was read and passed at first reading on _________, 2020.

____

Lisa Sulka, Mayor
Town of Bluffton, South Carolina

____
Kimberly Chapman
Town Clerk, Town of Bluffton, South Carolina

A public hearing was held on this Ordinance on _______________, 2021.

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

____
Kimberly Chapman
Town Clerk, Town of Bluffton, South Carolina

This Ordinance was passed at second reading held on ____________, 2021.

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

____
Kimberly Chapman
Town Clerk, Town of Bluffton, South Carolina

3.10 Development Plan, 3.10.3. Application Review Criteria

3.10.3.B. Final Development Plan

The UDO Administrator shall consider the following criteria in assessing an application for a Final Development Plan:

5. The Applicant has provided Sureties as required by Section 3.13 of the UDO, as applicable~~.~~;

3.13 Development Surety and Stormwater Surety

3.13.1 Intent

This Section is intended to provide procedures and standards to facilitate the review of Development Surety Applications and Stormwater Surety Applications. Review of Development Surety Applications and Stormwater Surety Applications will be required to ensure completion of the required improvements within a specified time period.

3.13.2 Applicability

Development Surety and/or Stormwater Surety as set forth herein shall be accepted where the Applicant desires to record a plat before completion of all required improvements and where a Temporary Certificate of Compliance is being issued pursuant to this article. The Development Surety and/or Stormwater Surety shall ensure the satisfactory completion of all required improvements shown on the approved Subdivision Plan or Development Plan.

A. Development Surety: The installation and maintenance of drinking water systems, sewer systems, streetlights and signs, open space areas, and any other improvements to be constructed or indicated in lieu of actual construction prior to final approval; and

B. Stormwater Surety: The installation and maintenance of erosion and sediment control Best Management Practices (BMPs), drainage systems, stormwater management systems, street systems (roadway paving, curb and gutter, roadway swales, roadway stormwater inlets, pipes and structures), grading, any other improvements to be constructed or indicated in lieu of actual construction prior to final stormwater permit approval not included in the Development Surety.

3.13.3 Application Review Criteria

The UDO Administrator shall consider the following criteria in assessing an application for Development Surety and/or Stormwater Surety:

A. The application must comply with applicable requirements in the Applications Manual and/or *Southern Lowcountry Stormwater Design Manual (Design Manual)*;

B. The following types of Development Surety and/or Stormwater Surety may be accepted by the UDO Administrator:

1. Cash;

2. A surety bond that names the Town of Bluffton as beneficiary;

3. A bank certified check payable to "Town of Bluffton"; and

4. An irrevocable letter of credit approved by the UDO Administrator that names the Town of Bluffton as beneficiary.

C. Prior to the UDO Administrator's acceptance of any Development Surety and/or Stormwater Surety, the Applicant shall submit to the UDO Administrator a copy of a contract signed by both the developer and a licensed contractor for the completion of required improvements and infrastructure, or an itemized and certified cost estimate for such work prepared by a licensed contractor, registered engineer, registered architect, or registered landscape architect, or any combination thereof, as appropriate, which will cover the costs for completion of all required improvements and infrastructure. The amount of a Development Surety and/or Stormwater Surety shall be the amount determined by the UDO Administrator to be necessary to assure completion of required improvements and infrastructure, based on such contract or cost estimate, but not less than 150% of the improvement and infrastructure costs. The surety amount includes a contingency amount to ensure completion of work which may have been underestimated or unanticipated, a maintenance fee to cover the cost of maintenance and stabilization of the site improvements, and an administrative fee to cover any potential cost incurred by the Town of Bluffton in administering completion of any unfinished portion of the work and may include, but shall not be limited to, staff time and expenses, use of Town of Bluffton equipment, and/or possible professional consultant fees.

3.13.4 Effect and Expiration of Approvals

A. Subsequent to on-site inspection by the UDO Administrator verifying that all improvements subject to the Development Surety and/or Stormwater Surety have been satisfactorily completed or a percentage has been satisfactorily completed in the opinion of the UDO Administrator, the surety, either in whole, in part, or any remaining balance thereof, shall be released in accordance with the following:

1. A release of an appropriate portion of a Development Surety and/or Stormwater Surety, which has been accepted by the UDO Administrator in the form of cash or certified check (hereinafter a "drawdown") or amendment of the face value of any letter of credit or performance bond (hereinafter a "markdown") that has previously been accepted by the UDO Administrator may be permitted provided that:

a. Prior to a request for a drawdown or markdown, the Applicant shall submit to the UDO Administrator the contractor's itemized list of work completed, including requisite submittals, certifications, and preliminary As-Built Drawings, or any other documents or information deemed reasonably necessary by the UDO Administrator, and work remaining as secured by the surety, which has been certified by the project engineer or owner;

b. The UDO Administrator has inspected the work site and has verified in writing that, to the best of his/her knowledge, all such respective work has been completed;

c. The requested drawdown or markdown shall be at least twenty percent (20%) of the original face value of the approved surety, but not less than 30% of the original surety posting plus administrative fees; and

d. No more than one such drawdown or markdown shall be approved during any thirty-day period, except for the request for a final drawdown or markdown.

2. In all cases where a drawdown or markdown is requested, the contingency fee and the administrative fee shall remain intact until the work secured by the Development Surety and/or Stormwater Surety is verified by the UDO Administrator to have been completely finished and a final drawdown or markdown has been requested; and

3. A Development Surety shall be completely released by the UDO Administrator upon the full completion of all required improvements and infrastructure and the issuance by the UDO Administrator of a final Certificate of Construction Compliance.

4. A Stormwater Surety shall be completely released by the UDO Administrator upon the full completion of all required improvements, infrastructure, Final As-Builts (Final As-Builts include re-survey and As-Built of previously submitted information and new development and stormwater systems constructed as part of the phase and/or subphase), or any other documents or information deemed reasonably necessary by the UDO Administrator, and the issuance by the UDO Administrator of a Notice of Termination of the stormwater permit.

B. Time limits on Development Surety and/or Stormwater Surety shall be as follows:

1. The maximum length of time for which a Development and/or Stormwater Surety may be held by the UDO Administrator shall be one year. Any Development Surety and/or Stormwater Surety submitted as a letter of credit or performance bond shall state on its face that, subsequent to the date of expiration, the Town of Bluffton as beneficiary shall have 30 days from the date of expiration to make demand upon the issuing bank or agency for the honoring of such surety, if the respective work has not been fully completed; and

2. Any Development Surety and/or Stormwater Surety submitted as a letter of credit or performance bond shall also state that the letter of credit or performance bond shall be automatically renewed until such time that the surety issuer provides the UDO Administrator with a 30 days written notice of the expiration of such surety.

C. If all improvements and infrastructure work secured by a Development and/or Stormwater Surety have not been completed as of the stated date for such completion, the UDO Administrator shall contract to complete the remaining work and stabilize and maintain the site following normal Town of Bluffton procurement procedures.

1. In the case of a cash or certified check surety, the Town of Bluffton shall take possession of the full amount or remaining balance of such surety.

2. In the case of a letter of credit or bond, the UDO Administrator shall make demand upon the issuer of such surety for immediate payment to the Town of Bluffton of the full or amended face value of such surety.

D. In addition to any Penalties set forth in this Ordinance, failure by the Applicant to keep current any Development and/or Stormwater Surety prior to the issuance of a Certificate of Construction Compliance shall cause the UDO Administrator to immediately order all Development work stopped and all necessary Town of Bluffton inspections of the Development work suspended until a Development and/or Stormwater Surety meeting the requirements of this article has been approved.

5.10 Stormwater

5.10.1 General provisions

A. Intent

1. The May River and the surrounding receiving waters have been designated by the State of South Carolina as Outstanding Resource Waters. The use of the river's natural resources has historical and traditional significance to the area in general and to the Town of Bluffton in particular. It is in the public interest that the pristine condition of these areas be maintained and preserved for future generations. Uncontrolled stormwater runoff may have significant, adverse impact on the health, safety and general welfare of the Town and the quality of life of its citizens by transporting pollutants into receiving waters and by causing erosion and/or flooding. Development can alter the hydrologic response of local watersheds by increasing stormwater runoff rates, volumes, and pollutant loads; flooding; soil erosion; stream channel erosion; non-point source pollution; pollutant and sediment transport and deposition in rivers and streams, wetlands, and estuaries; and fluctuations in salinity concentrations and productivity in estuaries. Certain Development including removal of trees and alteration of natural drainage patterns, can alter the hydrologic response of local watersheds, increasing stormwater runoff rates and volumes, and, consequently, decreasing the amount of rainfall that is available to recharge shallow groundwater aquifers. These changes in stormwater runoff may contribute to increased quantities of water-borne pollutants and alterations in hydrology which are harmful to public health, safety, and welfare, as well as to the natural environment.

2. Point source pollution may have significant, adverse impact on the health, safety and general welfare of the Town and the quality of life of its citizens by transporting pollutants into receiving waters. The allowance of discharge pipes and outfalls for non-stormwater discharges, illegal dumping, and improper handling of accidental spills and intentional disposals increase the quantities of water-borne pollutants which are harmful to public health, safety, and welfare, as well as to the natural environment.

3. The effects of point and non-point source pollution, such as uncontrolled runoff, have shown evidence of degrading the Town's receiving waters; thereby adversely affecting the unique qualities of the Town's receiving waters, its recreational opportunities and commercial, oystering, boating and fishing, the ecosystem's ability to naturally reproduce and thrive, and the general ability of the area to sustain its natural estuarine resources.

4. Grading can create problems with storm drainage and water quality by generating non-pint source pollution. Grading plans for compliance with overall Development shall be to maximize

groundwater recharge, minimize runoff, ensure positive drainage within and from the site with no impact on adjacent property, ensure offsite drainage is received to an existing, adequate conveyance system, and prevent Mass Grading and Clearing of a site without review per this Section.

5. These deleterious effects can be managed and minimized by applying proper design and well-planned controls to manage stormwater runoff from Development sites, to protect existing natural features, such as trees and contours, that maintain hydrology and provide water quality control, and to eliminate potential sources of pollution to receiving waters. Public education regarding the cause and effect of these types of pollutions and the implementation of the controls and management policies is key to fundamentally changing public behavior.

6. The Town of Bluffton is required to comply with a number of State and Federal regulations that require the adverse impacts of stormwater runoff rates, volumes and pollutant loads to be controlled and minimized.

7. The Town of Bluffton has determined that it is in the public interest to control and minimize the adverse impacts of certain Development activities and has established this set of stormwater management provisions to regulate post-construction stormwater runoff rates, volumes and pollutant loads on Development sites.

8. This article is not in conflict with any development agreements to which the Town is a party and does not prevent the Development set forth in any development agreement.

9. This article is essential to the public health, safety or welfare and shall apply to any Development that is subject to a development agreement.

10. Laws of general application throughout the Town necessary to protect health, safety and welfare are anticipated and are provided for in development agreements.

11. Substantial changes in Development impacts have occurred since the time the development agreements were signed, which changes, if not addressed in this article would pose a threat to public health, safety or welfare.

B. Purpose

1. It is the purpose of this article to protect, maintain, and enhance the environment of the Town and the short and long-term public health, safety, and general welfare of the citizens of the Town by establishing requirements and procedures to control the potential adverse effects of increased stormwater runoff associated with both future Development and existing developed land. Proper management of existing natural features and stormwater runoff will minimize damage to public and private property, ensure a functional drainage system, reduce the effects of Development on land and stream channel erosion, attain and maintain water quality standards, enhance the local environment associated with the drainage system, reduce local flooding, reduce pollutant loading to the maximum extent practicable and maintain to the extent practicable the pre-developed hydrologic characteristics of the area, and facilitate economic development while minimizing associated pollutant, flooding, and drainage impacts.

2. This article specifically authorizes and enables the Town at a minimum to:

a. Establish decision-making processes surrounding Development activities that protect the integrity of local aquatic resources;

b. Prohibit Illicit Discharges to the Stormwater System and receiving waters.

c. Define procedures for site plan review, inspection, and enforcement relative to stormwater management.

d. Control the discharge of spills, dumping or disposal of materials other than stormwater to the Stormwater System and receiving waters.

e. Address specific categories of non-stormwater discharges and similar other incidental non-stormwater discharges.

f. Require temporary erosion and sediment controls to protect water quality to the maximum extent practicable during construction activities, in accordance with current state regulations.

g. Define procedures for receipt and consideration of information submitted by the public.

h. Address runoff, particularly volume, rate, and quality through the control and treatment of stormwater with stormwater management facilities and/ or Best Management Practices (BMPs) to provide volume control and at least an eighty (80) percent reduction in total suspended solids loads, thirty (30) percent reduction of total nitrogen load, and sixty (60) percent reduction in bacteria load.

i. Develop post-construction stormwater quality performance standards, through enforcement of minimum design standards for BMPs.

j. Ensure effective long-term operation and maintenance of BMPs.

k. Carry out all inspection, surveillance, monitoring, and enforcement procedures necessary to determine compliance and noncompliance with this article and stormwater permit (permit) conditions including the prohibition of Illicit Discharges to the Town's Stormwater System and the protection of water quality of the receiving waters.

l. Establish minimum post-Development stormwater management standards and design criteria set forth by the *Southern Lowcountry Stormwater Design Manual* (*Design Manual*) with the intent of reducing flooding, channel erosion, and pollutant transport and deposition in local aquatic resources;

m. Establish minimum post-Development stormwater management standards and design criteria in the *Design Manual* with the intent of preserving existing hydrologic conditions on Development sites;

n. Establish design criteria in the *Design Manual* for structural and nonstructural stormwater management practices that can be used to meet the minimum post-Development stormwater management standards and design criteria;

o. Establish that Better Site Design (BSD), natural vegetative buffers, tree conservation, and site planning have been incorporated, documented, and presented in the Development design process.

p. Maintain structural and nonstructural stormwater management practices to ensure that they continue to function as designed and pose no threat to public safety; and,

q. In the event these requirements cannot be met, a fee-in-lieu shall be required as outlined in Section 5.10.3.K.

3. The article requires prudent site planning, including special considerations for the purposes of preserving natural drainage ways incorporating on-site stormwater detention and infiltration, including natural resource preservation, to minimize runoff from individual sites to receiving waters by use of effective runoff management, structural and nonstructural BMPs, drainage structures, and stormwater facilities to maintain the pre-development hydrology of a Development.

C. Applicability

Beginning with and subsequent to its effective date, this article shall be applicable to:

1. The following activities, unless exempt pursuant to Section 5.10.1.C.2 below:
   a. Development and/or Redevelopment that involves the creation, addition or replacement of 5,000 square feet or more of impervious surface or that involves other Land Disturbing activities of one acre or more.

   b. Development and/or Redevelopment, regardless of size, that is part of a Larger Common Plan of Development, even though multiple, separate and distinct Land Disturbing activities may take place at different times and on different schedules.

   c. A Major Substantial Improvement of an existing property.

2. The following activities are exempt from this Article:
   a. Any maintenance, alteration, renewal, or improvement as approved by the Town which does not alter existing drainage pattern, does not result in change or adverse impact on adjacent property, or create adverse environmental or water quality impacts, and does not increase the temperature, rate, quality, or volume or location of stormwater runoff discharge;

   b. Projects that are exclusively for agricultural or silvicultural activities, not involving relocation of drainage canals, within areas zoned for these uses;

   c. Redevelopment that constitutes the replacement of the original square footage of impervious cover and original acreage of other ~~land~~ Development activity when the original Development is wholly or partially lost due to natural disaster or other acts of God occurring after January 1, 2021; and,

   d. Work by governmental agencies or property owners required to mitigate emergency flooding conditions. If possible, emergency work should be approved by the duly appointed officials in charge of emergency preparedness or emergency relief. Property owners performing emergency work will be responsible for any damage or injury to persons or property caused by their unauthorized actions. Property owners will stabilize the site of the emergency work within 60 days, or as soon as reasonable, following the end of the emergency period.

3. Any illicit discharges.

4. The provisions of this article shall apply throughout the incorporated areas of the Town.

5.10.2 Stormwater Management Program

A. Coordination with Other Agencies.

The UDO Administrator will coordinate the Town's activities with other federal, state, and local agencies, which manage and perform functions relating to the protection of receiving waters.

B. Cooperation with Other Governments.

The Town may enter into agreements with other governmental and private entities to carry out the purposes of this ~~article~~ Section.

These agreements may include, but are not limited to enforcement, resolution of disputes, cooperative monitoring, and cooperative management of stormwater systems and cooperative implementation of stormwater management programs.

Nothing in this ~~article~~ Article or in this ~~section~~ Section shall be construed as limitation or repeal of any ordinances of these local governments or of the powers granted to these local governments by the South Carolina Constitution or statutes, including, without limitation, the power to require additional or more stringent stormwater management requirements within their jurisdictional boundaries.

C. Southern Lowcountry Stormwater Design Manual

The UDO Administrator shall utilize the standards, criteria, and information presented in the *Design Manual* or applicable addendums, appendices, technical memorandums, and/or applicable revisions that may be applied for the proper implementation of this ~~Article~~ Section. This Manual may be updated and expanded periodically, based on improvements in science, engineering, monitoring, local experience, and state or federal water quality requirements.

The *Design Manual* identifies Special Watershed Protection Areas that have standards and criteria specific to ~~land~~ Development in these areas.

D. Compatibility with Other Regulations

This ~~Article~~ Section is not intended to interfere with, modify or repeal any other ordinance, rule, regulation, or other provision of law. The procedures and standards set forth in this Ordinance, and the policies, procedures, and design data specified in the *Design Manual* provide the minimum standards to be adhered to by ~~land~~ Development activities under the jurisdiction of the Town of Bluffton. If any regulation or requirement of this ~~Article~~ Section is in conflict with any other local, state or federal law, the most restrictive, or whichever imposes the highest protective standards for human health or the environment, shall apply.

5.10.3 Standards

A. General Requirements

1. All ~~land~~ Development activities shall utilize Structural and Nonstructural Stormwater Management Practices to control and minimize the increased stormwater runoff rates, volumes, and pollutant loads caused by ~~land~~ Development in accordance with the criteria presented in the *Design Manual*.

2. For Structural and Nonstructural Stormwater Management Practices not included in the *Design Manual*, or for which pollutant removal and runoff reduction rates have not been provided, the effectiveness

of the Structural and Nonstructural Stormwater Management Practices must be documented through prior studies, literature reviews, or other means and receive approval from the Town before being included in the design of a stormwater management system. In addition, if the site is located in a Watershed Protection Area or a Special Watershed Protection Area the Town may impose additional requirements as deemed necessary, which are located in the *Design Manual*.

3. All Development, including single family lots not part of a Larger Common Plan of Development meeting applicability requirements in Section 5.10.1.C.1, in the Town shall meet the following General Requirements to the Maximum Extent Practicable. Developments requiring the stormwater management plans for construction shall meet all Requirements of this article.

4. All Development shall disconnect Impervious Surfaces with vegetative surfaces to the maximum extent practicable.

5. Stormwater runoff shall be controlled in a manner that:

    a. Promotes positive drainage from structures resulting from Development as detailed in the *Design Manual*.

    b. Includes the use of vegetated conveyances, such as swales and existing natural channels to promote infiltration.

    c. Promotes runoff velocities that maintain sheet flow condition to prevent erosion and promote infiltration.

    d. Limits its interaction with potential pollutant sources that may become water-borne and create non-point source pollution.

6. Better Site Design, Natural Vegetative Buffers, and Tree Conservation

Better Site Design, natural vegetative buffers, and tree conservation play an integral part in minimizing the volume of stormwater runoff by promoting infiltration and acting as a first line of treatment of water quality pollution. As such all Development subject to this Article shall comply with the following:

    a. ~~Any and all~~ Better Site Design practices set forth in *Design Manual* to the Maximum Extent Practicable*;*

    b. Any and all buffer requirements of this article; other applicable Sections of the UDO, and if applicable, any approved concept plan, and/or approved master plan.

    c. Tree conservation requirements of the ~~Unified Development Ordinance~~ ~~Article Section~~ UDO 3.22, 5.3, and other applicable sections that may apply.

B. Permit Application Requirements

No owner or Developer shall perform any ~~land~~ Development activity without first meeting the requirements of this ~~Article~~ Section 5.10 and the *Design Manual* and having been issued a permit from the Town. Unless specifically exempted by this ~~Article~~ Section 5.10, any owner or Developer proposing ~~a land~~ Development activity shall submit to the Town a permit application and accompanying items as required in the *Design Manual* ~~and Town for that purpose~~.

~~systems~~. The *Design Manual* standards shall describe in detail how post-development stormwater runoff will be controlled and managed, the design of all stormwater facilities and practices, the components of a project plan necessary to meet the requirements of this ~~Article~~ Section and post-construction maintenance and inspection requirements.

C. Maximum Extent ~~Practical~~ Practicable ~~Guidelines and~~ Process

The Maximum Extent Practicable, or "MEP," ~~is the language of the Federal Clean Water Act that sets the standards to evaluate efforts pursued to achieve pollution reduction to the waters of the United States. It is the determination of this Article that all proposed development, sites meet the requirements of the *Design Manual* to achieve reduction of pollution to the waters of the Southern Lowcountry. If it is technically infeasible to do so, the applicant shall document and provide such information to the Town for review. Information provided shall demonstrate how a combination of several iterations of Better Site Design and post development stormwater management design scenarios fail to meet the minimum requirements of the *Design Manual* and justification of their determination of infeasibility. Cost is not a viable justification.~~

~~The MEP~~ process defined by the *Design Manual* shall be the basis of submittals for plan approval under this ~~Article~~ Section. ~~The MEP submittal must provide documentable evidence of the process the applicant has performed that demonstrates the restrictions to the use and implementation of BMPs to meet the requirements of this Manual in whole or in part.~~ The consideration for a waiver of this ~~Article's~~ Section's requirements will rely on the MEP submittal and UDO Administrator review.

D. Stormwater Surety

~~The Town is authorized under this Article to require stormwater performance bonds for construction of stormwater management systems, as detailed in the *Design Manual*.~~

Financial sureties for the cost of stormwater facilities approved for the proposed Development shall be provided in accordance with the Town Stormwater Surety ~~performance bond~~ and stormwater permit issuance process in ~~Article~~ Section 3.13 ~~3.10.3.B~~. ~~The Town shall require from the developer a surety or cash bond, irrevocable letter of credit, or other means of security acceptable to the Town prior to the issuance of any grading and/or stormwater permit for any land development, redevelopment or major substantial improvement activity. The bond required in this Section shall include provisions relative to forfeiture for failure to complete work specified in the approved stormwater management design plan, compliance with all of the provisions of this Article, other applicable laws and regulations, and any time limitations.~~

E. Stormwater Volume Control

~~Some portion of the stormwater runoff generated on a land development or, redevelopment and major substantial improvement site shall be captured and retained, reused, or otherwise reduced in order to preserve and/or replicate pre-development site hydrology, recharge shallow groundwater aquifers, promote baseflow to on-site and downstream aquatic resources, and minimize the water quality impacts of land development.~~ Applicants shall follow the runoff reduction, peak flow and extreme flood requirements in the *Design Manual*.

F. Stormwater Conveyance Systems

Stormwater conveyance systems, which may include but are not limited to culverts, stormwater drainage pipes, catch basins, drop inlets, junction boxes, headwalls, gutters, swales, channels, ditches, and energy dissipaters, shall be provided when necessary for the protection of public right-of-way and properties adjoining Development sites. Stormwater conveyance systems that are designed to convey stormwater runoff from more than one parcel shall meet the following requirements:

a. Methods used to calculate stormwater runoff rates and volumes shall be in accordance with the latest edition of the *Design Manual*;

b. All culverts, pipe systems, and open channel flow systems shall be sized in accordance with the stormwater management design plan using the methods included in the latest edition of the *Design Manual*; and,

c. Planning and design of stormwater conveyance systems shall be in accordance with the criteria and specifications found in the latest edition of the *Design Manual*.

d. Off-site discharge points in the final approved stormwater plan submission and/or grading ~~permit~~ plan must be identified on the plan. ~~and~~ The receiving conveyance system must be determined ~~and certified by the Applicant Engineer to be adequate by the applicant/engineer~~ to safely convey the 25-year storm, as certified by a licensed South Carolina Engineer, and to not ~~have negative~~ adversely impact ~~on~~ downstream properties.

G. Overbank Flood Protection

All stormwater management systems shall be designed to control the post-development peak discharge generated by the Overbank Flood Protection storm event, as defined in the latest edition of the *Design Manual*, to prevent an increase in the frequency and magnitude of damaging overbank flooding and safely convey the design storms. A stormwater management system complies with this requirement if:

a. It provides Overbank Flood Protection in accordance with the criteria and information provided in the latest edition of the *Design Manual*; and,

b. Appropriate Structural and Nonstructural Stormwater Management Practices have been selected, designed, constructed, and maintained in accordance with the standards, criteria, and information presented in the latest edition of the *Design Manual*.

c. Off-site discharge points in the final approved stormwater plan submission must be identified on the plan. ~~and~~ The receiving conveyance system must be determined ~~and certified by the Applicant Engineer to be adequate by the applicant/engineer~~ to safely convey the 2- to 25-year, 24-hour storm, as certified by a licensed South Carolina Engineer, and to not ~~have negative~~ adversely impact ~~on~~ downstream properties.

H. Extreme Flood Protection

All stormwater management systems shall be designed to control and/or safely convey the post-development peak discharge generated by the Extreme Flood Protection storm event, as defined in the latest edition of the *Design Manual*, to protect downstream properties from flood damage, maintain the boundaries of existing floodplains, and protect the physical integrity of downstream stormwater conveyance features and flood control facilities. A stormwater management system complies with this requirement if:

a. It provides Extreme Flood Protection in accordance with the criteria and information provided in the latest edition of the *Design Manual*;

b. Appropriate Structural and Nonstructural Stormwater Management Practices have been selected, designed, constructed, and maintained in accordance with the standards, criteria, and information presented in the latest edition of the *Design Manual*; and

c. Adequate 100 year flow overflow path (as documented in the 10% analysis submission) from the site to adjacent properties is identified and determined to not have a negative impact on existing downstream receiving conveyance system(s), adjacent properties, and/or structures.~~;~~ This overflow path must be certified by a ~~professional~~ licensed South Carolina Engineer.

I. Structural Stormwater Management Practices

All Structural Stormwater Management Practices shall be selected, designed, constructed, and maintained in accordance with the standards, criteria, and information presented in the latest edition of the *Design Manual* and any relevant addenda. Applicants shall consult the latest edition of the *Design Manual* for guidance on selecting Structural Stormwater Management Practices that can be used to satisfy the post-construction stormwater management criteria.

J. Grading

Mass Grading and Clearing shall not be permitted except in compliance with this Ordinance. No land within the Town shall be cleared, disturbed, graded, excavated, except as follows:

1. It shall be unlawful to perform any Land Disturbance, or land disturbing activity, in excess of 5,000 square feet or create an increase in impervious surface in excess of 2,000 square feet unless a Grading Plan has been submitted to and approved by the Town of Bluffton as provided for herein.

2. A Grading Plan shall be filed with and become part of any Application that equals or exceeds the threshold limits provided above. Such plan shall be prepared in accordance with ~~Article~~ Section 3.3 ~~3.2~~.

3. Amendments to Grading Plans. Amendments, changes or modifications of a minor nature to a plan required as a result of field conditions arising during construction may be ordered or approved by the UDO Administrator.

4. All Grading Plan shall follow the requirements setforth in Article 5 Design Standards.

5. Soil erosion and sediment control measures shall, at a minimum, conform to the Standards for Soil Erosion and Sediment Control per the *Design Manual*.

K. Fee-in-Lieu

A fee-in-lieu may be approved by the UDO Administrator when none or only partial stormwater requirements, as defined in the ~~Article~~ Section and in the *Design Manual*, cannot be attained on the site (due to impractical site characteristics or constraints). A Maximum Extent Practicable analysis shall be required by the applicant for review by the UDO Administrator to make this determination.

L. Waiver

Individuals seeking a waiver from the requirements of this Section ~~Article~~ may submit to the UDO Administrator a request for a waiver in accordance with the *Design Manual*.

5.10.4 Maintenance

A. General Requirements

1. Function of BMPs as Intended. The owner of each structural BMP installed pursuant to this article shall maintain and operate it to preserve and continue its function in controlling stormwater quality and quantity at the degree or amount of function for which the structural BMP was designed.

2. Right of Town to Inspection. Every Structural BMP installed pursuant to this article shall be made accessible for adequate inspection by the Town.

3. ~~Annual~~ Maintenance Inspection and Report. The person responsible for maintenance of any structural BMP installed pursuant to this article shall submit to the UDO Administrator an inspection report from a certified post-construction BMP inspector, a registered South Carolina Professional Engineer, or Landscape Architect. The inspection report, at a minimum, shall contain all of the following:

   a. The name and address of the land owner;

   b. The recorded book and page number of the lot of each structural BMP or a digital representation of the geographic location of each structural BMP;

   c. A statement that an inspection was made of all structural BMPs;

   d. The date the inspection was made;

   e. A statement that all inspected structural BMPs are performing as originally designed/intended and comply with the terms and conditions of the approved maintenance agreement required by this article;

   f. The inspector's original signature and/or seal of the engineer inspecting the structural BMPs; and

   g. Digital photographs of the structural BMPs and pertinent components integral to its operation, including but not limited to inlet/outlet control structures, downstream receiving channel/area, embankments and spillways, safety features, and vegetation.

   h. All inspection reports shall be provided to the UDO Administrator. An original inspection report shall be provided to the UDO Administrator one year from the date of As-Built certification and thereafter every three (3) years on or before the date of the As-Built certification.

B. Operation and Maintenance Agreement

1. Prior to the issuance of stormwater permit requiring a structural BMP pursuant to this article, the applicant or owner of the site must execute an operation and maintenance agreement/covenant for each structural BMP identified on the approved Stormwater Management Plan for recordation in Land Records. The operations and maintenance agreement must be approved by the UDO

Administrator or designee and shall be binding on all subsequent owners of the site, portions of the site, and lots or parcels served by the structural BMP.

2. The operation and maintenance agreement shall:

   a. Require the owner or owners to maintain, repair and, if necessary, reconstruct the structural BMP to ensure the BMP functions as designed and intended in perpetuity.

   b. For each BMP identified on the approved Stormwater Management Plan, state the terms, conditions, and schedule of maintenance for each structural BMP.

   c. Grant to the Town a right of entry to inspect, monitor, maintain, repair, or reconstruct the structural BMP; however, in no case shall the right of entry, of itself, confer an obligation on the Town to assume responsibility for the structural BMP.

   d. Allow the Town to recover from the property or homeowner's association and its members any and all costs the Town expends to maintain or repair the structural BMPs or to correct any operational deficiencies. Failure to pay the Town all of its expended costs, after 45 days written notice, shall constitute a breach of the agreement. The Town shall thereafter be entitled to bring an action against the association and its members to pay, or foreclose upon the lien hereby authorized by the agreement against the property, or both, in case of a deficiency. Interest, collection costs, and attorney fees shall be added to the recovery.

   e. Provide a statement that this agreement shall not obligate the Town to maintain or repair any structural BMPs, and the Town shall not be liable to any person for the condition or operation of structural BMPs.

   f. Provide a statement that this agreement shall not in any way diminish, limit, or restrict the right of the Town to enforce any of its ordinances as authorized by law.

   g. Contain a provision indemnifying and holding harmless the Town for any costs and injuries arising from or related to the structural BMP, unless the Town has agreed in writing to assume the maintenance responsibility for the structural BMPs accepted dedication of all rights necessary to carry out that maintenance.

   h. Contain an attachment with the locations, dimensions, elevations, and characteristics of all structural BMPs detailed in the Stormwater Management Plan. The attachment shall include a north arrow, scale, boundary lines of the site, lot lines, existing and proposed roads and other information necessary to locate the structural BMPs.

3. Operation and Maintenance Agreement Recordation

   Upon approval by the UDO Administrator or his designee, the operations and maintenance agreement shall be recorded with the county Register of Deeds to appear in the chain of title of all subsequent purchasers under generally accepted searching principles. A copy of the recorded operation and maintenance agreement shall be given to the UDO Administrator prior to issuance of the development permit

C. Records of Installation and Maintenance Activities.

The owner of each structural BMP shall keep records of inspections, maintenance, and repairs for at least five years from the date of the record and shall submit the same upon reasonable request to the UDO Administrator.

D. Nuisance.

The owner of each stormwater BMP shall maintain it so as not to create or result in a nuisance condition, such as but not limited to flooding, erosion, excessive algal growth, overgrown vegetation, mosquito breeding habitat, existence of unsightly debris, or impairments to public safety and health.

5.10.6 Illicit Discharges and Connections

Remainder of Current Section 5.10.5 Illicit Discharges and Connections remains unchanged.

D. Spills.

Spills or leaks of polluting substances released, discharged to, or having the potential to released or discharged to a receiving water or the stormwater conveyance system, shall be contained, controlled, collected, and properly disposed. All affected areas shall be restored to their preexisting condition.

Persons in control of the polluting substances shall immediately report the release or discharge to persons owning the property on which the substances were released or discharged, and within two hours of such an event shall notify the Bluffton Township Fire Department and Town of Bluffton Police Department (who will also notify the UDO Administrator), and all required federal and state agencies of the release or discharge. Notification shall not relieve any person of any expenses related to the restoration, loss, damage, or any other liability which may be incurred as a result of said spill or leak, nor shall such notification relieve any person from other liability which may be imposed by State or other law.

5.10.7 Inspections

A. Inspections. The Town is authorized under this Article to perform and require ongoing inspections of stormwater management systems as detailed in the *Design Manual*.

The Town will maintain the right to inspect any and all Stormwater Systems within its jurisdiction as outlined below:

1. An Inspector designated by the UDO Administrator, bearing proper credentials and identification, may enter and inspect all properties for regular inspections, periodic investigations, monitoring, observation measurement, enforcement, sampling and testing, to ensure compliance with the provisions of this article.

2. Upon refusal by any property owner to permit an inspector to enter or continue an inspection, the Inspector may terminate the inspection or confine the inspection to areas concerning which no objection is raised. The Inspector shall immediately report the refusal and the grounds to the UDO Administrator. The UDO Administrator will promptly seek the appropriate compulsory process.

3. In the event that the UDO Administrator or Inspector reasonably believes that discharges from the property into the Town's Stormwater System or receiving waters may cause an imminent and substantial threat to human health or the environment, the inspection may take place at any time after an initial attempt to notify the owner of the property or a representative on site. The

Inspector shall present proper credentials upon reasonable request by the owner or representative. Inspection reports will be maintained in a permanent file at the offices of the Town.

B. Construction Inspections. The Town is authorized under this ~~Article~~ Section to perform construction inspections including, but not limited to~~,~~ preconstruction, preclearing, and construction sequence inspections as detailed in the *Design Manual*. The Town is authorized under this ~~Article~~ Section to perform final construction inspections and require As-Built plans for all permanent stormwater management practices as detailed in the *Design Manual*.

C. Post-construction Inspections. The Town is authorized under this ~~Article~~ Section to perform post-construction inspections and require ongoing maintenance of stormwater management systems as detailed in the *Design Manual*.

5.10.8 Violations, Enforcement, and Penalties

The Town is authorized under this Article to enforce the provisions of this Article as described in UDO Article 8 Penalties and Enforcement. Any action or inaction that violates the provisions of this Article or the requirements of an approved stormwater management design plan, stormwater management inspection and maintenance agreement and plan, or permit may be subject to the enforcement actions. Any such action or inaction that is continuous with respect to time is deemed to be a public nuisance and may be abated by injunctive or other equitable relief.

9.0 Definitions and Interpretation

9.2 Defined Terms

All words and phrases shall have their ordinary and customary meanings unless the context of the word or phrase indicates otherwise. The following terms shall have the meaning given below, unless the context of the use of the term clearly indicates otherwise based on the purposes, intent, design objective or other guidance associated with its use in a particular section.

100 Year Flood: The storm, flood or level of floodwater measured from mean sea level from large low-frequency storm events that has a one percent chance of being equaled or exceeded in any given year.

As-built/Record Drawings: A set of drawings prepared by and certified by a South Carolina registered professional engineer~~,~~ that accurately represent~~s~~ the actual final configuration, locations, site grading, elevations, excavated/constructed dimensions~~,~~ (depths, lengths, widths~~,~~ ~~(~~to verify if constructed volumes meet or exceed design volumes), materials, landscaping of the stormwater systems, and BMPs and other related infrastructure constructed in a development.

Best Management Practices (BMP): Stormwater management practices, either structural, nonstructural or natural that have been demonstrated to effectively control movement of pollutants, prevent degradation of environmental and water resources, especially by reducing runoff volume and the pollutant loads carried in that runoff, and that are compatible with the planned land use.

Better Site Design: Site design techniques that can be used during the site design process to minimize the creation of new impervious cover and reduce a site's impact on the watershed. Better site design techniques include reduced clearing and grading limits, roadway lengths and widths, and parking lot and building footprints.

Better Site Planning: Site planning techniques that can be used during the site planning process to protect and conserve natural areas that are critical in preserving pre-development site hydrology and reducing a site's impact on the watershed. Better site planning techniques include conserving significant stands of trees and other vegetation, natural drainage features, and riparian buffers.

Building: Any structure, either temporary or permanent, used or intended for supporting or sheltering any use or occupancy. Each portion of a building separated from other portions by a firewall shall be considered as a separate building.

Caliper: The width of a tree trunk as measured six (6) inches above the root ball.

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

Clearing: The cutting or removal of trees or other vegetation as regulated by the Town of Bluffton Tree Conservation, Planting, and Landscaping standards (Article 5.3).

Clear–cutting: The complete or nearly complete removal of trees and understory within the proposed disturbed land area and/or limit of lot grading area of a development site or forestry activity.

Detention: The collection and temporary storage of surface water or stormwater runoff for subsequent controlled discharge at a rate that is less than the rate of inflow.

Developer: A person who undertakes land development or redevelopment activities.

Development: The performance of any building or mining operation; the making of any material; change in the use of any structure or land; or the division of land into two or more parcels. The following specific activities or uses shall be categorized as Development, Redevelopment and/or Major Substantial Improvements:

A. A material change in type of use of a structure or land which would tangibly affect the area's natural environment, drainage, transportation patterns, public health, or economic values;
B. A building operation involving construction, reconstruction, or alteration of the size of a structure which would result in a tangible effect on the area's natural environment, transportation patterns, public health, or economic values;
C. A material increase in the intensity of land use, such as an increase in the number of businesses, manufacturing establishments, offices, or dwelling units in a structure or on land; when such increase would tangibly affect the area's natural environment, transportation patterns, public health, or economic values;
D. Subdivision of a parcel or tract of land into two or more lots, parcels, or pieces for the purpose of sale or transfer of title;
E. Commencement of any mining operation on a parcel of land;
F. In connection with the use of land, the making of any material, change in noise levels, thermal conditions, or emissions of waste materials;
G. Alteration of a shore, bank, or flood plain of a seacoast, river, stream, lake, or other natural water body;
H. Reestablishment of a use which has been abandoned for one year; ~~and~~
I. Construction of major electrical and telephone utility lines over three-fourths of a mile in length and involving tree removal, construction of any utility line substation, or construction of any utility line crossing wetlands;
J. Any change in land cover, including, but not limited to, clearing, digging, grubbing, stripping, removal of vegetation, dredging, grading, excavating, filling, and paving, that alters the hydrologic response of local watersheds; and

The following operations or uses do not constitute development for the purpose of this Ordinance:

A. The construction of any public street or other public way, grounds, buildings, Town of Bluffton Unified Development Ordinance 9-7 structures, or facilities. Such public project Development Plans are submitted and reviewed for approval under a separate administrative procedure;
B. Work for the maintenance, renewal, improvement, or alteration, of any structure, if the work affects only the interior or the color of the structure, or decoration of the exterior of the structure;
C. The use of any structure or land devoted to dwelling uses for any purposes customarily incidental to enjoyment of the dwelling;
D. The use of any land for the purpose of growing plants, crops, trees, or for other agricultural purposes;
E. A transfer of title to land not involving the division of land into parcels;
F. The division of land into parcels of five acres or more where no improvements are involved;
G. The division of land into parcels for conveyance to other persons through the provisions of a will or similar document and in the settlement of an intestate's estate;

H. The division of land into lots for the purpose of sale or transfer to members of one's own immediate family, where no new street is involved, is exempt from the standard submission and review procedures;
I. The combination or recombination of portions of previously platted lots where the total number of lots is not increased and the resultant lots are equal to the standards of the governing authority;
J. The recordation of a plat of land or property for purposes other than the sale or transfer of title to land including:
   1. The creation or termination of mortgages, leases, easements, or liens;
   2. Lot line corrections on existing recorded properties;
   3. The creation, termination, or amendment of private covenants or restrictions on land;
   4. Property trades or swaps between immediately adjacent landowners not resulting in the creation of new parcels of record; and
   5. Division of land for the purpose of sale or transfer to an immediately adjacent landowner for the sole purpose of enlarging the adjacent landowner's property and not resulting in the creation of new parcels.

Easement: An interest in land of another that entitles the holder to a specified limited use.

Erosion and Sedimentation Control Plan: A plan that is designed to minimize the accelerated erosion and sediment runoff at a site during land development or redevelopment activities.

Existing Conditions: Land use and land cover conditions at the time of a land development or redevelopment permit application.

Extreme Flood Protection: Stormwater control measures taken to prevent adverse impacts from large low-frequency storm events that have a one percent chance of being equaled or exceeded in any given year.

Fee-in-lieu: A payment collected by approval of the UDO Administrator as an alternative to meeting the requirements of onsite stormwater control facilities and/or tree conservation.

Flooding: A volume of surface water that cannot be confined within the banks or walls of a conveyance or stream channel and that overflows onto adjacent lands.

Grading: Any activity involving the clearing, grading, transporting, filling or excavation of land, stump removal or any other activity which causes land to be exposed to danger of erosion.

Grading Plan: A plan that depicts existing and proposed elevations, contours and drainage which meets or exceeds the standards for soil erosion and sediment control as outlined in the Southern Lowcountry Stormwater Design Manual.

Greenspace: As pertaining to Stormwater, permanently protected area(s) of the site that are preserved in a natural state.

Hydrologic Soil Group (HSG): 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: Those streams, rivers and lakes that currently do not meet their designated use classification and associated water quality standards and as identified in the Clean Water Act Section 303(d) list by the South Carolina Department of Health and Environmental Control.

Impervious Surface: A surface compacted or composed of any material that impedes or prevents the passive, natural infiltration of water into soil. Impervious surfaces include, but are not limited to, rooftops, buildings, streets, roads, and compacted stone or gravel, except those designed specifically to provide active, engineered infiltration.

Infill Development: 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: The process of percolating stormwater runoff into the subsoil.

Infiltration Practice: Any stormwater management practice designed to provide active, engineered infiltration of retained water to the subsurface. These stormwater management practices may be above or below grade.

Inspection and Maintenance Agreement and Covenant: A written agreement and covenant providing for the long-term inspection and maintenance of stormwater management facilities and practices on a site or with respect to a land development or redevelopment project, which when properly recorded in the deed records constitutes a restriction on the title to a site or other land involved in a development project.

Land Disturbance or Land Disturbing Activity: The use of land by any person that results in a change in the natural vegetated cover or topography, including clearing vegetation that may contribute to or alters the quantity and/or quality of stormwater runoff.

Larger Common Plan of Development: A common plan for development or sale. It identifies a site where multiple separate and distinct construction activities (areas of disturbance) are occurring on contiguous areas. Such sites may have one operator or owner or several operators and owners. Construction activities may take place at different times on different schedules, in separate stages, and/or in separate phases, and/or in combination with other construction activities. Each developer, operator or owner for each site or project determined to be a part of a larger common plan of development are subject to land development approval and permitting requirements as defined herein and the *Southern Lowcountry Stormwater Design Manual*.

Limits of Disturbance (LOD): The outermost boundary of the area planned to be disturbed by construction, grading, grubbing, landscaping, excavating, filling, plowing, tilling, or stockpiling of material as indicated by the approved design plan.

Low Impact Development: Small-scale, distributed stormwater management practices that can be used during the site design process to replicate existing hydrologic conditions, help offset the creation of new impervious cover, and reduce impact on the watershed.

Maintenance: Any action necessary to preserve stormwater management facilities in proper working condition, in order to serve the intended purposes and meet original design intent set forth in this article and to prevent structural failure of such facilities.

Major Substantial Improvement: Specific to stormwater, a renovation or addition to a structure that meets the following cost and size thresholds: a) construction costs for the building renovation/addition are greater than or equal to 50% of the pre-project assessed value of the structure as developed using current Building Valuation Data of the International Code Council, and b) combined footprint of structure(s) exceeding the cost threshold and any land disturbance is greater than or equal to 5,000 square feet.

Mass Grading: The movement of earth by mechanical means to alter the gross topographic features (elevations, slopes, etc.) to prepare a site for final grading and the construction of facilities (buildings, roads, parking, etc.).

Maximum Extent Practicable (MEP): The extent of efforts to comply with the post-construction stormwater management requirements.

Nonpoint Source Pollution: A form of water pollution that does not originate from a discrete point, such as a sewage treatment plant or industrial discharge, but involves the transport of pollutants, such as sediment, fertilizers, pesticides, heavy metals, oil, grease, bacteria, nutrients, organic materials, and other contaminants from land to surface water and groundwater via mechanisms such as precipitation, stormwater runoff and leaching. Nonpoint source pollution is a by-product of land use practices, such as agriculture, silviculture, mining, construction, subsurface disposal, suburban and urban runoff.

Nonstructural Stormwater Management Practice or **Nonstructural Practice**: Any natural or planted vegetation or other nonstructural component of the stormwater management plan that provides for or enhances stormwater quantity and/or quality control or other stormwater management benefits and includes, but is not limited to, riparian buffers, open and greenspace areas, overland flow filtration areas, natural depressions, and vegetated channels.

Overbank Flood Protection: Measures taken to prevent an increase in the frequency and magnitude of out-of-bank flooding (i.e. flow events that exceed the capacity of the channel and enter the floodplain) and that are intended to protect downstream properties from flooding for the 2-year through 25-year frequency storm events.

Post-development: The time period or the conditions that may reasonably be expected or anticipated to exist, after completion of the land development or redevelopment activity on a site.

Pre-development: The time period or the conditions that exist, on a site prior to land development. For the purpose of determining pre-development surface runoff conditions, it is assumed that predevelopment is meadow conditions.

Project: A land development, major substantial improvement, or redevelopment project.

Recharge: The replenishment of groundwater aquifers.

Redevelopment: As pertains to stormwater, change to previously existing, improved property, including but not limited to the 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 Facility or **Regional Facility**: Stormwater management facilities designed to control stormwater runoff from multiple properties, where the owners or developers of the individual properties may assist in the financing of the facility and the requirement for on-site controls in the contributing drainage area is either eliminated or reduced.

Riparian Buffer: An area of land at or near a streambank, wetland, or waterbody that has intrinsic water quality value due to the ecological and biological processes it performs or is otherwise sensitive to changes which may result in significant degradation of water quality.

Runoff: Stormwater runoff.

Runoff Reduction: The total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainwater harvesting, engineered filtration, or extended filtration.

Special Watershed Protection Area: A watershed or drainage catchment designated by the Town to provide specific stormwater management requirements beyond those established in the *Southern Lowcountry Stormwater Design Manual* for the general three watershed protection areas of the Southern Lowcountry.

Stop Work Order: An administrative order that requires development activity on a site to be stopped. The extent of the stop work order is determined by the UDO Administrator and is identified in accompanying details of each Order.

Stormwater: Stormwater runoff, precipitation runoff, and surface runoff.

Stormwater Hotspot: An area where land use or activities generate highly contaminated runoff with concentrations of pollutants in excess of those typically found in stormwater runoff. The following operations are examples of, but not limited to, stormwater hot spots in this ordinance: car washes, industrial sites, auto repair shops, parking garages, vehicle fueling and storage areas, golf courses, marinas, and transportation equipment repair facilities.

Stormwater Management: The collection, conveyance, storage, treatment, and disposal of stormwater runoff in a manner intended to prevent increased flood damage, streambank channel erosion, habitat degradation, and water quality degradation, and to enhance and promote the public health, safety, and general welfare.

Stormwater Management Facility: Any infrastructure that controls or conveys stormwater runoff.

Stormwater Management Plan (SWMP): The set of drawings and other documents that comprise all of the information and specifications for the programs, drainage systems, Stormwater Management Systems, structures, BMPs, concepts, and techniques for the control of stormwater.

Stormwater Retrofit: A stormwater management practice designed for an existing development site that previously had either no stormwater management practice in place or a practice inadequate to meet the requirements of the *Southern Lowcountry Stormwater Design Manual*.

Structural Stormwater Management Practice: A structural stormwater management facility or device that controls stormwater runoff and changes the characteristics of that runoff including, but not limited to, the quantity and quality, the period of release, or the velocity of flow of such runoff.

Surety: A financial guarantee in the form of a letter of credit, bond, cash or other form as may be accepted by the UDO Administrator that ensures he completion of all required improvement per approved plan.

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

Watershed Management Plan: A document, usually developed cooperatively by government agencies and other stakeholders, to protect, restore, and/or otherwise manage the water resources within a particular watershed or subwatershed. The plan commonly identifies threats, sources of impairment, institutional issues, and technical and programmatic solutions or projects to protect and/or restore water resources.

Watershed Protection Area: A watershed or drainage catchment designated in the *Southern Lowcountry Stormwater Design Manual* with specific stormwater management requirements that are intended to enhance the quality of development, protect and enhance stormwater quality and management, protect aquatic resources from the negative impacts of land development process, address water quality impairments or a total maximum daily load, as identified by the South Carolina Department of Health and Environmental Control (DHEC), or address localized flooding issues.

ATTACHI
Recommended Motion

RECOMMENDED MOTION LANGUAGE

"I make a motion to approve Second and Final Reading of Amendments to the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 3 – Application Process, Article 5 – Design Standards, Sec. 5.10 Stormwater Management, and Article 9 – Definitions and Interpretation Related to Adoption of the Southern Lowcountry Post Construction Stormwater Ordinance and *Southern Lowcountry Stormwater Design Manual*."

TOWN COUNCIL

STAFF REPORT
Department of Growth Management

MEETING DATE:	February 9, 2021
PROJECT:	Consideration of Amendments to the Town of Bluffton Code of Ordinances, Chapter 19 – Flood Damage Protection, Specifically as it Relates to the Updates to the National Floodplain Insurance Program Regulations and FEMA's Re-evaluation of Flood Hazards in the Town of Bluffton Reflected in Updated Flood Insurance Rate Maps – Second and Final Reading
PROJECT MANAGER:	Heather Colin, AICP Director of Growth Management

REQUEST: Approve Second and Final Reading of an Ordinance to amend the Town of Bluffton Code of Ordinances, Chapter 19 – Flood Damage Protection, Specifically as it Relates to the Updates to the National Floodplain Insurance Program (NFIP) Regulations and FEMA's Re-evaluation of Flood Hazards in the Town of Bluffton Reflected in Updated Flood Insurance Rate Maps.

Town Council made a motion to approve the proposed Amendments to the Code of Ordinances, Chapter 19, Flood Damage Protection on January 12, 2021.

No changes have been made since First Reading.

BACKGROUND: FEMA recently completed a reevaluation of flood hazards in the community. On June 30, 2017 and August 9, 2019, FEMA provided the Town with preliminary and revised preliminary copies of the Flood Insurance Study (FIS) and FIRM that identify existing flood hazards. Both the required publication and appeals periods have been met and the FIRM for Bluffton will become effective on March 23, 2021.

Because the FIS report establishing the flood hazard determinations has been completed, certain additional requirements must be met under the National Flood Insurance Act of 1968 as *amended no later than March 23, 2021*. The required amendments were outlined by the Flood Mitigation Specialist and are included in attachment 4.

PROPOSED AMENDMENTS: The proposed amendments incorporate the required amendments identified the Flood Mitigation Specialist from the South Carolina Department of Natural Resources and included in attachment 4.

In addition to the minimum amendments required by FEMA for eligibility in the NFIP, staff is proposing that the current requirement of a one foot freeboard be increased to a three foot freeboard for all construction. Freeboard is defined as the factor of safety usually expressed in feet above a flood level for purposes of flood plain management.

The purpose of freeboard is as follows:

- Reduces flood losses in the habitable portion of homes so that citizens can return home faster;
- Benefits citizens as they will receive improved flood insurance rates;
- Most of Bluffton's construction located in the special hazard flood zones are new construction areas with no unregulated areas affected; and
- With the additional 2 feet of freeboard recommended there should be less drastic height deviations between new and existing construction.

The Town of Bluffton currently has multiple elevation requirements varying from 12 to 16 feet depending on the location. The current base flood elevation (BFE) required on the current maps (FIRM) is 11 to 15 feet. The FIRMs effective March 23, 2021 BFE varies from five to nine feet.

Currently approximately five percent of the land area in Bluffton is located within a special flood zone. Upon the effective date of the FIRM, it will decrease to approximately three percent.

NEXT STEPS: Should Town Council approve the First Reading of the Ordinance, a Second Reading is anticipated at the February 9, 2021 Town Council meeting. The revised FIRMs will be effective March 23, 2021.

ATTACHMENTS:

1. Presentation
2. Proposed Ordinance
3. Correspondence from FEMA dated September 23, 2020
4. Audit of Current Regulations
5. Maps
6. Proposed Motion

Consideration of Amendments to the Town of Bluffton Code of Ordinances, Chapter 19 – Flood Damage Protection, Specifically as it Relates to the Updates to the National Floodplain Insurance Program Regulations and FEMA's Re-evaluation of Flood Hazards in the Town of Bluffton Reflected in Updated Flood Insurance Rate Maps – Second and Final Reading

Presentation to Town Council
February 9, 2021
Department of Growth Management
Heather Colin, AICP, Director of Growth Management

Introduction

- FEMA recently completed a reevaluation of flood hazards in the community.
- On June 30, 2017 and August 9, 2019, FEMA provided the Town with preliminary and revised preliminary copies of the Flood Insurance Study (FIS) and FIRM that identify existing flood hazards.
- Both the required publication and appeals periods have been met and the FIRM for Bluffton will become effective on March 23, 2021.

Town Council Action

- Town Council approved the proposed Amendments to the Ordinance on January 12, 2021.

- No changes were made to the proposed Amendments since First Reading.

Introduction

- Because the FIS report establishing the flood hazard determinations has been completed, certain additional requirements must be met under the National Flood Insurance Act of 1968 as ***amended no later than March 23, 2021***.
- The required amendments were outlined by the Flood Mitigation Specialist and are included in the proposed Ordinance.

Proposed Amendments

- The proposed amendments incorporate the required amendments identified the Flood Mitigation Specialist from the South Carolina Department of Natural Resources; and
- The current 1 foot of freeboard is proposed to increase to 3 feet for all new construction.

Freeboard

- The factor of safety usually expressed in feet above a flood level for purposes of flood plain management.

- The purpose of freeboard is as follows:
  - Reduces flood losses in the habitable portion of homes so that citizens can return home faster;
  - Benefits citizens as they will receive improved flood insurance rates;
  - Most of Bluffton’s construction located in the special hazard flood zones are new construction areas with no unregulated areas affected; and
  - With the additional 2 feet of freeboard recommended there should be less drastic height deviations between new and existing construction.

QUESTIONS?

Proposed Motion

"I move to approve the Proposed Ordinance Amending the Town of Bluffton Code of Ordinances, Chapter 19 – Flood Damage Protection, Specifically as it Relates to the Updates to the National Floodplain Insurance Program Regulations and FEMA's Re-evaluation of Flood Hazards in the Town of Bluffton Reflected in Updated Flood Insurance Rate Maps"

ORDINANCE NO. 2021 – _____

TOWN OF BLUFFTON, SOUTH CAROLINA

AN ORDINANCE AMENDING THE TOWN OF BLUFFTON'S MUNICIPAL CODE OF ORDINANCES, CHAPTER 19 – FLOOD DAMAGE PROTECTION, SPECIFICALLY AS IT RELATES TO THE UPDATES TO THE NATIONAL FLOODPLAIN INSURANCE PROGRAM REGULATIONS AND FEMA'S RE-EVALUATION OF FLOOD HAZARDS IN THE TOWN OF BLUFFTON REFLECTED IN UPDATED FLOOD INSURANCE RATE MAPS

WHEREAS, the Town of Bluffton desires to improve the general safety, welfare, health and properties of the citizens of the Town of Bluffton; and,

WHEREAS, to establish the necessary provisions to accomplish the above, the Town of Bluffton has authority to enact resolutions, ordinances, regulations, and procedures pursuant to South Carolina Code of Laws; and,

WHEREAS, on December 18, 1986, the Department of Homeland Security's Federal Emergency Management Agency (FEMA) issued a Flood Insurance Rate Map (FIRM) that identified the SFHAs, the areas subject to inundation by the base (1 percent annual chance) flood in the Community;

WHEREAS, the Town of Bluffton initially adopted a Flood Damage and Prevention Ordinance on August 3, 1993; and

WHEREAS, the Town of Bluffton desires to be in compliance with all flood requirements as promulgated by the Federal Emergency Management Act and the Federal Emergency Management Agency (FEMA); and

WHEREAS, the Town of Bluffton adopted the Flood Damage Prevention Ordinance, effective January 5, 2009 to be in compliance with the National Flood Insurance Program (NFIP); and

WHEREAS, in order to continue the Town's eligibility in the NFIP, the Town must adopt floodplain management regulations that meet the standards of the NFIP regulations by the March 23, 2021, the effective date of the FIRM; and

WHEREAS, the Town of Bluffton Town Council desires to amend the Consideration of Amendments to the Town of Bluffton Code of Ordinances, Chapter 19 – Flood Damage Protection, Specifically as it Relates to the Updates to the National Floodplain Insurance Program Regulations and FEMA's Re-evaluation of Flood Hazards in the Town of Bluffton Reflected in Updated Flood Insurance Rate Maps

NOW, THEREFORE, BE IT ORDERED AND ORDAINED BY THE TOWN COUNCIL OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, in accordance with the foregoing, the Town hereby amends the Code of Ordinances for the Town of Bluffton, Chapter 19, Flood Damage Protection:

SECTION 1. AMENDMENT. The Town of Bluffton hereby amends the Code Ordinances for the Town Of Bluffton, South Carolina by adopting and incorporating amendments to Chapter 19 – Flood Damage Protection, as shown on Exhibit A attached hereto and fully incorporated herein by reference.

SECTION 2. Adoption of the current effective FIS report and FIRM to which the regulations apply and other modifications made by the map revisions.

SECTION 3. REPEAL OF CONFLICTING ORDINANCES. All ordinances or parts of ordinances inconsistent with this Ordinance are hereby repealed to the extent of such inconsistency.

SECTION 4. ORDINANCE IN FULL FORCE AND EFFECT. This entire Ordinance shall take full force and effect ______________, 2021.

DONE, RATIFIED AND ENACTED this ______ day of _____________, 2021.

This Ordinance was read and passed at first reading on January 12, 2021.

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

____
Kimberly Chapman
Town Clerk, Town of Bluffton, South Carolina

Second and Final Reading was held on this Ordinance on ______________, 2021.

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

____
Kimberly Chapman
Town Clerk, Town of Bluffton, South Carolina

This Ordinance was passed at second reading held on ____________, 2021.

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

____
Kimberly Chapman
Town Clerk, Town of Bluffton, South Carolina

Chapter 19 - FLOOD DAMAGE PREVENTION

ARTICLE I. - GENERAL STANDARDS

Sec. 19-1. - Statutory authorization—Municipality.

The Legislature of the State of South Carolina has in SC Code of Laws, Title 5~~,~~ ~~Chapters 7, 23, and 25 (Articles 5 and 7)~~ and Title 6, ~~Chapter 7,~~ and amendments thereto, delegated the responsibility to local governmental units to adopt regulations designed to promote the public health, safety, and general welfare of its citizenry. Therefore, Town ~~Council of The Town~~ of Bluffton, South Carolina does ordain as follows:

Sec. 19-2. - Findings of fact.

The special flood hazard areas of the Town of Bluffton are subject to periodic inundation which could result in loss of life, property, health and safety hazards, disruption of commerce and governmental services, extraordinary public expenditures of flood protection and relief, and impairment of the tax base, all of which adversely affect the public health, safety, and general welfare.

Furthermore, these flood losses may be caused by the cumulative effect of obstructions in floodplains causing increases in flood heights and velocities, and by the occupancy in flood hazard areas by uses vulnerable to floods or hazardous to other lands which are inadequately elevated, floodproofed, or otherwise unprotected from flood damages.

Sec. 19-3. - Statement of purpose and objectives.

It is the purpose of this chapter to protect human life and health, minimize property damage, and encourage appropriate construction practices to minimize public and private losses due to flood conditions by requiring that uses vulnerable to floods, including facilities which serve such uses, be protected against flood damage at the time of initial construction. Uses of the floodplain which are dangerous to health, safety, and property due to water or erosion hazards, or which increase flood heights, velocities, or erosion are restricted or prohibited. These provisions attempt to control the alteration of natural floodplains, stream channels, and natural protective barriers which are involved in the accommodation of flood waters, and control filling, grading, dredging and other development which may increase flood damage or erosion. Additionally, the ordinance prevents or regulates the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards to other lands.

The objectives of this ordinance are to protect human life and health, to help maintain a stable tax base by providing for the sound use and development of flood-prone areas in such a manner as to minimize flood blight areas, and to ensure that potential home buyers are notified that property is in a flood area. The provisions of the ordinance are intended to minimize damage to public facilities and utilities such as water and gas mains, electric, telephone, and sewer lines, streets and bridges located in the floodplain, and prolonged business interruptions. Also, an important floodplain management objective of this ordinance is to minimize expenditure of public money for costly flood control projects and rescue and relief efforts associated with flooding.

Floodplains are an important asset to the community. They perform vital natural functions such as temporary storage of floodwaters, moderation of peak flood flows, maintenance of water quality, groundwater recharge, prevention of erosion, and habitat for diverse natural wildlife populations, recreational opportunities, and aesthetic quality. These functions are best served if floodplains are kept in their natural state. Wherever possible, the natural characteristics of floodplains and their associated wetlands and water bodies should be preserved and enhanced. Decisions to alter floodplains, especially floodways and stream channels, should be the result of careful planning processes that evaluate resource conditions and human needs.

Sec. 19-4. - Lands to which this chapter applies.

This chapter shall apply to all areas of special flood hazard within the jurisdiction of the Town of Bluffton as identified by the Federal Emergency Management Agency in its Flood Insurance Study, dated March 23, 2021~~December 18, 1986~~, as amended and updated, with accompanying maps and other supporting data that are hereby adopted by reference and declared to be a part of this chapter. Upon annexation any special flood hazard areas identified by the Federal Emergency Management Agency in its Flood Insurance Study for the unincorporated areas of Beaufort County, with accompanying map and other data are adopted by reference and declared part of this chapter.

Sec. 19-5. - Establishment of development permit.

A development permit shall be required in conformance with the provisions of this chapter prior to the commencement of any development activities (excluding single family structures that require a building permit and that do not require a development permit).

Sec. 19-6. - Compliance.

No structure or land shall hereafter be located, extended, converted, or structurally altered without full compliance with the terms of this chapter and other applicable regulations.

Sec. 19-7. - Interpretation.

In the interpretation and application of this chapter all provisions shall be considered as minimum requirements, liberally construed in favor of the governing body, and deemed neither to limit nor repeal any other powers granted under State law. This chapter is not intended to repeal, abrogate, or impair any existing easements, covenants, or deed restrictions. However, where this chapter and another conflict or overlap, whichever imposes the more stringent restrictions shall prevail.

Sec. 19-8. - Partial invalidity and severability.

If any part of this chapter is declared invalid, the remainder of the chapter shall not be affected and shall remain in force.

Sec. 19-9. - Warning and disclaimer of liability.

The degree of flood protection required by this chapter is considered reasonable for regulatory purposes and is based on scientific and engineering consideration. Larger floods can and will occur on rare occasions. Flood heights may be increased by man-made or natural causes. This chapter does not imply that land outside the areas of special flood hazard or uses permitted within such areas will be free from flooding or flood damages. This chapter shall not create liability on the part of the Town of Bluffton or by any officer or employee thereof for any flood damages that result from reliance on this chapter or any administrative decision lawfully made hereunder.

Sec. 19-10. - Penalties for violation.

Violation of the provisions of this chapter or failure to comply with any of its requirements, including violation of conditions and safeguards established in connection with grants of variance or special exceptions, shall constitute a misdemeanor. Any person who violates this chapter or fails to comply with any of its requirements shall, upon conviction thereof, be fined not more that $500.00 per violation or imprisoned for not more than 30 days, or both. Each day the violation continues shall be considered a separate offense. Nothing herein contained shall prevent the Town of Bluffton from taking such other lawful action as is necessary to prevent or remedy any violation.

Secs. 19-11—19-20. - Reserved.

Article II. - DEFINITIONS

Sec. 19-21. - General.

Unless specifically defined below, words or phrases used in this chapter shall be interpreted so as to give them the meaning they have in common usage and to give this chapter its most reasonable application.

Accessory Structure.Structures that are located on the same parcel of property as the principal structure and the use of which is incidental to the use of the principal structure. ~~Garages, carports and storage sheds are common urban accessory structures. Pole barns, hay sheds and the like qualify as accessory structures on farms, and may or may not be located on the same parcel as the farm dwelling or shop building.~~ Accessory Structures should constitute a minimal investment, may not be used for human habitation, and be designed to have minimal flood damage potential. Examples of accessory structures are detached garages, carports, storage sheds, pole barns, and hay sheds.

Addition (to an existing building). An extension or increase in the floor area or height of a building or structure. Additions to existing buildings shall comply with the requirements for new construction regardless as to whether the addition is a substantial improvement or not. Where a firewall or load-bearing wall is provided between the addition and the existing building, the addition(s) shall be considered a separate building and must comply with the standards for new construction.

Agricultural structure. A structure used solely for agricultural purposes in which the use is exclusively in connection with the production, harvesting, storage, drying, or raising of agricultural commodities, including the raising of livestock. Agricultural structures are not exempt from the provisions of this chapter.

Appeal. A request for a review of the local administrator's interpretation of any provision of this chapter.

Area of shallow flooding. A designated AO or VO Zone on a community's Flood Insurance Rate Map (FIRM) with base flood depths of one to three feet where a clearly defined channel does not exist, where the path of flooding is unpredictable and indeterminate, and where velocity flow may be evident.

Area of special flood hazard. The land in the floodplain within a community subject to a one percent or greater chance of being equaled or exceeded in any given year.

Base flood. The flood having a one percent chance of being equaled or exceeded in any given year.

Basement. Any enclosed area of a building that is below grade on all sides.

Building - ~~any structure built for support, shelter, or enclosure for any occupancy or storage.~~ See structure

Coastal high hazard area. An area of special flood hazard extending from offshore to the inland limit of the primary frontal dune along an open coast and any other area subject to velocity wave action from storms or seismic sources.

Critical development. Development that is critical to the community's public health and safety, is essential to the orderly functioning of a community, store or produce highly volatile, toxic or water-reactive materials, or house occupants that may be insufficiently mobile to avoid loss of life or injury. Examples of critical development include jails, hospitals, schools, fire stations, nursing homes, wastewater treatment facilities, water plants, and gas/oil/propane storage facilities.

Development. Any man-made change to improved or unimproved real estate, including, but not limited to, buildings or other structures, mining, dredging, filling, grading, paving, excavation or drilling operations, or storage of equipment or materials.

Elevated building. A non-basement building built to have the lowest floor elevated above the ground level by means of fill, solid foundation perimeter walls, pilings, columns, piers, or shear walls parallel to the flow of water.

Executive Order 11988 (Floodplain Management). Issued by President Carter in 1977, this order requires that no federally assisted activities be conducted in or have the potential to affect identified special flood hazard areas, unless there is no practicable alternative.

Existing construction. Means, for the purposes of determining rates, structures for which the start of construction commenced before the effective date of the FIRM, or before September 30, 1977, for FIRMs effective before that date.

Existing manufactured home park or manufactured home subdivision. A manufactured home park or subdivision for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including, at a minimum, the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete pads) is completed before December 18, 1986.

Expansion to an existing manufactured home park or subdivision. The preparation of additional sites by the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including the installation of the utilities, the construction of the streets, and either final site grading or the pouring of concrete slabs).

Flood. A general and temporary condition of partial or complete inundation of normally dry land areas from the overflow of inland or tidal waters, or the unusual and rapid accumulation of runoff of surface waters from any source.

Flood Hazard Boundary Map (FHBM). An official map of a community, issued by the Federal Emergency Management Agency, where the boundaries of the areas of special flood hazard have been defined as Zone A.

Flood Insurance Rate Map (FIRM). An official map of a community, on which the Federal Emergency Management Agency has delineated both the areas of special flood hazard and the risk premium zones applicable to the community.

Flood Insurance Study. The official report provided by the Federal Emergency Management Agency~~. The report~~ which contains flood profiles, as well as the Flood Boundary Floodway Map and the water surface elevation of the base flood.

Flood-resistant material. Any building material capable of withstanding direct and prolonged contact (minimum 72 hours) with floodwaters without sustaining damage that requires more than low-cost cosmetic repair. Any material that is water-soluble or is not resistant to alkali or acid in water, including normal adhesives for above-grade use, is not flood-resistant. Pressure-treated lumber or naturally decay-resistant lumbers are acceptable flooring materials. Sheet-type flooring coverings that restrict evaporation from below and materials that are impervious, but dimensionally unstable are not acceptable. Materials that absorb or retain water excessively after submergence are not flood-resistant. Please refer to Technical Bulletin 2~~-93~~, *Flood Damage-Resistant Materials Requirements,* ~~*for Buildings Located in Special Flood Hazard Areas in Accordance with the National Flood Insurance Program*, document number FIA-TB-2,~~ dated ~~4/93~~ 8/08, and available from the Federal Emergency Management Agency. Class 4 and 5 materials, referenced therein, are acceptable flood-resistant materials.

Floodway. The channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.

Freeboard. A factor of safety usually expressed in feet above a flood level for purposes of flood plain management. "Freeboard" tends to compensate for the many unknown factors that could contribute to flood heights greater than the height calculated for a selected size flood and floodway conditions, such as wave action, bridge openings, and the hydrological effect of urbanization of the watershed.

Functionally dependent ~~facility~~ use. A ~~facility~~ use which cannot ~~be used~~ perform ~~for~~ its intended purpose unless it is located or carried out in close proximity to water. ~~such as a~~ The term includes only docking facilities, ~~or~~ port facility necessary for the loading and unloading of cargo or passengers, and shipbuilding and ship repair facilities~~,~~ or seafood processing facilities. The term does not include long-term storage, manufacture, sales, or service facilities.

Highest adjacent grade. The highest natural elevation of the ground surface, prior to construction, next to the proposed walls of the structure.

Historic Structure. Any structure that is: (a) listed individually in the National Register of Historic Places (a listing maintained by the U.S. Department of the Interior (DOI)) or preliminarily determined by the Secretary of the Interior as meeting the requirements for individual listing on the National Register; (b) certified or preliminarily determined by the Secretary of the Interior as contributing to the historical significance of a registered historic district or a district preliminarily determined by the Secretary to qualify as a registered historic district; (c) individually listed on a State inventory of historic places; (d) individually listed on a local inventory of historic places in communities with historic preservation programs ~~as determined~~ that have been certified (1) by the Secretary of Interior, or (2) directly by the Secretary of Interior in states without approved programs. Some structures or districts listed on the State or local inventories **MAY NOT** be "Historic" as cited above but have been included on the inventories because it was believed that the structures or districts have the **potential** for meeting the "Historic" structure criteria of the DOI. In order for these structures to meet NFIP historic structure criteria, it must be demonstrated and evidenced that the South Carolina ~~certified (1) by an approved State~~ Department of Archives and History has **individually determined** that the structure or district meets DOI historic structure criteria.

Increased Cost of Compliance (ICC). Applies to all new and renewed flood insurance policies effective on and after June 1, 1997. The NFIP shall enable the purchase of insurance to cover the cost of compliance with land use and control measures established under Section 1361. It provides coverage for the payment of a claim to help pay for the cost to comply with State or community floodplain management laws or ordinances after a flood event in which a building has been declared substantially or repetitively damaged.

Limited storage. An area used for storage and intended to be limited to incidental items that can withstand exposure to the elements and have low flood damage potential. Such an area must be of flood resistant or breakaway material, void of utilities except for essential lighting and cannot be temperature controlled. If the area is located below the base flood elevation in an A, AE and A1-A30 zone it must meet the requirements of section 19.52 (1) If the area is located below the base flood elevation in a V, VE and V1-V30 zone it must meet the requirements of section 19.52(2)of this chapter.

Lowest Adjacent Grade (LAG). An elevation of the lowest ground surface that touches any of the exterior walls of a building or proposed building walls.

Lowest Floor. The lowest floor of the lowest enclosed area (including basement). An~~y~~ unfinished or flood resistant enclosure, usable solely for parking of vehicles, building access, or storage in an area other than a basement area is not considered a building's lowest floor; provided, that such an enclosure is not built so as to render the structure in violation of ~~other provisions~~ the applicable non-elevation design requirements of this ordinance.

Manufactured home. A structure, transportable in one or more sections, which is built on a permanent chassis and designed to be used with or without a permanent foundation when connected to the required utilities. The term "manufactured home" does not include a "recreational vehicle".

Manufactured home park or subdivision. A parcel (or contiguous parcels) of land divided into two or more manufactured home lots for rent or sale.

Mean sea level. ~~The average height of the sea for all stages of the tide. It is used as a reference for establishing various elevations within the floodplain. For purposes of this ordinance, the term is synonymous with National Geodetic Vertical Datum (NGVD).~~ For the purpose of this ordinance, the Nations Geodetic Vertical Datum (NGVD) of 1929, North American Vertical Datum (NAVD) of 1988, or other datum, to which the base flood elevations shown on a community's Flood Insurance Rate Maps (FIRM) are shown.

National Geodetic Vertical Datum (NGVD) of 1929. As corrected in 1929, elevation reference points set by National Geodetic Survey based on mean sea level.

North American Vertical Datum (NAVD) of 1988 - ~~datum point established at Pointe-au-Père on the St. Lawrence River, Quebec Province, Canada, based on the mass or density of the earth. The datum listed as the reference datum on Flood Insurance Rate Maps should be used for Elevation Certificate and floodproofing certificate completion.~~ vertical control, as corrected in 1988, used as the reference datum on Flood Insurance Rate Maps.

New construction. Structure for which the start of construction commenced on or after the effective date of the FEMA maps. ~~(the effective date of the first floodplain management code, ordinance, or standard based upon specific technical base flood elevation data which establishes the area of special flood hazard) or (specific date).~~ The term also includes any subsequent improvements to such structure.

New manufactured home park or subdivision. A manufactured home park or subdivision for which the construction of facilities for servicing the lots on which the manufactured homes are to be affixed (including at a minimum, the installation of utilities, the construction of streets, and either final site grading or the pouring of concrete slabs) is completed ~~on or after September 30, 1977.~~ after the effective date on the FEMA maps.

Primary frontal dune. A continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and subject to erosion and overtopping from high tides and waves during coastal storms. The inland limit of the primary frontal dune occurs at the point where there is a distinct change from a relatively steep slope to a relatively mild slope.

Recreational vehicle. A vehicle which is: (a) built on a single chassis; (b) 400 square feet or less when measured at the largest horizontal projection; (c) designed to be self-propelled or permanently towable by a light duty truck; and, (d) designed primarily not for use as a permanent dwelling, but as temporary living quarters for recreational, camping, travel, or seasonal use.

Repetitive loss. A building covered by a contract for flood insurance that has incurred flood-related damages on two occasions during a ten-year period ending on the date of the event for which a second claim is made, in which the cost of repairing the flood damage, on the average, equaled or exceeded 25 percent of the market value of the building at the time of each such flood event.

Section 1316 of the National Flood insurance Act of 1968. The act provides that no new flood insurance shall be provided for any property found by the Federal Emergency Management Agency to have been declared by a state or local authority to be in violation of state or local ordinances.

Stable Natural Vegetation. The first place on the oceanfront where plants such as sea oats hold sand in place.

Start of construction. (For other than new construction or substantial improvements under the Coastal Barrier Resources Act (P.L. 97-348), includes substantial improvement, and means the date the complete building permit application was received, provided the actual start of construction, repair, reconstruction, rehabilitation, addition, or improvement was within 180 days of the permit date. The actual start means the first placement of permanent construction of a structure (including a manufactured home) on a site, such as the pouring of slabs or footings, installation of piles, construction of columns, or any work beyond the stage of excavation or the placement of a manufactured home on a foundation. Permanent construction does not include land preparation, such as clearing, grading, and filling; nor does it include the installation of streets and/or walkways; nor does it include excavation for footings, piers or foundations, or the erection of temporary forms; nor does it include the installation on the property of accessory buildings, such as garages or sheds not occupied as dwelling units or not part of the main structure. For a substantial improvement, the actual start of construction means the first alteration of any wall, ceiling, floor, or other structural part of the building, whether or not that alteration affects the external dimensions of the building.

Structure. A walled and roofed building, a manufactured home, including a gas or liquid storage tank, or other man-made facility or infrastructure that is principally above ground.

Substantial damage. Damage of any origin sustained by a structure whereby the cost of restoring the structure to its before damaged condition would equal or exceed 50 percent of the market value of the structure before the damage occurred. Such repairs may be undertaken successively and their costs counted cumulatively. Please refer to the definition of "substantial improvement".

Substantial improvement. Any repair, reconstruction, rehabilitation, addition, or other improvement of a structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the start of construction of the improvement. This term includes structures that have incurred repetitive loss or substantial damage, regardless of the actual repair work performed. The term does not, however, include either:

(a) Any project of improvement to a structure to correct existing violations of State or local health, sanitary, or safety code specifications which have been identified by the local code enforcement official and which are the minimum necessary to assure safe living conditions (does not include American with Disabilities Act compliance standards); or,

(b) Any alteration of a historic structure, provided that the alteration will not preclude the structure's continued designation as a historic structure.

(c) Permits shall be cumulative for a period of five years. If the improvement project is conducted in phases, the total of all costs associated with each phase, beginning with the issuance of the first permit, shall be utilized to determine whether "substantial improvement" will occur.

Substantially improved existing manufactured home park or subdivision. Where the repair, reconstruction, rehabilitation or improvement of the streets, utilities and pads equals or exceeds 50 percent of the value of the streets, utilities and pads before the repair, reconstruction, or improvement commenced.

Variance. A grant of relief from a term or terms of this chapter.

Violation. The failure of a structure or other development to be fully compliant with these regulations.

Secs. 19-22—19-30. - Reserved.

Article III. - ADMINISTRATION

Sec. 19-31. - Designation of local administrator.

The ~~building official~~ Town Manager or his/her designee is hereby appointed to administer and implement the provisions of this chapter as they apply to vertical construction. The Town Manager shall appoint a designee(s) to administer and implement all other provisions of this chapter.

Sec. 19-32. - Adoption of Letter of Map Revisions (LOMR).

All LOMRs that are issued in the areas identified in Section 19.4 of this ordinance are hereby adopted.

Sec. 19-33. Reserved~~- Designation of party responsible for biennial report.~~

~~The building official is hereby designated as the party responsible to submit the biennial report to FEMA.~~

Sec. 19-34. - Development permit and certification requirements.

(1) *Development permit*. Application for a development permit shall be made to the local administrator following the standards and procedures outlined elsewhere in the Town of Bluffton ordinances on forms furnished by him or her prior to any development activities. The development permit may include, but not be limited to, plans in duplicate drawn to scale showing: the nature, location, dimensions, and elevations of the area in question; existing or proposed structures; and the location of fill materials, storage areas, and drainage facilities. Specifically, the following information is required relative to flood damage prevention:

(a) A plot plan that shows the 100-year floodplain contour or a statement that the entire lot is within the floodplain must be provided by the development permit applicant when the lot is within or appears to be within the floodplain as mapped by the Federal Emergency Management Agency or the floodplain identified pursuant to either the Duties and Responsibilities of the local floodplain administrator~~s~~ of Article III.D.11or the Standards for Subdivision Proposals of section 19.52(13)~~12~~ and the Standards for streams without Estimated Base Flood Elevations and~~/or~~ Floodways of Article IV.C. The plot plan must be prepared by or under the direct supervision of a registered land surveyor or professional engineer and certified by it. The plot plan must show the floodway, if any, as identified by the Federal Emergency Management Agency or the floodway identified pursuant to either the duties or responsibilities of the local administrators of Article 2 or section 19.35the standards for subdivision proposals of Article IV.B.12 and the standards for streams without estimated base flood elevations and~~/or~~ floodways of section 19.52 (14).

(b) Where base flood elevation data is provided as set forth in section 19-4 or the duties and responsibilities of the local administrators of section 19-35(11) the application for a development permit within the flood hazard area shall show:

1. The elevation (in relation to mean sea level) of the lowest floor of all new and substantially improved structures, and

2. If the structure will be floodproofed in accordance with the non-residential construction requirements of section 19-51(2) the elevation (in relation to mean sea level) to which the structure will be floodproofed.

(c) Where base flood elevation data is not provided. If no base flood elevation data is provided as set forth in section 19-4 or the duties and responsibilities of the local administrators of section 19-35(11), then the provisions in the standards for streams without estimated base flood elevations and/or floodways of section 19-35(11) must be met.

(d) Alteration of watercourse. Where any watercourse will be altered or relocated as a result of proposed development, the application for a development permit shall include a description of the extent of watercourse alteration or relocation, an engineering ~~report on the~~ study to demonstrate that the ~~effects of the proposed project on the~~ flood- carrying capacity of the altered or relocated watercourse ~~and the effects to properties located both upstream and downstream;~~ is maintained and, a map showing the location of the proposed watercourse alteration or relocation.

(2) *Certifications*.

(a) *Floodproofing certification*. When a structure is floodproofed, the applicant shall provide certification from a registered, professional engineer or architect that the non-residential, floodproofed structure meets the floodproofing criteria in the non-residential construction requirements of section 19-52(14).

(b) *Certification during construction*. A lowest floor elevation or floodproofing certification is required after the lowest floor is completed. As soon as possible after completion of the lowest floor and before any further vertical construction commences, or floodproofing by whatever construction means, whichever is applicable, it shall be the duty of the permit holder to submit to the local administrator a certification of the elevation of the lowest floor, or floodproofed elevation, whichever is applicable, as built, in relation to mean sea level. Said certification shall be prepared by or under the direct supervision of a registered land surveyor or professional engineer and certified by it. Any work done prior to submission of the certification shall be at the permit holder's risk. The local administrator shall review the floor elevation survey data submitted. The permit holder immediately and prior to further progressive work being permitted to proceed shall correct deficiencies detected by such review. Failure to submit the survey or failure to make said corrections required hereby shall be cause to issue a stop-work order for the project.

(c) *V-Zone certification*. When a structure is located in Zones V, VE, or V1-30, certification shall be provided from a registered professional engineer or architect, separate from submitted plans, that new construction or substantial improvement meets the criteria for the coastal high hazard areas outlined in section 19-35(8)d.

(d) *As-built certification*. Upon completion of the development a registered professional engineer, land surveyor or architect, in accordance with SC law, shall certify according to the requirements of section 19-34(2)(a)—(c) that the development is built in accordance with the submitted plans and previous pre-development certifications.

Sec. 19-35. - Duties and responsibilities of the local administrators.

~~Duties of the local administrators or their designees shall include, but not be limited to:~~

(1) *Permit review*. Review all development permits to assure that the requirements of this chapter have been satisfied.

(2) *Requirement of Federal and/or state permits*. Advise permittee that additional federal or State permits may be required, and if specific federal or State permits are known, require that copies of such permits be provided and maintained on file with the development permit.

(3) *Watercourse alterations*.

a. Notify adjacent communities and the South Carolina Department of Natural Resources, Land Resources and Conservation Districts Division, State Coordinator for the National Flood Insurance Program, prior to any alteration or relocation of a watercourse, and submit evidence of such notification to the Federal Emergency Management Agency.

b. In addition to the notifications required watercourse alterations per section 19-35(3)a., written reports of maintenance records must be maintained to show that maintenance has been provided within the altered or relocated portion of said watercourse so that the flood-carrying capacity is not diminished. This maintenance must consist of a comprehensive program of periodic inspections, and routine channel clearing and dredging, or other related functions. The assurance shall consist of a description of maintenance activities, frequency of performance, and the local official responsible for maintenance performance. Records shall be kept on file for FEMA inspection.

c. If the proposed project will impact the configuration of the watercourse, floodway, or base flood elevation for which a detailed Flood Insurance Study has been developed, the applicant shall apply for and must receive approval for a Conditional Letter of Map Revision with the Federal Emergency Management Agency prior to the start of actual construction.

d. Within 60 days of completion of an alteration of a watercourse, referenced in the certification requirements of section 19-34(2) the applicant shall submit as-built certification, by a registered professional engineer, to the Federal Emergency Management Agency.

(4) *Floodway encroachments*. Prevent encroachments within floodways unless the certification and flood hazard reduction provisions of section 19-52(5) are met.

(5) *Development proposals*. Require development proposals for proposed developments prior to signing off on and CLOMRs or LOMRs.

(6) *Adjoining floodplains*. Cooperate with neighboring communities with respect to the management of adjoining floodplains and/or flood-related erosion areas in order to prevent aggravation of existing hazards.

(7) *Notifying adjacent communities*. Notify adjacent communities prior to permitting substantial commercial developments and large subdivisions to be undertaken in areas of special flood hazard and/or flood-related erosion hazards.

(8) *Certification requirements.*

a. Obtain and review actual elevation (in relation to mean sea level) of the lowest floor of all new or substantially improved structures, in accordance with administrative procedures outlined in section 19-34(2)(b-d) or the coastal high hazard area requirements outlined in section 19-34(a).

b. Obtain the actual elevation (in relation to mean sea level) to which the new or substantially improved structures have been floodproofed, in accordance with the floodproofing certification outlined in section 19-34(2)(a).

c. When floodproofing is utilized for a particular structure, obtain certifications from a registered professional engineer or architect in accordance with the non-residential construction requirements outlined in section 19-52(2).

d. A registered professional engineer or architect shall certify that the design, specifications and plans for construction are in compliance with the provisions contained in the coastal high hazard area requirements outlined in sections 19-34(a) of this chapter.

(9) *Map interpretation*. Where interpretation is needed as to the exact location of boundaries of the areas of special flood hazard (for example, where there appears

to be a conflict between a mapped boundary and actual field conditions), make the necessary interpretation. The person contesting the location of the boundary shall be given a reasonable opportunity to appeal the interpretation as provided in this article ~~to the construction board of adjustments and appeals.~~

(10) *Prevailing authority*. Where a map boundary showing an area of special flood hazard and field elevations disagree, the base flood elevations for flood protection elevations (as found on an elevation profile, floodway data table, etc.) shall prevail. The correct information should be submitted to FEMA as per the map maintenance activity requirements outlined in section 19-52(7)b.

(11) *Use of best available data*. When base flood elevation data or floodway data has not been provided in accordance with section 19-4, obtain, review, and reasonably utilize best available base flood elevation data and floodway data available from a federal, State, or other source, including data developed pursuant to the standards for subdivision proposals outlined in section 19-52(13)section in order to administer the provisions of this chapter. Data from preliminary, draft, and final Flood Insurance Studies constitutes best available data from a federal, state, or other source. Data must be developed using hydraulic models meeting the minimum requirement of NFIP approved model. If an appeal is pending on the study in accordance with 44 CFR Ch. 1, Part 67.5 and 67.6, the data does not have to be used.

(12) *Special flood hazard area/topographic boundaries conflict*. When the exact location of boundaries of the areas special flood hazards conflict with the current, natural topography information at the site the property owner may apply and be approved for a Letter of Map Amendment (LOMA) by FEMA. The local administrator in the permit file will maintain a copy of the Letter of Map Amendment issued from FEMA.

(13) *On-Site inspections*. Make on-site inspections of projects in accordance with the administrative procedures outlined in section 19-36(4).

(14) *Administrative notices*. Serve notices of violations, issue stop-work orders, revoke permits and take corrective actions in accordance with the administrative procedures in section 19-36.

(15) *Records maintenance*. Maintain all records pertaining to the administration of this chapter and make these records available for public inspection.

(16) *Annexations and detachments*. Notify the South Carolina Department of Natural Resources Land, Water and Conservation Division, within six months, of any annexations or detachments that include special flood hazard areas. ~~The community must incorporate applicable maps from surrounding jurisdictions into this chapter within 90 days of date of the annexation.~~

(17) *Federally funded development*. The President issued Executive Order 11988, Floodplain Management May 1977. E.O. 11988 directs federal agencies to assert a

leadership role in reducing flood losses and losses to environmental values served by floodplains. Proposed developments must go through an eight-step review process. Evidence of compliance with the executive order must be submitted as part of the permit review process.

(18) *Substantial damage determination*. Perform an assessment of damage from any origin to the structure using FEMA's Residential Substantial Damage Estimator (RSDE) procedures to determine if the damage equals or exceeds 50 percent of the market value of the structure before the damage occurred.

(19) *Substantial improvement determination*. Perform an assessment of permit applications for improvements or repairs to be made to a building or structure equals or exceeds 50 percent of the market value of the structure before the improvement or repair is started. Cost of work counted for determining if and when substantial improvement to a structure occurs shall be cumulative for a period of five years. If the improvement project is conducted in phases the total of all cost associated with each phase, beginning with the issuance of the first permit, shall be utilized to determine whether "substantial improvement" will occur.

a. Methods of market value determination. The market values shall be determined by one of the following methods:

1. The current assessed building value as determined by the county's assessor's office or,

2. One or more certified appraisals from a registered professional licensed appraiser in accordance with the laws of South Carolina. The appraisal shall indicate actual replacement value of the building or structure in its pre-improvement condition, less depreciation for functionality and obsolescence and site improvements. The Marshall & Swift Residential Cost Handbook shall be used to determine costs for buildings or structures.

3. Real Estate contract within 6 months prior to the date of the application for a permit.

Sec. 19-36. - Administrative procedures.

(1) *Inspections of work in progress*. As the work pursuant to a permit progresses, the local administrator shall make as many inspections of the work as may be necessary to ensure that the work is being done according to the provisions of the local ordinance and the terms of the permit. In exercising this power, the administrator has a right, upon presentation of proper credentials, to enter on any

premises within the territorial jurisdiction at any reasonable hour for the purposes of inspection or other enforcement action.

(2) *Stop-work orders.* Whenever a building or part thereof is being constructed, reconstructed, altered, or repaired in violation of this chapter, the administrator may order the work to be immediately stopped. The stop-work order shall be in writing and directed to the person doing the work. The stop-work order shall state the specific work to be stopped, the specific reasons for the stoppage, and the conditions under which the work may be resumed. Violation of a stop-work order constitutes a misdemeanor.

(3) *Revocation of permits*. The local administrator or his designee may revoke and require the return of the development permit by notifying the permit holder in writing, stating the reason for the revocation. Permits shall be revoked for any substantial departure from the approved application, plans, or specifications; for refusal or failure to comply with the requirements of State or local laws; or for false statements or misrepresentations made in securing the permit. Any permit mistakenly issued in violation of an applicable State or local law may also be revoked.

(4) *Periodic inspections*. The local administrator and each member of his inspections department shall have a right, upon presentation of proper credentials, to enter on any premises within the territorial jurisdiction of the department at any reasonable hour for the purposes of inspection or other enforcement action.

(5) *Violations to be corrected*. When the local administrator finds violations of applicable State and local laws, it shall be his duty to notify the owner or occupant of the building of the violation. The owner or occupant shall immediately remedy each of the violations of law on the property he owns.

(6) *Actions in event of failure to take corrective action*. If the owner of a building or property shall fail to take prompt corrective action, the administrator shall give him written notice, by certified or registered mail to his last known address or by personal service, that:

a. The building or property is in violation of the chapter,

b. A hearing will be held before the local administrator at a designated place and time, not later than ten days after the date of the notice, at which time the owner shall be entitled to be heard in person or by counsel and to present arguments and evidence pertaining to the matter, and

c. Following the hearing, the local administrator may issue such order to alter, vacate, or demolish the building; or to remove fill as appears appropriate.

(7) *Order to take corrective action*. If, upon a hearing held pursuant to the notice prescribed above, the administrator shall find that the building or development is in violation of the chapter, he shall make an order in writing to the owner, requiring the owner to remedy the violation within such period, not less than 60 days, the administrator may prescribe; provided that where the administrator finds that there is imminent danger to life or other property, he may order that corrective action be taken in such lesser period as may be feasible.

(8) *Appeal*. Any owner who has received an order to take corrective action may appeal from the order to the Construction Board of Adjustments and Appeals by giving notice of appeal in writing to the administrator and the clerk within ten days following issuance of the final order. In the absence of an appeal, the order of the administrator shall be final. The Construction Board of Adjustments and Appeals shall hear an appeal within a reasonable time and may affirm, modify and affirm, or revoke the order.

(9) *Failure to comply with order*. If the owner of a building or property fails to comply with an order to take corrective action from which no appeal has been taken, or fails to comply with an order of the governing body following an appeal, he shall be guilty of a misdemeanor and shall be punished in the discretion of the court.

(10) *Denial of flood insurance under the NFIP*. If a structure is declared in violation of this chapter and the violation is not remedied then the local administrator shall notify the Federal Emergency Management Agency to initiate a Section 1316 of the National Flood insurance Act of 1968 action against the structure upon the finding that the violator refuses to bring the violation into compliance with the ordinance. Once a violation has been remedied the local administrator shall notify FEMA of the remedy and ask that the Section 1316 be rescinded.

(11) The following documents are incorporated by reference and may be used by the local administrator or his designee to provide further guidance and interpretation of this chapter as found on FEMA's website at www.fema.gov:

a. FEMA 55 Coastal Construction Manual

b. All FEMA Technical Bulletins

c. All FEMA Floodplain Management Bulletins

d. FEMA 348 Protecting Building Utilities from Flood Damage

e. FEMA 499 Home Builder's Guide To Coastal Construction Technical Fact Sheets

Secs. 19-37—19-50. - Reserved.

ARTICLE IV. - PROVISIONS FOR FLOOD HAZARD REDUCTION

Sec. 19-51. - General standards.

Development may not occur in the floodplain where alternative locations exist due to the inherent hazards and risks involved. Before a permit is issued, the applicant shall demonstrate that new structures cannot be located out of the floodplain and that encroachments onto the floodplain are minimized. In all areas of special flood hazard the following provisions are required:

(1) Reasonably safe from flooding – Review all permit applications to determine whether proposed building sites will be reasonably safe from flooding.

(1) *Anchoring*. All new construction and substantial improvements shall be anchored to prevent flotation, collapse, or lateral movement of the structure,

(2) *Flood resistant materials and equipment*. All new construction and substantial improvements shall be constructed with flood resistant materials and utility equipment resistant to flood damage in accordance with Technical Bulletin 2, *Flood Damage-Resistant Materials Requirements,* dated 8/08, and available from the Federal Emergency Management Agency.

(3) *Minimize flood damage*. All new construction or substantial improvements shall be constructed by methods and practices that minimize flood damages,

(4) *Critical development*. All new construction shall be elevated to the 500-year flood elevation or be elevated to the highest known historical flood elevation (where records are available), whichever is greater. If no data exists establishing the 500-year flood elevation or the highest known historical flood elevation, the applicant shall provide a hydrologic and hydraulic engineering analysis that generates 500-year flood elevation data,

(5) Utilities - Electrical, ventilation, plumbing, heating and air conditioning equipment (including ductwork), and other service facilities shall be designed and/or located so as to prevent water from entering or accumulating within the components during conditions of the base flood plus three (3) feet. ~~This requirement does not preclude the installation of outdoor faucets for shower heads, sinks, hoses, etc., as long as cut off devices and back flow devices are installed to prevent contamination to the service components and thereby minimize any flood damages to the building,~~

(6) *Water supply systems*. All new and replacement water supply systems shall be designed to minimize or eliminate infiltration of floodwaters into the system,

(7) *Sanitary sewage systems*. New and replacement sanitary sewage systems shall be designed to minimize or eliminate infiltration of floodwaters into the

systems and discharges from the systems into floodwaters, on-site waste disposal systems shall be located and constructed to avoid impairment to them or contamination from them during flooding,

(8) *Gas or liquid storage tanks*. All gas or liquid storage tanks, either located above ground or buried, shall be anchored to prevent flotation or lateral movement resulting from hydrodynamic and hydrostatic loads.

(9) *Alteration, repair, reconstruction, or improvements*. Any alteration, repair, reconstruction, or improvement to a structure that is in compliance with the provisions of this chapter, shall meet the requirements of "new construction" as contained in this chapter. This includes post-FIRM development and structures.

(10) *Non-conforming buildings or uses*. Non-conforming buildings or uses may not be enlarged, replaced, or rebuilt unless such enlargement or reconstruction is accomplished in conformance with the provisions of this chapter. Provided, however, nothing in this chapter shall prevent the repair, reconstruction, or replacement of an existing building or structure located totally or partially within the floodway, provided that the bulk of the building or structure below base flood elevation in the floodway is not increased and provided that such repair, reconstruction, or replacement meets all of the other requirements of this chapter,

(11) *Americans with Disabilities Act (ADA)*. A building must meet the specific standards for floodplain construction outlined in section 19-52, as well as any applicable ADA requirements. The ADA is not justification for issuing a variance or otherwise waiving these requirements. Also, the cost of improvements required to meet the ADA provisions shall be included in the costs of the improvements for calculating substantial improvement.

Sec. 19-52. - Specific standards.

In all areas of special flood hazard (Zones A, AE, AH, AO and A1-30) where base flood elevation data has been provided, as set forth in section 19-4 or outlined in the duties and responsibilities of the local administrator section 19-35 the following provisions are required:

(1) *Residential Construction.*

a) New construction or substantial improvement of any residential structure (including manufactured homes) shall have the lowest floor elevated no lower than one (1) foot above the center line of the adjacent roadway or three (3) feet above the base flood elevation whichever is higher. No basements are permitted. Should solid foundation perimeter walls be used to elevate a structure, openings sufficient to facilitate the unimpeded movements of floodwaters shall be provided in accordance with the elevated buildings requirements in section 19.52(4).

(2) *Non-Residential Construction*.

a) New construction or substantial improvement of any commercial, industrial, or non-residential structure (including manufactured homes) shall have the lowest floor elevated no lower than one (1) foot above the center line adjacent roadway or three (3) feet, above the level of the base flood elevation whichever is higher. Should solid foundation perimeter walls be used to elevate a structure, openings sufficient to facilitate the unimpeded movements of floodwaters shall be provided in accordance with the elevated buildings requirements in Article IV B.4. No basements are permitted. Structures located in A-zones may be floodproofed in lieu of elevation provided that all areas of the structure below the required elevation are watertight with walls substantially impermeable to the passage of water, using structural components having the capability of resisting hydrostatic and hydrodynamic loads and the effect of buoyancy.

b) A registered, professional engineer or architect shall certify that the standards of this subsection are satisfied. Such certifications shall be provided to the official as set forth in the floodproofing certification requirements in Article III.D.2.a. A variance may be considered for wet-floodproofing agricultural structures in accordance with the criteria outlined in Article V.D of this ordinance. Agricultural structures not meeting the criteria of Article V.D must meet the non-residential construction standards and all other applicable provisions of this ordinance. Structures that are floodproofed are required to have an approved maintenance plan with an annual exercise. The local administrator must approve the maintenance plan and notification of the annual exercise shall be provided to it.

(3) *Manufactured homes*.

a. Manufactured homes that are placed or substantially improved on sites outside a manufactured home park or subdivision, in a new manufactured home park or sub-division, in an expansion to an existing manufactured home park or subdivision, or in an existing manufactured home park or subdivision on which a manufactured home has incurred "substantial damage" as the result of a flood, must be elevated on a permanent foundation such that the lowest floor of the manufactured home is elevated no lower than one foot above the centerline of the adjacent roadway or three (3) feet ~~one foot~~ above the base flood elevation whichever is higher and be securely anchored to an adequately anchored foundation system to resist flotation, collapse, and lateral movement.

b. Manufactured homes that are to be placed or substantially improved on sites in an existing manufactured home park or subdivision that are not subject to the provisions for residential construction in section 19-52(1) of this chapter must be elevated so that the lowest floor of the manufactured home is elevated no lower than one foot above the centerline of the adjacent roadway or three (3) feet ~~one foot~~ above the base flood elevation whichever is higher, and be securely anchored to an adequately anchored foundation to resist flotation, collapse, and lateral movement.

c. Manufactured homes shall be anchored to prevent flotation, collapse, or lateral movement. For the purpose of this requirement, manufactured homes must be anchored to resist flotation, collapse, or lateral movement in accordance with Section 19-425.39 of the South Carolina Manufactured Housing Board Regulations, effective date May 25, 1990, as amended. Additionally, when the elevation requirement would be met by an elevation of the chassis at least 36 inches or less above the grade at the sight, reinforced piers or other foundation elements of at least equivalent strength shall support the chassis. When the elevation of the chassis is above 36 inches in height an engineering certification is required.

(4) *Elevated buildings*. New construction or substantial improvements of elevated buildings that include fully enclosed areas that are usable solely for the parking of vehicles, building access, or limited storage in an area other than a basement, and which are subject to flooding shall be designed to preclude finished space and be designed to automatically equalize hydrostatic flood forces on exterior walls by allowing for the entry and exit of floodwaters.

a. Designs for complying with this requirement must either be certified by a professional engineer or architect or meet the following minimum criteria:

1. Provide a minimum of two openings on opposite walls having a total net area of not less than one square inch for every square foot of enclosed area subject to flooding,

2. The bottom of all openings shall be no higher than one foot above the higher of the interior or exterior grade immediately under the opening ~~above grade~~,

~~3. Openings may be equipped with screens, louvers, valves, or other coverings or devices provided they permit the automatic flow of floodwaters in both directions; and,~~ Only the portions of the openings that are below the base flood elevation (BFE) can be counted towards the required net opening area.

4. Fill placed around foundation walls must be graded so that the grade inside the enclosed area is equal to or higher than the adjacent grade outside the building on at least one side of the building.

b. Hazardous velocities. Hydrodynamic pressure must be considered in the design of any foundation system where velocity waters or the potential for debris flow exists. If flood velocities are excessive (greater than five feet per second), foundation systems other than solid foundations walls should be considered so that obstructions to damaging flood flows are minimized.

c. Enclosures below BFE.

1. Access to the enclosed area shall be the minimum necessary to allow for parking of vehicles (garage door) or limited storage of maintenance equipment used in connection with the premises (standard exterior door) or entry to the living area (stairway or elevator).

2. The interior portion of such enclosed area shall not be partitioned or finished into separate rooms, except to enclose a storage areas which meet the requirements of section 19-52(4) and must be void of utilities except for essential lighting as required, and cannot be temperature controlled.

3. One wet location switch and/or outlet connected to a ground fault interrupt breaker may be installed below the required lowest floor elevation specified in the specific standards outlined in section 19-52(1)—(3).

4. All construction materials below the required lowest floor elevation specified in the specific standards outlined in section 19-52(1)—(3) should be of flood resistant materials.

(5) *Floodways*. Located within areas of special flood hazard established in section 19-4, are areas designated as floodways. The floodway is an extremely hazardous area due to the velocity of floodwaters that carry debris and potential projectiles and has erosion potential. The following provisions shall apply within such areas:

a. No encroachments, including fill, new construction, substantial improvements, additions, and other developments shall be permitted unless it has been demonstrated through hydrologic and hydraulic analyses performed in accordance with standard engineering practice that the proposed encroachment would not result in any increase in the flood levels during the occurrence of the base flood. Such certification and technical data shall be presented to the local administrator. A Conditional Letter of Map Revision (CLOMAR) has been approved by FEMA. A letter of Map Revision must be obtained upon completion of the proposed development.

b. If section 19-52(5)a. is satisfied, all new construction and substantial improvements shall comply with all applicable flood hazard reduction provisions of Article IV.

c. ~~Stream crossings for any purpose (i.e. timber harvesting operations), if temporary, shall be permitted in accordance with floodway requirements of section 19-52(5) and the temporary development provisions of section 16-52(11). Otherwise, the development shall comply with all applicable flood hazard reduction provisions of Article IV.~~

c. ~~d.~~ No manufactured homes shall be permitted, except in an existing manufactured home park or subdivision. A replacement manufactured home may be placed on a lot in an existing manufactured home park or subdivision provided the anchoring and the elevation standards of section 19-52(3) are met and the encroachment standards of Article IV.B.5(a) are met.

d.~~e.~~ Permissible uses within floodways may include: general farming, pasture, outdoor plant nurseries, horticulture, forestry, wildlife sanctuary, game farm, and other similar agricultural, wildlife, and related uses. Also, lawns, gardens, play areas, picnic grounds, and hiking and horseback riding trails are acceptable uses, provided that they do not employ structures or fill. Substantial development of a permissible use may require a no-impact certification. The uses listed in this subsection are permissible only if and to the extent that they do not cause any increase in base flood elevations or changes to the floodway configuration.

6. Recreational Vehicles

a) A recreational vehicle is ready for highway use if it is:

(1) on wheels or jacking system

(2) attached to the site only by quick-disconnect type utilities and security devices; and

(3) has no permanently attached additions

b) Recreational vehicles placed on sites shall either be:

(1) on site for fewer than 180 consecutive days; or

(2) be fully licensed and ready for highway use, or
meet the development permit and certification requirements of Article III.D, general standards outlined in Article IV.A, and manufactured homes standards in Article IV.B.3 and B.4.

(7) *Map maintenance activities*. The National Flood Insurance Program requires flood data to be reviewed and approved by FEMA. This ensures that flood maps, studies and other data identified in section 19-4 accurately represent flooding conditions so appropriate floodplain management criteria are based on current data, the following map maintenance activities are identified:

a. Requirement to Submit New Technical Data

1. For all development proposals that impact floodway delineations or base flood elevations, the community shall ensure that technical data reflecting such changes be submitted to FEMA within six months of the date such information becomes available. These development proposals include:

(i) Floodway encroachments that increase or decrease base flood elevations or alter floodway boundaries;

(ii) Fill sites to be used for the placement of proposed structures where the applicant desires to remove the site from the special flood hazard area;

(iii) Alteration of watercourses that result in a relocation or elimination of the special flood hazard area, including the placement of culverts; and

(iv) Subdivision or large scale development proposals requiring the establishment of base flood elevations in accordance with section 19-52(13)f.

2. It is the responsibility of the applicant to have technical data, required in accordance with section 19-52(7), prepared in a format required for a Conditional Letter of Map Revision or Letter of Map Revision, and submitted to FEMA. Submittal and processing fees for these map revisions shall also be the responsibility of the applicant.

3. The Floodplain Administrator shall require a Conditional Letter of Map Revision prior to the issuance of a floodplain development permit for:

4. Proposed floodway encroachments that increase the base flood elevation; and

5. Proposed development which increases the base flood elevation by more than one foot in areas where FEMA has provided base flood elevations but no floodway.

6. Floodplain development permits issued by the Floodplain Administrator shall be conditioned upon the applicant obtaining a Letter of Map Revision from FEMA for any development proposal subject to section 19-52(7).

7~~. Conditional Letter of Map revisions (CLOMR) and/or Letters of Map Revision (LOMR) must go through the variance process outlined in Article V.~~

b. *Right to submit new technical data*. The floodplain administrator may request changes to any of the information shown on an effective map that does not impact floodplain or floodway delineations or base flood elevations, such as labeling or planimetric details. Such a submission shall include appropriate supporting documentation made in writing by the local jurisdiction and may be submitted at any time.

(8) *Accessory structures*.

a. A detached accessory structure or garage, the cost of which is greater than $3,000.00, must comply with the requirements as outlined in FEMA's Technical Bulletin 7-93 Wet Floodproofing Requirements or be elevated in accordance with section 19-52(1) and (4) or dry floodproofed in accordance with section 19-52(2).

b. When accessory structures of $3,000.00 or less are to be placed in the floodplain, the following additional criteria shall be met:

1. Accessory structures shall not be used for human habitation (including work, sleeping, living, cooking or restroom areas),

2. Accessory structures shall be designed to have low flood damage potential,

3. Accessory structures shall be constructed and placed on the building site so as to offer the minimum resistance to the flow of floodwaters,

4. Accessory structures shall be firmly anchored to prevent flotation, collapse or lateral movement of the structure,

5. Service facilities such as electrical and heating equipment shall be installed in accordance with section 19-51(5); and

6. Openings to relieve hydrostatic pressure during a flood shall be provided below base flood elevation in conformance with section 19-52(4)a.

7. Accessory structures shall be built with flood resistance materials in accordance with Technical Bulletin 2, *Flood Damage-Resistant Materials Requirements*, dated 8/08, and available from the Federal Emergency Management Agency. Class 4 and 5 materials, referenced therein, are acceptable flood-resistant materials.

(9) *Swimming pool utility equipment rooms*. If the building cannot be built at or above the BFE, because of functionality of the equipment then a structure to house the utilities for the pool may be built below the BFE with the following provisions:

a. Meet the requirements for accessory structures in section 19-52(8).

b. The utilities must be anchored to prevent flotation and shall be designed to prevent water from entering or accumulating within the components during conditions of the base flood.

~~c. A variance may be granted to allow wet floodproofing of the structure.~~

(10) *Elevators*.

a. Install a float switch system or another system that provides the same level of safety is necessary for all elevators where there is a potential for the elevator cab to descend below the BFE during a flood per FEMA's Technical Bulletin 4-93 Elevator Installation for Buildings Located in Special Flood Hazard Areas.

b. All equipment that may have to be installed below the BFE such as counter weight roller guides, compensation cable and pulleys, and oil buffers for traction elevators and the jack assembly for a hydraulic elevator must be constructed using flood-resistant materials where possible per FEMA's Technical Bulletin 4-93 Elevator Installation for Buildings Located in Special Flood Hazard Areas.

(11) *Reserved*.

~~(11) *Temporary development*. Certain types of structures (e.g. fruit stands, construction site offices, portable toilets, etc.) may be situated temporarily on flood-prone property without having to comply with the elevation or floodproofing criteria of section 19-52(1) and (2), respectively, provided that the following criteria are met:~~

~~a. All applicants must submit to the local administrator or his designee, prior to the issuance of the development permit, a written plan for the removal of any temporary structures or development in the event of a hurricane or flash flood warning notification. The plan shall be reviewed and approved in writing, and must include the following information:~~

~~1. A specified time period for which the temporary use will be permitted,~~

~~2. The name, address and phone number of the individual responsible for the removal of temporary structures or development;~~

~~3. The time frame prior to the event at which any structures will be removed (i.e. minimum of 72 hours before landfall of a hurricane or immediately upon flood warning notification);~~

~~4. A copy of the contract or other suitable instrument with a trucking company to insure the availability of removal equipment when needed,~~

~~5. Designation, accompanied by documentation, of a location outside the floodplain to which any temporary structure will be moved;~~

~~6. A determination of permanent structures which would be adversely affected by increased flooding upstream or downstream, and a method for covering this liability, such as a performance bond; and,~~

~~7. A plan to restore the area to its natural condition once the temporary permit expires or the temporary use is terminated, whichever is first.~~

~~b. The structure is mobile, or can be made so, and is capable of being removed from the site with a maximum of four hours warning.~~

~~c. The structure will not remain on the property for more than 180 days.~~

(12) *Fill*. An applicant shall demonstrate that fill is the only alternative to raising the building to meet the residential and non-residential construction requirements of section 19-52(1) and (2), and that the amount of fill used will not affect the flood storage capacity or adversely affect adjacent properties. The following provisions shall apply to all fill placed in the special flood hazard area:

a. Fill may not be placed in the floodway unless it is in accordance with the requirements in section 19-52(5)a.,

b. Fill may not be placed in tidal or non-tidal wetlands without the required State and federal permits,

c. Fill must consist of soil and rock materials only. A registered professional geotechnical engineer may use dredged material as fill only upon certification of suitability. Landfills, rubble fills, dumps, and sanitary fills are not permitted in the floodplain,

d. Fill used to support structures must comply with ASTM Standard D-698, and its suitability to support structures certified by a registered, professional engineer,

e. Fill slopes shall be no greater than two horizontal to one vertical. Flatter slopes may be required where velocities may result in erosion; and,

f. The use of fill shall not increase flooding or cause drainage problems on neighboring properties;

g. Fill may not be used for structural support in the coastal high hazard (V Zone) areas;

h. Will meet the requirements of FEMA Technical Bulletin 10-01, *Ensuring That Structures Built On Fill In Or Near Special Flood Hazard Areas Are Reasonable Safe From Flooding.*

(13) *Standards for subdivision proposals*.

a. All subdivision proposals shall be consistent with the need to minimize flood damage and are subject to all applicable standards in these regulations;

b. All subdivision proposals shall have public utilities and facilities such as sewer, gas, electrical, and water systems located and constructed to minimize flood damage;

c. All subdivision proposals shall have adequate drainage provided to reduce exposure to flood damage; and

d. In all areas of special flood hazard where base flood elevation data are not available, the applicant shall provide a hydrologic and hydraulic engineering analysis that generates base flood elevations for all subdivision proposals and other proposed developments containing at least 50 lots or five acres, whichever is less.

e. If the areas of special flood hazard is identified as an area of open space and is deeded as such then a hydrologic and hydraulic engineering analysis that generates base flood elevations for the subdivision proposal would not be required.

f. The applicant shall meet the requirement to submit technical data to FEMA in section 19-52(7) when a hydrologic and hydraulic analysis is completed that generates base flood elevations.

(~~14) *Recreational vehicles*.~~

~~a. A recreational vehicle is ready for highway use if it is:~~

~~1. On wheels or jacking systems;~~

~~2. Attached to the site only by quick-disconnect type utilities and security devices; and~~

~~3. Has no permanently attached additions.~~

~~b. Recreational vehicles placed on site shall either be:~~

~~1. On site for fewer than 180 consecutive days; and,~~

~~2. Be fully licensed and ready for highway use, or meet the development permit and certification requirements of~~ ~~section 19-34~~, ~~general standards outlined in~~ ~~section 19-51~~, ~~and manufactured homes standards in~~ ~~section 19-52~~(3)~~.~~

14. Standards for Streams without Established Base Flood Elevations and Floodways - Located within the areas of special flood hazard (Zones A and V) established in section 19.4, are small streams where no base flood data has been provided and where no floodways have been identified. The following provisions apply within such areas:

1. In all areas of special flood hazard where base flood elevation data are not available, the applicant shall provide a hydrologic and hydraulic engineering analysis that generates base flood elevations for all subdivision proposals and other proposed developments containing at least 50 lots or 5 acres, whichever is less.

2. No encroachments, including fill, new construction, substantial improvements and new development shall be permitted within 100 feet of the stream bank unless certification with supporting technical data by a registered professional engineer is provided demonstrating that such encroachments shall not result in any increase in flood levels during the occurrence of the base flood discharge.

3. If sections 19.52(1) or (2) are satisfied and base flood elevation data is available from other sources, all new construction and substantial improvements within such areas shall comply with all applicable flood hazard ordinance provisions of Article IV and shall be elevated or flood proofed in accordance with elevations established in accordance with section 19.34.

4. Data from preliminary, draft, and final Flood Insurance Studies constitutes best available data. Refer to FEMA Floodplain Management Technical Bulletin 1-98 *Use of Flood Insurance Study (FIS) Data as Available Data*. If an appeal is pending on the study in accordance with 44 CFR Ch. 1, Part 67.5 and 67.6, the data does not have to be used.

5. When base flood elevation (BFE) data is not available from a federal, state, or other source one of the following methods may be used to determine a BFE For further information regarding the methods for determining BFEs listed below, refer to FEMA's manual *Managing Floodplain Development in Approximate Zone A Areas*:

a) Contour Interpolation

(1) Superimpose approximate Zone A boundaries onto a topographic map and estimate a BFE.

(2) Add one-half of the contour interval of the topographic map that is used to the BFE.

b) Data Extrapolation - A BFE can be determined if a site within 500 feet upstream of a reach of a stream reach for which a 100-year profile has been computed by detailed methods, and the floodplain and channel bottom slope characteristics are relatively similar to the downstream reaches. No hydraulic structures shall be present.

c) Hydrologic and Hydraulic Calculations- Perform hydrologic and hydraulic calculations to determine BFEs using FEMA approved methods and software.

15. Standards for Streams with Established Base Flood Elevations but without Floodways - Along rivers and streams where Base Flood Elevation (BFE) data is provided but no floodway is identified for a Special Flood Hazard Area on the FIRM or in the FIS.

1. No encroachments including fill, new construction, substantial improvements, or other development shall be permitted unless certification with supporting technical data by a registered professional engineer is provided demonstrating that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one foot at any point within the community.

16. Standards for Areas of Shallow Flooding (AO Zones) - Located within the areas of special flood hazard established in section 19.4, are areas designated as shallow flooding. The following provisions shall apply within such areas:

i. All new construction and substantial improvements of residential structures shall have the lowest floor elevated to at least as high as the depth number specified on the Flood Insurance Rate Map, in feet, above the highest adjacent grade. If no depth number is specified, the lowest floor shall be elevated at least three (3) feet above the highest adjacent grade.

ii. All new construction and substantial improvements of non-residential structures shall:

1. Have the lowest floor elevated to at least as high as the depth number specified on the Flood Insurance Rate Map, in feet, above the highest adjacent grade. If no depth number is specified, the lowest floor shall be elevated at least three (3) feet above the highest adjacent grade; or,

2. Be completely flood-proofed together with attendant utility and sanitary facilities to or above that level so that any space below that level is watertight with walls substantially impermeable to the passage of water and with structural components having the capability of resisting hydrostatic and hydrodynamic loads and effects of buoyancy. Certification is required as stated in section 19.34(2).

iii. All structures on slopes must have drainage paths around them to guide water away from the structures.

17. Coastal High Hazard Areas (V-Zones) Located within the areas of special flood hazard established in section 19.4or section 19.35(2) are areas designated as coastal high hazard areas. These areas have special flood hazards associated with wave wash. The following provisions shall apply within such areas:

i. All new construction and substantial improvements shall be located landward of the reach of mean high tide, first line of stable natural vegetation and comply with all applicable Department of Health and Environmental Control (DHEC) Ocean and Coastal Resource Management (OCRM) setback requirements.

ii. All new construction and substantial improvements shall be elevated so that the bottom of the lowest supporting horizontal structural member (excluding pilings or columns) of the lowest floor is located no lower than three (3) feet above the base flood elevation.

iii. All buildings or structures shall be securely anchored on pilings or columns, extending vertically below a grade of sufficient depth and the zone of potential scour, and securely anchored to the subsoil strata.

iv. All pilings and columns and the attached structures shall be anchored to resist flotation, collapse, lateral movement and scour due to the effect of wind and water loads acting simultaneously on all building components.

v. A registered professional engineer or architect shall certify that the design, specifications and plans for construction are in compliance with the provisions contained in Article IV Section 19.52of this ordinance.

vi. There shall be no fill used as structural support. Non-compacted fill may be used around the perimeter of a building for landscaping/aesthetic purposes provided the fill will wash out from storm surge, thereby rendering the building free of obstruction prior to generating excessive loading forces, ramping effects, or wave deflection. Only beach compatible sand may be used. The local floodplain administrator shall approve design plans for landscaping/ aesthetic fill only after the applicant has provided an analysis by an engineer, architect, and/or soil scientist that demonstrates that the following factors have been fully considered:

1. Particle composition of fill material does not have a tendency for excessive natural compaction,

2. Volume and distribution of fill will not cause wave deflection to adjacent properties; and

3. Slope of fill will not cause wave run-up or ramping.

vii. There shall be no alteration of sand dunes that would increase potential flood damage.

viii. All new construction and substantial improvements have the space below the lowest floor either free of obstruction or constructed with non-supporting breakaway walls, open wood lattice-work, or insect screening intended to collapse under wind and water loads without causing collapse, displacement, or other structural damage to the elevated portion of the building or supporting foundation system. For the purpose of this section, a breakaway wall shall have a design safe loading resistance of not less than 10 and no more than 20 pounds per square foot. Breakaway wall enclosures shall not exceed 299 square feet. Only flood resistant materials shall be used below the required flood elevation specified in Article IV.B. One wet location switch and/or outlet connected to a ground fault interrupt breaker may be installed below the required lowest floor elevation specified in Article IV section 19.52(1)

Use of breakaway walls which exceed a design safe loading resistance of 20 pounds per square foot may be permitted only if a registered professional engineer or architect certifies that the designs proposed meet the following conditions:

a) Breakaway wall collapse shall result from water load less than that which would occur during the base flood.

b) The elevated portion of the building and supporting foundation system shall not be subject to collapse, displacement, or other structural damage due to the effects of wind and water loads acting simultaneously on all building components (structural and nonstructural). The water loading shall be those values associated with the base flood. The wind loading values shall be those required by applicable IBC International Building Code.

c) Such enclosed space shall be useable solely for parking of vehicles, building access, or storage. Such space shall not be used for human habitation, finished or partitioned into multiple rooms, or temperature controlled.

9. No manufactured homes shall be permitted except in an existing manufactured home park or subdivision. A replacement manufactured home may be placed on a lot in an existing manufactured home park or subdivision provided the anchoring and elevation standards of Article IV section 19.52(3).

10. Recreational vehicles shall be permitted in Coastal High Hazard Areas provided that they meet the Recreational Vehicle criteria of Article IV section 19.52.

11. Accessory structures, below the required lowest floor elevation specified in Article IV section 19.52(1) are prohibited except for the following:

a) Swimming Pools

(1) They are installed at-grade or elevated so long as the pool will not act as an obstruction

(2) They must be structurally independent of the building and its foundation.

(3) They may be placed beneath a coastal building only if the top of the pool and any accompanying decking or walkway are flush with the existing grade and only if the lower area remains unenclosed.

(4) As part of the certification process for V-zone buildings the design professional must consider the effects that any of these elements will have on the building in question and any nearby buildings.

b) Access Stairs Attached to or Beneath an Elevated Building:

(1) Must be constructed of flood-resistant materials.

(2) Must be constructed as open staircases so they do not block flow under the structure in accordance with Article IV section 19.52(2).

c) Decks

(1) If the deck is structurally attached to a building then the bottom of the lowest horizontal member must be at or above the elevation of the building's lowest horizontal member.

(2) If the deck is to be built below the BFE then it must be structurally independent of the main building and must not cause an obstruction.

(3) If an at-grade, structurally independent deck is proposed then a design professional must evaluate the design to determine if it will adversely affect the building and nearby buildings.

12. Parking areas should be located on a stable grade under or landward of a structure. Any parking surface shall consist of gravel or aggregate.

13. Electrical, ventilation, plumbing, heating and air conditioning equipment (including ductwork), and other service facilities shall be designed and/or located so as to prevent water from entering or accumulating within the components during conditions of base flood event plus three (3) feet. This requirement does not exclude the installation of outdoor faucets for shower heads, sinks, hoses, etc., as long as cut off devices and back flow prevention devices are installed to prevent contamination to the service components and thereby minimize any flood damages to the building. *No* utilities or components shall be attached to breakaway walls.

Secs. 19-53—19-60. - Reserved.

ARTICLE V. - VARIANCE PROCEDURES

Sec. 19-61. - Establishment of appeal board.

The Construction Board of Adjustments and Appeals (appeal board) as established by the Town of Bluffton shall hear and decide requests for variances from the requirements of this chapter.

Sec. 19-62. - Right to appeal.

Any person aggrieved by the decision of the appeal board or any taxpayer may appeal such decision to the Court.

Sec. 19-63. - Historic structures.

Variances may be issued for the repair or rehabilitation of historic structures upon the determination that the proposed repair or rehabilitation will not preclude the structure's continued designation as a historic structure and the variance is the minimum necessary to preserve the historic character and design of the structure.

Sec. 19-64.-Functionally Dependent Uses.

Variances may be issued for development necessary for the conduct of a functionally dependent use, provided the criteria of this Article are met, no reasonable alternative exist, and the development is protected by methods that minimize flood damage and create no additional threat to public safety.

Sec. 19-64. - Agricultural structures.

Variances may be issued to wet floodproof an agricultural structure in accordance with Technical Bulletin 7-93, *Wet Floodproofing Requirements for Structures Located in Special Flood Hazard Areas in accordance with the National Flood Insurance Program*, document number FIA-TB-7, dated 12/93, and available from the Federal Emergency Management Agency. In order to minimize flood damages during the base flood and the threat to public health and safety, the structure must meet all of the conditions and considerations of section 19-68, this section, and the following standards:

(1) Use of the structure must be limited to agricultural purposes as listed below:

a. Pole frame buildings with open or closed sides used exclusively for the storage of farm machinery and equipment;

b. Steel grain bins and steel frame corncribs;

c. General-purpose barns for the temporary feeding of livestock that are open on at least one side;

d. For livestock confinement buildings, poultry houses, dairy operations, and similar livestock operations, variances may not be issued for structures that were substantially damaged. New construction or substantial improvement of such structures must meet the elevation requirements of section 19-52(1) of this chapter; and,

~~e. Detached garages and storage sheds solely used for parking and limited storage in connection with agricultural uses only, which are no greater than 400 square feet in area.~~

(2) The agricultural structure must be built or rebuilt, in the case of an existing building that is substantially damaged, with flood-resistant materials for the exterior and interior building components and elements below the base flood elevation,

(3) The agricultural structure must be adequately anchored to prevent flotation, collapse, or lateral movement. All of the structure's components must be capable of resisting specific flood-related forces including hydrostatic, buoyancy, hydrodynamic, and debris impact forces. Where flood velocities exceed five feet per second, fast-flowing floodwaters can exert considerable pressure on the building's enclosure walls or foundation walls,

(4) The agricultural structure must meet the venting requirement of section 19-52(4) of this chapter,

(5) Any mechanical, electrical, or other utility equipment must be located above the base flood elevation so that they are contained within a watertight, floodproofed enclosure that is capable of resisting damage during flood conditions in accordance with section 19-51(5) of this chapter,

(6) The agricultural structure must comply with the floodway encroachment provisions of section 19-52(5) of this chapter; and,

(7) Major equipment, machinery, or other contents must be protected. Such protection may include protective watertight floodproofed areas within the building, the use of equipment hoists for readily elevating contents, permanently elevating contents on pedestals or shelves above the base flood elevation, or determining that property owners can safely remove contents without risk to lives and that the contents will be located to a specified site out of the floodplain ~~in accordance with the temporary development provisions of section 19-52(11).~~

Sec. 19-65. - Considerations.

In passing upon such applications, the appeal board shall consider all technical evaluations, all relevant factors, all standards specified in other sections of this chapter, and:

(1) The danger that materials may be swept onto other lands to the injury of others;

(2) The danger to life and property due to flooding or erosion damage, and the safety of access to the property in times of flood for ordinary and emergency vehicles;

(3) The susceptibility of the proposed facility and its contents to flood damage and the effect of such damage on the individual owner;

(4) The importance of the services provided by the proposed facility to the community;

(5) The necessity to the facility of a waterfront location, where applicable;

(6) The availability of alternative locations, not subject to flooding or erosion damage, for the proposed use;

(7) The compatibility of the proposed use with existing and anticipated development, and the relationship of the proposed use to the comprehensive plan and floodplain management program for that area;

(8) The expected heights, velocity, duration, rate of rise, and sediment transport of the floodwaters and the effects of wave action, if applicable, expected at the site;

(9) The costs of providing governmental services during and after flood conditions including maintenance and repair of public utilities and facilities such as sewer, gas, electrical and water systems, and streets and bridges; and,

(10) Agricultural structures must be located in wide, expansive floodplain areas, where no other alternative location for the agricultural structure exists. The applicant must demonstrate that the entire farm acreage, consisting of a contiguous parcel of land on which the structure is to be located, must be in the special flood hazard area and no other alternative locations for the structure are available.

Sec. 19-66. - Findings.

Findings listed above shall be submitted to the appeal board, in writing, and included in the application for a variance. Additionally, comments from the Department of Natural Resources, Land, Water and Conservation Division, State Coordinator's Office, may be taken into account and included in the permit file.

Sec. 19-67. - Floodways.

Variances shall not be issued within any designated floodway if any increase in flood levels during the base flood discharge would result unless a CLOMR is obtained prior to issuance of the variance. In order to insure the project is built in compliance with the CLOMR for which the variance is granted the applicant must provide a bond for 100 percent of the cost to perform the development.

Sec. 19-68. - Conditions.

Upon consideration of the factors listed above and the purposes of this chapter, the appeal board may attach such conditions to the granting of variances as it deems necessary to further the purposes of this chapter. The following conditions shall apply to all variances:

(1) Variances may not be issued when the variance will make the structure in violation of other federal, State, or local laws, regulations, or ordinances.

(2) Variances shall only be issued upon a determination that the variance is the minimum necessary, considering the flood hazard, to afford relief.

(3) Variances shall only be issued upon a showing of good and sufficient cause, a determination that failure to grant the variance would result in exceptional hardship, and a determination that the granting of a variance will not result in increased flood heights, additional threats to public safety, extraordinary public expense, create nuisance, cause fraud on or victimization of the public, or conflict with existing local laws or ordinances.

(4) Any applicant to whom a variance is granted shall be given written notice specifying the difference between the base flood elevation and the elevation to which the structure is to be built and a written statement that the cost of flood insurance will be commensurate with the increased risk resulting from the reduced lowest floor elevation. Such notification shall be maintained with a record of all variance actions.

(5) The local administrator shall maintain the records of all appeal actions and report any variances to the Federal Emergency Management Agency upon request.

(6) Variances shall not be issued for unpermitted development or other development that is not in compliance with the provisions of this chapter. Violations must be corrected in accordance with section 19-36(5) of this chapter.

Secs. 19-69—19-75. - Reserved.

ARTICLE VI. - LEGAL STATUS PROVISIONS

Sec. 19-76. - Effect on rights and liabilities under the chapter.

This chapter in part comes forward by re-enactment of some of the provisions of the flood damage prevention ordinance enacted September 30, 1977, as amended, and it is not the intention to repeal but rather to re-enact and continue to enforce without interruption of such existing provisions, so that all rights and liabilities that have accrued there under are reserved and may be enforced. The enactment of this chapter shall not affect any action, suit or proceeding instituted or pending. All provisions of the flood damage prevention ordinance of Town of Bluffton enacted on September 30, 1977, as amended, which are not reenacted herein, are repealed.

Sec. 19-77. - Effect upon outstanding building permits.

Nothing herein contained shall require any change in the plans, construction, size or designated use of any building, structure or part thereof for which a building permit has been granted by the chief building official ~~inspector~~ or his authorized agents before the time of passage of this chapter; provided, however, that when construction is not begun under such outstanding permit within a period of 60 days subsequent to passage of this chapter, construction or use shall be in conformity with the provisions of this chapter.

Federal Emergency Management Agency

Washington, D.C. 20472

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

IN REPLY REFER TO:
19P

September 23, 2020

The Honorable Lisa Sulka
Mayor, Town of Bluffton
20 Bridge Street
Bluffton, South Carolina 29910

Community: Town of Bluffton,
Beaufort County,
South Carolina
Community No.: 450251
Map Panels Affected: See FIRM Index

Dear Mayor Sulka:

This is to formally notify you of the final flood hazard determination for the Town of Bluffton, Beaufort County, South Carolina and Incorporated Areas in compliance with Title 44, Chapter I, Part 67, Section 67.11, Code of Federal Regulations (CFR). This section requires that notice of final flood elevations shall be sent to the Chief Executive Officer of the community, all individual appellants, and the State Coordinating Agency, and shall be published in the *Federal Register*. The flood hazard determinations for you community may include addition of and/or modification to Base Flood Elevations (BFEs), base flood depths, Special Flood Hazard Areas (SFHAs), zone designations, and regulatory floodways. SFHAs are the areas subject to inundation by the flood having a 1-percent change of being equaled or exceeded in any given year (base flood).

On December 18, 1986, the Department of Homeland Security's Federal Emergency Management Agency (FEMA) issued a Flood Insurance Rate Map (FIRM) that identified the SFHAs, the areas subject to inundation by the base (1-percent-annual-chance) flood, in your community. Recently, FEMA completed a re-evaluation of flood hazards in your community. On June 30, 2017 and August 9, 2019, FEMA provided you with Preliminary and revised Preliminary copies of the Flood Insurance Study (FIS) report and FIRM that identify existing flood hazards in your community. A notification of the proposed flood hazard determinations for your community was published in *The Beaufort Gazette* and *The Island Packet* on June 5, 2018 and June 12, 2018, and in the *Federal Register*, at Part 67, Volume 83, Page 14471 on April 4, 2018.

The statutory 90-day appeal period, which was initiated on the second newspaper publication date cited above, has ended. FEMA did not receive any appeals of the proposed flood hazard determinations during that time. Accordingly, the flood hazard determinations for your community are considered final. The flood hazard determinations will be published in the *Federal Register* as soon as possible. The FIRM for your community will become effective on March 23, 2021. Before the effective date, FEMA will send you final printed copies of the FIRM and FIS report.

Because the FIS report establishing the flood hazard determinations for your community has been completed, certain additional requirements must be met under Section 1361 of the National Flood Insurance Act of 1968, as amended, within 6 months from the date of this letter. Prior to March 23, 2021, your community is required, as a condition of continued eligibility in the National Flood Insurance Program (NFIP), to adopt or show evidence of adoption of floodplain management regulations that meet the standards of Paragraph 60.3(d and e) of the NFIP regulations (44 CFR 59, etc.) by the effective date of the FIRM. These standards are the minimum requirements and do not supersede any State or local requirements of a more stringent nature.

It must be emphasized that all the standards specified in Paragraph 60.3(d and e) of the NFIP regulations must be enacted in a legally enforceable document. This includes adoption of the current effective FIS report and FIRM to which the regulations apply and other modifications made by this map revision. Some of the standards should already have been enacted by your community in order to establish initial eligibility in the NFIP. Your community can meet any additional requirements by taking one of the following actions:

1. Amending existing regulations to incorporate any additional requirements of Paragraph 60.3(d and e);

2. Adopting all the standards of Paragraph 60.3(d and e) into one new, comprehensive set of regulations; or

3. Showing evidence that regulations have previously been adopted that meet or exceed the minimum requirements of Paragraph 60.3(d and e).

Communities that fail to enact the necessary floodplain management regulations will be suspended from participation in the NFIP and subject to the prohibitions contained in Section 202(a) of the Flood Disaster Protection Act of 1973 (Public Law 93-234) as amended.

In addition to your community using the FIS report and FIRM to manage development in the floodplain, FEMA will use the FIS report and FIRM to establish appropriate flood insurance rates. On the effective date of the revised FIRM, actuarial rates for flood insurance will be charged for all new structures and substantial improvements to existing structures located in the identified SFHAs. These rates may be higher if structures are not built in compliance with the floodplain management standards of the NFIP. The actuarial flood insurance rates increase as the lowest elevations (including basement) of new structures decrease in relation to the BFEs established for your community. This is an important consideration for new construction because building at a higher elevation can greatly reduce the cost of flood insurance.

To assist your community in maintaining the FIRM, we have enclosed a Summary of Map Actions (SOMA) to document previous Letter of Map Change (LOMC) actions (i.e., Letters of Map Amendment [LOMAs], Letters of Map Revision [LOMRs]) that will be superseded when the revised FIRM panels referenced above become effective. Information on LOMCs is presented in the following four categories: (1) LOMCs for which results have been included on the revised FIRM panels; (2) LOMCs for which results could not be shown on the revised FIRM panels because of scale limitations or because the LOMC issued had determined that the lots or structures involved were outside the SFHA as shown on the FIRM; (3) LOMCs for which results have not been included on the revised FIRM panels because the flood hazard information on which the original determinations were based are being superseded by new flood hazard information; and (4) LOMCs issued for multiple lots or structures where the determination for one or more of the lots or structures cannot be revalidated through an administrative process like the LOMCs in Category 2 above. LOMCs in Category 2 will be revalidated through a single letter that reaffirms the validity of a previously issued LOMC; the letter will be sent to your community shortly before the effective date of the revised FIRM and will become effective 1 day after the revised FIRM becomes effective. For the LOMCs listed in Category 4, we will review the data previously submitted for the LOMA or LOMR request and issue a new determination for the affected properties after the revised FIRM becomes effective.

The FIRM and FIS report for your community have been prepared in our countywide format, which means that flood hazard information for all jurisdictions within Beaufort County has been combined into one FIRM and FIS report. When the FIRM and FIS report are printed and distributed, your community will receive only those panels that present flood hazard information for your community. We will provide complete sets of the FIRM panels to county officials, where they will be available for review by your community.

The FIRM panels have been computer-generated. Once the FIRM and FIS report are printed and distributed, the digital files containing the flood hazard data for the entire county can be provided to your community for use in a computer mapping system. These files can be used in conjunction with other thematic data for floodplain management purposes, insurance purchase and rating requirements, and many other planning applications. Copies of the digital files or paper copies of the FIRM panels may be obtained by calling our FEMA Mapping and Insurance eXchange (FMIX), toll free, at 1-877-FEMA MAP (1-877-336-2627). In addition, your community may be eligible for additional credits under our Community Rating System if you implement your activities using digital mapping files.

If your community is encountering difficulties in enacting the necessary floodplain management measures required to continue participation in the NFIP, we urge you to call the Director, Mitigation Division of FEMA, Region IV, in Atlanta, Georgia, at (770) 220-5200 for assistance. Additional information and resources your community may find helpful regarding the NFIP and floodplain management, such as *The National Flood Insurance Program Code of Federal Regulations*, *Answers to Questions About the National Flood Insurance Program*, *Frequently Asked Questions Regarding the Effects that Revised Flood Hazards have on Existing Structures, Use of Flood Insurance Study (FIS) Data as Available Data,* and *National Flood Insurance Program Elevation Certificate and Instructions,* can be found on our website at http://www.floodmaps.fema.gov/lfd. Paper copies of these documents may also be obtained by calling our FMIX.

Sincerely,

Luis Rodriguez, P.E., Director
Engineering and Modeling Division
Federal Insurance and Mitigation Administration

Enclosure:
Final SOMA

cc: Community Map Repository
Mr. Richard Spruce, Building Official, Town of Bluffton

FINAL SUMMARY OF MAP ACTIONS

Community: BLUFFTON, TOWN OF Community No: 450251

To assist your community in maintaining the Flood Insurance Rate Map (FIRM), we have summarized below the effects of the enclosed revised FIRM panels(s) on previously issued Letter of Map Change (LOMC) actions (i.e., Letters of Map Revision (LOMRs), Letter of Map Revision based on Fill (LOMR-Fs), and Letters of Map Amendment (LOMAs)) that will be affected when the revised FIRM becomes effective on March 23, 2021.

1. LOMCs Incorporated

The modifications effected by the LOMCs listed below will be reflected on the revised FIRM. In addition, these LOMCs will remain in effect until the revised FIRM becomes effective.

LOMC	Case No.	Date Issued	Project Identifier	Original Panel	Current Panel
LOMR	14-04-5124P	04/13/2015	PALMETTO BLUFF	4500250080D 4500250110D	45013C0405G 45013C0408G 45013C0412G 45013C0416G
LOMR	15-04-2707P	06/05/2015	PALMETTO BLUFF	4500250110D	45013C0408G

2. LOMCs Not Incorporated

The modifications effected by the LOMCs listed below will not be reflected on the revised FIRM panels or will not be reflected on the revised FIRM panels because of scale limitations or because the LOMC issued had determined that the lot(s) or structure(s) involved were outside the Special Flood Hazard Area, as shown on the FIRM. These LOMCs will remain in effect until the revised FIRM becomes effective. These LOMCs will be revalidated free of charge 1 day after the revised FIRM becomes effective through a single revalidation letter that reaffirms the validity of the previous LOMCs.

FINAL SUMMARY OF MAP ACTIONS

Community: BLUFFTON, TOWN OF Community No: 450251

2A. LOMCs on Revised Panels

LOMC	Case No.	Date Issued	Project Identifier	Original Panel	Current Panel
LOMR-F	07-04-5095A	09/20/2007	THE HERITAGE AT NEW RIVERSIDE, PHASE 1B, LOTS 59-66 & 71-85 & PHASE 1C, LOTS 119-130 & 133-144	4500250050D	45013C0405G
LOMR-F	09-04-1246A	03/06/2009	THE HAVEN AT NEW RIVERSIDE, BLOCK 2, LOTS 228, 229 & 230 -- 9, 10 & 11 BAYBRIDGE COURT	4500250080D	45013C0405G
LOMR-F	19-04-5016A	08/08/2019	HERITAGE, PHASE 3, LOTS 3023-3029 -- 22, 20, 18, 16, 14, 15 & 17 STEPPING STONE WAY	4500250050D	45013C0385G
LOMR-F	20-04-0016A	01/27/2020	THE HERITAGE PHASE 3, LOTS 3020 -3022, 3030-3032, 3047 & 3048 -- STEPPING STONE WAY & LAKEWAY DRIVE	4500250050D	45013C0385G
LOMR-F	20-04-4188A	07/13/2020	THE HERITAGE, PHASE 3, LOTS 3033, 3045, 3046 -- 25 STEPPING STONE WAY; 106 & 108 LAKEWAY DRIVE	4500250050D	45013C0385G
LOMR-F	20-04-4189A	08/05/2020	THE HERITAGE, PHASE 5, LOTS 5014 -5019 -- 122, 126, 143, 139, 135, 131 OLD MILL CROSSING	4500250050D	45013C0385G
LOMR-F	20-04-4403A	08/18/2020	CYPRESS RIDGE PH 12, LOTS 2501-2514, 2518-2523; PHA 13, LOTS 2601, 2636, 2638; PH 16, LTS 1631-1633	4500250050D	45013C0265G
LOMR-F	20-04-4467A	08/21/2020	CYPRESS RIDGE, PHASE 16, LOTS 1629, 1630; PHASE 13, LOTS 2635, 2637 -- HULSTON LANDING ROAD	4500250050D	45013C0265G

2B. LOMCs on Unrevised Panels

LOMC	Case No.	Date Issued	Project Identifier	Original Panel	Current Panel
			NO CASES RECORDED		

FINAL SUMMARY OF MAP ACTIONS

Community: BLUFFTON, TOWN OF Community No: 450251

3. LOMCs Superseded

The modifications effected by the LOMCs listed below have not been reflected on the Final revised FIRM panels because they are being superseded by new or revised flood hazard information or the information available was not sufficient to make a determination. The reason each is being superseded is noted below. These LOMCs will no longer be in effect when the revised FIRM becomes effective.

LOMC	Case No.	Date Issued	Project Identifier	Reason Determination Will be Superseded
			NO CASES RECORDED	

1. Insufficient information available to make a determination.
2. Lowest Adjacent Grade and Lowest Finished Floor are below the proposed Base Flood Elevation.
3. Lowest Ground Elevation is below the proposed Base Flood Elevation.
4. Revised hydrologic and hydraulic analyses.
5. Revised topographic information.
6. Superseded by another LOMC.

4. LOMCs To Be Redetermined

The LOMCs in Category 2 above will be revalidated through a single revalidation letter that reaffirms the validity of the determination in the previously issued LOMC. For LOMCs issued for multiple lots or structures where the determination for one or more of the lots or structures is no longer valid, the LOMC cannot be revalidated through this administrative process. Therefore, we will review the data previously submitted for the LOMC requests listed below and if appropriate issue a new determination for the affected properties after the effective date of the revised FIRM.

LOMC	Case No.	Date Issued	Project Identifier	Original Panel	Current Panel
			NO CASES RECORDED		

LOCAL FLOODPLAIN ORDINANCE REVIEW

Date: **4/6/2018**

Ordinance Reviewed Under:

○ MAP MOD ● CAP-SSSE

Community Information

Community: Town of Bluffton CID: 450251

County: Beaufort

Floodplain Manager: Richard Spruce Title: Chief Building Offical

CEO: Lisa Sulka Title: Mayor

Community Contact: Richard Spruce

Applicable Floodplain Designations

☐ Community Not Mapped

☐ Zone A ☐ Zone A99 ☐ Zone V ☑ Zone X
☑ Zone AE ☐ Zone AH ☐ Zone VE ☐ Zone B
☐ Zone A1-30 ☐ Zone AO ☐ Zone V1-30 ☐ Zone C

STATE REVIEWER INFORMATION

Name: Jessica Artz Date: 4/6/2018
Title: Flood Mitigation Specialist
Address: 1000 Assembly Street, Columbia, SC 29202
Telephone: (803) 734-4012 Fax: (803) 734-3457 Email: artzj@dnr.sc.gov

Item Description	Action			Ordinance Section/Comments
	Addition	Update	Delete	
Article II		✓		Update definitions of accessory structure, existing structure (with initial FIRM date of 12/18/1986), Mean Sea Level, North American Vertical Datum, New constructin (add date of initial ordinance). Refer to the model ordinance for language.
Article II	✓			Add the following definitions: Stable Natural Vegetation. Refer to the model ordinance for language.
Article III.C.			✓	Delete this language. Biennial reports are no longer required.
Article III.E.2.		✓		Update language using Article III.D.2. of the model ordinance.
Article III.E.5.			✓	Can be removed.
Article III.E. 19.		✓		Update language using Article III.D.18. of the model ordinance.
Article IV.A.		✓		Add "Reasonably Safe From Flooding Language"*. Refer to Article IV.A.1. of the model ordinance.

Reviewers Initials: ________

Article IV.B.3.	✓			Add language regarding an evacuation plan for manufactured home parks. Refer to Article IV.B.3.d) of the model ordinance.
Article IV.B.5.c)			✓	Remove all language regarding temporary development.
Article IV.B.6.a)(7)			✓	Can be removed.
Article IV.B.7.b).		✓		This language has been updated. Refer to Article IV.B.8.b) of the model ordinance.
Article IV.B. 11.			✓	Remove all language regarding temporary development.
Article IV. B.13.e)			✓	Can be removed.
Article IV.B.13.d)		✓		This language has been moved. Refer to Article IV.C.1. of the model ordinance.
Missing from ordinance, add as applicable to new maps.		✓		Article IV.C., Article IV.D., Article IV.E., Article IV.F.

Comments

These are suggested changes based on the differences between the Town's ordinance and the December 2015 version of the SC Flood Damage Prevention model ordinance. The required changes are noted with a "*".

Please submit a **certified true copy that includes a Town seal** to this office. This office will review the updated ordinance to ensure the needed updates are correct prior to the ordinance going before Council.

Reviewers Initials: ________

Reviewers Initials: ________

FEMA Preliminary Flood Hazard Data Town of Bluffton

Ryan Coleman, GISP
1/4/2021 5:16 PM

FEMA Current Flood Hazard Data Town of Bluffton

Ryan Coleman, GISP
1/4/2021 5:14 PM

Attachment 6

Proposed Motion

Consideration of Amendments to the Town of Bluffton Code of Ordinances, Chapter 19 – Flood Damage Protection, Specifically as it Relates to the Updates to the National Floodplain Insurance Program Regulations and FEMA's Re-evaluation of Flood Hazards in the Town of Bluffton Reflected in Updated Flood Insurance Rate Maps

"I move to approve the Proposed Ordinance Amending the Town of Bluffton Code of Ordinances, Chapter 19 – Flood Damage Protection, Specifically as it Relates to the Updates to the National Floodplain Insurance Program Regulations and FEMA's Re-evaluation of Flood Hazards in the Town of Bluffton Reflected in Updated Flood Insurance Rate Maps"

TOWN COUNCIL

STAFF REPORT
Finance and Administration Department

MEETING DATE:	February 9, 2021
PROJECT:	Consideration of an Ordinance Amending the Town of Bluffton Fiscal Year 2021 Budget to reflect the issuance and sale of General Obligation Bonds, 2020A for the purpose of funding the Town of Bluffton Stormwater Utility Fund Capital Improvements Program Project Fund and associated fees and Donation – First Reading
PROJECT MANAGER:	Chris Forster, MPA, CPFO, CGFM, Director of Finance and Administration

RECOMMENDATION:

Town Council consider the approval of the proposed ordinance amending the FY 2021 budget increasing the Debt Service Fund $1,103,408, the Stormwater Utility Fund $93,051, and the new Capital Improvements Program Project Fund $5,080,000 to reflect the issuance and sale of General Obligation Bonds, 2020A for the purpose of funding the Town of Bluffton Stormwater Utility Fund Capital Improvements Program Project Fund and the associated fees. As well as an increase to the General Fund of $9,000 to reflect a private donation to provide AED equipment for the Police department.

BACKGROUND/DISCUSSION:

Town Council authorized the issuance and sale of not to exceed $5,250,000 General Obligation Bonds, 2020 or such other appropriate series designation (the "Bonds"), for the purpose of funding the Town of Bluffton Stormwater Utility Fund Capital Improvements Program projects on second and final reading at the November 10, 2020 Town Council meeting.

Our Bond Counsel, Francenia Heizer, Esquire with Burr Forman McNair and our Financial Advisor, Brian Nurick, Senior Managing Director with Compass Municipal Advisors, LLC, recommended that the Bond be issued before the end of 2020 to take advantage of favorable interest rates.

On December 3, 2020, the Town of Bluffton sold twenty-year General Obligation Bonds, Series 2020A with a Par Value of $5,080,000 and a net interest rate of 1.698% taking advantage of favorable interest rates and the Town's strong financial position.

The increase to the Debt Service Fund of $1,103,408 is to record the transfer in from the Stormwater Utility Fund for the first interest payment of $93,408 and principal payment of $1,010,000 which is offset by the $810,224 Deposit Net Bid Premium, resulting in the net payment of $1,103,408.

The increase to the Stormwater Utility Fund of $93,051 is to record the transfer to Debt Service for the first interest payment. Funds to cover the interest were budgeted in the FY 2021 revenue and therefore reflected as a reduction to fund balance.

The increase to the new Capital Improvements Program Project Fund of $5,003,000 is to record the par value of the bonds of $5,080,000 less the cost of issuance of $77,000.

On January 27, 2021, the Town of Bluffton received a $9,000 private donation to provide AED equipment for the Police department.

ATTACHMENTS:

1. Ordinance
   - Attachment A: General Fund Budget
   - Attachment B: Debt Service Fund Budget
   - Attachment C: Stormwater Utility Fund Budget
   - Attachment D: Capital Improvements Program Project Fund Budget
   - Attachment E: Consolidated Budget
2. Council Motion Recommendation

AN ORDINANCE OF THE TOWN OF BLUFFTON
ORDINANCE NO. 2021-
FISCAL YEAR 2021 BUDGET

TO AMEND THE BUDGET FOR THE TOWN OF BLUFFTON, SOUTH CAROLINA, FOR THE FISCAL YEAR ENDING JUNE 30, 2021;
TO PROVIDE FOR THE EXPENDITURES OF CERTAIN FUNDS;
AND TO ALLOCATE THE SOURCES OF REVENUE FOR THE SAID FUNDS.

WHEREAS, Section 5-7-260 of the Code of Laws of South Carolina requires that a municipal council act by ordinance to adopt a budget and levy taxes, pursuant to public notice; and

WHEREAS, the Town Council did adopt Budget Ordinance 2020-07 on June 9, 2020; and did adopt Budget Amendment Ordinance 2020-23 on October 13, 2020; and did adopt Budget Amendment Ordinance 2020-26 on November 20, 2020;

WHEREAS, pursuant to Sections 6 and 7 of said budget ordinance, the Town Council is desirous of amending the budget so as to revised the General Fund to reflect revenue and expenditures associated with the private donation to provide AED equipment for the Police department; and

WHEREAS, pursuant to Sections 6 and 7 of said budget ordinance, the Town Council is desirous of amending the budget so as to revise the Debt Service Fund and Stormwater Utility Fund to reflect revenue and expenditures associated with the issuance and sale of General Obligation Bonds, 2020A for the purpose of funding the Town of Bluffton Stormwater Utility Fund Capital Improvements Program Project Fund; and

WHEREAS, pursuant to Section 3 of said ordinance, the Town Council is desirous of establishing a Capital Improvements Program Project Fund for the purpose of recording the General Obligation Bonds for the Stormwater Utility Projects; and

NOW, THEREFORE, BE IT ORDERED AND ORDAINED BY THE TOWN COUNCIL OF THE TOWN OF BLUFFTON, SOUTH CAROLINA; AND IT IS ORDAINED BY THE AUTHORITY OF THE SAID TOWN COUNCIL:

SECTION 1. AMENDMENT

The adopted fiscal year 2021 budget is amended to make the following changes and additions to the funds from prior years and to the projected revenue and expenditure accounts as follows:

GENERAL FUND		
Revenues and Other Sources		
Revenues		
Donation	$	9,000
Other Sources		
Prior Year Fund Balance		
Total Revenues and Other Sources	$	9,000

DEBT SERVICE FUND

Revenues and Other Sources	
Other Sources	
Premium on Sale of Bonds	$ 810,224
Transfer In - Stormwater Utility Fund	293,184
Total Revenues and Other Sources	$ 1,103,408
Expenditures and Other Uses	
Seris 2020A GO Bond Debt Service	
Principal	$ 1,010,000
Interest	93,408
Total Expenditures and Other Uses	$ 1,103,408

STORMWATER UTILITY FUND

Revenues and Other Sources	
Other Sources	
Prior Year Fund Balance	$ 93,051
Total Revenues and Other Sources	$ 93,051
Expenditures and Other Uses	
Other Uses	
Contribution to Fund Balance	$ (357)
Transfer to Capital Improvements Program Fund	93,408
Total Expenditures and Other Uses	$ 93,051

STORMWATER UTILITY CAPITAL IMPROVEMENTS PROGRAM PROJECT FUND

Revenues and Other Sources	
Other Sources	
Series 2020A GO Bond	$ 5,080,000
Total Revenues and Other Sources	$ 5,080,000
Expenditures and Other Uses	
Cost of Issuance	$ 77,000
Other Uses	
Transfer to Capital Improvements Program Fund	708,565
Contribution to Fund Balance	4,294,435
Total Expenditures and Other Uses	$ 5,080,000

The effect of this amendment will be to increase the General Fund to $19,501,476 (Attachment A); the Debt Service Fund to $5,125,119 (Attachment B); the Stormwater Utility Fund to $2,538,882 (Attachment C); the Stormwater Utility Capital Improvements Program Project Fund to $5,080,000 (Attachment D). The Capital Improvements Program Fund remains at $11,619,161 for a total Consolidated Budget of $43,864,638 (Attachment E).

SECTION 2. SEVERABILITY

If any section, phrase, sentence, or portion of this Ordinance is for any reason held invalid or unconstitutional by any court of competent jurisdiction, such portion shall be deemed a separate, distinct, and independent provision, and such holding shall not affect the validity of the remaining portions thereof.

SECTION 3. EFFECTIVE DATE

This Ordinance shall be effective upon its enactment by the Town Council for the Town of Bluffton.

PASSED, APPROVED, AND ADOPTED BY THE COUNCIL FOR THE TOWN OF BLUFFTON ON THIS _____ DAY OF _______________, 2021.

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

ATTEST:

____
Kim Chapman, Town Clerk
Town of Bluffton, South Carolina

First Reading: February 9, 2021
Second Reading:

Attachments:

A. General Fund Budget
B. Debt Service Fund Budget
C. Stormwater Utility Fund Budget
D. Capital Improvements Program Project Fund Budget
E. Consolidated Budget

Town of Bluffton
General Fund Budget

	Adopted FY 2021 Budget	Carry Forward Budget Amendment	Budget Amendment #2	Budget Amendment #3	Proposed FY 2021 Budget
Revenues					
Property Taxes	$ 6,533,000	$ -	$ -	$ -	$ 6,533,000
Licenses & Permits					
Business Licenses	2,161,080	-	55,250	-	2,216,330
MASC Telecommunications	68,000	-	-	-	68,000
MASC Insurance Tax Collection	2,341,000	-	-	-	2,341,000
Franchise Fees	2,758,000	-	-	-	2,758,000
Building Safety Permits	2,106,000	-	-	-	2,106,000
Application Fees	50,000	-	-	-	50,000
Administrative Fees	44,000	-	-	-	44,000
Total Licenses & Permits	9,528,080	-	55,250	-	9,583,330
Grants and Entitlements	410,000	-	-	-	410,000
Intergovernmental	408,000	-	-	-	408,000
Service Revenues	618,035	-	-	-	618,035
Fines & Fees	220,000	-	-	-	220,000
Interest Income	25,000	-	-	-	25,000
Miscellaneous Revenues	138,000	-	-	9,000	147,000
Total Revenues	17,880,115	-	55,250	9,000	17,944,365
Other Financing Sources	-	-	-	-	-
Transfers In	1,482,900	101,461	(27,250)	-	1,557,111
Total Other Financing Sources & Tranfers In	1,482,900	101,461	(27,250)	-	1,557,111
Total Revenues and Other Financing Sources	$ 19,363,015	$ 101,461	$ 28,000	$ 9,000	$ 19,501,476
Expenditures					
Town Council	$ 117,185	$ -	$ -	$ -	$ 117,185
Executive	923,516	-	-	-	923,516
Economic Development	405,120	-	-	-	405,120
Human Resources	413,660	-	-	-	413,660
Police	7,102,892	-	-	9,000	7,111,892
Municipal Judges	59,910	-	-	-	59,910
Municipal Court	361,836	-	-	-	361,836
Finance	964,265	-	28,000	-	992,265
Information Technology	1,245,776	-	-	-	1,245,776
Customer Service	239,700	-	-	-	239,700
Planning & Community Development	1,368,670	-	-	-	1,368,670
Building Safety	680,505	-	-	-	680,505
Project Management	918,172	-	-	-	918,172
Public Works	2,064,708	-	-	-	2,064,708
Town Wide	2,439,100	-	-	-	2,439,100
Total Expenditures	19,305,015	-	28,000	9,000	19,342,015
Other Financing Uses					
Transfers Out to Capital Improvements Program Fund	58,000	101,461	-	-	159,461
Total Transfers	58,000	101,461	-	-	159,461
Total Expenditures and Other Financing Uses	$ 19,363,015	$ 101,461	$ 28,000	$ 9,000	$ 19,501,476

Town of Bluffton
Debt Service Fund Budget

		Adopted FY 2021 Budget		Carry Forward Budget Amendment		Budget Amendment #2		Budget Amendment #3		Proposed FY 2021 Budget
Revenues										
Property Taxes										
Real & Personal Property Tax (TIF)	$	2,429,000	$	-	$	-	$	-	$	2,429,000
GO Bond Debt Service Property Tax		380,507		-		-		-		380,507
Total Property Tax		2,809,507		-		-		-		2,809,507
Licenses & Permits										
Municipal Improvement District Fee		262,440		-		-		-		262,440
Grants and Entitlements		-		-		-		-		-
Intergovernmental		-		-		-		-		-
Service Revenues		-		-		-		-		-
Fines & Fees		-		-		-		-		-
Interest Income		4,400		-		-		-		4,400
Miscellaneous Revenues		-		-		-		-		-
Total Revenues		3,076,347		-		-		-		3,076,347
Other Financing Sources		-		-		-		-		-
Premium on Sale of Bonds		-		-		-		810,224		810,224
Transfers In		555,281		390,083		-		293,184		1,238,548
Total Other Financing Sources & Tranfers In		555,281		390,083		-		1,103,408		2,048,772
Total Revenues and Other Financing Sources	$	3,631,628	$	390,083	$	-	$	1,103,408	$	5,125,119
Expenditures										
Series 2014 TIF Bonds Debt Service										
Principal	$	808,488	$	-	$	-	$	-	$	808,488
Interest		123,193		-		-		-		123,193
Series 2020 GO Bonds Debt Service										
Principal		210,000		-		-		-		210,000
Interest		166,371		-		-		-		166,371
Series 2020A GO Bonds Debt Service (Projects)										
Principal		-		-		-		1,010,000		1,010,000
Interest		-		-		-		93,408		93,408
Miscellaneous		50		-		-		-		50
Total Expenditures		1,308,102		-		-		1,103,408		2,411,510
Other Financing Uses										
Transfers Out to Capital Improvements Program Fund		2,323,526		390,083		-		-		2,713,609
Total Transfers		2,323,526		390,083		-		-		2,713,609
Total Expenditures and Other Financing Uses	$	3,631,628	$	390,083	$	-	$	1,103,408	$	5,125,119

Town of Bluffton
Stormwater Utility Fund Budget

	Adopted FY 2021 Budget	Carry Forward Budget Amendment	Budget Amendment #2	Budget Amendment #3	Proposed FY 2021 Budget
Revenues					
Stormwater Utility Fee	$ 1,678,667	$ -	$ -	$ -	$ 1,678,667
Licenses & Permits					
NPDES Plan Review Fee	365,000	-	-	-	365,000
NPDES Inspection Fee	-	-	-	-	-
Total Licenses & Permits	365,000	-	-	-	365,000
Grants and Entitlements	-	-	-	-	-
Intergovernmental	-	-	-	-	-
Service Revenues	-	-	-	-	-
Fines & Fees	-	-	-	-	-
Interest Income	150	-	-	-	150
Miscellaneous Revenues	-	-	-	-	-
Total Revenues	2,043,817	-	-	-	2,043,817
Other Financing Sources	-	-	-	-	-
Transfers In	-	402,014	-	93,051	495,065
Total Other Financing Sources & Tranfers In	-	402,014	-	93,051	495,065
Total Revenues and Other Financing Sources	$ 2,043,817	$ 402,014	$ -	$ 93,051	$ 2,538,882
Expenditures					
Watershed Management	$ 1,190,783	$ -	$ -	$ -	$ 1,190,783
Total Expenditures	1,190,783	-	-	-	1,190,783
Other Financing Uses					
Transfers Out to Capital Improvements Program Fund	722,677	402,014	-	-	1,124,691
Transfers Out to General Fund	130,000	-	-	-	130,000
Transfer to Debt Service	-	-	-	93,408	93,408
Contribution to Fund Balance	357	-	-	(357)	-
Total Transfers	853,034	402,014	-	93,051	1,348,099
Total Expenditures and Other Financing Uses	$ 2,043,817	$ 402,014	$ -	$ 93,051	$ 2,538,882

Town of Bluffton
Capital Project Fund

	Adopted FY 2021 Budget	Carry Forward Budget Amendment	Budget Amendment #2	Budget Amendment #3	Proposed FY 2021 Budget
Revenues					
Property Taxes	$ -	$ -	$ -	$ -	$ -
Licenses & Permits					
Grants and Entitlements	-	-	-	-	-
Intergovernmental	-	-	-	-	-
Service Revenues	-	-	-	-	-
Fines & Fees	-	-	-	-	-
Interest Income	-	-	-	-	-
Miscellaneous Revenues	-	-	-	-	-
Total Revenues	-	-	-	-	-
Other Financing Sources	-	-	-	5,080,000	5,080,000
Transfers In	-	-	-	-	-
Total Other Financing Sources & Tranfers In	-	-	-	5,080,000	5,080,000
Total Revenues and Other Financing Sources	$ -	$ -	$ -	$ 5,080,000	$ 5,080,000
Expenditures					
Cost of Issuance	$ -	$ -	$ -	$ 77,000	$ 77,000
Total Expenditures	-	-	-	77,000	77,000
Other Financing Uses					
Transfers Out to Capital Improvements Program Fund	-	-	-	708,565	708,565
Contribution to Fund Balance	-	-	-	4,294,435	4,294,435
Total Transfers	-	-	-	5,003,000	5,003,000
Total Expenditures and Other Financing Uses	$ -	$ -	$ -	$ 5,080,000	$ 5,080,000

Town of Bluffton
Consolidated Budget

		Adopted FY 2021 Budget		Carry Forward Budget Amendment		Budget Amendment #2		Budget Amendment #3		Proposed FY 2021 Budget
Revenues										
General Fund	$	19,363,015	$	101,461	$	28,000	$	9,000	$	19,501,476
Stormwater Fund		2,043,817		402,014		-		93,051		2,538,882
CIP Fund		9,185,407		2,433,754		-		-		11,619,161
Debt Service Fund		3,631,628		390,083		-		1,103,408		5,125,119
Capital Project Fund		-		-		-		5,080,000		5,080,000
Total Revenues	$	34,223,867	$	3,327,312	$	28,000	$	6,285,459	$	43,864,638
Expenditures										
General Fund	$	19,363,015	$	101,461	$	28,000	$	9,000	$	19,501,476
Stormwater Fund		2,043,817		402,014		-		93,051		2,538,882
CIP Fund		9,185,407		2,433,754		-		-		11,619,161
Debt Service Fund		3,631,628		390,083		-		1,103,408		5,125,119
Capital Project Fund		-		-		-		5,080,000		5,080,000
Total Expenditures	$	34,223,867	$	3,327,312	$	28,000	$	6,285,459	$	43,864,638

TOWN COUNCIL

STAFF REPORT
Executive Office

MEETING DATE:	February 9, 2021
PROJECT:	Consideration of an Emergency Ordinance of the Town of Bluffton, South Carolina, Requiring Individuals to Wear Face Coverings in Certain Circumstances in Light of the COVID-19 Pandemic; and Matters Related Thereto; and Severability
PROJECT MANAGER:	Scott M. Marshall, MPA, ICMA-CM – Interim Town Manager

RECOMMENDATION:

Request Town Council's consideration of the Emergency Ordinance at Attachment 1, which renews the current requirement for the wearing of face coverings in certain public settings and by employees of certain public establishments, as set forth in Emergency Ordinance 2020-10 and extended by Emergency Ordinances 2020-18, 2020-22 and 2020-29.

BACKGROUND:

On June 30, 2020, in response to an increasing number of positive COVID-19 tests reported by the South Carolina Department of Health and Environmental Control (SCDHEC) and as part of a regional effort to slow the spread of the disease, Town Council enacted Emergency Ordinance 2020-10. Emergency Ordinance 2020-10 requires the wearing of face coverings in certain social situations and by employees of certain establishments who come into contact with the public in the performance of their jobs.

This Emergency Ordinance was first adopted on June 30 and has been renewed three times since then. Most recently, Town Council renewed this Emergency Ordinance by unanimous approval of Emergency Ordinance 2020-29 on December 8, 2020. Emergency Ordinance 2020-29 will expire on February 12, 2021 unless otherwise renewed, amended, or rescinded by Town Council.

DISCUSSION:

The Town of Bluffton Emergency Ordinance presented for consideration at Attachment 1 replicates the requirements specified in Emergency Ordinances 2020-10, 2020-18, 2020-22 and 2020-29; and contains the following features:

Section 1. Definitions.

a. "Face Covering" is defined as a uniform piece of cloth, fabric, or other material that securely covers a person's nose and mouth and remains affixed in place without the use of one's hands. Face Coverings include, but are not limited to, bandanas, medical masks, cloth masks, scarves, and gaiters, provided that they are worn such that they securely cover the person's nose and mouth.

b. "Person" as used in the context of Section 3.b. is defined as any individual associated with the business who has the control or authority and ability to enforce the requirements of the Ordinance within the business, such as an owner, manager or supervisor. "Person" may also include an employee or other designee that is present at the business but does not have the title of manager, supervisor, etc., but has the authority and ability to ensure that the requirements of this Ordinance are met while the business is open to the public.

Section 2. Requirements for Face Coverings.

a. All persons entering any building open to the public in the Town must wear a face covering while inside the building.

b. All restaurants, retail establishments of every description, salons, grocery stores, and pharmacies in the limits of the Town shall require their employees to wear a Face Covering at all times that the employees are in any area where the general public is allowed. This requirement also applies to all persons providing or utilizing over-the-road public or commercial transportation, including tours; and all businesses or employees while interacting with people in outdoor spaces, including, but not limited to, curbside pickup, delivery, and service calls. All such businesses must provide face coverings or materials for the making of such face coverings for their employees. Such coverings or materials may be made available staff-wide or individually upon employee request so long as the result is the organization-wide use of face coverings. Nothing shall prevent an employee from fashioning his or her own cloth face mask. If a worker or customer refuses to wear a cloth face covering for other than medical reasons, a business may decline entry or service to that individual.

c. The following individuals are exempt from this Ordinance: any person under the age of eight, or who is unable to safely wear a Face Covering due to age or an underlying health condition, or who is unable to remove the Face Covering without the assistance of others; and any person traveling in a personal vehicle, or when a person is alone or is in the presence of only household members in an enclosed space, and people who are actively drinking or eating. This Ordinance does not relieve business establishments and restaurants from other social distancing requirements imposed by the Governor's Executive Orders.

Section 3. Penalties.

a. Failure to comply is a civil infraction, punishable by a fine of not more than $50.00.

b. Each day of non-conformance is a separate and distinct offense. Repeated offenses may result in suspension or revocation of occupancy permits and/or business license, where applicable. Repeated violations may also be declared a public nuisance. **However, every effort shall be made to bring the person or business into compliance before issuing a citation**.

Section 4. Severability. If any part of the Ordinance is deemed invalid, the remaining portion(s) of the Emergency Ordinance shall remain valid.

Section 5. Effective Date; Expiration.

a. Must be passed by a super majority of at least 2/3 of Town Council on a single reading. This means the ordinance must receive a favorable vote of no less than four out of five members of the Town Council of the Town of Bluffton.

b. Emergency Ordinance shall be effective on February 12, 2021

c. Emergency Ordinance is terminated when rescinded by a subsequent ordinance, or on the 61st day of enactment, whichever is sooner. This means the Emergency Ordinance, in absence of further Town Council action, would expire on April 14, 2021.

ATTACHMENTS:

1. Emergency Ordinance of the Town of Bluffton, South Carolina, Requiring Individuals to Wear Face Coverings in Certain Circumstances in Light of the COVID-19 Pandemic; and Matters Related Thereto; and Severability
2. Emergency Ordinance 2020-29
3. Motion Language

EMERGENCY ORDINANCE No. 2021-

TOWN OF BLUFFTON, SOUTH CAROLINA

AN EMERGENCY ORDINANCE OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, REQUIRING INDIVIDUALS TO WEAR FACE COVERINGS IN CERTAIN CIRCUMSTANCES IN LIGHT OF THE COVID-19 PANDEMIC; AND MATTERS RELATED THERETO; AND SEVERABILITY

WHEREAS, it is well recognized that SARS-CoV-2 the virus that causes the disease COVID-19 presents a public health concern that requires extraordinary protective measures and vigilance; and

WHEREAS, on March 11, 2020, the World Health Organization declared a world-wide pandemic; and

WHEREAS, on March 13, 2020, the President of the United States declared a National Emergency for the United States and its territories in an effort to reduce the spread of the virus; and

WHEREAS, also on March 13, 2020, the Governor of the State of South Carolina (the "State") issued Executive Order 2020-08, declaring a State of Emergency based on a determination that the COVID-19 poses an actual or imminent public health emergency for the State; and

WHEREAS, the Governor of the State has continued to declare that a State of Emergency exists throughout South Carolina and has issued the following Executive Orders extending the State of Emergency throughout the State: 2020-15, 2020-23, 2020-29, 2020-35, 2020-38, 2020-40, 2020-42, 2020-44, 2020-48, 2020-53, 2020-56, 2020-59, 2020-62, 2020-63, 2020-65, 2020-67, 2020-70,2020-72, 2020-75, 2020-77, 2021-03 and 2021-07; and

WHEREAS, COVID-19 has spread across the state with the South Carolina Department of Health and Environmental Control ("SCDHEC") confirming that localized person-to-person contact in South Carolina enables a significant risk of exposure, propagates the spread of COVID–19 infection and creates an extreme public health risk; and

WHEREAS, SC DHEC's two-week incidence rate of COVID-19 infections currently places Beaufort County in the High Incidence category; and

WHEREAS, it is vitally important that we all work together to decrease the widespread proliferation of COVID-19 among us all now rather than suffer the unfortunate and devastating consequences later; and

WHEREAS, the Centers for Disease Control and Prevention ("CDC") and SCDHEC advise the use of cloth face coverings to slow the spread of COVID-19; and

WHEREAS, S.C. Code § 5-7-250(d) provides that "to meet public emergencies affecting life, health, safety or the property of the people, council may adopt emergency ordinances by the affirmative vote of at least two-thirds of the members of council present. An emergency ordinance is effective immediately upon its enactment without regard to any reading, public hearing, publication requirements, or public notice requirements. Emergency ordinances shall expire automatically as of the sixty-first day following the date of enactment;" and

WHEREAS, taking measures to control outbreaks minimizes the risk to the public and contributes to the health and safetyof the Town's residents and limits the spread of infection in our community and within the healthcare delivery system; and

WHEREAS, in order to protect, preserve, and promote the general health, safety and welfare and the peace and order of the community, the Town is taking steps to try to protect the citizens and employees of the Town from increased risk of exposure; and

WHEREAS, considering the foregoing, Council adopted Emergency Ordinance 2020-10 on June 30, 2020, which prescribed requirements for face coverings as specified in Section 2 of this ordinance; and

WHEREAS, Emergency Ordinance 2020-10 has since been renewed three times, with the latest renewal by Emergency Ordinance 2020-29 on December 8, 2020; and

WHEREAS, data indicate a correlation between mandated requirements for face coverings and a downward trend in positive COVID-19 cases; and

WHEREAS, in response to the continuing health risk associated with the COVID-19 pandemic, Council deems the wearing of face coverings to be an effective infection control strategy; and

WHEREAS, Emergency Ordinance 2020-29 is set to expire on February 12, 2021 and Council is continuing to take measures to control outbreaks and minimize public health risks.

NOW, THEREFORE, BE IT ORDAINED BY THE TOWN COUNCIL OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, in accordance with the forgoing as follows:

Section 1. Definitions.

(a) "Face Covering" means a uniform piece of cloth, fabric, or other material that securely covers a person's nose and mouth and remains affixed in place without the use of one's hands. Face Coverings include, but are not limited to, bandanas, medical masks, cloth masks, scarves, and gaiters, provided that they are worn such that they securely cover the person's nose and mouth.

(b) For the purposes of Section 3(b) of this Ordinance, "person" shall be defined as any individual associated with the business who has the control or authority and ability to enforce the requirements of the Ordinance within the business, such as an owner, manager or supervisor. "Person" may also include an employee or other designee that is present at the business but does not have the title of manager, supervisor, etc., but has the authority and ability to ensure that the requirements of this Ordinance are met while the business is open to the public.

Section 2. Requirements for Face Coverings.

(a) All persons entering any building open to the public in the Town must wear a face covering while inside the building.

(b) All restaurants, retail establishments of every description, salons, grocery stores, and pharmacies in the limits of the Town shall require their employees to wear a Face Covering at all times that the employees are in any area where the general public is allowed. This requirement also applies to all persons providing or utilizing over-the-road public or commercial transportation, including tours; and all businesses or employees while interacting with people in outdoor spaces, including, but not limited to, curbside pickup, delivery, and service calls. All such businesses must provide face coverings or materials for the making of such face coverings for their employees. Such coverings or materials may be made available staff-wide or individually upon employee request so long as the result is the organization-wide use of face coverings. Nothing shall prevent an employee from fashioning his or her own cloth face mask. If a worker or customer refuses to wear a cloth face covering for other than medical reasons, a business may decline entry or service to that individual.

(c) The following individuals are exempt from this Ordinance: any person under the age of eight, or who is unable to safely wear a Face Covering due to age or an underlying health condition, or who is unable to remove the Face Covering without the assistance of others; and any person traveling in a personal vehicle, or when a person is alone or is in the presence of only household members in an enclosed space, and people who are actively drinking or eating. This Ordinance does not relieve business establishments and restaurants from other social distancing requirements imposed by the Governor's Executive Orders.

Section 3. Penalties.

(a) A person who fails to comply with Section 2.(a) or Section 2.(b) of this Ordinance shall be guilty of a civil infraction, punishable by a noncriminal fine of not more than $50.00. No state assessments will be assessed on this civil infraction/noncriminal fine.

(b) Each day of a continuing violation of this Ordinance shall be considered a separate and distinct offense. In addition to the fines established by this section, repeated violations of this Ordinance by a person who owns, manages, operates or otherwise controls a business subject to this Ordinance may, subject to all procedural protections set forth in the Town Code of Ordinances, result in the suspension or revocation of any occupancy permit or business license issued to business where the repeated violations occurred. Repeated violations of this Ordinance are additionally hereby declared to be a public nuisance, which may be abated by the Town by restraining order, preliminary and permanent injunction, or other means provided for by the Town Code of Ordinances and laws of this state. The foregoing notwithstanding, every effort shall be made to bring the business into voluntary compliance with the terms of this Ordinance prior to the issuance of any citation.

(c) The Town of Bluffton Municipal Court shall have jurisdiction on any and all infractions and/or suspension/revocation of permits or licenses as set out in this Section 3.

Section 4. Severability. If any provision, clause, sentence or paragraph of this Ordinance or the application thereof to any person or circumstances shall be held invalid, that invalidity shall not affect the other provisions of this Ordinance which can be given effect without the invalid provisions or application, and to this end the provisions of this Ordinance are declared to be severable.

Section 5. Effective Date; Expiration. The provisions hereof shall be adopted upon a single hearing and two-thirds vote of the Governing Body, and shall be effective on February 12, 2021, and shall be terminated by the issuance of another ordinance or shall automatically expire on the 61st day after enactment of this Ordinance, whichever date is earlier.

DONE, RATIFIED AND ENACTED AS AN EMERGENCY ORDINANCE BY THE TOWN COUNCIL OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, AT AN EMERGENCY MEETING, and approved at a meeting duly assembled by no less than an affirmative vote of two-thirds of the members of the Governing Body present, on this 9th day of February, 2021.

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

ATTEST:

____
Kimberly Chapman, Town Clerk
Town of Bluffton, South Carolina

EMERGENCY ORDINANCE No. 2020-29

TOWN OF BLUFFTON, SOUTH CAROLINA

AN EMERGENCY ORDINANCE OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, REQUIRING INDIVIDUALS TO WEAR FACE COVERINGS IN CERTAIN CIRCUMSTANCES IN LIGHT OF THE COVID-19 PANDEMIC; AND MATTERS RELATED THERETO; AND SEVERABILITY

WHEREAS, it is well recognized that SARS-CoV-2 the virus that causes the disease COVID-19 presents a public health concern that requires extraordinary protective measures and vigilance; and

WHEREAS, on March 11, 2020, the World Health Organization declared a world-wide pandemic; and

WHEREAS, on March 13, 2020, the President of the United States declared a National Emergency for the United States and its territories in an effort to reduce the spread of the virus; and

WHEREAS, also on March 13, 2020, the Governor of the State of South Carolina (the "State") issued Executive Order 2020-08, declaring a State of Emergency based on a determination that the COVID-19 poses an actual or imminent public health emergency for the State; and

WHEREAS, the Governor of the State has continued to declare that a State of Emergency exists throughout South Carolina and has issued the following Executive Orders extending the State of Emergency throughout the State: 2020-15, 2020-23, 2020-29, 2020-35, 2020-38, 2020-40, 2020-42, 2020-44, 2020-48, 2020-53, 2020-56, 2020-59, 2020-62, 2020-63, 2020-65, 2020-67 and 2020-70; and

WHEREAS, COVID-19 has spread across the state with the South Carolina Department of Health and Environmental Control ("SCDHEC") confirming that localized person-to-person contact in South Carolina enables a significant risk of exposure, propagates the spread of COVID–19 infection and creates an extreme public health risk; and

WHEREAS, SC DHEC's two-week incidence rate of COVID-19 infections currently places Beaufort County in the High Incidence category; and

WHEREAS, it is vitally important that we all work together to decrease the widespread proliferation of COVID-19 among us all now rather than suffer the unfortunate and devastating consequences later; and

WHEREAS, the Centers for Disease Control and Prevention ("CDC") and SCDHEC advise the use of cloth face coverings to slow the spread of COVID-19; and

WHEREAS, S.C. Code § 5-7-250(d) provides that "to meet public emergencies affecting life, health, safety or the property of the people, council may adopt emergency ordinances by the affirmative vote of at least two-thirds of the members of council present. An emergency ordinance is effective immediately upon its enactment without regard to any reading, public hearing, publication requirements, or public notice requirements. Emergency ordinances shall expire automatically as of the sixty-first day following the date of enactment;" and

WHEREAS, taking measures to control outbreaks minimizes the risk to the public and contributes to the health and safety of the Town's residents and limits the spread of infection in our community and within the healthcare delivery system; and

WHEREAS, in order to protect, preserve, and promote the general health, safety and welfare and the peace and order of the community, the Town is taking steps to try to protect the citizens and employees of the Town from increased risk of exposure; and

WHEREAS, considering the foregoing, Council adopted Emergency Ordinance 2020-10 on June 30, 2020, which prescribed requirements for face coverings as specified in Section 2 of this ordinance; and

WHEREAS, Emergency Ordinance 2020-10 has since been renewed twice, with the latest renewal by Emergency Ordinance 2020-22 on October 13, 2020; and

WHEREAS, data indicate a correlation between mandated requirements for face coverings and a downward trend in positive COVID-19 cases; and

WHEREAS, in response to the continuing health risk associated with the COVID-19 pandemic, Council deems the wearing of face coverings to be an effective infection control strategy; and

WHEREAS, Emergency Ordinance 2020-22 is set to expire on December 13, 2020 and Council is continuing to take measures to control outbreaks and minimize public health risks.

NOW, THEREFORE, BE IT ORDAINED BY THE TOWN COUNCIL OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, in accordance with the forgoing as follows:

Section 1. Definitions.

(a) "Face Covering" means a uniform piece of cloth, fabric, or other material that securely covers a person's nose and mouth and remains affixed in place without the use of one's hands. Face Coverings include, but are not limited to, bandanas, medical masks, cloth masks, scarves, and gaiters, provided that they are worn such that they securely cover the person's nose and mouth.

(b) For the purposes of Section 3(b) of this Ordinance, "person" shall be defined as any individual associated with the business who has the control or authority and ability to enforce the requirements of the Ordinance within the business, such as an owner, manager or supervisor. "Person" may also include an employee or other designee that is present at the business but does not have the title of manager, supervisor, etc., but has the authority and ability to ensure that the requirements of this Ordinance are met while the business is open to the public.

Section 2. Requirements for Face Coverings.

(a) All persons entering any building open to the public in the Town must wear a face covering while inside the building.

(b) All restaurants, retail establishments of every description, salons, grocery stores, and pharmacies in the limits of the Town shall require their employees to wear a Face Covering at all times that the employees are in any area where the general public is allowed. This requirement also applies to all persons providing or utilizing over-the-road public or commercial transportation, including tours; and all businesses or employees while interacting with people in outdoor spaces, including, but not limited to, curbside pickup, delivery, and service calls. All such businesses must provide face coverings or materials for the making of such face coverings for their employees. Such coverings or materials may be made available staff-wide or individually upon employee request so long as the result is the organization-wide use of face coverings. Nothing shall prevent an employee from fashioning his or her own cloth face mask. If a worker or customer refuses to wear a cloth face covering for other than medical reasons, a business may decline entry or service to that individual.

(c) The following individuals are exempt from this Ordinance: any person under the age of eight, or who is unable to safely wear a Face Covering due to age or an underlying health condition, or who is unable to remove the Face Covering without the assistance of others; and any person traveling in a personal vehicle, or when a person is alone or is in the presence of only household members in an enclosed space, and people who are actively drinking or eating. This Ordinance does not relieve business establishments and restaurants from other social distancing requirements imposed by the Governor's Executive Orders.

Section 3. Penalties.

(a) A person who fails to comply with Section 2.(a) or Section 2.(b) of this Ordinance shall be guilty of a civil infraction, punishable by a noncriminal fine of not more than $50.00. No state assessments will be assessed on this civil infraction/noncriminal fine.

(b) Each day of a continuing violation of this Ordinance shall be considered a separate and distinct offense. In addition to the fines established by this section, repeated violations of this Ordinance by a person who owns, manages, operates or otherwise controls a business subject to this Ordinance may, subject to all procedural protections set forth in the Town Code of Ordinances, result in the suspension or revocation of any occupancy permit or business license issued to business where the repeated violations occurred. Repeated violations of this Ordinance are additionally hereby declared to be a public nuisance, which may be abated by the Town by restraining order, preliminary and permanent injunction, or other means provided for by the Town Code of Ordinances and laws of this state. The foregoing notwithstanding, every effort shall be made to bring the business into voluntary compliance with the terms of this Ordinance prior to the issuance of any citation.

(c) The Town of Bluffton Municipal Court shall have jurisdiction on any and all infractions and/or suspension/revocation of permits or licenses as set out in this Section 3.

Section 4. Severability. If any provision, clause, sentence or paragraph of this Ordinance or the application thereof to any person or circumstances shall be held invalid, that invalidity shall not affect the other provisions of this Ordinance which can be given effect without the invalid provisions or application, and to this end the provisions of this Ordinance are declared to be severable.

Section 5. Effective Date; Expiration. The provisions hereof shall be adopted upon a single hearing and two-thirds vote of the Governing Body, and shall be effective on December 13, 2020, and shall be terminated by the issuance of another ordinance or shall automatically expire on the 61st day after enactment of this Ordinance, whichever date is earlier.

DONE, RATIFIED AND ENACTED AS AN EMERGENCY ORDINANCE BY THE TOWN COUNCIL OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, AT AN EMERGENCY MEETING, and approved at a meeting duly assembled by no less than an affirmative vote of two-thirds of the members of the Governing Body present, on this 8th day of December, 2020.

Lisa Sulka

Lisa Sulka, Mayor
Town of Bluffton, South Carolina

ATTEST:

Kimberly Chapman

Kimberly Chapman, Town Clerk
Town of Bluffton, South Carolina

ATTACHMENT 3

MOTION LANGUAGE

"I MOVE TO APPROVE THE EMERGENCY ORDINANCE OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, REQUIRING INDIVIDUALS TO WEAR FACE COVERINGS IN CERTAIN CIRCUMSTANCES IN LIGHT OF THE COVID-19 PANDEMIC; AND MATTERS RELATED THERETO; AND SEVERABILITY"

TOWN COUNCIL

STAFF REPORT
Executive Office

MEETING DATE:	February 9, 2021
PROJECT:	Consideration of an Emergency Ordinance of the Town of Bluffton Continuing the Suspension of the Normal Operating Procedures of the Town of Bluffton Town Council Meetings and Other Town of Bluffton Public Meetings; and Modifying the Authority of the Town Manager to Develop and Enact Such Plans and Policies Needed to Ensure Continuity in the Delivery of Government Services in Light of the COVID-19 Outbreak; and Severability
PROJECT MANAGER:	Scott M. Marshall, MPA, ICMA-CM, Interim Town Manager

RECOMMENDATION:

Request Town Council's Consideration of the Emergency Ordinance presented at Attachment 1.

BACKGROUND:

Background on this issue is found in the Staff Report from December 8, 2020, found at Attachment 2.

DISCUSSION:

The Emergency Ordinance presented for consideration continues the provisions established by Emergency Ordinance 2020 – 30. and substantively accomplishes the following:

1. Section 1 incorporates recitals contained in the Town of Bluffton Emergency Ordinance 2020-03 and also incorporates recitals of the SC Governor's Executive Orders which establish a statewide State of Emergency due to the COVID-19 pandemic.
2. Section 2 rescinds Section 1 of Emergency Ordinance 2020-03, which allows for the conduct of public meetings electronically. Adoption of the Electronic Meeting Ordinance negates the need to place this provision in this and future Emergency Ordinance.
3. Section 3, which was previously approved by Town Council when adopting Emergency Ordinance 2020-21 on October 13, 2020, rescinds and replaces Section 2 of Emergency Ordinance 2020-03, pertaining to the "Authorization of Town Manager." Substantive amendments are as follows:
    a. Special event permits be conditioned upon full compliance with applicable SC Governor's Executive Orders and associated COVID-19 pandemic related restrictions and/or recommendations regarding social distancing.
    b. Authority for closing Town owned or operated property is limited to Town Hall offices and other Town of Bluffton offices or buildings normally open to the public. Access to Town owned or operated parks, playgrounds, docks, and other open spaces available to the public will be consistent with rules for each facility/amenity as designated in the Town of Bluffton Code of Ordinances.

A single 2/3 vote of Town Council is required to approve this Emergency Ordinance.

If approved, this Emergency Ordinance would become effective on February 12, 2021 and would expire on April 14, 2021, unless otherwise modified, amended, extended, or rescinded by subsequent Emergency Ordinance.

NEXT STEPS:

Pending Town Council's approval, the ordinance will be filed by the Town Clerk, as appropriate, and the Town will continue to function under emergency condition protocols consistent with this Emergency Ordinance and other applicable Ordinances.

ATTACHMENTS:

1. Emergency Ordinance of the Town of Bluffton Continuing the Suspension of the Normal Operating Procedures of the Town of Bluffton Town Council Meetings and Other Town of Bluffton Public Meetings; and Modifying the Authority of the Town Manager to Develop and Enact Such Plans and Policies Needed to Ensure Continuity in the Delivery of Government Services in Light of the COVID-19 Outbreak; and Severability
2. Staff Report from December 8, 2020, sans Attachments
3. Suggested Motion Language

EMERGENCY ORDINANCE No. 2021 - __________

TOWN OF BLUFFTON, SOUTH CAROLINA

AN EMERGENCY ORDINANCE OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, CONTINUING THE SUSPENSION OF THE NORMAL OPERATING PROCEDURES OF TOWN OF BLUFFTON TOWN COUNCIL MEETINGS AND OTHER TOWN OF BLUFFTON PUBLIC MEETINGS; AND MODIFYING THE AUTHORITY OF THE TOWN MANAGER TO DEVELOP AND ENACT SUCH PLANS AND POLICIES NEEDED TO ENSURE CONTINUITY IN THE DELIVERY OF GOVERNMENT SERVICES IN LIGHT OF THE COVID-19 OUTBREAK; AND SEVERABILITY

WHEREAS, on March 13, 2020, the Honorable Henry McMaster, Governor of South Carolina, issued Executive Order No. 2020-08 related to 2019 Novel Coronavirus ("***COVID-19***") and declared that a State of Emergency exists in South Carolina; and,

WHEREAS, the Governor of the State has continued to declare that a State of Emergency exists throughout South Carolina and has issued the following Executive Orders extending the State of Emergency throughout the State: 2020-15, 2020-23, 2020-29, 2020-35, 2020-38, 2020-40, 2020-42, 2020-44, 2020-48, 2020-53, 2020-56, 2020-59, 2020-62, 2020-63, 2020-65, 2020-67, 2020-70,2020-72, 2020-75, 2020-77, 2021-03, 2021-07; and

WHEREAS, on March 16, 2020, in accordance with Section 2-202(a) of the Code of Ordinances for the Town of Bluffton, South Carolina (the "***Town Code***"), the Honorable Lisa Sulka, Mayor of the Town of Bluffton, issued a proclamation declaring a state of emergency throughout the Town to protect the public health, safety, and welfare of the residents, guests, and visitors to the Town of Bluffton from the dangers caused by the increasing number of confirmed cases of COVID-19; and,

WHEREAS, on March 17, 2020, the Town Council for the Town of Bluffton, South Carolina, (the "***Town Council***") adopted Emergency Ordinance 2020-03, which established certain standards for the conducting of electronic meetings for Town bodies and which authorized the Town Manager to take certain actions to ensure that Town business continued to operate during the state of emergency; and,

WHEREAS, on May 12, 2020, Town Council adopted Emergency Ordinance 2020-05, which extended key provisions of Emergency Ordinance 2020-03; and,

WHEREAS, on July 14, 2020, Town Council adopted Emergency Ordinance 2020-13, which extended key provisions of Emergency Ordinance 2020-03; and,

WHEREAS, on September 8, 2020, Town Council adopted Emergency Ordinance 2020-20, which extended key provisions of Emergency Ordinance 2020-03; and,

WHEREAS, on October 13, 2020, Town Council adopted Emergency Ordinance 2020-21, which extended key provisions of Emergency Ordinance 2020-03; and

WHEREAS, on December 8, 2020, Town Council adopted Emergency Ordinance 2020-30, which extended key provisions of Emergency Ordinance 2020-03; and

WHEREAS, while it is imperative for local government to continue to take steps to minimize the significant public health threats and other impacts associated with the COVID-19 pandemic to protect, the

Town Council must also regularly review such measures to ensure that any deviations from standard procedure are narrowly crafted to address continuing and new threats caused by COVID-19; and,

WHEREAS, in light of the foregoing, and in an effort to provide for and protect the health and welfare of the people of Bluffton, the Town Council has determined that it is necessary and appropriate to extend certain temporary, targeted and narrowly tailored emergency measures and restrictions designed to limit community spread and transmission of COVID-19; and,

WHEREAS, in light of the uncertain duration of the COVID-19 pandemic and for other reasons, the Town Council has also determined that it is necessary and appropriate to modify, rescind, and replace certain emergency measures adopted by Emergency Ordinance 2020-03, as amended and extended, as part of its process of regularly reviewing such measures; and,

WHEREAS, it is well recognized that COVID-19 presents a public health concern that requires extraordinary protective measures and vigilance; and,

WHEREAS, South Carolina law provides that cities and counties may enact emergency ordinances to meet public emergencies affecting life, health, safety or the property of the people upon a single reading; and,

WHEREAS, it is hereby determined that a public emergency affecting life, health, and safety does exist within the Town of Bluffton, and therefore, it is appropriate and necessary to adopt this Emergency Ordinance.

NOW THEREFORE, BE IT ORDERED AND ORDAINED BY THE TOWN COUNCIL OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, in accordance with the foregoing, as follows:

Section 1. Incorporation of Recitals. The above recitals, the recitals contained within Town of Bluffton Emergency Ordinance 2020-03, and the recitals contained within the Governor of South Carolina's Executive Orders 2020-50, 2020-62, 2020-63, 2020-65, 2020-67, 2020-70, 2020-72, 2020-75, 2020-77, 2021-03 and 2021-07 are hereby incorporated herein and made an integral part hereof.

Section 2. Recission of Section 1 of the Town of Bluffton Emergency Ordinance 2020-03, Entitled "Standards of Electronic Meetings.". The provisions of Section 1 of the Town of Bluffton Emergency Ordinance 2020-03, which authorizes all public bodies of the Town to conduct public meetings exclusively in electronic form and setting the standards governing the same, are rescinded.

Section 3. Rescission and Replacement of Section 2 of the Town of Bluffton Emergency Ordinance 2020-03, Entitled "Authorization of Town Manger." Section 2 of Town of Bluffton Emergency Ordinance 2020-03, which ratified the authority of the Town Manager to take certain actions during the State of Emergency in accordance with Section 2-116 of the Town Code, is hereby amended, modified, superseded, rescinded, restated and replaced in its entirety as follows:

To the fullest extent permitted by law, the Town Manager is hereby authorized to develop and enact all such plans and policies intended to ensure the continuity in the delivery of government services in light of the COVID-19 outbreak and to take necessary action to protect the health, safety, and welfare of Town residents, visitors, and employees and staff. These policies, plans, and actions may include but are not limited to the following:

a. Cancelling and revoking any special event permits issued prior to the date hereof, limiting the issuance of any special event permits during the term of this State of Emergency, and requiring that any and all special event permits be conditioned upon full compliance with the Governor of the State of South Carolina's Executive Order 2020-63 or any future Executive Order issued by the Governor, with such compliance being determined as of the date of such special event; and,

b. Utilizing all available resources of the Town as reasonably necessary to cope with the COVID-19 pandemic; and,

c. Consistent with existing Town policies, including the Town of Bluffton Employee Handbook, requiring any and all Town staff to work remotely and reimbursing staff for personal expenses incurred or necessary for such remote work; and,

d. Closing all or portions of Town Hall and other Town offices or buildings to the public. Access to parks, playgrounds, docks and other open spaces will remain consistent with codified rules for each facility/amenity.

Section 4. Effective Date; Expiration. The provisions hereof shall be adopted upon a single hearing and two-thirds vote of the Governing Body, shall be effective on February 12, 2021 and shall expire on the 61st day following the effective date hereof, unless otherwise modified, amended, extended, or rescinded by subsequent Emergency Ordinance.

Section 5. Reaffirmation of Prior Emergency Ordinances. All other Emergency Ordinances adopted by the Town Council shall remain in effect and are hereby ratified, confirmed, and reaffirmed, except to the extent that such Emergency Ordinances are, in whole or in part, in conflict with the terms hereof.

Section 6. Severability. If any provision, clause, sentence or paragraph of this Ordinance or the application thereof to any person or circumstances shall be held invalid, that invalidity shall not affect the other provisions of the Ordinance which can be given effect without the invalid provision or application, and to this end the provisions of this Ordinance are declared to be severable.

DONE, RATIFIED AND ENACTED AS AN EMERGENCY ORDINANCE BY THE TOWN COUNCIL FOR THE TOWN OF BLUFFTON, SOUTH CAROLINA, and approved at a meeting duly assembled by no less than an affirmative vote of two-thirds of the members of the Governing Body present, on this 9th day of February, 2021

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

ATTEST:

____
Kimberly Chapman, Town Clerk
Town of Bluffton, South Carolina

TOWN COUNCIL

STAFF REPORT
Executive Office

MEETING DATE:	December 8, 2020
PROJECT:	Consideration of an Emergency Ordinance of the Town of Bluffton Continuing the Suspension of the Normal Operating Procedures of the Town of Bluffton Town Council Meetings and Other Town of Bluffton Public Meetings; and Modifying the Authority of the Town Manager to Develop and Enact Such Plans and Policies Needed to Ensure Continuity in the Delivery of Government Services in Light of the COVID-19 Outbreak; and Severability
PROJECT MANAGER:	Scott M. Marshall, MPA, ICMA-CM, Deputy Town Manager

RECOMMENDATION:

Request Town Council's Consideration of the Emergency Ordinance presented at Attachment 1.

BACKGROUND:

On March 16, 2020, Mayor Lisa Sulka declared that a State of Emergency existed in the Town of Bluffton because of the COVID-19 pandemic. On March 17, 2020 Town Council unanimously passed Emergency Ordinance 2020-03, a copy of which is found at Attachment 2. This Ordinance expired on May 17, 2020 and accomplished the following:

1. Section 1 provides standards for electronic meetings.
2. Section 2 provides authorization to the Town Manager, pursuant to the Town of Bluffton Code of Ordinances, Section 2-116, to develop and enact all such plans and policies intended to ensure the continuity of delivery of government services In light of the COVID-19 outbreak and to take necessary action to protect the health, safety, and welfare of town residents, visitors, and employees and staff.
3. Section 3 suspends certain municipal deadlines.
4. Section 4, in accordance with Governor McMasters Executive Order 2020-10, extends certain municipal tax deadlines.

Sections 3 and 4 of Emergency Ordinance 2020-3 were extended and modified on April 14, 2020 by Emergency Ordinance 2020-4, extending deadlines for certain municipal taxes and business license fees.

Sections 1 and 2 of Emergency Ordinance 2020-03 were effectively extended with the adoption of the following Emergency Ordinances:

- Emergency Ordinance 2020-05 on May 12, 2020; and
- Emergency Ordinance 2020-13 on July 14, 2020 ; and
- Emergency Ordinance 2020-20 on September 8, 2020; and

- Emergency Ordinance 2020-21 on October 13, 2020. This Emergency Ordinance rescinded and replaced Section 2 to modify authority granted to the Town Manager.

Emergency Ordinance 2020-21, unless otherwise modified, amended, extended, or rescinded by subsequent Emergency Ordinance, will expire December 13, 2020.

As a reminder, under the authority granted under Sections 1 and 2 of Emergency Ordinance 2020-03, the following actions have been taken so far:

1. All public meetings to conduct Town business have been conducted electronically. (Section 1)
2. Under "Authorization of Town Manager:" (Section 2)
   a. Public access to Town facilities has been restricted.
   b. Physical staffing of Town facilities has been reduced to the minimum required to conduct Town business.
   c. Telecommuting policies have been implemented for employees able to work remotely.
   d. The following decisions regarding access to public facilities were made:
      1) Access to all Town of Bluffton docks and boat ramps was closed on April 1, 2020, consistent with Governor McMaster's Executive Orders to close public access to beaches, public piers and parking lots associated with those activities.
      2) Consistent with the Governor's subsequent Executive Order to re-open boat ramps, the Oyster Factor Boat Ramp was re-opened on April 17, 2020.
      3) Restrictions to Town Public Docks remained in place after the Governor's Executive Order that such restrictions could be lifted on April 21, 2020.
      4) Access to parks and playgrounds was closed on April 1 to be consistent with the Governor's Executive Order to close public playgrounds and activities that involve the use of shared sporting apparatus and equipment.
      5) Access to Town parks and docks was opened on June 1, 2020 simultaneous with expiration of previous Executive Order issued by the Governor; however, access to playgrounds remains closed until October 3, 2020 when they were reopened by the Town Manager.

DISCUSSION:

The Emergency Ordinance presented for consideration substantively accomplishes the following:

1. Section 1 incorporates recitals contained in the Town of Bluffton Emergency Ordinance 2020-03 and also incorporates recitals of the SC Governor's Executive Orders which establish a statewide State of Emergency due to the COVID-19 pandemic.
2. Section 2 rescinds Section 1 of Emergency Ordinance 2020-03, which allows for the conduct of public meetings electronically. Adoption of the Electronic Meeting Ordinance negates the need to place this provision in this and future Emergency Ordinance.
3. Section 3, which was previously approved by Town Council when adopting Emergency Ordinance 2020-21 on October 13, 2020, rescinds and replaces Section 2 of Emergency Ordinance 2020-03, pertaining to the "Authorization of Town Manager." Substantive amendments are as follows:

a. Special event permits be conditioned upon full compliance with applicable SC Governor's Executive Orders and associated COVID-19 pandemic related restrictions and/or recommendations regarding social distancing.

b. Authority for closing Town owned or operated property is limited to Town Hall offices and other Town of Bluffton offices or buildings normally open to the public. Access to Town owned or operated parks, playgrounds, docks, and other open spaces available to the public will be consistent with rules for each facility/amenity as designated in the Town of Bluffton Code of Ordinances.

A single 2/3 vote of Town Council is required to approve this Emergency Ordinance.

If approved, this Emergency Ordinance would become effective on December 13, 2020 and would expire on February 12, 2021, unless otherwise modified, amended, extended, or rescinded by subsequent Emergency Ordinance.

NEXT STEPS:

Pending Town Council's approval, the ordinance will be filed by the Town Clerk, as appropriate, and the Town will continue to function under emergency condition protocols consistent with this Emergency Ordinance and other applicable Ordinances.

ATTACHMENTS:

1. Emergency Ordinance of the Town of Bluffton Continuing the Suspension of the Normal Operating Procedures of the Town of Bluffton Town Council Meetings and Other Town of Bluffton Public Meetings; and Modifying the Authority of the Town Manager to Develop and Enact Such Plans and Policies Needed to Ensure Continuity in the Delivery of Government Services in Light of the COVID-19 Outbreak; and Severability
2. Town of Bluffton Emergency Ordinance 2020-3
3. Town of Bluffton Emergency Ordinance 2020-5
4. Town of Bluffton Emergency Ordinance 2020-13
5. Town of Bluffton Emergency Ordinance 2020-20
6. Town of Bluffton Emergency Ordinance 2020-21
7. Suggested Motion Language

ATTACHMENT 3

MOTION LANGUAGE

"I move to approve an Emergency Ordinance of the Town of Bluffton Continuing the Suspension of the Normal Operating Procedures of the Town of Bluffton Town Council Meetings and Other Town of Bluffton Public Meetings; and Modifying the Authority of the Town Manager to Develop and Enact Such Plans and Policies Needed to Ensure Continuity in the Delivery of Government Services in Light of the COVID-19 Outbreak; and Severability"

TOWN COUNCIL

STAFF REPORT
Department of Growth Management

MEETING DATE:	February 9, 2021
PROJECT:	Consideration of an Ordinance Amending the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 5 – Design Standards Related to Certain Building Types, Maximum Building Footprint, Size and Height
PROJECT MANAGER:	Heather Colin, AICP Director of Growth Management

REQUEST: Approve First Reading of an Ordinance Amending the Town of Bluffton Code of Ordinances, Chapter 23 – Unified Development Ordinance, Article 5 – Design Standards Related to Certain Building Types, Maximum Building Footprint, Size and Height.

BACKGROUND: With an increase in commercial and mixed-used infill development within Old Town Bluffton Historic District, concern has been expressed that some buildings seem too large for the District. In response, a workshop was held with Town Council in November 2020, followed by discussion of building size with the Historic Preservation Commission in December 2020 and January 2021.

Old Town Bluffton, also known as the Old Town Bluffton Historic District, is among Beaufort County's most desirable locations for new development, including mixed-use and commercial. Its roots as a small coastal village remain intact with its physical development pattern, historic buildings, Lowcountry architecture, mature tree canopy, as well as its eclectic character. This unique environment has spanned centuries, prior to Bluffton's dramatic growth as one of South Carolina's fastest growing communities. As referenced in the Old Town Master Plan (Master Plan), this uniqueness is Bluffton's "franchise" and "the key to [its] economy."

The Master Plan, adopted by Town Council in 2006, is a policy document developed through extensive study and community participation that established a clear, unified vision for Old Town Bluffton. The vision guides the Town's policies, programs, and regulations, including the Unified Development Ordinance (UDO). The UDO includes site and architectural standards specific to Old Town that may vary by zoning district and building type. There are five (5) zoning districts in Old Town, as well as a variety of permitted building types based on traditional Lowcountry building forms that differ by zoning district. The zoning district map is provided as Attachment 2; the various building types are shown in Attachment 3.

While mixed use and commercial development are located mostly north of May River Road or along May River Road, the heart of Old Town Bluffton Historic District is increasingly attractive for more intensive land use due to the availability of undeveloped or underdeveloped land. As land and construction costs escalate, maximization of land area and building square footage often follow. This may appear at odds with Old Town Bluffto more organic development, particularly south of May River Road, where portions of the historic district were developed prior to zoning and single-family residences were the predominant use.

In 2020, the Town "calibrated" land uses, as well as some general and architectural standards for the Old Town Bluffton Historic District. However, these amendments may not have been substantial enough relative to permitted land uses and building size to ensure that Old Town Bluffton's character, charm and eclectic nature will be maintained. By some accounts, certain building types, all of which are identified in UDO Sec. 5.15.8, may allow for building footprints, sizes and height that are incongruous with existing development and the Master Plan.

The purpose of the November Town Council workshop was to provide an overview of building size, including processes and regulations that could contribute to the development of larger buildings. This included a discussion of building types (Main Street and Additional), zoning districts that permit Main Street buildings, the "Shopfront" area on Calhoun Street and "Large Footprint Buildings." Based on this discussion, Town Council expressed the following:

- Focus on the Neighborhood Center-Historic District (NCE-HD) zoning district. The Neighborhood Core-Historic District is not at issue as it was intended to be the district where more intense uses and larger scale buildings would be located in Old Town (e.g., Promenade).
- Consider reducing the maximum allowed building footprint to no more than 2,000 to 2,500 square feet and the maximum building square footage to 5,000 square feet.
- The possibility that there too much commercial development.
- That mass and scale should relate to the streetscape, and that both may need to be defined.
- Is may be time to update the Old Town Bluffton Master Plan as the Town's vision for the district may need more specificity.

Staff also held an informal discussion regarding building size with the Historic Preservation Commission (HPC) at its December 2 meeting. The HPC is responsible for approving the appearance of all buildings within the Old Town Historic District, applying the standards of the UDO. The general consensus was that building size and how it is perceived is a function of its design and site placement, among other things, and not necessarily the size of its footprint and/or its total square footage. Additionally, it was noted that some of the UDO requirements do not necessarily reflect the Old Town Master Plan.

Given the Master Plan's age and the amount of development that has occurred in Old Town in the past 15 years, re-evaluation of the Plan may be in order. As part of the Town's Comprehensive Plan update in 2021, this will be explored. The Comprehensive Plan is a state-required policy document that identifies the Town's long-range goals and objectives and serves as a blueprint to guide its growth. Because the update process will occur over the next year, minor amendments are proposed which, if adopted, could be revised with more extensive study of Old Town Bluffton.

Based on earlier feedback from Town Council and from the HPC, the amendments in Attachment 4 are proposed. These amendments were shared with the HPC at their January 6 meeting for discussion purposes only.

REVIEW CRITERIA & ANALYSIS: When assessing an application for UDO Text Amendments, the Town Council is required to consider the criteria set forth in UDO Section 3.5.3, Application Review Criteria. These criteria are provided below, followed by a Finding.

1. Section 3.5.3.A. Consistency with the Comprehensive Plan or, if conditions have changed since the Comprehensive Plan was adopted, the consistency with the overall intent of the Plan, recent development trends and the general character of the area.

   Finding. The proposed amendments are consistent with the needs, goals, and implementation strategies of the Comprehensive Plan to maintain Old Town Bluffton's eclectic, Low Country character.

2. Section 3.5.3.B. Consistency with demographic changes, prevailing economic trends, and/or newly recognized best planning practices.

   Finding. As stated in the Comprehensive Plan, Bluffton's "franchise" is its unique character in a village-type setting that has evolved over centuries. The proposed amendments will serve to protect this character while Old Town's long-term vision is re-examined through the Comprehensive Plan process and, possibly, and update to the Old Town Master Plan. Smaller building sizes may help to protect Old Town Bluffton's development character while allowing for increased commercial and mixed-use development.

3. Section 3.5.3.C. Enhancement of the health, safety, and welfare of the Town of Bluffton.

   Finding. Though not health or safety issues, smaller building sizes will help to maintain Old Town Bluffton's historic development pattern of smaller mixed-use and commercial buildings, thus helping to maintain the district's historic welfare and the Town's economic engine.

4. Section 3.5.3.D. Impact of the proposed amendment on the provision of public services.

   Finding. The amendments will have no impact on providing public services.

5. Section 3.5.3.E. The application must comply with applicable requirements in the Applications Manual.

   Finding. The application complies with all applicable requirements of the Applications Manual.

PROPOSED AMENDMENTS: As shown in Attachment 4, amendments are proposed to the Main Street building type (Sec. 5.15.8.A) and the following characteristics that relate to size: 1) size range (the overall building square footage); 2) maximum building footprint (not to include porches); and 3) building height.

Differentiating building size and height for Main Street buildings in the Neighborhood-Core Historic District (NC-HD), a zoning district that exists north of May River Road and along portions of May River Road in Old Town, and the NCE-HD district acknowledges the differences between their development intensity. Changes to size and height for Main Street buildings in the NC-HD district are not proposed.

For the NCE-HD District (Sec. 5.15.5.B), amendments are proposed to increase the front build-to zone from 0-10 feet to 10-25 feet for both the Main Street and Additional building types. A front building setback from 10-25 feet will allow larger buildings to set back farther from the public right-of-way so as not to overwhelm the streetscape, which is typical of the NCE-HD development pattern, especially on Calhoun Street. The setback can be usable space, such seating or dining, that can serve as an extension of the public right-of-way and create more vibrant spaces in Old Town. The side yard setback would increase from five feet to eight feet for Additional building types, which is consistent with the Main Street building type.

The Additional building type allows developers to propose buildings that are not one of the approved building types within all five of Old Town Bluffton's zoning districts. Additional building types, however, can be desirable as the UDO does not limit its footprint or size. Therefore, an amendment to Sec. 5.15.5 (General Standards) is proposed to limit the building footprint and size to be no larger than the largest size permitted within any of Old Town Bluffton's zoning districts for other building types within a given district. As an example, the largest building size and footprint in the Neighborhood Core-HD district is 8,000 square feet and 3,500 square feet, respectively, for a Main Street building; therefore, an Additional building type in the Neighborhood Core-HD district could not exceed the maximum square footage permitted for a Main Street building.

TOWN COUNCIL ACTIONS: As granted by the powers and duties set forth in Section 2.2.6.C.4 of the UDO, Town Council has the authority to take the following actions with respect to this application:

1. Approval of the application as submitted;

2. Approval of the application with amendments; or

3. Denial of the application as submitted.

PLANNING COMMISSION RECOMMENDATION: The Planning Commission recommends approval to Town Council of the proposed Text Amendments as submitted. The Commission also expressed that additional work, in the future, is necessary and should consider incorporating a context-sensitive approach where standards could vary by site location.

NEXT STEPS:

UDO Text Amendment Procedure	Date	Complete
Step 1. Town Council Workshop	November 10, 2020	✓
Step 2. Historic Preservation Commission Workshop	December 2, 2020 & January 6, 2021	✓
Step 3. Planning Commission Public Hearing and Recommendation	January 27, 2021	✓
Step 4. Town Council – 1st Reading	February 9, 2021	✓
Step 5. Town Council Meeting – Final Reading and Public Hearing	March 9, 2021	✓

ATTACHMENTS:

1. Presentation (Attachment 1)
2. Old Town Bluffton Historic District Zoning Map (Attachment 2)
3. Building Types (Attachment 3)
4. Proposed Amendments and Ordinance (Attachment 4)
5. Proposed Motion (Attachment 5)

Consideration of Amendments to Chapter 23 – Unified Development Ordinance, Article 5 – Design Standards Related to Certain Building Types, Maximum Building Footprint, Size and Height

Presentation to Town Council
February 9, 2021
Department of Growth Management
Heather Colin, AICP, Director of Growth Management

Issue

With an increase in commercial and mixed-used infill development within Old Town Bluffton (Old Town Bluffton Historic District), there is concern that some buildings may be too large and that the Unified Development Ordinance (UDO) should be amended to reduce the size of Main Street and Additional building types, and to revise some related UDO standards.

Background

- Old Town Bluffton is an increasingly desirable location for new development and redevelopment, including mixed-use and commercial
- Such development has occurred mostly north of May River Road or along May River Road, but is increasing to the south, in the heart of Old Town Bluffton
- Compatibility with Old Town's character (historic, organic, architecture, tree canopy, eclectic nature) is a concern
- Old Town Bluffton Master Plan (2006) notes that Old Town's character is its "franchise" and "the key to [its] economy"
- Master Plan provides a unified vision for Old Town that guides policies, programs and regulations, such as the Unified Development Ordinance (UDO)
- UDO includes site and architectural standards specific to Old Town, some of which were recently amended but may not adequately address concerns with building size

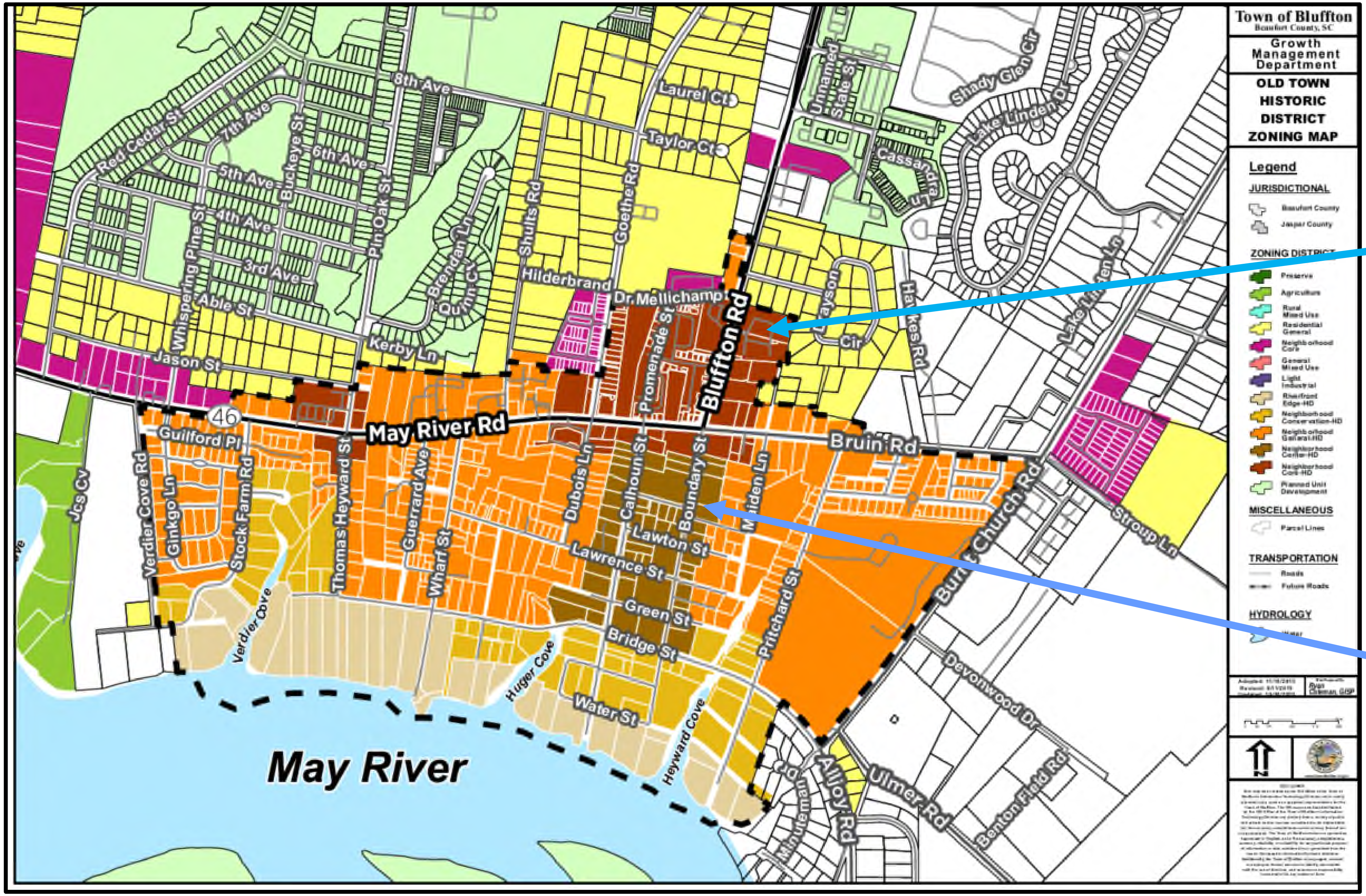
Recent Meetings Regarding Building Size

- **Town Council Workshop (November 10, 2020)**
    - ➢ Focus on the Neighborhood Center – HD District *[See next slide]*
- **Historic Preservation Commission (December 2, 2020)**
    - ➢ Mass and Scale were main discussion; good design is more vital than size
- **Historic Preservation Commission (January 6, 2021)**
    - ➢ Town Staff shared proposed amendments
- **Planning Commission (January 27, 2021)**
    - ➢ Consider context-sensitive standards for future work

Old Town Bluffton Zoning Map

ATTACHMENT

Section XI. Item #5.



Zoning Districts

- Old Town Bluffton has five (5) zoning districts. The type of development or use of land is determined by the zoning district for each property. Additionally, each district specifies which building types are permitted.

- The Neighborhood Core-HD and Neighborhood Center-HD are the most intensive in terms of land uses permitted and building size.

- Neighborhood Core-HD is the "commercial heart of the Historic District with the greatest potential for mixed-use and multi-story buildings." The Promenade is zoned NC-HD.

- Neighborhood Center-HD (NCE-HD) is intended for "[m]oderate-intensity, mixed use development within the Historic District." This includes portions of Calhoun and Boundary Streets south of May River Road and north of Bridge Street.

- Amendments are proposed only for the NCE-HD district, and for Additional Building types in all five zoning districts.

Main Street Buildings (Characteristics)

Same for NC and NCE Districts

5.15.8 Building Types

A. Main Street Building

General: Detached Mixed Use Building.

Size Range: 2,000 – 8,000 sq. ft.

Maximum Footprint (not including porches): 3,500 sq. ft.

Height: 2 - 3 stories.

Notes:

A shopfront building.

Retail/office space on ground floor.

Office/living space on upper levels.

Must have an arcade, colonnade, marquee or awning along the front façade (arcades/colonnades are preferred).

District	
CORE	●
CENTER	●
GENERAL	
CONSERVE	
RIVER EDGE	

Neighborhood Center-HD Zoning District

B. Neighborhood Center Historic District (NCE-HD)

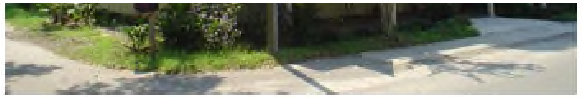
Planters Mercantile (1890)

The Pearl (2005)

NCE-HD Precedent Imagery

The red lines indicate the locations of required shopfront buildings (Main Street Building, Commercial Cottage, or Live-Work Sideyard). In addition to store-front buildings, civic structures are allowed within these areas.

Neighborhood Center-HD Zoning District



NCE-HD Precedent Imagery

Neighborhood Center-HD Building Type Requirements:	**Front Build-to Zone**	**Lot Width**	**Frontage Requirement**	**Rear Setback** *(from rear property line)*	**Side Setback** *(from side property lines)*	**Height** *(in stories)*
Main Street Building	0'-10'	50'-80'	75% - 90%	25'	8'	2-2.5
Commercial Cottage	5'-20'	50'-60'	50% - 70%	25'	8'	1-1.5
Live-Work Sideyard	0'-5'	50'-60'	40% - 75%	25'	5'	1.5-2.5
Duplex	10'-20'	55'-70'	N/A	25'	8'	1.5-2.5
Triplex		70'-100'				
Mansion Apartment House	10'-20'	60'-80'	N/A	25'	10'	2-2.5
Carriage House	One Carriage House may be built per primary structure and may have a maximum footprint of 800 sq. ft. Carriage Houses must be located behind the primary structure. See *5.15.8.F* for a full description of this type.			5'	5'	1-2
Cottage	5'-15'	50'-60'	N/A	25'	5'	1-1.5
Village House	5'-15'	50'-60'	N/A	25'	5'	2-2.5
Sideyard House	5'-10'	50'-65'	N/A	25'	8'	2-2.5
Vernacular House	10'-20'	60'-80'	N/A	25'	10'	1.5
Civic Building	5'-25'	N/A	N/A	N/A	5'	2
Additional Building Types						
As approved by the UDO Administrator or Board / Commission with approval authority in accordance with Article 2 of this Ordinance, additional building types may be allowed in the Neighborhood Center - zoning district. Building types not specifically listed shall be regulated by the folllowing general require-ments.	0'-25'	50'-100'	to be determined by UDO Admin.	25'	5'	1-2.5

“Additional Building Type”

- Allows flexibility for innovative design that the UDO otherwise would not permit
- Not defined by UDO
- Not identified in Sec. 5.18.8 (Building Types)
- When and why this building type is permitted in place of other building types is not specified by the UDO
- Allowed in all zoning districts.
- In the NCE-HD, the site requirements differ from Main Street Building Types as follows:

Building Type	Front Build-to	Lot Width	Frontage	Side Yard Setback (min)	Height (in stories)	Characteristics	Building Footprint (max)	Building Square Footage
Main Street	0–10 ft	50-80 ft	75-95%	8 ft	2-2.5		3,500	2,000 – 8,000 sf
Additional	0-25 ft	50-100 ft	UDO Admin Determines	5 ft	1-2.5		UDO does not specify	UDO does not specify

Proposed Amendments

Sec. 5.15.8.A. Building Types, Main St Buildings

A. Main Street Building		
General: Detached Mixed Use Building		Core •
Size Range: ~~2,000 – 8,000 sq. ft.~~ NC–HD: 2,000 – 8,000 sq. ft. NCE-HD: 2,000 – 5,000 sq. ft.		Center •
Maximum Footprint (not including porches): ~~3,500 sq. ft.~~ NC–HD: 3,500 sq. ft. NCE-HD: 2,500 sq. ft.		General
Height: ~~2-3 stories~~ NC–HD: 2-3 stories NCE-HD: 2-2.5 stories		Conserve
Notes: A shopfront building Retail/office space on ground floor Office/living space on upper levels Must have an arcade, colonnade, marquee or awning along the front façade (arcades/colonnades are preferred)		River Edge

Sec. 5.15.5.B, NCE-HD District Site Standards

Neighborhood Center – HD Building Type Requirements:	Front Build-to Zone	Lot Width	Frontage Requirement	Rear Setback (from property line)	Side Setback (from side property line)	Height (in stories)
Main Street Building	~~0’ - 10’~~ 10’ -25’	50’- 80’	75% - 90%	25’	8’	2 – 2.5
Additional Building Types						
As approved by the UDO Administrator or Board/Commission with approval authority in accordance with Article 2 of this Ordinance, additional building types may be allowed in the Neighborhood Center zoning district. Building types not specifically listed shall be regulated by the following general requirements.	~~0’ - 25’~~ 10’ -25’	50’- 100’	To be determined by the UDO Administrator	25’	~~5’~~ 8’	1 – 2.5

Sec. 5.15.5, General Standards

The maximum building footprint and building size for the Additional Building Type is proposed to be no larger than the largest footprint and size permitted by for other building types within the same zoning district.

Example: Neighborhood Core-HD Main Street building type allows a maximum of 8,000 sf and maximum footprint of 3,500 sf. An Additional building type could not exceed these square footages.

The existing or proposed building type shall determine the applicable lot standards. The maximum building footprint and building size for an Additional Building Type shall not exceed the largest building footprint and building size permitted for other building types permitted within the same zoning district. Building types shall only be permitted as listed in the applicable District. The maximum allowed density is based on the dimensional characteristics established for each building type in combination with other site characteristics that may limit the amount of land able to accommodate density. These other site characteristics include, but are not limited to, lot configuration, right-of-way, easements, protected natural resources, open space, topography, and parking.

Review Criteria

Text Amendment Review Criteria

When assessing an application for a UDO Text Amendment, the Planning Commission and Town Council are required to consider the criteria set forth in UDO Section 3.5.3, Application Review Criteria. These criteria include:

1. **Section 3.5.3.A.** Consistency with the Comprehensive Plan or, if conditions have changed since the Comprehensive Plan was adopted, the consistency with the overall intent of the Plan, recent development trends and the general character of the area.

2. **Section 3.5.3.B.** Consistency with demographic changes, prevailing economic trends, and/or newly recognized best planning practices.

3. **Section 3.5.3.C.** Enhancement of the health, safety, and welfare of the Town of Bluffton.

4. **Section 3.5.3.D.** Impact of the proposed amendment on the provision of public services.

5. **Section 3.5.3.E.** The application must comply with applicable requirements in the Applications Manual.

Planning Commission Recommendation

The Planning Commission made a recommendation at their January 27, 2021 meeting to unanimously approve the proposed amendments to the Unified Development Ordinance.

Town Council Action

As granted by the powers and duties set forth in Section 2.2.6.C.4 of the UDO, the Town Council has the authority to take any of the following actions:

1. Approve the application as submitted;

2. Approve the application with amendments; or

3. Deny the application as submitted.

Proposed Motion

"I move to approve amendments to the Town of Bluffton Code of Ordinances Chapter 23 – Unified Development Ordinance, Article 5 – Design Standards, Relating to Certain Building Types, Maximum Building Size, Footprint and Height."

Next Steps

UDO Text Amendment Procedure	Date	Complete
Step 1. Town Council Workshop	November 10, 2020	✓
Step 2. Historic Preservation Commission Workshop	December 2, 2020 & January 6, 2021	✓
Step 3. Planning Commission Public Hearing and Recommendation	January 27, 2021	✓
Step 4. Town Council – 1st Reading	February 9, 2021	✓
Step 5. Town Council Meeting – Final Reading and Public Hearing	March 9, 2021	✓

QUESTIONS


Town of Bluffton
Beaufort County, SC
Growth Management Department
OLD TOWN HISTORIC DISTRICT ZONING MAP
Legend
JURISDICTIONAL
Beaufort County
Jasper County
ZONING DISTRICT
Preserve
Agriculture
Rural Mixed Use
Residential General
Neighborhood Core
General Mixed Use
Light Industrial
Riverfront Edge-HD
Neighborhood Conservation-HD
Neighborhood General-HD
Neighborhood Center-HD
Neighborhood Core-HD
Planned Unit Development
MISCELLANEOUS
Parcel Lines
TRANSPORTATION
Roads
Future Roads
HYDROLOGY
Water
Adopted: 11/10/2015
Revised: 8/11/2015
Updated: 10/30/2020
Map Prepared By:
Ryan Coleman, GISP
Feet
0
85
170
340
510
680
N
TOWN OF BLUFFTON
EST. 1825
SOUTH CAROLINA
www.townofbluffton.sc.gov
DISCLAIMER:
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8th Ave
7th Ave
6th Ave
5th Ave
4th Ave
3rd Ave
Red Cedar St
Buckeye St
Pin Oak St
Whispering Pine St
Able St
Jason St
Kerby Ln
Brendan Ln
Quinn Ct
Shults Rd
Hilderbrand
Goethe Rd
Dr Mellichamp
Laurel Ct
Taylor Ct
Unnamed State St
Cassandra Ln
Shady Glen Cir
Lake Linden Dr
Lake Linden Ln
Drayson Cir
Hawkes Rd
Bluffton Rd
Promenade St
46
May River Rd
Bruin Rd
Guilford Pl
Verdier Cove Rd
Ginkgo Ln
Stock Farm Rd
Thomas Heyward St
Guerrard Ave
Wharf St
Dubois Ln
Calhoun St
Boundary St
Maiden Ln
Lawton St
Lawrence St
Green St
Bridge St
Water St
Pritchard St
Burnt Church Rd
Stroup Ln
Devonwood Dr
Ulmer Rd
Benton Field Rd
Alljoy Rd
Minuteman Dr
Jcs Cv
Verdier Cove
Huger Cove
Heyward Cove
May River

5.15.8 Building Types

A. Main Street Building

General: Detached Mixed Use Building.

Size Range: 2,000 – 8,000 sq. ft.

Maximum Footprint (not including porches): 3,500 sq. ft.

Height: 2 - 3 stories.

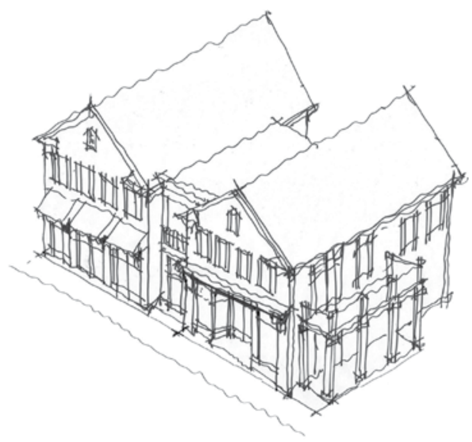
Notes:

A shopfront building.

Retail/office space on ground floor.

Office/living space on upper levels.

Must have an arcade, colonnade, marquee or awning along the front façade (arcades/colonnades are preferred).



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Main Street Building Precedent Imagery

*Precedent images are for illustrative purposes only, with no regulatory effect. They are provided as examples, and shall not imply that every element in the photograph is permitted.

B. Commercial Cottage

General: Detached Mixed Use Building.

Size Range: 600 – 1,800 sq. ft.

Maximum Footprint (not including porches): 1,500 sq. ft.

Height: 1 – 1.5 stories.

Notes:

A shopfront building.

Similar to the historic Peeples' Store on Calhoun Street.

May contain a living unit in the attic story.

Typically 18' - 30' wide, but may vary.

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Commercial Cottage Precedent Imagery

*Precedent images are for illustrative purposes only, with no regulatory effect. They are provided as examples, and shall not imply that every element in the photograph is permitted.

C. Live-Work Sideyard

General: Detached Mixed Use Building.

Size Range: 1,800 – 3,200 sq. ft.

Maximum Footprint (not including porches): 1,500 sq. ft.

Height: 1.5 – 2.5 stories.

Notes:

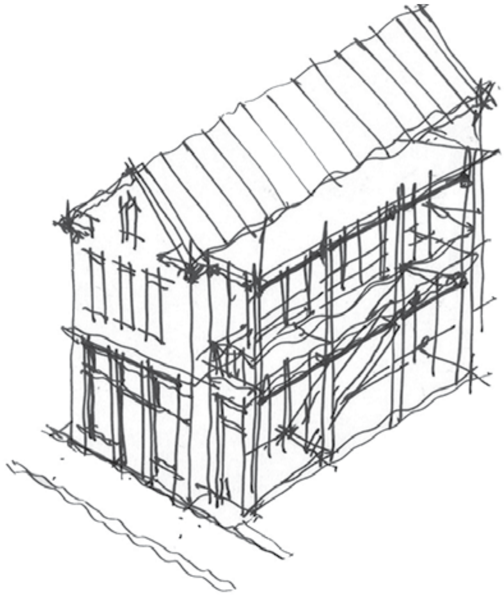
A shopfront building.

A retail or office space on the ground floor, with one dwelling unit above.

Must have a single/double story side porch or arcade.

Building tends to be positioned with the non-porch side close to the adjacent side property line, creating a "side yard" which the porch faces onto.

Typically 24' - 40', including the side porch.



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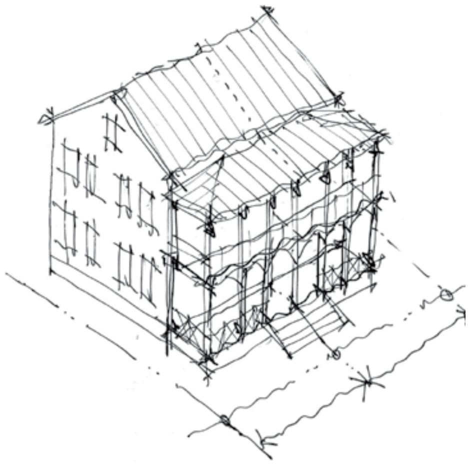
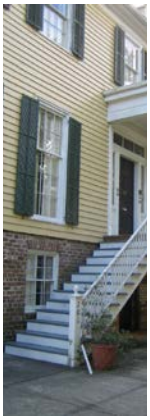
Live-Work Sideyard Precedent Imagery

*Precedent images are for illustrative purposes only, with no regulatory effect. They are provided as examples, and shall not imply that every element in the photograph is permitted.

D. Duplex/Triplex

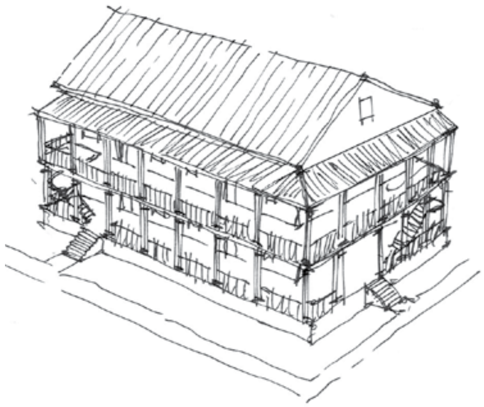
General: Two or Three Attached Single Family Residences.		CORE ●
Size Range: 800 – 2,800 sq. ft. (per unit).		CENTER ●
Maximum Footprint (not including porches): 1,000 sq. ft. (per unit).		GENERAL
Height: 1.5 – 2.5 stories.		CONSERVE
Notes: Each unit must have own separate, forward (street). Facing entrance. Units shall be arranged with fronts parallel to the street. Units shall all be constructed simultaneously and be of the same architectural character. Units may be rentals or condominiums. Units share one single lot. One carriage house is allowed per unit. Triplex may be 3 full stories if raised up on a full height basement. Each unit is typically 15' - 30' wide.	*Precedent images are for illustrative purposes only, with no regulatory effect. They are provided as examples, and shall not imply that every element in the photograph is permitted.	RIVER EDGE

Duplex/Triplex Precedent Imagery



E. Mansion Apartment House

General: Detached Multi-Family Building (4-6 units).	
Size Range: 1,800 – 4,500 sq. ft. (per unit).	
Maximum Footprint (not including porches): 2,000 sq. ft.	
Height: 2 – 2.5 stories.	
Notes: Building may contain 4-6 units. Has the appearance of a large home. Must have one primary entrance. Shall have a shared front porch. Units may be rentals or condominiums. Building is typically center hall in format. One carriage house is allowed on the same lot. Typically 40' - 60' wide.	



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Mansion Apartment House Precedent Imagery

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F. Carriage House

General: Detached Accessory Structure.

Size Range: 250 – 1,200 sq. ft. (per unit).

Maximum Footprint (not including porches): 800 sq. ft.

Height: 1 – 2 stories.

Notes:

Must be an accessory structure.

Only one permitted per lot, unless otherwise noted.

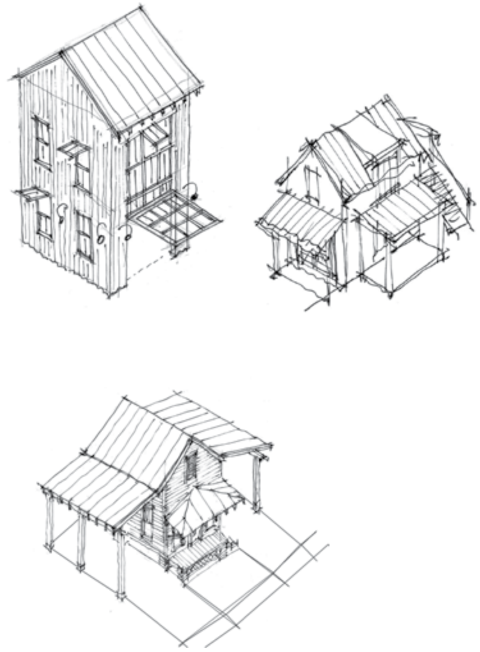
May be used as a garage, living unit or home business (or combination).

May function as a small-scale shop, studio or workshop.

Garages are limited to 2 cars, with maximum garage door widths of 12' each.

Must be of same general character as primary structure.

Must be placed behind the primary structure and towards the back of the lot



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Carriage House Precedent Imagery




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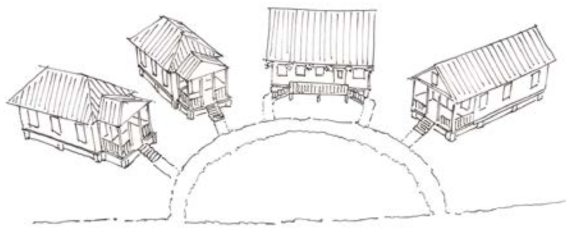
G. Bungalow Court

General: Detached Clustered Single Family Residences.

Size Range: 400 – 900 sq. ft.

Maximum Footprint (not including porches): 700 sq. ft.

Height: 1 – 1.5 stories.



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Notes:

Units must face each other or an adjacent public ROW.

Court must contain a center green or common space.

All units share one lot (condominiums).

Bungalows shall be accessed by pedestrian paths.

Parking and driveways must be located behind units and along adjacent property lines - may be communal parking.

Carriage houses are not allowed.

Schemes for courts in which any of the bungalows face the back of adjacent buildings or turn their back on an adjacent street shall not be permitted.

Bungalow Court Precedent Imagery.

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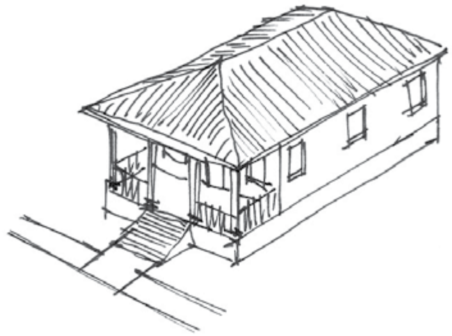
H. Cottage

General: Detached Single Family Residence.	
Size Range: 700 – 1,500 sq. ft.	
Maximum Footprint (not including porches): 900 sq. ft.	
Height: 1 – 1.5 stories.	
Notes: Almost always has a front porch. Typically 18' - 28' wide. Typically positioned close to one of the adjacent side property lines.	

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Cottage Precedent Imagery




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I. Village House

General: Detached Single Family Residence.	
Size Range: 1,200 – 2,400 sq. ft.	
Maximum Footprint (not including porches): 1,100 sq. ft.	
Height: 2 – 2.5 stories.	
Notes:	

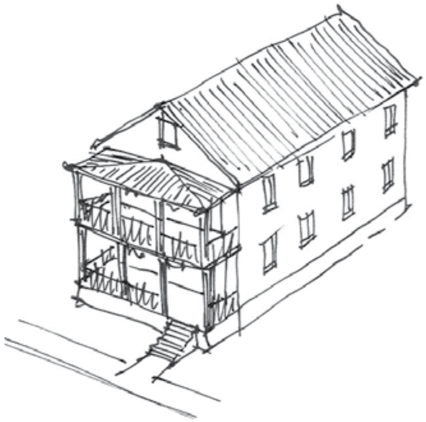
Almost always has a front porch.

Shall be narrower along the street front than it is deep.

Typically positioned close to one of the adjacent side property lines.

Principal mass of the building typically has a forward facing gable.

Typically 20' - 30' wide.



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RIVER EDGE	

Village House Precedent Imagery

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1 Introduction
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J. Sideyard House

General: Detached Single Family Residence.

Size Range: 1,200 – 2,800 sq. ft.

Maximum Footprint (not including porches): 1,200 sq. ft.

Height: 2 – 2.5 stories.

Notes:

Positioned with narrow side facing the street and a full-length side porch.

House tends to be positioned with the non-porch side close to the adjacent side property line, creating a "side yard" onto which the porch faces.

Typically 24' - 35' wide, including the side porch.

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Sideyard House Precedent Imagery

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K. Vernacular House

General: Detached Single Family Residence.

Size Range: 1,600 – 2,800 sq. ft.

Maximum Footprint (not including porches): 1,800 sq. ft.

Height: 1.5 stories.

Notes:

Similar to the Heyward House and Seabrook House.

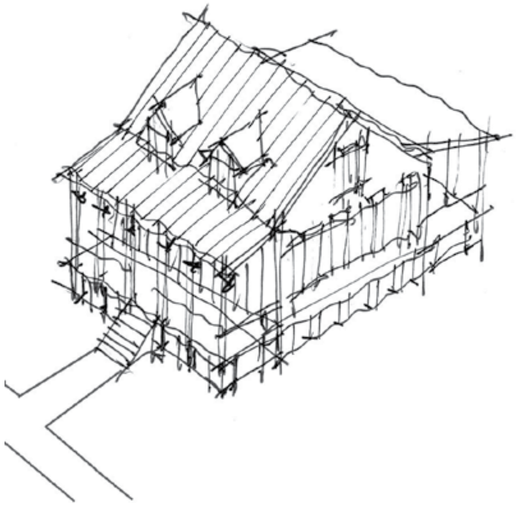
Must have a full-length front porch.

May have dormers.

May have side or rear wings, which are secondary to the main mass of the structure.

Typically 38' - 50' wide.

Gables always occur on the sides of the house, i.e., the roof ridge shall run parallel to the front façade of the house.



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Vernacular House Precedent Imagery.

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Design Standards 5
Sustainable Development Incentives 6
Nonconformities 7
Penalties & Enforcement 8
Definitions & Interpretation 9

L. Center Hall House

General: Detached Single Family Residence.

Size Range: 2,000 – 5,500 sq. ft.

Maximum Footprint (not including porches): 2,000 sq. ft.

Height: 2 - 2.5 stories.

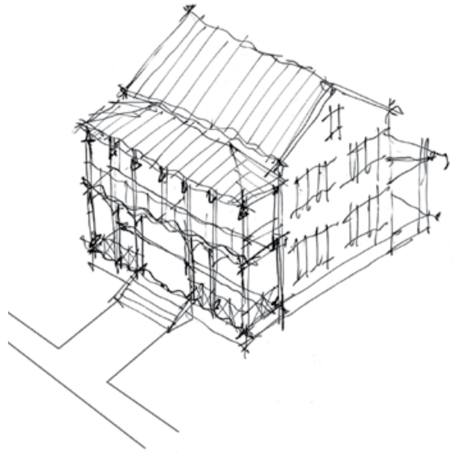
Notes:

Similar to Seven Oaks and Guerrard's Bluff.

May have a single or double height front porch.

May have side or rear wings, which are secondary to the main mass of the building.

Typically 40' - 55' wide.



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CONSERVE	●
RIVER EDGE	●

Center Hall House Precedent Imagery.

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M. River House

General: Detached Single Family Residence.

Size Range: 2,000 – 4,800 sq. ft.

Maximum Footprint (not including porches): 2,000 sq. ft.

Height: 2 - 2.5 stories.

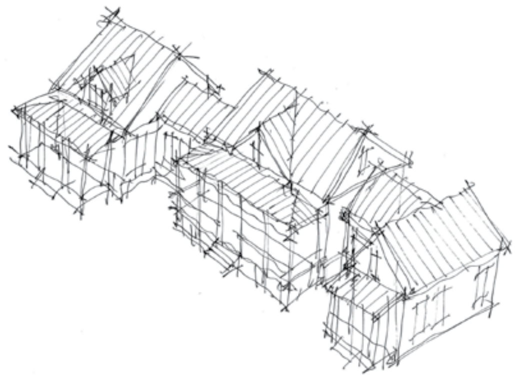
Notes:

Similar to Pritchard House.

Typically has a porch on both the street and river sides.

Large, central mass like the Vernacular House, but with smaller wings extending out from one or both sides.

Typically 60' - 90' wide.



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River House Precedent Imagery

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N. Civic Building

CORE	CENTER	GENERAL	CONSERVE	RIVER EDGE
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1. Civic buildings contain uses of special public importance. Civic buildings include, but are not limited to, municipal buildings, churches, libraries, schools, recreation facilities, and places of assembly. Civic buildings do not include retail buildings, residential buildings, or privately owned office buildings. Civic buildings should be monumental and should help to enhance the public realm, rather than take away from it. The buildings should evoke a civic character and be carefully designed to reflect the architectural character of Bluffton and the Lowcountry. The design of civic buildings shall be subject to review and approval by the UDO Administrator and the Historic Preservation Commission.
2. Civic buildings are reviewed on a case-by case basis. Although intended uses will be a significant determinant of form, there are several common design principals inherent to civic buildings. These principals affect their relationship to private buildings and to their setting as a whole.
3. Placement
   a. Civic buildings should be oriented toward the public realm (streets, squares and plazas) in a very deliberate way.
   b. Placement of buildings and primary architectural elements at the termination of public vistas can provide an appropriate level of visual importance.
   c. Building entrances should always take access from the most prominent façade(s). Avoid entrances that take access from the rear or are visually concealed.
   d. Placement of civic buildings, depending upon program and site, can often benefit from being set back from the adjacent build-to lines of private development. This allows the scale of the building to have more visual emphasis and can create a public space in the foreground. The amount of this setback should be carefully determined based on the urban design objectives of the particular site.
   e. The primary massing of civic buildings should be symmetrical in form. The appearance of a balanced design increases the level of formality which is appropriate to the public use.
   f. Massing of civic buildings, although often larger as a whole, should be divided into visually distinct sections. Massing divisions should provide visual order to the building and create vertical proportions within individual elements.
4. Scale/Height
   a. The scale of civic buildings should be larger than corresponding buildings

in order to be more prominent and visible across greater distances.

b. Floor-to-ceiling heights and architectural details should be proportionately larger than those of private buildings that exist or are anticipated within adjacent blocks.

c. Prominent roof forms and additive elements such as cupolas can visually extend the height of the building.

5. Materials/Details

a. It is of great importance that civic buildings be made of durable, high quality materials. The use of long-lasting materials is an expression of confidence in the future of the Town.

b. Civic buildings should be made of masonry, including brick, stone, and cast concrete. In some cases wood construction is appropriate and should be executed with the highest quality framing and cladding materials. Stucco should be avoided as a material that lacks scale and texture. If used, stucco should be traditional, have integral pigment, and be scored to define human-scaled dimensions on the façade.

c. Building details should be designed at two scales. At the larger scale, details should be robust to read from a distance. Closer to the building, the details of the lower levels should have another measure of refinement that can only be seen at the up-close, pedestrian scale.

Civic Building Precedent Imagery.

The following are examples of civic buildings which demonstrate the general architectural and urban character intended by these standards.

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O. Church Buildings

CORE	CENTER	GENERAL	CONSERVE	RIVER EDGE
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1. Church buildings contain uses of special public importance. Church buildings include, but are not limited to, churches, synagogues, other facilities used for prayer, contemplation by persons of similar beliefs or conducting formal religious services on a regular basis and places of religious assembly.
2. Church buildings should be significant and should help to enhance the public realm, rather than take away from it. The buildings should be carefully designed to reflect the architectural character of Bluffton and the Lowcountry. The design of church buildings shall be subject to review and approval by the UDO Administrator and Historic Preservation Commission.
3. Church buildings are reviewed on a case by case basis. Although intended uses will be a significant determinant of form, there are several common design principles inherent to church buildings. These principles affect their relationship to private buildings and to their setting as a whole.
4. Placement
   a. Church buildings should be oriented toward the public realm (streets, squares and plazas) in a very deliberate way.
   b. Placement of buildings and primary architectural elements at the termination of public vistas can provide an appropriate level of visual importance.
   c. Building entrances should always take access from the most prominent façade(s). Avoid entrances that take access from the rear or are visually concealed.
   d. Placement of church buildings, depending on program and site, can often benefit from being set back from the adjacent build-to lines of private development. This allows the scale of the building to have more visual emphasis and can create a public space in the fore ground. The amount of this setback should be carefully determined based on the urban design objectives of the particular site.
   e. The primary massing of church buildings should be symmetrical in form. The appearance of a balanced design increases the level of formality which is appropriate to the use.
   f. Massing of church buildings, although often larger as a whole, should be divided into visually distinct sections. Massing divisions should provide visual order to the building and create vertical proportions within individual elements.
5. Scale/Height
   a. The scale of church buildings should be larger than corresponding buildings in order to be more prominent and visible across greater distances.
   b. Floor to ceiling heights and architectural details should be proportionately

larger than those of private buildings that exist or are anticipated within adjacent blocks.

c. Prominent roof forms and additive elements such as cupolas can visually extend the height of the building.

6. Materials/Details
   a. It is of great importance that church buildings be made of durable, high quality materials. The use of long-lasting materials is an expression of confidence in the future of the Town.
   b. Church buildings should be made of masonry, including brick, stone, and cast concrete. In some cases wood construction is appropriate and should be executed with the highest quality framing and cladding materials. Stucco should be avoided as a material that lacks scale and texture. If used, stuccor should be traditional, have integral pigment, and be scored to define human scaled dimensions on the façade.
   c. Building details should be designed at two scales. At the larger scale, details should be robust to read from a distance. Closer to the building, the details of the lower levels should have another measure of refinement that can only be seen at the up-close, pedestrian scale.
   d. Decorative and artistic features or materials of a more formal or religious design, for example stained glass windows, should be permitted.

Church Building Precedent Imagery.

The following are examples of church buildings which demonstrate the general architectural and urban character intended by these standards.

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P. Manufactured Homes (for replacement only, see Section 5.15.2.E. for applicability)

CORE	CENTER	GENERAL	CONSERVE	RIVER EDGE
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1. Except as noted in this Section, the replacement of existing manufactured homes located in the HD zoning districts are exempt from the architectural standards of Section 5.15.6.

2. Placement
   a. Placement of the manufactured home shall be in accordance to the lot standards prescribed for the Additional Building Type of the applicable zoning district.
   b. Location of the primary entrance shall be located on the exterior wall facing the frontage street except in those cases where the existing lot configuration and required setbacks prohibit this orientation.
   c. Service yards and utilities shall be located in the rear or side yard and fully screened from view.

3. Porches/Stoops
   a. Design of porches and stoops shall be subject to Section 5.15.6.E.5 – Section 5.15.6.E.6.
   b. Design of any associated railings, columns, or balustrades shall be subject to Section 5.15.6.H.

4. Foundation Piers/Skirting & Underpinning
   a. Each manufactured home must be set on an appropriate foundation.
   b. Design of any exposed foundation walls or foundation piers shall be subject to Section 5.15.6.H.
   c. All hauling mechanisms, such as hitches, shall be removed prior to occupancy.
   d. The entire perimeter area between the bottom of the structure and the ground of each manufactured home shall be skirted or underpinned and shall use the manufacturer's skirting material or other allowed material prescribed in Section 5.15.6.O.

5. Building Walls
   a. Building walls may be clad in vinyl or aluminum siding (smooth, horizontal preferred) or a permitted finish material in accordance with Section 5.15.6.G.

6. Roof
   a. Roofing material and configurations shall be in accordance with Section 5.15.6.J.

7. Shutters
   a. Shutters are encouraged, and when used should be sized to match opening and situated as would be an operable shutter.

ORDINANCE NO. 2021 – _____

TOWN OF BLUFFTON, SOUTH CAROLINA

AN ORDINANCE AMENDING THE TOWN OF BLUFFTON'S MUNICIPAL CODE OF ORDINANCES, CHAPTER 23, UNIFIED DEVELOPMENT ORDINANCE, ARTICLE 5 – DESIGN STANDARDS, RELATING TO CERTAIN BUILDING TYPES, BUILDING SIZE, FOOTPRINT AND HEIGHT

WHEREAS, the Town of Bluffton desires to improve the general safety, welfare, health and properties of the citizens of the Town of Bluffton; and,

WHEREAS, to establish the necessary provisions to accomplish the above, the Town of Bluffton has authority to enact resolutions, ordinances, regulations, and procedures pursuant to South Carolina Code of Laws 1976, Section 5-7-30; and,

WHEREAS, the Town of Bluffton's Town Code and Ordinances provide guidance and requirements for development within the Town of Bluffton through regulations set forth to protect and promote the health, safety, and welfare of the Town's citizens, as espoused through the provisions of the Town of Bluffton Comprehensive Plan and as authorized by the South Carolina Local Government Comprehensive Planning Enabling Act of 1994, Title 6, Chapter 29 of the Code of Laws for South Carolina; and

WHEREAS, the Town of Bluffton Town Council adopted the aforementioned standards, which are known as the Unified Development Ordinance, Chapter 23 of the Code of Ordinances for the Town of Bluffton, South Carolina on October 11, 2011 through Ordinance 2011-15; and

WHEREAS, the Unified Development Ordinance unifies the subdivision, land use, development/design regulations, as well as the Old Town Bluffton Historic District Code into a single set of integrated, updated, and streamlined standards; and

WHEREAS, the Town Council shall from time to time examine ordinances to ensure that they are properly regarded, enforced, sufficient and satisfactory to the needs of the community and can further suggest changes as deemed appropriate; and,

WHEREAS, the Town of Bluffton Town Council desires to amend the Unified Development Ordinance, Article 5 – Design Standards, Relating to Certain Building Types, Size, Footprint and Height.

NOW, THEREFORE, BE IT ORDERED AND ORDAINED BY THE TOWN COUNCIL OF THE TOWN OF BLUFFTON, SOUTH CAROLINA, in accordance with the foregoing, the Town hereby amends the Code of Ordinances for the Town of Bluffton, Chapter 23, Unified Development Ordinance as follows:

SECTION 1. AMENDMENT. The Town of Bluffton hereby amends the Code Ordinances for the Town Of Bluffton, South Carolina by adopting and incorporating amendments to Chapter 23 – Unified Development Ordinance, Article 5 – Design Standards, Relating to Certain Building Types, Building Size, Footprint and Height as shown on Exhibit A attached hereto and fully incorporated herein by reference.

SECTION 2. REPEAL OF CONFLICTING ORDINANCES. All ordinances or parts of ordinances inconsistent with this Ordinance are hereby repealed to the extent of such inconsistency.

SECTION 3. ORDINANCE IN FULL FORCE AND EFFECT. This entire Ordinance shall take full force and effect upon adoption.

DONE, RATIFIED AND ENACTED this ______ day of _____________, 2021.

This Ordinance was read and passed at first reading on ________, 2021.

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

____
Kimberly Chapman
Town Clerk, Town of Bluffton, South Carolina

A public hearing was held on this Ordinance on ______________, 2021.

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

____
Kimberly Chapman
Town Clerk, Town of Bluffton, South Carolina
This Ordinance was passed at second reading held on ___________, 2021.

Lisa Sulka, Mayor
Town of Bluffton, South Carolina

Kimberly Chapman
Town Clerk, Town of Bluffton, South Carolina

EXHIBIT A

Sec. 5.15.5.B (Design Standards - Neighborhood Center Historic District, NCE-HD)

Neighborhood Center – HD Building Type Requirements:	Front Build-to Zone	Lot Width	Frontage Requirement	Rear Setback (from property line)	Side Setback (from side property line)	Height (in stories)
Main Street Building	~~0' – 10'~~ 10' -25'	50'- 80'	75% - 90%	25'	8'	2 – 2.5
Additional Building Types						
As approved by the UDO Administrator or Board/Commission with approval authority in accordance with Article 2 of this Ordinance, additional building types may be allowed in the Neighborhood Center zoning district. Building types not specifically listed shall be regulated by the following general requirements.	~~0' – 25'~~ 10' -25'	50'- 100'	To be determined by the UDO Administrator	25'	~~5'~~ 8'	1 – 2.5

Sec. 5.15.8.A. (Design Standards - Building Types, Main Street Building)

A. Main Street Building		
General: Detached Mixed Use Building		Core •
Size Range: ~~2,000 – 8,000 sq. ft.~~ NC–HD: 2,000 – 8,000 sq. ft. NCE-HD: 2,000 – 5,000 sq. ft.		Center •
Maximum Footprint (not including porches): ~~3,500 sq. ft.~~ NC–HD: 3,500 sq. ft. NCE-HD: 2,500 sq. ft.		General
Height: ~~2-3 stories~~ NC–HD: 2-3 stories NCE-HD: 2-2.5 stories		Conserve
Notes: A shopfront building Retail/office space on ground floor Office/living space on upper levels Must have an arcade, colonnade, marquee or awning along the front façade (arcades/colonnades are preferred)		River Edge

Sec. 5.15.5 (Design Standards - General Standards)

The existing or proposed building type shall determine the applicable lot standards. The maximum building footprint and building size for an Additional Building Type shall not exceed the largest building footprint and building size permitted for other building types permitted within the same zoning district. Building types shall only be permitted as listed in the applicable District. The maximum allowed density is based on the dimensional characteristics established for each building type in combination with other site characteristics that may limit the amount of land able to accommodate density. These other site characteristics include, but are not limited to, lot configuration, right-of-way, easements, protected natural resources, open space, topography, and parking.

Proposed Motion

Approval of Amendments to the Town of Bluffton Code of Ordinances Chapter 23 – Unified Development Ordinance, Article 5 – Design Standards, Relating to Certain Building Types, Maximum Building Size, Footprint and Height– Heather Colin, Director of Growth Management

"I move to approve amendments to the Town of Bluffton Code of Ordinances Chapter 23 – Unified Development Ordinance, Article 5 – Design Standards, Relating to Certain Building Types, Maximum Building Size, Footprint and Height."

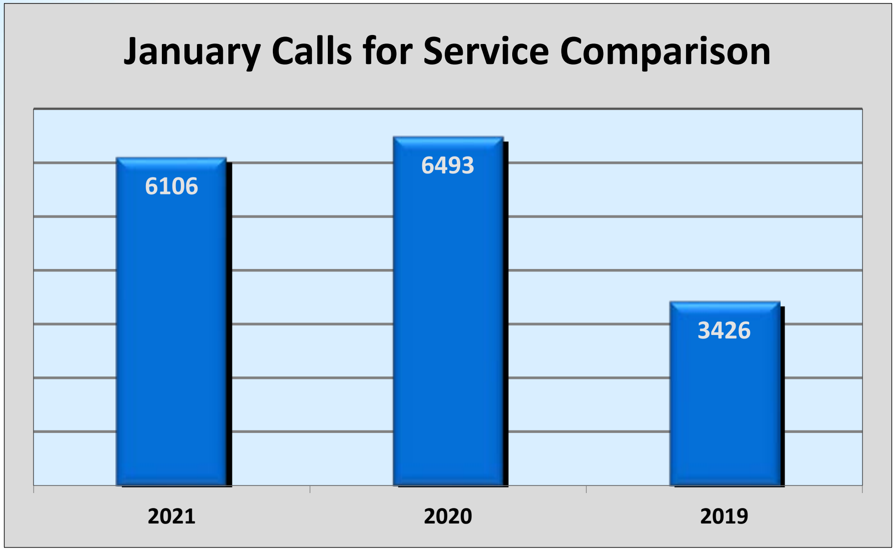
Bluffton Police Department
January 2021 Statistical Information

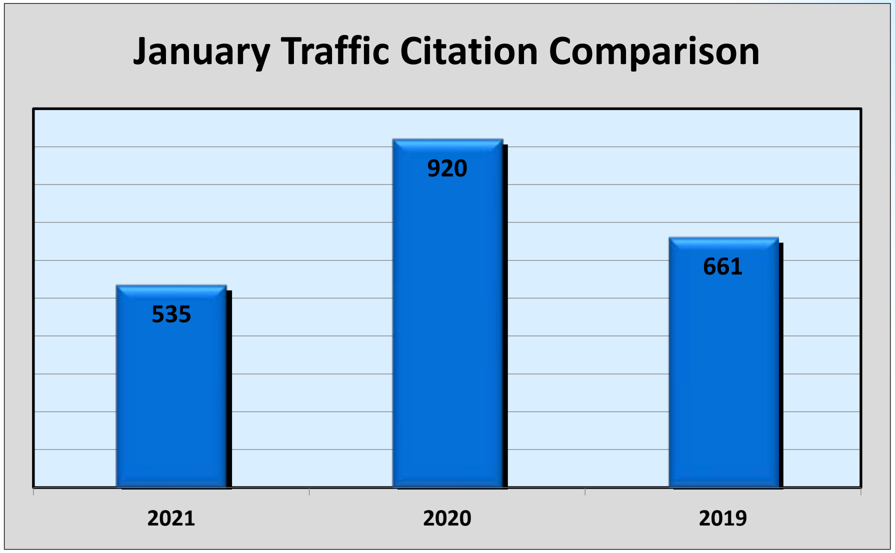
Presented by:
Chief Stephenie Price

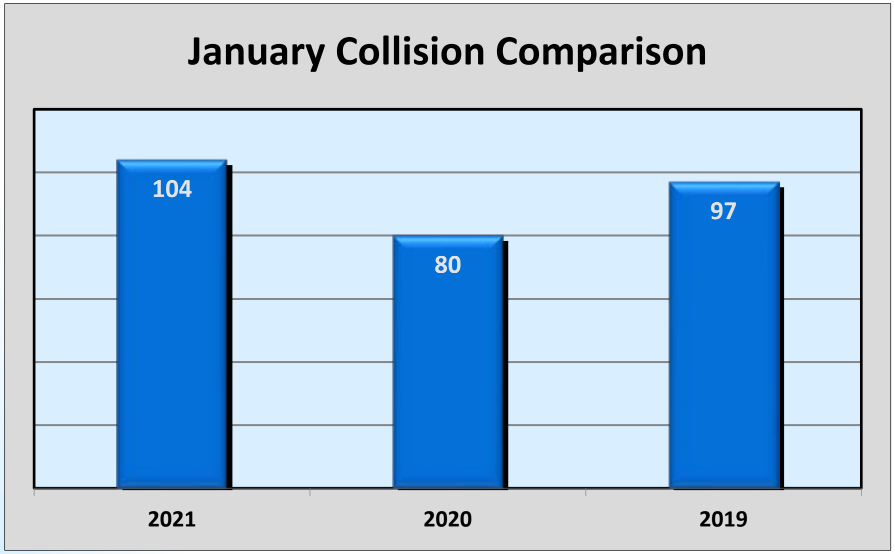
January 31, 2021

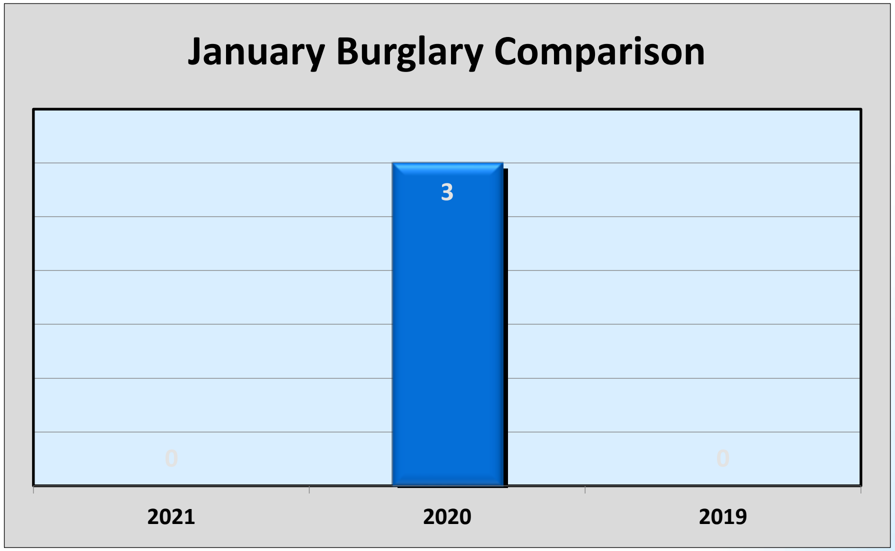
January Trends

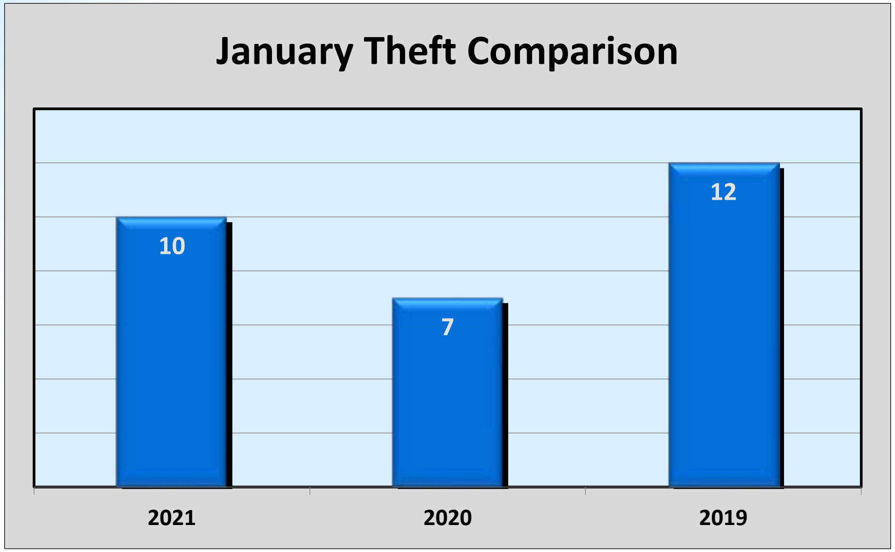
Section XII. Item #1.

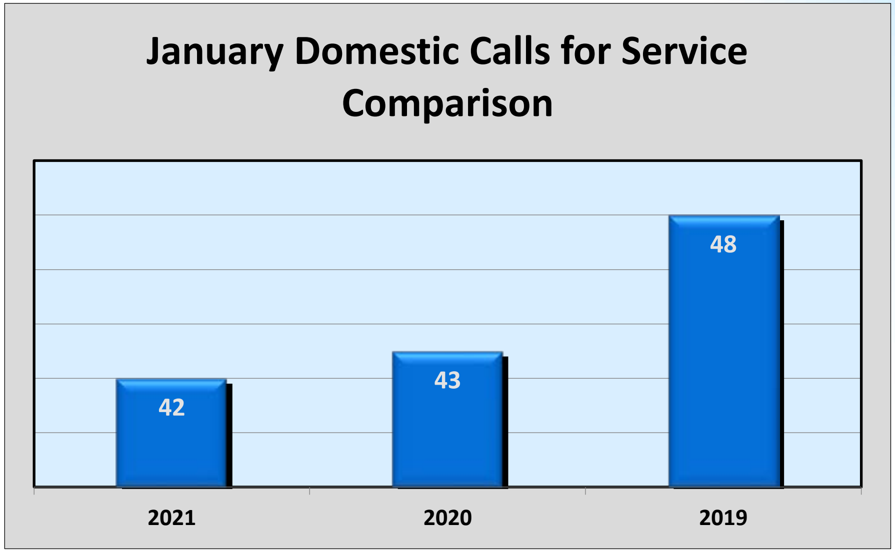


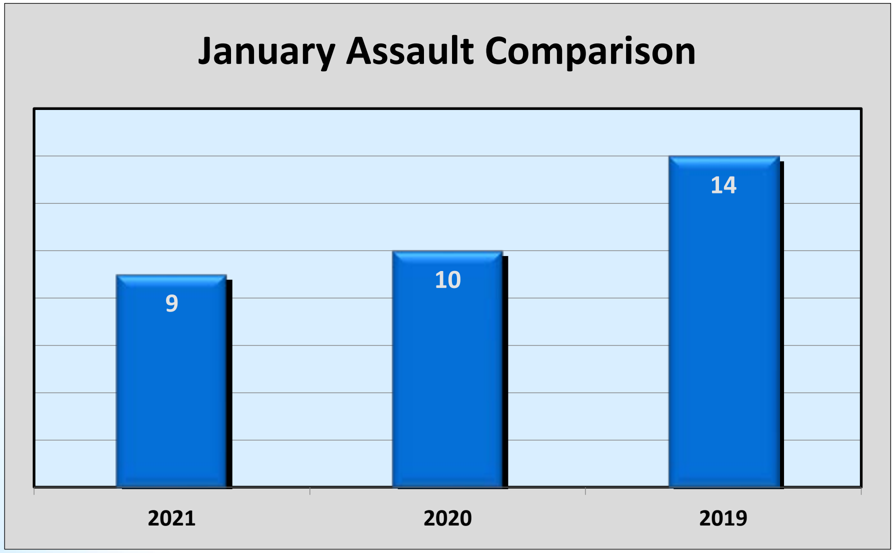


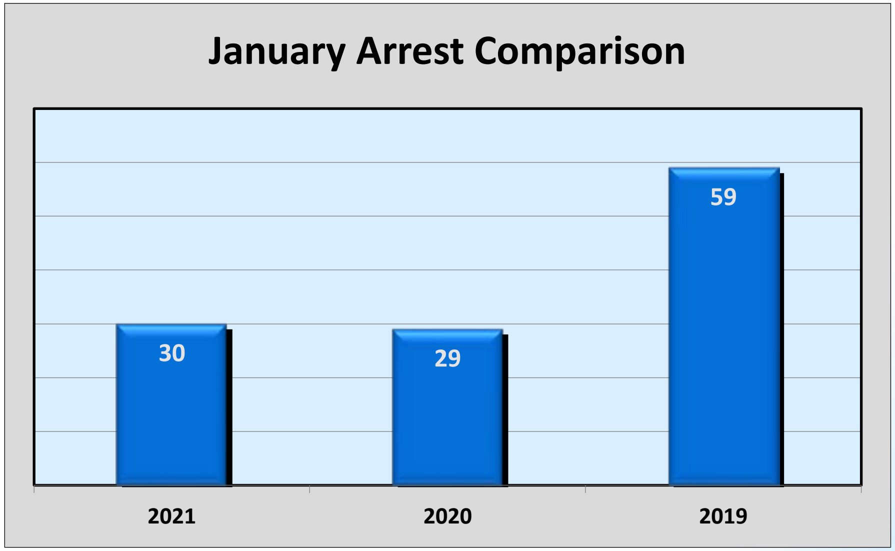




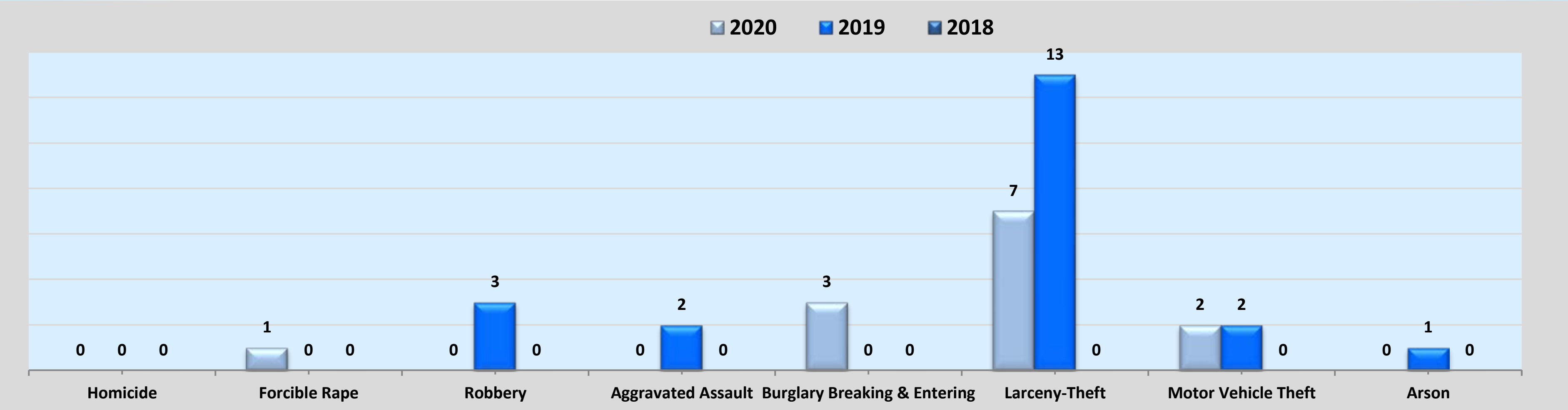

January Theft Comparison
10
7
12
2021
2020
2019

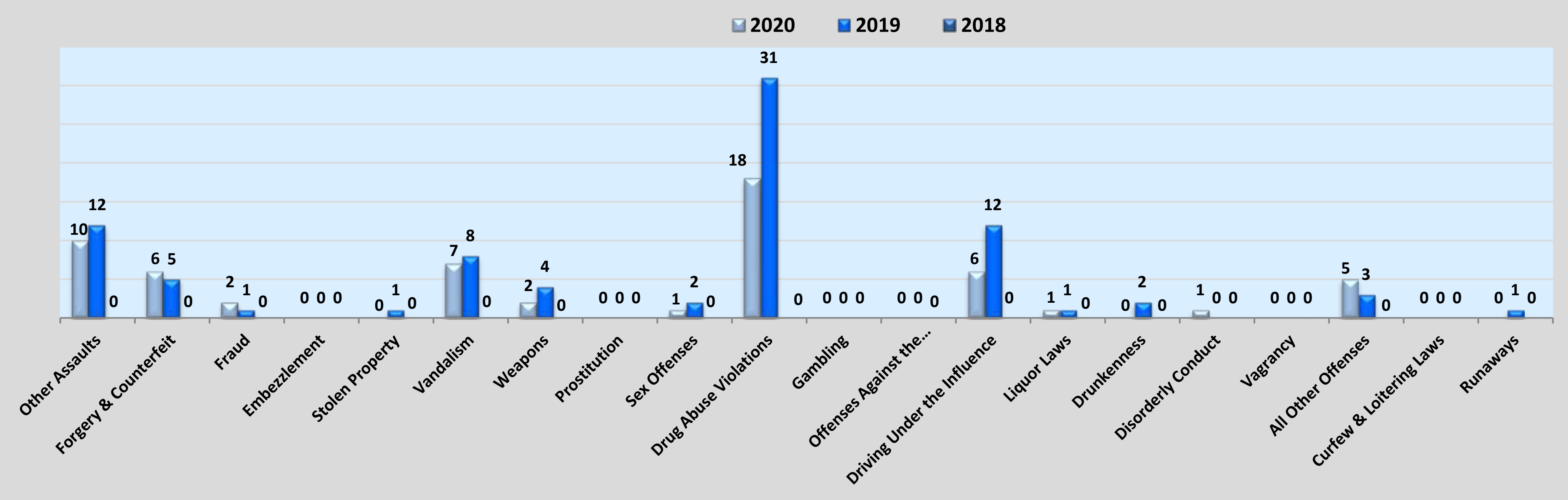

January Domestic Calls for Service Comparison
42
43
48
2021
2020
2019


January Assault Comparison
9
10
14
2021
2020
2019


January Arrest Comparison
30
29
59
2021
2020
2019

Part I and Part II Offenses





Department Highlights

Arrests
Adult Felony: 5
Adult Misdemeanor: 12
Juvenile: 1
DUI: 13

Safer at Home
#BlufftonStrong

Complaints
No complaints received in January 2021

Commendations
Officer Terry Harden – Employee of the Quarter

Law Enforcement Advisory Committee
The Law Enforcement Citizens Advisory Committee held its second meeting on January 14, 2021. The committee determined that it would focus on the President's Task Force on 21st Century Policing The initial focus would be on Pillar 5: Training and Education. Members of the committee will be working with Police Department staff in reviewing training, recruitment and policy.

The department held a hiring and recruitment event on January 23rd. Several committee members joined department staff in welcoming potential new employees.

Department Highlights

<u>Meetings Attended by Chief Stephenie Price</u>
Every Wednesday – Attended Senior Staff Communications Meeting
Bi-Weekly – Town Update Zoom Meeting

Jan 3rd – Commanders Meeting
Jan 3rd – Budget Meeting
Jan 6th – Attend Sun City TV Interview
Jan 7th – Lutzie 43 Meeting
Jan 7th – Enterprise Rental Car zoom meeting
Jan 12th – Attend VITRA Firearms Simulator demonstration
Jan 12th –Town Attorney and HR Director zoom meeting
Jan 12th – Town Council zoom meeting
Jan 13th – Attend Dept Head Strategic Plan Discussion
Jan 14th – Attend MedTrust Contract meeting
Jan 14th – Budget Meeting
Jan 14th – Law Enforcement Advisory Committee zoom meeting
Jan 15th – Recruitment Event meeting
Jan 18th – Attend MLK Vehicle Parade and Gullah Market
Jan 19th – Lowcountry Radio Recording Session
Jan 19th – Lunch meeting with Support Division Commander
Jan 19th – Commanders Meeting
Jan 20th – Attend meeting with BCSO
Jan 20th – Lunch meeting with Special Operations Commander
Jan 20th – Command Staff meeting
Jan 21st – Enterprise Fleet zoom meeting
Jan 21st – Lunch meeting with HR
Jan 22nd – Meeting with Town Manager
Jan 23rd – BPD Recruitment Event
Jan 25th – Attend Strategic Planning Workshop
Jan 26th – Meeting with Town Manager
Jan 26th – Commanders meeting
Jan 27th – Meeting with Sergeant and Human Resource
Jan 27th - Lowcountry Community Church check donation
Jan 27th – Lunch meeting with Captain
Jan 27th – Employee of the Quarter Award Presentation
Jan 28th – Lunch meeting with Investigations Commander
Jan 28th – Meeting with Operations Captain

DO THE FIVE

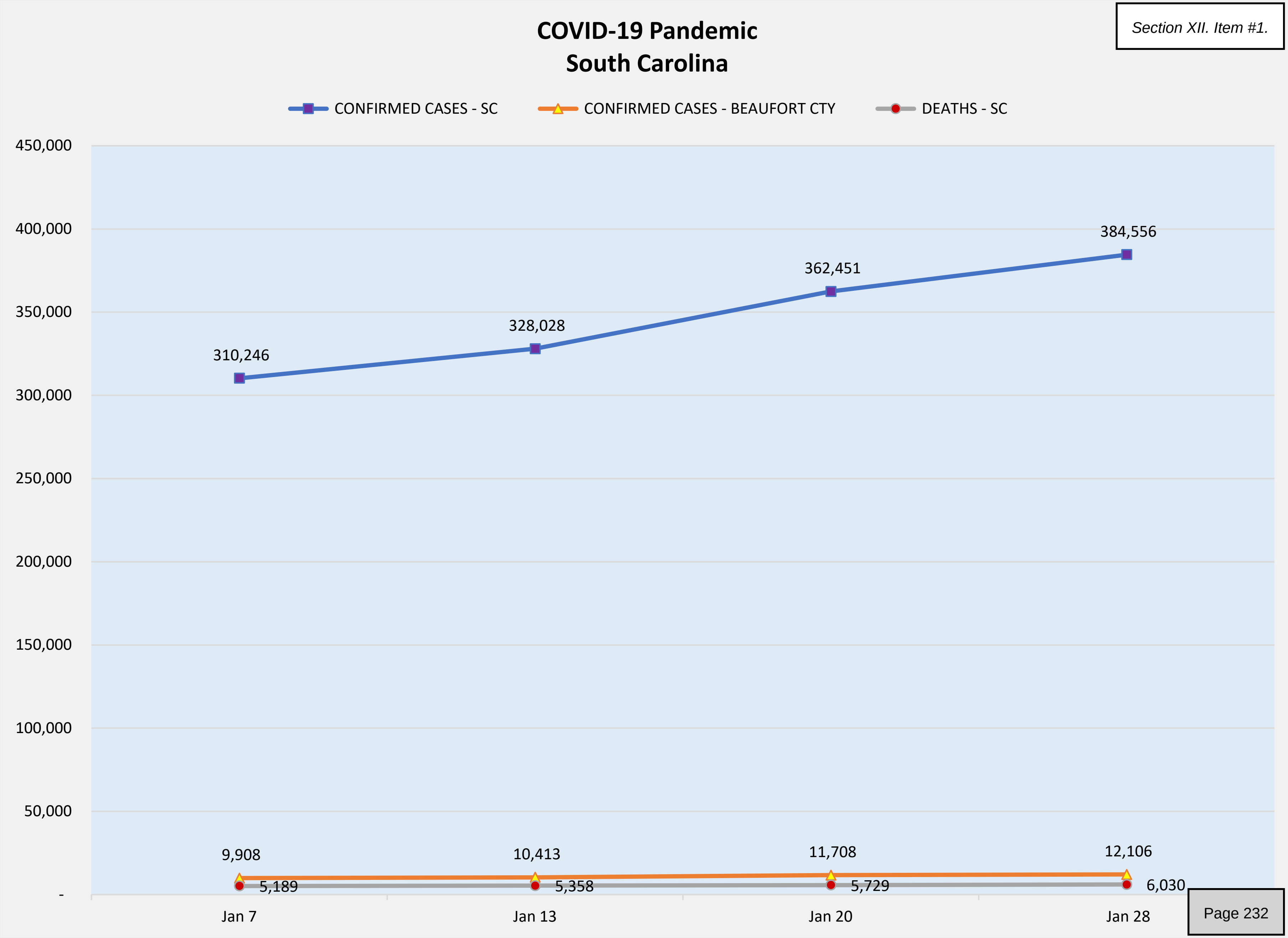
Help stop coronavirus

1. **HANDS** Wash them often
2. **ELBOW** Cough into it
3. **FACE** Don't touch it
4. **SPACE** Keep safe distance
5. **HOME** Stay if you can

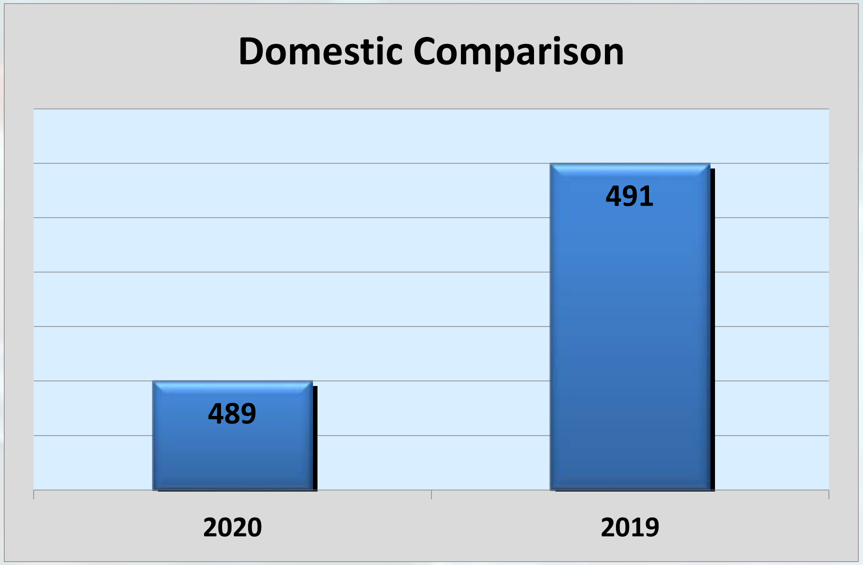
United States: as of 1/27/2021
Cases Confirmed: 25,565,874
Deaths: 428,015

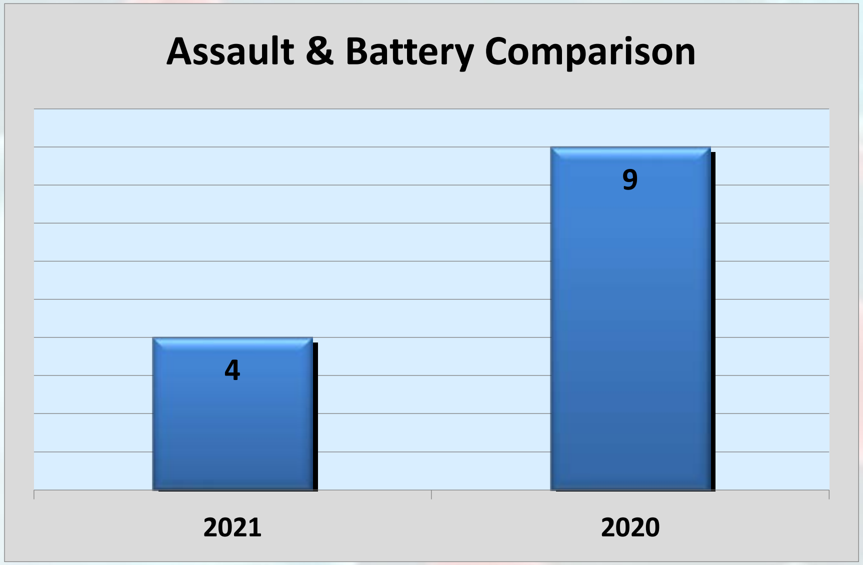
South Carolina:
Cases Confirmed: 384,556
Deaths: 6,030

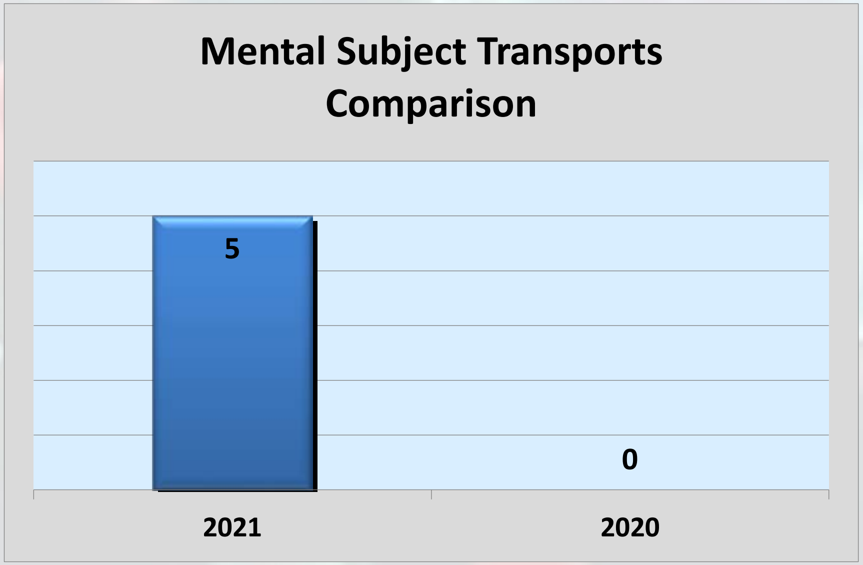
Beaufort County:
Cases Confirmed: 12,106
Deaths: 135

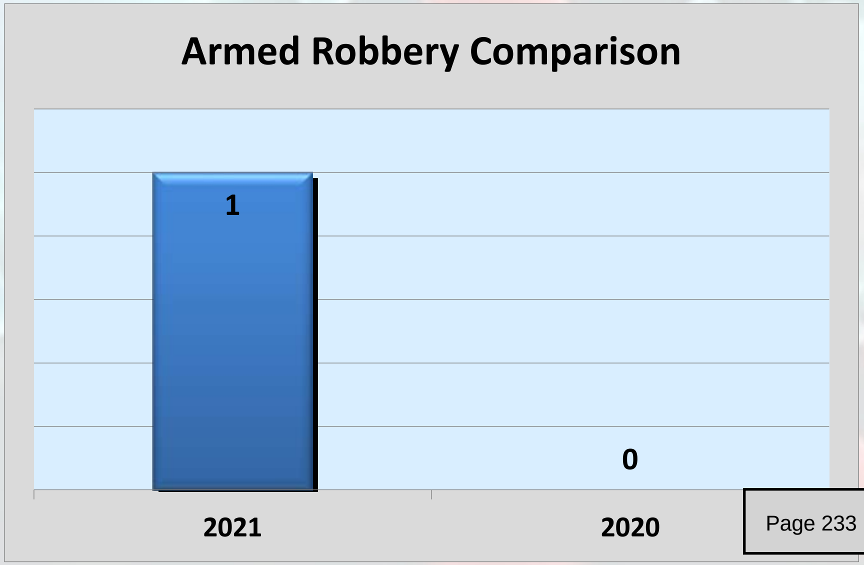

COVID-19 Pandemic
South Carolina
CONFIRMED CASES - SC
CONFIRMED CASES - BEAUFORT CTY
DEATHS - SC
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
310,246
328,028
362,451
384,556
9,908
10,413
11,708
12,106
5,189
5,358
5,729
6,030
Jan 7
Jan 13
Jan 20
Jan 28

COVID-19 Pandemic
Calls for Service Comparison Charts
Month of January







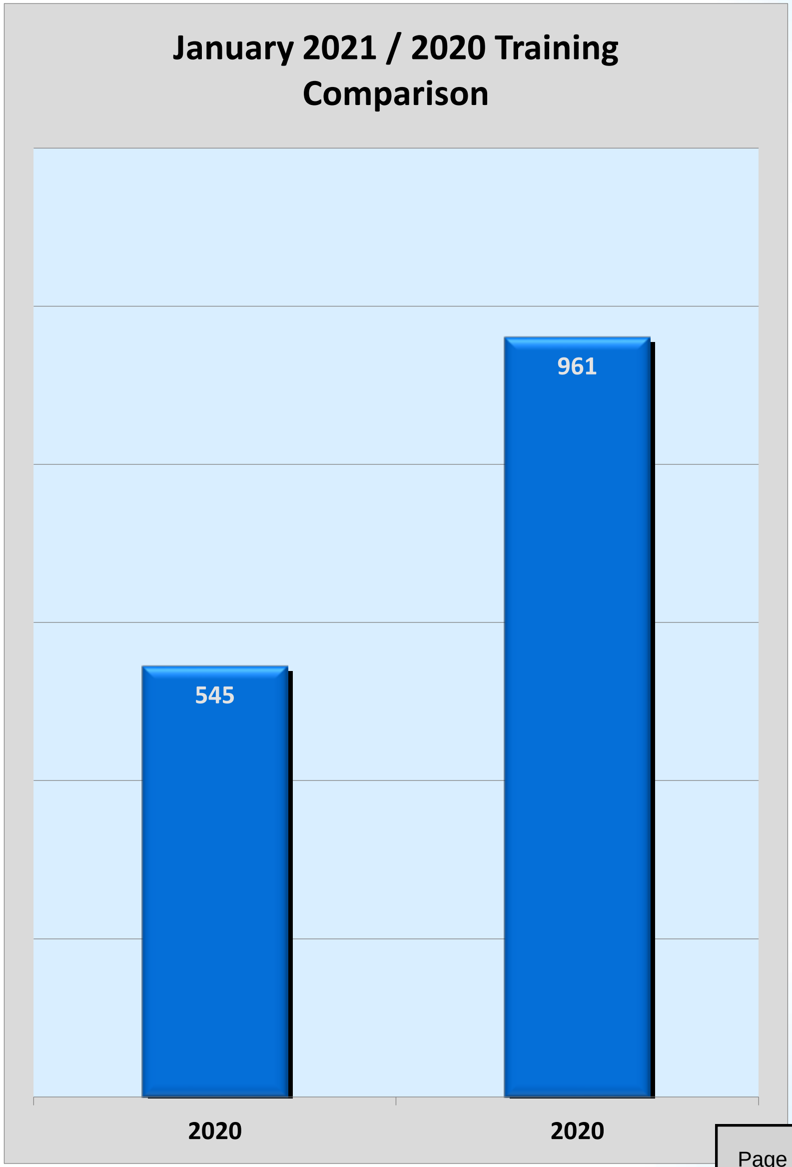


Department Highlights

Training – In-House
Bloodborne Pathogens for First Responders – 44 Officers
Hazmat First Responder Awareness – 41 Officers
Line-Up 2021 – 36 Officers
Legal Update – 16 Officers
DV Update – 2 Officers
Vulnerable Adult Training – 1 Officer
Pre-Service Recruit Training – 2 Recruits

Training – Outside
Taser Instructor – 2 Officers

Marine Patrol
No Marine Patrol activity during January.



Patrol Division

CALLS FOR SERVICE TOP 10 CALL TYPES	
Extra Pat Busin	2857
Extra Pat Resid	1514
Traffic Stop	544
911 Hang-Up	130
Activated Alarm	117
Case Follow Up	85
Susp Vehicle	78
Community Relat	71
Accident	66
Disturbance	62

Total Calls for Service: 6106
Avg per day: 197

UNIFORM TRAFFIC CITATIONS TOP 10 VIOLATIONS	
Speeding15mph-24mph & mor	47
Exp or Unreg Lice Plate &	17
Driving without a License	12
DUS/notsuspforDUI-1st & m	12
DUI/1st Offense & More &	10
Speeding 11mph-15mph & mo	9
Speeding10MphOrLess & mor	8
Speeding25MphOrMore & mor	7
StopSign;Disregarding & m	5
Parking Other-In Comments	3

Total Traffic Citations Issued: 160
Avg per day: 6

WARRANTS SERVED VIOLATION TYPES	
Fugitive from justice warrant, non-crim	1
Manf, poss sub in Sch I,II,III witd-1st	1
Manuf Poss sub in Sch I,II,III witd-1st	1
Poss of controlled sub Sch I-V-1st	1
Poss of less than one gram meth-1st	1
Sale or delivery of pistol: stolen pisto	1
Unlawful carrying of pistol	1

UNIFORM TRAFFIC WARNINGS TOP 10 VIOLATIONS	
Speeding	120
Speeding & more	48
Vehcle Licnse Viol	40
Defective Equipmnt	29
Improper Lane Use	17
Defective Equipmnt & more	16
Disregrd Stop Sign	16
Other	12
Improper Turn	9
Disrgrd Traf Signl	6

Total Warning Citations Issued: 376
Avg per day: 12

Criminal Investigation Division

CRIMINAL INVESTIGATIONS	
Cases Assigned	14
Incident Reports Taken	2
Supplemental Reports	31
Cases Closed	17
Arrests Made	1
Arrest Warrants	1
Bond Court	2
Case Call Outs	4
Search Warrants	5

Main Cases January 2021:
20BP91141 Shots Fired
20BP91448 Shots Fired
21BP00025 Vehicle v. Pedestrian

Case Call Outs January 2021:
20BP91448 Shots Fired Into Dwelling
20BP91141 Shots Fired Into Dwelling
21BP00025 Vehicle v. Pedestrian
21BP04201 Structure Fire
21BP02804 Suspicious Activity

Bond Court January 2021:
21BP00871 DV 2nd Chandler Cool
21BP01923 DV 2nd Angel Rosales

CAREER CRIMINAL UNIT	
Cases Assigned	4
Incident Reports Taken	3
Supplemental Reports	4
Cases Closed	2
Arrests Made	0
Arrest Warrants	0
Bond Court	1
Case Call Outs	1
Search Warrants	1

CCU Ongoing Cases:
19BP52996- Attempted Murder
19BP62723- Murder
20BP26435- Confidential Case (Conspiracy)
20BP74802- CSC
21BP01143- Assist DEA (Distribution of Methamphetamine)

CCU/CID Case Call Outs:
21BP05542- Assist BCSO/ Missing person / Murder

Court / Grand Jury:
Cancelled / Postponed.

Digital Forensic Extractions: One digital forensic search warrant/extractions- 20BP86219

Community Action Team – January 2021

Traffic Officer:
Cpl. Dickson
Tickets: 45
Warnings: 5
Total Citations: 50
Collision Reports: 6
Incident Reports: 0

Officer Harden
Tickets: 23
Warnings: 61
Total Citations: 84
Collision Reports: 7
Incident Reports: 0

Downtown Traffic Stats:
Tickets: 16
Warnings: 9
Truck Route: 0
Parking Tickets: 0

Code Enforcement:

Sign Violations: Multiple Business advertisement signs removed

Business License:
93 letters sent to various businesses operating with unpaid taxes and/or expired license

- 8 Accommodations Tax
- 29 Hospitality Tax
- 56 Expired Business License

Complaints/Property Checks:

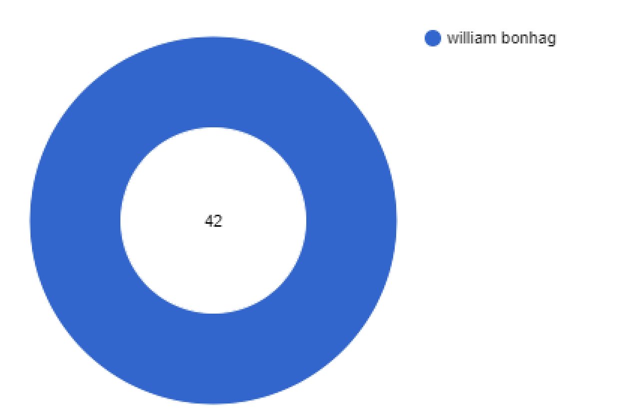
- Corks – Noise complaint
- Palmetto Bluff – Mask Ordinance
- Benton Circle (Alston Park) – Noise complaint
- Thomas Heyward Bridge – Carcasses being dumped
- 7 Overcup Oak lane – Potential Business License
- Hulston Landing (Mill Creek) – Noise complaint
- 14 Saxony Lane (Pinecrest) – Illegal burning

Court: None

Community Service Assistants – January 2021

Section XII. Item #1.

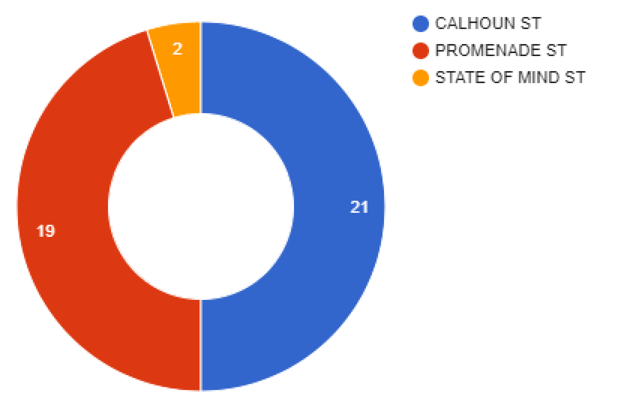
Tickets By Officer Jan. 2021



Total Count: 42

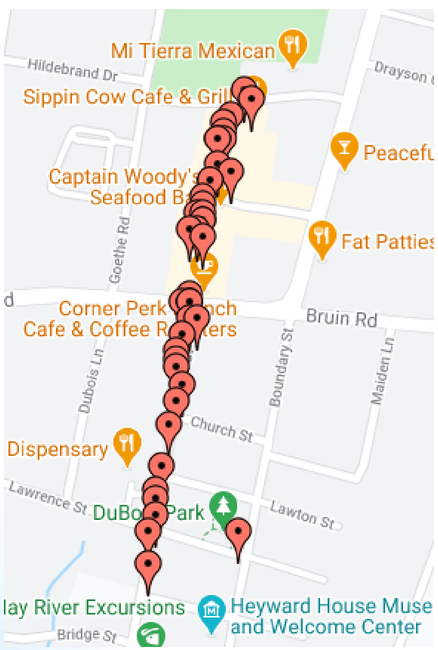
As of 2/1/2021, 12:00:00 AM

Tickets By Location Jan. 2021

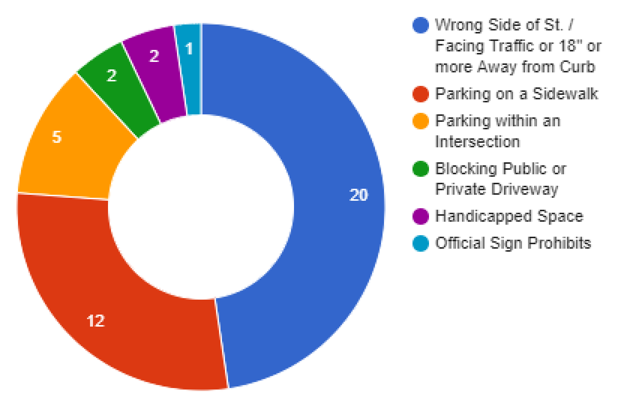


Total Count: 42

As of 2/1/2021, 12:00:00 AM



Tickets By Violation Jan. 2021



Total Count: 42

As of 2/1/2021, 12:00:00 AM

Lutzie 43 Actions

Redevelop Plan:

- 1-year long Lutzie 43 Awareness Program and Education Campaign

Take 43 Key Seconds to Complete the Safe Driving Checklist

Clear Head
Ensure you have a clear head - one that is not affected by alcohol, drugs, emotions or fatigue.

Clear Hands
Have clear hands - send a text, adjust the radio, and put all devices away so you can drive hands-free.

Clear Eyes
Set your sights on the road ahead. Do not look to the side at a passenger or down at a text.

Click It
Finally, click your seatbelt. It's the law and could save your life!

Now, Turn Your Key.

43 KEY SECONDS

In April 2019, the Town of Bluffton partnered with the Lutzie 43 Foundation. The objective – inspire all of us to make better decisions as drivers. According to the National Highway Traffic Safety Administration, 3,166 lives were lost in 2017 as a result of distracted driving. Join the Town of Bluffton in its efforts to make the state of South Carolina a handsfree state. **#HandsFreeSC**

The 43 Key Seconds initiative aims to produce safe and successful lifelong drivers who will serve as ambassadors for change in their communities. This reminds each driver and passenger to **TAKE 43 KEY SECONDS TO STOP AND PRIORITIZE SAFETY** before driving. It's all in an effort to **END DISTRACTED DRIVING.**

To learn more visit www.Lutzie43.org

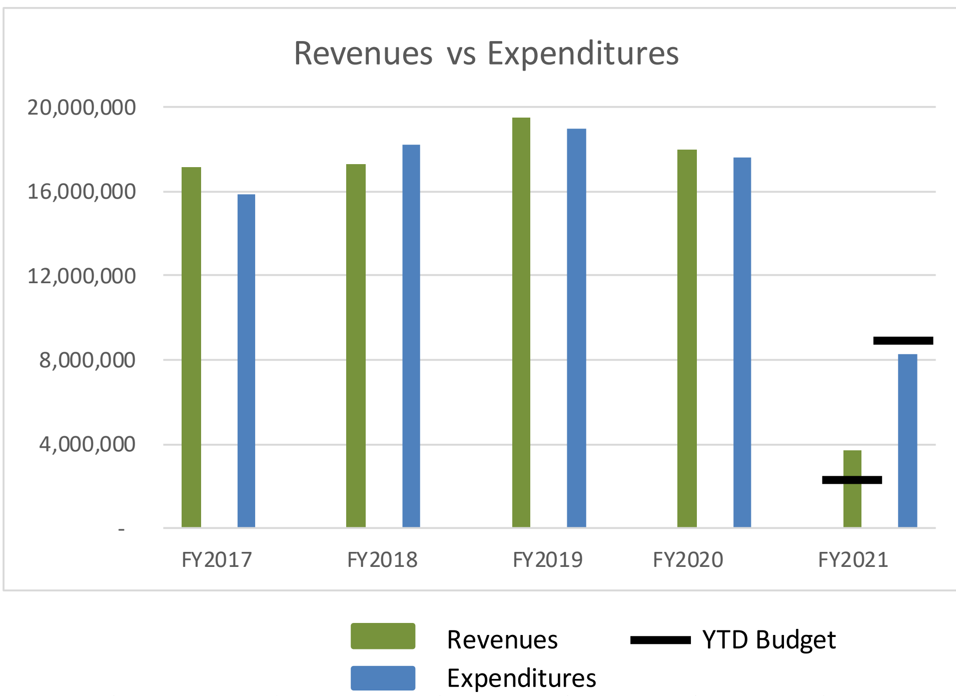
LUTZIE 43

TOWN COUNCIL
STAFF REPORT
Finance & Administration Department

MEETING DATE:	February 9, 2021
PROJECT:	Consent Agenda: Year-to-date Financial Report
PROJECT MANAGER:	Chris Forster, MPA, CPFO, CGFM, Director of Finance & Administration

General Fund Financial Overview:

The chart below shows the revenue collections and expenditures trend for the last four full years and FY2021 year-to-date (YTD) through December 2020. Revenues have been higher than expenditures the last four full years except for FY2018 which reflects a budgeted use of fund balance transferred to the Capital Improvements program fund for the Town Hall renovation project.



FY2022 YTD through December shows revenues slightly above the budget amount due to higher building permits and business licenses partially offset by timing of grant reimbursements and contract police service and rental income revenue impacts of COVID-19. YTD December expenditures are tracking slightly below the budgeted amounts.

FY21 General Fund Financial Overview

Revenues		Expenditures
$3,722k	*YTD*	$8,259k
138.1%	*% of Budget*	87.8%
$2,695k	*YTD Budget*	$9,408k

ATTACHMENTS:

1. General Fund
2. Stormwater Fund
3. Capital Improvement Program Fund
4. Debt Service Fund
5. Special Revenue Funds
6. Business License Statistics

Town of Bluffton
Actual Versus Budget
General Fund

	Month of December					Year-to-Date thru December				
	FY 2020	FY 2021	More/(Less)	Budget	Over / (Under)	FY 2020	FY 2021	More/(Less)	Budget	Over / (Under)
Revenues										
Property Taxes	$ -	$ 66,356	$ 66,356	$ -	$ 66,356	$ 311,794	$ 348,837	$ 37,043	$ 315,092	$ 33,745
Licenses & Permits										
Business Licenses	59,605	89,974	30,369	52,072	37,902	306,296	391,727	85,431	267,586	124,141
MASC Telecommunications	-	22	22	-	22	-	22	22	-	22
MASC Insurance Tax Collection	-	345	345	-	345	-	345	345	-	345
Franchise Fees	57,399	-	(57,399)	57,251	(57,251)	558,657	515,924	(42,733)	557,220	(41,296)
Building Safety Permits	349,224	390,895	41,671	211,847	179,048	1,371,402	1,669,688	298,286	1,003,961	665,727
Application Fees	4,870	5,600	730	3,802	1,798	34,990	36,495	1,505	27,318	9,177
Administrative Fees	-	-	-	-	-	-	-	-	-	-
Total Licenses & Permits	471,098	486,836	15,738	324,972	161,864	2,271,345	2,614,201	342,856	1,856,084	758,117
Grants and Entitlements	18,657	46,200	27,543	198,479	(152,279)	95,078	122,621	27,543	268,478	(145,857)
Intergovernmental	-	-	-	-	-	-	-	-	-	-
Service Revenues	84,827	109,053	24,226	68,093	40,960	432,289	459,580	27,291	313,879	145,701
Fines & Fees	21,670	9,198	(12,472)	26,585	(17,387)	77,926	48,588	(29,338)	95,389	(46,801)
Interest Income	-	2,010	2,010	-	2,010	23,877	9,746	(14,131)	12,856	(3,110)
Miscellaneous Revenues	10,007	9,369	(638)	5,196	4,173	113,293	86,274	(27,020)	101,413	(15,139)
Total Revenues	587,602	729,022	141,420	424,845	304,177	3,230,524	3,567,226	336,702	2,694,713	872,513
Other Financing Sources	-	-	-	-	-	-	-	-	-	-
Transfers In	30,059	31,802	1,743	-	31,802	30,059	31,802	1,743	-	31,802
Total Other Financing Sources & Tranfers In	30,059	31,802	1,743	-	31,802	30,059	31,802	1,743	-	31,802
Total Revenues and Other Financing Sources	$ 617,661	$ 760,824	$ 143,163	$ 424,845	$ 335,979	$ 3,260,583	$ 3,599,028	$ 338,445	$ 2,694,713	$ 904,315
Expenditures										
Town Council	$ 7,677	$ 8,571	$ 894	$ 7,456	$ 1,115	$ 61,127	$ 51,539	$ (9,588)	$ 49,195	$ 2,344
Executive	74,834	62,216	(12,618)	104,429	(42,213)	435,061	383,973	(51,088)	443,988	(60,015)
Economic Development	30,184	27,577	(2,607)	29,973	(2,396)	181,652	180,344	(1,308)	193,419	(13,075)
Human Resources	37,548	22,902	(14,646)	42,911	(20,009)	173,233	154,178	(19,055)	185,836	(31,658)
Police	539,069	495,159	(43,910)	852,065	(356,906)	3,530,738	3,038,941	(491,797)	3,582,836	(543,895)
Municipal Judges	4,204	3,967	(237)	4,874	(907)	24,659	24,417	(242)	28,494	(4,077)
Municipal Court	31,778	24,986	(6,792)	36,087	(11,101)	157,112	185,309	28,197	158,503	26,806
Finance	63,090	80,682	17,592	93,613	(12,931)	408,997	447,586	38,589	445,230	2,356
Information Technology	60,268	136,728	76,460	138,658	(1,930)	612,292	649,089	36,797	650,849	(1,760)
Customer Service	13,720	17,158	3,438	24,369	(7,211)	109,210	102,122	(7,088)	140,915	(38,793)
Planning & Community Development	88,218	78,397	(9,821)	144,832	(66,435)	477,512	459,258	(18,254)	634,894	(175,636)
Building Safety	44,762	50,241	5,479	120,129	(69,888)	339,282	275,699	(63,583)	354,656	(78,957)
Project Management	67,099	65,454	(1,645)	96,908	(31,454)	385,758	380,007	(5,751)	426,572	(46,565)
Public Works	139,704	110,002	(29,702)	193,249	(83,247)	758,040	766,038	7,998	1,017,154	(251,116)
Town Wide	112,546	207,479	94,933	132,409	75,070	853,948	1,160,548	306,600	1,095,472	65,076
Total Expenditures	1,314,701	1,391,519	76,818	2,021,962	(630,443)	8,508,619	8,259,048	(249,571)	9,408,014	(1,148,966)
Other Financing Uses										
Transfers Out to Capital Improvements Program Fund	-	-	-	-	-	1,650	-	(1,650)	-	-
Total Transfers	-	-	-	-	-	1,650	-	(1,650)	-	-
Total Expenditures and Other Financing Uses	$ 1,314,701	$ 1,391,519	$ 76,818	$ 2,021,962	$ (630,443)	$ 8,510,269	$ 8,259,048	$ (251,221)	$ 9,408,014	$ (1,148,966)

Town of Bluffton
Actual Versus Budget
Stormwater Utility Fund

	Month of December					Year-to-Date thru December				
	FY 2020	FY 2021	More/(Less)	Budget	Over / (Under)	FY 2020	FY 2021	More/(Less)	Budget	Over / (Under)
Revenues										
Stormwater Utility Fee	$ 1,995	$ -	$ (1,995)	$ 2,289	$ (2,289)	$ 6,364	$ 3,327	$ (3,037)	$ 7,301	$ (3,974)
Licenses & Permits										
NPDES Plan Review Fee	-	10,250	10,250	30,417	(20,167)	-	36,500	36,500	182,500	(146,000)
NPDES Inspection Fee	-	17,650	17,650	-	17,650	-	100,125	100,125	-	100,125
Total Licenses & Permits	-	27,900	27,900	30,417	(2,517)	-	136,625	136,625	182,500	(45,875)
Grants and Entitlements	-	-	-	-	-	-	-	-	-	-
Intergovernmental	-	-	-	-	-	-	-	-	-	-
Service Revenues	-	-	-	-	-	-	-	-	-	-
Fines & Fees	-	-	-	-	-	-	-	-	-	-
Interest Income	-	-	-	-	-	-	-	-	-	-
Miscellaneous Revenues	-	-	-	-	-	-	-	-	-	-
Total Revenues	1,995	27,900	25,905	32,705	(4,805)	6,364	139,952	133,588	189,801	(49,849)
Other Financing Sources	-	-	-	-	-	76,421	76,421	-	-	76,421
Transfers In	-	-	-	-	-	18,657	-	(18,657)	-	-
Total Other Financing Sources & Tranfers In	-	-	-	-	-	95,078	76,421	(18,657)	-	76,421
Total Revenues and Other Financing Sources	$ 1,995	$ 27,900	$ 25,905	$ 32,705	$ (4,805)	$ 101,442	$ 216,373	$ 114,931	$ 189,801	$ 26,572
Expenditures										
Watershed Management	$ 107,099	$ 121,647	$ 14,548	$ 117,852	$ 3,795	$ 337,371	$ 398,471	$ 61,100	$ 371,244	$ 27,227
Total Expenditures	107,099	121,647	14,548	117,852	3,795	337,371	398,471	61,100	371,244	27,227
Other Financing Uses										
Transfers Out to Capital Improvements Program Fund	-	-	-	224,938	(224,938)	67,990	-	(67,990)	337,407	(337,407)
Transfers Out to General Fund	-	-	-	26,000	(26,000)	-	-	-	39,000	(39,000)
Contribution to Fund Balance	-	-		-	-	-	-		-	-
Total Transfers	-	-	-	250,938	(250,938)	67,990	-	(67,990)	376,407	(376,407)
Total Expenditures and Other Financing Uses	$ 107,099	$ 121,647	$ 14,548	$ 368,790	$ (247,143)	$ 405,361	$ 398,471	$ (6,890)	$ 747,651	$ (349,180)

Town of Bluffton
Budget and Actual - Capital Improvement Program Fund
For Period Ending December 31, 2020

		YTD Actual	Adopted Budget	Budget Amendments and Transfers	Revised Budget	Actual vs Budget Difference	Actual as % of Budget
	Infrastructure						
00040	Buckwalter Place Multi-County Commerce Park	$ 18,037	$ 271,492	$ 154,149	$ 425,641	$ 407,604	4.2%
00042	Calhoun Street Streetscape	110	242,714	43,098	285,812	285,702	0.0%
00050	Historic District Lighting, Signage, Parking & Streetscape Enhancements	21,242	188,550	59,034	247,584	226,342	8.6%
00052	Watershed Management Facility Improvements	16,375	22,200	1,893	24,093	7,718	68.0%
00055	Goethe - Shults Neighborhood Improvements Phase 2	18,955	997,449	73,056	1,070,505	1,051,550	1.8%
00059	Oyster Factory Park		26,600	77,100	103,700	103,700	0.0%
00060	Don Ryan Center for Innovation Upfit	822	-	61,122	61,122	60,300	1.3%
00062	Calhoun Street Regional Dock	275,767	209,324	204,735	414,059	138,292	66.6%
00063	68 Boundary Street Park	8,000	-	24,433	24,433	16,433	32.7%
00064	184 Bluffton Road Parking Improvements	1,335	-	36,218	36,218	34,883	3.7%
00069	Boundary Street Lighting		-	48,539	48,539	48,539	0.0%
00077	Law Enforcement Center Facility Improvements	55,276	1,029,943	-	1,029,943	974,667	5.4%
00078	Public Works Facility Improvements		-	160	160	160	0.0%
00079	Rotary Community Center Facility Improvements	1,900	-	7,609	7,609	5,709	25.0%
00082	Bridge Street Streetscape	1,934	72,848	34,530	107,378	105,444	1.8%
00085	New Riverside Park / Barn Site	30,110	225,000	15,842	240,842	210,732	12.5%
00088	Town Hall Improvements	12,723	62,139	5,422	67,561	54,838	18.8%
00089	Ulmer Auditorium Improvements	1,030	-	7,543	7,543	6,513	13.7%
00092	New River Trail	3,941	-	10,906	10,906	6,965	36.1%
00093	Ghost Roads	1,064	20,000	4,059	24,059	22,995	4.4%
00094	Boundary Street Streetscape	83	115,000	-	115,000	114,917	0.1%
	Total Infrastructure	**468,704**	**3,483,259**	**869,448**	**4,352,707**	**3,769,086**	**10.8%**
	May River & Surrounding Rivers and Their Watersheds						
00044	Buck Island - Simmonsville Sewer Phase 5	258,817	1,243,718	429,416	1,673,134	1,414,317	15.5%
00045	Jason-Able Sewer	106,415	-	129,178	129,178	22,763	82.4%
00054	Buck Island - Simmonsville Neighborhood Sidewalks & Lighting	46,459	405,203	155,169	560,372	513,913	8.3%
00061	Sewer Connections	700	482,000	(66)	481,934	481,234	0.1%
00070	Historic District Sewer Extension Phase 1	261,745	243,282	439,868	683,150	421,405	38.3%
00071	Historic District Sewer Extension Phase 2	1,660	348,940	35,845	384,785	383,125	0.4%
00072	Historic District Sewer Extension Phase 3		161,250	-	161,250	161,250	0.0%
00073	Historic District Sewer Extension Phase 4		141,125	-	141,125	141,125	0.0%
00074	Historic District Sewer Extension Phase 5		26,000	-	26,000	26,000	0.0%
00075	Historic District Sewer Extension Phase 6		31,250	-	31,250	31,250	0.0%
	Total May River & Surrounding Rivers and Their Watersheds	**675,796**	**3,082,768**	**1,189,410**	**4,272,178**	**3,236,757**	**15.8%**
	Economic Growth						
00020	Land Acquisition	487,033	993,386	-	993,386	506,353	49.0%
00087	Town of Bluffton Housing Project		841,592	38,729	880,321	880,321	0.0%
00090	Technical College of the Lowcountry		500,000	-	500,000	500,000	0.0%
	Total Economic Growth	**487,033**	**2,334,978**	**38,729**	**2,373,707**	**1,886,674**	**20.5%**
	Community Quality of Life						
00065	Wright Family Park	178,819	104,302	313,259	417,561	238,742	42.8%
00066	Oscar Frazier Park	87,607	105,100	(1,636)	103,464	15,857	84.7%
00067	Squire Pope Carriage House Preservation		-	15,150	15,150	15,150	0.0%
00086	Park Improvements		-	8,197	8,197	8,197	0.0%
00091	Community Safety Cameras Phase 5	39,535	75,000	1,197	76,197	36,662	51.9%
	Total Community Quality of Life	**305,961**	**284,402**	**336,167**	**620,569**	**314,608**	**49.3%**
	Total CIP Expenditures	**$ 1,937,494**	**$ 9,185,407**	**$ 2,433,754**	**$ 11,619,161**	**$ 9,207,125**	**16.7%**

Section XII. Item #1.

Town of Bluffton
Actual Versus Budget
Debt Service Fund

	Month of December					Year-to-Date thru December				
	FY 2020	**FY 2021**	**More/(Less)**	**Budget**	**Over / (Under)**	**FY 2020**	**FY 2021**	**More/(Less)**	**Budget**	**Over / (Under)**
Revenues										
Property Taxes										
Real & Personal Property Tax (TIF)	$ -	$ (465)	$ (465)	$ -	$ (465)	$ (3,365)	$ (2,523)	$ 842	$ (3,308)	$ 785
GO Bond Debt Service Property Tax	-	5,940	5,940	-	5,940	28,264	31,480	3,216	18,567	12,913
Total Property Tax	-	5,475	5,475	-	5,475	24,899	28,957	4,058	15,259	13,698
Licenses & Permits										
Municipal Improvement District Fee	-	-	-	-	-	1,978	150	(1,828)	1,846	(1,696)
Grants and Entitlements	-	-	-	-	-	-	-	-	-	-
Intergovernmental	-	-	-	-	-	-	-	-	-	-
Service Revenues	-	-	-	-	-	-	-	-	-	-
Fines & Fees	-	-	-	-	-	-	-	-	-	-
Interest Income	3,226	1,195	(2,031)	283	912	3,226	5,313	2,087	1,837	3,476
Miscellaneous Revenues	-	-	-	-	-	-	-	-	-	-
Total Revenues	3,226	6,670	3,444	283	6,387	30,103	34,420	4,317	18,942	15,478
Other Financing Sources	-	-	-	-	-	-	-	-	-	-
Transfers In	-	-	-	-	-	-	-	-	-	-
Total Other Financing Sources & Tranfers In	-	-	-	-	-	-	-	-	-	-
Total Revenues and Other Financing Sources	$ 3,226	$ 6,670	$ 3,444	$ 283	$ 6,387	$ 30,103	$ 34,420	$ 4,317	$ 18,942	$ 15,478
Expenditures										
Series 2014 TIF Bonds Debt Service										
Principal	$ 787,895	$ 808,488	$ 20,593	$ 808,488	$ -	$ 787,895	$ 808,488	$ 20,593	$ 808,488	$ -
Interest	76,975	68,811	(8,164)	66,811	2,000	76,975	68,811	(8,164)	66,811	2,000
Series 2020 GO Bonds Debt Service										
Principal	-	-	-	-	-	-	-	-	-	-
Interest	-	-	-	-	-	144,308	82,721	(61,587)	82,721	-
Miscellaneous	-	-	-	-	-	-	-	-	-	-
Total Expenditures	864,870	877,299	12,429	875,299	2,000	1,009,178	960,020	(49,158)	958,020	2,000
Other Financing Uses										
Transfers Out to Capital Improvements Program Fund	-	-	-	-	-	14,328	-	(14,328)	814,083	(814,083)
Total Transfers	-	-	-	-	-	14,328	-	(14,328)	814,083	(814,083)
Total Expenditures and Other Financing Uses	$ 864,870	$ 877,299	$ 12,429	$ 875,299	$ 2,000	$ 1,023,506	$ 960,020	$ (63,486)	$ 1,772,103	$ (812,083)

Town of Bluffton
Special Revenue Accounts
For Period Ending December 31, 2020

FY2021

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Period 13	YTD	Original Estimate
Revenues															
State Accommodations Tax	83	96	93	96	161,152	118								161,639	357,000
Local Accommodations Tax	703	109,748	84,408	95,168	104,684	228,957								623,668	570,000
Hospitality Tax	4,414	143,715	157,912	199,174	152,896	237,961								896,072	2,115,000
Vehicle Tag Fee	-	-	-	14,525	37,445	39,975								91,945	550,000
Miscellaneous	-	-	-	-										-	-
Total Revenues	5,200	253,559	242,413	308,963	456,177	507,011	-	-	-	-	-	-	-	1,773,324	3,592,000

FY2021 Vehicle Tag Fee to begin collections in September

FY2020

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Period 13	YTD	Revised Estimate
Revenues															
State Accommodations Tax	65	98	84	65	126,264	67	63	16,219	82,212	103,665	80	80	101,167	430,129	338,000
Local Accommodations Tax	231	70,939	67,549	72,015	86,878	90,101	57,345	30,074	8,242	52,158	9,413	24,493	134,915	704,353	654,000
Hospitality Tax	270	163,652	185,507	246,036	212,605	200,201	201,746	161,402	113,507	107,614	103,756	144,364	235,032	2,075,693	1,474,000
Miscellaneous	-	-	-	-	-	-	-	-	-	-	-			-	-
Total Revenues	567	234,689	253,140	318,117	425,747	290,370	259,155	207,695	203,960	263,437	113,249	168,936	471,113	3,210,174	2,466,000

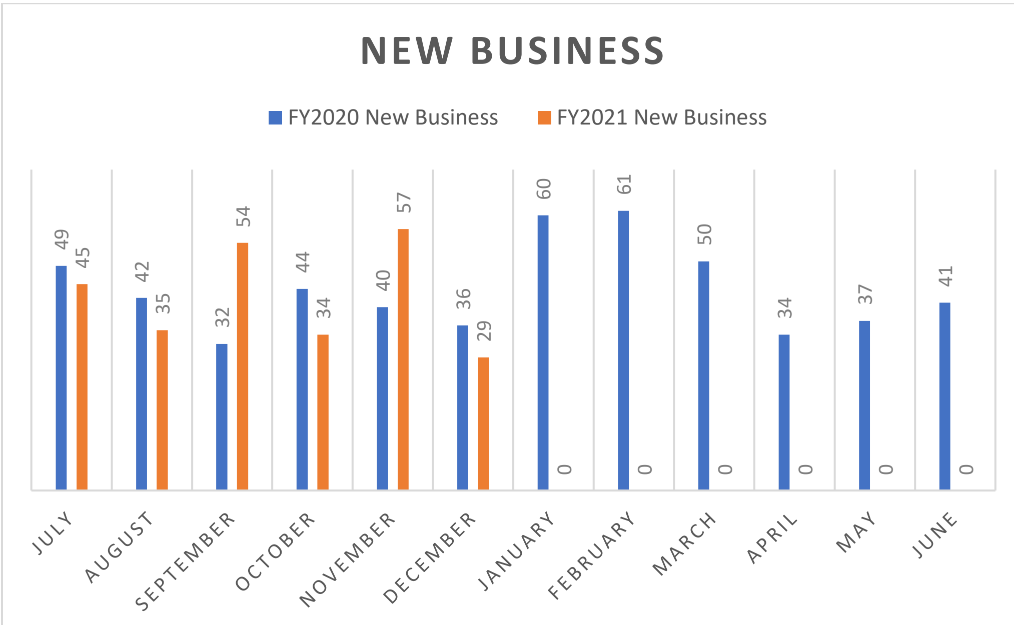
FY2020 Hospital Tax and Local ATAX collections changed from Quarterly option to Monthly requirement

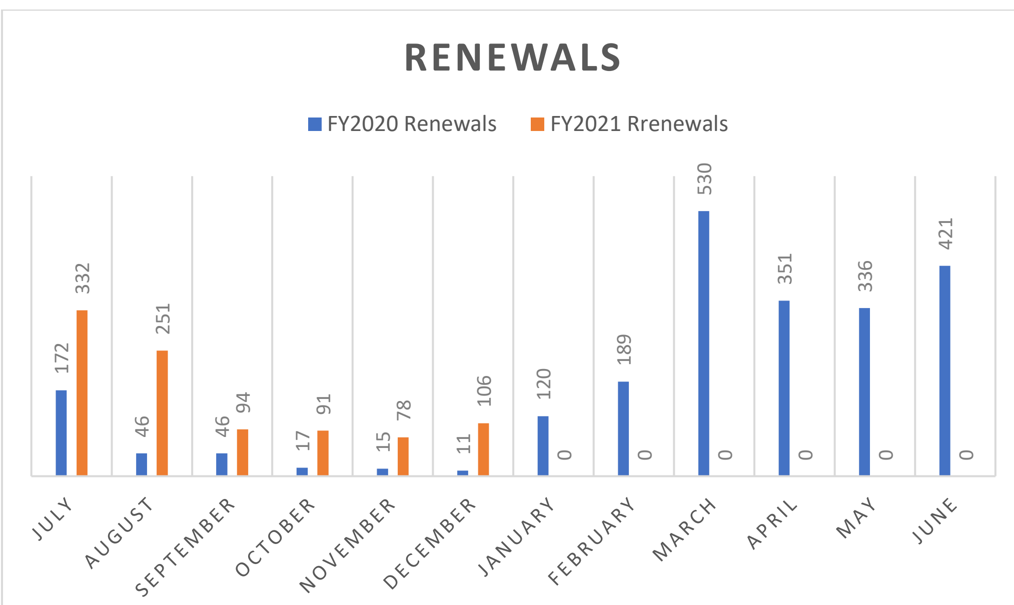
FY2021 VS FY2020 (more / (less)

	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	Period 13	YTD
Revenues														
State Accommodations Tax	18	(2)	9	31	34,888	51								34,996
Local Accommodations Tax	472	38,809	16,859	23,153	17,806	138,856								235,955
Hospitality Tax	4,144	(19,937)	(27,595)	(46,862)	(59,709)	37,760								(112,200)
Vehicle Tag Fee	-	-	-	14,525	37,445	39,975								91,945
Miscellaneous	-	-	-	-										-
Total Revenues	4,634	18,870	(10,726)	(9,153)	30,430	216,641	-	-	-	-	-	-	-	250,696

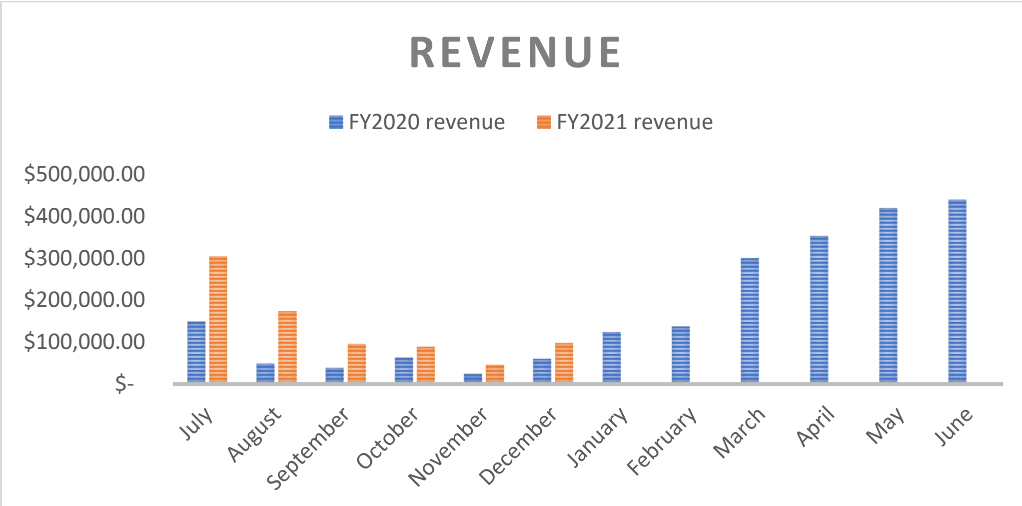
Business License Statistics:

Business License applications for FY2021 through December total 1170 (255 new business and 915 renewals) compared to FY2020's total of 550 (243 new business and 307 renewals).





Business license renewals reflect an increase of 864% and revenue collections show an increase of 63% for the month of December when comparing to last year. This is primarily due to continued code enforcement efforts to bring expired licenses current.



The amended ordinance that went into effect January 1st, 2019 included additional incentives for new businesses and businesses with multiple locations within the Town. For the extended business license due to August 07, 2020, one hundred and sixty-nine (169) businesses qualified for the Town's incentives, with seven of those businesses qualifying for more than one, for a total revenue reduction of $113,370.88 in fiscal year 2020.

Incentive	Number of Businesses	Gross Income Deducted	Total Incentive Amount
10%	39	$ 6,813,048	$ 7,297
20%	66	10,207,213	10,605
40%	51	5,713,529	7,200
CAP	5	80,374,700	80,375
2+	8	7,888,191	7,894
Grand Total	**169**	**$ 110,996,681**	**$ 113,371**

Rate Class	Number of Businesses	Total Incentive Amount
1	59	$ 61,393
2	46	5,993
3	25	2,040
4	1	821
5	6	1,954
6	5	360
7	4	353
8.1	20	31,371
8.5	3	9,086
Grand Total	**169**	**$ 113,371**

TOWN COUNCIL

STAFF REPORT
Municipal Court Department

MEETING DATE:	February 9, 2021
PROJECT:	December Activity Report
PROJECT MANAGER:	Lisa Cunningham, Clerk of Court

Court Summary

Town of Bluffton Municipal Court convenes every Tuesday, typically with a morning session and an afternoon session. In December, 2020 a total of eight sessions were scheduled which included four morning sessions and four afternoon session.

Municipal Court currently has 760 cases pending which is a combination of 577 criminal/traffic cases, 135 jury trial request, and 48 defendants enrolled in alternative programs.

Indigent Defense cases

Town of Bluffton currently contracts with the 14th Circuit Public Defenders Office to provide Indigent Defense Counsel to all defendants who meet the Annual Federal Poverty Guidelines. Year to date our Indigent Defense Attorney has 231 cases which is a combination of 95 pending and 136 disposed on the docket as of December 2020.

Alternative Programs

Defendants are sometimes offered the opportunity to complete Alternative Programs in lieu of convictions on their traffic and/or criminal record.

There are currently 11 active participates in the Conditional Discharge Program. The Conditional Discharge Program requires the completion of 40 hours of community service as well as a drug and alcohol program. Participants must also pay a program fee of $150.00 upon completion.

There are currently 7 active participants in the Alive@25 classes which are offered through the National Safety Council. Alive@25 classes are for traffic offenders under 25 years of age who have never had a traffic infraction and the current charge pending carries no more than 4 points.

Traffic Education Program referred to as TEP has 13 active participates. The TEP Program cost is $280.00 plus the cost of online driving class. It is designed for offenders who have pending moving violations except for Driving under the Influence, Driving under Unlawful Alcohol Concentration, and Reckless Driving.

Alcohol Education Program referred to as AEP has 0 active participants. AEP is only inclusive for alcohol related charges such as minor in procession of alcohol or false identification for offenders between the ages of 17-21. AEP costs $250.00 plus the cost of online driving class and alcohol education classes.

Pre-Trial Intervention referred to as PTI has 17 active participants. PTI is a program for first-time offenders charged with non-violent crimes all charges are accepted in the program except for Driving Under Influence (DUI) or Driving under Unlawful Alcohol Concentration (DUAC). Program cost $350.00 plus the cost of online driving class, counseling and/or drug testing.

TEP, AEP, and PTI are directly managed through the Solicitors office. The Court provides a referral and the Solicitors Office provides a completion or termination report upon completion date.

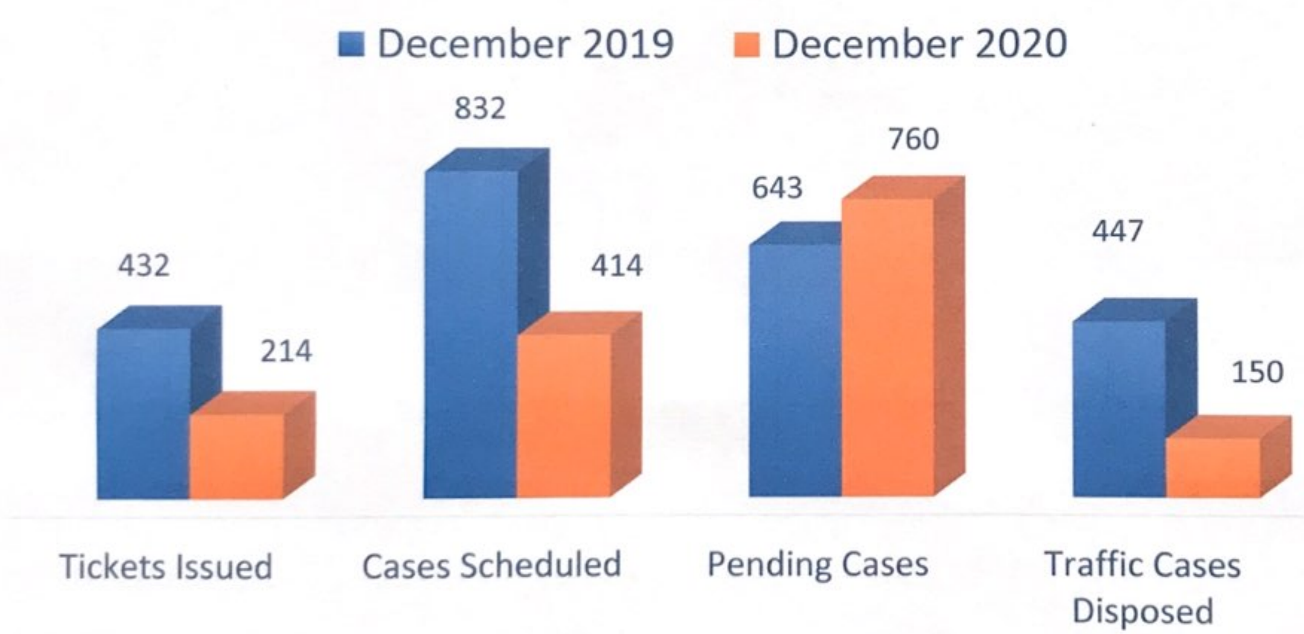
Town of Bluffton Municipal Court

Statistics for December 2020

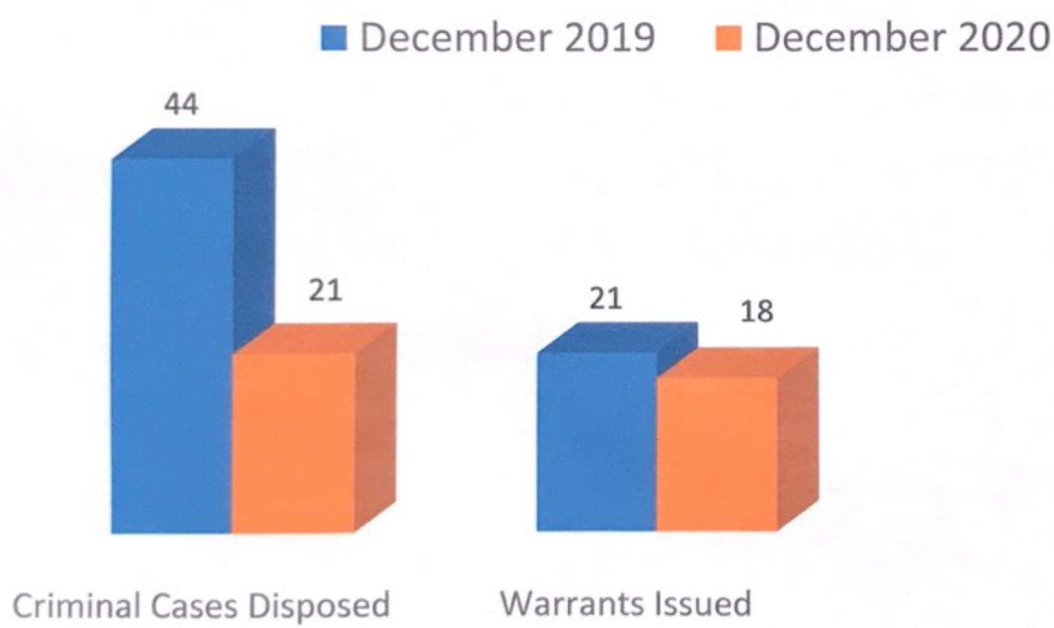
Presented by:

Lisa Cunningham, Clerk of Court

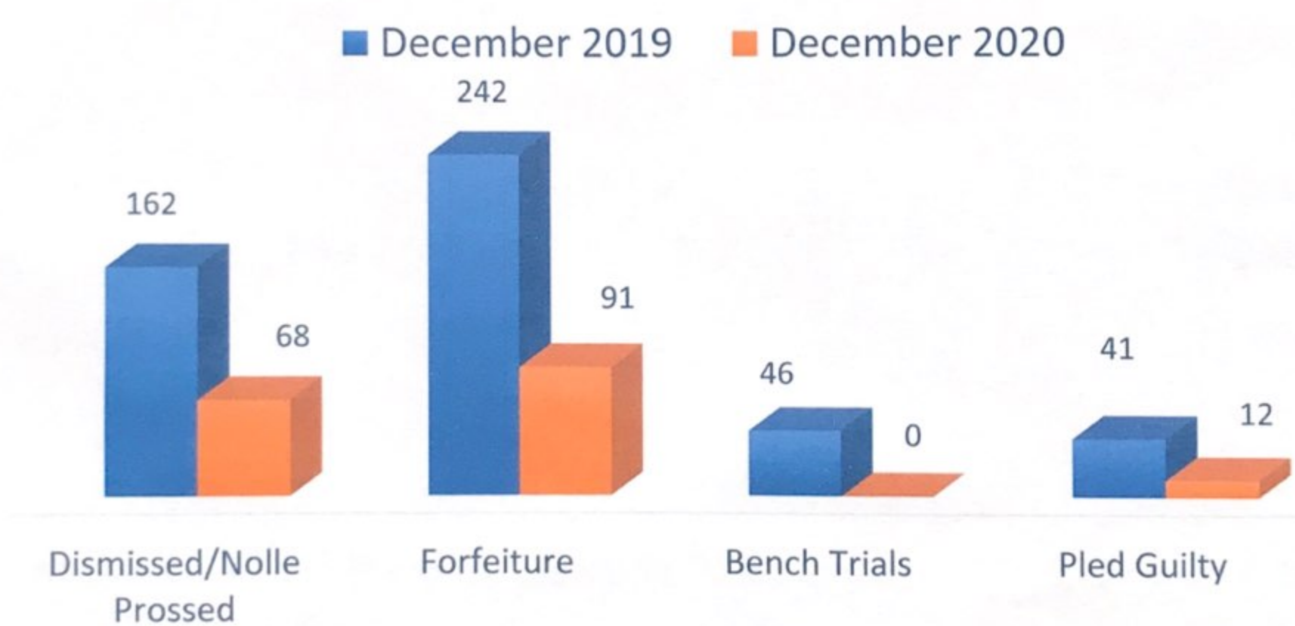
Town of Bluffton Municipal Court



Town of Bluffton Municipal Court



Town of Bluffton Municipal Court



TOWN COUNCIL

STAFF REPORT
Engineering Department

MEETING DATE:	February 9, 2021
SUBJECT:	Engineering Department Monthly Report
PROJECT MANAGER:	Bryan McIlwee, Director of Engineering

CAPITAL IMPROVEMENTS PROGRAM (CIP) AND SPECIAL PROJECTS UPDATE

PATHWAYS

1. Goethe-Shults Sidewalks Phase 2

- Construction documents and easements are complete.
- Invitation for Bids were posted on 1/8/2021
- **Next Steps**
  - Obtain bids on 2/15/2021.
  - Submit contract for approval at the March Town Council meeting.

2. Buck Island-Simmonsville Neighborhood Sidewalks and Lighting

- Phase 5 Kitty Road to 301 Buck Island Road, construction is complete. Design of street lighting is underway.
- Phase 6A along Simmonsville Road from Grayco northward to Sugaree Drive is under design and permit review. Invitation to bid to be posted in February.
- Phase 6B along Simmonsville Road from Sugaree Drive northward to the existing New Mustang Road sidewalks is under design.
- **Next Steps**
  - Phase 5 from Kitty Road to lot 310 Buck Island Road inspection and permit closeout.
  - Submit Phase 5 street lighting for an SCDOT encroachment permit. Install street lighting in the second quarter of 2021.
  - Phase 6 design and construction of the remaining Simmonsville Road sidewalks, to be completed in FY 2021-2022.

3. Bridge Street Streetscape

- Construction documents and permitting are underway for Phase 1 streetscape, Burnt Church Road to Calhoun Street. 70% construction drawings are complete and Staff provided plan comments to Cranston Engineering.

- SCDHEC 319 grant application was awarded for $179,700 for drainage and water quality improvements.
- **Next Steps**
  - Complete engineering design in February 2021.
  - Execute contract with Cranston Engineering to complete design modifications and reporting related to the 319 Grant.
  - Prepare easement plats, appraisals, obtain easements and issue bid documents in FY 2021.
  - Construction to start in FY 2022.

4. Boundary Street Streetscape

- Obtained contract approval for engineering services with Thomas and Hutton.
- Project kick off meeting on 1/28/21
- **Next Steps**
  - Begin Preliminary Engineering Design in February 2021.

5. New Riverside Linear Trail

- **Next Steps**
  - Begin surveying and prepare a Conceptual Master Plan in FY 2022, pending budget approval.
  - Research grant opportunities to fund planning and construction of future trail improvements.

SEWER & WATER

1. Buck Island-Simmonsville Sewer (Phases 5A-5D)

- Construction is underway on Phase 5A-D.
- **Next Steps**
  - Complete construction on Phase 5A-D by 7/1/21 contingent upon no extensive weather delays or unforeseen utility conflicts.
  - Start house connections after the main line is approved by DHEC.

2. Historic District Sewer Extension Phase 1 - Pritchard Street

- Construction has started.
- **Next Steps**
  - Start house connections after the main line is approved by DHEC.

3. Historic District Sewer Extension Phase 2 - Bridge Street

- Received SCDHEC permit to construct.
- Continue negotiations with property owners for right of entry agreements.

- **<u>Next Steps</u>**
    - Obtain road ownership from SCDOT.
    - Advertise for bids.

4. Historic District Sewer Extension Phase 3 – Colcock Street

- Started surveying and design.
- **<u>Next Steps</u>**
    - Review design drawings.

5. Historic District Sewer Extension Phase 4 – Lawrence Street

- Started surveying and design.
- **<u>Next Steps</u>**
    - Review design drawings.

6. Historic District Sewer Extension Phase 5 – Green Street

- Started surveying and design.
- **<u>Next Steps</u>**
    - Review design drawings.

7. Historic District Sewer Extension Phase 6 – Water Street

- Started surveying and design.
- **<u>Next Steps</u>**
    - Review design drawings.

<u>HISTORIC DISTRICT IMPROVEMENTS</u>

1. Boundary Street Lighting

- Phase 2 photometric plans complete.
- Received encroachment permit from SCDOT.
- Lighting agreements approved by Town Council in May 2020.
- Agreement has been executed by both parties.
- Dominion Energy is negotiating modifications to SCDOT encroachment permits.
- SCDOT and Dominion indicated poles must be installed on Private Property due to conflicts with Sewer Force Main along Boundary Street
- **<u>Next Steps</u>**
    - Obtain easements as needed for Phase 2 street lighting.
    - Begin installation of street lighting in March 2021.

2. Historic District Enhancements

- Watershed Management Staff is evaluating preliminary plans to prepare drainage solutions at AME Church.
- Traffic calming guidelines and plan are being negotiated with engineering consultant.

- **Next Steps**
  - ADA ramps and crosswalks are being mapped in Cartegraph by GIS/IT.
  - Continue planning of crosswalks and ADA improvements.
  - Complete Traffic Calming Assessment and Plan.

3. Calhoun Street Streetscape

- Conceptual Master Planning is complete and reviewed at the July Quarterly Workshop.
- Obtained contract approval for Engineering services at the January 2021 Town Council meeting
- Project Kick-off meeting on 1/28/2021.
- **Next Steps**
  - Begin Engineering design in February 2021.

4. Squire Pope Carriage House Preservation

- Construction Documents are complete and submitted to SHPO for a courtesy review.
- **Next Steps**
  - Finalize any modifications to the Construction Documents and prepare bid solicitation package.
  - Awaiting budget approval for future construction.
  - Coordinate design of "Coming Soon" sign.

PARK DEVELOPMENT

1. Oyster Factory Park

- Conceptual Master Plan has been updated and reviewed by Town Council at the January Quarterly Workshop.
- **Next Steps**
  - Obtain ACOE and DHEC Permit for installation of salvaged dock components from Calhoun Street.
  - Begin final design of next phase of improvements per Town Council direction provided at the Workshop.

2. 68 Boundary Street Park Renovations

- Construction and maintenance contracts complete.
- **Next Steps**
  - Fabricate Martin Family dedication sign prior to 4/8/2021 park dedication.

3. Calhoun Street Dock and Public Riverfront Access Improvements

- Dock construction is complete.
- **Next Steps**
  - Complete installation of Dock signage.

4. **Wright Family Park**
   - Bulkhead, boardwalk, restroom building, perimeter sidewalks, landscaping and parking area are complete.
   - Site signage, and furniture are 99% complete.
   - **Next Steps**
     - Coordinate Ribbon Cutting Ceremony as pandemic allows.
     - Additional benches are on reorder and will be installed in February 2021.
     - Prepare change order to add a sidewalk connection from park to the hammerhead/dock.

5. **Oscar Frazier Park**
   - **Next Step**
     - Sidewalk construction complete.
     - Continue planning of future improvements in FY 2022.

6. **New Riverside Barn/Park**
   - Submitted grant application to LWCF for $500,000.00 funding of the initial phase of the project. Application is under review by NPS and Staff expects to hear response in the Spring of 2021.
   - Archeological Report complete as needed for Grant eligibility.
   - Obtained Town Council approval of the Conceptual Master Plan at the December 2020 Council meeting.
   - Obtained Proposals from Thomas and Hutton for Phase 1 Engineering design.
   - **Next Steps**
     - Hart Howerton to complete Design Development drawings for Phase 1 site development and schematic design of barn improvements.
     - Complete construction drawings, cost estimating and permitting of Phase 1 development by July 2021.
     - Phase 1 bidding and construction anticipated to begin in FY 2022.

TOWN FACILITIES AND MISCELLANEOUS PLANNING

1. **Buckwalter Place Multi-County Commerce Park**
   - Buckwalter Place Park and Veterans Memorial are complete. Additional work was approved to modify irrigation system conversion from irrigation pond to BJWSA system.
   - Executed contracts for Buckwalter Park restroom design with Thomas and Hutton and Pearce Scott Architects.
   - Site planning for future development parcel underway with Cranston Engineering.
   - Prepared estimate of probable construction cost and appraisal for future development site.

- **Next Steps**
  - Complete irrigation conversion at Park by January 2021.
  - Review progress plans for restroom building and utility extensions at Buckwalter Park.
  - Continue site planning for future development parcel.

2. Town of Bluffton Housing Project

- Surveying and geotechnical services complete for 1095 May River Road and 115 Bluffton Road sites.
- **Next Steps**
  - Planning and design to begin in FY 2021 as directed by Joint Venture Agreement.
  - Assist with the preparation of a comprehensive cost estimate for planning, design and construction for the various housing projects.

3. Law Enforcement Center Facility Improvements

- Parking and Service Yard Expansion construction began in December 2020 with CBG Siteworks Construction.
- Interior paint of Substation complete.
- **Next Steps**
  - Continue construction of LEC service yard and parking improvements. Construction anticipated to be complete by the July 2021.
  - Information Technology department coordinating upgrades to building security systems.

4. Ghost Roads

- Surveying and easement exhibits are complete.
- Pritchard Street Quit Claim Deed exhibits are 95% complete.
- The Town Attorney is working with Bridge Street property owners to obtain Quit Claim Deeds and agreement to extend service to homes.
- Staff is meeting with individual property owners to raise awareness of the acquisition efforts and communicate next steps.
- **Next Steps**
  - Continue meeting with individual property owners and obtaining quit claim deeds.

5. Community Safety Cameras

- Cameras have been installed at Bluffton Road Public Parking Lot, Veterans Park, Wright Family Park, Calhoun Street Dock .
- 14 older cameras in the network have been replaced.
- **Next Steps**
  - Continue with camera replacements and upgrades as necessary.

6. Public Works Facility Improvements

- Finalize the plans for expanding of Public Works yard.
- Install new plumbing/ electric for the washer and dryer.
- **<u>Next Steps</u>**
    - o Begin permitting and bid for the expansion of the yard.
    - o Bid the installation of the plumbing / electric.

7. Rotary Community Center Facility Improvements

- Replace the hardwood floor in the main area.
- **<u>Next Steps</u>**
    - o Request bids for the replacement of the new floor.

8. Watershed Management Facility Improvements

- Remove the carpet and install new flooring in the rear office space.
- **<u>Next Steps</u>**
    - o Request quotes on completing the new flooring in the office.

<u>DIVISION/STAFF UPDATES</u>

<u>Project Management</u>

Thirty-five (35) CIP projects are currently in progress. Don Ryan Center, Veteran Memorial, Buckwalter Park and BIS Phase 5 sidewalks, Wright Family Park and the Calhoun Street Dock have recently been completed. CIP projects including BIS Phase 5E sewer, and Pritchard Street sewer are currently under construction and nearing completion. The LEC Parking Expansion, BIS Phase 5A-D Sewer started construction in December 2020, and the Boundary Street Lighting projects is expected to start construction in March 2021. The remaining CIP projects are in the design phase and several are planned for construction in FY 2022.

<u>Watershed Management</u>

1. Southern Lowcountry Regional Board (SoLoCo)

a. Regional Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual

- Via concurrence of the Mayor and direction by the Town Manager, staff has participated in the SoLoCo Technical Working Group to develop a regional stormwater model ordinance and design manual and investigate the viability of a regional stormwater authority.
- 8/27/20 Unanimous recommendation from May River Watershed Action Plan Advisory Committee for adoption.
- 10/28/20 Unanimous recommendation from Planning Commission for adoption.
- 12/8/20 Town Council – 1st reading with unanimous approval.
- **<u>Next Steps</u>**
    - o 2/9/21 Town Council – Public Hearing and 2nd reading.
    - o Anticipated implementation date of 3/1/21.

2. **Sea Level Rise Task Force**

- Following Beaufort County's presentation and request for regional participation at the 10/22/19 SoLoCo meeting, staff is attending the Sea Level Rise Task Force meetings to discuss a possible No Fill Ordinance and county-wide sea level rise adaptation strategies.
- Meetings continue to discuss projected impacts of sea level rise on the region with a focus on ways that local government can respond through policies, ordinances and projects to mitigate the potential impacts of sea level rise.
- Internal staff reviews of draft documents complete and feedback provided to Task Force.
- Task Force met 12/15/20 and 12/18/20 to prioritize recommendations for final document.
- **Next Steps**
  - Beaufort County to present and request a recommendation from SoLoCo for regional partners to adopt.

3. **Joint Councils Meeting for Watershed Management Initiatives**

- BJWSA developed their CIP list for FY 2020 sewer projects which does not include any projects in the County's jurisdiction in the May River Headwaters without cost-sharing.
- Following the Joint Councils Meeting with BJWSA, held on 2/25/20, staff from Beaufort County and Town of Bluffton met to discuss sewer extension scope and strategy on 2/27/20.
- Staff from the Town, County, and BJWSA met via Zoom 3/27/20 to confirm project scope, cost, and potential project manager. the last project cost estimate to extend, connect, and abandon septic in the Stoney Creek project area is $4.7 million (B. Chemsak email 7/22/19) but they anticipate those numbers increasing to $5.5 million. The proposal is 1/3 cost-share, so the Town's portion would be approximately $1.83 million. Beaufort County has not formally agreed or committed any funding.
- Neither BJWSA nor Beaufort County have committed funds in FY 2021 to begin sewer extension.
- Town Manager, Director of Engineering and staff met with BJWSA General Manager, Engineer and staff on 6/5/20 to discuss how to move the project forward.
- The Town submitted a response on 12/18/21 to BJWSA's "call for projects" request that prioritizes May River Watershed sewer projects.
- **Next Steps**
  - Staff is drafted a letter to Beaufort County requesting a commitment to cost-sharing sewer projects.

4. **SC Department of Health and Environmental Control May River Shellfish Harvesting Monitoring Data Year-to-Date and May River Shellfish Harvesting Status Exhibit – Attachments 1 and 1a**

5. **May River Watershed Action Plan Implementation Summary - Attachment 2**

6. **Municipal Separate Storm Sewer System (MS4) Program Update**
   - Staff is currently updating the Town's MS4 Stormwater Management Plan and supporting documentation. SCDHEC is currently in the process of developing a revised National Pollutant Discharge and Elimination (NPDES) Permit for Small MS4s and will re-issue to permittees, including the Town, in the future.

7. **MS4 Minimum Control Measure (MCM) - #1 Public Education and Outreach, and MS4 MCM - #2 Public Participation and Involvement**
   - No Beaufort County Stormwater Utility Board meeting in January 2021.
   - The May River Watershed Action Plan Advisory Committee met 1/21/21. The Committee unanimously recommended that Town Council adopt the May River Watershed Action Plan Update. **Attachment 3**
   - Staff is working the Town Digital Communication Manager to promote a series of MS4 stormwater educational tips and reminders for the Bluffton community via the Town's Facebook page.
   - Staff has tentatively set the date for the 2021 May River Cleanup for 5/01/21. Over the next several months, staff will be working to secure partnerships and coordinate this event.

8. **MS4 MCM – #3 Illicit Discharge Detection and Elimination**
   - Stormwater Infrastructure Inventory Map - **Attachment 4a**
   - *E. coli* Concentrations Trend Map - **Attachment 4b**
   - Monthly, Microbial Source Tracking (MST) Maps - **Attachments 4c and 4d**
     - Town staff coordinates with the SC Department of Health and Environmental Control (SCDHEC) to pull MST samples concurrently with the state's routine shellfish harvesting water quality sampling at stations 19-19, 19-19A, 19-19B, 19-19C, and 19-24. SCDHEC will conduct sampling on 1/14/21. Staff will notify Council and Senior Staff of any pertinent findings from this sampling event via email.
   - Illicit Discharge Investigations – **Attachment 4e**

9. **MS4 MCM – #4 Construction Site Stormwater Runoff Control – Attachment 5**

10. **MS4 MCM – #5 Stormwater Plan Review and Related Activity – Attachment 6**

11. **MS4 MCM – #6 Good Housekeeping (Staff Training/Education)**
    - Staff participated in the US Coastal Research Program's Human & Ecosystem Health Workkkshop Series.
    - Staff participated in a Sontek IQ-flow monitoring equipment training on 1/14/21.

12. **Citizen Drainage, Maintenance, and Inspections Concerns Map – Attachment 7**

13. Citizen Request for Watershed Management Services & Activities – Attachment 8

Public Works

1. MS4 MCM – #6 Good Housekeeping (Ditch, Drainage and Roadside Maintenance)

- Performed weekly street sweeping on Calhoun Street, Highway 46, Bruin Road, May River Road, Pin Oak Street, and curbs and medians on Simmonsville and Buck Island Roads.
- Performed ditch inspections
  - Arrow ditch (2,569 LF)
  - Red Cedar ditch (966 LF)
  - Buck Island roadside ditch (15,926 LF)
  - Simmonsville roadside ditch (13,792 LF)
- Ongoing roadside mowing, litter clean-up and maintenance of Masters' Way, McCracken Circle, Hampton Parkway, Buck Island and Simmonsville Roads, Goethe Road, Shults Road, Jason and Able Streets, Whispering Pine Road, May River Road and Eagles Field.
- Ongoing mowing of the New River side trail and field at New River barn.
- Beautification Program –Landscape Maintenance - ongoing routine.

2. Facilities

- Facilities and Parks Maintenance - ongoing routine.

3. Public Works Activities Report - Attachment 10

Attachments

1. SCDHEC Shellfish Harvesting Monitoring Data Year-to-Date
   a. SCDHEC May River Shellfish Harvesting Status Exhibit
2. May River Watershed Action Plan Implementation Summary*
3. MS4 Minimum Control Measures #1 and #2 – May River Watershed Action Plan Advisory Committee Cancelation Notice
4. MS4 Minimum Control Measure #3 – Illicit Discharge Detection and Elimination
   a. Stormwater Infrastructure Inventory Map
   b. *E. coli* Concentrations Trend Map
   c. Microbial Source Tracking Trend Map – Human Source
   d. Microbial Source Tracking Map – All Sources
   e. Illicit Discharge Investigations
5. MS4 Minimum Control Measure #4 – Construction Site Stormwater Runoff Control
6. MS4 Minimum Control Measure #5 – Stormwater Plan Review and Related Activity
7. Citizen Drainage, Maintenance and Inspections Concerns Map
8. Citizen Request for Watershed Management Services and Activities Map
9. Beautification Committee Agenda
10. Public Works Activities Report
11. CIP Project Schedules

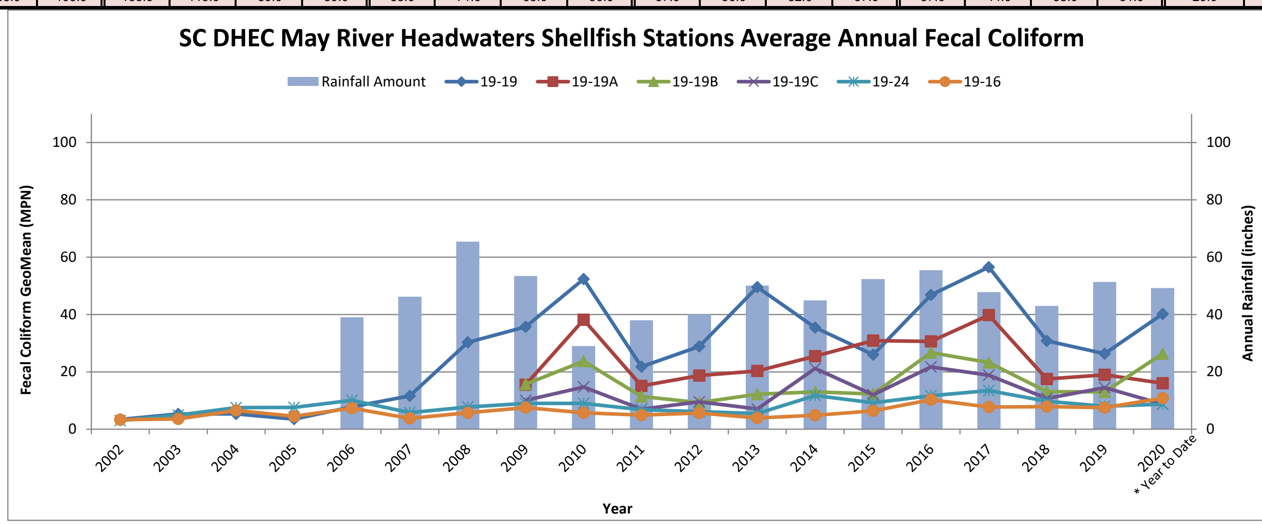
* Attachment noted above includes the latest updates in bold and italic font.

	19-19				19-19A				19-19B				19-19C				19-24				19-16			
	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020	2017	2018	2019	2020
	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)	Fecal Coliform (MPN)
December	1600.0	79.0	170.0	17.0	920.0	49.0	33.0	22.0	540.0	33.0	140.0	17.0	240.0	46.0	33.0	4.5	220.0	23.0	13.0	4.0	49.0	21.0	110.0	11.0
November	49.0	49.0	17.0	70.0	33.0	13.0	6.8	31.0	7.8	23.0	7.8	17.0	31.0	17.0	11.0	13.0	2.0	17.0	4.5	13.0	2.0	7.8	2.0	4.5
October	22.0	79.0	7.8	49.0	49.0	23.0	4.5	79.0	33.0	7.8	2.0	31.0	23.0	7.8	4.5	21.0	6.8	7.8	1.8	33.0	2.0	2.0	2.0	79.0
September	17.0	49.0	79.0	110.0	7.8	23.0	33.0	49.0	11.0	13.0	6.8	49.0	4.5	17.0	17.0	33.0	2.0	17.0	4.5	33.0	1.8	17.0	1.8	33.0
August	79.0	70.0	70.0	49.0	70.0	23.0	49.0	49.0	21.0	13.0	33.0	23.0	33.0	4.5	22.0	23.0	33.0	7.8	7.8	17.0	33.0	17.0	17.0	22.0
July	350.0	23.0	4.5	33.0	110.0	33.0	13.0	13.0	130.0	11.0	7.8	23.0	49.0	7.8	17.0	7.8	49.0	13.0	22.0	7.8	22.0	4.5	13.0	17.0
June	23.0	11.0	33.0	NS	49.0	23.0	49.0	NS	13.0	23.0	49.0	NS	17.0	7.8	46.0	NS	7.8	4.5	13.0	NS	4.5	1.8	4.5	NS
May	17.0	17.0	7.8	70.0	23.0	33.0	9.2	49.0	7.8	17.0	7.8	23.0	2.0	13.0	2.0	22.0	23.0	23.0	6.8	6.8	4.5	13.0	4.5	4.5
April	7.8	33.0	23.0	33.0	23.0	13.0	13.0	33.0	4.5	17.0	7.8	13.0	7.8	17.0	6.8	6.8	13.0	49.0	23.0	13.0	4.5	17.0	6.8	13.0
March	350.0	22.0	23.0	170.0	11.0	21.0	23.0	49.0	33.0	4.5	6.8	130.0	13.0	11.0	13.0	49.0	13.0	7.8	7.8	70.0	33.0	9.3	4.5	33.0
February	13.0	17.0	64.0	17.0	7.8	7.8	33.0	7.8	13.0	17.0	23.0	21.0	9.3	17.0	31.0	4.5	4.5	2.0	6.8	4.5	1.8	7.8	13.0	6.8
January	95.0	13.0	23.0	95.0	79.0	2.0	23.0	33.0	31.0	4.5	13.0	33.0	49.0	2.0	33.0	17.0	27.0	1.8	7.8	17.0	33.0	4.5	23.0	17.0
Additional Samples																								
Additional Samples																								
Average Annual GeoMean	56.5	30.8	26.4	51.4	39.8	17.5	19.0	31.9	23.3	13.1	13.0	27.3	18.8	10.7	14.5	14.0	13.5	9.8	8.0	13.8	7.7	7.9	7.5	15.3
** Truncated GeoMetric Mean	44.0	42.0	35.0	34.0	36.0	29.0	23.0	21.0	20.0	20.0	16.0	16.0	16.0	15.0	14.0	12.0	10.0	10.0	10.0	10.0	7.0	8.0	7.0	9.0
** Truncated 90th Percentile	203.0	176.0	168.0	106.0	133.0	115.0	89.0	59.0	83.0	71.0	63.0	50.0	57.0	56.0	52.0	37.0	37.0	44.0	38.0	31.0	29.0	30.0	32.0	35.0

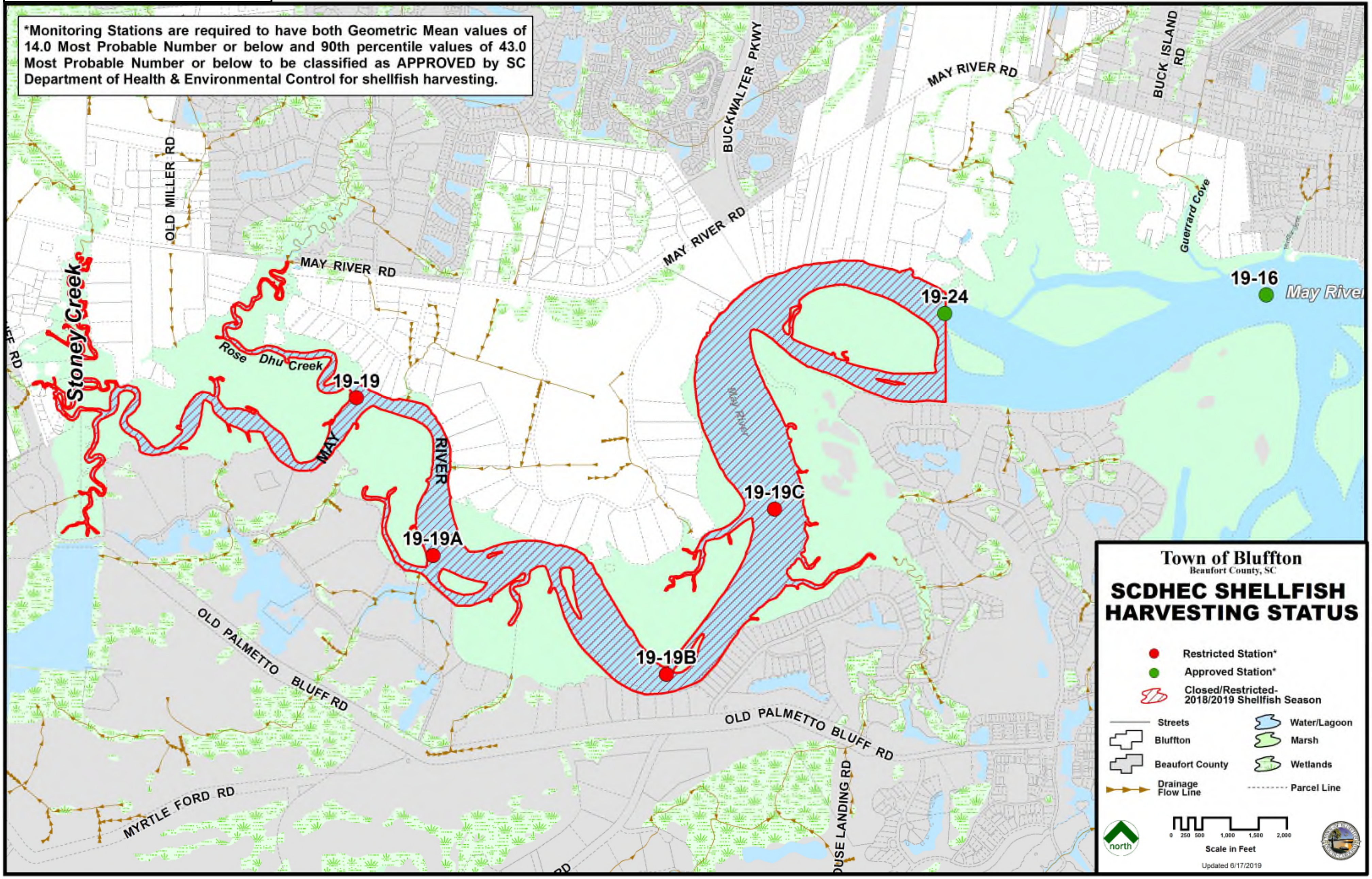
NS = No Sample

AS = Additional Samples

** Town staff calculations utilizing DHEC statistics



May River Headwaters



ACTIVITY - FINANCIAL	STATUS
Funding Opportunities	Council unanimously adopted $115 SWU Fee and NPDES-related Fees on 6/9/20.
ACTIVITY - POLICIES	**STATUS**
Sewer Connection & Extension Policy	*Completed 2017.*
Septic to Sewer Conversion Program	*Completed 2018.*
Sewer Connection Ordinance and Ordinance Amendment	*Completed 2015 and 2018, respectively.*
Southern Lowcountry Regional Stormwater Ordinance and Design Manual	***Current project updates are included in Engineering Consent Agenda under "Southern Lowcountry Regional Board (SoLoCo)."***
ACTIVITY - PROJECTS	**STATUS**
Sanitary Sewer Extension	**Completed Buck Island/Simmonsville Road (BIS) Phases I, II, III, IV; Toy Fields; and Jason/Able.** Six project phases of Historic District sewer extension are proposed in the 5-year Capital Improvement Program. ***Current project updates are included in Engineering Consent Agenda under "Sewer & Water."***
May River 319 Grant Phase 1 - New Riverside Pond (Grant award of $483,500 in 2009)	*Completed 2013.*
May River 319 Grant Phase 2 - Pine Ridge (Grant award of $290,000 in 2011)	*Completed 2016.*
May River 319 Grant Phase 3 - Town Hall Parking Retrofit (Grant award of $231,350 in 2016)	*Completed 2019*.
May River 319 Grant Phase 4 - Sanitary Sewer Connections (Grant award of $365,558.36 in 2019)	Grant to construct 49 sewer lateral connections in Poseys Court, Little Aaron and Historic District Phases 1 and 2. ***Current project updates are included in Engineering Consent Agenda under "Sewer & Water."***
May River 319 Grant Phase 5 - Bridge Street Streetscape (Grant award of $179,900 in 2020)	Supports enhanced drainage and water quality improvements as part of the Bridge Street Streetscape project. Contract signed on 12/4/20 and kick-off meeting held on 12/16/20.
Stoney Creek Wetlands Restoration: Preliminary Design Phase	Project on hold following Council direction on 5/31/17.
May River Watershed Water Quality Model	Contract awarded to McCormick Taylor with final deliverables received 11/20. ***Final Report as the May River Watershed Action Plan Update reviewed during Town Council Workshop on 1/19/21, WAPAC recommendation to adopt on 1/21/21, and Town Council adoption anticiptated on 2/9/21.***
ACTIVITY - PROGRAMS	**STATUS**
Public Outreach/Participation/Involvement (MS4 Minimum Control Measures #1 & 2)	Outreach and involvement efforts continue through county-wide partnership with Carolina Clear as Lowcountry Stormwater Partners - Neighbors for Clean Water, through local cleanups, civic group presentations, and the May River Watershed Action Plan Advisory Committee. ***Current updates are included in Engineering Consent***
Infrastructure Mapping/GIS (MS4 Minimum Control Measure #3)	Data points continue to be collected with new development to meet MS4 requirements & populate water quality model. ***Current updates are included in Engineering Consent Agenda Attachment 4a.***
Water Quality Monitoring Program (MS4 Minimum Control Measure #3)	1. SCDHEC Shellfish monitoring results and map 2. *E. coli* bacteria "hot spot" concentrations 3. Microbial Source Tracking of bacteria 4. Illicit Discharge investigation and monitoring 5. BMP efficacy monitoring 6. MS4 monitoring ***Current updates are included in Engineering Consent Agenda Attachments 1, 1a, 4b - 4d.***

ACTIVITY - PROGRAMS continued	STATUS continued
Illicit Discharge Detection & Elimination (IDDE) Program (MS4 Minimum Control Measure #3)	Response to reported and observed non-stormwater discharges to the stormwater drainage system. ***Current updates are included in Engineering Consent Agenda Attachment 4e.***
Construction Site Stormwater Runoff Control Program (MS4 Minimum Control Measure #4)	Sediment and erosion control inspections with escalating enforcement response. ***Current updates are included in Engineering Consent Agenda Attachment 5.***
Stormwater Plan Review & Related Activity Program (MS4 Minimum Control Measure #5)	SCDHEC delegated plan review-related activities. ***Current updates are included in Engineering Consent Agenda Attachment 6.***
Ditch Inspection/Maintenance Program (MS4 Minimum Control Measure #6)	Continued coordination with SCDOT, Beaufort County and Town Public Works to inspect and maintain ditches within the Town's jurisdiction. ***Current updates are included in Engineering Consent Agenda Attachment 7.***
Neighborhood Assistance Program - Septic System Maintenance Program	On-going assistance offered to Town residents regardless of financial status through Neighborhood Assistance Program (NAP). ***Current updates are provided in Growth Management Consent Agenda.***

TOWN OF BLUFFTON
MAY RIVER WATERSHED ACTION PLAN ADVISORY COMMITTEE MEETING

ELECTRONIC MEETING

Thursday, January 21, 2021 | 9 AM

AGENDA

This meeting can be viewed on the Town of Bluffton's Facebook page (https://www.facebook.com/TownBlufftonSC/)

I. CALL TO ORDER

II. NOTICE REGARDING POSTING OF MEETING PER SOUTH CAROLINA FREEDOM OF INFORMATION (FOIA) REQUIREMENTS

III. ROLL CALL AND CONFIRMATION OF QUORUM

IV. ADOPTION OF AGENDA

V. ADOPTION OF MINUTES – December 3, 2020

VI. PUBLIC COMMENTS

Public Comments may be submitted electronically via the Town's website at (https://www.townofbluffton.sc.gov/FormCenter/Town-15/Public-Comment-60) or by emailing your comments to the Stormwater Coordinator at ldelhomme@townofbluffton.com. Comments will be accepted up to close of business (5:30 PM) the day prior to the scheduled meeting start time. All comments will be read aloud for the record.

VII. NEW BUSINESS

1. Welcome New Town of Bluffton Stormwater Coordinator/Field Assistant
2. May River Watershed Action Plan Update

VIII. OLD BUSINESS

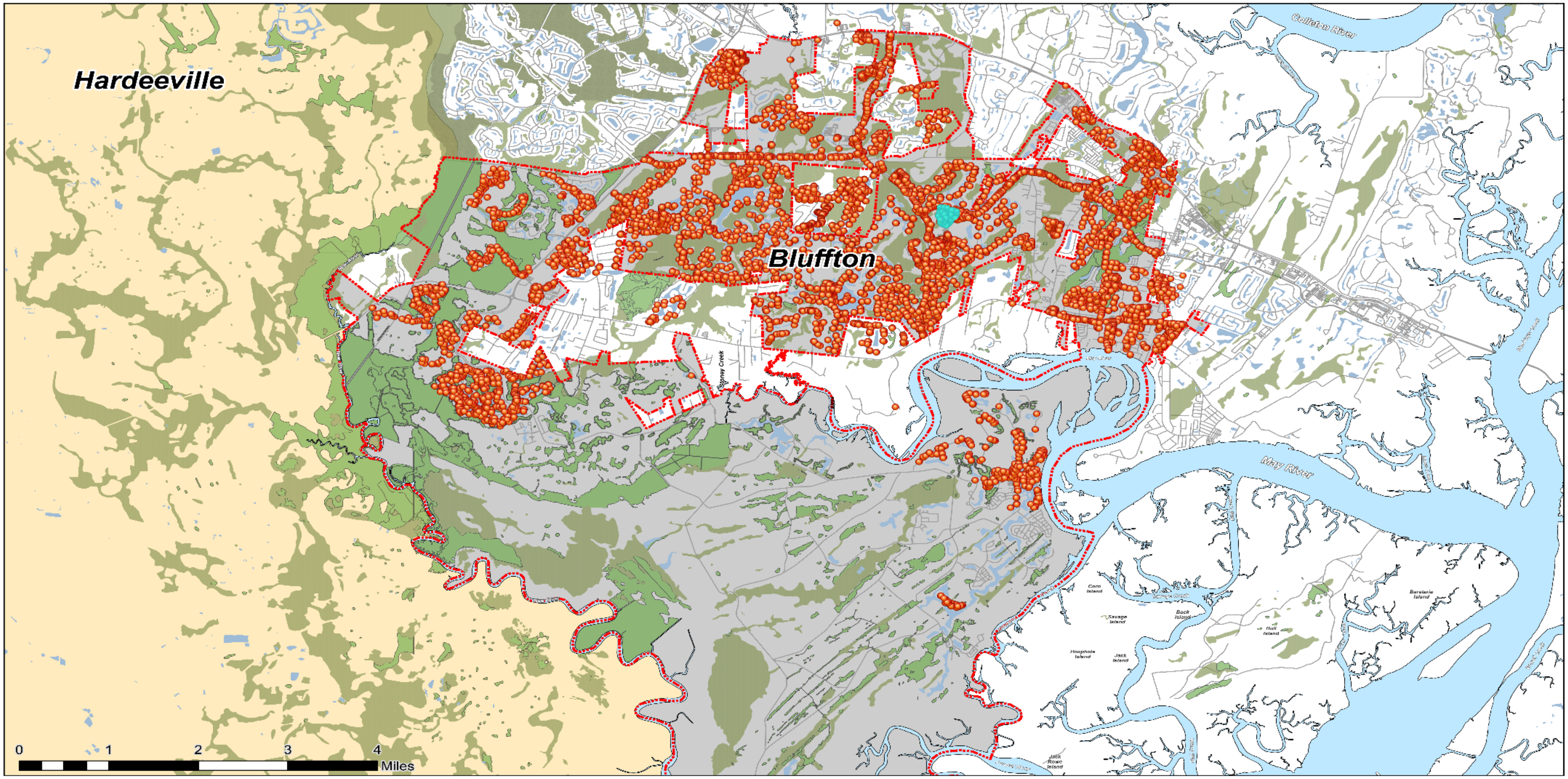
1. Water Quality Monitoring Program (standing item)
   A. Monthly Sampling Update
   B. Microbial Source Tracking (MST) Update
   C. SCDHEC Shellfish Data Update

IX. DISCUSSION

X. ADJOURNMENT

NEXT MEETING DATE: Proposed 9:00 AM, Thursday, February 25, 2021

MS4 Minimum Control Measure #3 – IDDE (Illicit Discharge Detection & Elimination): Stormwater Infrastructure Inventory



SW STRUCTURE
SW PIPE
TOWN OF BLUFFTON
BEAUFORT COUNTY
JASPER COUNTY
WETLAND
WATER
ROADS

Town of Bluffton
Beaufort County, SC

STORMWATER INFRASTRUCTURE

Updated Date: 1/19/2021

N
W
E
S

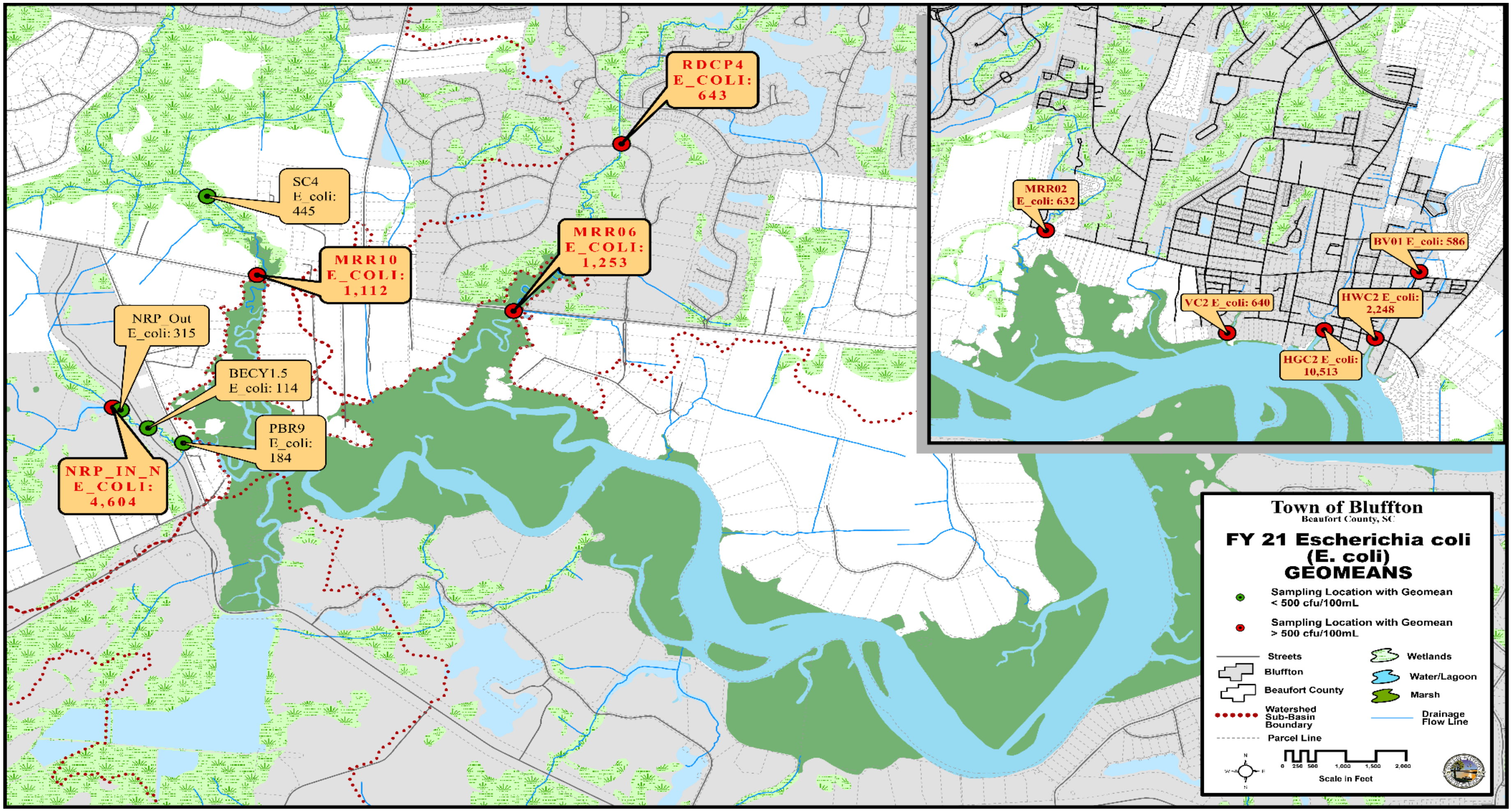
Stormwater Infrastructure Inventory Collection Status	
FY 2021 YTD Collection Totals	869
FY 2020 Collection Totals	4,878
FY 2019 Collection Totals	2,925
FY 2018 Collection Totals	3,777

1/20/2021

ATTACH

Section XII. Item #1.

MS4 Minimum Control Measure #3 – IDDE: *E. coli* Concentrations Trend Map

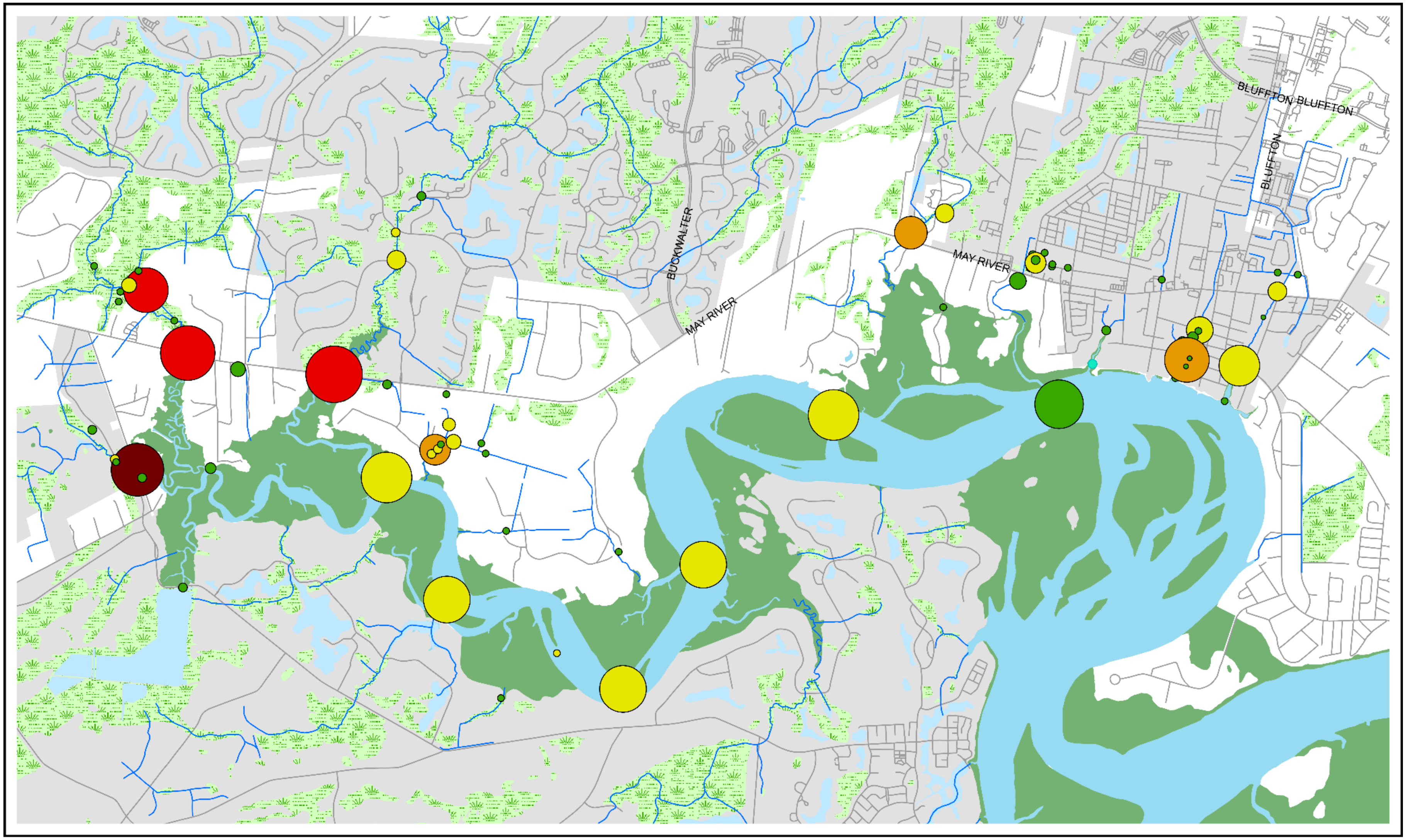


E coliform geomeans updated as of: 1/19/2021

	USCB Water Quality Samples	Microbial Source Tracking Samples	MS4 Quarterly Samples Collected
FY 2021 YTD Totals	211	53	54
FY 2020 Totals	223	115	123
FY 2019 Totals	280	193	264
FY 2018 Totals	216	217	224

- MST program began November 2016; MS4 Quarterly Sampling initiated 2/2017
- Totals include only samples submitted for laboratory analysis, and not *in situ* parameters.

MS4 Minimum Control Measure #3 – IDDE: Microbial Source Tracking (MST) Trend Map – Human Source



Town Jurisdiction
Beaufort County
Drainage Flow Lines

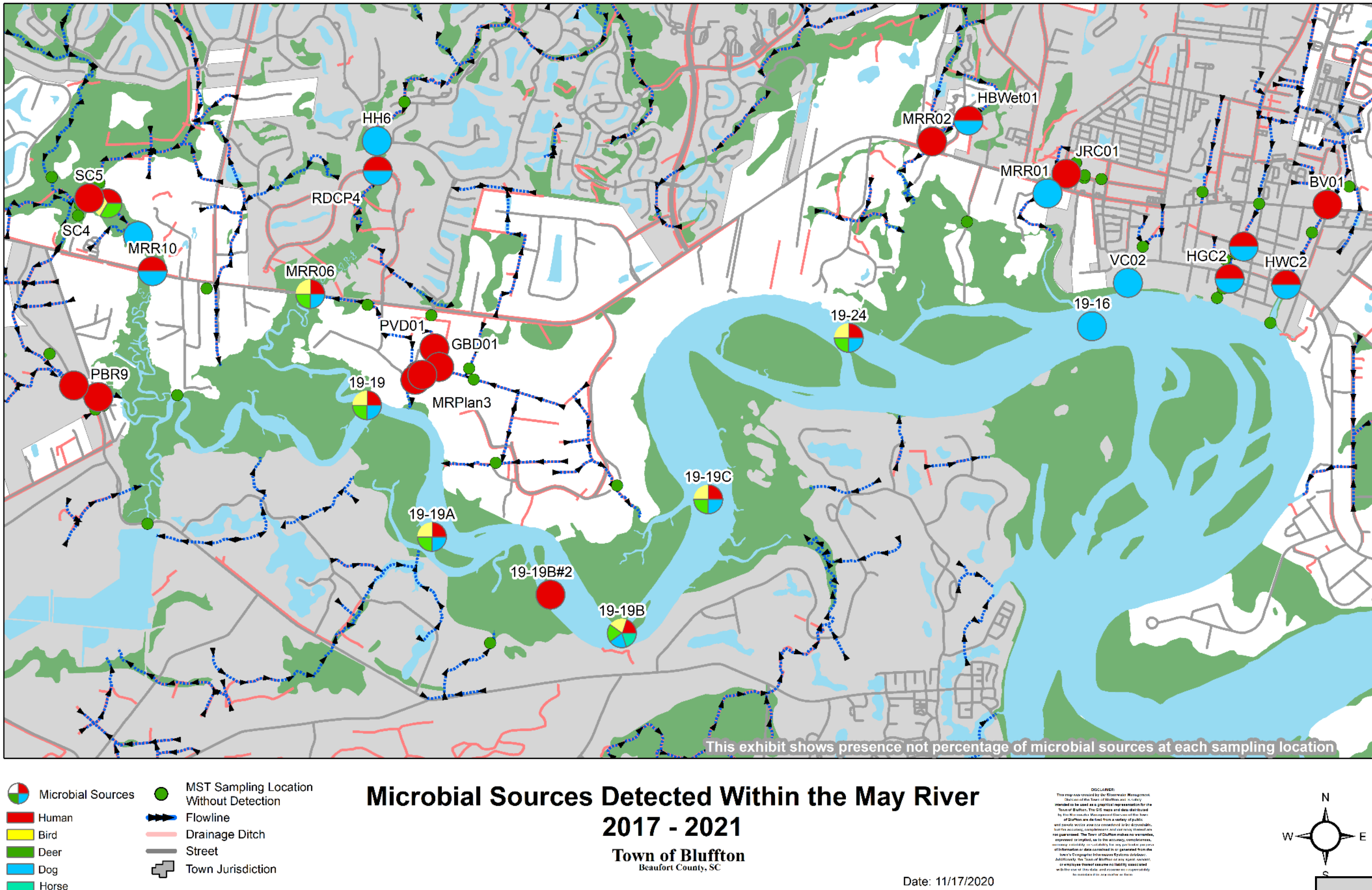
Positive Hits
0 1-3 3-6 6-9 >10

Times Sampled
1 - 3 4 - 6 7 - 10 >10

Size of dot correlates to # of times the site has been sampled.

Updated Date: 1/19/2021

MS4 Minimum Control Measure #3 – IDDE: Microbial Source Tracking (MST) Map – All Sources

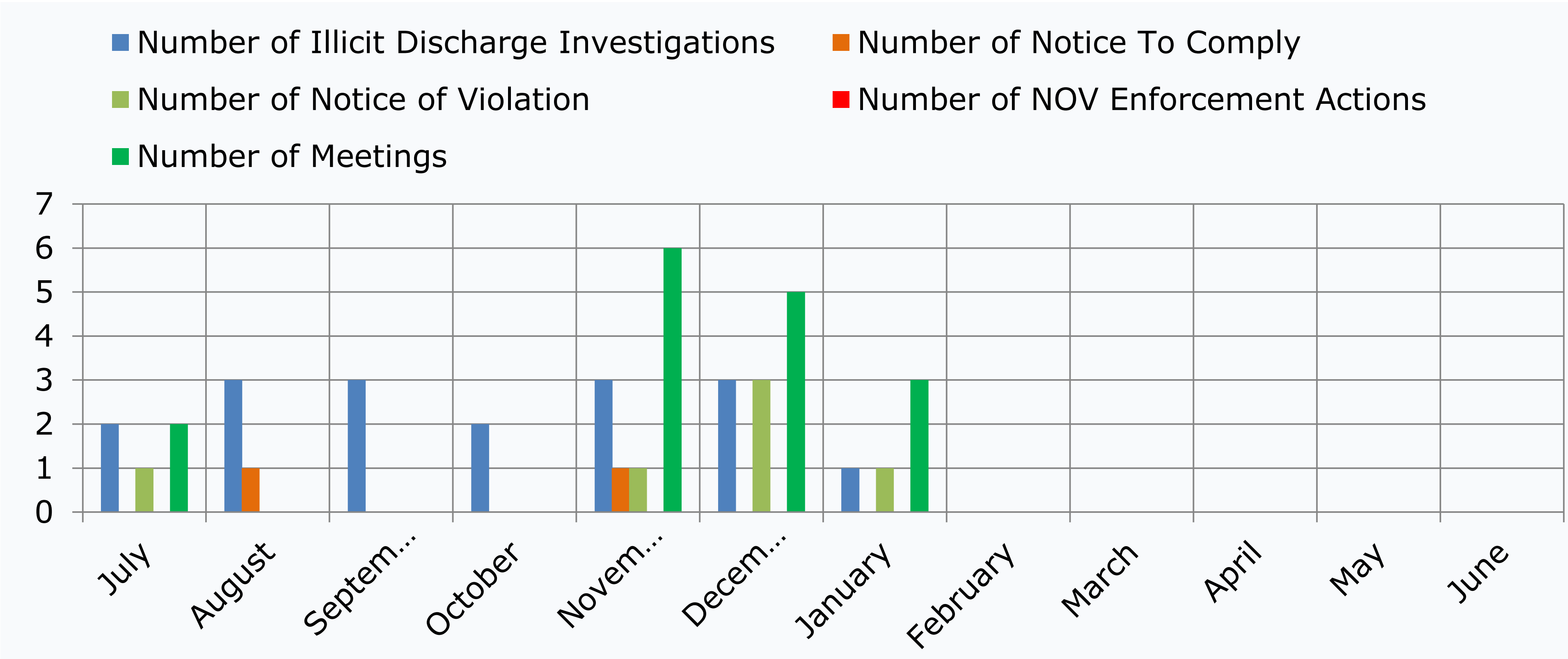


Microbial Sources Detected Within the May River 2017 - 2021

Town of Bluffton
Beaufort County, SC

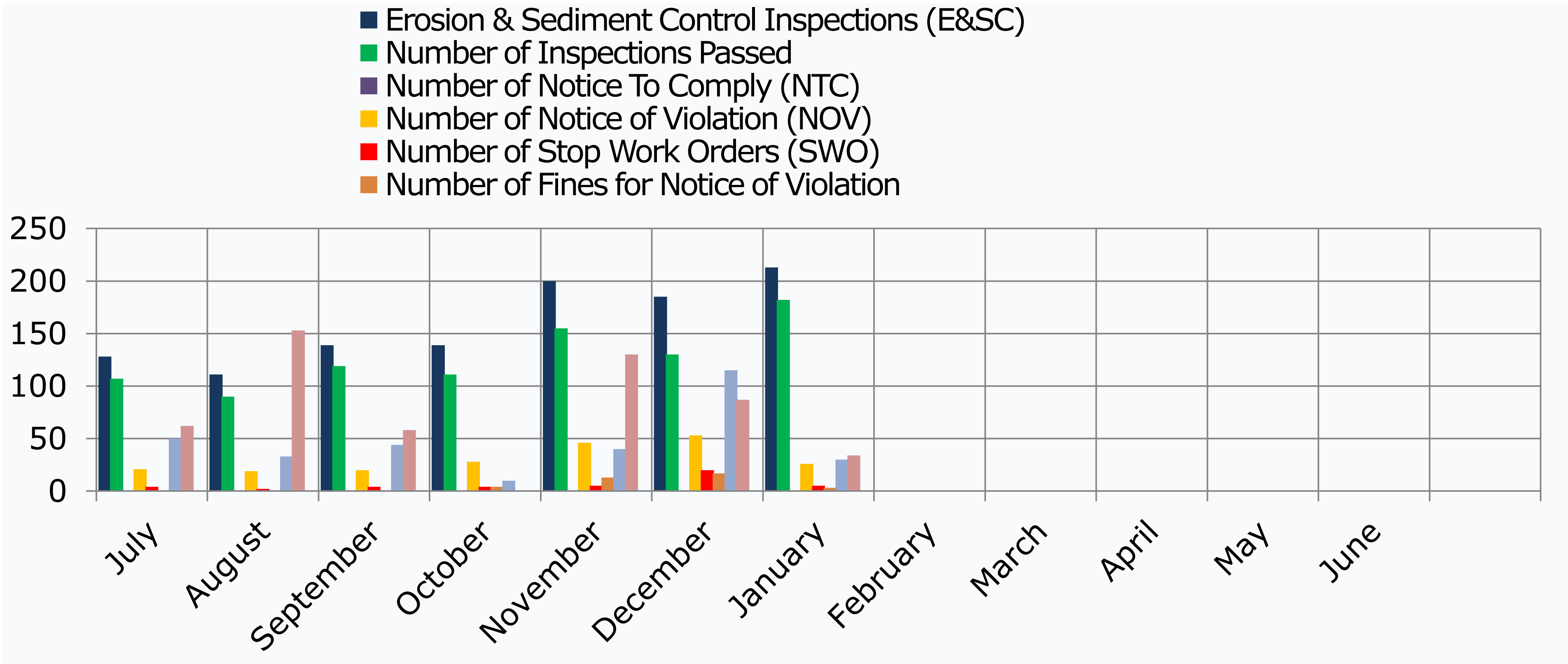
Date: 11/17/2020

MS4 Minimum Control Measure #3 – IDDE: Illicit Discharge Investigations



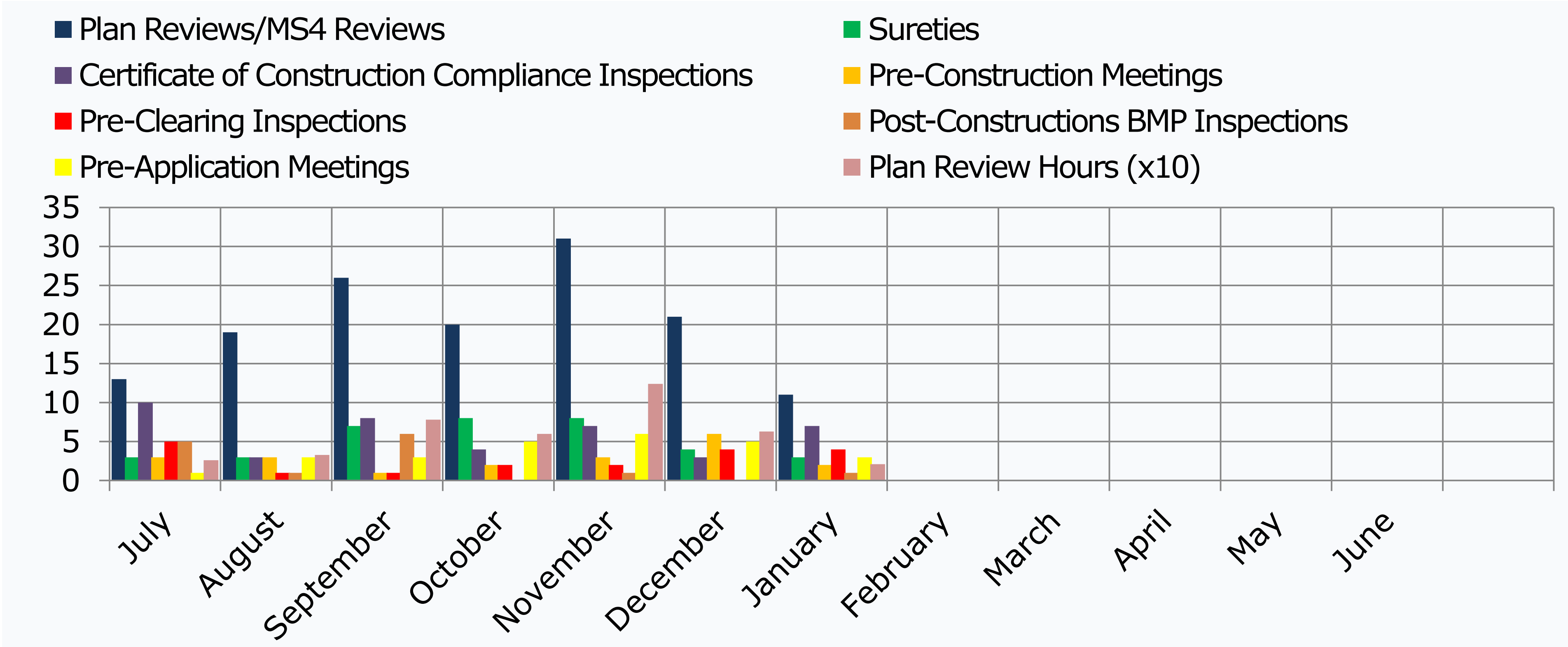
	Number of Illicit Discharge Investigations	Number of Notices To Comply Issued	Number of Notices of Violation Issued	Number of NOV Enforcement Actions	Number of Meetings
FY 2021 YTD Totals	17	8	2	0	16
FY 2020 Totals	45	10	8	6	49
FY 2019 Totals	38	20	3	1	61
FY 2018 Totals	48	20	4	2	60

MS4 Minimum Control Measure #4 - Construction Site Stormwater Runoff Control



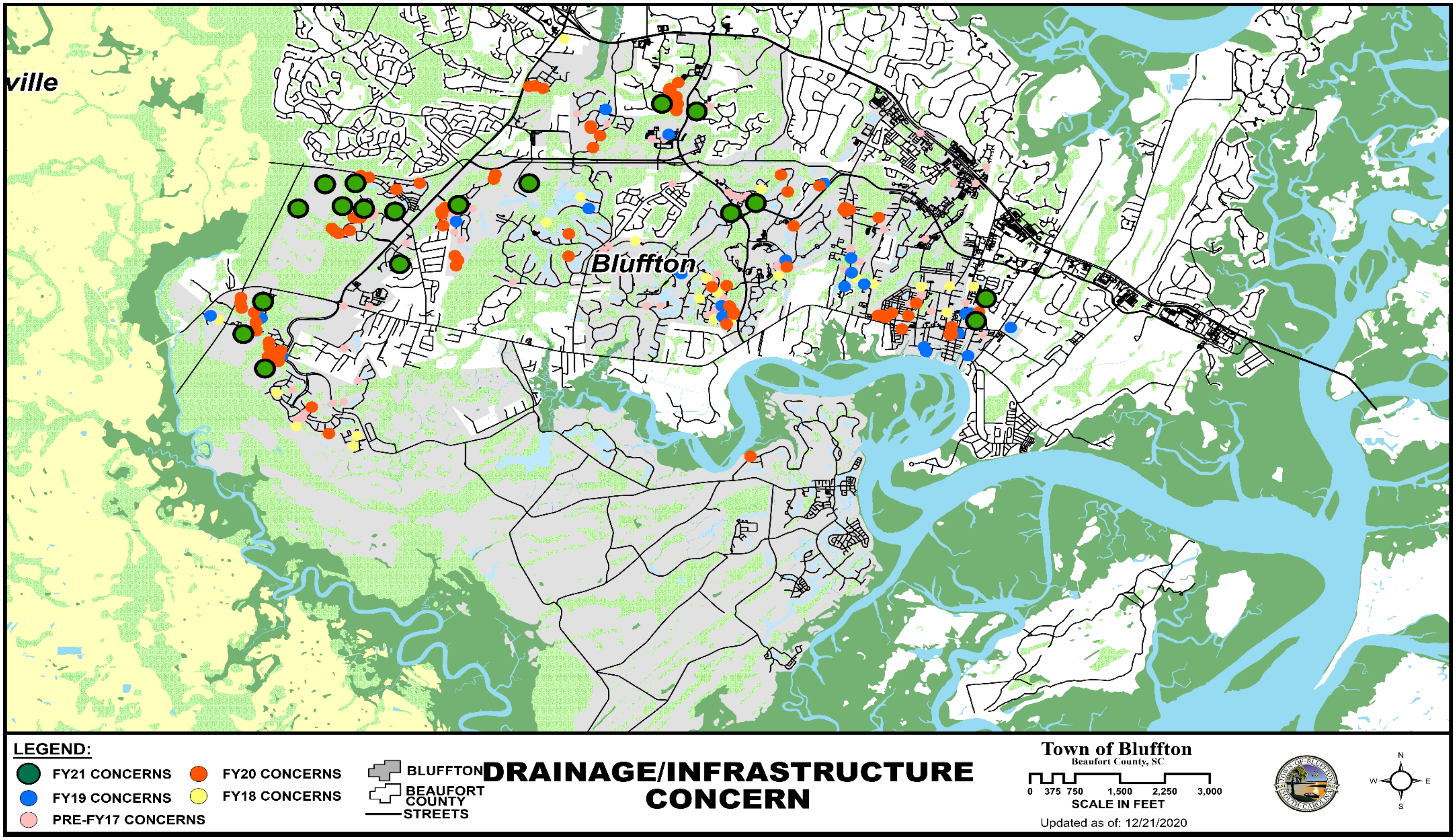
	Number of Sediment & Erosion Control Inspections	Number of Inspections Passed	Number of NTC Issued	Number of NOVs Issued	Number of SWO Issued	Number of NOV Enforcement Actions	Number of E&SC Meetings
FY 2021 YTD Totals	1098	912	N/A	179	25	20	248
FY 2020 Totals	1,517	1187	128	185	16	9	496
FY 2019 Totals	1,688	1,384	254	72	N/A	7	403

MS4 Minimum Control Measure #5
Stormwater Plan Review & Related Activity



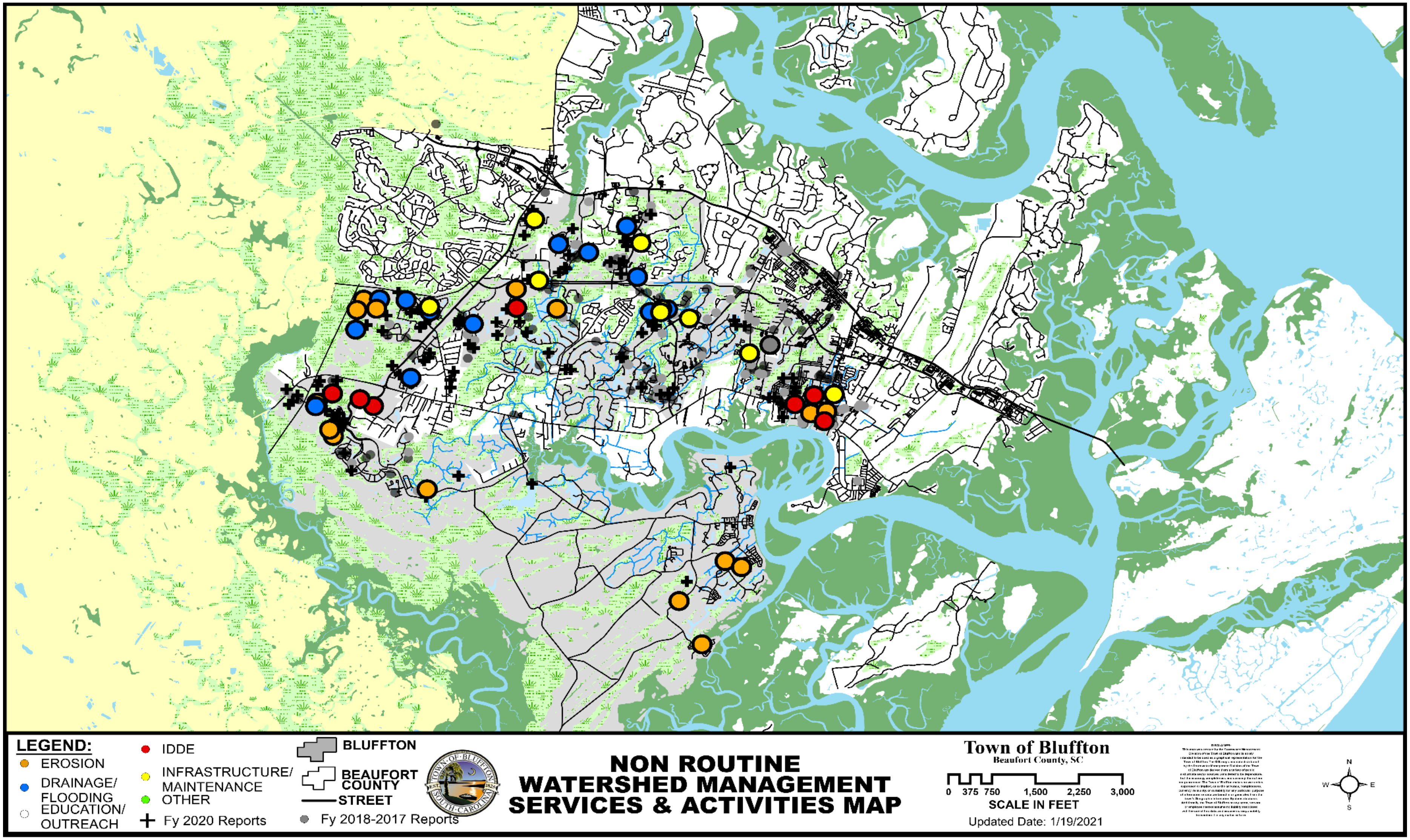
	Plan Reviews MS4 Reviews	Sureties	Certificate of Construction Compliance Inspections	Pre-Construction Meetings	Pre-Clearing Inspections	Post Construction BMP Inspections	Pre-Application Meetings	Total Plan Review Hours
FY 2021 YTD Totals	120	32	39	13	15	14	21	342 Hrs.
FY 2020 Totals	176	53	46	36	17	8	36	789 Hrs.
FY 2019 Totals	208	52	53	47	37	27	63	1,040 Hrs.

Citizen Drainage, Maintenance and Inspections Concerns Map



	Number of Drainage Concerns Investigated	Number of Meetings
FY 2021 YTD Totals	18	25
FY 2020 Totals	68	76
FY 2019 Totals	54	59

Citizen Request for Watershed Mngt. Services & Activities Map



	Number of Citizen Requests Investigated	Number of Meetings
FY 2021 YTD Totals	27	29
FY 2020 Totals	99	102
FY 2019 Totals	75	79

PUBLIC NOTICE

The Beautification Committee (BC)
Meeting scheduled for

Thursday, January 21, 2021,
at 10:00 a.m.

Has been CANCELED
due to lack of agenda items

The next meeting is scheduled for
Thursday, February 18, 2021

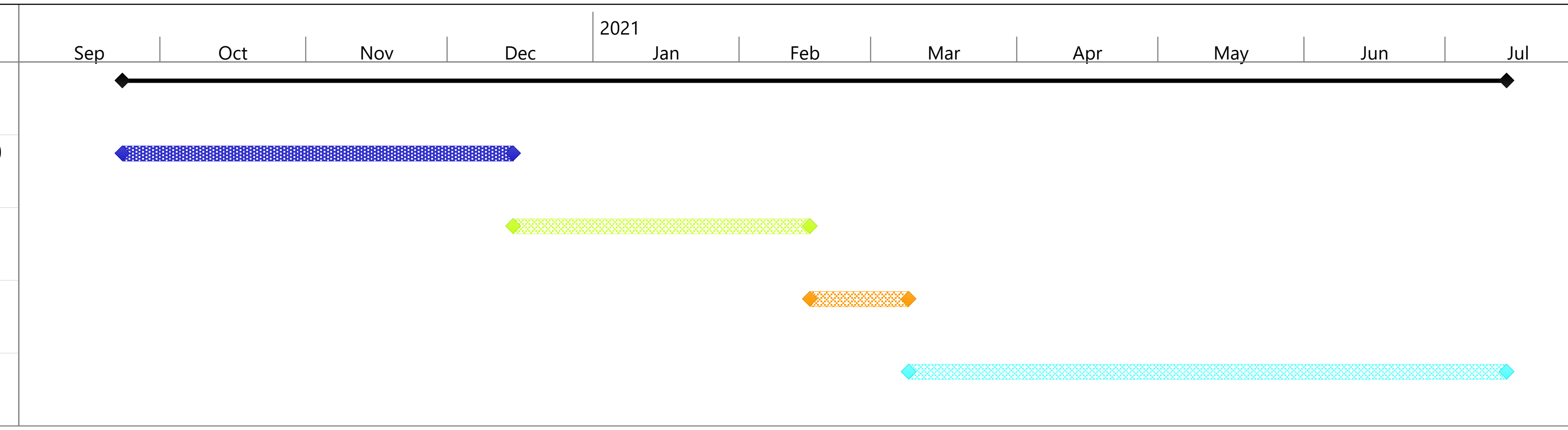
If you have questions, please contact
Engineering at: 843-706-4599

Public Works Activities Report

Week	# of Activities	Labor Cost	Equipment Cost	Other Cost	Total
FY21WK1	61	$4,397.00	$3,188.00		**$7,584.00**
FY21WK2	56	$5,474.00	$3,574.00	$121.00	**$9,168.00**
FY21WK3	48	$4,880.00	$3,502.00		**$8,382.00**
FY21WK4	62	$5,828.00	$3,970.00		**$9,799.00**
FY21WK5	45	$4,706.00	$3,575.00		**$8,281.00**
FY21WK6	54	$5,645.00	$3,114.00		**$9,126.00**
FY21WK7	60	$4,855.00	$4,232.00		**$9,087.00**
FY21WK8	67	$5,118.00	$4,221.00		**$9,339.00**
FY21WK9	50	$5,784.00	$3,923.00		**$9,707.00**
FY21WK10	54	$6,131.00	$4,248.00	$21.00	**$10,400.00**
FY21WK11	41	$4,677.00	$2,740.00		**$7,417.00**
FY21WK12	70	$5,580.00	$2,587.00	$326.00	**$8,494.00**
FY21WK13	94	$5,864.00	$5,084.00		**$10,949.00**
FY21WK14	49	$6,171.00	$4,261.00		**$10,431.00**
FY21WK15	53	$5,870.00	$4,059.00		**$9,929.00**
FY21WK16	62	$5,239.00	$3,531.00		**$8,771.00**
FY21WK17	77	$4,660.00	$3,769.00	$364.00	**$8,792.00**
FY21WK18	45	$4,679.00	$3,417.00		**$8,096.00**
FY21WK19	62	$6,186.00	$7,048.00		**$13,234.00**
FY21WK20	41	$4,135.00	$2,633.00		**$6,768.00**
FY21WK21	51	$5,446.00	$3,073.00		**$8,519.00**
FY21WK22	39	$3,229.00	$3,599.00		**$6,828.00**
FY21WK23	51	$5,072.00	$3,014.00		**$8,085.00**
FY21WK24	76	$6,073.00	$5,257.00		**$11,329.00**
FY21WK25	56	$4,245.00	$2,976.00		**$7,221.00**
FY21WK26	38	$1,890.00	$1,936.00		**$3,826.00**
FY21WK27	50	$4,417.00	$4,060.00		**$8,477.00**
FY21WK28	69	$5,753.00	$4,185.00		**$9,938.00**
FY21WK29	36	$4,703.00	$6,365.00		**$11,069.00**
FY21WK30					
FY21WK31					
FY21WK32					
FY21WK33					
FY21WK34					
FY21WK35					
FY21WK36					
FY21WK37					
FY21WK38					
FY21WK39					
FY21WK40					
FY21WK41					
FY21WK42					
FY21WK43					
FY21WK44					
FY21WK45					
FY21WK46					
FY21WK47					
FY21WK48					
FY21WK49					
FY21WK50					
FY21WK51					
FY21WK52					
Total	**1617**	**$146,707.00**	**$111,141.00**	**$832.00**	**$259,046.00**

BUCKWALTER PLACE PARK RESTROOMS
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**Buckwalter Place Park Restrooms**	**210 days**	**Wed 9/23/20**	**Tue 7/13/21**
2	**Planning and Conceptual Design**	**59 days**	**Wed 9/23/20**	**Mon 12/14/20**
7	**Final Design and Construction Documents**	**45 days**	**Tue 12/15/20**	**Mon 2/15/21**
10	**Permitting**	**15 days**	**Tue 2/16/21**	**Mon 3/8/21**
13	**Bidding and Contracts**	**91 days**	**Tue 3/9/21**	**Tue 7/13/21**

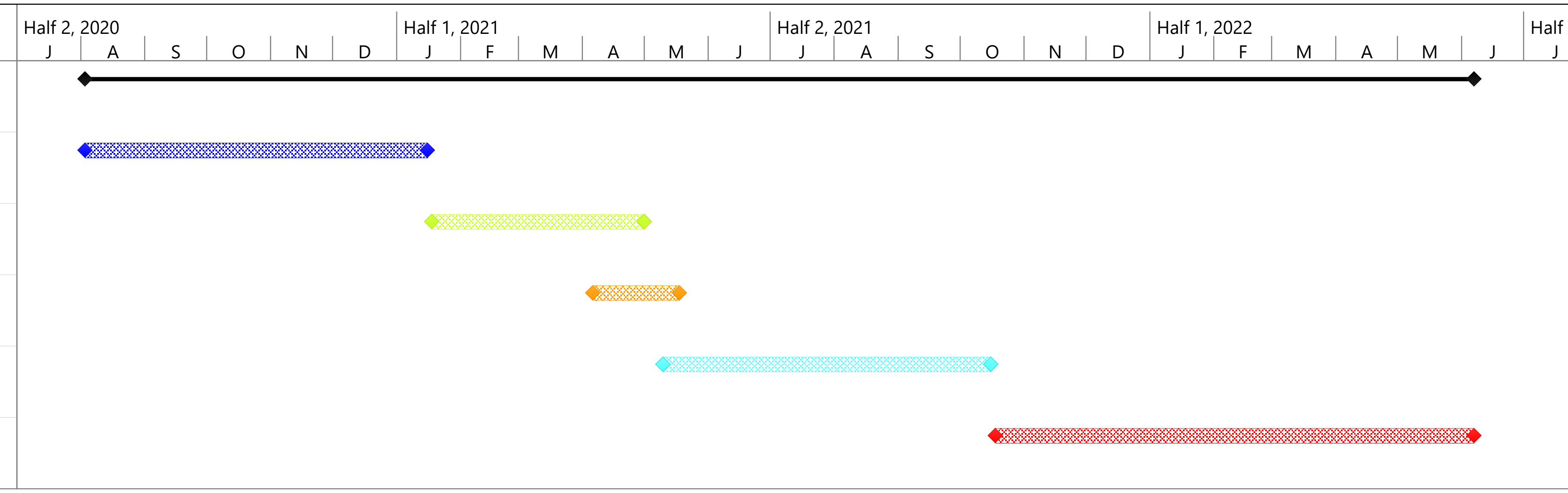


Project: 00040
Date: Wed 1/27/21

Milestone	Project Duration	Permitting	Construction
Critical Task	Planing and Conceptual Design	Easements and Land Acquisitions	
Task	Final Design and Construction Documents	Bidding and Contracts	

BUCKWALTER MULTI-COUNTY COMMERCE PARK
PHASE II DEVELOPMENT PARCEL - PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**PHASE II DEVELOPMENT PARCEL**	**481 days**	**Mon 8/3/20**	**Mon 6/6/22**
2	**Planning and Conceptual Design**	**120 days**	**Mon 8/3/20**	**Fri 1/15/21**
9	**Final Design and Construction Documents**	**75 days**	**Mon 1/18/21**	**Fri 4/30/21**
16	**Permitting**	**30 days**	**Tue 4/6/21**	**Mon 5/17/21**
21	**Bidding and Contracts**	**115 days**	**Mon 5/10/21**	**Fri 10/15/21**
32	**Construction**	**166 days**	**Mon 10/18/21**	**Mon 6/6/22**

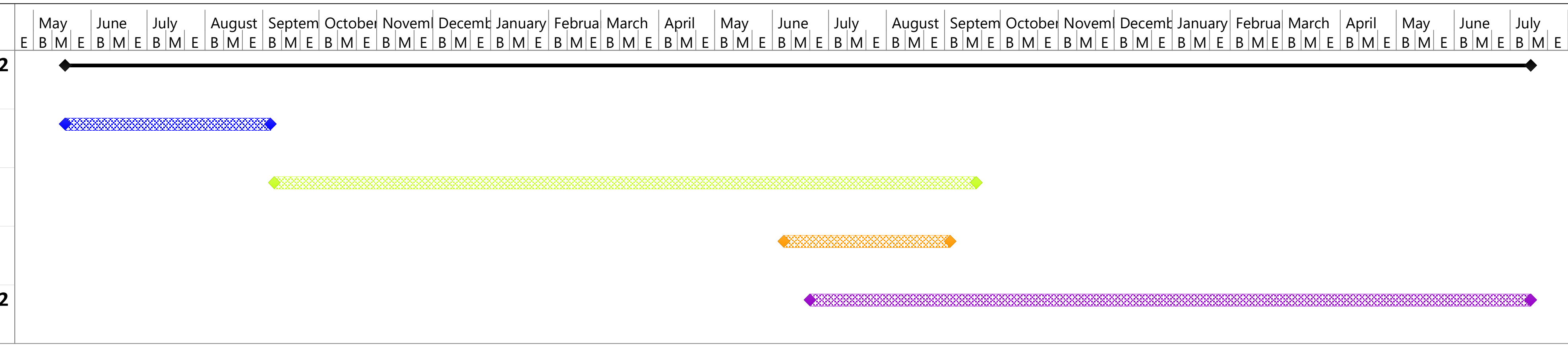


Project: 00040
Date: Tue 1/5/21

Milestone	Project Duration	Permitting	Construction
Critical Task	Planning and Conceptual Design	Easements and Land Acquisition	
Task	Final Design and Construction Documents	Bidding and Contracts	

CALHOUN STREET STREETSCAPE
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**CALHOUN STREET STREETSCAPE**	**561 days**	**Mon 5/18/20**	**Mon 7/11/22**
2	**Planning and Conceptual Design**	**80 days**	**Mon 5/18/20**	**Fri 9/4/20**
7	**Final Planning and Construction Documents**	**270 days**	**Mon 9/7/20**	**Fri 9/17/21**
27	**Permitting Phase**	**65 days**	**Mon 6/7/21**	**Fri 9/3/21**
32	**Easements and Land Acquisition**	**276 days**	**Mon 6/21/21**	**Mon 7/11/22**

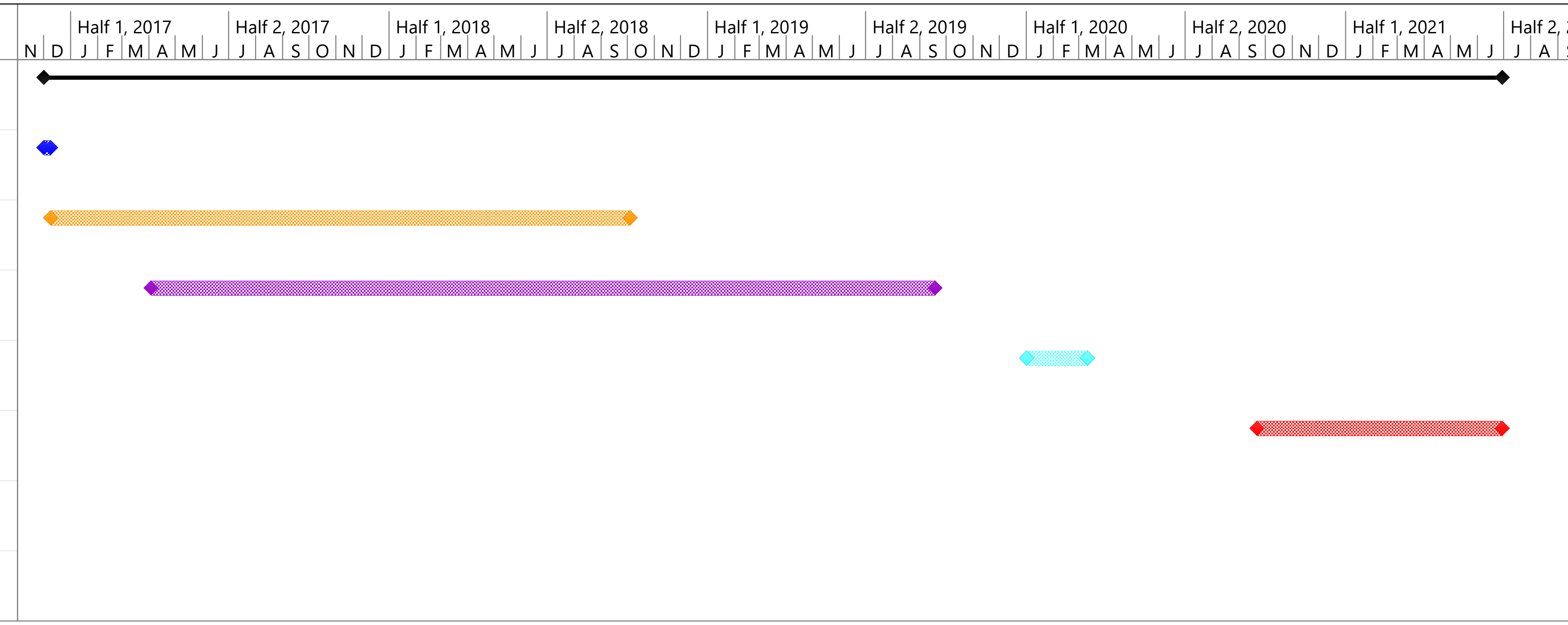


Project: 00042
Date: Wed 1/27/21

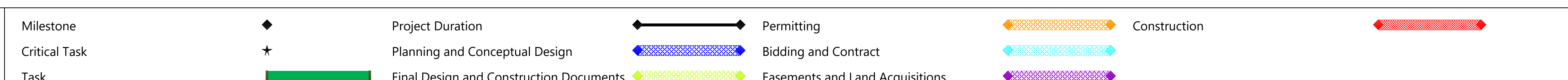
Milestone	◆	Task		Planning and Conceptual Design		Permitting	
Critical Task	★	Project Duration		Final Design and Construction Documents		Bidding and Contract	
				Easements and Land Acquisitions		Construction	

BUCK ISLAND-SIMMONSVILLE SANITARY SEWER PHASE 5 A-D
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**PHASE 5 A-D**	**1193 days?**	**Thu 12/1/16**	**Mon 6/28/21**
2	**Planning and Conceptual Design**	**6 days**	**Thu 12/1/16**	**Thu 12/8/16**
4	**Permitting**	**474 days**	**Fri 12/9/16**	**Wed 10/3/18**
11	**Easements and Land Acquisition**	**642 days**	**Mon 4/3/17**	**Tue 9/17/19**
16	**Bidding and Contracts**	**50 days**	**Wed 1/1/20**	**Tue 3/10/20**
21	**Construction**	**201 days**	**Mon 9/21/20**	**Mon 6/28/21**
29				
30				

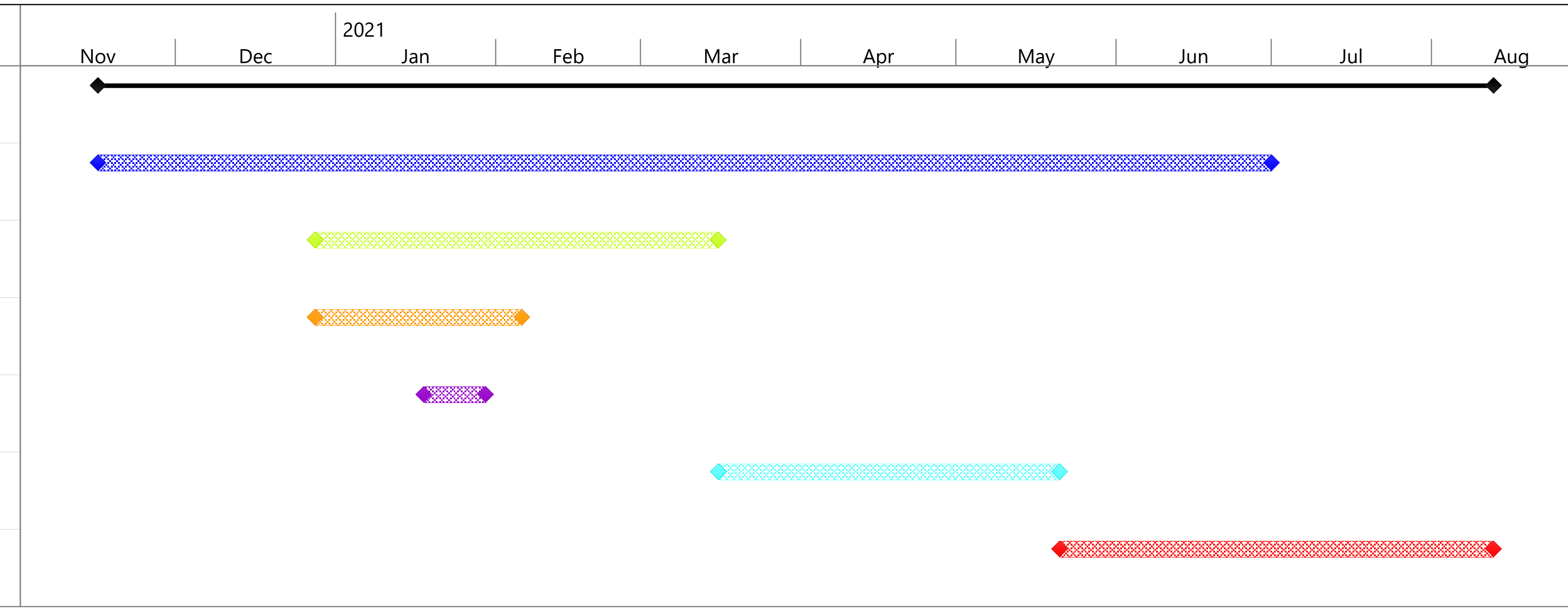


Project: 00044
Date: Wed 1/27/21



HISTORIC DISTRICT STREETSCAPE AND DRAINAGE IMPROVEMENTS PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**Traffic Calming Study and AME Church Rain Garden**	**194 days**	**Mon 11/16/20**	**Thu 8/12/21**
2	**Planning and Conceptual Design**	**163 days**	**Mon 11/16/20**	**Wed 6/30/21**
7	**Final Design and Construction Documents**	**56 days**	**Mon 12/28/20**	**Mon 3/15/21**
10	**Permitting**	**30 days**	**Mon 12/28/20**	**Fri 2/5/21**
14	**Easements and Land Acquisition**	**10 days**	**Mon 1/18/21**	**Fri 1/29/21**
17	**Bidding and Contracts**	**48 days**	**Tue 3/16/21**	**Thu 5/20/21**
22	**Construction**	**60 days**	**Fri 5/21/21**	**Thu 8/12/21**

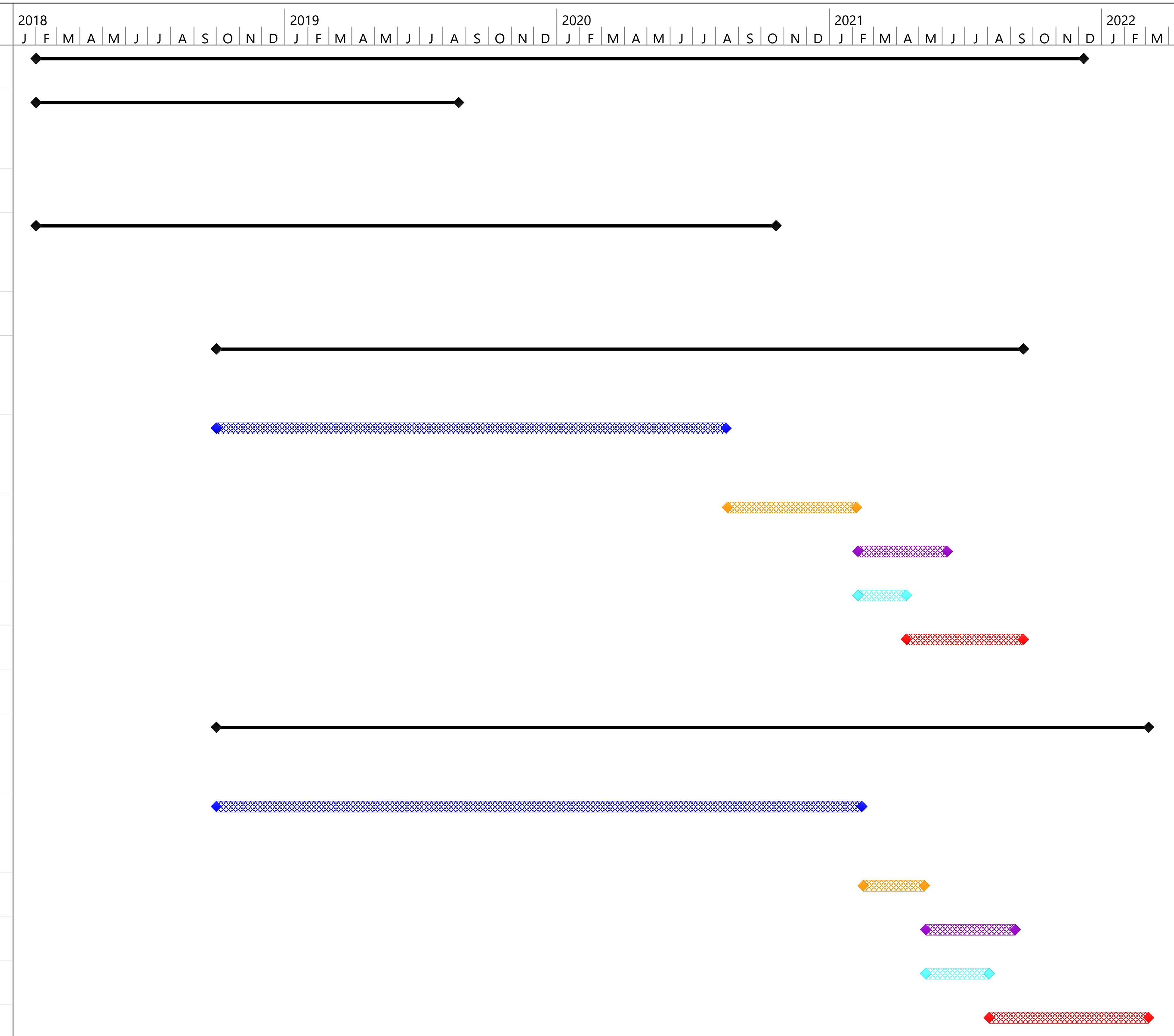


Project: 00050
Date: Tue 1/5/21

Milestone ◆ | Project Duration | Permitting | Construction
Critical Task ★ | Planing and Conceptual Design | Easements and Land Acquisitions
Task | Final Design and Construction Documents | Bidding and Contracts

BUCK ISLAND-SIMMONSVILLE NEIGHBORHOOD SIDEWALKS
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**SIDEWALKS AND LIGHTING**	1004 days	Thu 2/1/18	Tue 12/7/21
2	**Sidewalk from Jennifer Ct to Simmonsville Rd**	**405 days**	**Thu 2/1/18**	**Wed 8/21/19**
26				
27	**Sidewalk from Kitty Road to 301 Buck Island Rd**	**709 days**	**Thu 2/1/18**	**Tue 10/20/20**
53				
54	**Sidewalk from Grayco to Sugaree (Simmonsville Rd)**	**775 days**	**Mon 10/1/18**	**Fri 9/17/21**
55	**Final Design and Construction Documents**	**490 days**	**Mon 10/1/18**	**Fri 8/14/20**
61	**Permitting**	**125 days**	**Mon 8/17/20**	**Fri 2/5/21**
63	**Easements**	**86 days**	**Mon 2/8/21**	**Mon 6/7/21**
68	**Bidding/Contract**	**47 days**	**Mon 2/8/21**	**Tue 4/13/21**
73	**Construction**	**113 days**	**Wed 4/14/21**	**Fri 9/17/21**
80				
81	**Sidewalk from Sugaree to Windy Lake (Simmonsville Rd)**	**895 days**	**Mon 10/1/18**	**Fri 3/4/22**
82	**Final Design and Construction Documents**	**620 days**	**Mon 10/1/18**	**Fri 2/12/21**
88	**Permitting**	**60 days**	**Mon 2/15/21**	**Fri 5/7/21**
90	**Easements**	**86 days**	**Mon 5/10/21**	**Mon 9/6/21**
95	**Bidding/Contract**	**61 days**	**Mon 5/10/21**	**Mon 8/2/21**
100	**Construction**	**154 days**	**Tue 8/3/21**	**Fri 3/4/22**

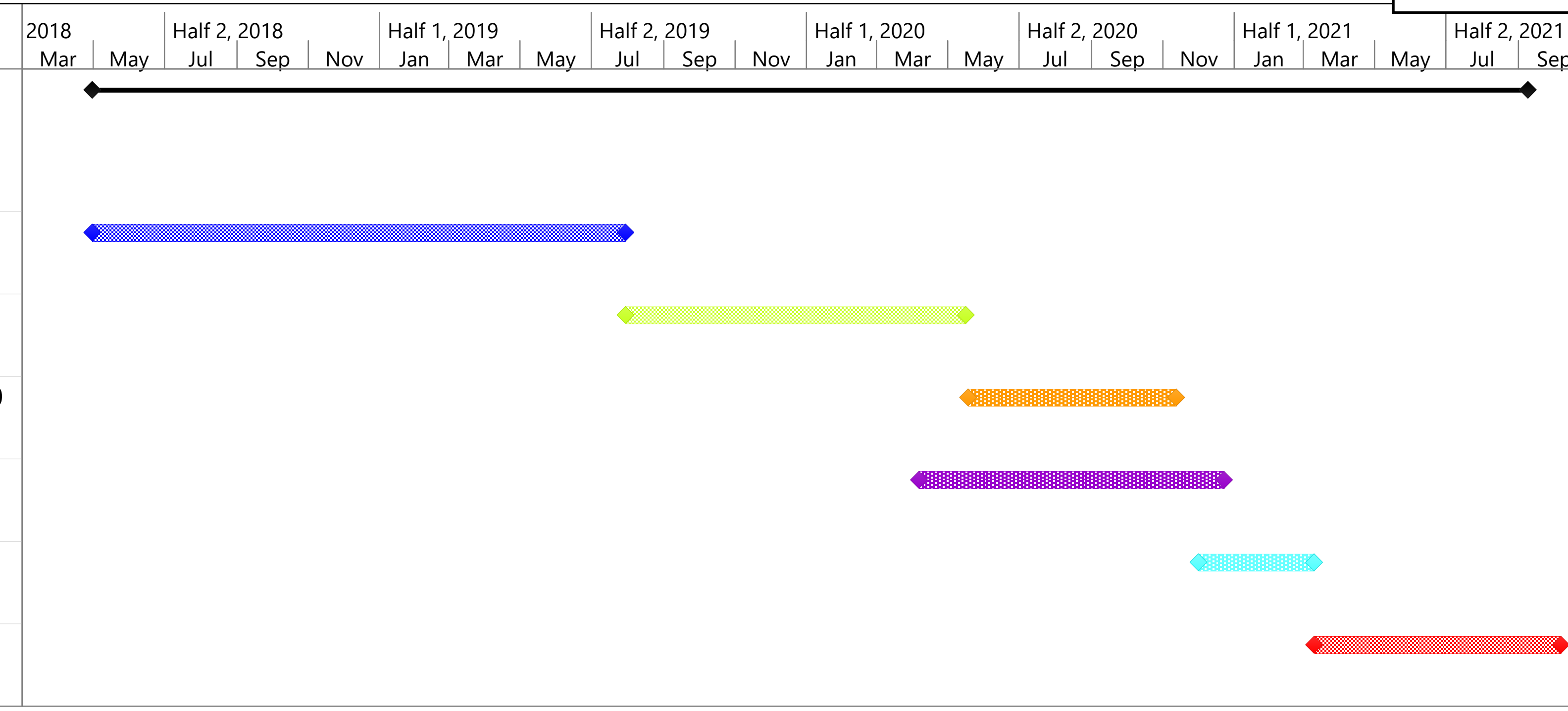


Project: 00054
Date: Wed 1/27/21

Milestone | Project Duration | Permitting | Construction
Critical Task | Planning and Conceptual Design | Bidding and Contract
Task | Final Design and Construction Documents | Easements and Land Acquisitions

GOETHE-SHULTS NEIGHBORHOOD IMPROVEMENTS PHASE 2
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**GOETHE/SHULTS NEIGHBORHOOD IMPROVEMENTS PHASE 2**	**878 days**	**Mon 4/30/18**	**Wed 9/8/21**
2	**PLANNING AND CONCEPTUAL DESIGN**	**326 days**	**Mon 4/30/18**	**Mon 7/29/19**
12	**FINAL DESIGN AND CONSTRUCTION DOCUMENTS**	**209 days**	**Tue 7/30/19**	**Fri 5/15/20**
21	**PERMITTING**	**128 days**	**Mon 5/18/20**	**Wed 11/11/20**
25	**EASEMENTS AND LAND ACQUISITION**	**187 days**	**Mon 4/6/20**	**Tue 12/22/20**
32	**BIDDING AND CONTRACTS**	**71 days**	**Tue 12/1/20**	**Tue 3/9/21**
37	**CONSTRUCTION**	**151 days**	**Wed 3/10/21**	**Wed 10/6/21**

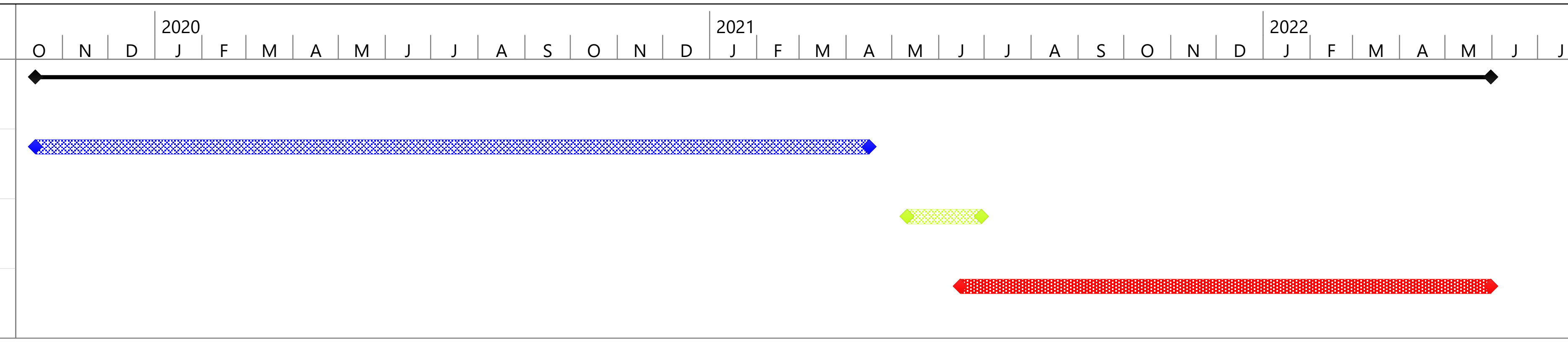


Project: 00055
Date: Tue 1/5/21

Milestone	Project Duration	Permitting	Construction
Critical Task	Planning and Conceptual Design	Easements and Land Acquisition	
Task	Final Design and Construction Documents	Bidding and Contracts	

OYSTER FACTORY PARK
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**Oyster Factory Park**	**686 days**	**Mon 10/14/19**	**Mon 5/30/22**
2	**Planning and Conceptual Design**	**394 days**	**Mon 10/14/19**	**Thu 4/15/21**
11	**Easement and Land Acquisition**	**35 days**	**Tue 5/11/21**	**Mon 6/28/21**
13	**Construction**	**250 days**	**Tue 6/15/21**	**Mon 5/30/22**

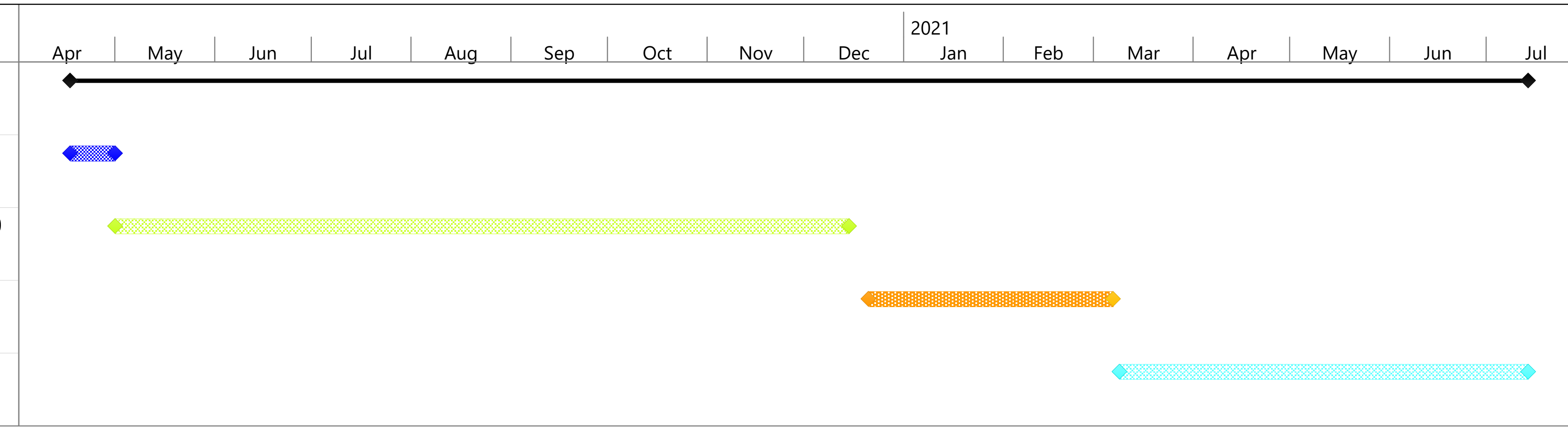


Project: 00059
Date: Tue 1/5/21

Milestone
Critical Task
Task
Project Duration
Planning and Conceptual Design
Final Design and Construction Documents
Permitting
Easements and Land Acquisition
Bidding and Contracts
Construction

SQUIRE POPE CARRIAGE HOSUE
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**Squire Pope Carriage House**	**323 days**	**Fri 4/17/20**	**Tue 7/13/21**
2	**Planning and Conceptual Design**	**10 days**	**Fri 4/17/20**	**Thu 4/30/20**
5	**Final Design and Construction Documents**	**162 days**	**Fri 5/1/20**	**Mon 12/14/20**
10	**Permitting**	**55 days**	**Mon 12/21/20**	**Sun 3/7/21**
13	**Bidding and Contracts**	**91 days**	**Tue 3/9/21**	**Tue 7/13/21**

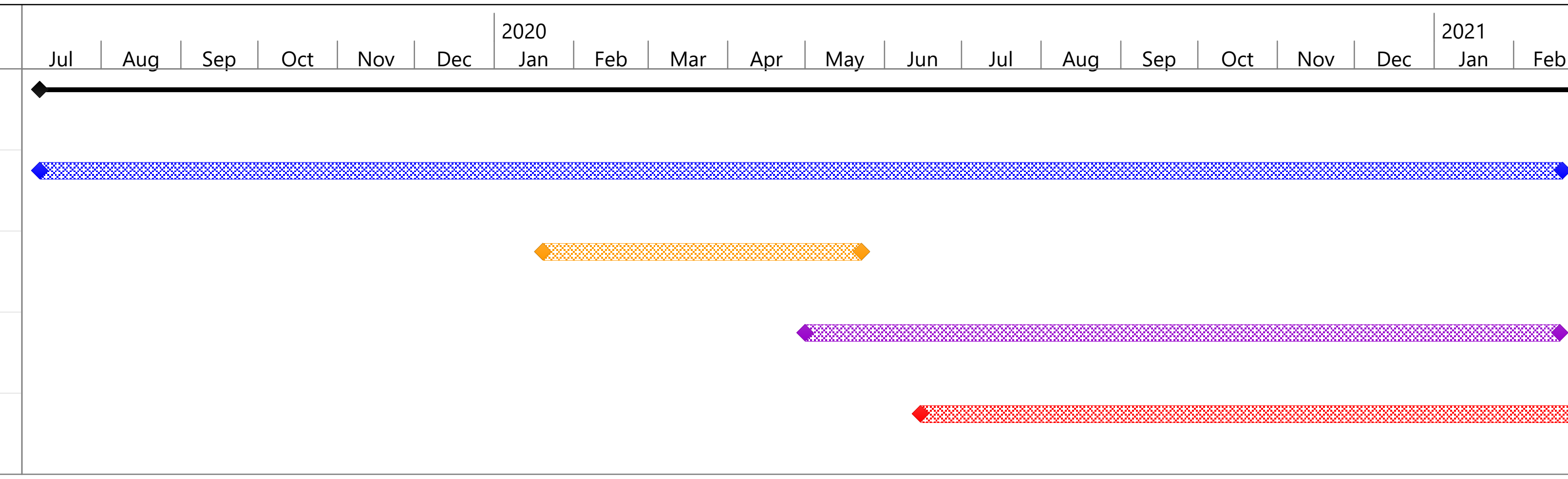


Project: 00067
Date: Wed 1/27/21

Milestone	◆	Project Duration		Permitting		Construction	
Critical Task	★	Planing and Conceptual Design		Easements and Land Acquisitions			
Task		Final Design and Construction Documents		Bidding and Contracts			

BOUNDARY STREET LIGHTING
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**BOUNDARY STREET LIGHTING PHASE 2**	**451 days**	**Mon 7/8/19**	**Mon 3/29/21**
2	**Planning and Conceptual Design**	**425 days**	**Mon 7/8/19**	**Fri 2/19/21**
13	**Permitting**	**90 days**	**Mon 1/20/20**	**Fri 5/22/20**
15	**Easements and Land Acquisition**	**210 days**	**Fri 5/1/20**	**Thu 2/18/21**
18	**Construction**	**206 days**	**Mon 6/15/20**	**Mon 3/29/21**

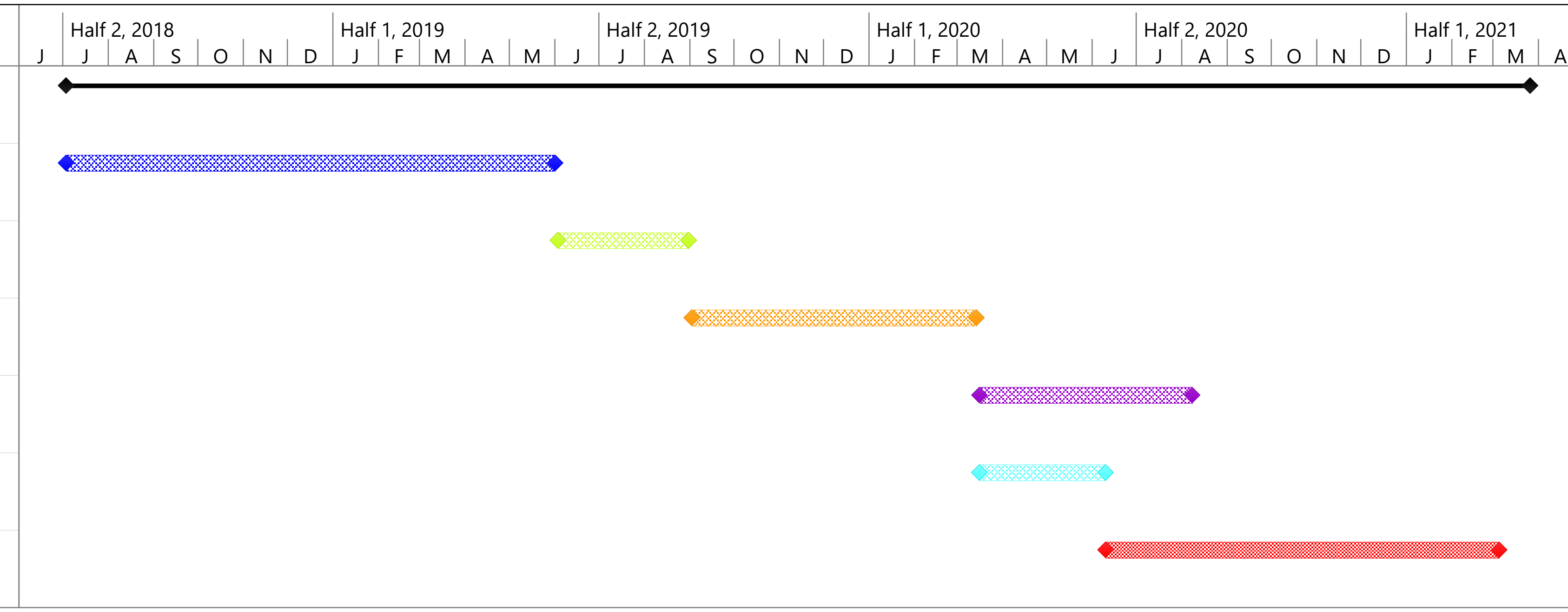


Project: 00069
Date: Tue 1/5/21

Milestone ◆
Critical Task ★
Task
Project Duration
Planning and Conceptual Design
Final Design and Construction Documents
Permitting
Easements and Land Acquisition
Bidding and Contract
Construction

HISTORIC DISTRICT SANITARY SEWER EXTENSION PHASE 1
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**PHASE 1**	**713 days**	**Tue 7/3/18**	**Thu 3/25/21**
2	**Planning and Conceptual Design**	**239 days**	**Tue 7/3/18**	**Fri 5/31/19**
9	**Final Design and Construction Documents**	**65 days**	**Mon 6/3/19**	**Fri 8/30/19**
11	**Permitting**	**140 days**	**Mon 9/2/19**	**Fri 3/13/20**
14	**Easements and Land Acquisition**	**105 days**	**Mon 3/16/20**	**Fri 8/7/20**
17	**Bidding and Contracts**	**62 days**	**Mon 3/16/20**	**Tue 6/9/20**
22	**Construction**	**192 days**	**Wed 6/10/20**	**Thu 3/4/21**

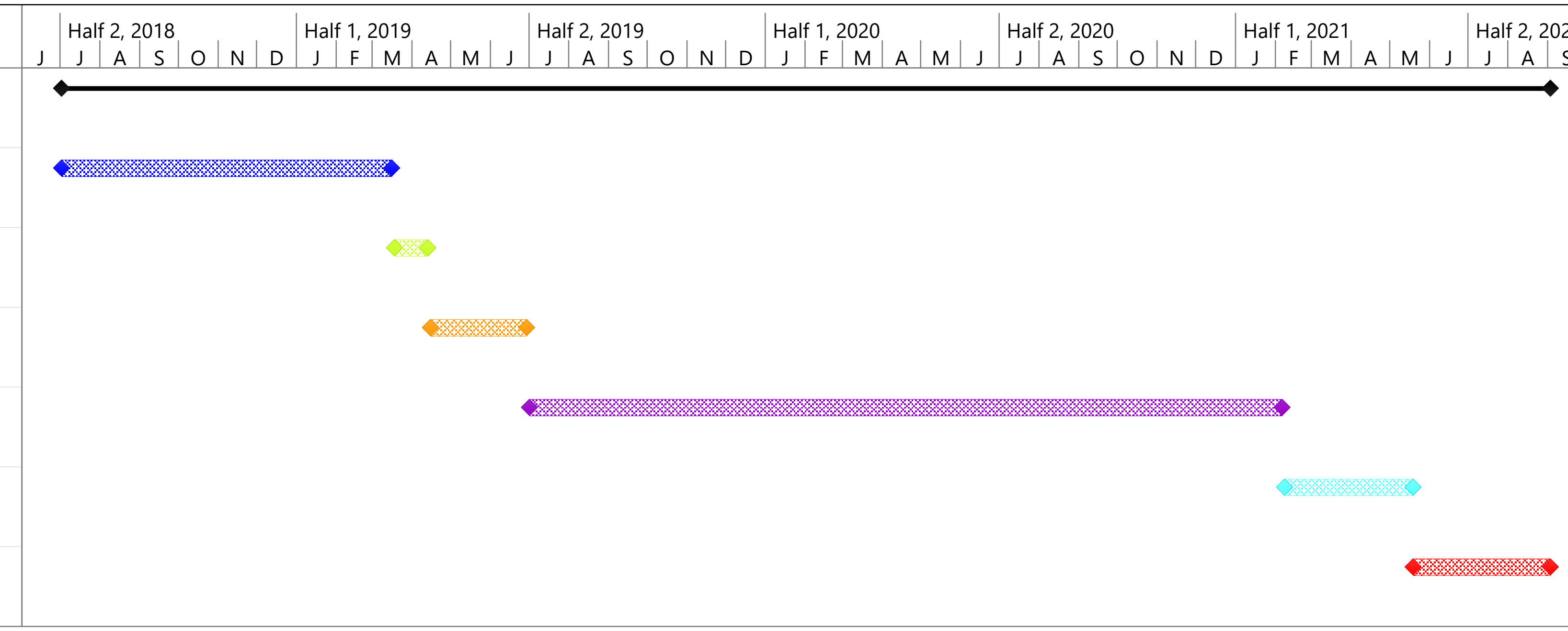


Project: 00070
Date: Wed 1/27/21

Milestone	◆	Project Duration		Permitting	
Critical Task	★	Planing and Conceptual Design		Easements and Land Acquisitions	
Task		Final Design and Construction Documents		Bidding and Contracts	
Construction					

HISTORIC DISTRICT SANITARY SEWER EXTENSION PHASE 2
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**PHASE 2**	**829 days**	**Mon 7/2/18**	**Thu 9/2/21**
2	**Planning and Conceptual Design**	**185 days**	**Mon 7/2/18**	**Fri 3/15/19**
10	**Final Design and Construction Documents**	**20 days**	**Mon 3/18/19**	**Fri 4/12/19**
12	**Permitting**	**55 days**	**Mon 4/15/19**	**Fri 6/28/19**
15	**Easements and Land Acquisition**	**420 days**	**Mon 7/1/19**	**Fri 2/5/21**
17	**Bidding and Contracts**	**72 days**	**Mon 2/8/21**	**Tue 5/18/21**
22	**Construction**	**77 days**	**Wed 5/19/21**	**Thu 9/2/21**

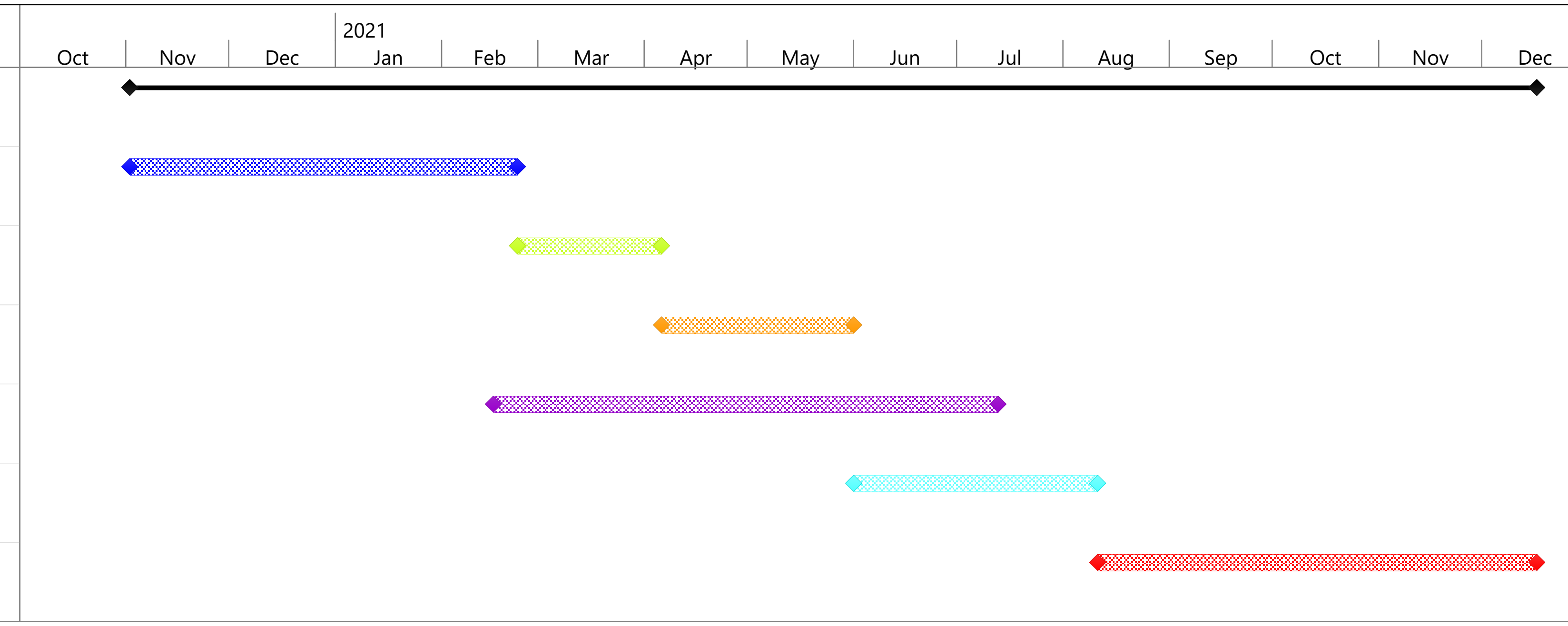


Project: 00071
Date: Tue 1/5/21

Milestone	Project Duration	Permitting	Construction
Critical Task	Planing and Conceptual Design	Easements and Land Acquisitions	
Task	Final Design and Construction Documents	Bidding and Contracts	

HISTORIC DISTRICT SANITARY SEWER EXTENSION PHASE 3
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**PHASE 3**	**294 days**	**Mon 11/2/20**	**Thu 12/16/21**
2	**Planning and Conceptual Design**	**81 days**	**Mon 11/2/20**	**Mon 2/22/21**
9	**Final Design and Construction Documents**	**30 days**	**Tue 2/23/21**	**Mon 4/5/21**
11	**Permitting**	**40 days**	**Tue 4/6/21**	**Mon 5/31/21**
14	**Easements and Land Acquisition**	**105 days**	**Tue 2/16/21**	**Mon 7/12/21**
17	**Bidding and Contracts**	**51 days**	**Tue 6/1/21**	**Tue 8/10/21**
22	**Construction**	**92 days**	**Wed 8/11/21**	**Thu 12/16/21**

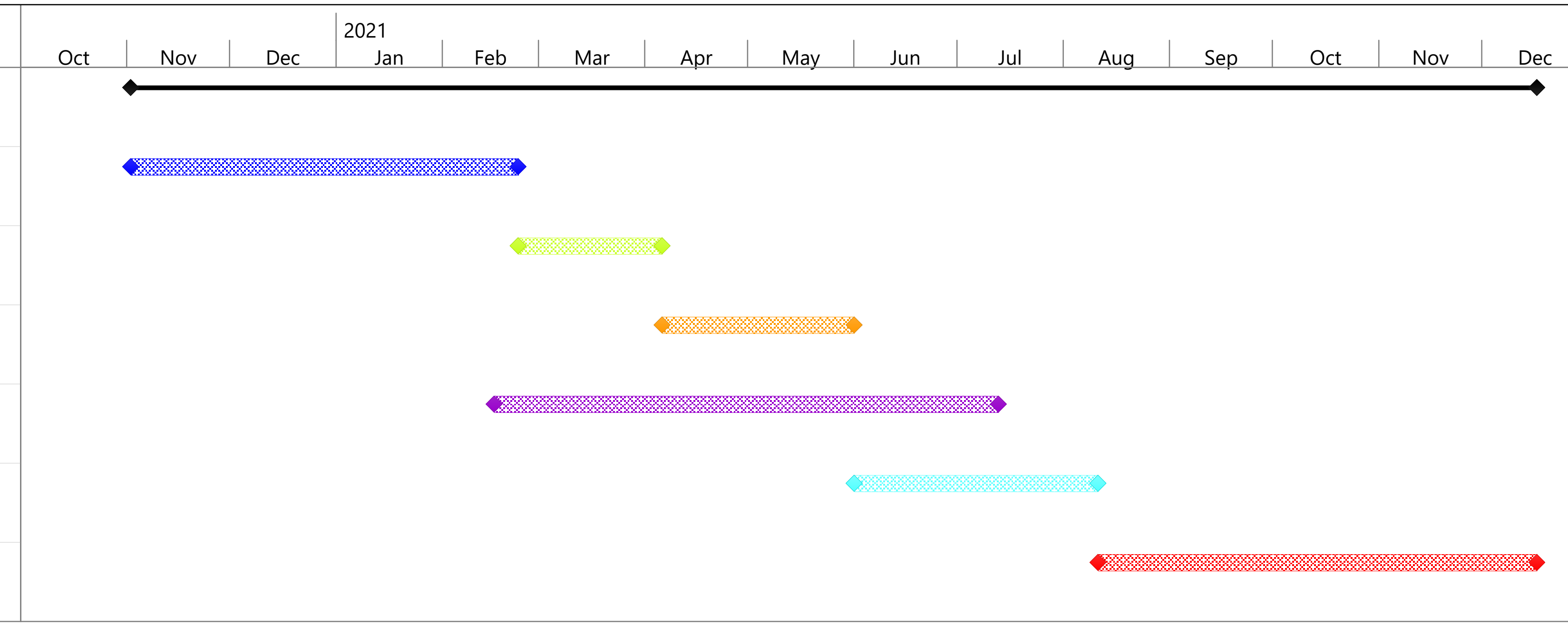


Project: 00072
Date: Tue 1/5/21

Milestone ◆
Critical Task ★
Task
Project Duration
Planing and Conceptual Design
Final Design and Construction Documents
Permitting
Easements and Land Acquisitions
Bidding and Contracts
Construction

HISTORIC DISTRICT SANITARY SEWER EXTENSION PHASE 4
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**PHASE 4**	**294 days**	**Mon 11/2/20**	**Thu 12/16/21**
2	**Planning and Conceptual Design**	**81 days**	**Mon 11/2/20**	**Mon 2/22/21**
9	**Final Design and Construction Documents**	**30 days**	**Tue 2/23/21**	**Mon 4/5/21**
11	**Permitting**	**40 days**	**Tue 4/6/21**	**Mon 5/31/21**
14	**Easements and Land Acquisition**	**105 days**	**Tue 2/16/21**	**Mon 7/12/21**
17	**Bidding and Contracts**	**51 days**	**Tue 6/1/21**	**Tue 8/10/21**
22	**Construction**	**92 days**	**Wed 8/11/21**	**Thu 12/16/21**

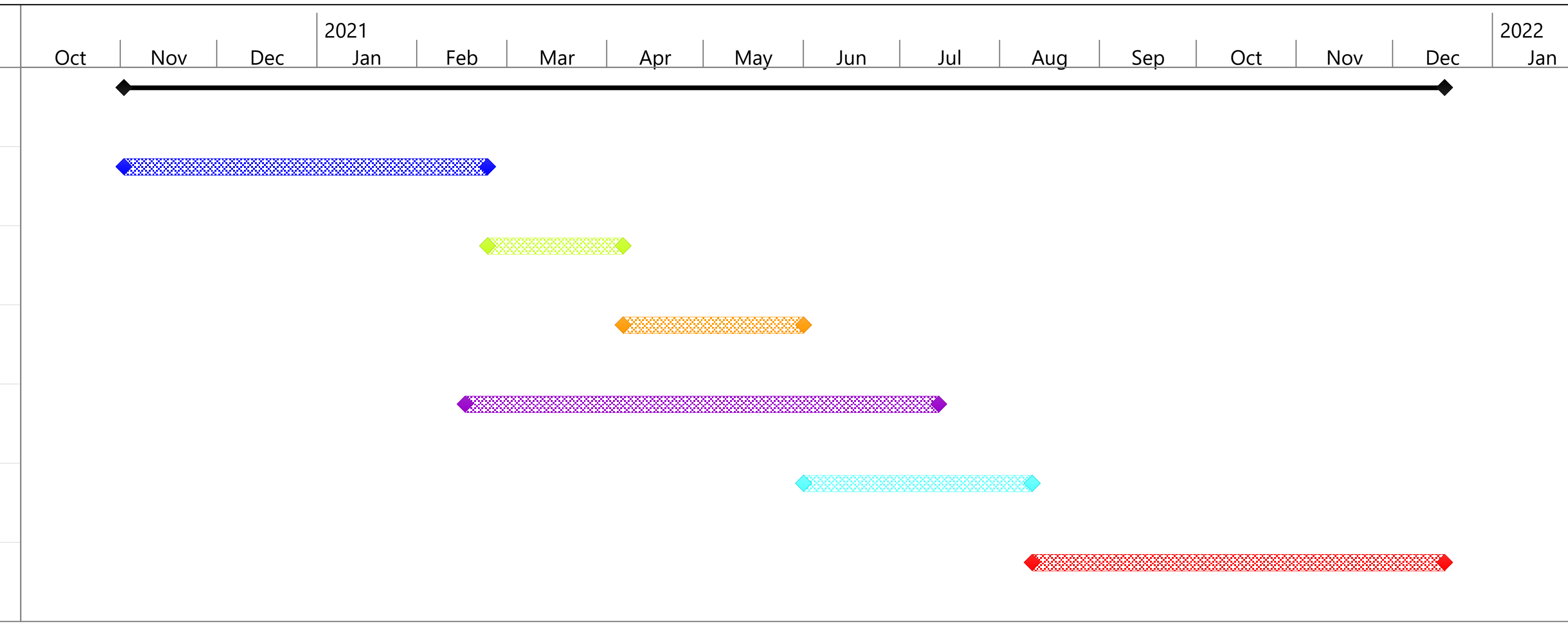


Project: 00073
Date: Tue 1/5/21

Milestone	Project Duration	Permitting	Construction
Critical Task	Planing and Conceptual Design	Easements and Land Acquisitions	
Task	Final Design and Construction Documents	Bidding and Contracts	

HISTORIC DISTRICT SANITARY SEWER EXTENSION PHASE 5
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**PHASE 5**	**294 days**	**Mon 11/2/20**	**Thu 12/16/21**
2	**Planning and Conceptual Design**	**81 days**	**Mon 11/2/20**	**Mon 2/22/21**
9	**Final Design and Construction Documents**	**30 days**	**Tue 2/23/21**	**Mon 4/5/21**
11	**Permitting**	**40 days**	**Tue 4/6/21**	**Mon 5/31/21**
14	**Easements and Land Acquisition**	**105 days**	**Tue 2/16/21**	**Mon 7/12/21**
17	**Bidding and Contracts**	**51 days**	**Tue 6/1/21**	**Tue 8/10/21**
22	**Construction**	**92 days**	**Wed 8/11/21**	**Thu 12/16/21**

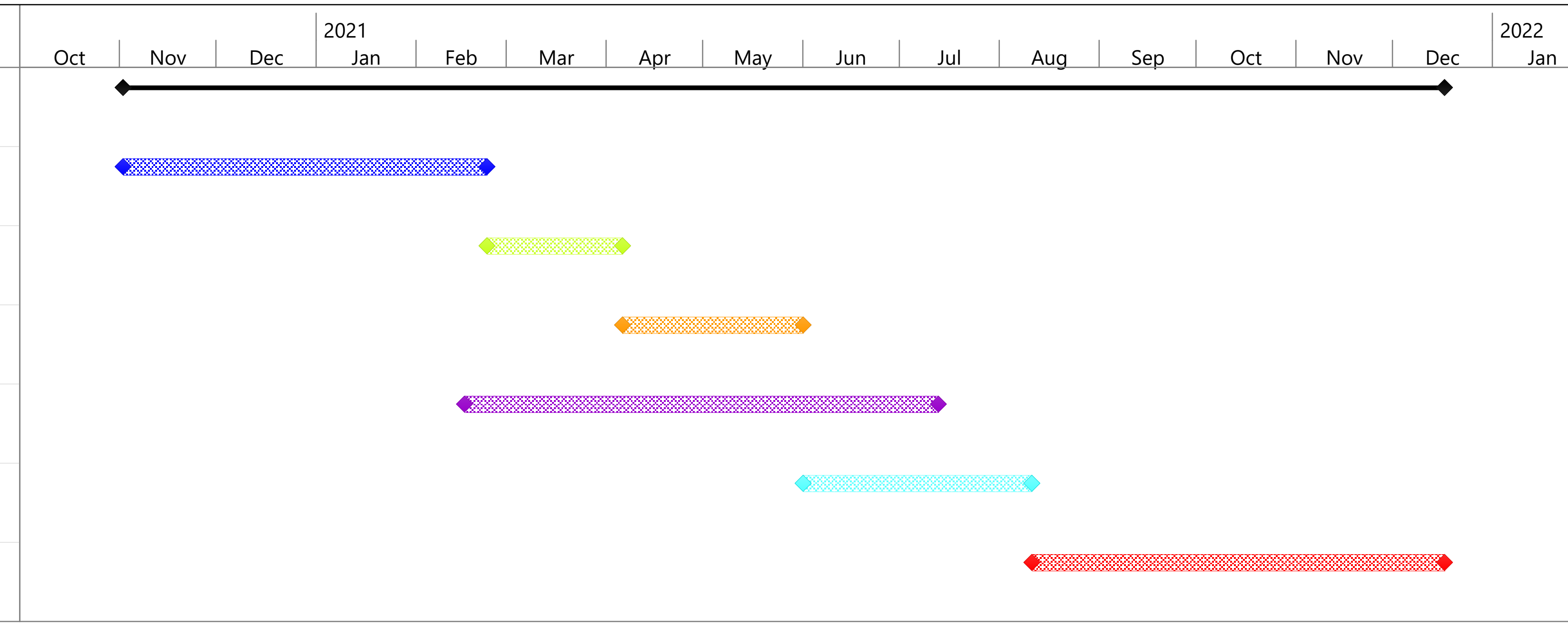


Project: 00074
Date: Tue 1/5/21

Milestone	◆	Project Duration		Permitting	
Critical Task	★	Planing and Conceptual Design		Easements and Land Acquisitions	
Task		Final Design and Construction Documents		Bidding and Contracts	
Construction					

HISTORIC DISTRICT SANITARY SEWER EXTENSION PHASE 6
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**PHASE 6**	**294 days**	**Mon 11/2/20**	**Thu 12/16/21**
2	**Planning and Conceptual Design**	**81 days**	**Mon 11/2/20**	**Mon 2/22/21**
9	**Final Design and Construction Documents**	**30 days**	**Tue 2/23/21**	**Mon 4/5/21**
11	**Permitting**	**40 days**	**Tue 4/6/21**	**Mon 5/31/21**
14	**Easements and Land Acquisition**	**105 days**	**Tue 2/16/21**	**Mon 7/12/21**
17	**Bidding and Contracts**	**51 days**	**Tue 6/1/21**	**Tue 8/10/21**
22	**Construction**	**92 days**	**Wed 8/11/21**	**Thu 12/16/21**

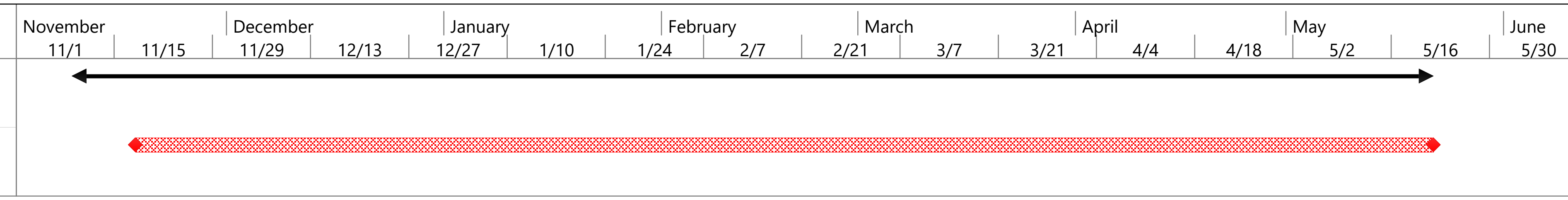


Project: 00075
Date: Tue 1/5/21

Milestone ◆
Critical Task ★
Task
Project Duration
Planing and Conceptual Design
Final Design and Construction Documents
Permitting
Easements and Land Acquisitions
Bidding and Contracts
Construction

BUCKWALTER MULTI-COUNTY COMMERCE PARK
LEC EXPANSION - PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**LEC Expansion**	**140 days**	**Mon 11/9/20**	**Fri 5/21/21**
2	**Construction**	**133 days**	**Wed 11/18/20**	**Fri 5/21/21**

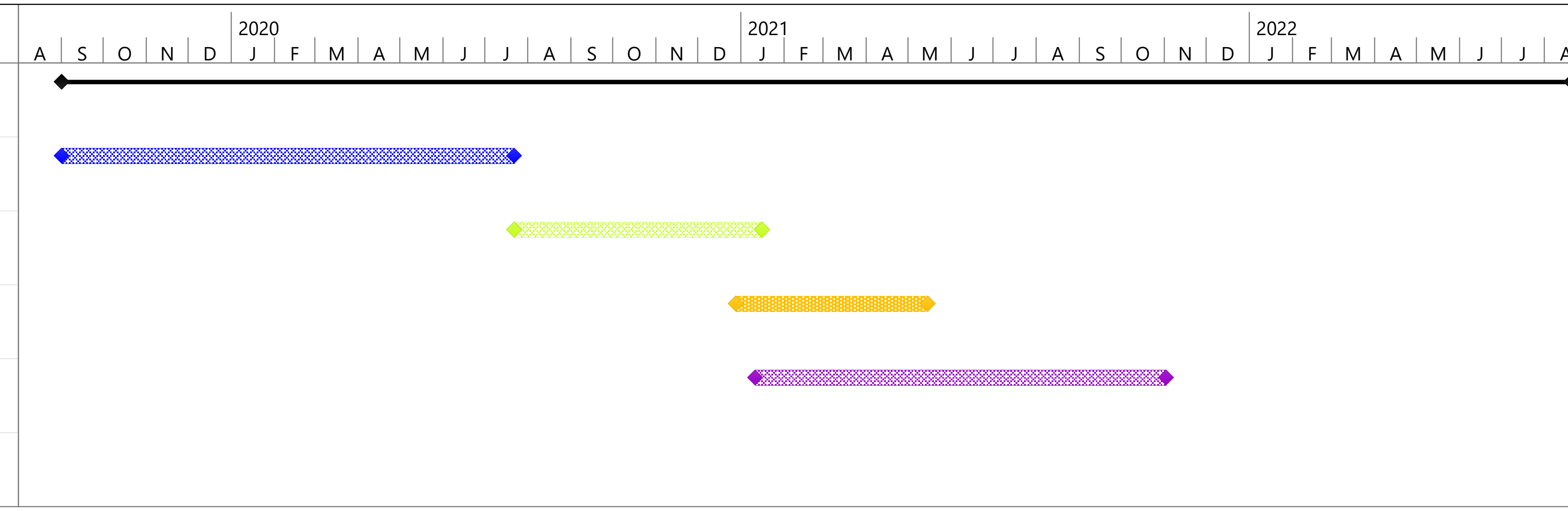


Project: 00077
Date: Tue 1/5/21

Milestone	◆	Project Duration		Permitting		Construction	
Critical Task	★	Planning and Conceptual Design		Easements and Land Acquisition			
Task		Final Design and Construction Documents		Bidding and Contracts			

BRIDGE STREET STREETSCAPE
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**BRIDGE STREET STREETSCAPE**	**776 days**	**Sun 9/1/19**	**Fri 8/19/22**
2	**Planning and Conceptual Design**	**232 days**	**Sun 9/1/19**	**Tue 7/21/20**
17	**Final Design and Construction Documents**	**128 days**	**Wed 7/22/20**	**Fri 1/15/21**
22	**Permitting**	**100 days**	**Mon 12/28/20**	**Fri 5/14/21**
27	**Easements and Land Acquisition**	**211 days?**	**Mon 1/11/21**	**Mon 11/1/21**
37	**Construction**			

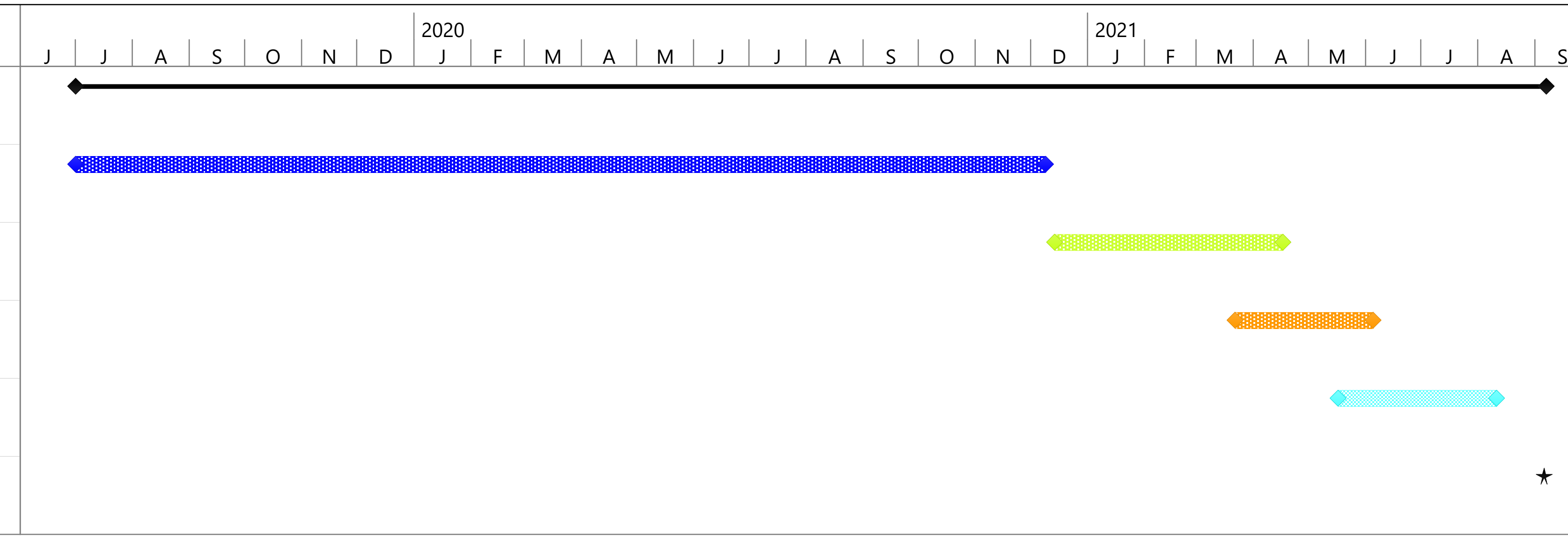


Project: 00082
Date: Tue 1/5/21

Milestone	◆	Project Duration		Permitting	
Critical Task	★	Planning and Conceptual Design		Easements and Land Acquisition	
Task		Final Design and Construction Documents		Bidding and Contracts	
				Construction	

NEW RIVERSIDE PARK/BARN SITE
PROPOSED SCHEDULE

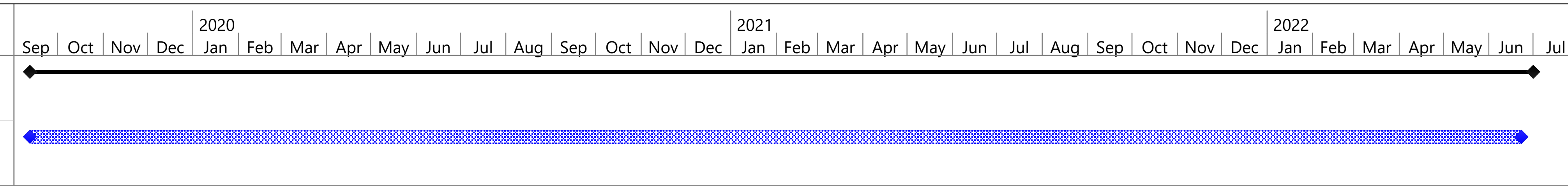
ID	Task Name	Duration	Start	Finish
1	**NEW RIVERSIDE PARK/BARN SITE**	**571 days**	**Mon 7/1/19**	**Mon 9/6/21**
2	**Planning and Conceptual Master Plan**	**377 days**	**Mon 7/1/19**	**Tue 12/8/20**
27	**Final Design (Phase 1)**	**90 days**	**Mon 12/14/20**	**Fri 4/16/21**
36	**Permitting (Phase 1)**	**55 days**	**Mon 3/22/21**	**Fri 6/4/21**
40	**Bidding (Phase 1)**	**62 days**	**Mon 5/17/21**	**Tue 8/10/21**
46	**Construction Start**	**1 day**	**Mon 9/6/21**	**Mon 9/6/21**



Project: 00085	Milestone	Project Duration	Permitting	Construction
Date: Tue 1/5/21	Critical Task	Planning and Conceptual Design	Easements and Land Acquisition	
	Task	Final Design and Construction Documents	Bidding and Contracts	

GHOST ROADS
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**GHOST ROADS**	**731 days**	**Thu 9/12/19**	**Thu 6/30/22**
2	**Planning and Conceptual Design**	**731 days**	**Thu 9/12/19**	**Thu 6/30/22**

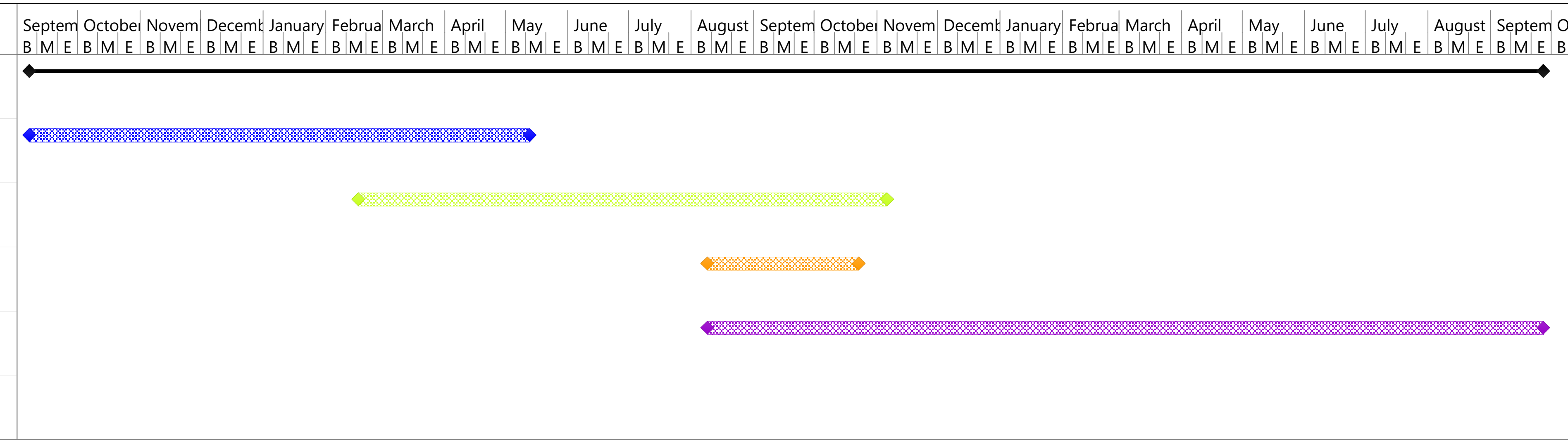


Project: 00093
Date: Tue 1/5/21

Milestone	Project Duration	Permitting	Construction
Critical Task	Planning and Conceptual Design	Easements and Land Acquisition	
Task	Final Design and Construction Documents	Bidding and Contracts	

BOUNDARY STREET STREETSCAPE
PROPOSED SCHEDULE

ID	Task Name	Duration	Start	Finish
1	**BOUNDARY STREET STREETSCAPE**	**536 days**	**Mon 9/7/20**	**Mon 9/26/22**
2	**Planning and Conceptual Design**	**178 days**	**Mon 9/7/20**	**Wed 5/12/21**
13	**Final Planning and Construction Documents**	**188 days**	**Wed 2/17/21**	**Fri 11/5/21**
27	**Permitting Phase**	**55 days**	**Mon 8/9/21**	**Fri 10/22/21**
32	**Easements and Land Acquisition**	**296 days**	**Mon 8/9/21**	**Mon 9/26/22**
41	**Construction**			



Project: 00094
Date: Wed 1/27/21

Milestone
Critical Task
Task
Project Duration
Planning and Conceptual Design
Final Design and Construction Documents
Permitting
Bidding and Contract
Easements and Land Acquisitions
Construction

Director's Report - DRCI
January 2021

Program KPIs

- 114 Members before Resiliency
- 418 Resiliency Plan
- **532 Total Members of DRCI**
- **23 Leads in program pipeline**
- 6 Customers engaged in programs (detail below)
    - 4 STARTUP
    - 2 GROWTH
    - 1 December graduate (4 Interview Pillars)
    - New company, The Bullet, owned by Dr. Mary Childs, entering program February 1st

Economic Development

- DRCI Board voted to approve Hardeeville Strategic Partnership
    - Program began January 1, 2021
        - Kick off meeting occurred
        - Press Release is out
        - Proceeding forward with partnership
- Relentless Challenge Grant
    - HEROS Program (Military/Veterans, Police, Fire, EMT)
    - DRCI awarded $55,000 By SC Department of Commerce
    - Fundraising in progress, received $26,000 in matching funds
- Project Mercury
    - DRCI provided recommendation to Town Manager and Town Council
    - Finalization of paperwork with Mercury in process

Marketing / Operations

- DRCI Strategic Planning completed and presented
- Finalized Syllabus for DRCI Entrepreneurial programs
- DRCI V1 Budget submitted
- January newsletter was communicated to all business license holders in Bluffton
- Communications
    - DRCI featured in Hilton Head Monthly Magazine
    - Feature in Local Biz Magazine
- New Women's Mastermind Group launched

- Boosted membership ads on Social Media to drive increased results
- Increased focus on GROWTH program marketing to drive higher participation.
- Beginning new initiative called "Member Monday". This program highlights members and their local businesses to gain awareness for Bluffton small business community.

Program Company Update:
Provide entrepreneurs with an inexpensive start-up environment, business support, mentorship, administrative, referral and networking services.

Company	Business Summary	Sector	Graduation
Right Now Help	**RightNowHelp** provides a gig marketplace where gig owners can post temporary tasks and helpers can bid on and accept those tasks to perform them quickly and efficiently at an affordable price.	High-Tech	July 2021
Beach Biscuit	**BeachBiscuit** manufactures and sells high-quality dog collars, leads and other related products online and through a growing network of retailers.	Consumer Packaged Goods	June 2021
American Air & Water®	**PrismUV** manufacturers a lightweight, portable disinfecting device that uses UV-C light to disinfect and clean a physical area of germs and microbes. Effective against COVID-19.	High-Tech	March 2021
robox	**RoboX Systems** is building a last-mile grocery delivery system that is a combination of AI-influenced software in conjunction with smart, climate controlled portable delivery containers.	High-tech	Sept 2021
Twist & Pour — Two easy steps to protect your pet	**Twist & Pour** manufactures and sells a unique portable cap that can be *easily attached* to most plastic bags. This allows you to pour the bag contents through a *convenient spout*. The cap is attached and easily screwed back on providing an airtight seal until the next time you need to open the bag. Once the bag is empty you remove the cap and use it on the next bag of your choosing.	Consumer Packaged Good	Sept 2021

DON RYAN CENTER FOR INNOVATION GROWTH

For businesses that need to scale to the next level or take a deeper dive into a particular area.

Greenbug offers a wide variety of all-natural pest control products. In addition, they sell a revolutionary pest control delivery system that integrates with the irrigation system at a home or business. This allows dispersion of all-natural pest control through the existing irrigation system.	Enviro-tech	July 2021

Old Town Bluffton Inn is a hotel that allows patrons to immerse themselves in a rich environment full of luxury and laughter surrounded by food, fun, art and libations all in a private and intimate space designed to inspire happiness and bring out every guest's inner southerner	Hospitality	July 2021

Graduate Company

4 Interview Pillars uses four distinctive "pillars" to unlock the potential of individuals preparing to interview for a dream job or coveted seat at a professional school by empowering him/her with a novel interview preparation experience at a competitive price.	High-Tech	Dec 2020

GROWTH MANAGEMENT UPDATE

February 9, 2021

1. **Town Council Appointed Boards/Commissions/Committees/Citizen Group Meetings:**

    a. **Planning Commission:** January 27, 2021 meeting agenda attached. Next meeting scheduled for Wednesday, February 24, 2021.

    b. **Historic Preservation Commission:** January 6, 2021 meeting agenda attached. Next meeting scheduled for Wednesday, February 3, 2021.

    c. **Board of Zoning Appeals:** January 5, 2021 cancellation notice attached. Next meeting scheduled for Tuesday, February 2, 2021.

    d. **Development Review Committee:** January 6, 13 & 27, 2021 cancellation notice attached and meeting agendas for Wednesday, January 20, 2021. Next meeting scheduled for Wednesday, February 3, 2021.

    e. **Historic Preservation Review Committee:** January 4 & 20, 2021 meeting agenda attached. January 11 & 25, 2021 cancellation notices attached. Next meeting scheduled for Monday, February 1, 2021.

    f. **Construction Board of Adjustment and Appeals:** Tuesday, January 19, 2021 cancellation notice attached. Next meeting scheduled for Tuesday, February 16, 2021.

    g. **Affordable Housing Committee: Community Development / Affordable Housing Committee Work Program:** January 7, 2021 meeting agenda attached. Next meeting scheduled for Thursday, February 4, 2021.

2. **Community Development / Affordable Housing Committee Work Program:**

    Neighborhood Assistance Program. The total available budget for this FY21 Town Council funded program is $166,308.03. Town Staff is continuing to process applications for assistance. As of January 22, 2021, $22,756.97(includes households in progress) has been spent to assist Town of Bluffton residents through the Neighborhood Assistance Program. As of January 22, 2021, we have 6 residents waiting on work estimates so that work can begin.

    <u>ATTACHMENTS:</u>

1. Planning Commission meeting agenda for Wednesday, January 27, 2021.
2. Historic Preservation Commission meeting agenda for Wednesday, January 6, 2021.
3. Board of Zoning Appeals cancellation notice for Tuesday, January 5, 2021.

4. Development Review Committee, January 6, 13 & 27, 2021 cancellation notice attached and meeting agendas for Wednesday, January 20, 2021. Next meeting scheduled for Wednesday, February 3, 2021.

5. Historic Preservation Review Committee, January 4 & 20, 2021 meeting agenda attached. January 11& 25, 2021 cancellation notices attached. Next meeting scheduled for Monday, February 1, 2021.

6. Construction Board of Adjustments and Appeals, January 19, 2021 cancellation notice.
7. Affordable Housing Committee meeting agenda notice for Thursday, January 7, 2021
8. Building Permits and Planning Applications:

    a. Building Permits Issued 2010-2021 (to January 22, 2021).
    b. Building Permits Issued Per Month 2010-2021 (to January 22, 2021).
    c. Value of Construction 2010-2021 (to January 22, 2021).
    d. New Single Family/Multi-Family Residential Building Permits Issued Per Month 2010-2021 (to January 22, 2021).
    e. New Single Family/Multi-Family Residential Building Permits Issued by Neighborhood 2010-2021 (to January 22, 2021).
    f. New Single Family/Multi-Family Certificates of Occupancy Issued by Neighborhood 2010-2021 (to January 22, 2021).
    g. New Commercial Construction/Additions Heated Square Footage 2010-2021 (to January 22, 2021).
    h. Planning and Community Development Applications Approved 2010-2021 (to January 25, 2021).

9. Planning Active Application Report

TOWN OF BLUFFTON
PLANNING COMMISSION MEETING AGENDA
ELECTRONIC MEETING
Wednesday, January 27, 2021, 6:00 PM

PUBLIC COMMENT

Public comments will be received via conference line provided by Staff. All requests for public hearing or public comment will be accepted up to two (2) hours prior to the scheduled meeting start time.

This meeting can be viewed on the Town of Bluffton's Facebook page (https://www.facebook.com/TownBlufftonSC/)

I. CALL TO ORDER

II. ROLL CALL

III. NOTICE REGARDING ADJOURNMENT
The Planning Commission will not hear new items after 9:30 P.M. unless authorized by a majority vote of the Commission Members present. Items which have not been heard before 9:30 P.M. may be continued to the next regular meeting or an additional meeting date as determined by the Commission Members.

IV. NOTICE REGARDING PUBLIC COMMENTS*

V. ADOPTION OF THE AGENDA

VI. ADOPTION OF MINUTES – November 18, 2020

VII. PUBLIC COMMENTS FOR ITEMS NOT ON THE AGENDA*

VIII. ELECTION OF OFFICERS

IX. OLD BUSINESS

X. NEW BUSINESS

1. FOR ACTION

A. Tupelo III (Preliminary Development Plan): A request by Vulcan Property Group, LLC on behalf of Parcel C1, LLC for approval of a

Preliminary Development Plan. The project consists of the construction of an office building, a daycare facility and associated parking and infrastructure. The property is zoned Buckwalter Planned Unit Development and consists of approximately 1.58 acres identified by R610 022 1122 0000 located at the intersection of Cassidy Drive and Buckwalter Parkway. (DP 08-20-14483) (Staff-Will Howard)

B. **6 Arley Way (Preliminary Development Plan): A request by Eric Hoover on behalf of Ceagull Investments, LLC for approval of a Preliminary Development Plan. The project consists of the construction of a 12,000 square foot commercial building with associated infrastructure. The property is zoned General Mixed Use and consists of approximately 2 acres identified by tax map number R600 031 0217 0000 located at 6 Arley Way. (DP 10-20-014720) (Staff-Will Howard)**

C. **New Riverside Village (Street Naming): A request by Mike Hughes of Thomas & Hutton on behalf of MFH LAND,LLC and The Town of Bluffton for approval of new street names for new roads within the proposed New Riverside Village, a mixed-use development consisting of residential, office and a commercial village on approximately 35.5 acres located at the southeast corner of the intersection of New Riverside Road and SC Hwy 46. (STR 12-12-14859) (Staff-Will Howard)**

D. **Belfair Towne Village (Certificate of Appropriateness – Highway Corridor Overlay District): A request by Wallace Milling of Witmer Jones Keefer, Ltd, on behalf of David Carpio of Brixmor for approval of a Certificate of Appropriateness – HCOD. The project consists of the removal of trees located along the frontage buffer with US HWY 278. The Property is zoned Belfair Planned Unit Development a located northeast of the intersection of US HWY 278 and Simmonsville Road. (COFA–01-21-14930) (Staff- Alan Seifert)**

E. Parcel 10B Multi-Family (Preliminary Development Plan): A request by SC Bodner Company, Inc on behalf of The Reed Group for approval of a Preliminary Development Plan. The project consists of the construction of 252 multifamily residential units with an amenity center and associated parking and infrastructure. The property is zoned Buckwalter Planned Unit Development and consists of approximately 45 acres identified by tax map number R610 029 000 0789 0000 located within the Parcel 10A/10B Master Plan. (DP 10-20-14645) (Staff-Will Howard)

F. Unified Development Ordinance Edits: Amendments to the Town of Bluffton Code of Ordinances Chapter 23 – Unified Development Ordinance, Article 5 – Design Standards, Certain Building Requirements for Building Size Range, Building Footprint, Height and Front Build-to Zone for Main Street and Additional Building Types in the Neighborhood Center-Historic District Zoning District and to Building Size Range and Footprint for Additional Building Types Elsewhere within Old Town Bluffton.

XI. DISCUSSION

XII. ADJOURNMENT

***Public Comments may be submitted electronically via the Town's website at (https://bit.ly/TOBPublicComment) or by emailing your comments to the Growth Management Coordinator at dmclain@townofbluffton.com. Comments will be accepted up 2 hours prior to the scheduled meeting start time. All comments will be read aloud for the record and will be provided to the Planning Commission Board.**

NEXT MEETING DATE: Wednesday, February 24, 2021

"FOIA Compliance – Public notification of this meeting has been published and posted in compliance with the Freedom of Information Act and the Town of Bluffton policies."

In accordance with the requirements of Title II of the Americans with Disabilities Act of 1990 ("ADA"), the Town of Bluffton will not discriminate against qualified individuals with disabilities on the basis of disability in its services, programs, or activities. The Town of Bluffton Council Chambers are ADA compatible. Any person requiring further accommodation should contact the Town of Bluffton ADA Coordinator at 843.706.4500 or adacoordinator@townofbluffton.com as soon as possible but no later than 48 hours before the scheduled event.

*Please note that each member of the public may speak at one public comment session and a form must be filled out and given to the Chairperson of the Commission. Public comment must not exceed three (3) minutes.

TOWN OF BLUFFTON
HISTORIC PRESERVATION COMMISSION

ELECTRONIC MEETING

Wednesday, January 6, 2021 6:00p.m.

This meeting can be viewed on the Town of Bluffton's Facebook page
https://www.facebook.com/TownBlufftonSC/

I. CALL TO ORDER

II. ROLL CALL

III. NOTICE REGARDING ADJOURNMENT
The Historic Preservation Commission will not hear new items after 9:30 p.m. unless authorized by a majority vote of the Commission Members present. Items which have not been heard before 9:30 p.m. may be continued to the next regular meeting or a special meeting date as determined by the Commission Members.

IV. NOTICE REGARDING PUBLIC COMMENTS*
Every member of the public who is recognized to speak shall address the Chairman and in speaking, avoid disrespect to Commission, Staff, or other members of the Meeting. State your name and address when speaking for the record. COMMENTS ARE LIMITED TO THREE (3) MINUTES.

V. ADOPTION OF AGENDA

VI. ADOPTION OF MINUTES – December 2, 2020

VII. ELECTION OF OFFICERS – Election for vice-chair and Historic Preservation Review Committee Member

VIII. PUBLIC COMMENTS FOR ITEMS NOT ON THE AGENDA*

IX. OLD BUSINESS

X. NEW BUSINESS

A. **Certificate of Appropriateness:** A request by Pearce Scott Architects, on behalf of the owners Gerard and Beth Romski, for approval of a Certificate of Appropriateness to allow the addition of an 85 SF golf cart bay and 600 SF second story addition to the existing one-story 514 SF Carriage House located at 5806 Yaupon Road, Lot 20A in the Stock Farm Development, in the Old Town Bluffton Historic District and zoned Neighborhood General-HD. (COFA-10-20-014698) (Staff – Katie Peterson)

B. **Certificate of Appropriateness:** A request by Pearce Scott Architects, on behalf of the owner Kate Eagen, for approval of a Certificate of Appropriateness to allow the construction of a 1.5-story single-family residential structure of approximately 2,117 SF and a 2-story Carriage House of approximately 1,172 SF located at 5718 Guilford Place, Lot 45 in the Stock Farm Development in the Old Town Bluffton Historic District, and zoned Neighborhood General-HD. (COFA-10-20-014673) (Staff – Katie Peterson)

C. **Certificate of Appropriateness:** A request by Webb Construction, on behalf of the owner Ernie Suozzi, for approval of a Certificate of Appropriateness to allow the construction of a 1.5-story single-family residential structure of approximately 1,954 SF and a 1-story Carriage House of approximately 352 SF located at 20 Meriwether Court, Lot 3 in the Landen Oaks Development in the Old Town Bluffton Historic District, and zoned Neighborhood General-HD. (COFA-10-20-014694) (Staff – Katie Peterson)

XI. DISCUSSION

1. Discussion regarding large scale commercial development in Old Town Bluffton Historic District *(No Staff Report Attached).*

XII. ADJOURNMENT

NEXT MEETING DATE– Wednesday, February 3, 2021

* Public Comments may be submitted electronically via the Town's website at (https://bit.ly/TOBPublicComment) or by emailing your comments to the Growth Management Coordinator at dmclain@townofbluffton.com. Comments will be accepted up to 2 hours prior to the scheduled meeting start time. All comments will be read aloud for the record and will be provided to the Historic Preservation Committee.

"FOIA Compliance – Public notification of this meeting has been published and posted in compliance with the Freedom of Information Act and the Town of Bluffton policies."

In accordance with the requirements of Title II of the Americans with Disabilities Act of 1990 ("ADA"), the Town of Bluffton will not discriminate against qualified individuals with disabilities on the basis of disability in its services, programs, or activities.

EXECUTIVE SESSION - The public body may vote to go into executive session for any item identified for action on the agenda.

Any person requiring further accommodation should contact the Town of Bluffton ADA Coordinator at 843.706.4500 or adacoordinator@townofbluffton.com as soon as possible but no later than 48 hours before the scheduled event.

PUBLIC NOTICE

The Board of Zoning Appeals (BZA)
Meeting scheduled for

Tuesday, January 5, 2021 at 6:00 p.m.

Has been CANCELED
due to lack of agenda items

The next meeting is scheduled for Tuesday, February 2, 2021

If you have questions, please contact
Growth Management at: 843-706-4522

PUBLIC NOTICE

The Development Review Committee (DRC)
Meeting scheduled for

Wednesday, January 6, 2021,
at 1:00 P.M.

Has been CANCELED
due to lack of agenda items

The next meeting is scheduled for
Wednesday, January 13, 2021

If you have questions, please contact
Growth Management at: 843-706-4500

PUBLIC NOTICE

The Development Review Committee (DRC)
Meeting scheduled for

Wednesday, January 13, 2021,
at 1:00 P.M.

Has been CANCELED
due to lack of agenda items

The next meeting is scheduled for
Wednesday, January 20, 2021

If you have questions, please contact
Growth Management at: 843-706-4500

TOWN OF BLUFFTON
DEVELOPMENT REVIEW COMMITTEE MEETING AGENDA

ELECTRONIC MEETING

Wednesday, January 20, 2021 1:00 p.m.

This meeting can be viewed on the Town of Bluffton's Facebook page stating at 1:00 p.m.
https://www.facebook.com/TownBlufftonSC/

All Applications can be viewed on the Town of Bluffton's Permit Finder page
https://www.townofbluffton.us/permit/

I. CALL TO ORDER

II. ROLL CALL

III. PUBLIC COMMENTS

IV. OLD BUSINESS

V. NEW BUSINESS

1. **Cross Outreach Ministries (Development Plan Amendment):** A request by Cross Outreach Ministries for approval of a Development Plan amendment. The project consists of the construction of a new 3 story classroom building on the Cross Schools campus. The property is zoned Buckwalter PUD and consists of approximately 78.04 acres identified by tax map number R610 030 000 1853 0000 located at 495 Buckwalter Parkway (DPA-04-17-0844) (Staff-Will Howard).

2. **Palmetto Bluff Block J2 (Preliminary Development Plan):** A request by Michael Hughes of Thomas & Hutton on behalf of Dallas Wood, May River Forest, LLC for approval of a Final Development Plan. The project consists of the construction of 41 residential lots and associated infrastructure. The property is zoned Palmetto Bluff Planned Unit Development and consists of approximately 16.5 acres identified by tax map number R614 046 000 0062 0000 located within the Palmetto Bluff Phase 2 Master Plan. (DP 08-20-14478) (Staff-Will Howard)

VI. DISCUSSION

VII. ADJOURNMENT

NEXT MEETING DATE: Wednesday January 27, 2021

* Public Comments may be submitted electronically via the Town's website at (https://bit.ly/TOBPublicComment) or by emailing your comments to the Growth Management Coordinator at dmclain@townofbluffton.com. Comments will be accepted up to 2 hours prior to the scheduled meeting start time. All comments will be read aloud for the record and will be provided to the Development Review Committee.

PUBLIC NOTICE

The Development Review Committee (DRC)
Meeting scheduled for

Wednesday, January 27, 2021,
at 1:00 P.M.

Has been CANCELED
due to lack of agenda items

The next meeting is scheduled for
Wednesday, February 3, 2021

If you have questions, please contact
Growth Management at: 843-706-4500

TOWN OF BLUFFTON
HISTORIC PRESERVATION REVIEW COMMITTEE MEETING AGENDA

ELECTRONIC MEETING

Monday, January 4, 2021, 2020 4:00 p.m.

This meeting can be viewed on the Town of Bluffton's Facebook page starting at 4:00 p.m.
https://www.facebook.com/TownBlufftonSC/

The applications can be viewed on the Town of Bluffton's page
https://www.townofbluffton.us/permit/

I. CALL TO ORDER

II. ROLL CALL

III. PUBLIC COMMENTS

IV. OLD BUSINESS

V. NEW BUSINESS

1. **114 Pritchard Street:** A request by Ansley Manuel, on behalf of the owner, Patricia Ellen Malphrus, for review of a Certificate of Appropriateness to allow an addition of approximately 4,065 SF to the existing single-family structure of approximately 1,095 SF and to enclose the existing Carriage House of approximately 1,075 SF located at 114 Pritchard Street in the Old Town Bluffton Historic District and zoned Neighborhood Conservation-HD. (COFA-12-20-014811) (Staff-Katie Peterson)

2. **38 Lawrence Street:** A request by Ansley Manuel, on behalf of James Mitchell and Laurie Brown for review of a Certificate of Appropriateness to allow an addition of approximately 2,580 SF to the existing single-family structure of approximately 1,545 SF located at 38 Lawrence Street in the Old Town Bluffton Historic District and zoned Neighborhood General-HD. (COFA-12-20-014812) (Staff-Katie Peterson)

VI. DISCUSSION

VII. ADJOURNMENT

NEXT MEETING DATE: Monday, January 11, 2021

* Public Comments may be submitted electronically via the Town's website at

(https://bit.ly/TOBPublicComment) or by emailing your comments to the Growth Management Coordinator at dmclain@townofbluffton.com. Comments will be accepted up to 2 hours prior to the scheduled meeting start time. All comments will be read aloud for the record and will be provided to the Historic Preservation Review Committee.

PUBLIC NOTICE

THE HISTORIC PRESERVATION
REVIEW COMMITTEE (HPRC)
Meeting scheduled for

Monday, January 11, 2021 at 4:00 P.M.

has been CANCELED
due to lack of agenda items

The next meeting is scheduled for
Monday, January 18, 2021

If you have questions, please contact
Growth Management at: 843-706-4500

TOWN OF BLUFFTON
HISTORIC PRESERVATION REVIEW COMMITTEE MEETING AGENDA

ELECTRONIC MEETING

Wednesday, January 20, 2021, 4:00 p.m.

This meeting can be viewed on the Town of Bluffton's Facebook page starting at 4:00 p.m.
https://www.facebook.com/TownBlufftonSC/

The applications can be viewed on the Town of Bluffton's page
https://www.townofbluffton.us/permit/

I. CALL TO ORDER

II. ROLL CALL

III. PUBLIC COMMENTS

IV. OLD BUSINESS

V. NEW BUSINESS

1. **6 Marianna Way:** A request by Court Atkins Architects, on behalf of the owner, Herkus, LLC, for review of a Certificate of Appropriateness to allow the construction of a new 2 1/2 -story multifamily residential building of approximately 5,328 SF located at 6 Marianna Way, Building 4 in the Old Village Square development, in the Old Town Bluffton Historic District and zoned Neighborhood General – HD. (Staff-Katie Peterson)(COFA-01-21-014892)

2. **10 Marianna Way:** A request by Court Atkins Architects, on behalf of the owner, Herkus, LLC, for review of a Certificate of Appropriateness to allow the construction of a new 2 1/2 -story multifamily residential building of approximately 5,328 SF located at 10 Marianna Way, Building 5 in the Old Village Square development, in the Old Town Bluffton Historic District and zoned Neighborhood General – HD. (Staff-Katie Peterson) (COFA-01-21-014894)

VI. DISCUSSION

VII. ADJOURNMENT

NEXT MEETING DATE: Monday, January 25, 2021

* PUBLIC COMMENT

Public comments will be received via conference line provided by Staff. All requests for public hearing or public comment will be accepted up to two (2) hours prior to the scheduled meeting start time.

PUBLIC NOTICE

THE HISTORIC PRESERVATION REVIEW COMMITTEE (HPRC)

Meeting scheduled for

Monday, January 25, 2021 at 4:00 P.M.

has been CANCELED
due to lack of agenda items

The next meeting is scheduled for
Monday, February 1, 2021

If you have questions, please contact
Growth Management at: 843-706-4500

PUBLIC NOTICE

The Construction Board of
Adjustments and Appeals (CBAA)
Meeting scheduled for

Tuesday, January 19, at 6:00 P.M.

has been CANCELED.
due to lack of agenda items.

The next meeting is scheduled for.
Tuesday, February 16, 2021

If you have questions, please contact.
Growth Management at: 843-706-4522

TOWN OF BLUFFTON
AFFORDABLE HOUSING COMMITTEE MEETING AGENDA
ELECTRONIC MEETING
Thursday, January 7, 2021 10:00 a.m.

This meeting can be viewed on the Town of Bluffton's Facebook page starting at 10:00 a.m.
https://www.facebook.com/TownBlufftonSC/

I. CALL TO ORDER

II. ROLL CALL

III. ADOPTION OF AGENDA

IV. ADOPTION OF MINUTES – December 3, 2020

V. ADOPTION OF 2021 MEETING DATES

VI. PUBLIC COMMENTS

VII. OLD BUSINESS

VIII. NEW BUSINESS

1. Neighborhood Assistance Program Budget Update
2. FY 2022 Budget Review & Recommendation

IX. PUBLIC COMMENTS

X. DISCUSSION

XI. ADJOURNMENT

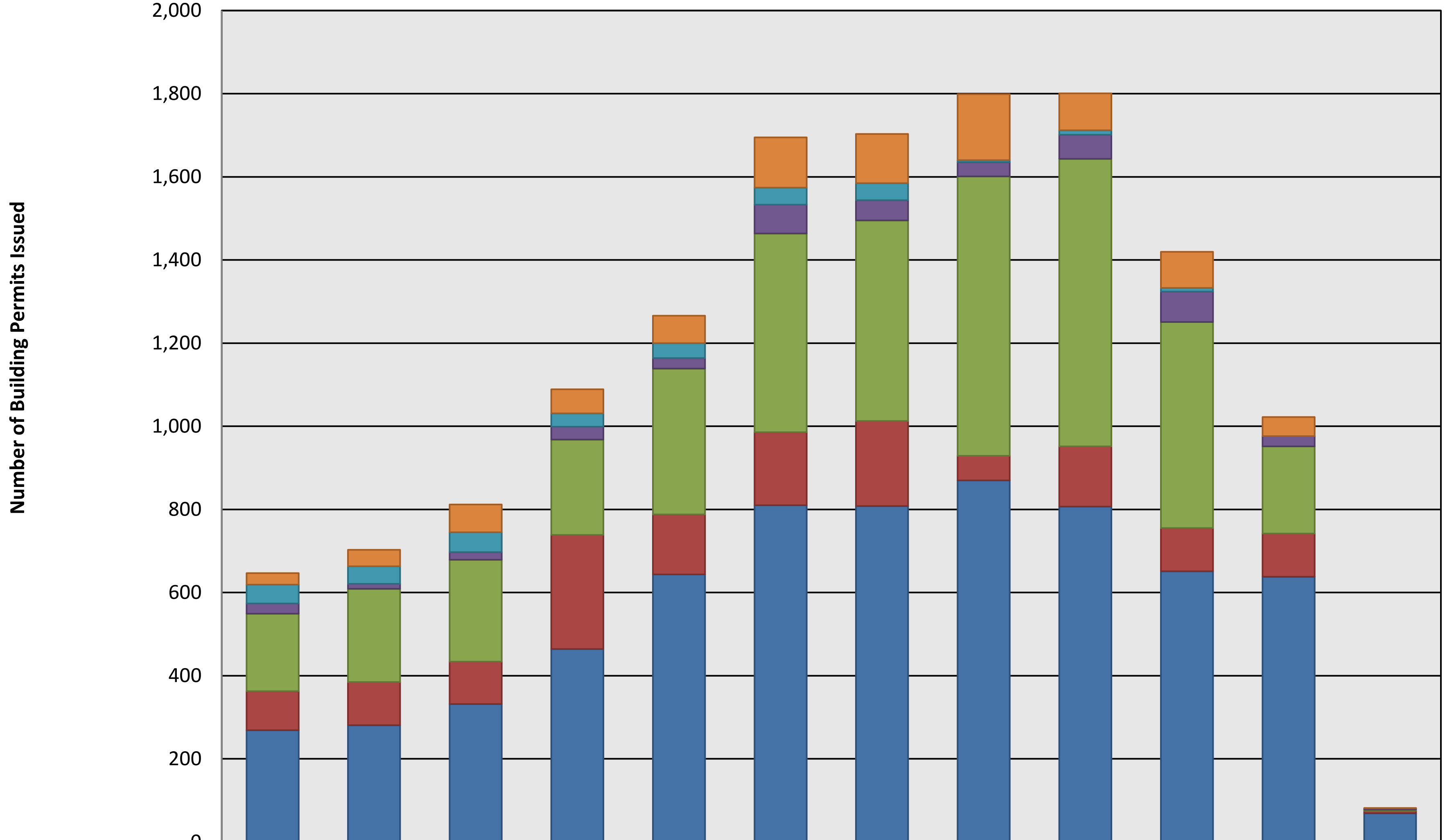
NEXT MEETING DATE: Thursday, February 4, 2021

* Public Comments may be submitted electronically via the Town's website at (https://bit.ly/TOBPublicComment) or by emailing your comments to the Growth Management Coordinator at dmclain@townofbluffton.com. Comments will be accepted up to 2 hours prior to the scheduled meeting start time. All comments will be read aloud for the record and will be provided to the Affordable Housing Committee.

Attach

Section XII. Item #1.

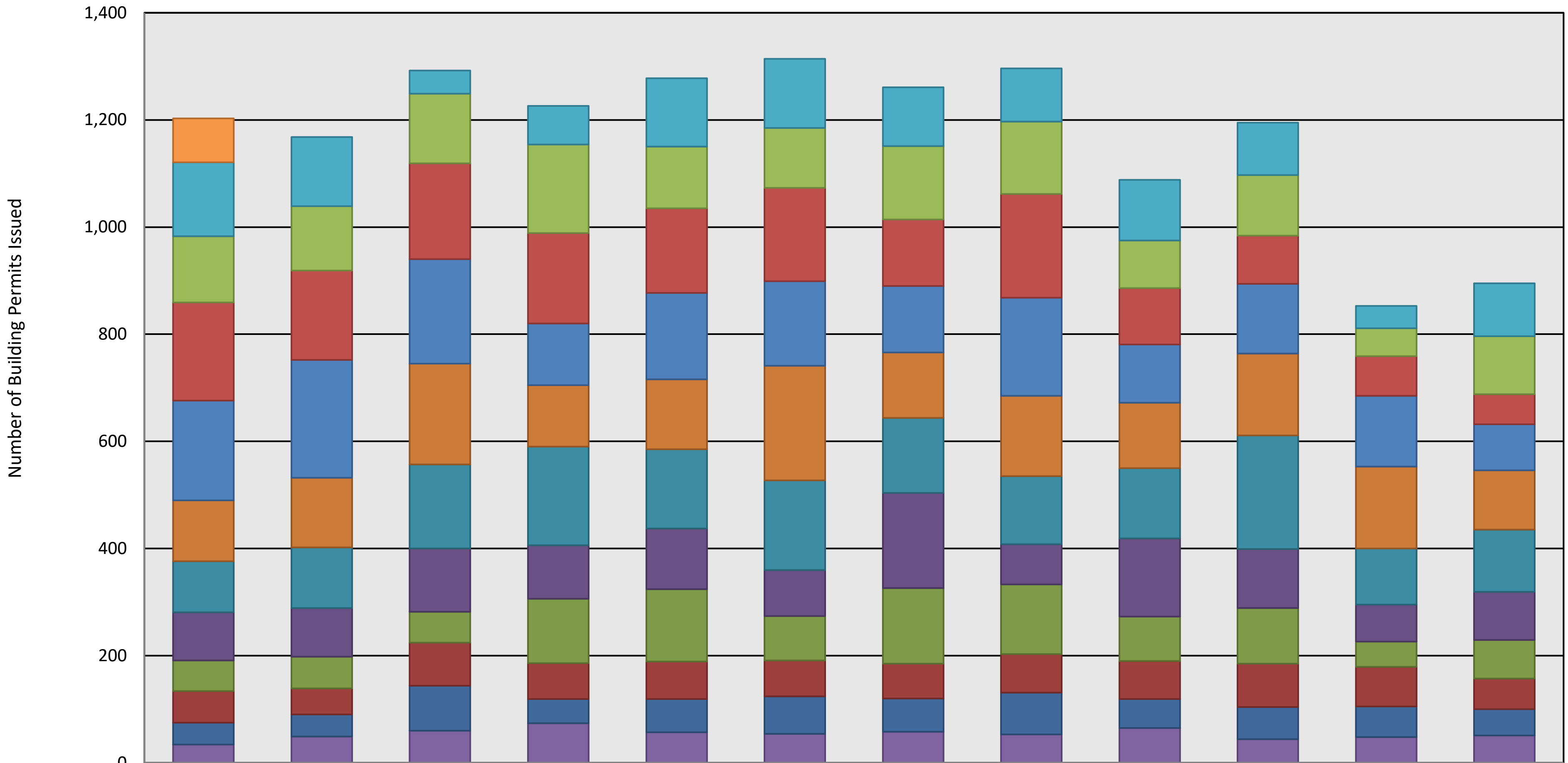
Town of Bluffton
Building Permits Issued
2010-2021



Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021 To Date
Other Commercial	28	40	67	58	66	121	118	159	89	87	46	1
Commercial Addition	45	42	48	32	36	41	41	5	11	9	0	0
New Commercial Construction/ Tenant Upfit	25	12	18	31	25	69	49	34	58	73	24	3
Other Residential	186	224	245	229	351	478	482	672	691	496	210	3
Residential Addition	94	104	102	275	144	176	205	59	145	104	104	6
New Single Family/ Multi-Family Residential	269	281	332	464	644	810	808	870	807	651	638	69

Notes: 1. "Other" Building Permits include permits for demolition, electrical, plumbing, gas, irrigation, HVAC replacement, pool/spa, roof repair, tent, construction trailer, fire sprinkler system, fire alarm system, and manufactured home replacement.
2. Building Permits Issued excludes those Building Permits which were voided or withdrawn.
3. The monthly average of building permits issued in 2018 (year to 12/01/2018) is 150 per month which is a 1.5% increase of building permits issued on a monthly basis from 2017.

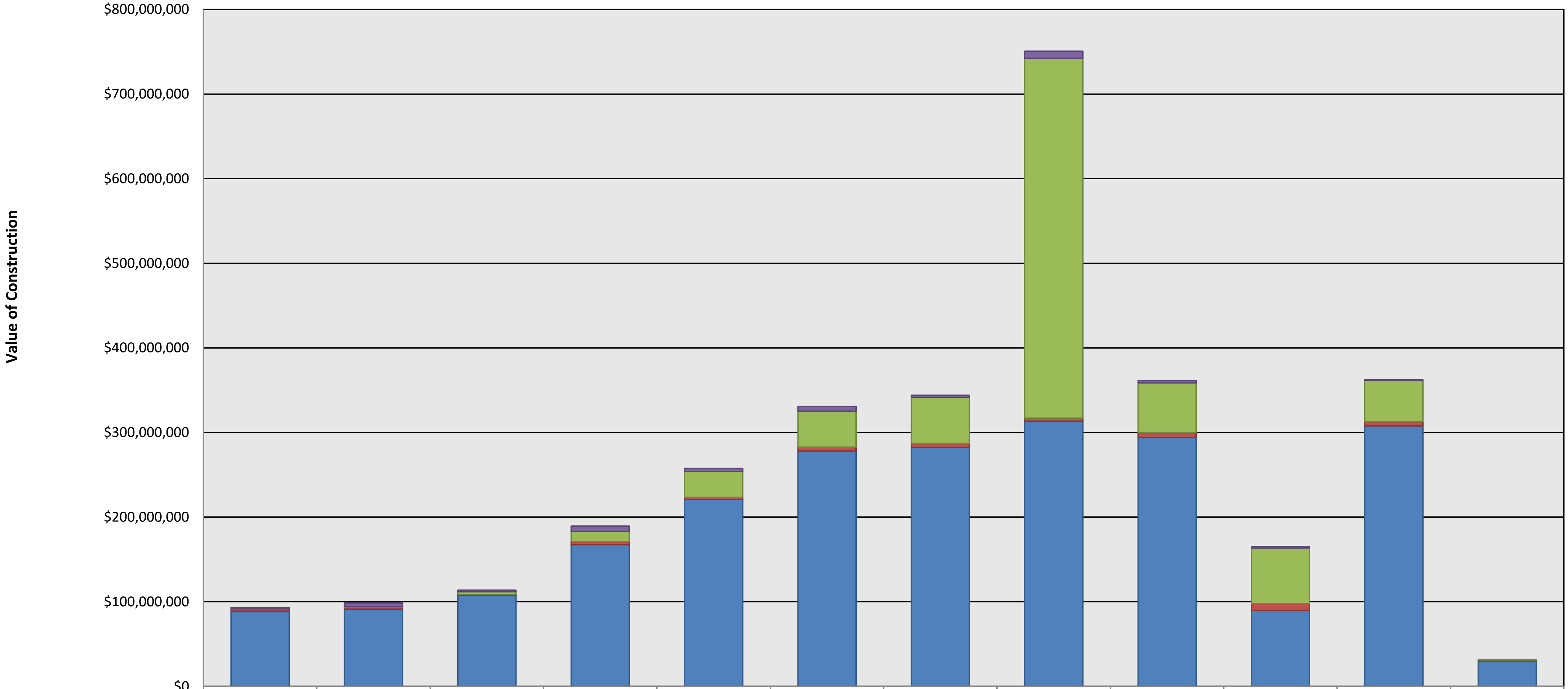
Town of Bluffton
Building Permits Issued Per Month
2010-2021



Month	January	February	March	April	May	June	July	August	September	October	November	December
2021	82											
2020	138	129	43	72	128	129	110	99	113	98	42	99
2019	124	120	130	165	115	112	137	135	89	113	52	108
2018	183	167	179	169	158	174	124	194	105	90	74	56
2017	186	220	195	115	161	158	124	183	109	130	132	86
2016	114	130	188	115	131	214	122	150	122	153	153	111
2015	95	113	157	184	148	167	140	127	131	212	105	116
2014	90	91	118	100	113	86	178	75	146	110	69	90
2013	57	59	58	120	135	83	141	130	83	104	47	72
2012	59	49	80	67	70	67	65	72	71	81	74	57
2011	41	41	84	45	62	70	62	78	54	60	57	49
2010	34	49	60	74	57	54	58	53	65	44	48	51

Notes: 1. "Other" Building Permits include permits for demolition, electrical, plumbing, gas, irrigation, HVAC replacement, pool/spa, roof repair, tent, construction trailer, fire sprinkler system, fire alarm system, and manufactured home replacement.
2. Building Permits Issued excludes those Building Permits which were voided or withdrawn.

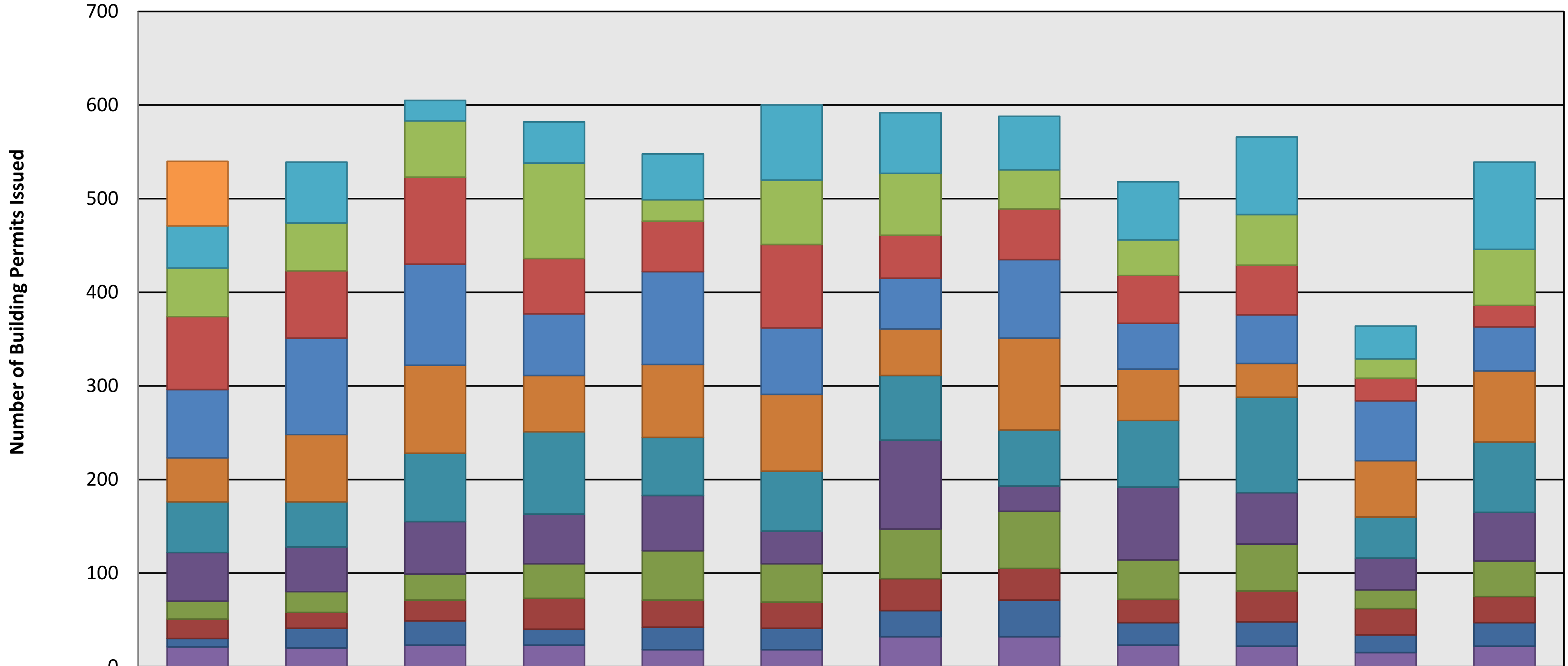
Town of Bluffton
Value of Construction
2010-2021



Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021 To Date
Commercial Additions	$1,900,201	$4,043,767	$1,829,112	$6,108,604	$3,581,161	$5,640,708	$2,395,534	$8,535,713	$2,736,915	$1,864,126	$446,060	$0
New Commercial/ Tenant Upfits	$456,337	$852,545	$3,265,626	$12,026,404	$30,496,645	$42,515,253	$54,982,666	$425,223,725	$59,076,385	$65,475,875	$48,961,453	$788,825
Residential Additions/ Renovations	$2,129,051	$2,279,051	$1,115,065	$3,729,782	$2,519,255	$4,652,929	$4,241,365	$3,563,611	$5,461,103	$8,346,412	$4,846,921	$1,203,689
New Single Family/ Multi-Family	$88,820,755	$91,316,936	$107,490,514	$167,435,317	$220,887,215	$278,078,709	$282,548,601	$313,502,148	$294,166,940	$89,627,180	$307,962,223	$29,864,904

Note: The Value of Construction is added to each respective property where the improvement was constructed. This increases the overall value, also refered to as market value, of the property used to which is used determine its assesed value which is subject to Town Millage. This increased value is realized in the following year's tax roll.

Town of Bluffton
New Single Family/ Multi-Family Residential Building Permits Issued Per Month
2010-2021

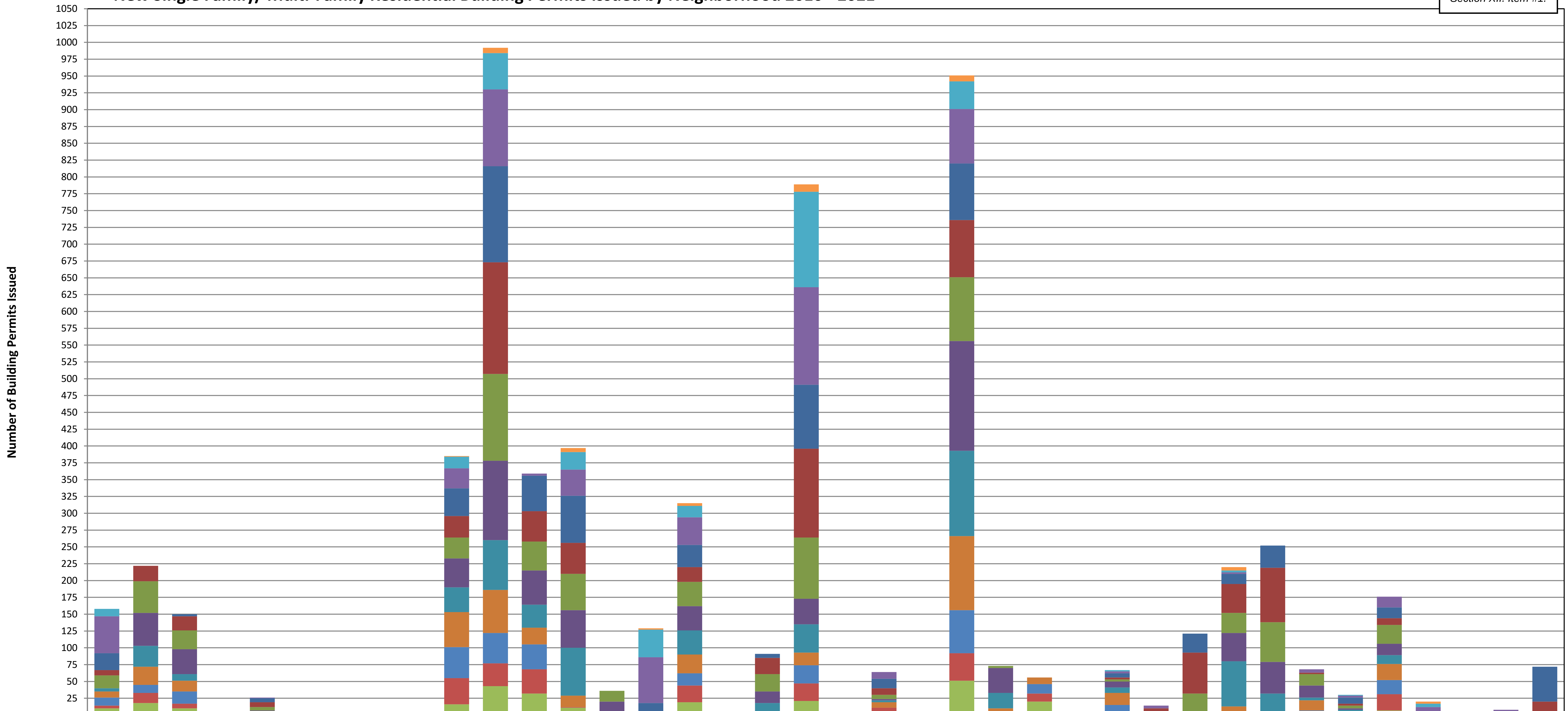


Month	January	February	March	April	May	June	July	August	September	October	November	December
2021	69											
2020	45	65	22	44	49	80	65	57	62	83	35	93
2019	52	51	60	102	23	69	66	42	38	54	21	60
2018	78	72	93	59	54	89	46	54	51	53	24	23
2017	73	103	108	66	99	71	54	84	49	52	64	47
2016	47	72	94	60	78	82	50	98	55	36	60	76
2015	54	48	73	88	62	64	69	60	71	102	44	75
2014	52	48	56	53	59	35	95	27	78	55	34	52
2013	19	22	28	37	53	41	53	61	42	50	20	38
2012	21	17	22	33	29	28	34	34	25	33	28	28
2011	9	21	26	17	24	23	28	39	24	26	19	25
2010	21	20	23	23	18	18	32	32	23	22	15	[illegible]

Note: Building Permits Issued excludes those Building Permits which were voided or withdrawn.

Attachment 2

Town of Bluffton
New Single Family/ Multi-Family Residential Building Permits Issued by Neighborhood 2010 - 2021

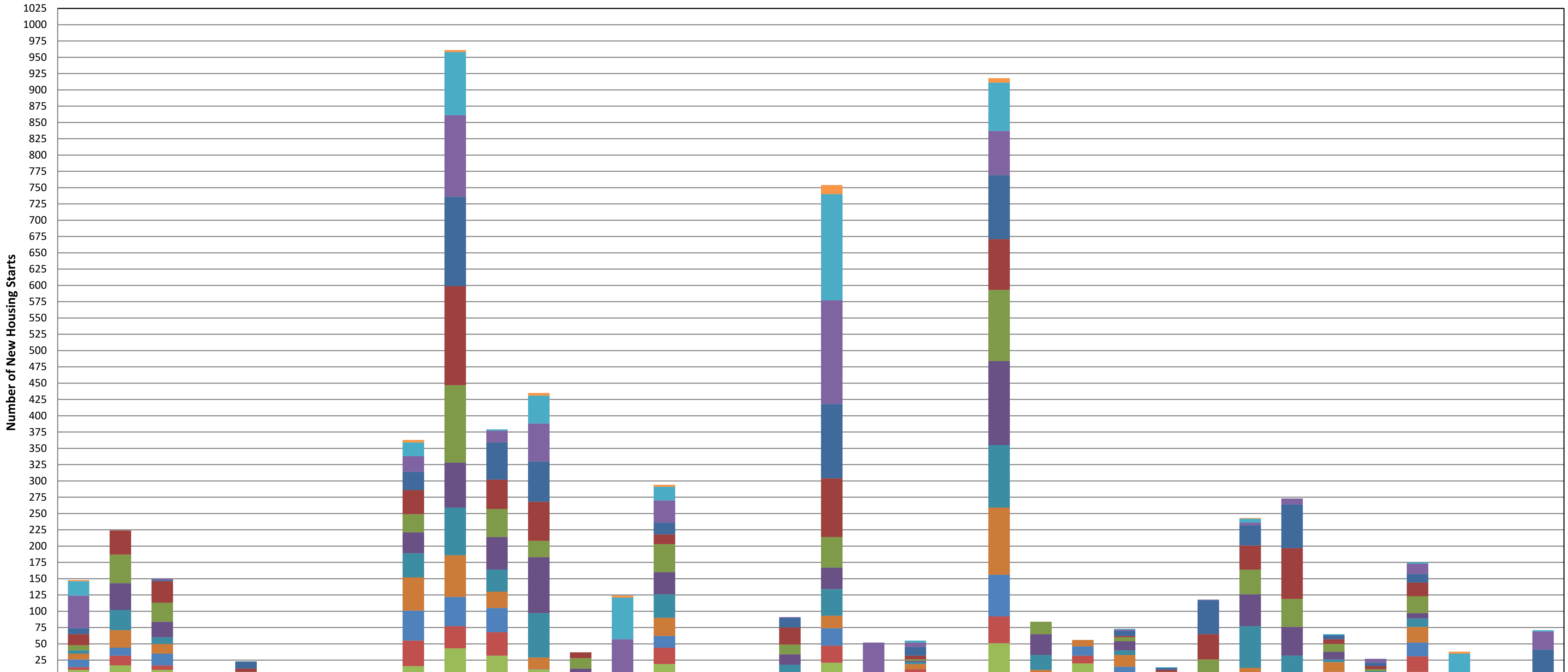


Neighborhood	Alston Park	Baynard Park	Bluffton Park	Brendan Woods	Buck Island/ Simmonsville	Buckwalter Place	Calhoun Street Promenade	Four Seasons at Carolina Oaks	Giddy Up	Hampton Hall	Hampton Lake	Haven at New Riverside	Heritage at New Riverside	Kirks Bluff	Landings at New Riverside	Lawton Station	Lot 26 Able St	Midpoint
2021 To Date										1	8		6		2	4		
2020	11	0	0	0	0	0	0	4	0	17	54	0	26	0	41	17	0	0
2019	55	0	0	0	1	0	0	0	0	30	114	3	39	0	68	41	3	0
2018	25	0	3	0	6	0	0	0	0	41	143	53	70	0	18	33	0	6
2017	8	23	21	0	7	0	0	0	1	32	166	45	46	0	0	22	0	24
2016	19	47	28	0	5	0	0	0	0	31	129	43	54	16	0	36	0	26
2015	0	49	37	0	2	0	0	0	1	43	118	51	56	17	0	36	0	17
2014	5	31	10	0	2	0	0	0	1	37	74	34	71	3	0	36	0	16
2013	9	27	16	0	2	0	0	0	0	52	64	25	17	0	0	28	0	0
2012	12	12	18	1	1	0	0	0	0	46	45	37	0	0	0	18	0	0
2011	4	15	7	0	0	0	0	0	0	39	34	36	1	0	0	25	0	0
2010	10	18	10	0	0	0	0	0	0	16	43	32	11	0	0	19	0	2

Neighborhood	Mill Creek at Cypress Ridge	New Riverside - Other	Old Town-Other	One Hampton Lake	Palmetto Bluff	Palmetto Pointe Townes	Parkside	Pine Ridge	Rose Dhu Creek Plantation	Schultz/ Goethe Road	Seagrass Station	Shell Hall	Southern Oaks	Stock Farm	Tabby Roads	The Village at Palmetto Pointe	The Walk	Ulmer Property	Village at Verdier Plantation	WellStone
2021 To Date	11				9							5					3			
2020	142	0	0	0	41	0	0	0	2	0	0	3	0	0	1	0	5	0	0	0
2019	145	0	10	3	81	0	0	1	3	4	0	2	0	5	3	16	12	5	8	0
2018	95	1	14	0	84	0	0	0	6	0	28	15	33	0	9	16	0	0	0	52
2017	132	0	10	0	85	0	0	0	3	4	61	43	81	2	3	10	0	0	0	20
2016	91	0	6	0	95	3	0	0	3	0	28	30	59	17	4	28	0	0	0	0
2015	38	0	2	0	163	37	0	0	9	3	4	42	47	18	2	17	0	0	0	0
2014	42	0	3	0	127	23	0	0	8	2	0	67	28	4	7	13	0	0	0	0
2013	19	0	8	0	110	10	10	0	18	0	0	9	0	15	1	24	0	0	0	0
2012	27	0	0	0	64	0	14	0	10	0	0	2	0	4	0	21	0	0	0	0
2011	26	0	10	0	41	0	12	0	2	1	0	2	0	2	0	24	0	0	[illegible]	[illegible]
2010	21	0	1	0	51	0	20	0	3	0	0	0	4	1	0	7	0	0	[illegible]	[illegible]

Attachment 8f

Town of Bluffton
New Single Family/ Multi-Family Certificates of Occupancy Issued by Neighborhood 2010 - 2021



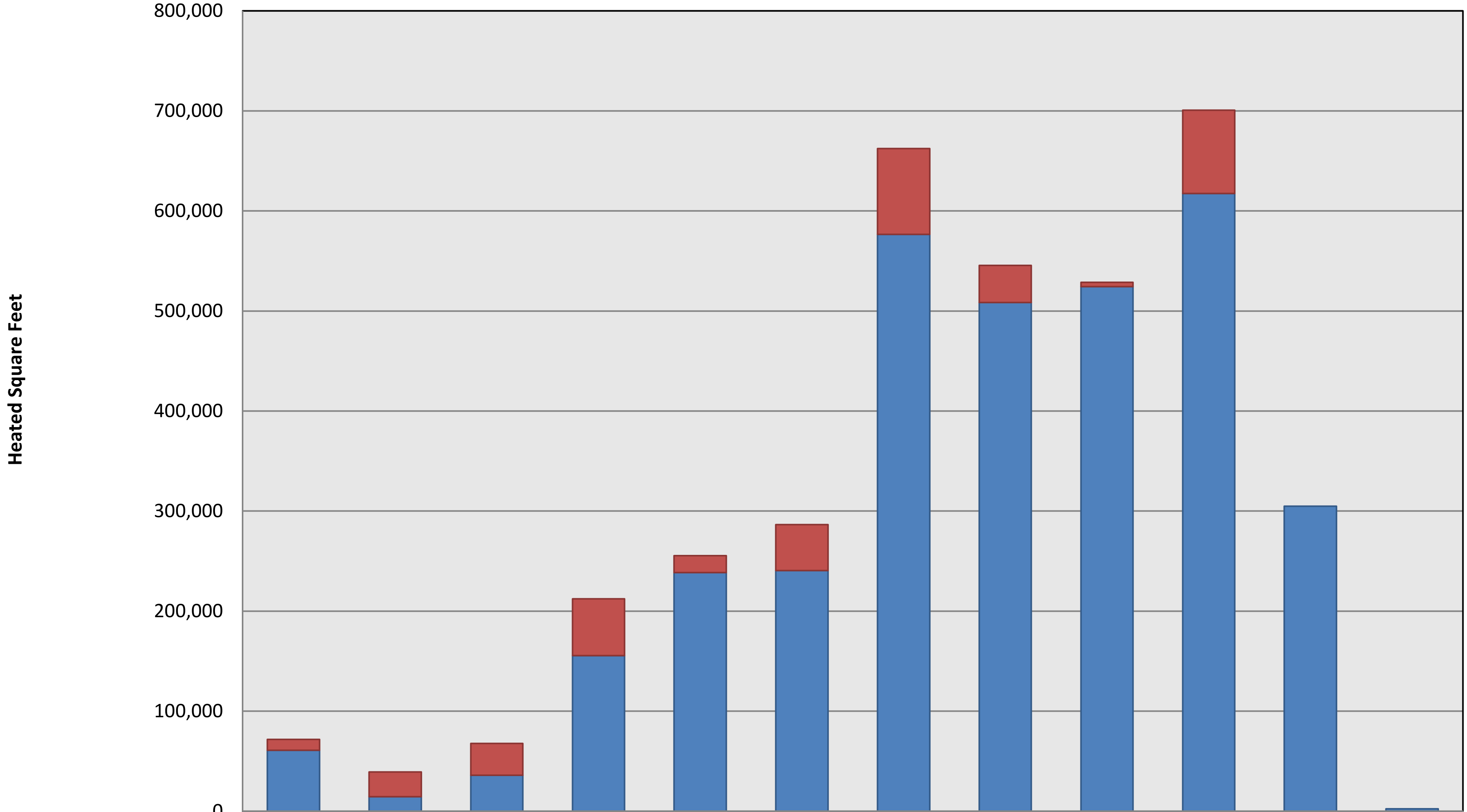
	Alston Park	Baynard Park	Bluffton Park	Brendan Woods	Buck Island/ Simmonsville	Buckwalter Place	Calhoun Street Promenade	Giddy Up	Hampton Hall	Hampton Lake	Haven at New Riverside	Heritage at New Riverside	Kirks Bluff	Landings at New Riverside	Lawton Station	Lee/Burnt Church Rd	Lot 26 Able St	Midpoint
2021 To Date	2								4	3		4		3	3			
2020	22	0	0	0	0	0	0	0	21	97	2	43	0	64	21	0	0	0
2019	50	0	2	0	0	0	0	0	24	125	18	58	0	57	34	1	3	1
2018	9	0	2	0	11	0	0	0	28	137	57	62	0	0	18	0	0	15
2017	17	37	33	0	5	0	0	1	37	152	45	60	9	0	15	0	0	26
2016	8	44	29	0	2	0	0	0	28	119	43	25	16	0	43	0	0	15
2015	0	41	24	0	0	0	0	2	32	69	50	86	9	0	34	0	0	16
2014	5	31	10	0	2	0	0	1	37	73	34	68	3	0	36	0	0	16
2013	9	27	15	0	2	0	0	0	51	64	25	17	0	0	28	0	0	0
2012	12	12	18	1	1	0	0	0	46	45	37	0	0	0	18	0	0	0
2011	4	15	7	0	0	0	0	0	39	34	36	1	0	0	25	0	0	0
2010	10	17	10	0	0	0	0	0	16	43	32	11	0	0	19	0	0	2

	Mill Creek at Cypress Ridge	Mystic Bluff Apartments	Old Town-Other	Palmetto Bluff Block	Palmetto Bluff	Palmetto Pointe Townes	Parkside	Rose Dhu Creek Plantation	Schultz/ Goethe Road	Seagrass Station	Shell Hall	Southern Oaks	Stock Farm	Tabby Roads	The Village at Palmetto Pointe	The Walk	Ulmer Property	Wellstone
2021 To Date	14				7						1					3		
2020	163	0	3	0	74	0	0	1	1	0	6	0	2	0	2	34	1	2
2019	159	52	7	2	68	0	0	2	0	1	4	9	0	6	16	1	2	28
2018	114	0	13	0	98	0	0	8	3	52	31	67	6	5	13	0	0	41
2017	90	0	6	0	78	0	0	2	3	39	37	78	7	5	21	0	0	0
2016	47	0	2	0	109	19	0	6	2	26	38	43	12	3	26	0	0	0
2015	33	0	2	0	129	32	0	14	2	0	49	44	12	0	8	0	0	0
2014	41	0	3	0	96	23	0	7	2	0	64	28	4	7	13	0	0	0
2013	19	0	8	0	103	10	10	18	0	0	9	0	15	1	24	0	0	0
2012	27	0	0	0	64	0	14	10	0	0	2	0	4	0	21	0	0	0
2011	26	0	10	0	41	0	12	2	1	0	2	0	2	0	24	0	0	0
2010	21	0	1	0	51	0	20	3	0	0	0	4	1	0	7	0	0	0

Town of Bluffton
New Commercial Construction and Additions Heated Square Footage
2010 - 2021

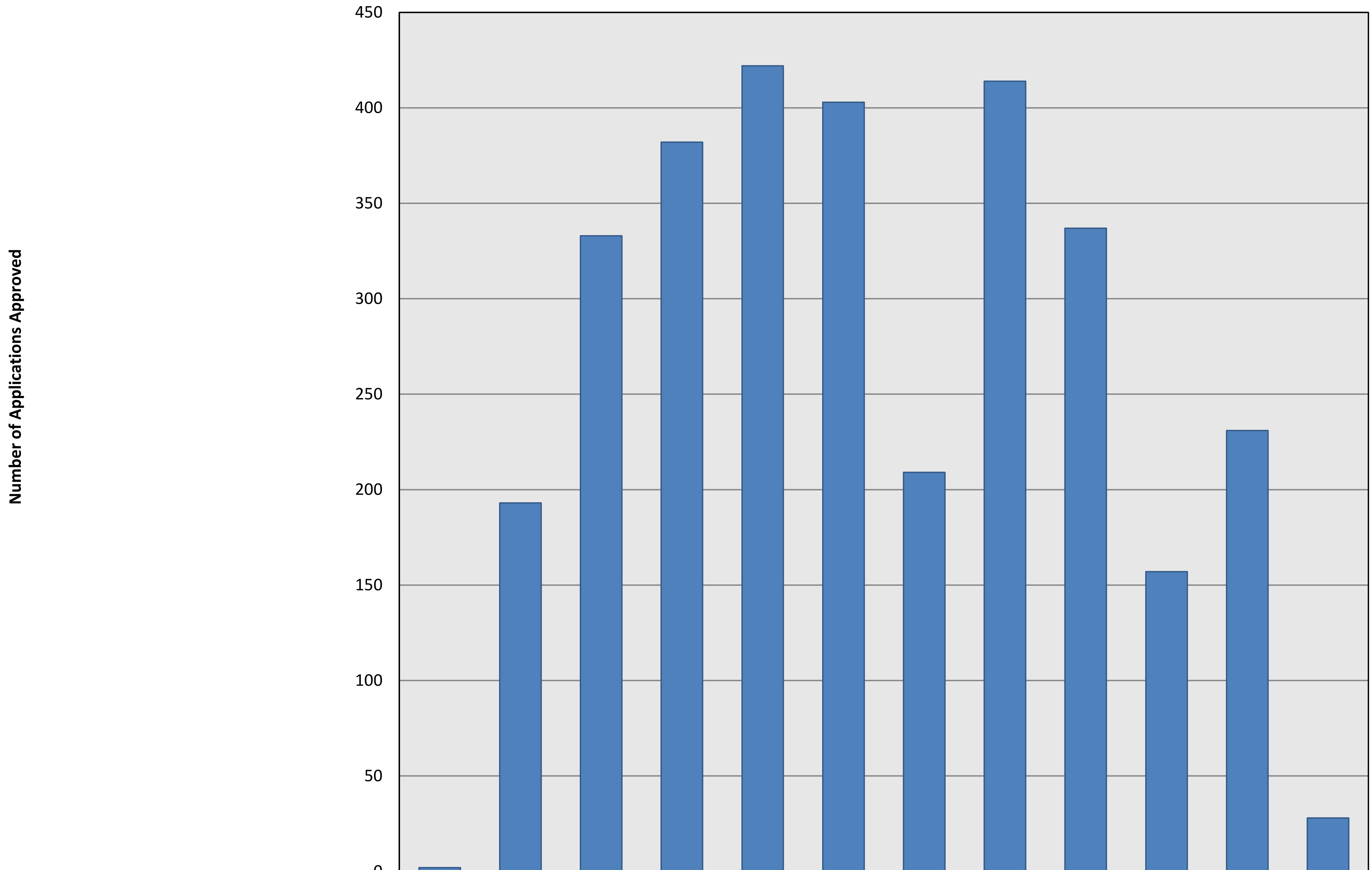
Attachment 8g

Section XII. Item #1.



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021 To Date
Commercial Additions	10,897	24,817	31,638	56,667	16,842	45,965	85,842	36,980	4,123	83,424	0	0
New Commercial	60,885	14,434	36,020	155,641	238,576	240,430	576,583	508,508	524,471	617,352	304,868	2,447

Town of Bluffton
Planning & Community Development Applications Approved
2010 - 2021



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021 To
Planning & Community Development Applications	2	193	333	382	422	403	209	414	337	157	231	28

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

Highway Corridor Overlay District

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-08-20-014496	08/25/2020		Certificate of Appropriateness	Active	Katie Peterson

Applicant: AVTEX Commercial Properties, INC **Owner:** MFH LAND, LLC

PLAN DESCRIPTION: A request by Thomas and Hutton on behalf the owners, Town of Bluffton and MFH Land, LLC for approval of a Certificate of Appropriateness -HCOD. The project consists of the infrastructure, landscaping, and lighting for future development. The property is zoned New Riverside Planned Unit Development and consists of approximately 35.4 acres identified by tax map numbers R610 036 000 1258 0000 and R610 036 000 3214 0000, commonly known as Parcel 4B-2 and 4B-3 located at the southeast corner of the SC Highway 46 and SC Highway 170 intersection.
STATUS 9-24-2020: The application was reviewed at the September 23, 2020 Planning Commission meeting and approved with conditions. Staff is awaiting resubmitted documents addressing Planning Commission Conditions. Once submitted, they will be reviewed to ensure that they meet the conditions of the approval and the Certificate of Appropriateness granted.

PROJECT NAME: NEW RIVERSIDE VILLAGE

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-10-20-014686	10/20/2020	35 PONDBERRY ST STREET	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Tarr Group, LLC **Owner:** HEPBLUFF LLC

PLAN DESCRIPTION: A request by WMG Development, LLC on behalf the owner, Hepbluff, LLC for approval of a Certificate of Appropriateness -HCOD. The project consists of a 4,200 SF professional dental office with the associated infrastructure, landscaping, and lighting. The property is zoned Jones Estate Planned Unit Development and consists of approximately 1.43 acres identified by tax map numbers R610 036 000 3210 0000, located at the northeast corner of the SC Highway 170 and Pondberry Street in the May River Crossing development.
STATUS 10-27-2020: The application is currently being reviewed by Staff for conformance with the [Unified Development Ordinance (UDO), or Development Agreement and Planned Unit Development documents], and any development plans associated with the parcel and was reviewed by the Planning Commission at the November 18, 2020 meeting and approved with conditions. Staff is awaiting resubmitted materials addressing the Planning Commission's conditions. Once submitted and satisfactorily reviewed a final Certificate of Appropriateness will be issued.

PROJECT NAME: TOWNE CENTRE AT NEW RIVERSIDE

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-03-18-011754	03/02/2018		Certificate of Appropriateness	Active	Katie Peterson

Applicant: Dan Keefer **Owner:** Michael Bradley Holdings, LLC

PLAN DESCRIPTION: A request by Dan Keefer, on behalf of the property owner, Michael Bradley Holdings, LLC., for a Certificate of Appropriateness – HCO for a 5.18 acre development consisting of a brewery/restaurant building of approximately 37,000 SF, an outdoor beer garden area and the associated parking, driveways, lighting and landscaping. The property is identified by tax map numbers R610-039-000-0021-0000, R610-039-000-0756-0000, R610-039-000-0757-0000 and is located adjacent to May River Road (SC Highway 46), Buck Island Road and Jennifer Court. It falls within the Town of Bluffton Highway Corridor Overlay District, and is zoned Neighborhood Core.
STATUS: The application was reviewed at the March 28th PC meeting and approved with conditions. Staff is awaiting updated materials. Once submitted, they will be reviewed to ensure that they meet the conditions of the approval and the Certificate of Appropriateness granted.
STATUS 3-19-2020: An email was sent to the Owner and Applicant as listed on the application notifying them of the impending expiration of the application.
STATUS 3-26-2020: Applicant response with plans to provide plans for resubmittal. Active.

PROJECT NAME: BUCK ISLAND/SIMMONSVILLE

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-09-20-014549	09/02/2020		Certificate of Appropriateness	Active	Katie Peterson

Applicant: Thomas & Hutton **Owner:** HEPBLUFF LLC

PLAN DESCRIPTION: A request by Thomas and Hutton on behalf the owner, HEPBLUFF, LLC for approval of a Certificate of Appropriateness -HCOD. The project consists of Building B, a commercial structure of approximately 2,965 SF and Building D, an unenclosed pavilion of approximately 385 SF within the May River Crossing Master Plan. The property is zoned Jones Estate Planned Unit Development and consists of approximately 17.7 acres identified by tax map numbers R610 036 000 0386 0000, R610 036 000 3209 0000, R610 036 000 3210 0000, R610 036 000 3211 0000, R610 036 000 3212 0000, and R610 036 000 3213 0000, located at the northeast corner of the SC Highway 46 and SC Highway 170 intersection.
STATUS 9-24-2020: The application was reviewed at the September 23, 2020 Planning Commission meeting and approved with conditions. Staff is awaiting updated materials. Once submitted, they will be reviewed to ensure that they meet the conditions of the approval and the Certificate of Appropriateness granted.

PROJECT NAME: May River Crossing

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

COFA-01-21-014930	01/21/2021		Certificate of Appropriateness	Active	Alan Seifert

Applicant: Witmer Jones Keefer Ltd. **Owner:** David Carpio

PLAN DESCRIPTION: A request by Wallace Milling of Witmer Jones Keefer, Ltd. on behalf the owner, David Carpio of Brixmor, for approval of a Certificate of Appropriateness -HCOD. The project consists of the modification of the existing landscape plan to remove trees. The property is zoned Belfair Planned Unit Development and consists of approximately 10 acres identified by tax map numbers R610 031 000 0194 0000, located within the Belfair Towne Village development.
STATUS 01-25-2021: The application is currently being reviewed by Staff for conformance with the [Unified Development Ordinance (UDO), or Development Agreement and Planned Unit Development documents], and any development plans associated with the parcel and is scheduled for review by the Planning Commission at the January 27th meeting.

PROJECT NAME: BELFAIR TOWNE VILLAGE

Historic District

COFA-10-20-014637	10/05/2020	22 STOCK FARM RD ROAD	Certificate of Appropriateness	Active	Katie Peterson

Applicant: DH ABNEY COMPANY **Owner:** James & Donna Brancato

PLAN DESCRIPTION: A request by DH Abney Company, on behalf of owners, Donna and James Brancato, for review of a Certificate of Appropriateness Application to allow for the construction of a new single-family residential structure of approximately 2.373 SF and a Carriage House of approximately 1,093 SF located at 22 Stock Farm Road, in the Stock Farm Development, in the Old Town Bluffton Historic District and zoned Neighborhood General – HD.
STATUS 10-27-2020: The application was reviewed at the October 26, 2020 HPRC meeting and comments were provided to the Applicant. Staff is awaiting the submission of a final application for full HPC review

PROJECT NAME: STOCK FARM

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-01-21-014892	01/11/2021	6 MARIANNA WAY WAY	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Court Atkins Architects, Inc. **Owner:** Herkus, LLC

PLAN DESCRIPTION: A request by Court Atkins Architects, on behalf of the owner, Herkus, LLC, for review of a Certificate of Appropriateness to allow the construction of a new 2 1/2 -story multifamily residential building of approximately 5,328 SF located at 6 Marianna Way, Building 4 in the Old Village Square development, in the Old Town Bluffton Historic District and zoned Neighborhood General – HD. [[Building 4-OVS]]
STATUS [1-12-2021]: The application received 1-11-2021 is currently being reviewed by Staff for conformance with the Unified Development Ordinance (UDO), Traditional Construction Patterns, and any development plans associated with the parcel and is scheduled for review by the HPRC at the 1-20-2021 meeting. Please note all comments provided at this meeting reflect the 1-11 submittal and do not take into consideration the revised drawings submitted 1-19-2021.

PROJECT NAME: OLD TOWN

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-10-20-014673	10/15/2020	5718 GUILFORD PL PLACE	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Pearce Scott Architects **Owner:** Kate Eagen

PLAN DESCRIPTION: A request by Pearce Scott Architects, on behalf of owner, Kate Eagen, for review of a Certificate of Appropriateness Application to allow for the construction of a new single-family residential structure of approximately 2,117 SF and a Carriage House of approximately 1,172 SF located at 5718 Guilford Place, identified as Lot 45 in the Stock Farm Development, in the Old Town Bluffton Historic District and zoned Neighborhood General – HD.
STATUS 10-27-2020: The application is currently being reviewed by Staff for conformance with the Unified Development Ordinance (UDO), Traditional Construction Patterns, and any development plans associated with the parcel and is scheduled for review by the HPRC at the November 2, 2020 meeting.
STATUS [11-4-2020]: The application was reviewed at the 11-2-2020 HPRC meeting and comments were provided to the Applicant. Staff is awaiting the submission of a final application for full HPC review.

PROJECT NAME: OLD TOWN

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-03-20-014097	03/09/2020	32 TABBY SHELL RD	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Southern Coastal Homes, LLC **Owner:** Scott Ready

PLAN DESCRIPTION: A request by Southern Coastal Homes, on behalf of the owner, Scott Ready, for review of a Certificate of Appropriateness to allow the construction of a new 1 ½-story single-family residential structure of approximately 1,813 SF located at 32 Tabby Shell Road (Lot 17) in the Tabby Roads Development and is zoned Neighborhood General – HD.
STATUS: The application was reviewed at the May 4, 2020 HPRC meeting and the June 3, 2020 HPC meeting and approved with conditions. Staff is awaiting updated materials. Once submitted, they will be reviewed to ensure that they meet the conditions of the approval and the Certificate of Appropriateness granted.

PROJECT NAME: TABBY ROADS PHASE 1

Growth Management Application Update Report

Town of Bluffton

Department of Growth Management

Office of Planning and Community Development

20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Active Cases

Certificate of Appropriateness

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-07-20-014386	07/13/2020	75 BRIDGE ST	Certificate of Appropriateness	Active	Katie Peterson

Applicant: James Guscio **Owner:** James Guscio

PLAN DESCRIPTION: A request by James Guscio, for review of a Certificate of Appropriateness to allow the construction of a new 2.5-story single-family building of approximately 2,310 SF located at 75 Bridge Street in the Old Town Bluffton Historic District and zoned Neighborhood Conservation-HD.
STATUS 9-24-2020: The application was reviewed at the August 3, 2020 HPRC meeting and comments were provided to the Applicant. A final application has been submitted and is being reviewed for conformance with the UDO and is scheduled for review by the full HPC at the October 7, 2020 meeting.
STATUS 10-8-2020: The Application was approved with conditions at the Oct. 7, 2020 HPC meeting Staff is awaiting resubmitted documents addressing conditions. Once recieved, they will be reviewed and if satisfactory, staff will stamp the plans and issue the final Certificate of Appropriateness.

PROJECT NAME:

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-07-19-013313	07/02/2019	215 GOETHE RD	Certificate of Appropriateness	Active	Katie Peterson

Applicant: The Bluffton Breeze, LLC **Owner:** Leonex Construction Group Inc.

PLAN DESCRIPTION: A request by Randolph Stewart, on behalf of Leonex Construction Group, for review of a Certificate of Appropriateness to allow the construction of a 3-story mixed use building of approximately 2,900 SF and a Carriage House of approximately 1,060 SF located at 215 Goethe Road within the May River Road development plan in the Old Town Bluffton Historic District, and zoned Neighborhood Core-HD.
STATUS: The Application was heard at the July 15th meeting of the HPRC. A Final Application has been submitted and was approved with conditions at the November 6th meeting of the HPC. Staff is awaiting resubmittal materials addressing HPC Conditions.
STATUS 11-27-19: Preliminary Approval Letter discussed with Applicant. Awaiting resubmitted materials.

PROJECT NAME: Schultz/Goethe

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-12-20-014811	12/04/2020	114 PRITCHARD ST STREET	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Manuel Studio, LLC **Owner:** P. Ellen Malphrus

PLAN DESCRIPTION: A request by Ansley Manuel, on behalf of the owner, Patricia Ellen Malphrus, for review of a Certificate of Appropriateness to allow an addition of approximately 2,971 SF to the existing single-family structure of approximately 1,095 SF located at 114 Pritchard Street in the Old Town Bluffton Historic District and zoned Neighborhood Conservation-HD.
STATUS: The Application was heard at the January 4, 2021 HPRC meeting where comments were provided to the Applicant. A Final Application was submitted and has been placed on the February 3rd Historic Preservation Commission meeting agenda.

PROJECT NAME: OLD TOWN

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

COFA-10-20-014694	10/21/2020	20 MERIWETHER CT COURT	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Webb Construction Inc **Owner:** Ernie Suozzi

PLAN DESCRIPTION: A request by Brian Webb, on behalf of owner, Ernie Suozzi, for review of a Certificate of Appropriateness Application to allow the construction of a new 1 ½ story single family residence of approximately 1,955 SF and a Carriage House of approximately 352 SF to be located at 20 Meriweather Court, in the Landon Oaks development, in the Old Town Bluffton Historic District and zoned Neighborhood General – HD.
STATUS [11-4-2020]: The application is currently being reviewed by Staff for conformance with the Unified Development Ordinance (UDO), Traditional Construction Patterns, and any development plans associated with the parcel and was reviewed by the HPRC at the November 16, 2020 meeting where comments were provided to the Applicant. A final application was submitted and heard at the January 6, 2021 HPC meeting and approved with conditions. Staff is awaiting the submittal of revised materials addressing the HPC conditions. Once received, and satisfactorily reviewed, Staff will issue the Final Certificate of Appropriateness.

PROJECT NAME: OLD TOWN

COFA-11-19-013711	11/21/2019	7 BLUE CRAB ST	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Ernest Suozzi **Owner:** Ernest Suozzi

PLAN DESCRIPTION: A request by Ernest Suozzi, for review of a Certificate of Appropriateness to allow the construction of a 2-story single family residential structure of approximately 1920 SF and a Carriage House of approximately 986 SF located on the property at 7 Blue Crab Street in the Tabby Roads development in the Old Town Bluffton Historic District, and zoned Neighborhood General-HD.
STATUS 3-24-2020:The application was heard at the December 9th meeting of the HPRC and comments provided to the Applicant. A final application was sapproved with conditions at the February 5, 2020 HPC meeting. Staff is awaiting updated materials. Once submitted, they will be reviewed to ensure that they meet the conditions of the approval and the Certificate of Appropriateness granted.

PROJECT NAME: TABBY ROADS PHASE 1

COFA-09-20-014565	09/08/2020	7 GUERRARD AVE AVENUE	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Buckwalter Place **Owner:** Curry Road Investments, LLC

PLAN DESCRIPTION: A request by Randy Brown and Matt Green, for review of a Certificate of Appropriateness to allow the construction of a new 1 ½ story single-family structure of approximately 1,952 SF and a Carriage House of approximately 286 SF located at 7 Guerrard Avenue in the Old Town Bluffton Historic District and zoned Neighborhood General-HD.

STATUS 9-24-2020: The application is currently being reviewed by Staff for conformance with the Unified Development Ordinance (UDO), Traditional Construction Patterns, and any development plans associated with the parcel and is scheduled for review by the HPRC at the September 28, 2020 meeting.

PROJECT NAME: OLD TOWN

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-06-20-014321	06/18/2020	29 LAWTON ST	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Keith Koobs **Owner:** Keith & Mary Koobs

PLAN DESCRIPTION: A request by Keith and Mary Koobs, for review of a Certificate of Appropriateness to allow the construction of a new 1-story single-family structure of approximately 1,415 SF located at 29 Lawton Street and zoned Neighborhood General – HD.

STATUS 9-24-2020: The application was reviewed at the June 29, 2020 HPRC meeting and the August 5, 2020 HPC meeting and approved with conditions. Staff is awaiting updated materials. Once submitted, they will be reviewed to ensure that they meet the conditions of the approval and the Certificate of Appropriateness granted.

AMENDMENT{11-17-2020}: New build of house - addition of 2 doors on front elevation of house (front porch).

PROJECT NAME: OLD TOWN

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-10-20-014698	10/22/2020	5806 YAUPON RD ROAD	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Pearce Scott Architects **Owner:** Gerard & Beth Romski

PLAN DESCRIPTION: A request by Pearce Scott Architects, on behalf of owners, Gerard and Beth Romski, for review of a Certificate of Appropriateness Application to allow for the addition of a golf cart bay and second floor of approximately 599 SF to the existing Carriage House of approximately 514 SF located at 5806 Yaupon Road, identified as Lot 20A in the Stock Farm Development, in the Old Town Bluffton Historic District and zoned Neighborhood General – HD.
STATUS 10-27-2020: The application is currently being reviewed by Staff for conformance with the Unified Development Ordinance (UDO), Traditional Construction Patterns, and any development plans associated with the parcel and is scheduled for review by the HPRC at the November 16, 2020 meeting.

PROJECT NAME: OLD TOWN

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

COFA-11-18-012562	11/14/2018	1268 MAY RIVER RD	Certificate of Appropriateness	Active	Erin Schumacher

Applicant: Kevin Farruggo **Owner:** McClure Real Estate LLC

PLAN DESCRIPTION: A request by Grady L Woods Architects on behalf of McClure Real Estate, LLC, for review of a Certificate of Appropriateness to allow the renovation of the existing contributing structure (known as the Nathanial Brown House) into a commercial office space of approximately 1,325 SF. The renovation includes: the removal of the gabled east wing of approximately 210 SF; installation of new windows, doors, and roof materials; and an interior upfit of the structure located at 1268 May River Road in the Old Town Bluffton Historic District and zoned Neighborhood General-HD.
STATUS: The application was reviewed at the November 19th HPRC meeting and the January 9th HPC meeting and approved with conditions. Staff is awaiting updated materials. Once submitted, they will be reviewed to ensure that they meet the conditions of the approval and the Certificate of Appropriateness granted.
STATUS 3-30-20: An email was sent to the applicant and owner as listed on the application notifying them of the impending expiration of the application.
STATUS 4-27-20: The applicant has responded that they are working on submittal information. Active.

PROJECT NAME: OLD TOWN

COFA-01-20-013886	01/21/2020	36 TABBY SHELL RD	Certificate of Appropriateness	Active	Katie Peterson

Applicant: James Guscio **Owner:** Riverside Retreats, Inc

PLAN DESCRIPTION: A request by James Guscio, on behalf of Riverside Retreats, for review of a Certificate of Appropriateness to allow the construction of a new 2-story single-family building of approximately 2,243 SF located at 36 Tabby Shell Road in the Tabby Roads development in the Old Town Bluffton Historic District, and zoned Neighborhood General-HD.
STATUS 3-30-20: The application was reviewed and was heard at the February 3, 2020 HPRC meeting where comments were provided to the Applicant. A Final Application was submitted and was approved with conditions at the March 4, 2020 meeting of the HPC. Staff is awaiting updated materials. Once submitted, they will be reviewed to ensure that they meet the conditions of the approval and the Certificate of Appropriateness granted.

PROJECT NAME: TABBY ROADS PHASE 1

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

COFA-09-20-014597	09/16/2020	5806 YAUPON RD ROAD	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Pearce Scott Architects **Owner:** Gerard & Beth Romski

PLAN DESCRIPTION: A request by Pearce Scott Architects, on behalf of owners Gerard and Beth Romski, for review of a Certificate of Appropriateness to allow the addition of a 120 SF outdoor shower area and landscaping revisions to the existing 2-story residential structure of approximately 2,850 SF located at 5806 Yaupon Road in the Old Town Bluffton Historic District, within the Stock Farm Development and zoned Neighborhood General-HD.
STATUS 9-16-2020: The application is currently being reviewed by Staff for conformance with the Unified Development Ordinance (UDO), Traditional Construction Patterns, and any development plans associated with the parcel and is scheduled for review by the HPRC at the October 12, 2020 meeting.

STATUS [11-4-2020]: The application was reviewed at the October 12, 2020 HPRC meeting and comments were provided to the Applicant. Staff is awaiting the submission of a final application for full HPC review.

STATUS [11-9-2020] FINAL APPLICATION SUBMITTED - Adding dog door with steps to right side of the elevation.

PROJECT NAME: OLD TOWN

COFA-12-18-012652	12/12/2018	6 HEAD OF THE TIDE	Certificate of Appropriateness	Active	Erin Schumacher

Applicant: Manuel Studio, LLC **Owner:** Deidre Jurgensen

PLAN DESCRIPTION: A request by Ansley Manuel, on behalf of Deidre Jurgensen, for review of a Certificate of Appropriateness to allow the construction of a new Carriage House of approximately 1,424 SF located at 6 Head of the Tide in the Old Town Bluffton Historic District, and zoned Neighborhood Conservation-HD.
STATUS: The application was reviewed at the January 2nd HPRC meeting and the May 1st HPC meeting and approved with conditions. Staff is awaiting updated materials. Once submitted, they will be reviewed to ensure that they meet the conditions of the approval and the Certificate of Appropriateness granted.
STATUS 3-30-20: A permit has been pulled for 5 Head of Tide to remove the Carriage House from this site, as one of the conditions on this permit. Once the work associated with that permit has been complete, this COFA will be able to be approved. RNEW-10-19-2005

PROJECT NAME: OLD TOWN

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

COFA-08-20-014495	08/24/2020	5806 GUILFORD PL	Certificate of Appropriateness	Active	Katie Peterson

Applicant: George Gomolski **Owner:** Gomo Enterprises, LLC

PLAN DESCRIPTION: A request by George Gomolski, for review of a Certificate of Appropriateness to allow the construction of a new 2-story mixed-use building of approximately 2,500 SF and a Carriage House of approximately 1,056 SF located at 58-6 Guilford Place in the Old Town Bluffton Historic District and zoned Neighborhood General-HD.
STATUS 10-6-2020: The application was reviewed at the September 14, 2020 HPRC meeting and comments were provided to the Applicant. A Final Application has been submitted and will be heard at the November 4, 2020 HPC meeting.

PROJECT NAME:

COFA-07-18-012236	07/25/2018	81 CALHOUN ST	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Pearce Scott Architects, Inc. **Owner:** 81 Calhoun Street LLC

PLAN DESCRIPTION: A request by Pearce Scott Architects on behalf of Chris Shoemaker, for review of a Certificate of Appropriateness to allow the construction of a mixed-use accessory Carriage House of approximately 1,200 SF located at 55 Bridge Street in the Old Town Bluffton Historic District and zoned Neighborhood Conservation-HD.
STATUS: The application was reviewed at the July 30th HPRC meeting and comments were provided to the Applicant. A final applications as approved with conditions at the November 9th meeting. Staff is awaiting resubmittal documents addressing HPC Conditions. Awaiting fees to be paid.

PROJECT NAME: OLD TOWN

COFA-06-19-013223	06/05/2019	127 BRIDGE ST	Certificate of Appropriateness	Active	Katie Peterson

Applicant: R. Stewart Design, LLC **Owner:** Spartina449

PLAN DESCRIPTION: A request by Randolph Stewart of R. Stewart Design, LLC., on behalf of Kay Stanley, for review of a Certificate of Appropriateness to allow for the renovation and construction of a new addition to the existing structure in the Old Town Bluffton Historic District located at 127 Bridge Street in the Old Town Bluffton Historic District, and zoned Riverfront Edge-HD.
The application was heard at the June 24th HPRC Meeting where comments were provided to the Applicant.
STATUS 3-24-2020: The Applicant submitted additional information and requested to be placed on the August 7th HPC Agenda as discussion only for their conceptual application. The Application was heard and comments provided. A final application was submitted and approved with conditions by the HPC at their October 2nd meeting. Staff is awaiting the submittal of revised materials addressing the HPC conditions. Awaiting window detail as final item for approval.
STATUS 9-24-2020: A window detail was submitted for review by the HPRC. It has been placed on the September 28, 2020 HPRC Agenda.

PROJECT NAME: OLD TOWN

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

COFA-12-20-014812	12/07/2020	38 LAWRENCE ST STREET	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Manuel Studio, LLC **Owner:** James Mitchell & Laurie Brown

PLAN DESCRIPTION: A request by Ansley Manuel, on behalf of James Mitchell and Laurie Brown for review of a Certificate of Appropriateness to an addition of approximately 2,580 SF to the existing single-family structure of approximately 1.545 SF located at 38 Lawrence Street in the Old Town Bluffton Historic District and zoned Neighborhood General-HD.
STATUS: The Application was heard at the January 4, 2021 HPRC meeting where comments were provided to the applicant. Staff is awaiting the submittal of a final application.

PROJECT NAME: OLD TOWN

COFA-09-20-014595	09/15/2020	23 PRITCHARD ST STREET	Certificate of Appropriateness	Active	Katie Peterson

Applicant: InCircle Architecture **Owner:** Trudy Eaton

PLAN DESCRIPTION: A request by Christopher Epps, on behalf of owner Trudy J Eaton Trust, for review of a Certificate of Appropriateness to allow the addition of a 578 SF second story to the existing 1-story Carriage House of approximately 514 SF located at 23 Pritchard Street in the Old Town Bluffton Historic District and zoned Neighborhood General-HD.
STATUS 9-15-2020: The application is currently being reviewed by Staff for conformance with the Unified Development Ordinance (UDO), Traditional Construction Patterns, and any development plans associated with the parcel and is scheduled for review by the HPRC at the October 12, 2020 meeting.
STATUS [11-04-2020]: The application was reviewed at the 10-12-2020HPRC meeting and comments were provided to the Applicant. A final application has been submitted and is being reviewed for conformance with the UDO and is scheduled for review by the full HPC at the 12-2-2020 meeting.

PROJECT NAME: OLD TOWN

COFA-07-20-014375	07/07/2020	56 PRITCHARD ST	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Vicky Cowen **Owner:** Vicky Cowen

PLAN DESCRIPTION: A request by Vicky Cowen, for review of a Certificate of Appropriateness to allow the construction of a new 1.5-story single-family building of approximately 2,728 SF and a Carriage House of approximately 575 SF located at 56 Pritchard Street in the Old Town Bluffton Historic District and zoned Neighborhood General-HD.
STATUS 9-24-2020: The application was reviewed at the August 3, 2020 HPRC meeting and comments were provided to the Applicant. Staff is awaiting the submission of a final application for full HPC review.

PROJECT NAME:

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Certificate of Appropriateness

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-01-21-014894	01/11/2021	10 MARIANNA WAY WAY	Certificate of Appropriateness	Active	Katie Peterson

Applicant: Court Atkins Architects, Inc. **Owner:** Herkus, LLC

PLAN DESCRIPTION: A request by Court Atkins Architects, on behalf of the owner, Herkus, LLC, for review of a Certificate of Appropriateness to allow the construction of a new 2 1/2 -story multifamily residential building of approximately 5,328 SF located at 10 Marianna Way, Building 5 in the Old Village Square development, in the Old Town Bluffton Historic District and zoned Neighborhood General – HD.
STATUS [1-12-2021]: The application received 1-11-2021 is currently being reviewed by Staff for conformance with the Unified Development Ordinance (UDO), Traditional Construction Patterns, and any development plans associated with the parcel and is scheduled for review by the HPRC at the 1-20-2021 meeting. Please note all comments provided at this meeting reflect the 1-11 submittal and do not take into consideration the revised drawings submitted 1-19-2021.

PROJECT NAME: OLD TOWN

Historic District - Demolition

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
COFA-11-18-012563	11/14/2018	1268 MAY RIVER RD	Certificate of Appropriateness	Active	Erin Schumacher

Applicant: Kevin Farruggo **Owner:** McClure Real Estate LLC

PLAN DESCRIPTION: A request by Grady L Woods Architects on behalf of McClure Real Estate, LLC, for review of a Certificate of Appropriateness - Demolition to allow the demolition of a 1-story cmu block building with an attached wooden structure with a shed roof of approximately 800 SF and a small wood shed of approximately 80 SF located at 1268 May River Road in the Old Town Bluffton Historic District, and zoned Neighborhood General-HD.
STATUS: The application was reviewed at the November 19th HPRC meeting, the December 3rd DRC meeting, and the January 9th HPC meeting and approved with conditions. Staff is awaiting updated materials. Once submitted, they will be reviewed to ensure that they meet the conditions of the approval and the Certificate of Appropriateness granted.
STATUS 4-27-20: The Applicant is preparing revised plans for resubmittal. Active.

PROJECT NAME: OLD TOWN

Total Certificate of Appropriateness Cases: 29

Comprehensive Plan Amendment

Comprehensive Plan Amendment

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Comprehensive Plan Amendment

COMP-07-19-013329	07/10/2019		Comprehensive Plan Amendment	Active	Aubrie Giroux

Applicant: Walter J Nester III **Owner:** Bishop of Charleston

PLAN DESCRIPTION: Request for an Ordinance to amend the Town of Bluffton Comprehensive Plan to extend the boundary shown on Map 8.1, Future Annexation Area to include the Saint Gregory the Great property consisting of approximately 61.093 Acres of land located at 323 Fording Island Road and identified as Beaufort County Tax Map No. R600 022 000 0125 0000 & R660 022 000 1120 0000, as well as change the subject properties future land use designation from Civic/Institutional to Medium Intensity Commercial.
STATUS: Town Council approved the “Intent to Annex”, First Reading of the Annexation Ordinance at their August 12, 2019 meeting. The Applicant previously requested to place this application on hold so they can prepare updated materials to reflect the Town’s desire for them to pursue incorporating the property into the Buckwalter Planned Unit Development Concept Plan Development Agreement as a new planning tract instead of General-Mixed use as requested. To bring the property into Buckwalter, amendments to the Planned Unit Development, Concept Plan, and Development Agreement are necessary which will require the submittal of additional applications and materials. Applicant submitted revised materials and the necessary additional applications on February 21, 2020. Additional revisions including a reduction of the requested number of residential development rights from 449 to 150 were submitted following Planning Commission's Workshop on the proposed Annexation and Zoning Map Amendment held on July 22, 2020. Planning Commission will hold a Public Hearing and Recommendation to Town Council on October 28, 2020. Town Council is scheduled to hold Ordinance First Readings at their January 6, 2021 meeting. Town Council is then scheduled to hold Public Hearings and Ordinance Second and Final Readings at their February 9, 2021 meeting.

PROJECT NAME: SAINT GREGORY THE GREAT CATHOLIC CHURCH

COMP-12-20-014814	12/07/2020		Comprehensive Plan Amendment	Active	Aubrie Giroux

Applicant: Ward Edwards, Inc. **Owner:** PKP Group LLC

PLAN DESCRIPTION: Rezoning to allow multi family use with six (6) units per acre.

PROJECT NAME: OLD CAROLINA

COMP-12-20-014851	12/21/2020		Comprehensive Plan Amendment	Active	Kevin Icard

Applicant: J. K. Tiller & Associates, Inc. **Owner:** Year Round Pool Co

PLAN DESCRIPTION: Amendment to the Old Carolina PUD to include BPC Planning area and associated densities and uses.

PROJECT NAME: OLD CAROLINA

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Total Comprehensive Plan Amendment Cases: 3

Concept Plan Amendment

Concept Plan Amendment

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
CPA-02-20-014047	02/26/2020		Concept Plan Amendment	Active	Aubrie Giroux

Applicant: McNair Law Firm, P.A. **Owner:** Bishop of Charleston

PLAN DESCRIPTION: 1A request for an Ordinance to approve an amendment to the Buckwalter Planned Unit Development Concept Plan to incorporate approximately 61.093 Acres of land located at 323 Fording Island Road, Beaufort County Tax Map Nos. R600 022 000 0125 0000 and R600 022 000 1120 0000 subject to a new Saint Gregory the Great Land Use Tract. STATUS: Town Council approved the “Intent to Annex”, First Reading of the Annexation Ordinance at their August 12, 2019 meeting. The Applicant previously requested to place this application on hold so they can prepare updated materials to reflect the Town’s desire for them to pursue incorporating the property into the Buckwalter Planned Unit Development Concept Plan Development Agreement as a new planning tract instead of General-Mixed use as requested. To bring the property into Buckwalter, amendments to the Planned Unit Development, Concept Plan, and Development Agreement are necessary which will require the submittal of additional applications and materials. Applicant submitted revised materials and the necessary additional applications on February 21, 2020. Additional revisions including a reduction of the requested number of residential development rights from 449 to 150 were submitted following Planning Commission's Workshop on the proposed Annexation and Zoning Map Amendment held on July 22, 2020. Planning Commission will hold a Public Hearing and Recommendation to Town Council on October 28, 2020. Town Council is scheduled to hold Ordinance First Readings at their January 6, 2021 meeting. Town Council is then scheduled to hold Public Hearings and Ordinance Second and Final Readings at their February 9, 2021 meeting.

PROJECT NAME: SAINT GREGORY THE GREAT CATHOLIC CHURCH

Total Concept Plan Amendment Cases: 1

Development Plan

Development Plan

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-08-20-014530	08/31/2020	700E MOUNT PELIA RD ROAD	Development Plan	Active	William Howard

Applicant: Dan Kunau **Owner:** May River Forest, LLC

PLAN DESCRIPTION: PB Citadel - Site development for flex space buildings, storage buildings, and gravel boat/trailer parking

PROJECT NAME: PALMETTO BLUFF PHASE 2

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-03-19-012966	03/27/2019		Development Plan	Active	William Howard

Applicant: New South Living, LLC **Owner:**

PLAN DESCRIPTION: The Applicant is proposing to construct a two lane, 200 foot extension of Able Street from its terminus with Red Cedar Street to provide access to the adjacent parcel.
STATUS: Comments on the Preliminary Development Plan were reviewed at the April 9, 2019 meeting of the DRC. Awaiting Final Development Plan.
STATUS UPDATE 03/31/2020: E-mailed the applicant to notify that their application has been inactive for more than 120 days and if the Town does not receive notification within 10 days that that they intend to pursue approval, the application will expire.
STATUS 04/23/2020: The Applicant has confirmed they intend to proceed with Development Plan Approval and will be re-submitting applications accordingly.

PROJECT NAME:

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-10-18-012476	10/15/2018	1268 MAY RIVER RD	Development Plan	Active	William Howard

Applicant: Kevin Farruggo **Owner:** McClure Real Estate LLC

PLAN DESCRIPTION: The Applicant is proposing to subdivide and use parcel and develop as mixed use at 1268 May River Road, Tax Map Number R610 039 00A 0147 0000.
STATUS 10/31/2018: Comments on the Preliminary Development Plan were provided at the Oct. 30 meeting of the DRC. Awaiting re-submittal and a response to comments before placing the Preliminary Plan on the agenda for review by the Planning Commission.
STATUS UPDATE 03/31/2020: E-mailed the applicant to notify that their application has been inactive for more than 120 days and if the Town does not receive notification within 10 days that that they intend to pursue approval, the application will expire.
STATUS 04/23/2020: The Applicant has confirmed they intend to proceed with Development Plan Approval and will be re-submitting applications accordingly.

PROJECT NAME: OLD TOWN

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

DP-01-21-014870	01/04/2021	2 PARKSIDE DR DRIVE	Development Plan	Active	William Howard

Applicant: Loftin-Moore, LLC **Owner:** Parcel C5 LLC

PLAN DESCRIPTION: The project proposes to construct a restaurant and retial space with an outdoor pavilion and amphitheater with associated infrastructure.

PROJECT NAME: Buckwalter

DP-06-19-013224	06/05/2019		Development Plan	Active	William Howard

Applicant: Watercrest Development LLC **Owner:** Speyside

PLAN DESCRIPTION: The Applicant is proposing to construct an assisted living facility within Washington Square.

STATUS 06/20/2019: Comments on the Preliminary Plan will be provided at the June 25 meeting of the DRC.
STATUS 08/26/2019: The Preliminary Plan will be reviewed by the Planning Commission at its August 28 meeting.
08/29/2019: The Preliminary Plan was approved by the Planning Commission. Awaiting Final Development Plan.
STATUS: The Final Development Plan has been submitted. Comments were reviewed at the November 13, 2019 DRC meeting. Awaiting re-submittal.

PROJECT NAME: Buckwalter

DP-01-21-014875	01/05/2021		Development Plan	Active	William Howard

Applicant: Thomas & Hutton **Owner:** LSSD NEW RIVERSIDE LLC

PLAN DESCRIPTION: 129 Single family residential lots with infrastructure.

PROJECT NAME: HERITAGE AT NEW RIVERSIDE PHASE 8 & 9

DP-01-21-014882	01/06/2021	24 INNOVATION DR DRIVE	Development Plan	Active	William Howard

Applicant: Ward Edwards Engineering **Owner:** Lighthouse Lagoon Miniature Golf

PLAN DESCRIPTION: Miniature golf facility in Buckwalter Place.

PROJECT NAME: BUCKWALTER PLACE

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

DP-09-18-012409	09/21/2018		Development Plan	Active	William Howard

Applicant: Village Park Communities **Owner:** Village Park Communities

PLAN DESCRIPTION: The Applicant is proposing a new residential subdivision located within New Riverside on Parcel 4A1. The residential subdivision will consist of 113 single family homes with a clubhouse. Tax Map Number R614 036 000 1318 0000 .
STATUS: Comments on the Preliminary Plan were reviewed at the Oct. 09 meeting of the DRC. Awaiting Final Development Plan.
STATUS 03/12/2019: The Final DP was reviewed at the March 5 meeting of the DRC. Re-submittal materials to address comments provided at DRC were received March 8, 2019. The Final Development Plan is APPROVED with the following condition:
* The walking trails shown on the exhibits provided to address Staff Comments on the Final Development Plan show walking trails as mulched or grass trails. The walking trails shall be constructed and maintained as mulched trails per the Approved Master Plan, and will be verified at the time of Final CCC inspection.

STATUS 10/18/2019: A development Plan Amendment to re-configure the site layout was reviewed at the Oct. 23 meeting of the DRC. Awaiting SC DHECC fianl approval of the Stormwater Plan for FInal approval.
STATUS 12/18/2019: The SC DHEC NPDES Final Approval was provided. The Development Plan Amendment is APPROVED.

PROJECT NAME: NEW RIVERSIDE PARCEL 4A-1

DP-09-20-014617	09/29/2020		Development Plan	Active	William Howard

Applicant: Thomas & Hutton **Owner:** May River Forest, LLC

PLAN DESCRIPTION: 117 single family lots and infrastructure.
Palmetto Bluff - Block M2 & 3

PROJECT NAME: PALMETTO BLUFF PHASE 2

DP-08-20-014483	08/18/2020		Development Plan	Active	William Howard

Applicant: Vulcan Property Group LLC **Owner:** Parcel 9A, LLC

PLAN DESCRIPTION: The applicant proposes to develop an office building, daycare, and all required infrastructure improvements.

PROJECT NAME: BUCKWALTER COMMONS

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-11-18-012564	11/14/2018	1217 MAY RIVER RD	Development Plan	Active	William Howard

Applicant: Dan Keefer **Owner:** May River Development LLC

PLAN DESCRIPTION: The Applicant is proposing to develop 5 existing parcels into a mixed use development consisting of 5 single family residences and 5 commercial buildings to include the site infrastructure, internal street-scape, drives, parking, walks, utilities, drainage, and stormwater BMPs .
STATUS 11/27/2018:
STATUS 12/18/2018: Comments on the Preliminary Development Plan were reviewed at the Dec. 4 meeting of the DRC. Awaiting Final Development Plan.
STATUS 05/14/2019: Comments on the Final Development Plan were reviewed at the May 14 meeting of the DRC. Awaiting re-submittal.
STATUS UPDATE 03/31/2020: E-mailed the applicant to notify that their application has been inactive for more than 120 days and if the Town does not receive notification within 10 days that that they intend to pursue approval, the application will expire.
STATUS 04/23/2020: The Applicant has confirmed they intend to proceed with Development Plan Approval and will be re-submitting applications accordingly.

PROJECT NAME: OLD TOWN

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-11-16-010264	11/10/2016		Development Plan	Active	William Howard

Applicant: Coleman Company Inc. **Owner:** WWH PALMETTO PT DEVELOPERS

PLAN DESCRIPTION: The applicant is requesting approval for a Preliminary Development Plan to construct 19 single family homes and associated infrastructure on 5.99 acres.
STATUS: Plan is scheduled for 11/29 DRC Meeting.
STATUS: The Preliminary Development Plan was heard at the December 6, 2016 DRC Meeting. A Final Development Plan was submitted, reviewed, and heard at the March 14th DRC meeting and comments provided to the Applicant.
STATUS: Awaiting resubmittal materials addressing staff comments.
STATUS: 04/03/17: APPROVED
STATUS: 7/19/17: Plan was reactivated for Certificate of Construction Compliance approval.

PROJECT NAME: VILLAGES AT PALMETTO POINTE PHASE 4B

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-04-17-010873	04/27/2017	1195 MAY RIVER RD	Development Plan	Active	William Howard

Applicant: Manuel Studio, LLC **Owner:** Trever Wells

PLAN DESCRIPTION: The Applicant is requesting approval of a new commercial building with 4 units.
STATUS 5/18/17: Comments were reviewed at the May 16 meeting of the DRC. Awaiting submittal of Final Development Plan.
STATUS 05/10/2019: Comments on the Final Development Plan were reviewed at the May 7 meeting of the DRC. Awaiting re-submittal.

PROJECT NAME: BUCK ISLAND/SIMMONSVILLE

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

DP-10-20-014720	10/30/2020	6 ARLEY WAY WAY	Development Plan	Active	William Howard

Applicant: Eric Hoover **Owner:** Ceagull Investments, LLC

PLAN DESCRIPTION: 12,000 SF commercial building and associated infrastructure in Westbury Park: Lot 20B

PROJECT NAME: WESTBURY PARK COMMERCIAL

DP-01-21-014886	01/08/2021		Development Plan	Active	William Howard

Applicant: Parcel 7A llc **Owner:** Parcel 7A llc

PLAN DESCRIPTION: Grading permit only - limited clearing, grubbing, leveling & re-stabilizing on site.

PROJECT NAME: Buckwalter

DP-05-19-013149	05/09/2019	335 BUCKWALTER PKWY	Development Plan	Active	William Howard

Applicant: Ryan Lyle PE **Owner:** St. Andrew by the Sea

PLAN DESCRIPTION: The Applicant is proposing to construct a 12,250 square foot building, an athletic field and the associated parking, sidewalks, BMPs, utilities and all other infrastructure for Phase 1 of this development located at 335 Buckwalter Parkway, Tax Map Number R610 030 000 0712 0000 & R610 030 000 0513 0000.
STATUS 05/28/2019: Comments on the Preliminary Plan were reviewed at the May 28 meeting of the DRC. A re-submittal of the Preliminary Plan is required for review and approval.
STATUS 10/23/2019: The Preliminary Development Plan was resubmitted and will be placed on the November 6, 2019 DRC agenda.
STATUS 11/19/2019: Comments were reviewed at the Nov. 6 DRC meeting. Awaiting re-submittal to address comments for presentation to the Planning Commission.
STATUS UPDATE 03/31/2020: E-mailed the applicant to notify that their application has been inactive for more than 120 days and if the Town does not receive notification within 10 days that that they intend to pursue approval, the application will expire.
STATUS 04/23/2020: The Applicant has confirmed they intend to proceed with Development Plan Approval and will be re-submitting applications accordingly.

PROJECT NAME: Buckwalter

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-10-20-014676	10/19/2020	441 PALMETTO BLUFF ROAD	Development Plan	Active	William Howard

Applicant: Grandview Care, Inc. **Owner:** MAY RIVER FOREST

PLAN DESCRIPTION: Construction of a new Wellness Center, office buildings, and independent living units.

PROJECT NAME: PALMETTO BLUFF PHASE 1

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-10-17-011380	10/05/2017		Development Plan	Active	William Howard

Applicant: Andrews Engineering Co. **Owner:** Micheal Bradley Holdings LLC

PLAN DESCRIPTION: The Applicant is requesting approval to construct a 37,000 SF building to house a brewery, retail sales area, a restaurant and bar space and associated infrastructure. Located on Jennifer Court near the intersection of Highway 46 and Buck Island Road.
STATUS 10/18/2017: The Preliminary Development Plan is under review and scheduled for the Oct. 24 meeting of the DRC.
STATUS 11/14/2017: Comments on the Preliminary Development Plan were reviewed at the Oct 24 meeting of the DRC. Awaiting submittal of the Final Development Plan.
STATUS UPDATE 03/31/2020: E-mailed the applicant to notify that their application has been inactive for more than 120 days and if the Town does not receive notification within 10 days that that they intend to pursue approval, the application will expire.
STATUS 04/23/2020: The Applicant has confirmed they intend to proceed with Development Plan Approval and will be re-submitting applications accordingly.

PROJECT NAME: BUCK ISLAND/SIMMONSVILLE

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-08-20-014478	08/18/2020	42 LAUREL OAK BAY RD	Development Plan	Active	William Howard

Applicant: Thomas & Hutton **Owner:** May River Forest, LLC

PLAN DESCRIPTION: The project consists of the construction of 41 single family lots aqnd associated infrastructure within Block J2 of Palmetto Bluff.

PROJECT NAME: Palmetto Bluff

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-08-20-014525	08/31/2020		Development Plan	Active	William Howard

Applicant: Thomas & Hutton **Owner:** May River Forest, LLC

PLAN DESCRIPTION: General clearing, installation of utilities, drainage, grading and paving for +/- 4.2 miles of road

PROJECT NAME:

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

DP-01-21-014926	01/20/2021	41 CALHOUN ST STREET	Development Plan	Active	William Howard

Applicant: R. Stewart Design, LLC **Owner:** Windsong Investments, LLC

PLAN DESCRIPTION: Restoration, Remodel, Addition to Contributing structure

PROJECT NAME: OLD TOWN

DP-09-20-014563	09/08/2020	35 PONDBERRY ST STREET	Development Plan	Active	William Howard

Applicant: Tarr Group, LLC **Owner:** HEPBLUFF LLC

PLAN DESCRIPTION: 4,200 SF professional dental office with parking and landscaping improvements.

PROJECT NAME: TOWNE CENTRE AT NEW RIVERSIDE

DP-05-20-014246	05/21/2020		Development Plan	Active	William Howard

Applicant: Thomas and Hutton **Owner:** MFH LAND, LLC

PLAN DESCRIPTION: A request by Thomas and Hutton on behalf of MFH Land LLC & Town of Bluffton for the review of the grading, roads, utilities, parks and related infrastructure for Phase 1 of New Riverside Village.

PROJECT NAME: NEW RIVERSIDE VILLAGE

DP-08-20-014479	08/18/2020	38 LAUREL OAK BAY RD ROAD	Development Plan	Active	William Howard

Applicant: Mike Hughes **Owner:** May River Forest, LLC

PLAN DESCRIPTION: The project scope shall consist of general clearing, installation of utilities, storm drainage infrastructure, grading and paving to serve the proposed 41 lots. The tax map number for the proposed development is R614 046 000 0062 0000.

PROJECT NAME: PALMETTO BLUFF PHASE 2

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

DP-10-20-014645	10/06/2020		Development Plan	Active	William Howard

Applicant: Mike Klein **Owner:** Reed Group Consulting, LLC

PLAN DESCRIPTION: 280 multifamily residential units and amenity center on Buckwalter Parcel 10B

PROJECT NAME:

Preliminary Development Plan

DP-08-20-014463	08/11/2020	115 PERSIMMON ST	Development Plan	Active	William Howard

Applicant: Sam Connor **Owner:** May River Commercial Properties LLC

PLAN DESCRIPTION: Commercial office and warehouse space to serve as Contractors office.

PROJECT NAME: SHULTZ TRACT

DP-03-20-014061	03/02/2020		Development Plan	Active	William Howard

Applicant: Thomas & Hutton **Owner:** LSSD NEW RIVERSIDE LLC

PLAN DESCRIPTION: The Applicant is requesting approval to construct 60 residential homes and associated infrastructure as Phase 6 of Heritage at New Riverside. The Preliminary Plan has been placed on the agenda for the May 6 meeting of the DRC.

PROJECT NAME: HERITAGE AT NEW RIVERSIDE PHASE 6

DP-07-20-014377	07/07/2020	2E MILL CREEK BLVD	Development Plan	Active	William Howard

Applicant: Thomas & Hutton **Owner:** DR HORTON

PLAN DESCRIPTION: Cypress Ridge Phase 19 is a 44 single family residential lots with infrastructure

PROJECT NAME: CYPRESS RIDGE PHASE 19

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

DP-07-20-014434	07/29/2020		Development Plan	Active	William Howard

Applicant: Thomas & Hutton **Owner:** Lamar Smith Signature HOmes, LLC

PLAN DESCRIPTION: 60 single family residential lots with infrastructure

PROJECT NAME: HERITAGE AT NEW RIVERSIDE PHASE 7

DP-10-19-013630	10/24/2019		Development Plan	Active	William Howard

Applicant: JK Tiller Associates Inc **Owner:** Speyside

PLAN DESCRIPTION: The applicant is requesting Preliminary Development Plan approval for a mixed-use development (Washington Square) consisting of office space, 36 residential apartments, 52,000 square feet of retail, 7,000 square feet of restaurant, and 80-unit boutique hotel, an assisted living home, and greenspace.
STATUS: The Preliminary Plan will be reviewed at the November 27 DRC meeting.
STATUS 12/12/2019: Awaiting re-submittal to address comments provided on Preliminary Development Plan.
STATUS 02/20/2020: Re-submittal materials have satisfied staff comments. The Preliminary Plan is scheduled for Planning Commission review Feb. 26, 2020.
STATUS 03/02/2020: Planning Commission approved the Preliminary Development Plan. Awaiting Final Plan.

PROJECT NAME: WASHINGTON SQUARE

DP-07-19-013387	07/30/2019	4407 BLUFFTON PKWY	Development Plan	Active	William Howard

Applicant: Thomas and Hutton **Owner:** STOPNSTOR

PLAN DESCRIPTION: The applicant is requesting approval of a development plan to construct an additional 7,500 SF 1 story storage building and stormwater infrastructure on approximately .5 acres.

STATUS 08/26/2019: The Preliminary Development Plan was reviewed at the August21 meeting of the DRC. Awaiting re-submittal to address comments provided to present to the Planning Commission for approval.
STATUS 10/22/2019: Comments on the re-submittal of the Preliminary Plan will be reviewed at the Oct. 30 meeting of the DRC.
STATUS 11/19/2019: Comments were provided at Oct. 30 DRC. Awaiting re-submittal to address comments to present to the Planning Commission.
STATUS 03/02/2020: THe Preliminary Plan was approved at the Feb. 26 meeting of the DRC. Awaiting Final Development Plan.

PROJECT NAME: SHULTZ TRACT

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

DP-01-20-013911	01/23/2020	48 LAWRENCE ST	Development Plan	Active	William Howard

Applicant: Dolnik Properties **Owner:** Dolnik Properties

PLAN DESCRIPTION: The applicant is requesting approval of a development plan to allow a change of use from residential to commercial for a clothing boutique on the ground floor.
Comments on the Preliminary Development Plan will be reviewed at the Feb. 5 meeting of the DRC.
STATUS 02/20/2026: The Preliminary Plan was approved by DRC and will be presented to the Planning Commission 02/26/2020.
STATUS 03/02/02020: The Preliminary Plan was approved by the Planning Commission. Awaiting Final Development Plan.

PROJECT NAME:

DP-08-19-013460	08/19/2019		Development Plan	Active	William Howard

Applicant: O'Reilly Auto Parts **Owner:** O'Reilly Auto Parts

PLAN DESCRIPTION: The applicant is requesting approval of a development plan for the construction of a new commercial building and infrastructure for the purpose of the retail sale of automotive parts and related accessories.
The Preliminary Plan will be reviewed at the September 18 meeting of the DRC.
STATUS: 9/20/2019 Awaiting for resubmittal of plans prior to bringing it to the Planning Commission for approval.
STATUS UPDATE 03/31/2020: E-mailed the applicant to notify that their application has been inactive for more than 120 days and if the Town does not receive notification within 10 days that that they intend to pursue approval, the application will expire.
STATUS UPDATE 09/11/2020: A Preliminary Plan has been re-submiited for review. Comments will be reviewed at the Sept. 16 meeting of the DRC.

PROJECT NAME: SHULTZ TRACT

DP-01-20-013861	01/13/2020		Development Plan	Active	William Howard

Applicant: Thomas & Hutton **Owner:** K Hovananian

PLAN DESCRIPTION: The Applicant is prosing to construct 79 single family lots with associated infrastructure as Phase 2 of Four Seasons at Carolina Oaks.

STATUS 01/22/2020: The plan review has placed on "Hold" and the applicant has been contacted for additional information related to land clearing. The plan review will be re-activated when the additional information and plan changes have been submitted.

PROJECT NAME: Four Seasons at Carolina Oaks

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
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20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-07-20-014412	07/21/2020	2 PARKSIDE DR	Development Plan	Active	William Howard

Applicant: Kelly Little **Owner:** Parcel C5 LLC

PLAN DESCRIPTION: The project proposes to construct a restaurant and retail space with an outdoor pavilion and amphitheater with associated infrastructure.

PROJECT NAME:

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-11-19-013727	11/26/2019		Development Plan	Active	William Howard

Applicant: Thomas & Hutton **Owner:** May River Forest, LLC

PLAN DESCRIPTION: **Final Development Plan 03/02/2020**
The Applicant is proposing to construct 71 single family lots and infrastructure within Block L5 of Palmetto Bluff.
STATUS 12/18/2019: Comments on the Preliminary Plan were reviewed at the Dec. 18 meeting of the DRC. Awaiting Final Development Plan.
STATUS 03/23/2020: The Final Development Plan is under review and will be placed on the agenda of the next meting of the DRC. The date of the meeting is TBD.
STatus 04/22/2020: Comments on the Final Plan will be reviewed at the May 6 meeting of the DRC.

PROJECT NAME: PALMETTO BLUFF PHASE 2

Public Project

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
DP-06-19-013267	06/19/2019		Development Plan	Active	William Howard

Applicant: Beaufort County **Owner:** Beaufort County

PLAN DESCRIPTION: The Applicant is seeking approval of a Development Plan (Public Project) to construct a 3.5 acre pond to treat run-off from Okatie Highway.
Staff Comments were provided at the July 9 meeting of the DRC. Awaiting re-submittal/stormwater permit for Final Approval.

PROJECT NAME:

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
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20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

DP-12-19-013803	12/20/2019		Development Plan	Active	William Howard

Applicant: Town of Bluffton **Owner:** Town of Bluffton

PLAN DESCRIPTION: The town is seeking permits to add pathways along Goethe Rd and Shults Rd in Bluffton, SC. The proposed project will disturb approximately 3.9 acres and occur within the Goethe Rd right of way (from Hwy 46 to Hilderbrand Rd) and Shults Rd right of way (from Eighth Avenue to Hilderbrand Road). Improvements to the roadside swales and drainage infrastructure are also proposed as well as the replacement of some driveways, as necessary to accommodate the proposed walkways.
STATUS 01/23/2020: The Public Project was reviewed at the Jan. 15 meeting of the DRC revisions are required. Awaiting re-submittal.

PROJECT NAME:

DP-11-20-014756	11/13/2020	25 PERSIMMON ST STREET	Development Plan	Active	William Howard

Applicant: WK Dickson **Owner:** Dominion Energy South Carolina, Inc.

PLAN DESCRIPTION: Dominion Energy is proposing to construct a new electric transmission substation and gravel access road located along Persimmon Street.

PROJECT NAME: BLUFFTON PARK PHASE C-1

DP-06-20-014293	06/08/2020		Development Plan	Active	William Howard

Applicant: Cranston Engineering Group **Owner:** Town of Bluffton

PLAN DESCRIPTION: New 5' concrete sidewalk in the Simmonsville Rd r/w, minor grading, stormwater infrastructure.

PROJECT NAME:

DP-01-19-012790	01/29/2019		Development Plan	Active	William Howard

Applicant: Town of Bluffton **Owner:** Town of Bluffton

PLAN DESCRIPTION: The Applicant is proposing side walks and related infrastructure along Buck Island Road from the intersection of Kitty Road to 289 Buck Island Road.
STATUS 02/18/2019: Comments on the Public Project were provided at the Feb. 12 meeting of the DRC. The project is Approved with Conditions pending SCDHEC NPDES approval letter.

PROJECT NAME: BUCK ISLAND/SIMMONSVILLE

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
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20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan

DP-10-20-014674	10/15/2020		Development Plan	Active	William Howard

Applicant: Town of Bluffton **Owner:** Town of Bluffton

PLAN DESCRIPTION: Proposed sidewalk along Goethe Road & Shults Road ROW with associated stormwater infrastructure.

PROJECT NAME: Schultz/Goethe

DP-02-19-012875	02/26/2019	52 WHARF ST	Development Plan	Active	William Howard

Applicant: Cranston Engineering Group **Owner:** Town of Bluffton

PLAN DESCRIPTION: New sanitary sewer gravity main in unserved area of Bridge Street.
STATUS 03/21/2019: The Application for Public Project has been entered and is awaiting review and approval of the Stormwater Management Plan. The project will receive review by the DRC upon Stormwater approval.
STATUS 06/20/2019: Comments were provided at the June 18 meeting of the DRC. Awaiting re-submittal for Final Approval.

PROJECT NAME: OLD TOWN

DP-06-19-013227	06/06/2019	125 PRITCHARD ST	Development Plan	Active	William Howard

Applicant: Town of Bluffton **Owner:** Town of Bluffton

PLAN DESCRIPTION: The Applicant is proposing to provide sewer mains on unserved areas of Pritchard Street.
Comments will be reviewed at the June 25 meeting of the DRC.

STATUS 07/22/2019: Comments were reviewed at the June 25 meeting of the DRC. A re-submittal of the design is required that will minimize the impact to significant oak trees in the project area.

PROJECT NAME: OLD TOWN

Total Development Plan Cases: 44

Development Plan Amendment

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Development Plan Amendment

NA

DPA-06-20-014304	06/12/2020	15 CAPTAINS CV	Development Plan Amendment	Active	William Howard

Applicant: Old Town Dispensary **Owner:** Old Town Dispensary

PLAN DESCRIPTION: Approve revised site plan.

PROJECT NAME:

Total Development Plan Amendment Cases: 1

Master Plan

NA

MP-02-20-014050	02/27/2020		Master Plan	Active	Aubrie Giroux

Applicant: McNair Law Firm, P.A. **Owner:** Bishop of Charleston

PLAN DESCRIPTION: Request for approval of a Master Plan for the Saint Gregory the Great property consisting of approximately 62.80 Acres of land located at 323 Fording Island Road and identified as Beaufort County Tax Map Nos. R600 022 000 0125 0000 & R660 022 000 1120 0000 for a mix of civic, institutional, residential, and commercial uses.
STATUS: Town Council approved the “Intent to Annex”, First Reading of the Annexation Ordinance at their August 12, 2019 meeting. The Applicant previously requested to place this application on hold so they can prepare updated materials to reflect the Town’s desire for them to pursue incorporating the property into the Buckwalter Planned Unit Development Concept Plan Development Agreement as a new planning tract instead of General-Mixed use as requested. To bring the property into Buckwalter, amendments to the Planned Unit Development, Concept Plan, and Development Agreement are necessary which will require the submittal of additional applications and materials. Applicant submitted revised materials and the necessary additional applications on February 21, 2020. Staff is currently reviewing the materials and applications for clarity, content, and completeness. Once Staff’s notes and comments are addressed, the request will be placed on the next available regularly scheduled Planning Commission agenda as a workshop item.

PROJECT NAME: SAINT GREGORY THE GREAT CATHOLIC CHURCH

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Total Master Plan Cases: 1

Master Plan Amendment

Major

MPA-09-19-013530	09/16/2019		Master Plan Amendment	Active	William Howard

Applicant: Thomas and Hutton **Owner:** D.R. Horton

PLAN DESCRIPTION: A request by D.R. Horton, Inc, to amend the Cypress Ridge Master Plan to update the transportation network by adding roads and service lanes to the commercial village area of Mill Creek. The development is zoned Jones Estate Planned Unit Development and is identified by Tax Map ID parcel R614-028-000-1138-0000, located at the intersection of Highway 170 and Mill Creek Blvd. This amendment request is associated with the previous amendment (PD-04-08-363).
STATUS: 9/27/2019 - The request is currently under staff review and is anticipated to be on the October 23, 2019 Development Review Committee meeting agenda.
STATUS 10/23/2019: Comments were provided at the Oct. 16 DRC meeting. A re-submittal to address comments provided is required before presentation to the Planning Commission. Awaiting re-submittal.
STATUS 11/19/2019: The Master Plan Amendment will be presented to the Planning Commission 11/20/2019.
STATUS 12/19/2019: The Master Plan Amendment was approved by the Planning Commission and will be presented at the Jan. 14 meeting of Town Council.
STATUS 01/15/2020: The Master Plan Amendment was presented to the Town Council on Jan. 14. The Amendment was tabled and the Applicant was asked to provide a tree and topo survey of the area where townhomes are proposed for construction

PROJECT NAME: CYPRESS RIDGE

MPA-12-20-014852	12/21/2020		Master Plan Amendment	Active	Kevin Icard

Applicant: J. K. Tiller & Associates, Inc. **Owner:** Year Round Pool Co

PLAN DESCRIPTION: Amendment to the Old Carolina PUD to include BPC Planning area and associated densities and uses.

PROJECT NAME: OLD CAROLINA

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Master Plan Amendment

MPA-03-20-014070	03/02/2020		Master Plan Amendment	Active	Aubrie Giroux

Applicant: Enmarket **Owner:** Grande Oaks II, LLC

PLAN DESCRIPTION: A request by Walter J. Nester, III on behalf of Enmark Station, Inc. for consideration of an amendment to the Buckwalter Commons Phase 1 Master Plan to incorporate certain property consisting of approximately 1.076 Acres of land located at 464 Buckwalter Parkway and identified as a portion of Beaufort County Tax Map No. R600 029 000 0014 0000 to supplement the development of the 9.18 acre Robertson site.

STATUS: Staff is currently reviewing the concurrent applications for Annexation, Zoning Map Amendment, Buckwalter Development Agreement Amendment, Buckwalter Concept Plan Amendment, and Buckwalter Commons Phase 1 Master Plan Amendment and their associated materials for clarity, content, and completeness. Once Staff's notes and comments are addressed, the request will be placed on the next available regularly scheduled Planning Commission agenda as a workshop item.

PROJECT NAME: ROBERTSON SITE

MPA-12-20-014813	12/07/2020		Master Plan Amendment	Active	William Howard

Applicant: Ward Edwards, Inc. **Owner:** PKP Group LLC

PLAN DESCRIPTION: Rezoning to Planned Unit Development, Old Carolina PUD to authorize multi family use with six (6) units per acre.

PROJECT NAME: OLD CAROLINA

Total Master Plan Amendment Cases: 4

Subdivision Plan

General

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Subdivision Plan

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
SUB-01-21-014904	01/13/2021	3 FLAT CREEK DR DRIVE	Subdivision Plan	Active	Alan Seifert

Applicant: Thomas & Hutton **Owner:** Ali Seabaugh

PLAN DESCRIPTION: Hampton Lake Phase 2 - The Lake (Subdivision): A request by Rusty Windsor of Thomas & Hutton on behalf of Ali Seabaugh of HL Development, LLC, owner, for review of a Subdivision Plan for the division of 36.64 acres to create a separate parcel for the lake within the Hampton Lake Community. The property is zoned Buckwalter PUD and therefore, should be reviewed based on the requirements set forth in the Buckwalter Development Agreement, Concept Plan, and Town of Bluffton Stormwater Design Manual.
STATUS [01/25/2021]: The application is being reviewed by Staff for conformance with the Buckwalter Development Agreement, Concept Plan, and Town of Bluffton Stormwater Design Manual and will be reviewed by the DRC at the February 17th meeting.

PROJECT NAME: HAMPTON LAKE PHASE 2

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
SUB-01-21-014911	01/19/2021	71 CALHOUN ST STREET	Subdivision Plan	Active	Alan Seifert

Applicant: Ward Edwards, Inc. **Owner:** Cunningham, LLC

PLAN DESCRIPTION: 71 Calhoun Street (Subdivision): A request by Ward Edwards Engineering on behalf of Cunningham South Carolina, LLC, owner, for review of a Subdivision Plan for the division of 0.903 acres into 3 mixed-use lots. The property is identified by tax map number R610 039 00A 0099 0000. The property is zoned Neighborhood Center-Hd and therefore, should be reviewed based on the requirements set forth in the Town of Bluffton Unified Development Ordinance and Stormwater Design Manual.
STATUS [01/25/2021]: The application is being reviewed by Staff for conformance with the Town of Bluffton Unified Development Ordinance and will be reviewed by the DRC at the February 3rd meeting.

PROJECT NAME: OLD TOWN

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
SUB-01-21-014905	01/13/2021		Subdivision Plan	Active	Alan Seifert

Applicant: Thomas and Hutton **Owner:** University Investments, LLC

PLAN DESCRIPTION: Parcel 12-A-1 (Subdivision): A request by Nathan B. Long of Thomas & Hutton on behalf of John Reed of University Investments, LLC, owner, for review of a Subdivision Plan for the creation of Parcel 12A-1, 0.155 acres, from parent parcel 12A. The property is identified as parcel #R610-029-000-0611-0000. The property is zoned Buckwalter PUD and therefore, should be reviewed based on the requirements set forth in the Buckwalter Development Agreement, Concept Plan, and Town of Bluffton Stormwater Design Manual.
STATUS [01/25/2021]: The application is being reviewed by Staff for conformance with the Buckwalter Development Agreement, Concept Plan, and Town of Bluffton Stormwater Design Manual and will be reviewed by the DRC at the February 17th meeting.

PROJECT NAME: Buckwalter

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Subdivision Plan

SUB-11-20-014778	11/23/2020	28 DUBOIS LN LANE	Subdivision Plan	Active	Alan Seifert

Applicant: Carol Healy **Owner:** Carol Healy

PLAN DESCRIPTION: 28 Dubois Lane (Subdivision): A request by C & C Preservation on behalf of Carol Healy and Cathy Cockman, owners, for review of a Subdivision Plan for the division of .49 acres into 2 single-family lots along with an associated access easement. The property is identified by tax map number R610 039 00A 0256 0000. The property is zoned Neighborhood General-Hd and therefore, should be reviewed based on the requirements set forth in the Town of Bluffton Unified Development Ordinance and Stormwater Design Manual.
STATUS [01/06/2021]: The application was reviewed by Staff for conformance with the Town of Bluffton Unified Development Ordinance and reviewed by the DRC at the December 30th meeting. Town Staff are currently awaiting a re-submittal to address comments from DRC.

PROJECT NAME: OLD TOWN

SUB-09-20-014606	09/21/2020	675 NEW RIVERSIDE RD ROAD	Subdivision Plan	Active	Alan Seifert

Applicant: Thomas & Hutton **Owner:** K Hovananian

PLAN DESCRIPTION: The Lakes at New Riverside - Phase 1C (Subdivision): A request by Mike Hughes of Thomas & Hutton on behalf of K. Hovnanian, Jeff Wiggins, owner, for review of a Subdivision Plan for the division of 5.802 acres into 23 single-family lots along with associated right of way and common areas. The property is identified by tax map number R610 044 000 0140 0000 and is located within the New Riverside Parcel 9 Master Plan. The property is zoned New Riverside PUD and therefore, should be reviewed based on the requirements set forth in the DSO 90/3 and its modifications and Town of Bluffton Stormwater Design Manual.
STATUS [10/16/2020]: The application is currently being reviewed by Staff for conformance with the New Riverside Development Agreement and Planned Unit Development documents and is scheduled for review by the DRC at the October 21th meeting.
STATUS [1-25-2021]: Awaiting submittal and approval of the required surety bond. Once approved, the application may be stamped and recorded.

PROJECT NAME: NEW RIVERSIDE -PARCEL 9

SUB-04-17-010766	04/03/2017		Subdivision Plan	Active	Katie Peterson

Applicant: Armando Servin **Owner:** Armando Servin

PLAN DESCRIPTION: A request by Armando Servin Rosales, for the approval of a Subdivision Plan. The proposed subdivision will divide the existing parcel into two parcels. The property is located on Buck Island Road within the Residential General Zoning District. The property is identified by tax map number R640 031 000 016A 0000. The application was heard at the April 25, 2017 DRC meeting and comments were provided to the applicant.
STATUS: Awaiting Applicant submittal of sewer connection confirmation.

PROJECT NAME: BUCK ISLAND/SIMMONSVILLE

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Subdivision Plan

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
SUB-10-20-014646	10/06/2020	3702 OKATIE HWY HIGHWAY	Subdivision Plan	Active	Alan Seifert

Applicant: John Paul Moore **Owner:** K Hovananian

PLAN DESCRIPTION: Four Seasons - Phase 1C (Subdivision): A request by John Paul Moore of Thomas & Hutton on behalf of K. Hovnanian, Jeff Wiggins, owner, for review of a Subdivision Plan for the division of 9.559 acres into 31 single-family lots along with associated right of way and common areas. The property is identified by tax map number R614 036 000 3372 0000 and is located within the Cypress Ridge Master Plan. The property is zoned Jones Estate PUD and therefore, should be reviewed based on the requirements set forth in the DSO 90/3 and its modifications and Town of Bluffton Stormwater Design Manual.
STATUS [10/30/2020]: The application is currently being reviewed by Staff for conformance with the Jones Estate Development Agreement and Planned Unit Development documents and is scheduled for review by the DRC at the November 4th meeting.
STATUS [1-25-2021]: Awaiting submittal and approval of the required surety bond. Once approved, the application may be stamped and recorded.

PROJECT NAME: Four Seasons at Carolina Oaks

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
SUB-08-19-013391	08/01/2019	21 LITTLE POSSUM LN	Subdivision Plan	Active	Katie Peterson

Applicant: Progressive Tax Services **Owner:** Progressive Tax Services

PLAN DESCRIPTION: A request by James Barnwell for approval of a Subdivision Plan. The project consists of subdividing one lot into seven lots. The property is zoned Residential General and consists of approximately 1.5 acres identified by tax map numbers R610 039 000 210B 0000 and R610 039 000 210A 0000 located at 21 and 33 Little Possum Lane.
STATUS: The application was reviewed at the August 21st meeting of the DRC where comments were provided to the Applicant. Staff is awaiting revised materials addressing comments.

PROJECT NAME: BUCK ISLAND/SIMMONSVILLE

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
SUB-11-20-014745	11/09/2020		Subdivision Plan	Active	Alan Seifert

Applicant: John Paul Moore **Owner:** K Hovananian

PLAN DESCRIPTION: The Lakes at New Riverside - Phase 1D (Subdivision): A request by Mike Hughes of Thomas & Hutton on behalf of K. Hovnanian, Jeff Wiggins, owner, for review of a Subdivision Plan for the division of 12.180 acres into 32 single-family lots along with associated right of way and common areas. The property is identified by tax map number R610 044 000 0140 0000 and is located within the New Riverside Parcel 9 Master Plan. The property is zoned New Riverside PUD and therefore, should be reviewed based on the requirements set forth in the DSO 90/3 and its modifications and Town of Bluffton Stormwater Design Manual.
STATUS [12/4/2020]: The application is currently being reviewed by Staff for conformance with the New Riverside Development Agreement and Planned Unit Development documents and is scheduled for review by the DRC at the December 9th meeting.
STATUS [1-25-2021]: Awaiting submittal and approval of the required surety bond. Once approved, the application may be stamped and recorded.

PROJECT NAME: NEW RIVERSIDE -PARCEL 9

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Subdivision Plan

SUB-02-17-010618	02/24/2017	22 PHOENIX RD	Subdivision Plan	Active	Katie Peterson

Applicant: Leona Woodard **Owner:** Terry Johnson

PLAN DESCRIPTION: The applicant is requesting approval to create a second lot from tax map number R610 031 000 0102 0000. The application was on the March 14th DRC meeting agenda, but no applicant was present. The item was tabled to the March 21st DRC meeting. The application was heard at the March 21st DRC meeting and comments provided to the Applicant.
STATUS: Awaiting applicant resubmittal addressing watershed and BJWSA comments.

PROJECT NAME: BUCK ISLAND/SIMMONSVILLE

SUB-09-20-014615	09/25/2020	675 NEW RIVERSIDE RD ROAD	Subdivision Plan	Active	Alan Seifert

Applicant: Michael Hughes **Owner:** K. Hovanian

PLAN DESCRIPTION: The Lakes at New Riverside - Phase 1E (Subdivision): A request by Mike Hughes of Thomas & Hutton on behalf of K. Hovnanian, Jeff Wiggins, owner, for review of a Subdivision Plan for the division of 5.248 acres into 21 single-family lots along with associated right of way and common areas. The property is identified by tax map number R610 044 000 0140 0000 and is located within the New Riverside Parcel 9 Master Plan. The property is zoned New Riverside PUD and therefore, should be reviewed based on the requirements set forth in the DSO 90/3 and its modifications and Town of Bluffton Stormwater Design Manual.
STATUS [10/26/2020]: The application is currently being reviewed by Staff for conformance with the New Riverside Development Agreement and Planned Unit Development documents and is scheduled for review by the DRC at the October 28th meeting.
STATUS [1-25-2021]: Awaiting submittal and approval of the required surety bond. Once approved, the application may be stamped and recorded.

PROJECT NAME: NEW RIVERSIDE -PARCEL 9

SUB-10-20-014644	10/06/2020		Subdivision Plan	Active	Alan Seifert

Applicant: Thomas & Hutton **Owner:** MAY RIVER FOREST

PLAN DESCRIPTION: Palmetto Bluff is a continuing development with Block L5. The project is located within the Palmetto Bluff PUD, finishing development between Block L3 and Block L4. The total project area is +/- 56.3 acres. The Project scope shall consist of general clearing, installation of utilities, storm drainage infrastructure, grading and paving to serve the propose 69 lots.

{Block L5}

PROJECT NAME: PALMETTO BLUFF PHASE 2

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Subdivision Plan

SUB-08-20-014458	08/10/2020		Subdivision Plan	Active	Alan Seifert

Applicant: Carrie's Fun World **Owner:** Carrie's Fun World

PLAN DESCRIPTION: 158 Simmonsville Road (Subdivision): A request by Carolyn Brown, applicant, on behalf of the Heirs of Frazier, owner, for review of a Subdivision Plan for the division of 9.21 acres into 11 single-family lots. The property is identified by tax map number R610 031 000 0019 0000 & R610 031 000 0168 0000. The property is zoned Residential General and, therefore, should be reviewed based on the requirements set forth in the Town of Bluffton Unified Development Ordinance and Town of Bluffton Stormwater Design Manual.
STATUS [09/04/2020]: The application was reviewed by Staff for conformance with the UDO documents and was reviewed by the DRC at the September 9th meeting.
STATUS [09/24/2020]: Staff is currently awaiting a resubmittal of the plat to address comments received during the DRC meeting.

PROJECT NAME:

SUB-11-18-012584	11/19/2018		Subdivision Plan	Active	Katie Peterson

Applicant: Thomas & Hutton **Owner:** HL Development

PLAN DESCRIPTION: A request by Thomas and Hutton, on behalf of HL Development, LLC, for approval of a Subdivision Plan. The project consists of 4 commercial parcels and associated infrastructure to be located on approximately 15 acres. The property is zoned Planned Unit Development, located within the Buckwalter PUD and is identified by tax map number R614 029 000 2050 0000, located west of the existing Hampton Lake community and east of Lawton Station.
STATUS: The application was reviewed by Staff and was placed on the December 12th DRC Agenda for review where comments were provided to the applicant. Awaiting updated materials addressing staff comment.

PROJECT NAME: Buckwalter

Historic District

SUB-08-19-013427	08/12/2019	6 SHELL RAKE ST	Subdivision Plan	Active	Katie Peterson

Applicant: Sunshine Living Properties, LLC **Owner:**

PLAN DESCRIPTION: This application is to divide Lot 31 Shell Rake into two lots, Lot 31 A and Lot 31 B Barnacle Cut Lane and create two future building sites.

Both lots meet UDO lot and road standards and complies with Article 3 of the UDO. The 911 address will also be changed to the addresses shown above.
Once the subdivision has been approved the applicant will provide surveyor sealed copies to be recorded.
The Application was heard by the DRC at their September 11th meeting where comments were provided to the applicant.
STATUS: Staff is awaiting the submittal of a Development Plan amendment and revised plans.

PROJECT NAME: OLD TOWN

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Subdivision Plan

Total Subdivision Plan Cases: 15

Zoning Action

Special Exception

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
ZONE-05-20-014229	05/13/2020	70 10 PENNINGTON DR	Zoning Action	Active	Kevin Icard

Applicant: Nelson Pinto **Owner:** Mathesoya Mgt Corp

PLAN DESCRIPTION: Veterinary clinic specialized in opthalmology (Outpatient only no over night care)

PROJECT NAME:

UDO Text Amendment

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Zoning Action

ZONE-03-18-011836	03/26/2018		Zoning Action	Active	Kevin Icard

Applicant: Town of Bluffton **Owner:** Town of Bluffton

PLAN DESCRIPTION: A request by the Unified Development Ordinance Administrator for consideration of revisions to the following sections of the Town of Bluffton's Municipal Code of Ordinances, Chapter 23, Unified Development Ordinance:

1.1.8 Activities That Do Not Constitute Development; 2.2 Establishment; 3.2 General Application Approval Process; 3.9 PUD Master Plan; 3.18 Certificate of Appropriateness – Historic District (HD); 3.19 Site Feature – Historic District (HD); 3.20.2 Applicability; 3.25 Designation of Contributing Structure; 3.26 Appeals; 4.4 Conditional Use Standards; 5.3.7 Specific Landscaping Standards; 5.15 Old Town Bluffton Historic District; 7.2.2. Illegal Nonconformities; 7.9 Nonconforming Sites Resulting from Right-Of-Way Dedication or Acquisition; 9.2 Definitions; 9.3 Interpretation of Dimensional Standards; and, 9.4 Description of Uses of Land and Buildings
STATUS: 1/29/2019 The Application was heard at the January 23, 2019 Planning Commission meeting where it was recommended for approval to Town Council with conditions related specifically to Public Projects, Minor and Major PUD Master Plans, Development Plans, requiring public notice for various projects and to include language related to appeals.
STATUS: 2/18/2019 The Application will be heard at the March 12th Town Council meeting.
STATUS: 5/28/2019 A portion of the text amendments were approved by Town Council at their March 12, meeting. Additional items will be presented to Town Council at a future date.
STATUS: 4/21/2020 Various UDO text amendments are being reviewed by Planning Commission, and Town Council over the coming months.

PROJECT NAME:

Zoning Appeal

ZONE-03-20-014108	03/11/2020		Zoning Action	Active	William Howard

Applicant: Sarah Kepple **Owner:** Jim Merli

PLAN DESCRIPTION: Review of the Buckwalter PUD interpretation; was it written to protect adjacent Beaufort Co. property or do adjacent wetlands and rural residential setback requirements provide enough buffer for our property use?
STATUS 4/21/2020 Due to COVID-19, this project is being held until such time that staff can hold an in-person Public Hearing.

PROJECT NAME:

Zoning Map Amendment

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Zoning Action

ZONE-12-20-014855	12/21/2020		Zoning Action	Active	Kevin Icard

Applicant: Ward Edwards, Inc. **Owner:** PKP Group LLC

PLAN DESCRIPTION: Rezoning to PUD, Old Carolina PUD to authorize multi family use with six (6) units per acre.

PROJECT NAME: OLD CAROLINA

ZONE-12-20-014853	12/21/2020		Zoning Action	Active	Kevin Icard

Applicant: J. K. Tiller & Associates, Inc. **Owner:** Year Round Pool Co

PLAN DESCRIPTION: Amendment to the Old Carolina PUD to include BPC Planning area and associated densities and uses.

PROJECT NAME: OLD CAROLINA

ZONE-07-19-013331	07/10/2019		Zoning Action	Active	William Howard

Applicant: Walter J Nester III **Owner:** Bishop of Charleston

PLAN DESCRIPTION: 1)A request for an Ordinance to approve an amendment to the Buckwalter Planned Unit Development Text to incorporate provisions for a New Land Use Tract to be Known as the Saint Gregory the Great Tract; and 2) A request for an Ordinance approving Zoning Map Amendment for approximately 61.093 acres located at 323 Fording Island Road and identified by Beaufort County Tax Map Nos. R600 022 000 0125 0000 and R600 022 000 1120 0000 to rezone the subject property to Buckwalter Planned Unit Development (PUD) subject to a new Saint Gregory the Great Land Use Tract
STATUS: Town Council approved the "Intent to Annex", First Reading of the Annexation Ordinance at their August 12, 2019 meeting. The Applicant previously requested to place this application on hold so they can prepare updated materials to reflect the Town's desire for them to pursue incorporating the property into the Buckwalter Planned Unit Development Concept Plan Development Agreement as a new planning tract instead of General-Mixed use as requested. To bring the property into Buckwalter, amendments to the Planned Unit Development, Concept Plan, and Development Agreement are necessary which will require the submittal of additional applications and materials. Applicant submitted revised materials and the necessary additional applications on February 21, 2020. Additional revisions including a reduction of the requested number of residential development rights from 449 to 150 were submitted following Planning Commission's Workshop on the proposed Annexation and Zoning Map Amendment held on July 22, 2020. Planning Commission will hold a Public Hearing and Recommendation to Town Council on October 28, 2020. Town Council is scheduled to hold Ordinance First Readings at their January 6, 2021 meeting. Town Council is then scheduled to hold Public Hearings and Ordinance Second and Final Readings at their February 9, 2021 meeting.

PROJECT NAME: SAINT GREGORY THE GREAT CATHOLIC CHURCH

Growth Management Application Update Report

Town of Bluffton
Department of Growth Management
Office of Planning and Community Development
20 Bridge Street P.O. Box 386 Bluffton, South Carolina 29910

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr

Active Cases

Zoning Action

Case Number	Application Date	Property Address	Plan Type	Plan Status	Plan Mgr
ZONE-08-20-014518	08/28/2020		Zoning Action	Active	Kevin Icard

Applicant: JK Tiller Associates Inc **Owner:** Huggins Hollow LLC

PLAN DESCRIPTION: Request for an Ordinance for a Zoning Map Amendment to designate the annexation of the Huggins Hollow properties consisting of approximately 36.26 acres located on Gibbet Road and identified as Beaufort County Tax Map Nos. R600 036 000 001F 0000, R600 036 000 001D 0000, R600 036 000 0364 0000, R600 036 000 001H 0000, R600 036 000 0001 0000, and R600 036 000 0439 0000 as Agricultural (AG) pursuant to the Town of Bluffton Unified Development Ordinance, as amended.

STATUS: Staff is currently reviewing the materials and applications for clarity, content, and completeness before scheduling Town Council Annexation Ordinance First Reading “Intent to Annex”.

PROJECT NAME: HUGGINS HOLLOW

Total Zoning Action Cases: 7

Total Active Cases: 105

Total Plan Cases: 105

INTEROFFICE MEMORANDUM

TO: MEMBERS OF TOWN COUNCIL

FROM: SCOTT M. MARSHALL, INTERIM TOWN MANAGER

SUBJECT: INTERIM TOWN MANAGER MONTHLY REPORT – JANUARY 2021

DATE: JANUARY 31, 2021

CC: KIM CHAPMAN, TOWN CLERK

Town Operations / Community Meetings

- January 20
  - Budget meeting with Human Resources and Finance
  - Strategic Planning Workshop preparations meeting with Marc Orlando and Lindsay Housaman
  - Budget meeting with Engineering and Finance
  - Executive Office budget meeting with Finance and Town Clerk
- January 21
  - Comprehensive Plan kickoff meeting with Growth Management staff and MKSK
  - Buck Island-Simmonsville Lighting Project Follow-up meeting with Palmetto Electric and Engineering staff
  - Beaufort County Economic Development Committee meeting
- January 26
  - Meeting with Engineering and Finance on FY22 CIP Requirements
  - Budget meeting with Chief Price and Finance
- January 27
  - Meeting with Interim Beaufort County Administrator, members of Beaufort County Finance Staff, Chris Forster and Marc Orlando regarding MCIP revenues
- January 28
  - Orientation meeting with Lee Levesque, Emergency Manager and Lieutenant Mike Danyov
  - Budget meeting with Engineering and Finance

Town Council / Attorney Related Meetings

- January 21 - Meeting with Mayor Sulka and Marc Orlando
- January 25 - Town Council annual strategic planning workshop
- January 28 - Meeting with Mayor Sulka and Mayor Pro-Tem Hamilton
- January 29 - Meeting with Terry Finger, Heather Colin and Aubrie Giroux regarding Palmetto Bluff Development Agreement

TOWN COUNCIL

STAFF REPORT
Engineering Department

MEETING DATE:	February 9, 2021
PROJECT:	Consideration of a Resolution to Adopt the May River Watershed Action Plan Update as a Supporting Document to the Comprehensive Plan
PROJECT MANAGER:	Bryan McIlwee, P.E., Director of Engineering

RECOMMENDATION:

Staff recommends that Town Council approve a Resolution to adopt the "May River Watershed Action Plan Update & Modeling Report" as a supporting document to the Town of Bluffton's Comprehensive Plan and authorize its implementation.

BACKGROUND/DISCUSSION:

Following a 2009 shellfish harvesting classification down-grade in the Headwaters of the May River, Town Council tasked Staff to work with Beaufort County, stakeholders, and a consultant team to develop a plan to improve conditions in the May River and protect all of the outstanding natural resources as outlined in the Comprehensive Plan.

The resulting May River Watershed Action Plan (Action Plan) was adopted on November 9, 2011 via Resolution as a supporting document to the Town's Comprehensive Plan. The Action Plan established a framework to synthesize all May River Watershed efforts and was the driver to collect background information, assimilate baseline data, identify problems, and implement solutions for the May River Watershed. The Action Plan established priorities, identified funding opportunities, coordinated project specific partners and timelines, and identified mechanisms for measuring the success of all Action Plan initiatives.

On May 8, 2012 Town Council established the May River Watershed Action Plan Advisory Committee to advise the Town on future and existing Action Plan strategies aimed at restoring shellfish harvesting in the May River. The Action Plan was designed to be dynamic and flexible to incorporate new State of the Knowledge information, and thus, be a "living" document to be periodically updated.

Since the Action Plan's 2011 adoption and subsequent implementation over nearly ten (10) years, land use conditions, stormwater Best Management Practices (BMPs), and State of the Knowledge for fecal coliform management have changed. Thus, the time has arrived to assess the Action Plan against these current conditions for relevancy of recommendations. Updating the Action Plan was a Fiscal Years 2019 – 2020 Strategic Plan Priority.

A Project Team of consultants developed water quality models for the four (4) Headwaters subwatersheds of the May River – Stoney Creek, Rose Dhu Creek, Duck Pond, and Palmetto Bluff. The intent of this modeling effort was to estimate pollutant loading and the potential impact of various types of Best Management Practices for the current conditions.

The results of the models were used to evaluate 2011 Action Plan recommendations against these current land use conditions, stormwater Best Management Practices, and State of Knowledge. Where appropriate, new recommendations for policies, programs, projects, and partnerships were developed and constitute the "May River Watershed Action Plan Update & Modeling Report."

MAY RIVER WATERSHED ACTION PLAN UPDATE & MODELING REPORT:

As the "May River Watershed Update & Modeling Report" is lengthy and technical in nature the following summary is provided to guide review. Most pertinent sections for review are in **bold**.

1. **Executive Summary** provides an overview of the project background, findings and interpretation, current state of knowledge concerning fecal coliform fate and transport, and an overview of proposed recommendations for the Town.
2. **1.0 Introduction** includes more detailed project background including the purpose of the document and the Project Team's tasks to 1) develop water quality models to compare current conditions (2018) to pre-shellfish impairment conditions (2002) to develop pollutant load reduction estimates, and 2) evaluate 2011 Action Plan BMPs for appropriateness under current conditions and provide up to eleven (11) alternative projects and preliminary cost estimates.
3. **2.0 Model Setup; 3.0 Model Calibration, and 4.0 Water Quality Model Results** details the methodology used by the Project Team to establish and calibrate the models and the model outputs. This highly technical information is necessary for future Water Quality (WQ) Model calibration and use for consistency.
4. **5.0 Recommendations** includes strategies to improve the Town's monitoring efforts to calibrate the WQ Model further (§5.1), strategies and BMPs for bacteria reduction (§5.2), an evaluation of 2011 Action Plan BMP projects (§5.3), and methodology used to develop 2020 Action Plan Update recommended projects (four septic to sewer conversion projects and eleven stormwater BMP retrofit projects) with cost-estimates and ranking/prioritization (§5.4).
5. **6.0 Conclusions** offers a summary of the WQ Model results in context of current state of knowledge.
6. **7.0 References** documents the prior research findings used to inform recommendations.
7. **Appendices** reference supporting materials:
    a. Montie et al. (2019) "Technical Report: Historical Analysis of Water quality, Climate Change Endpoints, and Monitoring in Natural Resources in the May River,"
    b. Technical Memo from Dr. Rachel Noble,
    c. Watershed Treatment Model Spreadsheets, and
    d. Detailed Project Cost Estimate Spreadsheets.

MAY RIVER WATERSHED ACTION PLAN ADVISORY COMMITTEE RECOMMENDATION:

The May River Watershed Action Plan Advisory Committee unanimously voted on January 21, 2021 that Town Council approve the "May River Watershed Action Plan Update & Modeling Report" as a supporting document to the Comprehensive Plan.

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NEXT STEPS:

"May River Watershed Action Plan Update & Modeling Report" Adoption	Date	Complete
Step 1. May River Watershed Action Plan Advisory Committee – Status Update	December 3, 2020	✓
Step 2. Town Council – Workshop	January 19, 2020	✓
Step 3. May River Watershed Action Plan Advisory Committee – Recommendation to Town Council	January 21, 2020	✓
Step 4. Town Council Meeting – Resolution to Adopt (*Anticipated*)	February 9, 2020	✓

SUMMARY:

The approval of the "May River Watershed Action Plan Update & Modeling Report" as a supporting document to the Town's Comprehensive Plan is consistent with the Comprehensive Plan and the May River and Surrounding Rivers and Watersheds Focus Area as a priority within the Fiscal Years 2019 - 2020 Strategic Action Plan. As a result, Town Staff recommends that Town Council approve a Resolution to adopt "May River Watershed Action Plan Update & Modeling Report" as a supporting document to the Comprehensive Plan and authorize staff to begin its implementation.

ATTACHMENTS:

1. Resolution Approving the Adoption of the "May River Watershed Action Plan Update & Modeling Report" as a Supporting Document to the Comprehensive Plan
2. "May River Watershed Action Plan Update & Modeling Report" (McCormick Taylor and Moffatt & Nichol, 2020)
3. Recommended Motion

RESOLUTION

APPROVING THE ADOPTION OF THE "MAY RIVER WATERSHED ACTION PLAN UPDATE & MODELING REPORT" AS A SUPPORTING DOCUMENT TO THE COMPREHENSIVE PLAN

WHEREAS, the Town of Bluffton is a coastal community that has historically had strong ties to its local waterbody, the May River; and

WHEREAS, the River is significant to the community for a number of reasons, including:

- its aesthetics and views which increase the popularity of the area for continued residential and commercial growth;
- its numerous natural resource populations that are directly harvested and utilized by local and regional residents;
- its economic impacts, both direct and indirect, to the community;
- its Outstanding Resource Waters (ORW) designation from the SC Department of Health & Environmental Control – Environmental Quality Control's (SC DHEC-EQC) Bureau of Water;
- its designation as a Priority Watershed by US Environmental Protection Agency and SC DHEC; and

WHEREAS, all of these facets of the River help provide a sense of community character and pride that is locally and regionally recognized; and

WHEREAS, in 2009 for the first time in its history, portions of the May River experienced a shellfish harvesting classification down-grade due to an increased level of fecal coliform in its headwaters; and

WHEREAS, in response to the classification change the Town of Bluffton and Beaufort County agreed to work together along with the citizens to take action and develop a plan to improve conditions in the May River and protect all of the outstanding natural resources as outlined in the Comprehensive Plan; and

WHEREAS, on November 9, 2011 Town Council adopted the May River Watershed Action Plan to establish priorities, identify funding opportunities, coordinate project specific partners and timelines, and identify mechanisms for measuring the success of all Plan initiatives to address water quality issues throughout the watershed; and

WHEREAS, on May 8, 2012 Town Council established the May River Watershed Action Plan Advisory Committee to advise the Town on future and existing Plan strategies aimed at restoring shellfish harvesting in the May River; and

WHEREAS, the Plan was designed to be dynamic and flexible to incorporate new State of the Knowledge information, and thus, be a "living" document to be periodically updated; and

WHEREAS, since the Plan's 2011 adoption, land use conditions, stormwater Best Management Practices, and State of the Knowledge for fecal coliform management have changed and thus updating the Action Plan was identified as a priority in the Town's Fiscal Years 2019 – 2020 Strategic Plan; and

WHEREAS, the 2011 Plan recommendations were assessed against these current conditions and stormwater Best Management Practices, and State of Knowledge and new recommendations for policies, programs, projects, and partnerships were developed as the "May River Watershed Action Plan Update & Modeling Report" (Action Plan Update); and

WHEREAS, the May River Watershed Action Plan Advisory Committee unanimously recommended on January 21, 2021 that Town Council adopt the Action Plan Update as a supporting document to the Town's Comprehensive Plan.

NOW, THEREFORE, BE IT RESOLVED BY THE TOWN COUNCIL AS FOLLOWS:

1. The Town Council hereby approves, confirms and adopts the "May River Watershed Action Plan Update & Modeling Report" as a supporting document to the Town's Comprehensive Plan.
2. The Town Council hereby grants Staff the authority to administer and implement the "May River Watershed Action Plan Update & Modeling Report."

THIS RESOLUTION SHALL TAKE FULL FORCE AND EFFECT ON FEBRUARY 9, 2021.

SIGNED, SEALED AND DELIVERED AS OF THIS NINTH DAY OF FEBRUARY 2021.

____

Lisa Sulka, Mayor

Town of Bluffton, South Carolina

ATTEST:

____

Kim Chapman, Town Clerk

Town of Bluffton, South Carolina

May River Watershed Action Plan Update & Modeling Report

November 9, 2020

Prepared For

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B. Technical Memo from Dr. Rachel Noble
C. Watershed Treatment Model Spreadsheets
D. Project Cost Estimate Spreadsheets

Executive Summary

Background

The May River is designated as an Outstanding Resource Water by the SC Department of Health and Environmental Control (SCDHEC) and is valued particularly for its oyster production, aesthetic qualities, and recreational opportunities. The entire May River watershed is 13,477 acres and accounts for approximately 39% of the entire Town of Bluffton area. The May River watershed is divided into seven subwatersheds, with the Headwaters comprising 12,257 acres and includes four subwatersheds: Duck Pond (683 acres); Palmetto Bluff (1,926 acres); Rose Dhu Creek (4,168 acres); and Stoney Creek (5,480 acres). Development within the Town saw a rapid increase in population from 794 residents in 1990 to 12,530 people in 2010 and an estimated 25,557 people in 2019 (US Census Bureau, 2020). The resulting changes in land use over this time period saw an increase in impervious surfaces in the Headwaters of the May River from 5.78% in 2002 to 15.31% in 2018. The Rose Dhu Creek and Stoney Creek basins are the most impervious at 19.74% and 15.49%, respectively.

Simultaneously with increasing development, rising fecal coliform (FC) bacteria levels in the river's Headwaters have created water quality impairments for shellfish harvesting and necessitated the closure of the shellfish harvesting beds in this portion of the May River in 2009. Multiple agencies including SCDHEC, Beaufort County, and the Town of Bluffton, have been conducting rigorous monitoring for fecal coliform. The Town is also conducting microbial source tracking in the May River and in upland tributaries. The Town's microbial source tracking (MST) program has detected human, deer, and dog markers within the May River. As a result of field investigations, five failing septic systems have been eliminated in the Headwaters and there are plans to convert more areas to sanitary sewer in partnership with Beaufort County and Beaufort-Jasper Water and Sewer Authority (BJWSA). In addition to these sources of fecal coliform, results from recent studies (Sanger and Tweel et al., 2015; Montie, 2019), combined with the Town of Bluffton FC hotspot Water Quality monitoring program, indicate that increased stormwater runoff volume from development is a key contributor to both stormwater volume and pollutant loading in the May River.

This knowledge resulted in the Town developing a volume-based stormwater ordinance in 2010 and the May River Watershed Action Plan (Action Plan) in 2011. The Action Plan has a parallel approach to protect and restore shellfish harvesting throughout the May River and lists multiple strategies and project recommendations, primarily stormwater pond modifications or construction. The Town's priority has been to implement Action Plan projects and refine its understanding of what water quality improvements can be expected following completion.

Based upon the Action Plan, the Town has successfully secured five (5) EPA 319 Grant awards from SCDHEC for water quality improvement projects implementation. As of 2020, three (3) of these projects have been completed. The first award was used to construct the New Riverside Stormwater Pond in 2013 at one of the hot spots. While the pond effectively reduces fecal coliform concentrations by greater than 95% pre- versus post-treatment, there is no statistically significant decrease in fecal coliform concentrations measured ~1,700 linear feet downstream prior to discharging into the May River. The second 319 Grant for a stormwater volume-reduction Best Management Practice (BMP) project was completed in 2016 and is currently under evaluation.

This project retrofitted an existing stormwater system, permitted before the current volume-based ordinance, with volume control through stormwater reuse for irrigation.

Both of these 319 Grant projects contribute to a better understanding of the true impact of a BMP to improve water quality. The Town will continue to evaluate BMP technologies upon completion. Thus, every project will help the Town refine the Action Plan to be tailored for specific needs and conditions. The Action Plan is intended to be a living document with frequent updates and modifications. It will evolve over time so that successful recommendations and projects are highlighted and expanded on, while less successful and ineffective concepts are removed.

Based upon changing land use conditions throughout the May River watershed, state of knowledge surrounding fecal coliform latency in the environment, and quantified impact of BMPs to downstream water quality, the time has come for a May River Watershed Action Plan Update (Action Plan Update). The Action Plan must maintain consistency and alignment with other official plans and guidance documents, with the goal of protecting the May River Watershed. The Action Plan Update will consist of several simultaneous activities including:

1. Developing a regional, model Stormwater Ordinance & Design Manual;
2. Updating the Stormwater Utility (SWU) Fee Rate Model to project SWU Fee needs for operations, debt service for Capital Improvement Program (CIP) projects, and capital expenditures;
3. On-going fecal indicator bacteria (FIB) and microbial source tracking water quality monitoring;
4. Developing local ability to conduct qPCR microbial source tracking;
5. Completing long-term trend analysis and monitoring of new biological and physical indicators in the May River;
6. Completing a Water Quality Model (WQ Model) for baseline (2002) and current (2018) conditions for the May River watershed using XPSWMM to identify project locations and types. The model initially prioritizes completion of four sub-basins in the Headwaters where the current shellfish harvesting restrictions are located.

Using the WQ Model results and current state of knowledge, the 2011 Action Plan CIP projects will be evaluated in terms of the potential reduction of fecal indicator bacteria (FIB). Cost estimates to implement a total of eleven (11) projects with the highest potential to remove FIB will be developed to inform the Town's SWU Fee and long-range CIP budget. These projects will arise from the 2011 Action Plan project evaluations and new projects resulting from the WQ Model.

FC bacteria persist in fresh water, and the volume of fresh water entering a receiving water body increases with the amount of development on the land. A recent study (Montie et. al., 2019) of the May River (Appendix A) concluded that developed and deforested lands have higher levels of freshwater input into estuaries, which leads to decreased salinity levels. Furthermore, FC levels were higher when salinity levels were lower and this relationship was strongest at SCDHEC sampling stations closest to the Headwaters (Montie et al., 2019). Other studies of tidal creek systems along the coast of South Carolina (Holland et al., 2004; Sanger et al., 2008; and Sanger and Blair et al., 2015) have found that when the impervious cover exceeded 10-20% in a watershed, measurable physical and chemical changes were observed such as altered hydrography, increased salinity variance, altered sediment characteristics, increased chemical contaminants, and increased fecal coliform loadings. Furthermore, measurable impacts were observed in living resources and ecological processes when impervious cover exceeded 20–30%. Health risks and flooding vulnerability of a headwater region become a concern when impervious cover exceeds 10-30%.

Project Findings and Interpretations

Impervious surfaces include roads, buildings, parking lots, and stormwater ponds. In the 2002 baseline condition, the predominant land covers in the subwatersheds contributing to the Headwaters of the May River (the Duck Pond, Palmetto Bluff, Rose Dhu Creek, and Stoney Creek subwatersheds), were evergreen forest (35.55%) and woody wetlands (33.35%). The total amount of developed lands amounted to 1,307.44 acres (10.67%). Within the 123 subcatchments in the Headwaters subwatersheds, 97 were less than 10% impervious; 19 were between 10-20% impervious; and 7 were between 20-30% impervious. The amount of development in each Headwaters' subwatershed, from least to greatest amount, was Duck Pond (9.13%); Stoney Creek (9.63%); Palmetto Bluff (9.66%); and Rose Dhu Creek (12.75%).

In the current 2018 condition, the predominant land covers in the Headwaters subwatersheds of the May River are still evergreen forest (25.71%) and woody wetlands (30.22%). However, the total amount of developed lands amounted to 3,765.46 acres (30.72%). As a result of development, of the 123 subcatchments in the Headwaters subwatersheds, 62 are 0-10% impervious; 28 are 10-20% impervious; 26 are 20-30% impervious; and 7 are more than 30% impervious. The amount of development in each Headwaters subwatershed, from least to greatest amount, is Duck Pond (8.85%); Palmetto Bluff (18.37%); Stoney Creek (25.01%); and Rose Dhu Creek (47.52%). The slight decrease in developed land in Duck Pond is the result of some of the developed open space being classified as either shrub/scrub by the National Land Cover Database.

In order to understand the underlying causes of the FC impairments in the May River Headwaters, and the extent to which development has contributed to them, McCormick Taylor and Moffatt & Nichol analyzed changes in baseline (2002) and current (2018) conditions which involved an analysis of multiple data sources including land use, impervious surfaces, meteorological data, soils, channel network, and water quality monitoring data. A water quality model was developed with the XPSWMM software and calibrated using available monitoring data.

Watershed loading models are subject to high levels of variability and uncertainty. The model itself is an approximation of reality and the model parameters can only be estimated. There is natural variability in land use and cover, meteorology, and management across the watershed. Next, monitoring data provide an imprecise target for model calibration, as laboratory results have their own associated uncertainty based on surface water grab samples providing a measure of water quality at the moment in time when the sample is collected, which may not be fully representative of daily average model predictions. Calibration thus consists of comparing two uncertain numbers, the monitored value and model value.

The XPSWMM model estimates stormwater runoff and FC concentration based on land use (natural land cover, low/medium and high intensity development, presence of septic vs. sanitary sewer systems), impervious cover, infiltration of soils, groundwater flow, and meteorological information (precipitation and evapotranspiration). This model was calibrated using available monitoring data. This report discusses ways that the Town can enhance and improve existing flow and fecal indicator bacteria monitoring efforts, which can be used in the future to recalibrate and refine the existing XPSWMM model. For this project, XPSWMM's Runoff and Sanitary modes were utilized to model both hydrologic behavior and FC concentrations. The net effect of all structural BMPs in the May River Headwaters watersheds model is implicit in the model results (as a function of land use and water quality calibration) at the outlets. In order to allow all users to evaluate the effectiveness of BMPs it was determined that use of the Watershed Treatment Model (WTM, a tool developed by the Center for Watershed Protection) would be the most accommodating option. The decision not to model BMPs in XPSWMM was the result of extensive consultation with the software developer's technical support advisors, who emphasized that XPSWMM modeling both water quality and hydraulics simultaneously is limited. Despite this limitation, the Team still believes that this model is a useful tool that will allow the Town to estimate the effect of current and future BMPs.

The XPSWMM water quality simulation model calculated FC concentrations for the outfalls at each of the four major subwatersheds every seven minutes for an entire year (2002 and 2018). Laboratory measurements of FC are typically given as "most probable number" (MPN) per 100/mL or as colony forming units (CFU) per 100 mL. Both units are equivalent but reflect different EPA approved methodologies for counting bacteria cells. For purposes of this report, to distinguish modeled estimates for bacteria, all results were given as "number of FC" (#) per 100/mL. In Regulation 61-68 Water Classifications and Standards, SCDHEC provides limits for FC concentrations for all water use designations. For shellfish harvesting in Outstanding Resource Waters (ORW), such as the May River, these limits are either for a daily maximum concentration (43 MPN/100 mL) or a monthly average (14 MPN/100 mL).

The modeled average daily maximum FC concentrations in all four subwatersheds were above the SCDHEC threshold. In 2002, the XPSWMM water quality model estimated the average maximum daily FC concentrations (the yearly average of the highest predicted FC concentration for each day) as 583 #/100mL for Rose Dhu Creek; 749 #/100mL for Palmetto Bluff; 827 #/100mL for Duck Pond; and 995 #/100mL for Stoney Creek. In 2018 the model estimated daily maximum FC concentrations in the four subwatersheds as 538 #/100mL for Duck Pond; 650 #/100mL for Rose Dhu Creek; 687 #/100mL for Palmetto Bluff; and 932 #/100mL for Stoney Creek.

Although the modeled FC concentrations are generally higher in 2002 than 2018, the total modeled bacteria load is lower in 2002 as a result of a very large increase in water volume in 2018 (585% increase in annual water volume for the entire Headwaters Watershed region). The increase in runoff is a result of the changes in land use such as the conversion of undeveloped, natural areas to those with more impervious surfaces (in the May River Headwaters, the total amount of impervious surfaces increased from 708 acres in 2002 to 1,876 acres in 2018). This model output is supported by an analysis of SCDHEC monitoring data from 1999 to 2017 in the May River (Montie et al., 2019) which found that FC levels at locations closest to the Headwaters were well above the approved SCDHEC shellfish water quality standard. Additionally, the data showed that FC levels were higher when salinity levels were lower, and this relationship is strongest at SCDHEC sampling stations closest to the Headwaters. Finally, FC levels in the Headwaters increased as population levels grew in the Town of Bluffton, and this relationship was strongest at SCDHEC sampling stations closest to the Headwaters.

The FC load for each subcatchment in each subwatershed is calculated by multiplying the concentration by the corresponding water volume at each time step in the model. In addition to calculating the total load for each subcatchment in the four subwatersheds, the Team also calculated the normalized load (total load divided by the subwatershed area) and rate of change in load (comparison between 2002 and 2018 conditions). In 2002, the XPSWMM water quality model results showed that Stoney Creek had the subcatchment with the greatest FC load and the average overall FC load was greatest in Stoney Creek subcatchments. In 2018, Rose Dhu Creek had the largest subcatchment load and average load. In general, the modeled results showed that total load for each subwatershed, as well as the average subcatchment load, increased by one to two orders of magnitude from 2002 to 2018. All ten of the subcatchments with the highest FC loads are found in subcatchments in the Stoney Creek or Rose Dhu Creek subwatersheds, and all were the same order of magnitude (10^{13} colonies of FC). The normalized loading for all four subwatersheds was on the same order of magnitude for 2002 (10^{9} bacteria/acre) and 2018 (10^{10} bacteria/acre), meaning that the normalized loading was ten times higher in 2018. Stoney Creek had the highest maximum and average normalized loading for both 2002 and 2018.

Bacteria hotspots in the May River Headwaters were identified as the ten subcatchments that had the highest total FC load, highest normalized FC load, and the greatest rate of change from 2002 to 2018. Two subcatchments (SUB-RD-09 and SUB-RD-12) appeared on all three lists. Three subcatchments (SC103, 106, and 112) are listed on both the top total FC load and top normalized FC load.

State of Knowledge Concerning FC Fate and Transport and BMP Efficiency

Because measured FC concentrations are above threshold limits for shellfish harvesting for the May River, the Project Team recruited environmental microbiology expert Dr. Rachel Noble to provide context and recommendations. Dr. Noble's experience with FIB in other coastal communities in North and South Carolina has shown that fecal indicating bacteria (FIB) do not correlate well with the occurrence of pathogens, and they do not identify the source of the contamination. In other words, it is possible to find populations of FIB in the environment that are separate from fecal material and are not associated with a risk of illness. Additionally, many studies – including monitoring efforts by the Town of Bluffton – have documented that FIB can colonize and regrow in biofilms and sediments in the storm drainage system. These constraints of FIB further limit the ability to track the original source of contamination (Burkhart, 2012). In general, human sewage contamination presents the greatest health risk and is a controllable source (fix underperforming septic systems and/or sanitary sewer conveyance systems) to reduce the risk of human exposure to pathogenic viruses and bacteria.

Available information from research indicates that BMP efficiency is variable and dependent on the design, maintenance, and other factors. For example, in some cases a net export of microbes can result due to improper maintenance, regrowth of microbes in the BMP, resuspension during storm events, or direct wildlife deposits (Characklis et al., 2009). Information regarding removal rates of FIB in the International BMP Database (Clary et al., 2010) are variable and dependent on the following, 1) season in which the FIB were quantified; 2) stormwater volume and flows; and 3) the type of FIB being measured. Removal values in coastal SC will most likely be lower than those included in the International BMP Database, which has many studies based on the West Coast. Dr. Noble informed the Project Team and the Town that this is primarily due to 1) SC temperature is higher during most seasons than in west coast environments; 2) SC water sources tend to be blackwater and tannic water, which reduces light penetration; and 3) persistent forms of FC are known to grow in the sediments of systems in SC. Furthermore, Dr. Noble stressed that research has called attention to the nature of temperature-warm, nutrient-rich, stagnant BMPs systems that appear to serve as a reservoir of FIB and at times may also preferentially grow the fecal indicator bacteria.

The International Stormwater BMP database contains approximately 600 pairs of influent and effluent data for fecal coliforms and E. coli. across multiple states. Clary et al. (2008) analyzed the fecal coliform and *E. coli* data and showed that swales and detention basins did not appear to effectively reduce FIB in effluent samples. Datasets for wetlands and manufactured devices were not of adequate size to draw meaningful conclusions, but sometimes these systems showed bacterial growth. The authors concluded that the ability of BMPs to reduce FIB varies widely across BMPs. No single BMP appears to consistently reduce FIB concentrations. Among the BMPs, retention pond and media filters appeared to show some positive trends, but these were not across the board. Additionally, high removal efficiency by a BMP does not always guarantee attainment of bacteria standards when inflow concentrations are high (Wood, 2018). Thus, FIB reduction BMPs may not consistently reduce FC concentrations downstream in receiving waterways.

Faced with these challenges of bacterial regrowth, varying BMP removal efficiencies, and potentially high inflow FC concentrations that cannot be reduced to attain bacteria standards, there is a movement away from stormwater ponds to reduce bacteria loads downstream across the southeastern region. Instead, other practices that encourage runoff reduction are increasingly emphasized. Runoff reduction is defined as "the total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainfall harvesting, engineered infiltration, or extended filtration."

Locally, the reduction of FC concentration and downstream efficacy of the New Riverside Pond, a stormwater pond BMP, has been studied by the Town and researchers at University of South Carolina-Beaufort (USCB). The results of this analysis showed that there was a statistically significant reduction in FC concentrations between the pond influent and pond effluent. Additionally, there was a statistically significant reduction in FC concentrations at a short distance downstream of the pond outlet, for observations before and after the pond was constructed. However, at the outfall to the May River, the was no statistically significant reduction in FC concentrations before and after the pond was constructed. In other words, even though a large stormwater treatment BMP was installed and effectively removed FC, there was not a benefit to the May River because the bacteria levels still increased downstream of the pond.

In particular, in the face of climate change and sea level rise, it has been important to begin to place tidal influence into the context of stormwater conveyance. The impact of higher tidal elevations in low-lying regions such as SC coastal Lowcountry cannot be overstated. This is because the extreme high tides, also known as perigean or king tides, interfere with the conveyance of stormwater to receiving waters. The rising tides have the capability of interfering with stormwater conveyance into receiving waters; adversely impacting sanitary sewer pump station and septic system drain field functionality; creating more frequent or longer duration flooding during storm events; inundating water, wastewater, and stormwater infrastructure by daily high tide (which promotes corrosion and pipe damage, as well as can impede the flow of both stormwater and wastewater conveyance systems); and elevating groundwater levels and increasing saltwater intrusion. There are multiple ways to address tidal influence at the outset, including installing check valves, locating sewer mains outside of tidally flooded areas, removing debris in problem areas, and promoting infiltration in creek and watershed restoration plans. Of initial importance are identifying thresholds at which the performance of the sewage and stormwater conveyance system are compromised.

Recommendations

Recommendations in this report include:

1. Detailing strategies to address current data gaps uncovered during the water quality model development and calibration (§3.0);
2. Establishing future monitoring to assess and calculate bacteria loading (§5.1);
3. Implementing projects, programs and policies that reflect the current state of knowledge regarding stormwater treatment (§5.2) and potential partnerships;
4. Evaluating the remaining proposed 2011 Action Plan projects for relevance under current conditions (§5.3); and
5. Proposing new projects, cost estimates, and ranking/prioritization of these projects to consider for inclusion in the Town's long-range CIP budget (§5.4).

In general, the recommended strategies involve Four Ps: Partnerships, Policies, Programs, and Projects. Overall, the goal will be to follow Better Site Design principles to conserve natural areas including tree canopy, reduce impervious cover, and manage designated stormwater reduction volumes by infiltration and/or filtration techniques as first priority, or other approved volume reduction techniques as second priority. These strategies are in agreement with local research (Holland et al., 2004; Sanger et al., 2008; Sanger and Blair et al., 2015; Sanger and Tweel et al., 2015; Montie, 2019) pertaining to the negative impacts of impervious surfaces in southeastern estuarine environments and are supported with design guidance (such as *Low Impact Development in Coastal South Carolina: A Planning and Design Guide*, Ellis et al., 2014) and in local ordinances. The Town of Bluffton is currently in the process of adopting a new regional stormwater design manual and ordinance with Beaufort County, Jasper County, the City of Beaufort, City of Hardeeville, and Towns of Port Royal and Yemassee.

Partners

The Town should continue to seek and formalize partnerships with a variety of organizations to protect and improve water quality in the May River watershed. These organizations may include Federal, State, County, Academic Institutions, Non-Governmental Organizations and Private Commercial Properties. The level of partnership required may range from short-term, project-specific agreements to long-term Memorandums of Agreement or Understanding to accomplish Action Plan Update objectives.

Policy

Overall, the goal for the Town of Bluffton should be to follow Better Site Design principles to conserve existing natural areas and tree canopy, reduce impervious cover, and manage designated stormwater reduction volumes by infiltration and/or filtration techniques as first priority, or other approved volume reduction techniques as second priority. These strategies are in agreement with national and local research pertaining to the negative impacts of impervious surfaces in southeastern estuarine environments, and are supported with design guidance, such as *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al., 2014) and *Southern Lowcountry Stormwater Design Manual* (Center for Watershed Protection and McCormick Taylor, 2020).

Policies to protect and improve water quality in the May River watershed include:

1. Adopt proposed regional *Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual.*
    a. The Town should incorporate volume reduction BMPs (those that encourage infiltration) within existing and future CIP projects to the maximum extent practical, especially for project locations with well-drained soils (Hydrologic Soil Group A or B)
2. Eliminate clear cutting approach within developed areas.
3. Increase buffer areas and requirements.
4. Increase conservation and open space requirements and require recorded conservation easements.
5. Reduce planned density/re-zone.
6. Increase tree protection/conservation areas and requirements
    a. Increase tree protection area from drip line to an additional 25' from drip line.
7. Offer incentives to renegotiate existing land development agreements to reduce density and meet current environmental objectives.
8. Develop strategies to effectively execute public/private partnerships.

Programs

Continuing and new program recommendations intended to protect and improve water quality in the May River watershed include:

1. Continue to support the Municipal Separate Storm Sewer System (MS4) program in the Town and County as they work to achieve the six (6) Minimum Control Measures.
2. Neighborhood Assistance Program
    a. Septic System Assistance Program to assist Town residents with septic system maintenance to ensure proper functioning until sanitary sewer connections are available.
    b. Septic to Sewer Conversion Program to assist Town residents with offsetting the potential costs to abandon existing septic systems and connect to available public sanitary sewer.
3. Establish an Impervious Area Restoration/Retrofit Program in areas where development pre-dated stormwater management requirements or failed to meet on-site retention of the 95th percentile storm. The purpose of this Program is to target large impervious areas to be retrofitted to meet 95th percentile storm retention of impervious surfaces with infiltration/filtration BMP to the maximum extent possible.
4. Water Quality Monitoring Program modifications include
    a. Developing in-house microbial source tracking
    b. Recommendations for future bacteria monitoring locations
    c. Recommendations for future water flow monitoring locations

Projects

Stormwater ponds are the predominant structural BMP utilized in the May River Headwaters. The total number of ponds has increased from 22 in 2002 to 262 in 2018. In a departure from the recommendations from the 2011 Action Plan, ponds and ditches are not recommended as BMP practices to address the fecal coliform bacteria impairment in the May River. Although they do provide important services for flood attenuation and some pollutant removal, they do not promote the infiltration of precipitation, and thus do not provide any runoff reduction (refer to *Southern Lowcountry Stormwater Design Manual*). Stormwater enters the system and leaves at a controlled flowrate, which is advantageous for flood protection, but may not prevent the persistence of FIB downstream of the practice (as has been documented in the literature and the Town's monitoring data). Recommendations are provided that detail criteria to "retrofit" existing ponds to achieve FC reduction and WQ improvements.

Four (4) septic to sewer conversion projects were evaluated in the Rose Dhu Creek and Stoney Creek subwatersheds: Cahill, Gascoigne, Stoney Creek, and Pritchardville. These projects overlap with 42 subcatchments in the Stoney Creek watershed and 11 in Rose Dhu Creek. Based on WQ Model outputs, these projects alone may potentially reduce FC loading by $3.46x10^{13}$ FC per year.

As part of the Project Scope, eleven (11) project sites (incorporating various individual BMPs) were selected in consultation with the Town (prioritizing subcatchments with FC bacteria hotspot and/or large impervious areas). These sites were evaluated in terms of the potential benefits gained by retrofitting to meet the 95th percentile storm retention, to the maximum extent possible, under the proposed Impervious Area Restoration/Stormwater Retrofit Program. All 11 projects were in Rose Dhu Creek (6 projects) and Stoney Creek (5 projects). These included: Bluffton Early Learning Center (BELC); Boys and Girls Club of Bluffton (BGC); Benton House (BH); Bluffton High School (BHS); Buckwalter Recreation Center (BRC); Lowcountry Community Church (LCC); McCracken Middle School/Bluffton Elementary School (MMSBES); May River High School (MRHS); One Hampton Lake Apartments (OHLA); Pritchardville Elementary School (PES); and Palmetto Pointe Townes (PPT).

The project team in consultation with the Town decided that the spreadsheet-based tool, the Watershed Treatment Model (WTM), allowed for flexibility to quickly analyze and evaluate a variety of stormwater BMPs, including permeable pavement, bioretention, green roofs, rainwater harvesting, filters, and infiltration trenches and chambers. In order to narrow down the extensive list of potential restoration projects to highlight priorities for the May River Headwaters Watersheds, an evaluation matrix was developed (Section 5.4.5 of this report). Each project was scored with respect to feasibility for cost (20 points), location within a subcatchment flagged as a FC bacteria hotspot (10 pts.), subcatchment imperviousness (10 pts.), potential bacteria load reduction (20 pts.), potential runoff reduction (15 pts.), maintenance requirements (15 pts.), potential for agreeable partnerships with landowners (10 pts.), amount of effort required for permitting (15 pts.), how well the surrounding community will respond to the project's installation (10 pts.), and ease of access to the site for both construction and maintenance (10 pts.).

If all 15 of the proposed projects were implemented, the XPSWMM and WTM model results indicate there is the potential to remove 1.67×10^{14} FC bacteria/year from stormwater (for Full stormwater retention volume (SWRv)) or 2.53×10^{14} FC bacteria/year (Reduced SWRv scenario). This is about 35% and 30% of the 2018 FC load for all four subwatersheds in the May River Headwaters.

All of the septic to sewer conversion projects and stormwater retrofit projects were located in the Rose Dhu Creek and Stoney Creek subwatersheds. The total FC load in 2018 for these two subwatersheds was 3.95×10^{14} FC bacteria/year, which accounts for about 83% of the bacteria load for the entire May River Headwaters. The estimated goals for FC reduction in these two subwatersheds are 96.1% and 97% for Rose Dhu Creek and Stoney Creek, respectively, to meet the daily maximum concentration threshold for shellfish harvesting (43 MPN/100 mL). The combination of septic to sewer conversion with the Full SWRv provides about 50% reduction, which is about half of what would be necessary in these watersheds.

The potential benefits of recommended projects was estimated to be 3.46×10^{13} FC reduction for septic to sewer conversion (only calculates benefits of sewer conversions within the Headwaters), 2.99×10^{14} FC reduction for the Full SWRv stormwater retrofit projects, and 2.53×10^{14} FC reduction for the Reduced SWRv projects. The estimated costs of these projects are $20.8 million for septic to sewer conversion (based on 2019 BJWSA cost estimates); $32.7 million for the Full SWRv projects; and $22.6 million for the Reduced SWRv projects.

Additional recommended types of projects beyond the eleven that were modeled include:

1. Impervious Surface Rehabilitation/Retrofit
2. On-site Volume Reduction
3. Modifications to Make Ponds Bacteria Neutral (Pond Retrofit)
4. Proprietary Products to Eliminate Bacteria
5. Nature-Based Solutions

1.0 Introduction

1.1 Project Overview

The May River is designated as an Outstanding Resource Water (ORW) by the SC Department of Health and Environmental Control (SCDHEC) and is valued particularly for its oyster production, aesthetic qualities, and recreational opportunities. Located within the jurisdictional limits of the Town of Bluffton and Beaufort County, the May River Watershed is approximately 13,477 acres and is divided into seven basins, also referred to as subwatersheds (Figure 1). Over nearly the past two decades, rising fecal coliform (FC) bacteria levels in the river's Headwaters have created water quality impairments for shellfish harvesting and necessitated the 2009 closure of portions of the SCDHEC shellfish harvesting beds in the May River Headwaters (Figure 2).

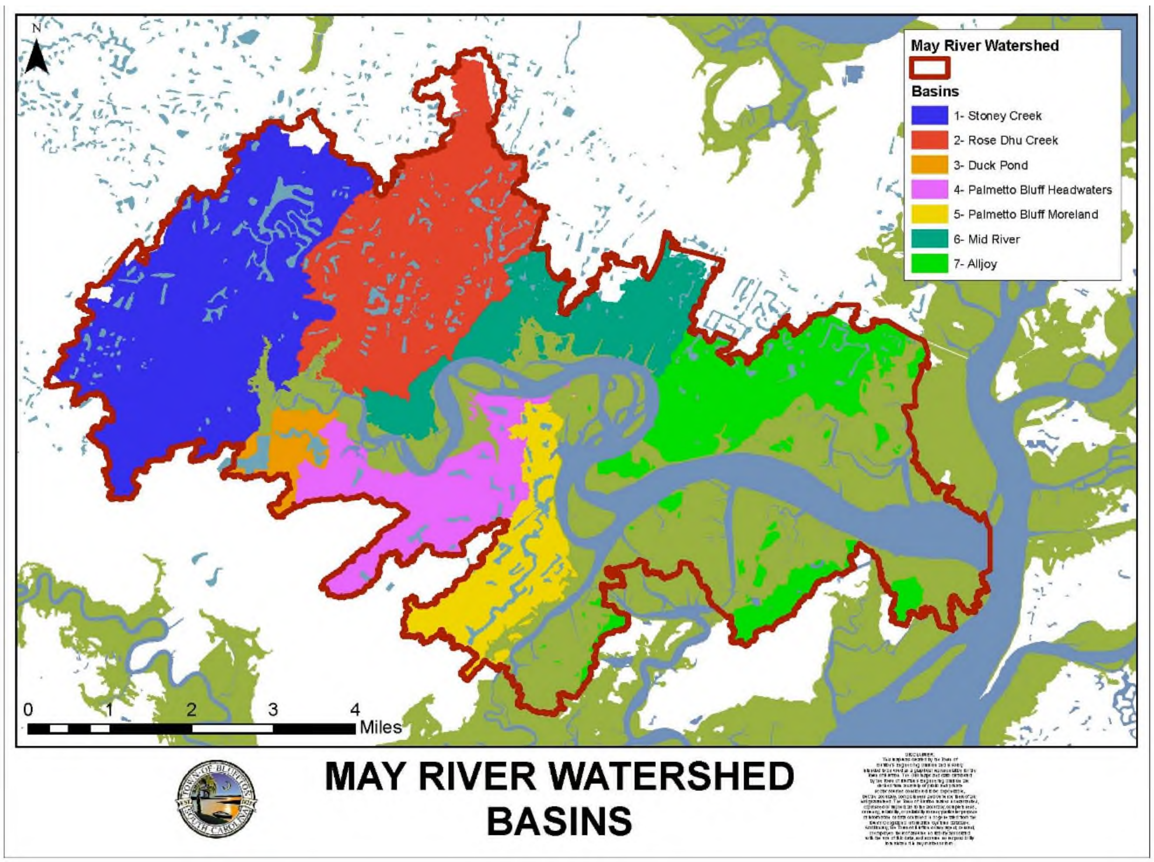


Figure 1. May River Watershed Basins

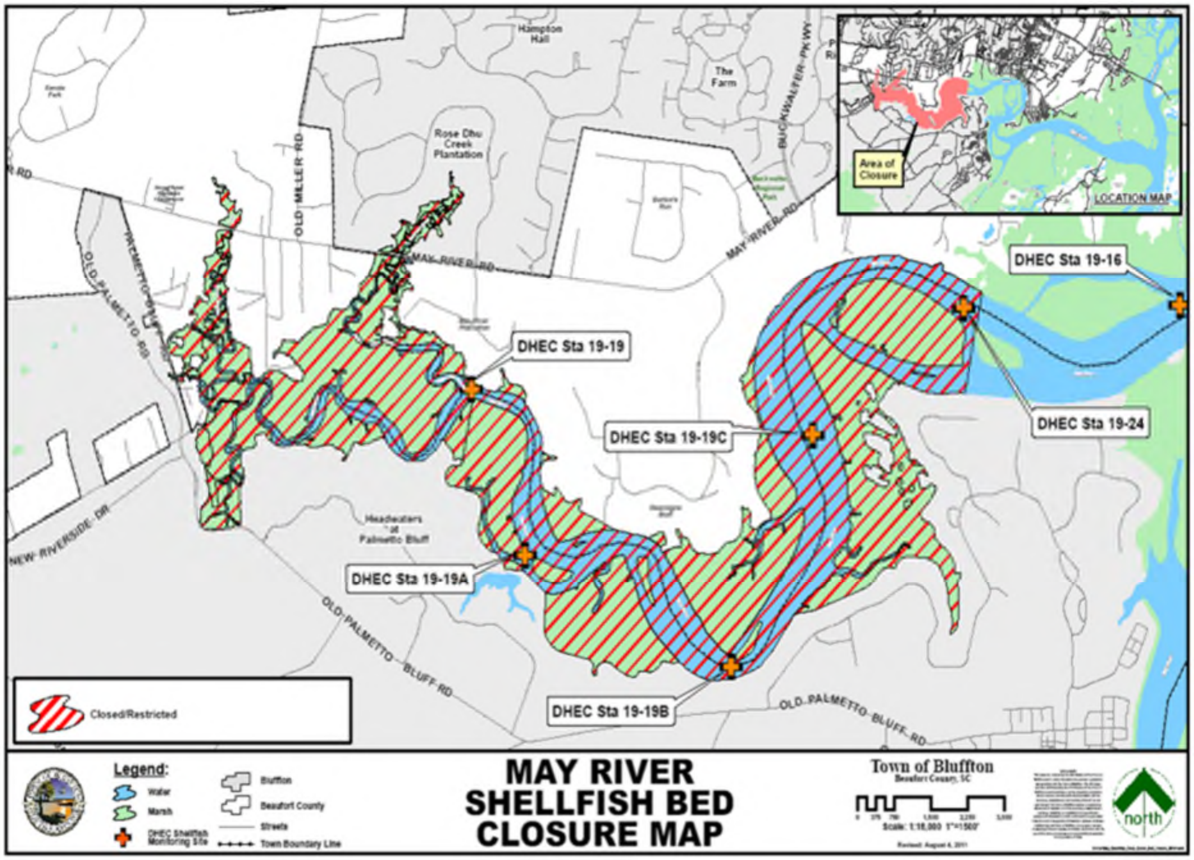


Figure 2. May River Shellfish Bed Closure Map

Through a weekly FC hotspot monitoring program focused in the Headwaters subwatersheds, comprised of the Duck Pond, Palmetto Bluff, Rose Dhu Creek, and Stoney Creek subwatersheds, the Town of Bluffton has identified areas of high FC concentration that contribute to pollutant loading within the May River. The indications from those efforts, as well as prior studies (Sanger et al., 2015; Montie, 2019), are that increased stormwater runoff volume from development is a key contributor to both stormwater volume and pollutant loading downstream, and that the Headwaters of the May River are particularly sensitive to freshwater inputs (as measured by changes in salinity). Development within the Town saw a rapid increase in population from 794 residents in 1990 to 12,530 people in 2010 and an estimated 25,557 people in 2019 (US Census Bureau, 2020). The resulting changes in land use over this time period saw an increase in impervious surfaces in the Headwaters from 5.78% in 2002 to 15.31% in 2018 (as summarized in Table 1). The Rose Dhu Creek and Stoney Creek basins are the most impervious at 19.74% and 15.49%, respectively.

Table 1: Change in Impervious Area in May River Headwaters

Subwatershed	Total Area (Acres)	2002 Impervious*		2018 Impervious*	
		Acres	%	Acres	%
Duck Pond	683.10	18.90	2.77%	18.90	2.77%
Palmetto Bluff	1,925.53	117.24	6.09%	186.24	9.67%
Rose Dhu Creek	4,168.06	342.00	8.21%	822.60	19.74%
Stoney Creek	5,480.16	229.79	4.19%	848.71	15.49%
TOTAL	12,256.85	707.93	5.78%	1,876.44	15.31%

*calculated from Town of Bluffton GIS files and referencing historic aerial imagery

The Town in partnership with a consultant team, stakeholders, and Beaufort County undertook a year-long planning effort to develop the May River Watershed Action Plan (Action Plan; AMEC et. al., 2011) to restore and protect shellfish harvesting throughout the length of the May River. The Action Plan lists multiple strategies and project recommendations, primarily stormwater pond modifications or construction, to achieve these goals. The Town's priority has been to implement Action Plan projects and refine Action Plan as a "living document" to reflect the current state of knowledge about stormwater treatment practices and policies to reduce FC. Since its 2011 adoption as a supporting document to the Town's Comprehensive Plan, watershed conditions, state of knowledge, and scientific evidence have advanced which necessitates an update of the Action Plan to reflect these current conditions.

The Town hired McCormick Taylor and Moffatt & Nichol (the Project Team) to develop watershed-water quality models for the four (4) May River Headwaters (Table 1) to support understanding of FC fate and transport in the Headwaters subwatersheds to develop strategies ultimately intended to open all shellfish stations to harvesting. In order to capture the variety of storm events, baseflow conditions, long-term trends, and variability in pollutant generation, transport, and fate, the Project Team developed a continuous simulation of both water quantity and quality within the XPSWMM environment.

1.2 Purpose of This Document

The purpose of this Water Quality (WQ) Modeling Report is to:

1. Provide the Town a summary of the data, processes, and assumptions the Project Team utilized to construct the XPSWMM water quality model,
2. Summarize the results (§2.0 Model Setup and §3.0 Model Calibration), and
3. Provide recommendations on policies, programs, projects, and potential strategic partnerships intended to restore and protect shellfish harvesting throughout the length of the May River as a substantial component of the May River Watershed Action Plan Update (Action Plan Update).

This report utilizes the significant amount of available information regarding the watershed and the May River itself, as well as lessons learned from previously implemented projects and policies within this watershed and similar watersheds. This document and the results of the model it describes will discuss changing land use conditions throughout the May River Watershed, state of knowledge surrounding FC in the environment, and the potential impact of BMPs to downstream water quality. The water quality model results have been prepared to estimate maximum FC concentrations (§4.1) and FC loads (§4.2) in order to identify hotspots.

Recommendations in this report include:

1. Detailing strategies to address current data gaps uncovered during the water quality model development and calibration (§3.0);
2. Establishing future monitoring to assess and calculate bacteria loading (§5.1);
3. Implementing projects, programs and policies that reflect the current state of knowledge regarding stormwater treatment (§5.2);
4. Evaluating the remaining proposed 2011 Action Plan projects for relevance under current conditions (§5.3); and
5. Proposing new projects, cost estimates, and ranking/prioritization of these projects to consider for inclusion in the Town's long-range CIP budget (§5.4).

1.3 Scope of Work

1.3.1 Develop Water Quality Models (Task 1)

The Project Team developed water quality models for the May River Headwaters subwatersheds of Rose Dhu Creek, Stoney Creek, Duck Pond, and Palmetto Bluff using XPSWMM (Version 2019.1.3). XPSWMM is a link-node network representation model, based on EPA SWMM 5, used to simulate hydrology, hydraulics, water quality, and surface flooding. For this project, XPSWMM's Runoff and Sanitary modes were utilized to model both hydrologic behavior and FC concentrations.

The models were developed to evaluate baseline (2002) and current (2018) land use conditions for FIB loading estimates pre- and post-shellfish harvesting impairment with the intent to reduce current loadings to pre-impairment levels. Calibration was based on field data provided by the Town and the calibrated models were applied to help determine the locations contributing to increases in fecal coliform and assess the potential impact of future Best Management Practices (BMPs) to reduce fecal coliform loadings to the May River. Model set up is described in Section 2.0 followed by a detailed description of the calibration process in Section 3.0 of this report.

The ultimate goal of the models is to provide a tool for Town staff to use to evaluate future development and BMP impacts to water quality and quantity.

Deliverables for Task 1 include:

- Completion of two May River watershed models, prioritizing the four (4) Headwaters subwatersheds for baseline (2002) and current (2018) land use conditions and BMP installation;
- Calibration of models based on field data from various sources (including the Town and USGS) to help determine what is responsible for increases in fecal coliform and potential impact of future BMPs to reduce fecal coliform loadings to the May River; and

- Delivery of the final models for staff use to evaluate future development and BMP impacts to water quality and quantity, as well as a summary report of assumptions made during model generation.

1.3.2 Evaluate Current Action Plan BMPs and Make Recommendations (Task 2)

Task 2 includes the evaluation of the current 2011 May River Watershed Action Plan's projects, as well as the state of the knowledge of best practices and policies implemented currently to address bacteria impairments in southeastern coastal regions.

Deliverables related to Task 2 include:

- Evaluation of the water quality monitoring data related to constructed BMPs' performance that has been recorded by the Town and stormwater industry.
- Identification and review of relevant research, regional case studies, etc. of fecal coliform reduction performance. This information will help the Project Team and Town evaluate if current practices, or other practices, such as changing outfall locations, policy changes, volume reduction, implementing green infrastructure, etc., would be suitable strategies to be included in the Action Plan Update.
- Evaluation of currently proposed projects in the 2011 Action Plan as they relate to the current state of knowledge related to fecal coliform reductions through stormwater BMPs. If current BMPs and/or locations are not in alignment with the water quality model outputs, the Project Team will propose new projects and locations for fecal reduction.
- Development of a GIS-based process for identifying new project locations. The process will be able to analyze existing Town of Bluffton geographic information (such as soils, stormwater drainage system assets, septic system/sanitary sewer system networks, property ownership, and FC hotspots) and flag new potential sites for BMPs that successfully address FC. This work also includes preparation of maps illustrating the potential properties to target for BMPs.
- Identification of data gaps that might limit the ability to complete Tasks 1 and 2 and steps to remediate those gaps.
- Development of cost estimates for approximately fifteen (15) proposed projects (based on preliminary sizing and planning-level costs) to inform the Town's long-term CIP funding needs.

2.0 Model Setup

To capture a variety of storm events, baseflow conditions, long-term trends, and variability in pollutant generation, transport, and fate, a continuous simulation of both water quantity and quality within the XPSWMM environment was developed. The stormwater management model (SWMM in XPSWMM) represents land areas as a series of subcatchments, with parameters that define retention and runoff of precipitation, infiltration, percolation to a shallow aquifer, and discharge from the aquifer. Subcatchments are connected to the drainage network, which may include natural watercourses, open channels, culverts and storm drainage pipes, storage and treatment units, outlets, diversions, and other elements of a drainage system. Nodes and links are used in XPSWMM to define the connectivity and control within the drainage network. Precipitation and other meteorological inputs are used to drive the hydrologic and water quality response in the simulation. Subcatchment runoff is directed to nodes within the link/node network, then transported throughout the network via model links.

The Town provided the Project Team with existing watershed delineations (for each of the four May River Headwaters subwatersheds), as well as several existing XPSWMM models. The existing models were short-term, event-based hydrologic & hydraulic simulations with no water quality component. Simulation times range from 24 hours to several days (i.e. they are not long-term/continuous models). These models included multiple versions of both the Stoney Creek and Duck Pond subwatersheds. There was no accompanying documentation that identified data sources or model setup procedures used for the existing models. As a result, it would have proven difficult to significantly draw on these models as a starting point beyond determining subcatchment delineations and confirming channel networks locations and cross-sections for the Project Team's continuous simulation water quality models developed as part of this scope of work effort. The following sections document and describe the procedures and model assumptions the Project Team followed to refine the watershed delineations and define the channel network, impervious cover, land use, meteorological data, infiltration, existing BMPs, and subcatchment parameters: area, width, slope, and impervious percentage.

Table 2: Summary of Data Compiled to Create Baseline and Current Conditions

Data Source	2002 Baseline Condition	2018 Current Condition
Watershed delineation*	Provided by Town	
Channel network*	GIS file: "drainage_7-16-15" and refinements with "LevelDEM79_40"	
Impervious area	Aerial imagery from 2002, GIS impervious file from Town	Aerial imagery from 2018, GIS impervious file from Town
Land use	2001 NLCD (National Land Cover Database)	2016 NLCD
Meteorological data	2002 KSAV Savannah Municipal Airport precipitation Calculated Daily PET (Potential Evapotranspiration) (Hamon method)	2018 KSAV Savannah Municipal Airport precipitation Calculated Daily PET (Hamon method)
Subcatchment parameters	Manning's n roughness coefficient for pervious land use	
Infiltration*	Minimum and maximum infiltration rates based on NRCS (Natural Resources Conservation Service) Soil Survey	
Groundwater*	USDA Web Soil Survey, USGS geologic & groundwater data, and professional judgment	
Water quality*	Fecal Coliform Event Mean Concentrations (EMCs) based on Land Use	
*Model parameter is identical for 2002 and 2018 conditions		

2.1 Watershed Delineation

The terminology the Project Team used to describe the various levels of watersheds (Figure 4) in the model are as follows: the May River **Watershed** is the entire drainage area of May River discharging to its confluence with Calibogue Sound (purple outline in Figure 2). **Subwatersheds** are the individual drainage areas for the May River that include the four Headwaters basins as shown in Figure 2: Rose Dhu Creek, Stoney Creek, Duck Pond, and Palmetto Bluff. **Subcatchments** represent a unique drainage area to a point (summarized in Table 3, and illustrated in Figure 3 for Stoney Creek, Figure 4 for Rose Dhu Creek, and Figure 6 for Duck Pond and Palmetto Bluff). Subcatchments were received from the Town and utilized in model construction. In some cases, where multiple subcatchments drained to a single point, subcatchment areas were combined to simplify modeling efforts. Additional procedures for development of model subcatchments is discussed in the Channel Network section below. Table 3 summarizes the subwatershed and subcatchment information.

Table 3: Watershed Delineation Information

Subwatershed	Total Area (acres)	Number of Subcatchments	Subcatchment Area (acres)		
			Average	Min	Max
Duck Pond	683.10	7	97.6	19.1	239.1
Palmetto Bluff	1,925.53	28	68.8	4.3	190.5
Rose Dhu Creek	4,168.06	26	160.3	9.1	465.6
Stoney Creek	5,480.16	62	88.4	3.8	593.3
TOTAL	12,256.85	123			

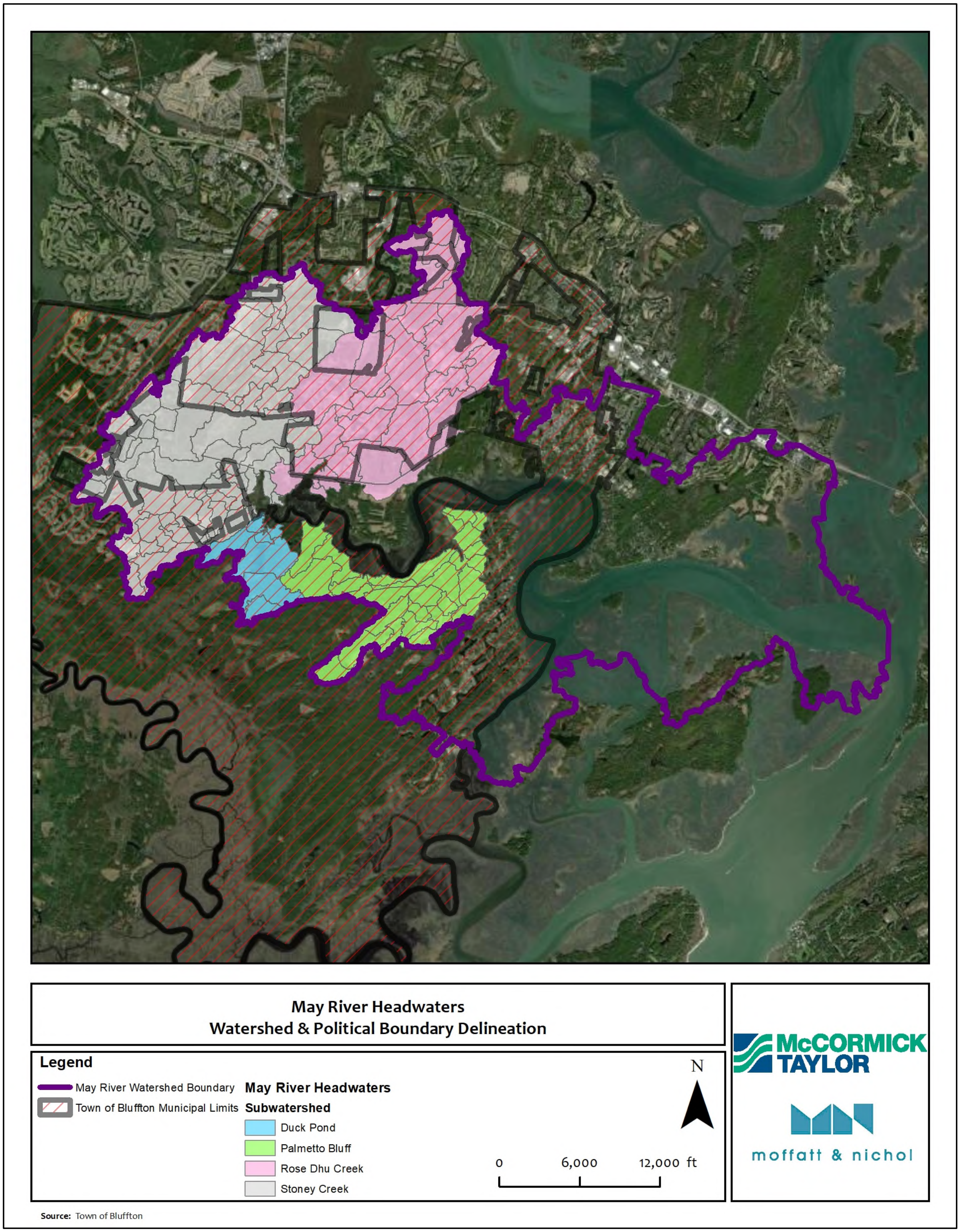


Figure 3. The May River Watershed and Headwaters

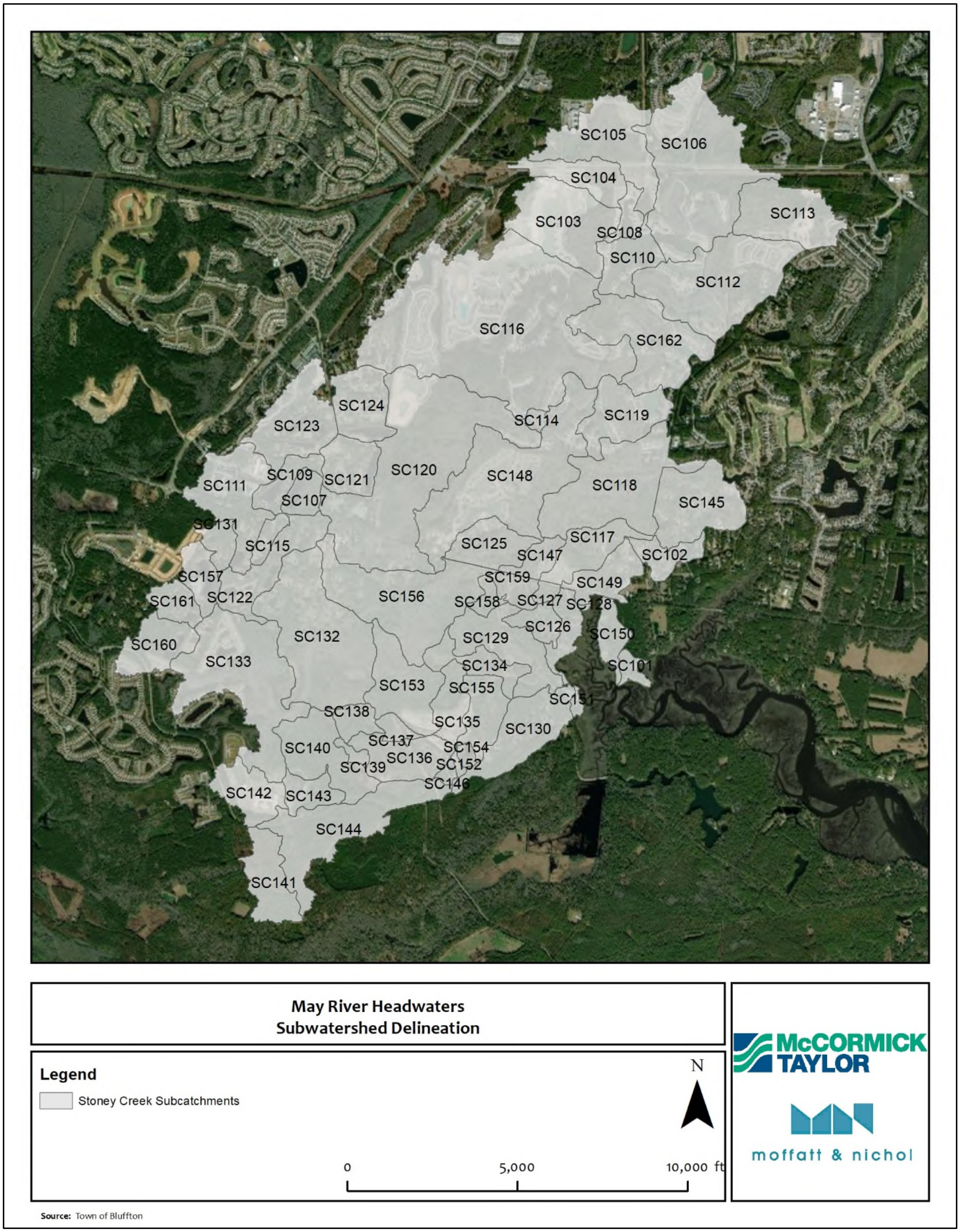


Figure 4. Stoney Creek Subwatershed and Subcatchments

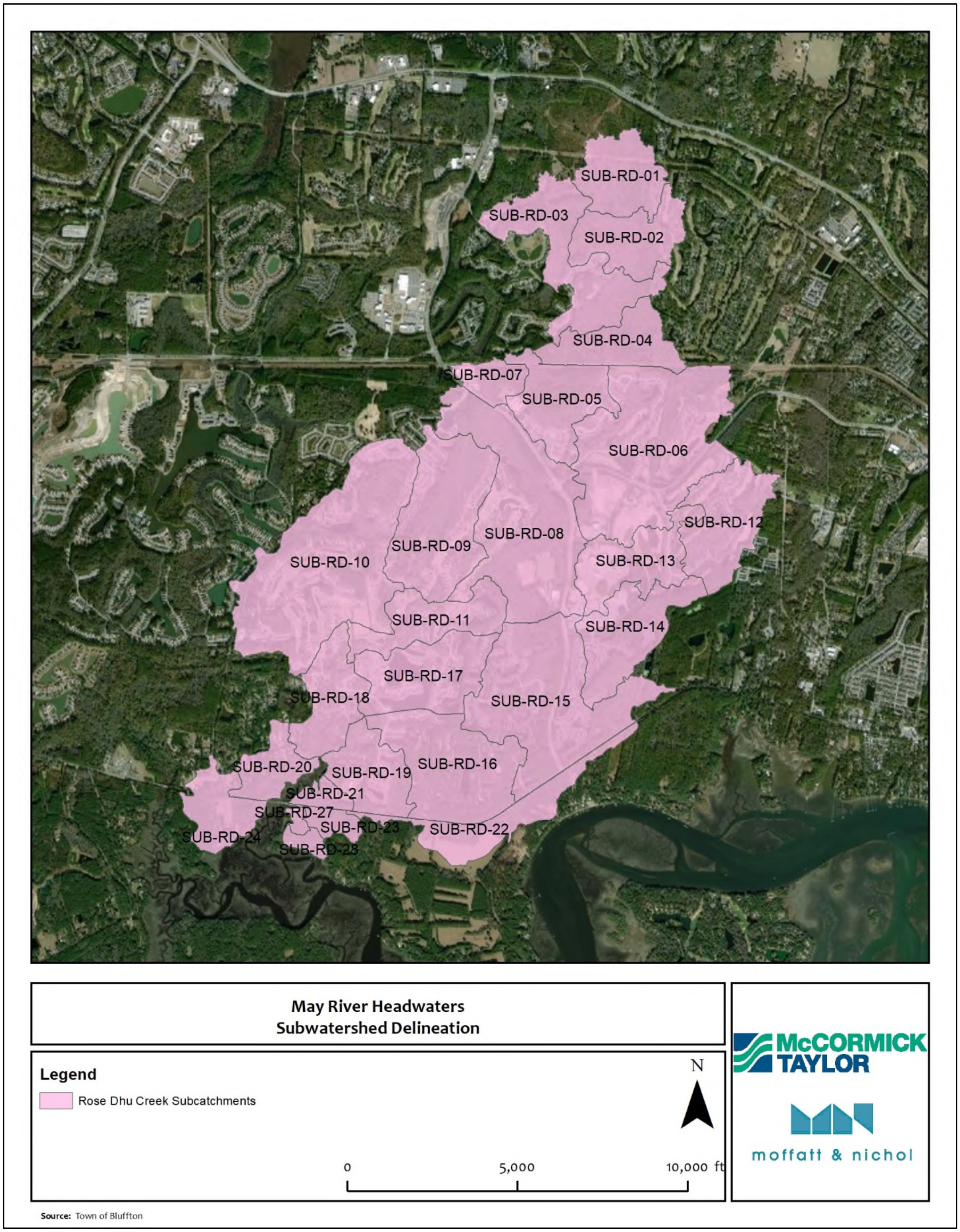


Figure 5. Rose Dhu Creek Subwatershed and Subcatchments

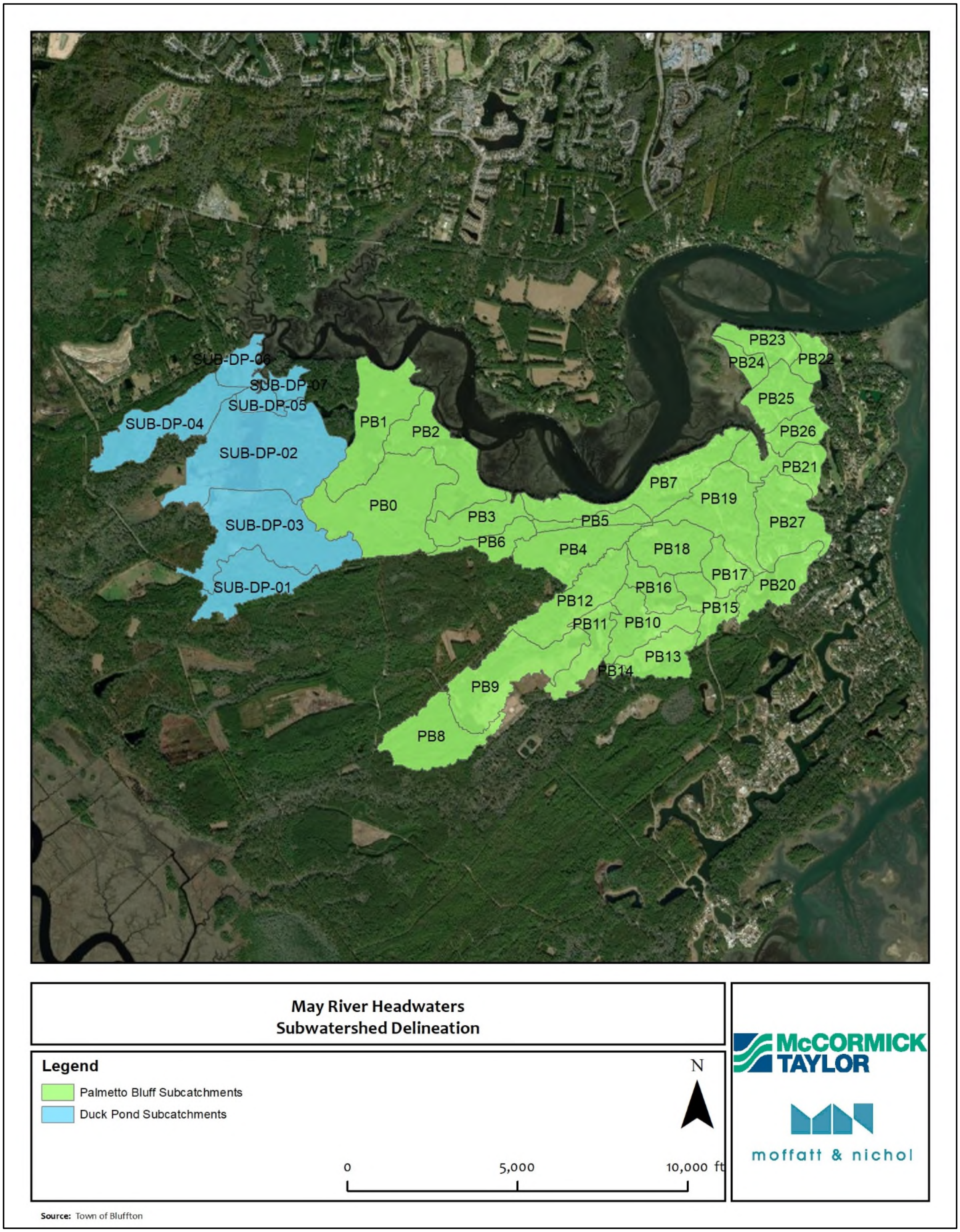


Figure 6. Duck Pond and Palmetto Bluff Subwatersheds and Subcatchments

2.2 Channel Network

Existing XPSWMM models for the Stoney Creek and Duck Pond subwatersheds were provided by the Town. These models contain cross section information including channel invert elevations and roughness coefficients for the channel network within each subwatershed. The previous existing hydraulic setup for Stoney Creek and Duck Pond was reviewed prior to use and a few modifications were made. Existing models for the Rose Dhu Creek and Palmetto Bluff subwatersheds were not available to the project teams in the early part of the project; therefore, the channel network and other model components were developed using provided data.

A balance was desired between maintaining an appropriate level of detail to adequately assess water quality concerns and minimizing the effort needed to construct model elements from scratch. Available data included delineated subwatershed and subcatchment boundaries, topography (including a 5x5 ft raster and 1-foot contours), impervious data, and National Land Cover Database (NLCD) land use datasets (further discussed in the Land Use section). Hydrologic parameters including area, land use, soil type, and infiltration loss rates were identified using available data. Hydraulic flow routing downstream from hydrologic points of concentration was more difficult to estimate as existing datasets do not contain cross section data. In order to limit the number of channel cross sections and characteristics that needed to be approximated, existing delineated subcatchments that drain to a common point were combined in some cases.

The drainage network for each subwatershed was determined using the 'drainage.shp' shapefile—the complete inventory of drainage features received in pieces from the Town and compiled by the Project Team—as a starting point. This file does not contain surveyed data for the channels (e.g. invert elevations, cross-section dimensions, or descriptions of the channel lining), but rather gave general descriptions of type (pipe or channel) and provided geographic location. Small, local drainage pipes and channels were filtered out to create a refined network containing only the major drainage conveyances necessary to provide connectivity between subcatchments and to the May River. Minor modifications to the channel flow paths were made in order to ensure that they align with the channel paths shown in the raster as described below:

Channel dimensions were approximated using the 'LevelDEM79_40' raster (provided by the Town), assuming a trapezoidal channel shape and estimating the top of bank location where the channel meets the surrounding floodplain (see Figure 7 below). A single channel cross section was determined for each subcatchment unless significant variation in cross section occurred within the subcatchment, in which case the channel was broken up to accommodate multiple channel cross sections.

Channel invert elevations were identified from the raster but adjusted as needed, as the bottom elevations shown in the raster appear to be approximate due to the 5x5 feet resolution (i.e. if the channel bottom width is less than 5 feet, the raster likely does not represent the lowest bottom elevation).

Channel roughness coefficients were assigned using the NLCD land use dataset, aerial imagery, and engineering judgment using Chow's suggested Manning's n values (provided in Table 4 below).

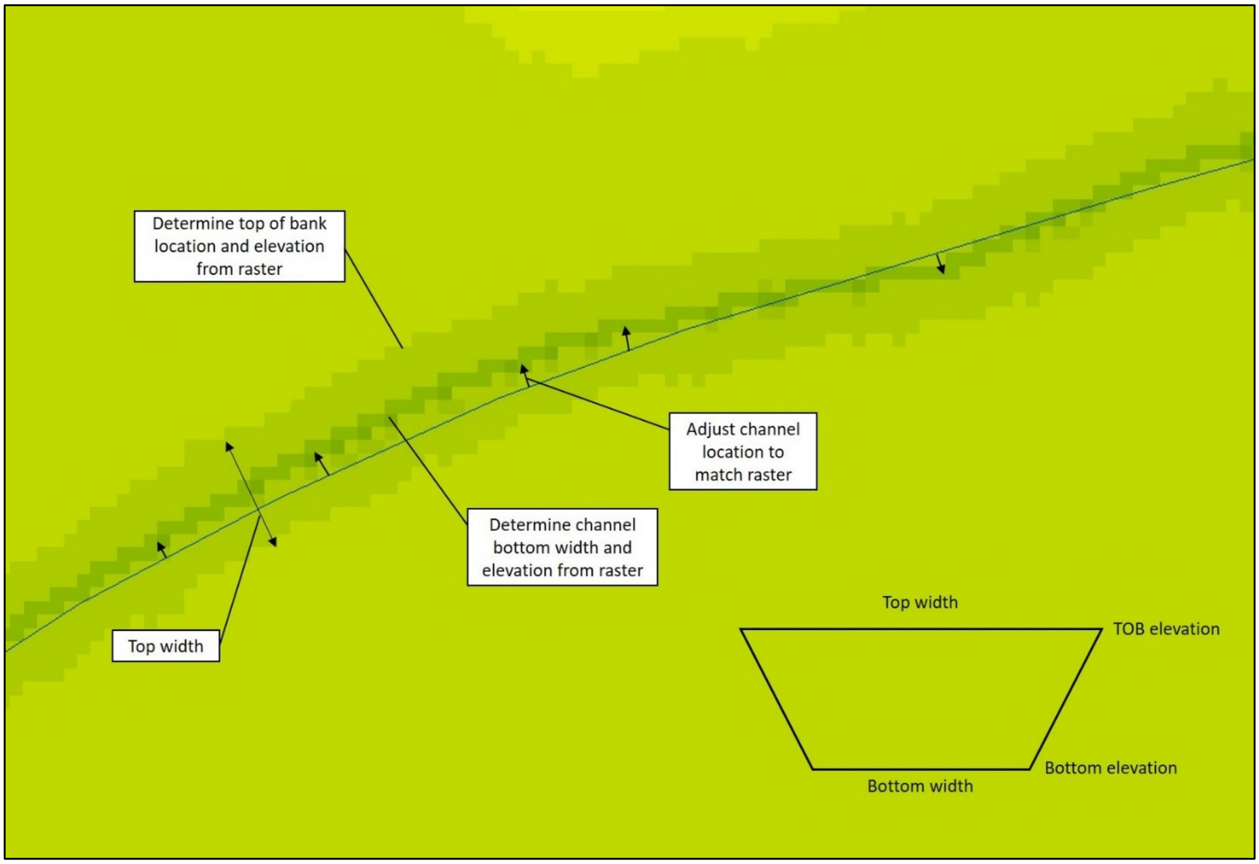


Figure 7. Channel cross section methodology

Table 4:. Chow's suggested Manning's n roughness coefficients

Type of Channel and Description	Minimum	Normal	Maximum
Natural streams - minor streams (top width at flood stage < 100 ft)			
1. Main Channels			
a. clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. same as above, but more stones and weeds	0.030	0.035	0.040
c. clean, winding, some pools and shoals	0.033	0.040	0.045
d. same as above, but some weeds and stones	0.035	0.045	0.050
e. same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. same as "d" with more stones	0.045	0.050	0.060
g. sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150

Type of Channel and Description	Minimum	Normal	Maximum
2. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
a. bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. bottom: cobbles with large boulders	0.040	0.050	0.070
3. Floodplains			
a. Pasture, no brush			
1.short grass	0.025	0.030	0.035
2. high grass	0.030	0.035	0.050
b. Cultivated areas			
1. no crop	0.020	0.030	0.040
2. mature row crops	0.025	0.035	0.045
3. mature field crops	0.030	0.040	0.050
c. Brush			
1. scattered brush, heavy weeds	0.035	0.050	0.070
2. light brush and trees, in winter	0.035	0.050	0.060
3. light brush and trees, in summer	0.040	0.060	0.080
4. medium to dense brush, in winter	0.045	0.070	0.110
5. medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. dense willows, summer, straight	0.110	0.150	0.200
2. cleared land with tree stumps, no sprouts	0.030	0.040	0.050
3. same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. same as 4. with flood stage reaching branches	0.100	0.120	0.160
4. Excavated or Dredged Channels			
a. Earth, straight, and uniform			
1. clean, recently completed	0.016	0.018	0.020
2. clean, after weathering	0.018	0.022	0.025
3. gravel, uniform section, clean	0.022	0.025	0.030
4. with short grass, few weeds	0.022	0.027	0.033
b. Earth winding and sluggish			
1. no vegetation	0.023	0.025	0.030
2. grass, some weeds	0.025	0.030	0.033
3. dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. earth bottom and rubble sides	0.028	0.030	0.035

Type of Channel and Description	Minimum	Normal	Maximum
5. stony bottom and weedy banks	0.025	0.035	0.040
6. cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. no vegetation	0.025	0.028	0.033
2. light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. smooth and uniform	0.025	0.035	0.040
2. jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. dense weeds, high as flow depth	0.050	0.080	0.120
2. clean bottom, brush on sides	0.040	0.050	0.080
3. same as above, highest stage of flow	0.045	0.070	0.110
4. dense brush, high stage	0.080	0.100	0.140

The network of nodes and links that was included in the May River Headwaters Watershed model are summarized in Table 5 and illustrated in Figure 8. Note that Stoney Creek and Palmetto Bluff have multiple subcatchments that have separate outfalls into the May River for the entire subwatershed. There are six nodes in Stoney Creek and nine nodes in Palmetto Bluff that are separate discharge points.

Table 5: Summary of Node and Link Information

Subwatershed	Number of Nodes	Number of Links
Duck Pond	8	7
Palmetto Bluff	39	30
Rose Dhu Creek	36	35
Stoney Creek	87	79
TOTAL	170	151

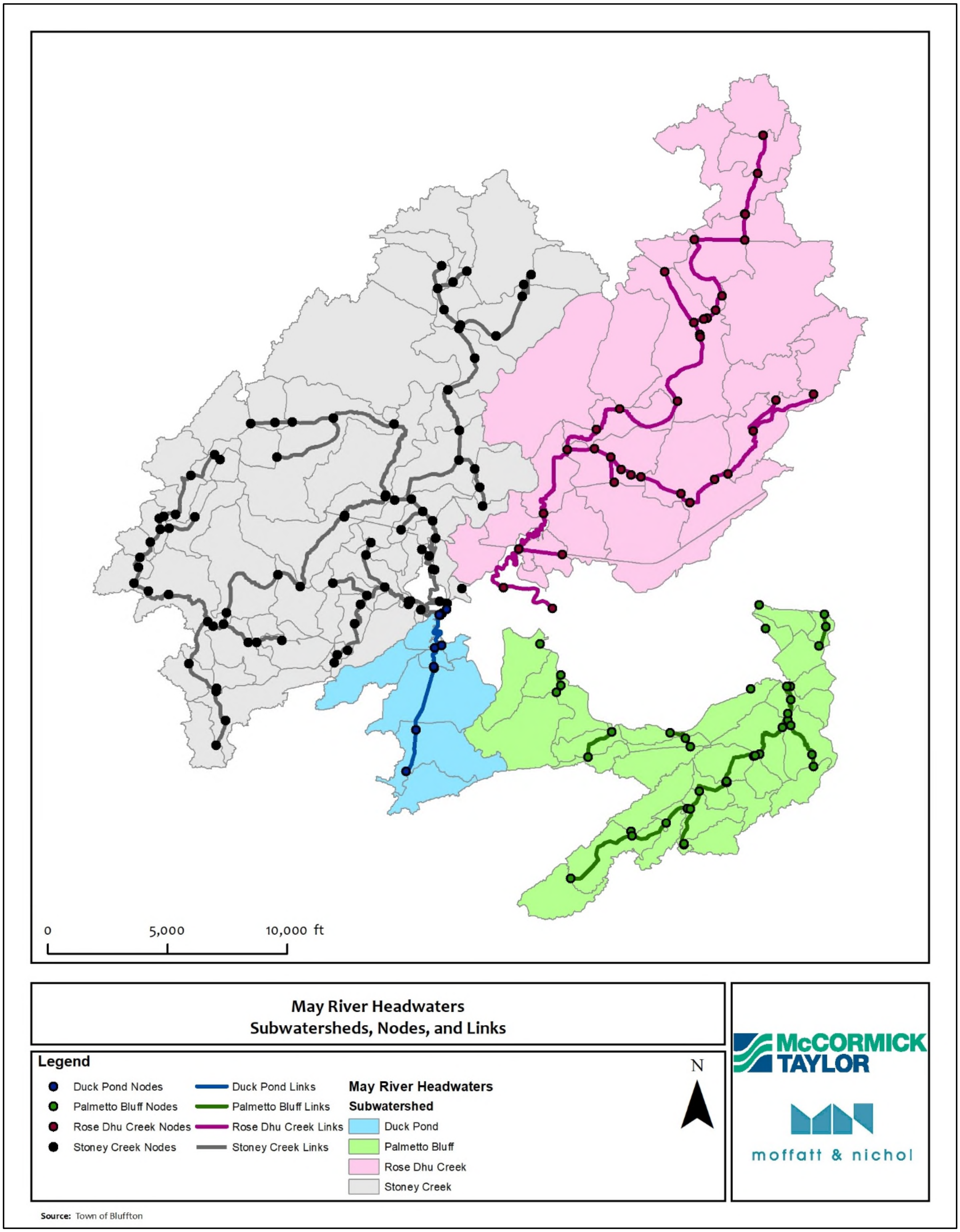


Figure 8. Subwatershed Node and Link Network for Model

2.3 Impervious Area

The Town provided impervious area (IA) data for 2018 that included building footprints, walkways/pathways, parking areas, driveways, roads, curbs, and ponds. A complete impervious dataset for 2018 was created by combining these shapefiles and checking for quality assurance using aerial imagery and land use data. Impervious data for 2002 was created by removing areas from the 2018 dataset, using historical aerial imagery and 2001 NLCD data to determine which areas were developed in 2002. Figures 9 and 10 illustrate the impervious area in each subcatchment as a percentage of total area for 2002 and 2018, respectively. Table 6 summarizes the subcatchments with the largest overall impervious area (acres) in 2018; Table 7 summarizes the subcatchments with the largest percentage of subcatchment area being impervious cover. Two subcatchments (SC112 and SUB-RD-13, highlighted in light grey within each Table) are included on both lists.

Table 6: 2018 Subcatchments with Largest Impervious Areas

Subcatchment	Total Area (acres)	Impervious Area (acres)	Impervious Area (%)
SC116	741.45	**163.72**	22%
SUB-RD-10	465.59	**105.56**	23%
SUB-RD-06	411.01	**100.14**	24%
SUB-RD-15	352.73	**87.68**	25%
SUB-RD-17	292.79	**76.46**	26%
SUB-RD-08	384.14	**67.19**	17%
SC162	741.45	**59.92**	8%
SC112	201.66	**58.95**	29%
SC106	260.56	**54.48**	21%
SUB-RD-13	133.88	**53.49**	40%

Table 7: 2018 Highest Percent Impervious Subcatchments

Subcatchment	Total Area (acres)	Impervious Area (acres)	Impervious Area (%)
SC110	56.46	37.11	66%
SUB-RD-13	133.88	53.49	40%
SC142	60.72	23.58	39%
SC119	84.22	27.55	33%
SC111	104.78	32.07	31%
SC124	64.47	19.39	30%
SC157	35.94	10.65	30%
SC143	33.46	9.79	29%
SC112	201.66	58.95	29%
SC123	103.57	29.52	29%

Throughout the entire May River Headwaters, the IA has been classified into four different groups based on ranges of impervious area (as shown in Figure 9 and Figure 10), and summarized in Table 8. In 2002 the majority (78%) of the subcatchments had less than 10% impervious area, and about 5% in the most impacted category. In 2018, development has increased such that almost one-third of all subcatchments in the May River Headwaters would have physical, chemical, and ecological impacts as a result of impervious area.

Table 8: Subcatchment Classification by Percent Impervious Area

Impervious Area (%)	Water Quality Concern*	Number of Subcatchments (2002)	Number of Subcatchments (2018)
0-10	Sensitive	97	62
10-20	Physical and Chemical Impacts	19	28
20-30	Ecological Process Impacts	7	26
>30		0	7
Total:		123	123
*based on thresholds from Sanger et al., 2015			

In XPSWMM, each subcatchment is divided into three areas: **pervious area**, **connected impervious area**, and **disconnected impervious area**. Both the pervious area and connected impervious area are directed to the subcatchment outlet, while the disconnected impervious area is directed to the pervious area before being routed to the outlet. The proportion of impervious area with runoff directed to pervious areas (i.e., disconnected impervious area) versus impervious area directly connected to the storm drainage system (directly connected impervious area) for each subcatchment was estimated using the breakdown of land use types. The proportion of disconnection is not explicitly known but can be estimated and can also be a calibration parameter. The percentage of impervious area that is disconnected versus connected was estimated for each land use type using guidance from the literature on estimating disconnection fractions (e.g., Sutherland, 2000) and professional modeling judgement (Table 9). The amount of connected impervious area is calculated as the total impervious area minus the disconnected impervious area.

Table 9: Estimated Disconnected Impervious Area for Land Use Classifications

Land Use	**Percent Disconnected**
Developed Open Space	80%
Developed Low Intensity	75%
Developed Medium Intensity	40%
Developed High Intensity	25%
Forest	100%
Shrubland, Grassland, Pasture, & Barren Land	100%
Wetlands	100%
Cultivated Cropland	100%

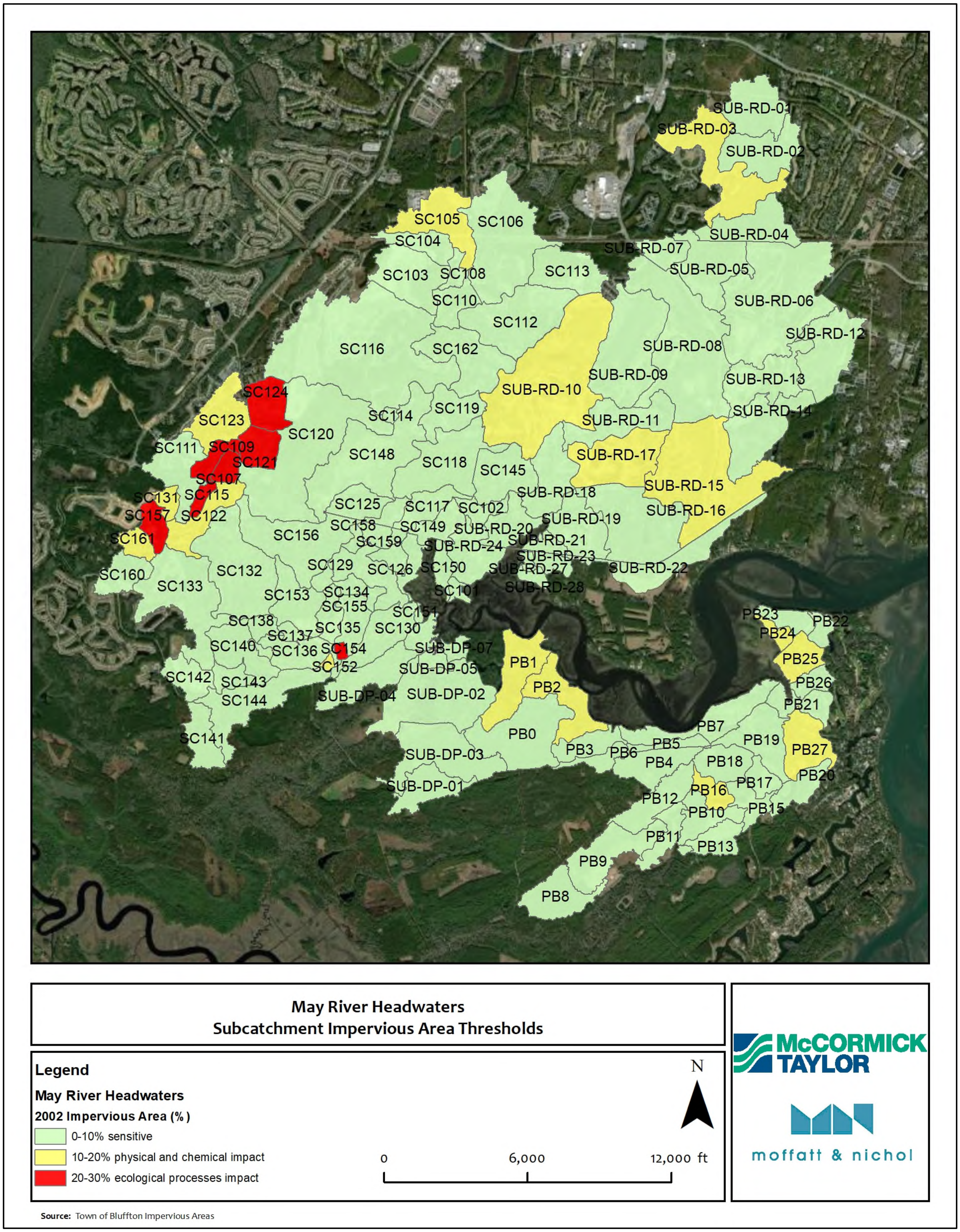


Figure 9. 2002 Impervious Area as Percent of Subcatchment Area

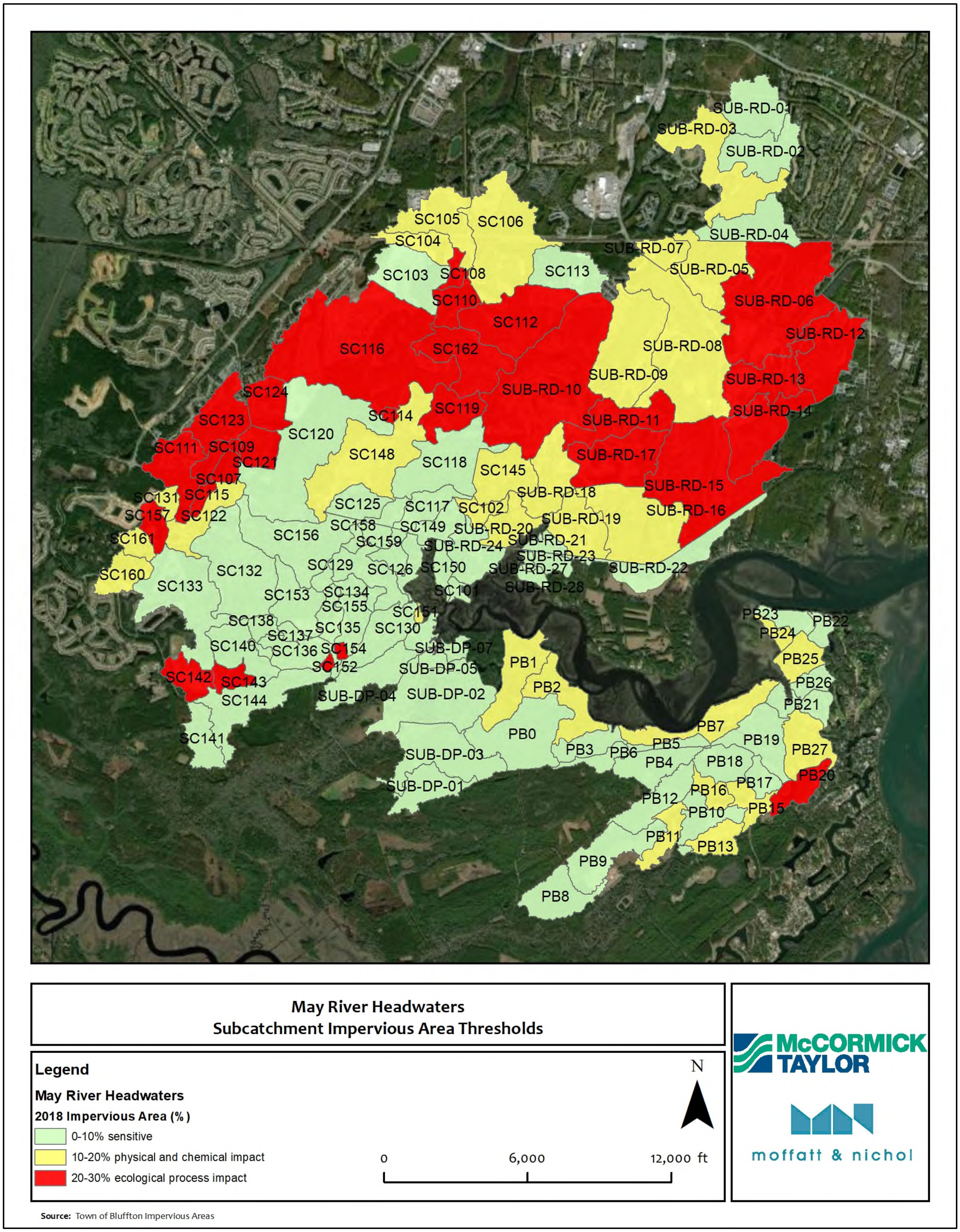


Figure 10. 2018 Impervious Area as Percent of Subcatchment Area

2.4 Land Use

Subcatchment hydrology is driven by land cover (impervious versus pervious surfaces), and pollutant generation and runoff are related to land use (e.g., commercial, residential, or natural) to a large extent. For example, each land use will have specific pollutant build-up and wash-off parameters. Both land use and land cover are defined within each subcatchment. Land use is assigned to subcatchments on a percentage basis.

The Town provided 2018 land use data; however, this data was a mixture of zoning and land use which made it difficult to determine what was on the ground. Also, comparable data was not readily available for 2002. Therefore, the National Land Cover Database (NLCD), developed by the Multi-Resolution Land Characteristics Consortium of US Geological Survey (USGS) and additional federal agencies, was used for both the 2002 and 2018 periods to provide a consistent basis upon which to develop baseline and current condition land use and land cover. Based on 30-meter Landsat imagery, NLCD data is available in seven different "epochs," including 2001 and 2016. The 2001 NLCD dataset was used to represent 2002 land use, and the 2016 NLCD dataset (the most current epoch available) was used to represent 2018 land use. The 2016 data was compared with the impervious data provided by the Town and it was determined that this would be the best available data to use. NOAA Coastal Change Analysis Program (C-CAP) data was also reviewed and compared to the NLCD data. The Project Team determined that smaller roadways were not included in the C-CAP data and therefore in the more residential areas, the NLCD data would provide the most accurate data. Table 10 summarizes the NLCD land cover classifications and descriptions. Maps (Figures 11 and 12) showing the NLCD datasets for 2001 and 2016 are provided in the sections 2.4.1 and 2.4.2 below.

There are two limitations related to use of NLCD for this model. First is the misalignment of time periods. Though the degree to which some development was not accounted for depends on how much occurred in each intervening period (e.g. how much development occurred between 2016 and 2018). However, the Team was able to address this concern in calibration (§3.2). The other issue is that it would have been better to use a combination of locally derived land use using parcel data combined with remote sensing sources like NLCD. That requires a robust starting dataset, which was not available, and an extensive amount of work (which was not feasible with the time or budget).

Table 10: NLCD Land Cover Classifications and Descriptions

Class\ Value	Classification Description
Water	
11	Open Water- areas of open water, generally with less than 25% cover of vegetation or soil.
12	Perennial Ice/Snow- areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
Developed	
21	Developed, Open Space- areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
22	Developed, Low Intensity- areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20% to 49% percent of total cover. These areas most commonly include single-family housing units.
23	Developed, Medium Intensity -areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50% to 79% of the total cover. These areas most commonly include single-family housing units.
24	Developed High Intensity-highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses and commercial/industrial. Impervious surfaces account for 80% to 100% of the total cover.
Barren	
31	Barren Land (Rock/Sand/Clay) - areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
Forest	
41	Deciduous Forest- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
42	Evergreen Forest- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
43	Mixed Forest- areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.

Class\ Value	Classification Description
Shrubland	
51	Dwarf Scrub- Alaska only areas dominated by shrubs less than 20 centimeters tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.
52	Shrub/Scrub- areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage or trees stunted from environmental conditions.
Herbaceous	
71	Grassland/Herbaceous- areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management such as tilling but can be utilized for grazing.
72	Sedge/Herbaceous- Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.
73	Lichens- Alaska only areas dominated by fruticose or foliose lichens generally greater than 80% of total vegetation.
74	Moss- Alaska only areas dominated by mosses, generally greater than 80% of total vegetation.
Planted/Cultivated	
81	Pasture/Hay-areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
82	Cultivated Crops -areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
Wetlands	
90	Woody Wetlands- areas where forest or shrubland vegetation accounts for greater than 20% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.
95	Emergent Herbaceous Wetlands- Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetative cover and the soil or substrate is periodically saturated with or covered with water.

2.4.1 2002 Baseline Land Use Condition

Table 11 summarizes the land cover/land use for the entire Headwaters region in 2002, and Figure 11 illustrates the spatial locations of these classifications. In the baseline condition, the predominant land covers in the Headwaters of the May River Headwaters were evergreen forest (35.55%) and woody wetlands (33.35%). The total amount of developed lands, the areas classified as "Developed Open Space and Low, Medium, and High Intensity" (highlighted in grey in Tables 11 – 14), amounted to 1,307.44 acres (10.67%).

Table 11: May River Headwaters Overall 2002 Baseline Land Use Condition

Land Cover	Land Use Code	Area (acres)	Percentage
Open Water	11	264.94	2.16%
Developed, Open Space	21	1,132.48	9.24%
Developed, Low Intensity	22	138.78	1.13%
Developed, Medium Intensity	23	33.01	0.27%
Developed, High Intensity	24	3.17	0.03%
Barren Land	31	13.37	0.11%
Deciduous Forest	41	66.50	0.54%
Evergreen Forest	42	4,356.95	35.55%
Mixed Forest	43	282.47	2.30%
Shrub/Scrub	52	461.25	3.76%
Herbaceous Grassland	71	1,131.36	9.23%
Hay/Pasture	81	111.64	0.91%
Cultivated Crops	82	25.77	0.21%
Woody Wetlands	90	4,087.70	33.35%
Emergent Herbaceous Wetlands	95	147.46	1.20%

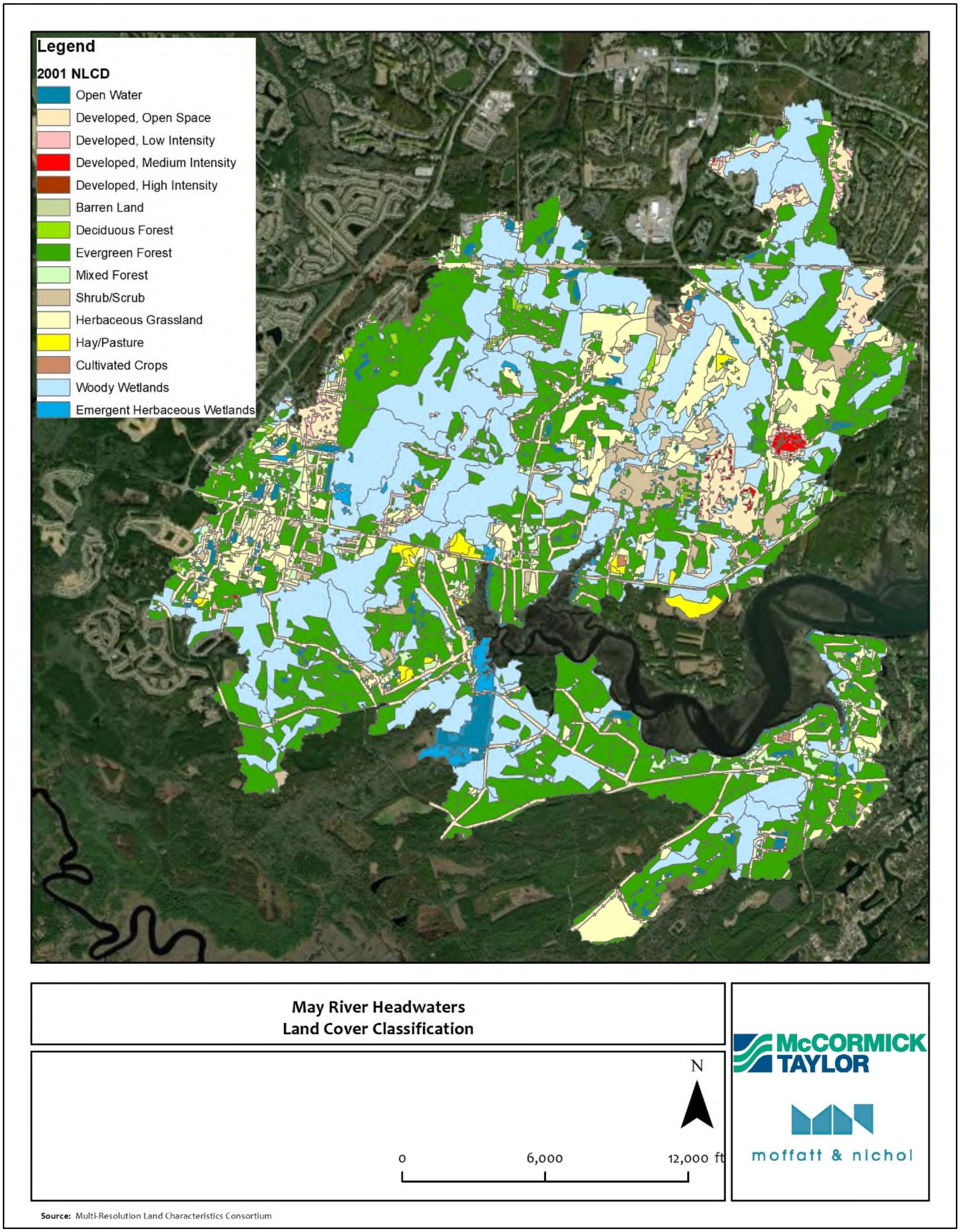


Figure 11. Baseline Land Cover in May River Headwaters

Table 12 summarizes the land cover/land use by subwatershed in 2002. The predominant land covers are evergreen forest and woody wetlands for all four of the subwatersheds. The amount of development in the baseline condition for each subwatershed, from least to greatest amount, is Duck Pond (9.13%); Stoney Creek (9.63%); Palmetto Bluff (9.66%); and Rose Dhu Creek (12.75%).

Table 12: May River Headwater Subwatersheds 2002 Baseline Land Use Condition

Land Cover/Land Use	Land Use Code	Duck Pond (acres)	Palmetto Bluff (acres)	Rose Dhu Creek (acres)	Stoney Creek (acres)
Open Water	11	64.10	52.24	46.92	101.67
Developed, Open Space	21	59.00	172.54	441.36	459.57
Developed, Low Intensity	22	3.36	12.57	57.32	65.54
Developed, Medium Intensity	23	0.00	0.67	29.64	2.71
Developed, High Intensity	24	0.00	0.22	2.95	0.00
Barren Land	31	0.00	4.65	7.08	1.64
Deciduous Forest	41	0.00	0.97	22.65	42.87
Evergreen Forest	42	204.57	1,092.85	1,103.61	1,955.91
Mixed Forest	43	1.32	64.85	69.33	146.98
Shrub/Scrub	52	0.49	10.43	327.71	122.62
Herbaceous Grassland	71	2.28	155.23	630.55	343.30
Hay/Pasture	81	0.00	6.40	50.21	55.03
Cultivated Crops	82	0.00	3.26	18.86	3.65
Woody Wetlands	90	275.19	339.74	1,337.36	2,135.41
Emergent Herbaceous Wetlands	95	72.80	8.92	22.50	43.25
Total Area		683.10	1,925.53	4,168.06	5,480.16

2.4.2 2018 Current Land Use Condition

In the 2018 current condition, the predominant land covers in the Headwaters of the May River were evergreen forest (25.71%) and woody wetlands (30.22%), as summarized in Table 13 and illustrated in Figure 12. The total amount of developed lands amounted to 3,765.46 acres (30.72%).

Table 13: May River Headwater Watersheds 2018 Current Land Use Condition

Land Cover/Land Use	Land Use Code	Area (acres)	Percentage
Open Water	11	347.93	2.84%
Developed, Open Space	21	2,180.14	17.79%
Developed, Low Intensity	22	1,134.82	9.26%
Developed, Medium Intensity	23	409.00	3.34%
Developed, High Intensity	24	41.49	0.34%
Barren Land	31	54.84	0.45%
Deciduous Forest	41	35.91	0.29%
Evergreen Forest	42	3,151.22	25.71%
Mixed Forest	43	270.49	2.21%
Shrub/Scrub	52	326.87	2.67%
Herbaceous Grassland	71	294.96	2.41%
Hay/Pasture	81	91.42	0.75%
Cultivated Crops	82	9.00	0.07%
Woody Wetlands	90	3,704.06	30.22%
Emergent Herbaceous Wetlands	95	204.70	1.67%

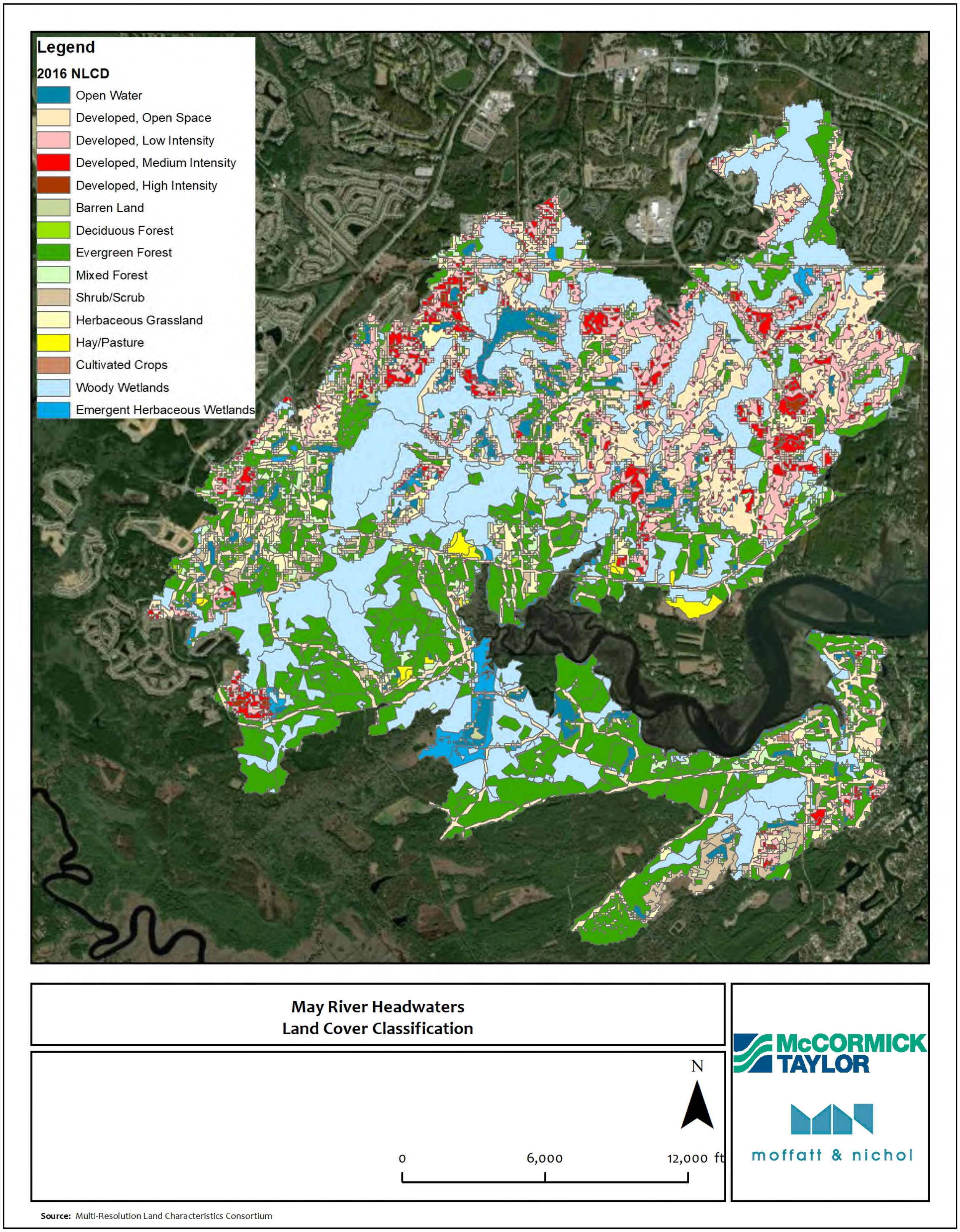


Figure 12. Current Condition Land Cover in May River Headwaters

Table 14 summarizes the current condition of land use/land cover by subwatershed. The predominant land covers are evergreen forest and woody wetlands for all the subwatersheds, except for Rose Dhu Creek where developed open space surpasses evergreen forest. The amount of development in each subwatershed, from least to greatest amount, is Duck Pond (8.85%); Palmetto Bluff (18.37%); Stoney Creek (25.01%); and Rose Dhu Creek (47.52%).

Table 14: May River Headwater Subwatersheds 2018 Current Land Use Condition

Land Cover/Land Use	Land Use Code	Duck Pond (acres)	Palmetto Bluff (acres)	Rose Dhu Creek (acres)	Stoney Creek (acres)
Open Water	11	32.49	72.80	63.10	179.54
Developed, Open Space	21	57.07	279.89	1092.11	751.07
Developed, Low Intensity	22	3.35	52.51	668.94	410.02
Developed, Medium Intensity	23	0.00	18.41	203.14	187.46
Developed, High Intensity	24	0.00	2.89	16.45	22.16
Barren Land	31	6.60	22.63	4.31	21.30
Deciduous Forest	41	0.00	5.93	11.44	18.53
Evergreen Forest	42	201.84	888.03	686.57	1374.78
Mixed Forest	43	1.13	63.72	53.98	151.65
Shrub/Scrub	52	0.75	125.64	72.01	128.48
Herbaceous Grassland	71	3.34	36.25	51.53	203.84
Hay/Pasture	81	0.00	3.44	38.98	48.99
Cultivated Crops	82	0.00	3.12	1.73	4.15
Woody Wetlands	90	280.28	337.00	1168.94	1917.85
Emergent Herbaceous Wetlands	95	96.26	13.25	34.84	60.35
Total Area		683.10	1925.53	4168.06	5480.16

2.4.3 Land Use Changes in the Headwaters of the May River

From 2002 to 2018, the developed area (areas classified as Developed Open Space and Low, Medium, and High Intensity) increased in all of the May River Headwaters subwatersheds except for Duck Pond. The percentage of forests and woody wetland areas decreased from 2002 to 2018 as a result of development. Note that the decrease in developed open space for the Duck Pond subwatershed may be related to increases in shrub/scrub or herbaceous grassland. Because developed open space (mostly turfgrass areas) is categorized as a type of development, the decrease in this category for Duck Pond does not mean that impervious surfaces like buildings or roads were removed.

Table 15: Changes in the May River Headwaters Land Use Condition

Land Cover/Land Use	Duck Pond	Palmetto Bluff	Rose Dhu Creek	Stoney Creek
Open Water	-49%	39%	34%	77%
Developed, Open Space	-3%	62%	147%	63%
Developed, Low Intensity	0%	318%	1067%	526%
Developed, Medium Intensity		2658%	585%	6819%
Developed, High Intensity		1200%	458%	
Barren Land		387%	-39%	1195%
Deciduous Forest		511%	-50%	-57%
Evergreen Forest	-1%	-19%	-38%	-30%
Mixed Forest	-14%	-2%	-22%	3%
Shrub/Scrub	54%	1105%	-78%	5%
Herbaceous Grassland	46%	-77%	-92%	-41%
Hay/Pasture		-46%	-22%	-11%
Cultivated Crops		-4%	-91%	14%
Woody Wetlands	2%	-1%	-13%	-10%
Emergent Herbaceous Wetlands	32%	49%	55%	40%

In addition to the NLCD land cover/land use breakdown, a distinction was made between developed land on septic versus sewer systems (as of 2018) using data provided by the Town, as illustrated in Figure 13. This information was used later as part of the water quality component of model development. The underlying assumption for the water quality model was developed areas that were not connected to sewer were utilizing septic systems. The Project Team later learned that some of this data was inaccurate. Specifically, many developed areas in Palmetto Bluff were not listed as being connected to sewer initially as sewer was extended following new phases of development. The XPSWMM model has been updated to reflect this, but Figure 12 shows the septic/sewer information as it was received from the Town. Further explanation of how the water quality parameters were assigned based on land use is discussed in Section 2.8.

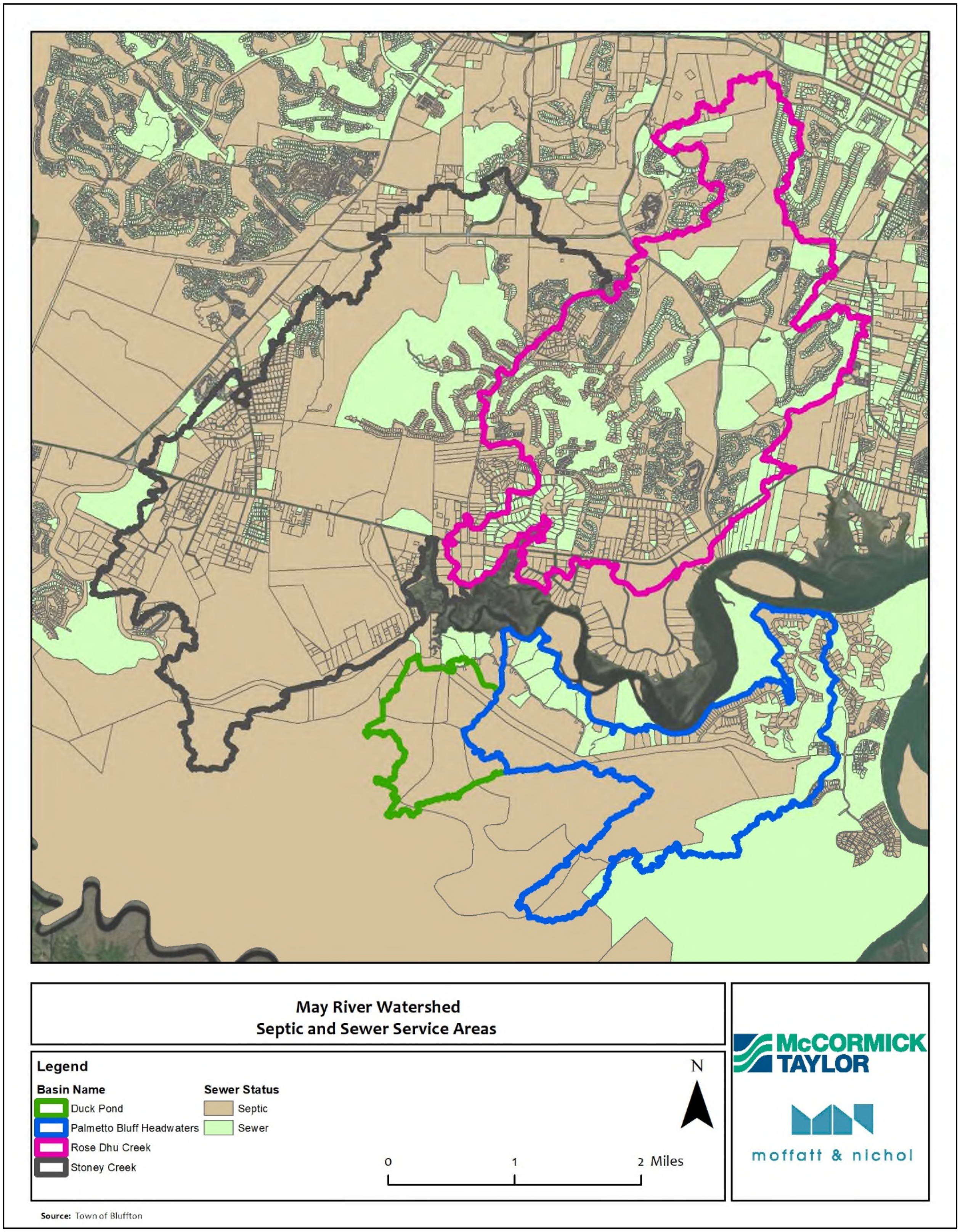


Figure 13. Areas with Sewer Service or Septic Systems in the May River Watershed

2.5 Meteorological Data

Simulation of hydrology and pollutant processes in the model are primarily driven by meteorological data, including rainfall and evaporation/evapotranspiration (ET). The ability of a model to predict hydrologic response and pollutant generation, fate, and transport is strongly affected by the accuracy and representation of meteorological data.

2.5.1 Precipitation

Complete precipitation time series were required for both the Baseline and Current model time periods. The Baseline model period runs from January 2000 through December 2004 and the Current model period runs from July 2015 until December 2018.

Precipitation data from 2000 through 2018 was retrieved from several stations in proximity to the study area (Table 16 and Figure 14) since there were no stations within the watershed that covered those complete time periods. While 15-minute precipitation data was desired for modeling, a complete record of 15-minute data was only available at the ACE Basin NERR monitoring station at Bennett's Point (ACEBPMET), which is approximately forty miles from the May River study area, and it is likely that the precipitation records at the ACEBPMET station vary considerably from stations closer to the study area. Therefore, a complete hourly precipitation record was created using data from the KSAV Savannah Municipal Airport station. Table 17 summarizes the total monthly precipitation for 2002 and 2018, as measured at KSAV.

Table 16: Availability of Precipitation Data

Station	Frequency	Time Period
USGS 02176735 May River	Daily	06/2002 - 06/2004
USGS 02197500 Savannah River	15 minute	09/2010 - 08/2019
USGS 021989784 Little Black River	15 minute	10/2007 - 10/2017
USGS 021989791 Little Back River	15 minute	10/2007 - 10/2017
USGS 0219897993 Savannah River	15 minute	08/2013 - 08/2019
COOP097847 Savannah GA International Airport	Hourly	01/2001 - 12/2013
KSAV Savannah Municipal Airport	Hourly	01/2000 - 08/2019
ACEBPMET	15 minute	03/2001 - 09/2019

*USGS 02197500 Savannah River not shown on map due to large distance from study area.

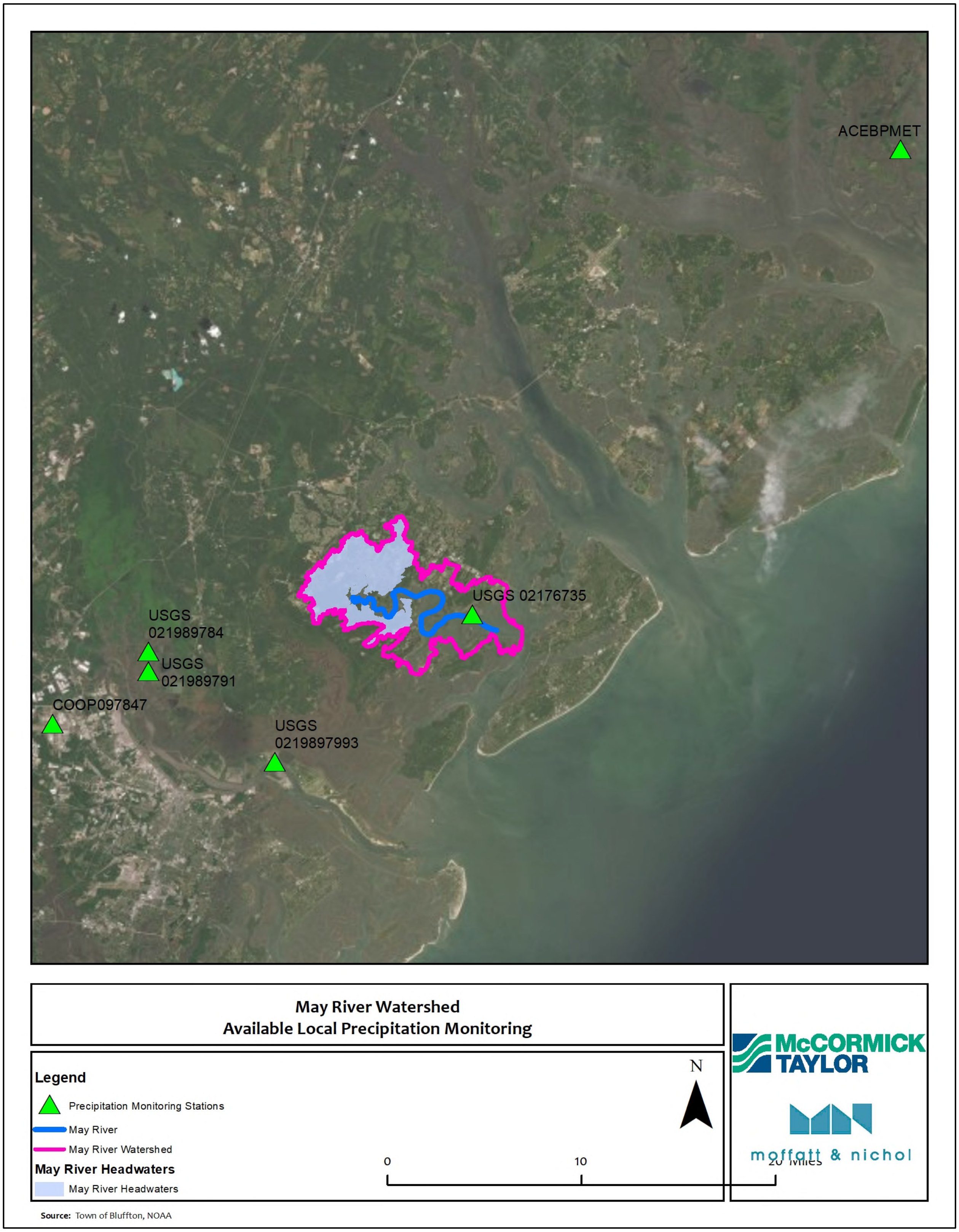


Figure 14. Locations of Precipitation Monitoring Stations

Table 17: Monthly Precipitation Data (inches) at KSAV Savannah Municipal Airport

Month	2002	2018
January	2.38	1.07
February	1.55	1.76
March	5.29	1.22
April	0.4	4.33
May	0.99	6.71
June	8.62	2.57
July	3.29	5.54
August	4.4	3.08
September	5.28	2.1
October	4.36	2.79
November	4.61	3.64
December	3.87	8.14
Total	45.04	42.95

Analysis was conducted to determine the validity of using Savannah airport station data to represent precipitation in the May River project area, as the Savannah station is approximately twenty miles from the study area. Hourly precipitation at KSAV Savannah Municipal Airport was aggregated to create daily precipitation values for comparison to the daily values recorded at the USGS 02176735 May River station, which is located just downstream from the headwater subwatersheds. Figure 15 shows a plot of the two datasets of daily values from June 2002 through June 2004 for comparison. The two records show similar overall precipitation patterns and magnitudes, supporting the assumption that Savannah airport data is a reasonable surrogate for use in the May River model.

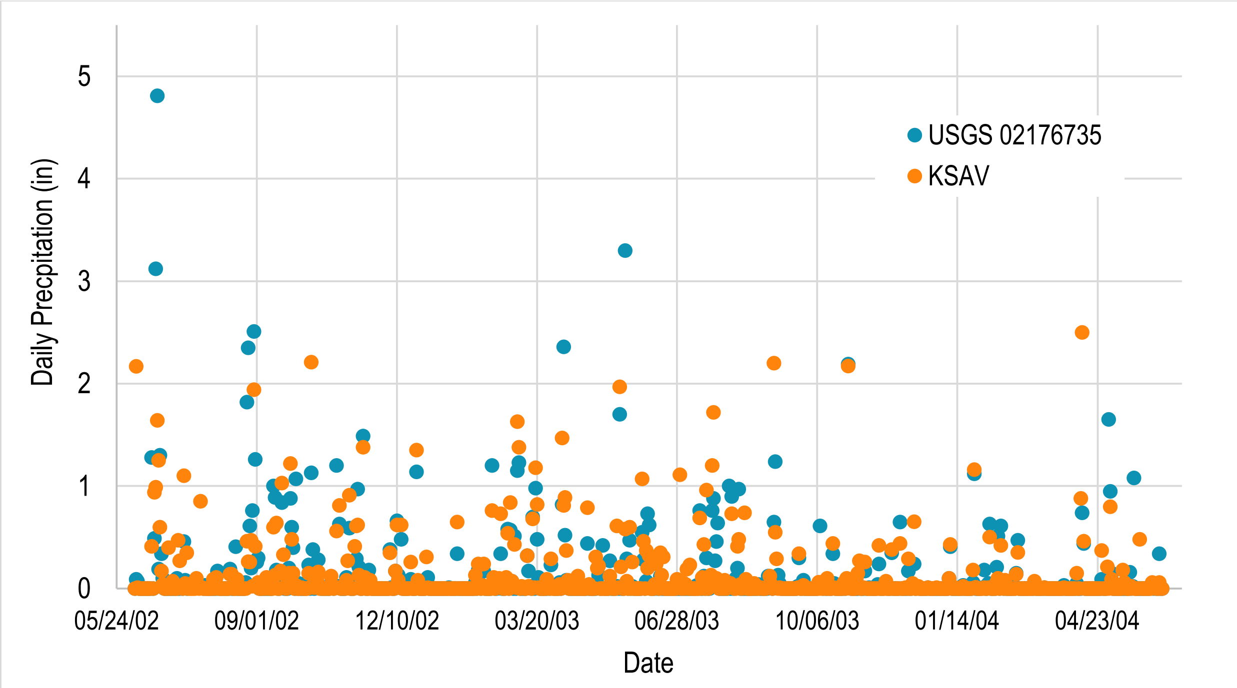
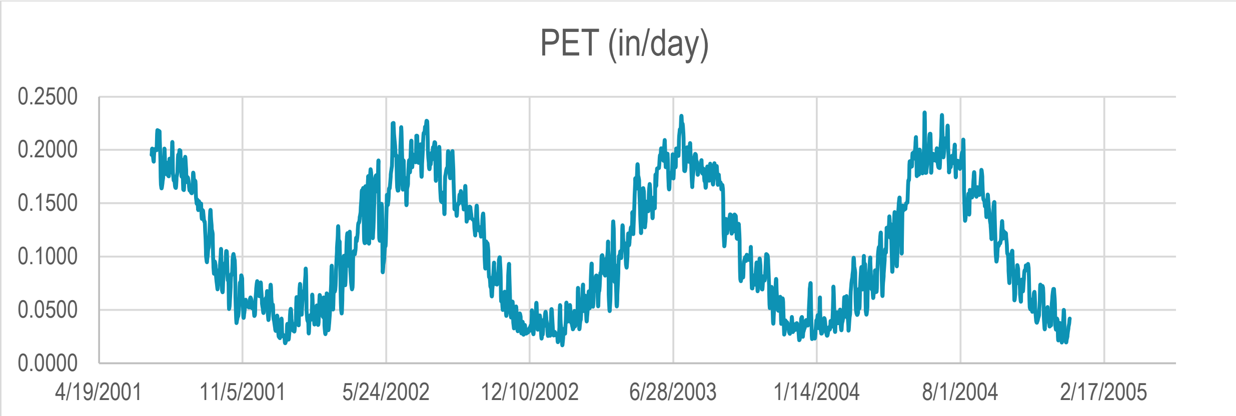


Figure 15. Locations Comparison between USGS 02176735 daily precipitation and KSAV hourly precipitation aggregated to daily values from 2002-2004

2.5.2 Evaporation/Evapotranspiration

James et al. (2005) indicate that event simulations are mostly insensitive to evaporation assumptions, but evaporation is significant during continuous long-term simulations. Daily potential evapotranspiration (PET) values (inches per day) were calculated using the Hamon method, which utilizes daily average temperature, latitude, Julian day of the year, and a monthly variable coefficient. Lu et al. (2005) include Hamon as one of the preferred methods for the Southeast, among others. The monthly variable coefficients, which allow for additional seasonal adjustment of evaporation values within the model, were set to default values from US EPA (2019).

Calculated PET values were compared to values provided in Amatya et al. (2018) for coastal South Carolina. The calculated Hamon PET values ranged from 0.02 to 0.24 in/day for both 2000-2004 and 2015-2018. The range shown in Amatya et al. (2018) was approximately 0.04 to 0.22 in/day for South Carolina (taken from monthly means and adjusted to daily), indicating that the calculated Hamon PET values are reasonable for use in the May River study area. Calculated PET values were used to generate monthly-averaged daily PET values over the range of the baseline (2001-2005) and current (2014-2019) conditions, as illustrated in Figure 16. Calculated PET values shown in the Table 18 were used as initial evaporation values within XPSWMM. These values were modified during the model adjustment process in order to attain proper hydrologic water balance, further discussed in the Model Calibration section.



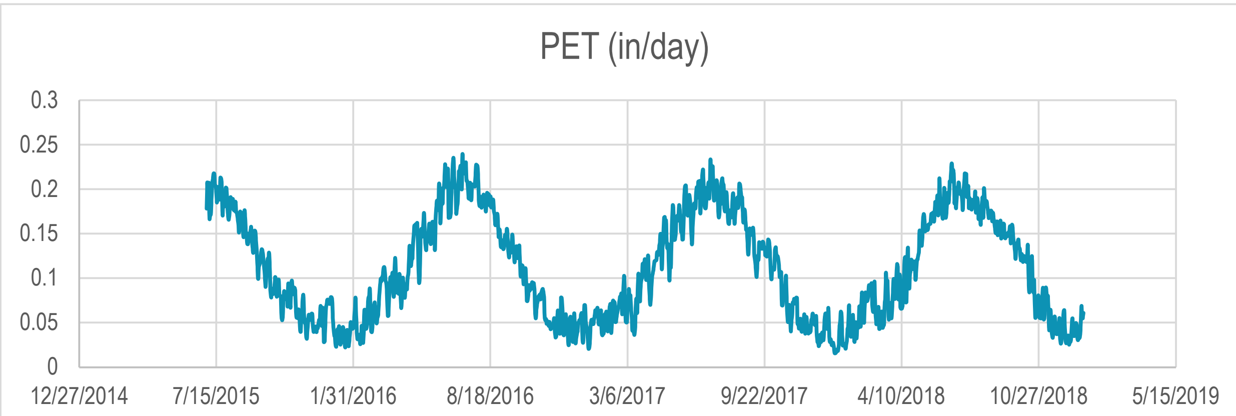


Figure 16. Daily Average PET values for baseline and current conditions

Table 18: Daily PET Values by Month

	2000-2004	2015-2018
Month	Daily PET (in/day)	Daily PET (in/day)
January	0.05	0.04
February	0.06	0.06
March	0.09	0.08
April	0.11	0.11
May	0.16	0.15
June	0.19	0.19
July	0.20	0.20
August	0.18	0.17
September	0.14	0.14
October	0.09	0.09
November	0.06	0.06
December	0.04	0.05

2.6 Subcatchment Parameters

Subcatchment parameters for hydrology were developed using the DEM, land use data, and aerial imagery. Parameters include subcatchment **area**, **width**, **slope**, and **impervious percentage**. The impervious percentage for each subcatchment was calculated for both 2002 and 2018 using impervious data discussed in Section 2.3 Impervious Cover. Subcatchment area, width, and slope were kept the same for 2002 and 2018, as the subcatchment shapes themselves do not change between the baseline and current conditions.

Additional subcatchment parameters were developed to support the infiltration portion of the rainfall-runoff simulation. The impervious and land use datasets were used to calculate area-weighted overland **Manning's n roughness coefficients** for the pervious portions of each subcatchment. To generate the pervious area datasets for 2002 and 2018, the 2002 impervious areas were subtracted (using the "Erase" analysis tool in the advanced license extension for ArcGIS) from the 2001 NLCD land use dataset, and the 2018 impervious areas were subtracted from the 2016 NLCD land use dataset. A Manning's n roughness value was assigned to each pervious land use category present in the study area, using the SWMM Hydrology Manual, Chow, TR-55, and SWMM User Manual as reference literature (as listed in Table 19). All impervious surfaces were assumed to have a Manning's n value of 0.013, which is the roughness value for concrete and asphalt (Chow, 1959).

Table 19: Manning's Roughness Coefficient Values for Pervious Areas

Land Use (NLCD)	Manning's n	Source
Developed Open Space	0.075	SWMM hydro manual – Parks/lawn
Developed Low Intensity (pervious portion)	0.05	TR-55
Developed Medium Intensity (pervious portion)	0.05	TR-55
Developed High Intensity (pervious portion)	0.038	TR-55
Barren Land	0.03	SWMM hydro manual – Moderate bare soil
Deciduous Forest	0.4	Hybrid of TR-55 and SWMM 5.1 user manual – forest
Mixed Forest	0.4	Hybrid of TR-55 and SWMM 5.1 user manual – forest
Evergreen Forest	0.4	Hybrid of TR-55 and SWMM 5.1 user manual – forest
Shrubland	0.12	SWMM hydro manual – shrubs and bushes
Grassland	0.1	SWMM hydro manual – dense grass
Pasture	0.055	SWMM hydro manual – pasture
Cultivated Cropland	0.035	Chow – cultivated areas, mature row crops
Woody Wetlands	0.075	Chow – floodplain, with growth of trees and sprouts
Herbaceous Wetlands	0.05	Chow – floodplain, medium brush

Values for **depression storage** were developed by calculating an area-weighted average of recommended depression storage values for various pervious land use types. Depression storage was calculated as 0.15 inches for Managed/Developed pervious land uses and 0.3 inches for Forested/Vegetated pervious land uses (Rossman, 2010). The depression storage value was set at 0.07 inches for all impervious surfaces. Values for the percentage of subcatchment area that contains zero depression storage were kept at the XPSWMM default value of 25 percent for all subcatchments.

2.7 Infiltration and Groundwater

The continuous model required representation of baseflow in the stream channels. Properties influencing the rate and volume of infiltration, evaporation, storage, movement, and discharge of water from shallow groundwater into streams are contained in the Infiltration and Groundwater sections of XPSWMM. Since this is a continuous simulation, both were used (as opposed to an event model that might only be concerned with infiltration). XPSWMM provides four methods to select for modeling infiltration in pervious areas: Horton, Green Ampt, Uniform Loss, and SCS Curve Number. For the May River Headwaters model, the Horton approach was selected because it works well for long-term hydrology simulations and is sensitive to differences in hydrologic soil group (HSG). The Horton approach is empirical and models infiltration capacity as a function of time as $Fp = Fc + (F_0\text{-}Fc)e^{-kt}$, where

Fp = infiltration rate into soil (in/hr),

Fc = minimum or asymptotic value of Fp (in/hr),

F_0 = maximum initial value of Fp (in/hr),

t = time from beginning of storm (sec), and

k = decay coefficient (1/sec).

When both infiltration and groundwater are modeled in XPSWMM, stormwater that infiltrates into the soil accumulates in and percolates through an unsaturated upper soil zone. Evapotranspiration (ET) produces water losses from the upper zone. Percolating water enters the saturated lower soil zone, which leads to a rise in water table (saturated zone) elevation. At the same time, groundwater is discharged from the saturated lower soil zone to the stream if the water table elevation is higher than the stream channel water elevation. The rate of groundwater discharge is dependent in part on the difference in elevation between the water table and the stream water surface elevation. Water can also be lost from the saturated lower zone through ET, as well as deep percolation to a regional aquifer system.

2.7.1 Infiltration Parameters

Infiltration parameters were developed using soils data from USDA's Web Soil Survey and land use data. Minimum infiltration rates were developed by calculating an area-weighted average of literature-recommended infiltration values based on the proportion of each hydrologic soil group (A, B, C, D) present within each subcatchment (Table 20) (James et al, 2005). Maximum infiltration values were computed based on the proportion of heavily vegetated pervious versus managed pervious area within each subcatchment, using recommended infiltration rates for these two types of pervious area (Table 21) (James et al., 2005). The XPSWMM default value of 0.001/sec for decay rate of infiltration was used for all subcatchments. No maximum infiltration was assigned.

Table 20: Minimum Infiltration Rates

HSG	in/hr
A	0.37
B	0.22
C	0.1
D	0.03

Table 21: Maximum Infiltration Rates

Pervious Area	in/hr
Managed/Developed Pervious	5
Forest/Heavy Vegetation	10

2.7.2 Groundwater Parameters

Groundwater setup in XPSWMM is divided into four categories: aquifer/water table depths and thicknesses, evapotranspiration, infiltration/percolation, and groundwater outflow. Several parameters within each category were developed in order to model groundwater flow. A total of 13 parameters were developed, including water table elevation, porosity, wilting point, field capacity, hydraulic conductivity, and more. This collection of parameters, in combination with the surface infiltration and runoff setups, drives the interaction between precipitation, surface runoff, infiltration, evaporation/evapotranspiration, and groundwater flow.

Parameters were calculated using a combination of USDA Web Soil Survey soils data, USGS geologic & groundwater data, input from water resources professionals from SC Department of Natural Resources (SCDNR) and Center for Watershed Protection, previous long-term continuous XPSWMM modeling experience, and professional engineering judgement. Initial groundwater parameters are provided in Table 22.

Table 22: Initial Groundwater Parameters

Parameter	Initial Value	Development Information
Upper Zone Depth (Depth to Water Table)	1.41 ft	Water table depth data provided in USDA Web Soil Survey data; USGS groundwater data used as additional reference
Lower Zone Depth (Aquifer Depth)	20 ft	Initial guess based on previous modeling experience and engineering judgement
Wilting Point	0.09	Calculated using USDA Web Soil Survey data
Field Capacity	0.17	Calculated using USDA Web Soil Survey data
Fraction of ET Assigned to Upper Zone	0.95	Initial guess based on previous modeling experience and engineering judgement
Max Depth of Significant Lower Zone ET	7 ft	Initial guess based on previous modeling experience and engineering judgement
Saturated Hydraulic Conductivity	7.4 in/hr	Calculated using USDA Web Soil Survey data
Porosity	0.45	Calculated using USDA Web Soil Survey data
Curve Fitting Parameter	45	Initial guess based on USDA Web Soil Survey data and SWMM guidance
Initial Upper Zone Moisture	0.17	Set equal to Field Capacity based on previous modeling experience and engineering judgement
Coefficient for Unquantified Losses	0.0009 in/hr	Initial guess based on previous modeling experience and engineering judgement
Tension/Soil Moisture Slope	1.25	Initial guess based on previous modeling experience and engineering judgement
Groundwater Flow Coefficient	0.00016	Initial guess based on previous modeling experience and engineering judgement

Following initial parameter development, several values were modified in order to achieve a proper surface-subsurface water balance, further discussed in the Model Calibration section.

2.8 Water Quality Parameters (Fecal Coliform)

Land surface pollutant loading in XPSWMM is represented using a build-up and wash-off approach. Pollutant build-up occurs in both natural and developed environments from multiple sources. For example, detached soil and waste from wild and domestic animals accumulates on land surfaces over time. During precipitation events, runoff carries these pollutants off surfaces and into streams. In XPSWMM, parameters defining build-up and wash-off processes are uniquely defined for each land use and a few different methods are available for both build-up and wash-off, such as exponential function and Event Mean Concentration (EMC) approaches. An EMC method is used for the May River Headwaters model. In this case, a fixed concentration is associated with runoff (Table 23) with no limit on available buildup. In developed areas where septic systems were present, the EMC values were increased initially by 20 percent based on professional modeling judgement since local information on septic performance and contributions to fecal loading was limited. Initial values are assigned as follows using information from the TMDL created for Fecal Coliform for the Shellfish Harvesting Areas in the Lockwoods Folly River, Lumber River Basin in North Carolina (NCDENR, 2010). These are within the range of values used for the May River Water Quality Model (2002), which were 140 to 6600 #/100 mL for runoff. Final values were determined through a calibration process, further discussed in the Model Calibration section.

Table 23: Initial Fecal Coliform EMC Values for Land Cover

Land Cover	Land Use Code	Initial FC Value (#/100 ml)
Open Water	11	400
Developed, Open Space	21	2500
Developed, Low Intensity - Sewer	22	5150
Developed, Low Intensity - Septic	22	6180
Developed, Medium Intensity - Sewer	23	5150
Developed, Medium Intensity - Septic	23	6180
Developed, High Intensity - Sewer	24	4000
Barren Land	31	400
Deciduous Forest	41	400
Evergreen Forest	42	400
Mixed Forest	43	400
Shrubland	52	400
Grassland	71	400
Pasture	81	400
Cultivated Crops	82	400
Woody Wetlands	90	400
Emergent Herbaceous Wetlands	95	400

The maximum number of land use categories that can be assigned to a single subcatchment in XPSWMM is five. Therefore, the Project Team aggregated the 17 land cover categories (from Table 23) as shown below (Table 24). These EMC differentiate between developed and undeveloped (natural) land covers. Additionally, the land use categories for low and medium density development are separated into two categories to distinguish between areas that are connected to sanitary sewer or septic systems.

Table 24: Fecal Coliform EMCs for XPSWMM Land Use

XPSWMM Land Use Category	Land Covers Included	Land Use Codes Included	Initial FC Value (#/100 ml)
Developed, Open Space	Developed, Open Space	21	2500
Developed, Low/Medium Intensity - Sewer	Developed, Low Intensity – Sewer; Developed, Medium Intensity – Sewer	22, 23	5150
Developed, Low/Medium Intensity - Septic	Developed, Low Intensity – Septic; Developed, Medium Intensity - Septic	22, 23	6180
Developed, High Intensity - Sewer	Developed, High Intensity - Sewer	24	4000
Natural/Open Water	Barren Land; Deciduous Forest; Evergreen Forest; Mixed Forest; Shrubland; Grassland; Pasture; Cultivated Crops; Woody Wetlands; Emergent Herbaceous Wetlands	31, 41, 42, 43, 52, 71, 81, 82, 90, 95	400

Once runoff is transported to the stream channel, in-stream pollutant processes are limited in XPSWMM to a simple exponential decay, which is used to represent bacteria die-off within the stream network. An initial decay value of 1.0 (units of 1/day) was used based on professional modeling judgement. Die off rates of 0.8 per day were used in May River Water Quality Model (Lopez and Wagner, 2002), prepared by Thomas & Hutton Engineering and Camp Dresser & McKee. Initial FC concentrations were assumed to be zero in groundwater because there are no significant point sources for consideration in the project area. However, fecal EMCs, the decay coefficient, and groundwater concentrations were adjusted during model calibration, further discussed in the Model Calibration (Section 3.0).

2.9 Existing BMPs

The predominant structural stormwater BMP utilized by the Town of Bluffton is stormwater ponds. As summarized in Table 25, the number of ponds has increased dramatically between the baseline and current conditions, most notably in Rose Dhu Creek and Stoney Creek subwatersheds. The Project Team in consultation with the Town, decided that the net effect of all structural BMPs in the May River Headwaters watersheds is implicit in the model results (as a function of land use and water quality calibration) at the outlets. There were documented challenges (see §5.4.2) that made incorporation of discrete, individual BMPs in the XPSWMM model unattainable. However, the Team is confident the model is a useful tool that will allow the Town to estimate the effect of current and future BMPs.

Table 25: Wet Ponds in May River Headwaters

Year	Duck Pond	Palmetto Bluff	Rose Dhu Creek	Stoney Creek	Total
2002	5	1	1	15	22
2018	7	20	142	93	262
Increase	40%	1,900%	14,100%	5,200%	1,091%

2.9.1 Proposed Projects in the 2011 May River Action Plan (Action Plan)

After reviewing the current Action Plan with the Town, the Project Team was informed that two of the fourteen (14) proposed projects (Table 26) were constructed in the May River Headwaters: the New Riverside Pond (NRP) and the Pine Ridge stormwater pond irrigation system (Areas A and H in Figure 17). The NRP project was created to enhance removal efficiency for bacteria at a known FC hotspot in the Stoney Creek watershed. The Pine Ridge irrigation system, located in the Rose Dhu Creek watershed, was designed to achieve stormwater volume reduction through application and infiltration on turfgrass areas.

Four of the 2011 proposed Action Plan projects (J, K, L and M, Figure 17) fall outside of the boundaries of the WQ Model project scope work area. However, Project Area K, primarily composed of the National Register Historic District of Bluffton, the Theodore D. Washington Municipal Building (Bluffton Town Hall) parking lot retrofits to reduce impervious surface and provide water quality improvements were completed. Funding for the NRP, Pine Ridge, and Town Hall cooperative projects was provided in part by the South Carolina Department of Health and Environmental Control with funds from the U.S. Environmental Protection Agency under Section 319 of the Clean Water Act. In addition, Project Area K currently includes CIP projects which will provide water quality BMPs to retain/infiltrate stormwater runoff as a retrofit of existing impervious surfaces pre-dating required stormwater BMPs.

Utilizing the procedure for the Watershed Treatment Model (WTM) in §5.4.2 of this model report, the estimated annual benefits for NRP and Pine Ridge projects are summarized in Table 27. Note that under the new *Southern Lowcountry Stormwater Design Manual*, ponds do not receive runoff reduction credit. Also, the Pine Ridge irrigation system was modeled as an infiltration practice based on average daily irrigation applications as listed in the report produced by the consultant (Thomas & Hutton, 2015).

Table 26: Recommended BMPs in 2011 May River Watershed Action Plan

Area	Project	Description
A	Future New Riverside Area	Construct three new stormwater ponds, modify one existing stormwater pond
B	Kenzie Park Outfall	Construct new stormwater pond
C	Rose Dhu Creek	Construct one new stormwater pond
D	Buckwalter Community Park and The Farm	Construct ditch modifications in existing ditch to divert water into adjacent ponds/wetland restoration
E	Ditch north of Stoney Crest	Construct earthen ditch blocks in existing ditch/wetland restoration
F	Hampton Lake Retrofit	Pond modification
G	Lakepoint Drive	Pond modification for up to nine existing stormwater ponds
H	Pinecrest	Modify five stormwater ponds
I	Pinecrest	Modify three stormwater ponds
J	Town Property	Expand existing Town stormwater pond
K	Guerrard/Wharf St.	Construct four new stormwater ponds
L	Gascoigne Bluff	Construct four new stormwater ponds
M	Traver Tract	Modify three existing stormwater ponds
N	Ditch in Hampton Lake	Construct earthen ditch blocks in existing ditch/wetland restoration

Table 27: Benefits of Completed 2011 Action Plan Projects

Project	Water Quality Volume (ft^3)	TN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Bacteria (billion/yr)	Runoff Reduction (ac-ft/yr)
New Riverside Pond	152,896	152.25	127.03	6834.63	9535.4	0
Pinecrest Irrigation	5,909	81.5	18.02	4.34	324.15	2.44
TOTAL	158,805	233.75	145.05	6,838.97	9,859.55	2.44

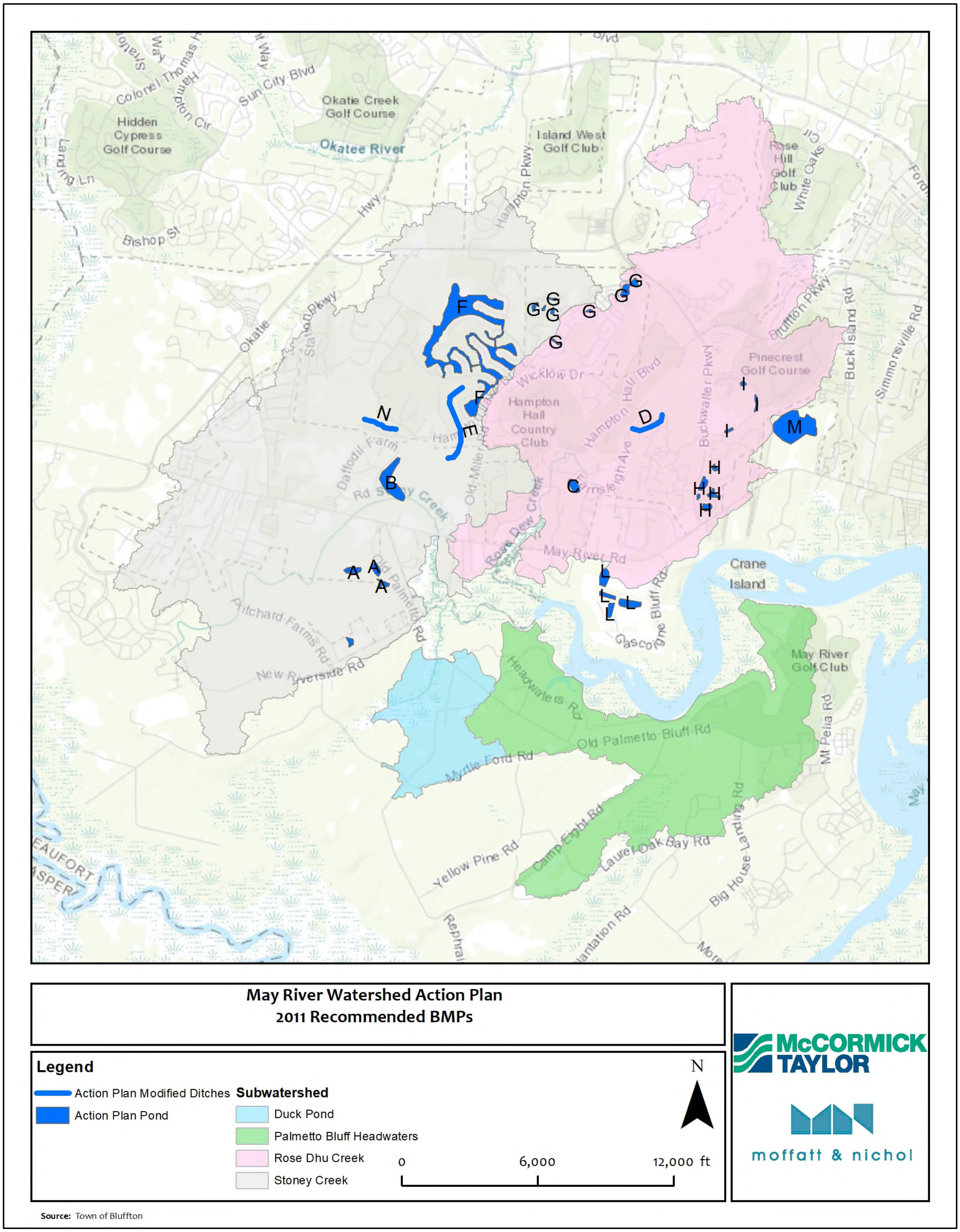


Figure 17. 2011 May River Watershed Action Plan Recommended BMPs

3.0 Model Calibration

To capture a variety of storm events, baseflow conditions, long-term trends, and variability in pollutant generation, transport, and fate, a continuous simulation of both water quantity and quality within the XPSWMM environment was developed. The Project Team developed and analyzed two conditions:

1. Baseline Conditions, 2002
2. Current Conditions, 2018

Therefore, in addition to using land use, land cover, imperviousness, and meteorology associated with each time period, the model calibration approach was designed to simulate and achieve model fit for periods of time including and surrounding these years. The simulation time periods stretched beyond just the two conditions to allow time at the beginning of the baseline and current periods for the model to ramp-up, helping to properly define antecedent soil moisture and baseflow conditions. For the baseline period, a model spin-up was used (running from January to December 2000) and the simulation extended through December 2004. For current conditions, spin-up was from July to December 2015. The current conditions model simulation extended through December 2018.

The initial approach called for calibration of both flow and water quality using existing data sources. After further review of the flow data, it was determined that the locally available data was not sufficient to calibrate the model to flow. Therefore, a number of other comparisons were made to ensure the model was producing a reasonable rainfall-runoff response, as described in sections 3.1.3, 3.1.4, and 3.1.5. This approach falls short of a formal, more complete calibration given these limitations on data, which are described further below. However, the combination of the methods used to evaluate hydrologic response of the model with the water quality calibration suggests the current model is appropriate for use in comparing baseline and current conditions as well as evaluation of management scenarios on a relative basis rather than an absolute basis.

3.1 Hydrology Model

XPSWMM has the ability to model water quality parameters, like FC, but only in the sanitary setting. The drawback of this setting is that there is reduced accuracy with the hydrologic and hydraulic modeling. In this section, we will describe the process for calibrating the hydrology model. Local flow data from the Town and USGS were reviewed for use in the hydrology model calibration. These efforts are described below. Ultimately, these data sources could not be used as planned, and therefore the model was evaluated by considering the overall model water balance in comparison to regional literature values. In addition, the Project Team compared model output to nearby gages (outside of the watershed; drainage area adjusted) to demonstrate overall runoff trends and flow magnitudes. The goal of the latter comparison was not to match the adjusted gage data but rather to ensure our rainfall-runoff response was generally consistent with patterns observed in the region.

3.1.1 Town of Bluffton Flow Data

The overall hydrologic calibration goal was to calibrate the XPSWMM models to flow data provided by the Town for the baseline 2002 time period and validate the models to flow data recorded during the current 2018 time period supplemented by USGS data. Velocity data collected by the Town using a SonTek-IQ is present in short intervals (several minutes) for multiple stations across the Stoney Creek and Rose Dhu Creek subwatersheds for 2016 through 2018, but the Project Team was advised by the Town not to utilize this data for velocity/flow comparisons (Table 24) due to concerns with data accuracy. Flow data collected using a SonTek FlowTracker 2 for station SC4 in the Stoney Creek subwatershed is available for portions of 2016 and 2017, but there are significant data gaps and the flow magnitudes within the dataset are unexpectedly small for a subwatershed of Stoney Creek's size. Overall, the flow data provided did not offer consistent, continuous coverage for any of the four project subwatersheds for either the baseline or current time periods.

3.1.2 Local USGS Gages

Three USGS gages along the main stem of the May River have recorded flow data for portions of the baseline 2002 time period, with USGS 02176711 located closest to the project area (Table 28). Several numerical methods were applied in an attempt to eliminate tidal effects in the recorded flow gage data at USGS 02176711. These methods were successful at removing low-frequency astronomical tidal effects from the flow data but were unable to separate high-frequency river flow from high-frequency offshore meteorological activity (i.e., local winds, etc.). The Palmetto filter, a tidal adjustment tool used by researchers at SCDNR, was also explored as a method of removing tidal signals from the USGS flow gage data. The Palmetto filter produced a flow time series with reduced tidal variability, but it is difficult to discern whether all tidal influence has been removed by the filter, as negative flow values still occur throughout the time series (indicating flow in the upstream direction). Since the overall watershed signal is small in comparison to the tidal signal, it is difficult to separate the two without considerable effort which was beyond the resources available for the project. Therefore, model development proceeded without further use of this flow data. Realizing that this is a limitation of the current model, the Team has made recommendations for future refinements of the model (Table 34) based on enhanced flow monitoring recommendations (Section 5.1.3).

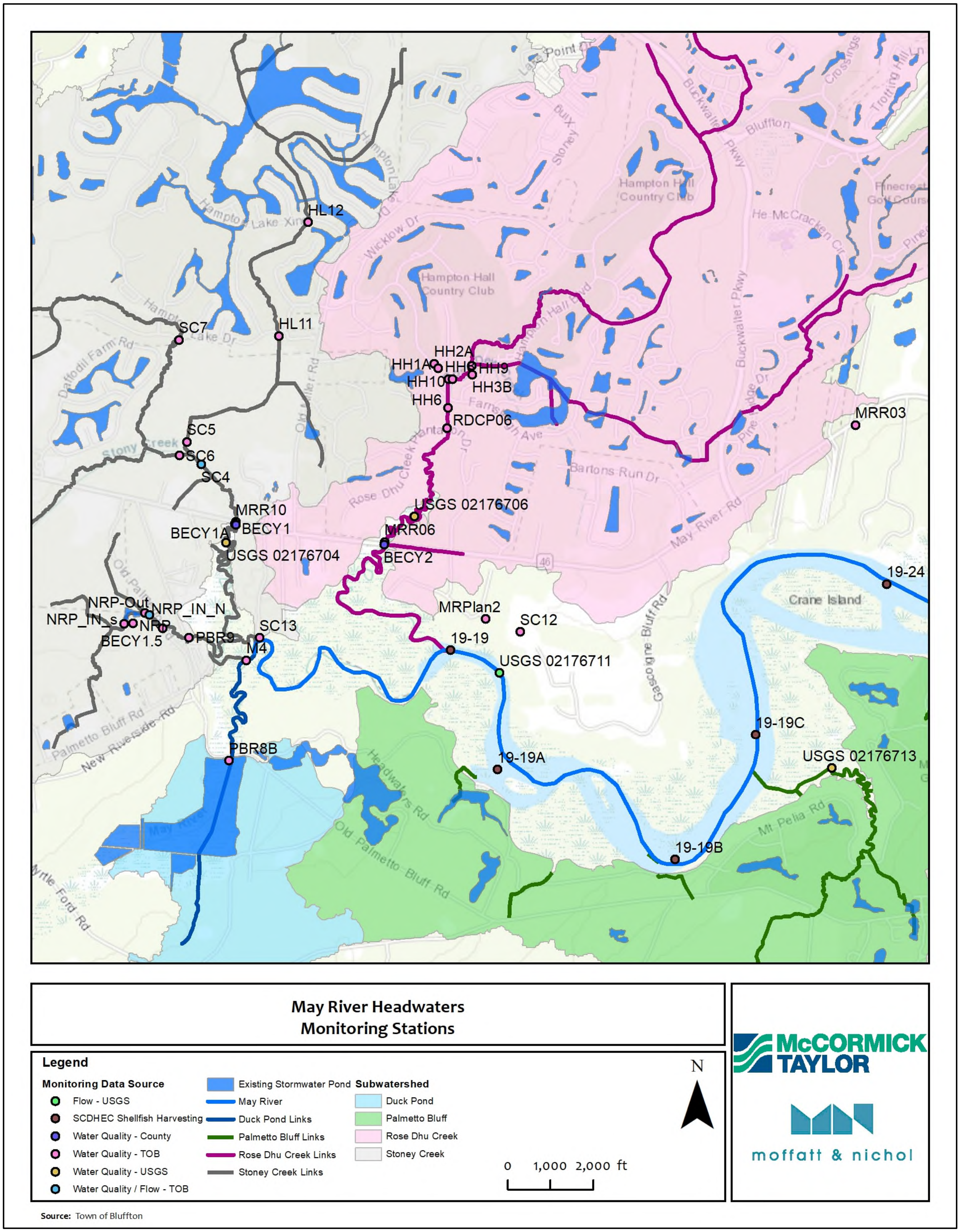


Figure 18. Water Quality and Flow Monitoring Stations

Table 28: Available Flow Data in May River Watershed

Data	Time Period	Location	Station	Collection Agency
Velocity, Temperature	10/4/2017 - 1 minute	Main Stem	BV01	TOB
Velocity, Temperature	10/4/2017 - 2 minutes	Main Stem	BV01	TOB
Velocity, Temperature	1/17/2018 - 6 minutes	Main Stem	BV01	TOB
Velocity, Temperature	5/15/2019 - 5 minutes	Main Stem	HGC01	TOB
Velocity, Temperature	10/4/2017 - 2 minutes	Main Stem	HGC01	TOB
Velocity, Temperature	1/17/2018 - 4 minutes	Main Stem	HGC01	TOB
Velocity, Temperature	5/10/2018 - 2 minutes	Main Stem	HGC01	TOB
Velocity, Temperature	6/11/2019 - 3 minutes	Main Stem	HGC01	TOB
Velocity, Temperature	2/7/2019 - 2 minutes	Main Stem	HGC01	TOB
Velocity, Temperature	5/10/2018 - 3 minutes	Rose Dhu Creek	HH6	TOB
Velocity, Temperature	2/7/2019 - 8 minutes	Rose Dhu Creek	HH6	TOB
Velocity, Temperature	5/15/2019 - 7 minutes	Rose Dhu Creek	HH6	TOB
Velocity, Temperature	6/11/2019 - 7 minutes	Rose Dhu Creek	HH6	TOB
Velocity, Temperature	8/2/2017 - 4 minutes	Unknown	MMR2	TOB
Velocity, Temperature	6/11/2019 - 1 minute	Unknown	MMR2	TOB
Velocity, Temperature	8/2/2017 - 2 minutes	Main Stem	MRR01	TOB
Velocity, Temperature	1/17/2018 - 1 minute	Main Stem	MRR01	TOB
Velocity, Temperature	2/7/2019 - <1 minute	Main Stem	MRR01	TOB
Velocity, Temperature	10/4/2017 - 3 minutes	Main Stem	MRR02	TOB
Velocity, Temperature	10/10/2017 - 2 minutes	Main Stem	MRR02	TOB
Velocity, Temperature	1/17/2018 - 2 minutes	Main Stem	MRR02	TOB
Velocity, Temperature	2/7/2019 - 1 minute	Main Stem	MRR02	TOB
Velocity, Temperature	6/11/2019 - 2 minutes	Stoney Creek	PBR9	TOB
Velocity, Temperature	5/15/2019 - 3 minutes	Unknown	PBRW	TOB
Velocity, Temperature	5/15/2019 - 18 minutes	Stoney Creek	SC4	TOB

Data	Time Period	Location	Station	Collection Agency
Velocity, Temperature	6/11/2019 - 12 minutes	Stoney Creek	SC4	TOB
Flow, Velocity, Temperature, Stage	7/28/2016 - 11/30/2016 (15 minute interval, some gaps)	Stoney Creek	SC4	TOB
Flow, Velocity, Temperature, Stage	7/28/2016 - 2/1/2017 (15 minute interval, some gaps)	Stoney Creek	SC4	TOB
Flow, Velocity, Temperature, Stage	7/28/2016 - 4/27/2017 (15 minute interval, some gaps)	Stoney Creek	NRP-OUT	TOB
Flow	6/1/2002 - 9/29/2004 (gaps 10/2002 - 10/2003, 11/2003, 12/2003)	Main Stem	USGS 02176711	USGS
Flow	6/6/2002 - 6/9/2004 (gaps 6/2002 - 7/2002, 12/2003)	Main Stem	USGS 02176720	USGS
Flow	6/6/2002 - 6/8/2004 (gaps 7/2003, 10/2003)	Main Stem	USGS 02176735	USGS

Note: USGS gage data was collected by the Project Team, not received from the Town.

3.1.3 Hydrologic Parameter Adjustment

During model calibration, multiple model parameters were adjusted from their initial values in order to improve hydrologic model performance. Model performance was evaluated based on overall water balance and by comparing flow patterns to nearby USGS gages, to be discussed in Section 3.1.4 and 3.1.5.

Potential Evaporation/Evapotranspiration (PET):

Calculated monthly-averaged daily PET values (discussed in Section 2.5.2) were modified during calibration in order to optimize performance and to help achieve an appropriate surface water balance. The calculated PET values were decreased by 20% during calibration; initial versus calibrated values are provided in Table 29.

Table 29: Calibrated PET Values for May River Headwaters

	2000-2004		2015-2018	
Month	Initial PET (in/day)	Calibrated PET (in/day)	Initial PET (in/day)	Calibrated PET (in/day)
January	0.05	0.04	0.04	0.03
February	0.06	0.05	0.06	0.05
March	0.09	0.07	0.08	0.06
April	0.11	0.09	0.11	0.09
May	0.16	0.12	0.15	0.12
June	0.19	0.15	0.19	0.15
July	0.20	0.16	0.20	0.16
August	0.18	0.14	0.17	0.14
September	0.14	0.11	0.14	0.11
October	0.09	0.07	0.09	0.07
November	0.06	0.05	0.06	0.04
December	0.04	0.03	0.05	0.04

Groundwater:

Several groundwater parameter values were modified during the calibration process in order to achieve a proper surface-subsurface water balance. Initial and calibrated values are provided in the Table 30.

Table 30: Calibrated Groundwater Values for May River Headwaters

Parameter	Initial Value	Calibrated Value	Calibration Information
Upper Zone Depth (Depth to Water Table)	1.41 ft	5 ft	Modified based on information from SCDNR staff
Lower Zone Depth (Aquifer Depth)	20 ft	30 ft	Modified based on USGS groundwater data
Wilting Point	0.09	0.09	No change
Field Capacity	0.17	0.17	No change
Fraction of ET Assigned to Upper Zone	0.95	0.95	No change
Max Depth of Significant Lower Zone ET	7 ft	7 ft	No change
Saturated Hydraulic Conductivity	7.4 in/hr	7.4 in/hr	No change
Porosity	0.45	0.45	No change
Curve Fitting Parameter	45	45	No change
Initial Upper Zone Moisture	0.17	0.17	No change
Coefficient for Unquantified Losses	0.0009 in/hr	0 in/hr	Modified to eliminate loss to deep groundwater
Tension/Soil Moisture Slope	1.25	1.25	No change
Groundwater Flow Coefficient	0.00016	0.00016	No change

3.1.4 Hydrologic Water Balance

Provided the lack of consistent flow data with which to calibrate the baseline 2002 XPSWMM models, model performance was evaluated in part using an overall hydrologic water balance. Modeled relationships between precipitation, evaporation/ET, infiltration, runoff, and stream baseflow were compared to literature-supported ratios for the region (Cherry et al., 2001; Lu et al., 2005). The literature values provided are for largely forested watersheds, and it should be noted that the May River watershed contained developed areas in the 2002 timeframe although much less than current conditions. Therefore, these literature values were used more as guidance or a benchmark for comparison rather than rule. As previously stated in Table 1, the percent imperviousness in 2001/2002 was 4.19% and 8.21%, respectively for Stoney Creek and Rose Dhu Creek. Water balance benchmarks and modeled values for Rose Dhu Creek and Stoney Creek (2000-2004) are summarized in Table 31. The ratio of runoff to streamflow is closer for Rose Dhu Creek than Stoney Creek, and this may be a reflection of differences in watershed characteristics such as size and shape (Stoney Creek is larger and has a more branched stream system).

Table 31: Water Balance Benchmarks and Modeled Values

Water Balance Benchmark	Modeled Value	
	Rose Dhu Creek	Stoney Creek
ET / Precipitation = 73-76%	75%	76%
Streamflow / Precipitation = 25-30%	28%	24%
Surface Runoff / Streamflow = 76%	75%	85%

3.1.5 Comparison to Nearby USGS Gages

To provide additional insight into the modeled outflow time series, flow data was compiled from two USGS gages outside of the May River watershed. Flow data at the USGS 02176500 gage on the Coosawhatchie River near Hampton, SC and USGS 02175500 gage on the Salkehatchie River near Miley, SC were collected for 2000 through 2004. The watershed area draining to these gages are larger and less developed than the May River watershed, but both gages are in reasonable proximity to the study area to be regionally representative and are located far enough inland to avoid tidal influences. Flow data from the USGS 02176500 and 02175500 gages was scaled via drainage areas separately to the Rose Dhu Creek and Stoney Creek subwatersheds. The goal of the comparison was not to precisely match modeled flow output with the scaled USGS flow, but only that data from these gages could be used to evaluate overall flow patterns and rainfall-runoff behavior. It is expected that flows modeled in XPSWMM will generally be higher than those seen at the USGS gages given that the May River watershed is more developed and will therefore produce higher (and more frequent) runoff volumes. Differences in precipitation patterns between the two USGS gage locations and the May River watershed also affect flow magnitudes, frequencies, and timing.

Figures 19 and 20 show comparisons between XPSWMM's modeled flow results for the Rose Dhu Creek and Stoney Creek subwatersheds and each USGS gage's data scaled down to the appropriate subwatershed drainage area. The comparisons show similar patterns throughout the simulation. As expected, the May River watersheds have higher peaks during wetter periods in 2003 and 2004. Note that periods of 2001 and 2002 were unusually dry for many parts of the region. In summary, the comparison suggests the May River model produces rainfall-runoff behavior consistent with regional expectations.

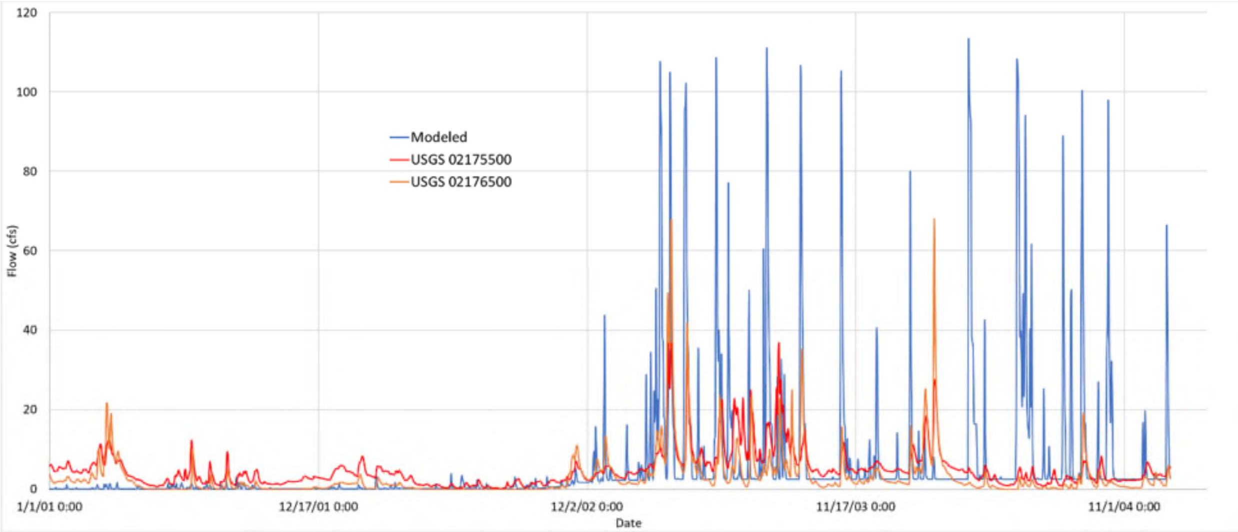


Figure 19. Scaled USGS Gage Data and Modeled Rose Dhu Creek Flow Results

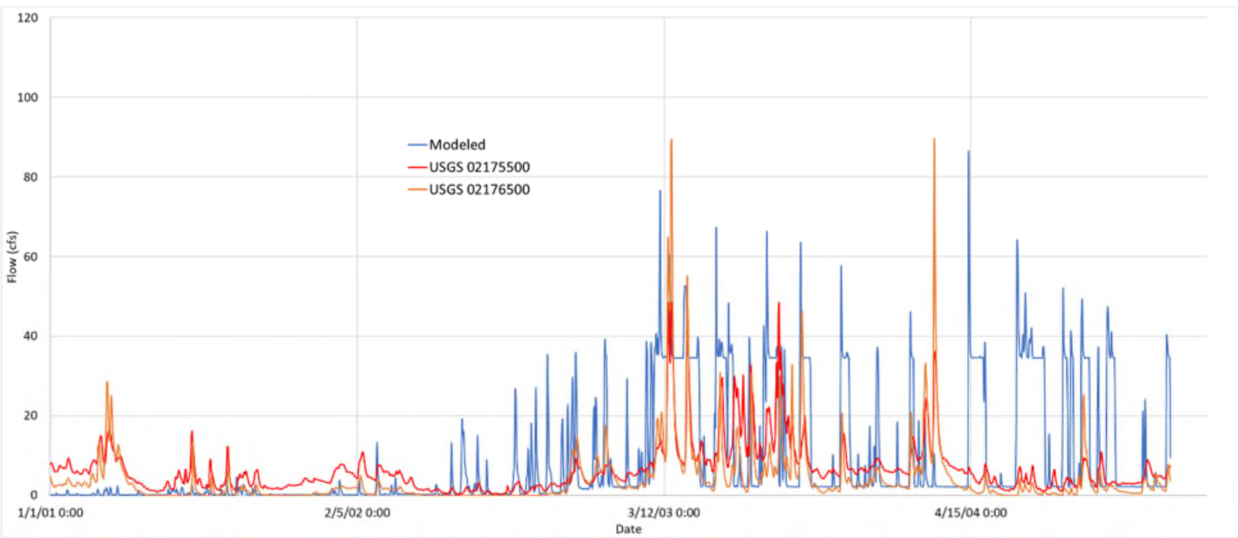


Figure 20. Scaled USGS Gage Data and Modeled Stoney Creek Flow Results

3.2 Water Quality Calibration

3.2.1 Calibration Approach

Watershed loading models are subject to high levels of variability and uncertainty. The model itself is an approximation of reality and the model parameters can only be estimated. There is natural variability in land use and cover, meteorology, and management across the watershed. Next, monitoring data provide an imprecise target for model calibration, as laboratory results have their own associated uncertainty as grab samples may not be fully representative of daily average model predictions. Calibration thus consists of comparing two uncertain numbers, the monitored value and model value. For this reason, the strategy for calibration focused on developing a common set of pollutant-related parameters aimed at fitting the data across years and stations to avoid over-fitting.

Measured FC data were used to calibrate the water quality component of the models. Fecal coliform data was provided by the Town for the current conditions time period. There was limited data available from the baseline period, which included a small amount of FC data from three USGS gages: one located in the Rose Dhu Creek subwatershed, one in the Stoney Creek subwatershed, and another in the Palmetto Bluff subwatershed. Measurements were recorded quarterly from May 2002 until March 2003, providing four measured values for each gage. Review of the Town's bacterial data showed wide variability in concentrations even within short distances along the stream network. Through discussions with the Town, the Project Team confirmed this trend in the monitoring observations (see Section 5.2.2 for more detailed discussion of this statistical analysis). In addition, the Town indicated that although some of the samples collected at the outfalls of some ponds had low FC concentrations, the influx of freshwater into the receiving drainage system (mainly ditches) appears to have supported the regrowth and subsequent spike in fecal coliform concentrations a short distance downstream from the outfall. The Town's staff have demonstrated this phenomenon is not a result of sampling or laboratory process errors, as the effect has been replicated at different times and locations throughout the Headwaters sampling stations. Unfortunately, the model will have trouble simulating this regrowth behavior.

Also, it should be noted that any lack of fit from the hydrology portion of the model will follow through into the water quality simulation. Loads are calculated by multiplying a concentration by a volume of water; therefore, the flow simulation can limit how well the water quality model can reproduce observed magnitudes and patterns. See Table 34 and §5.1 for recommendations for future simultaneous flow and bacteria monitoring.

3.2.2 Water Quality Parameter Adjustment

During model calibration for water quality, multiple parameters were adjusted in order to improve the performance of the water quality simulation in comparison to measured data. Bacterial event mean concentration (EMCs) assigned in the model by land use were adjusted to better fit model output to measured values. Initial versus calibrated fecal concentration values are shown in Table 32. Fecal coliform concentrations were also introduced into groundwater during calibration to reflect the ubiquitous nature of FC in the environment and its interaction with the shallow groundwater table. As the Town continues to enhance its monitoring program (both for flow and FC), the calibration of the model will be able to be further refined.

Table 32: Calibrated EMCs for FC for Land Use

XPSWMM Land Use Category	Initial FC Value (#/100 ml)	Calibrated FC Value (#/100ml)	FC Concentration in Groundwater (#/100ml)
Developed, Open Space	2500	6000	50
Developed, Low/Medium Intensity - Sewer	5150	8000	50
Developed, Low/Medium Intensity - Septic	6180	9500	100
Developed, High Intensity - Sewer	4000	5000	50
Natural/Open Water	400	900	20

Initially during model set up, a simple in-stream decay rate of 1.0 was simulated. However, given that the model could not be calibrated to local flow data and due to the issue of potential bacterial regrowth in channels indicated by Town staff, the Project Team decided to not include decay in the current model. Regrowth is a phenomenon that has been reported elsewhere, and in high organic matter environments can complicate the decay trends (Fries et al., 2007). Once additional flow and bacteria data are collected, this setting can be revisited.

Comparison plots showing observed data and modeled fecal coliform concentrations are provided in Figures 21- 38 for the time periods and nine stations described in Table 33. Note that no station had data available for both the baseline and current conditions. Also, there was no monitoring data available for either time period for Duck Pond. The goals of the calibration were to (1) use the same set of water quality parameters across all subwatersheds and time periods which required a compromise fit across all of them, and (2) achieve a best fit without overfitting the model due to issues with the flow calibration. Two types of graphs are shown for each station. The first is a plot of observed and modeled paired values along a 1-to-1 line (note the modeled value is a daily average) as shown in Figures 21, 23, 25, 27, 29, 31, 33, 35, and 37. The closer the values are to the 1 to 1, the better the fit between observed and modelled. The second plot is a time series of observed and modeled values (Figure 22, 24, 26, 28, 30, 32, 34, 36, and 38). All results plots display results for the time period specified in Table 31 for Baseline and Current Conditions—2001 through 2004 for the Baseline 2002 time period, and 2016 through 2018 for the Current 2018 time period.

Table 33: FC Monitoring Data for Assessing Baseline and Current Conditions

Subwatershed	Baseline 2002 (2001-2004)	Current 2018 (2016-2018)
Rose Dhu Creek	USGS 02176706	MRR06, HH9
Stoney Creek	USGS 02176704	MRR10, PBR9, SC4, SC6
Palmetto Bluff	USGS 02176713	--

Overall, the plots for 2002 (Figures 21-26) show a more limited amount of observed data available for comparison. There is some over prediction and some under prediction. Analysis of the period surrounding 2018 provides a better picture of model performance.

For the 2018 period (Figures 27-38), the paired data comparisons show a generally even distribution of under- and over- prediction with a good amount of scatter around the 1:1 line. However, most plots show underprediction when values are above 1,000 units. Time series show that many of the patterns are captured with a number of high measured values not captured.

The primary goals for the model calibration were to replicate storm event loading and overall loading; replicate the pattern of pollutant concentrations across a range of flows; and reduce the bias (i.e., consistently over or under prediction) in the predictions. The model does a reasonable job of this considering the lack of local flow data to calibration hydrology. However, some of the very high FC concentrations are not captured well in the model in addition to some of the high variability in the data.

In conclusion, the Project Team has developed a set of models based on the available data and resources that can be reasonably applied to understand relative loading between baseline and current conditions and by subcatchment. In addition, it provides a platform to understand the effects of management practices. However, there are several improvements that can be made to refine the model in the future. These recommendations are summarized in Table 34.

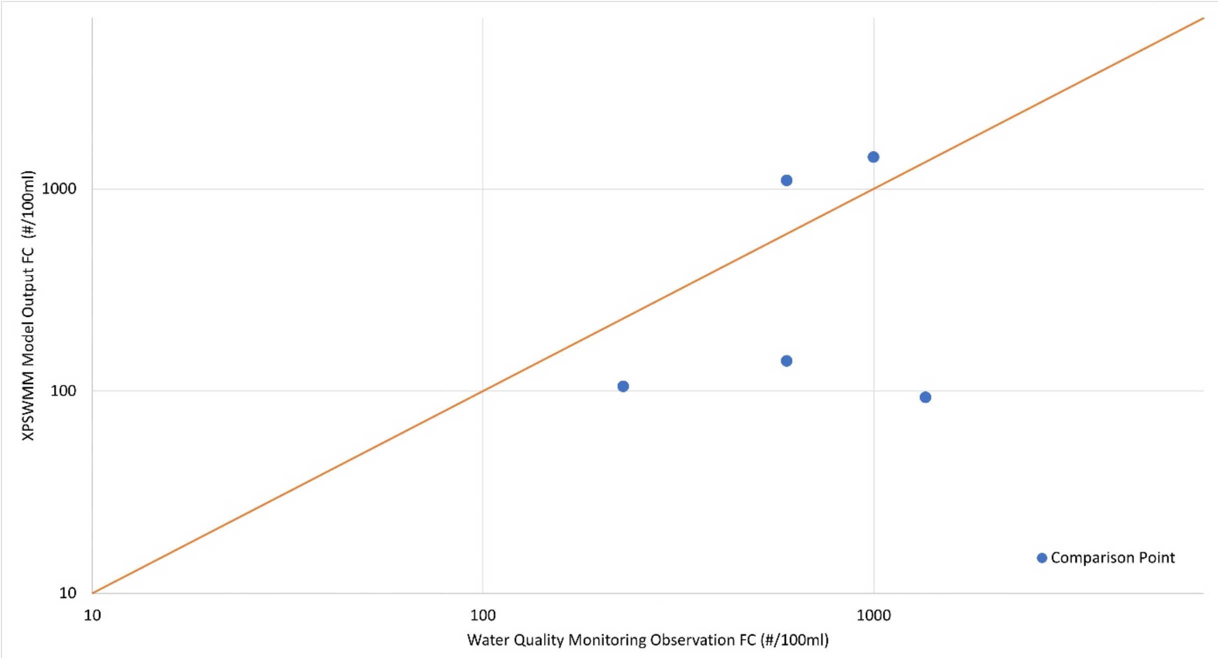


Figure 21. USGS 02176706 Observed vs. Modeled Fecal Concentrations – Baseline Conditions 2002 (Rose Dhu Creek)

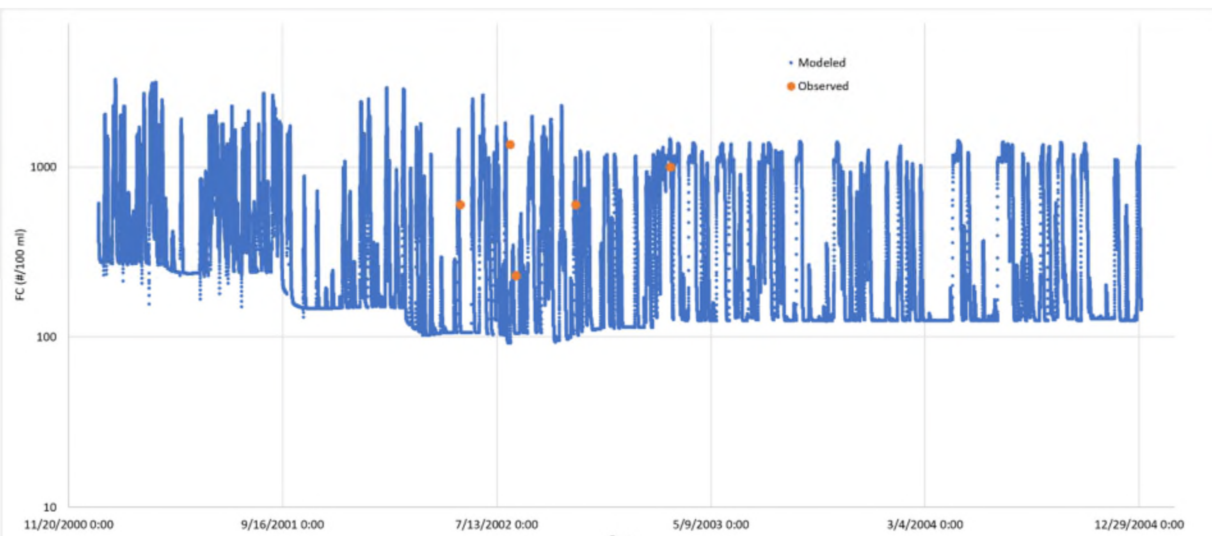


Figure 22. USGS 02176706 Observed and Modeled Fecal Concentrations – Baseline Conditions 2002 (Rose Dhu Creek)

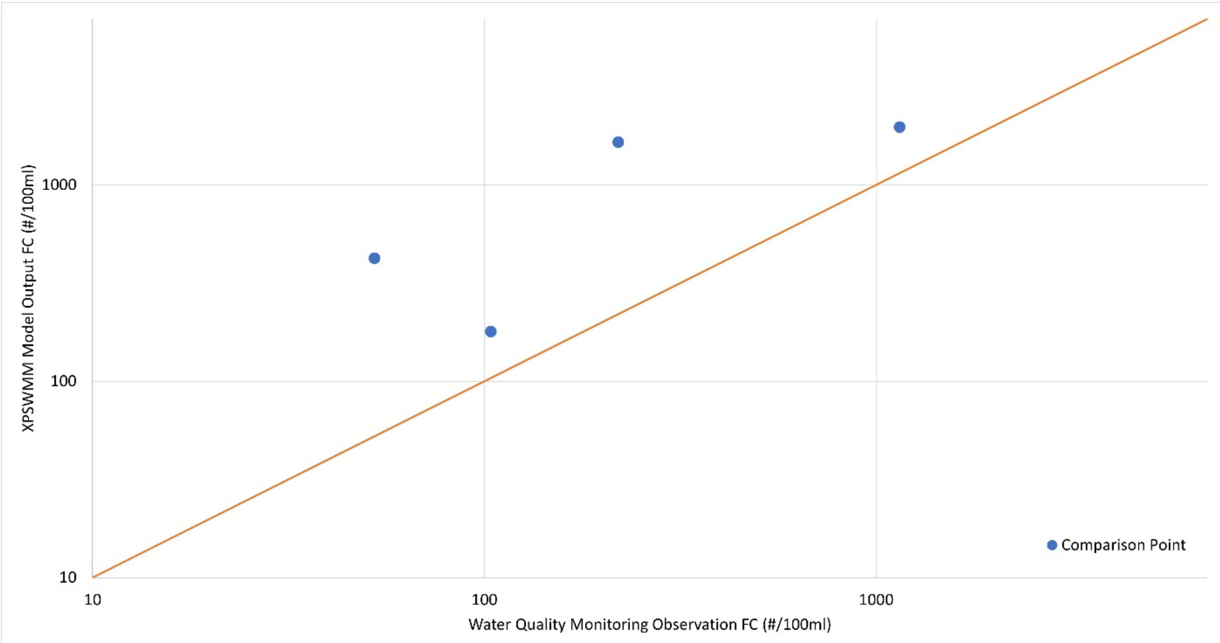


Figure 23. USGS 02176704 Observed vs. Modeled Fecal Concentrations – Baseline Conditions 2002 (Stoney Creek)

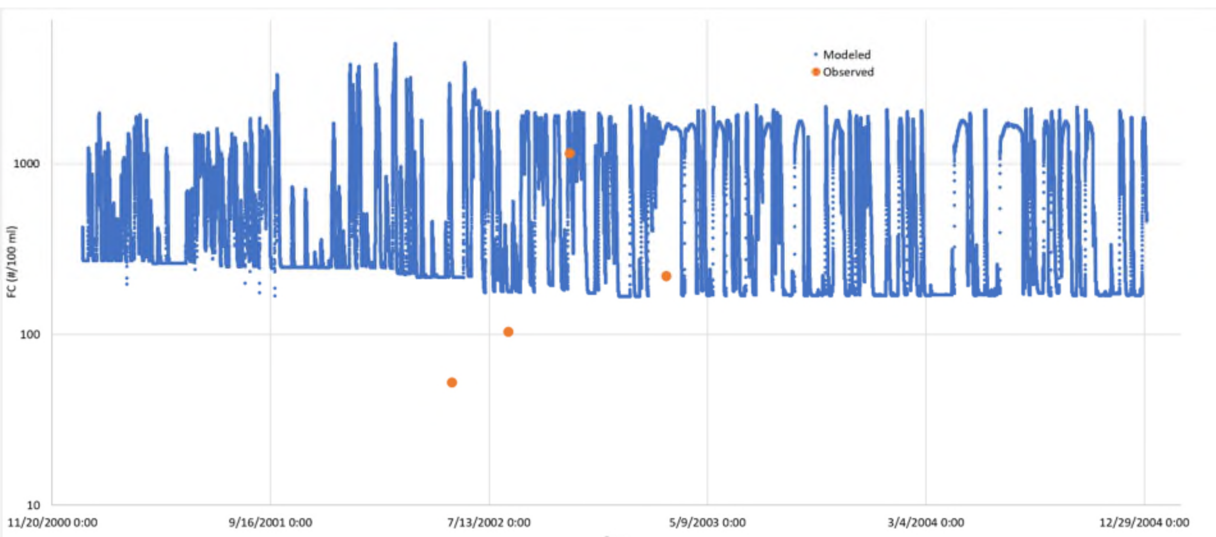


Figure 24. USGS 02176704 Observed and Modeled Fecal Concentrations – Baseline Conditions 2002 (Stoney Creek)

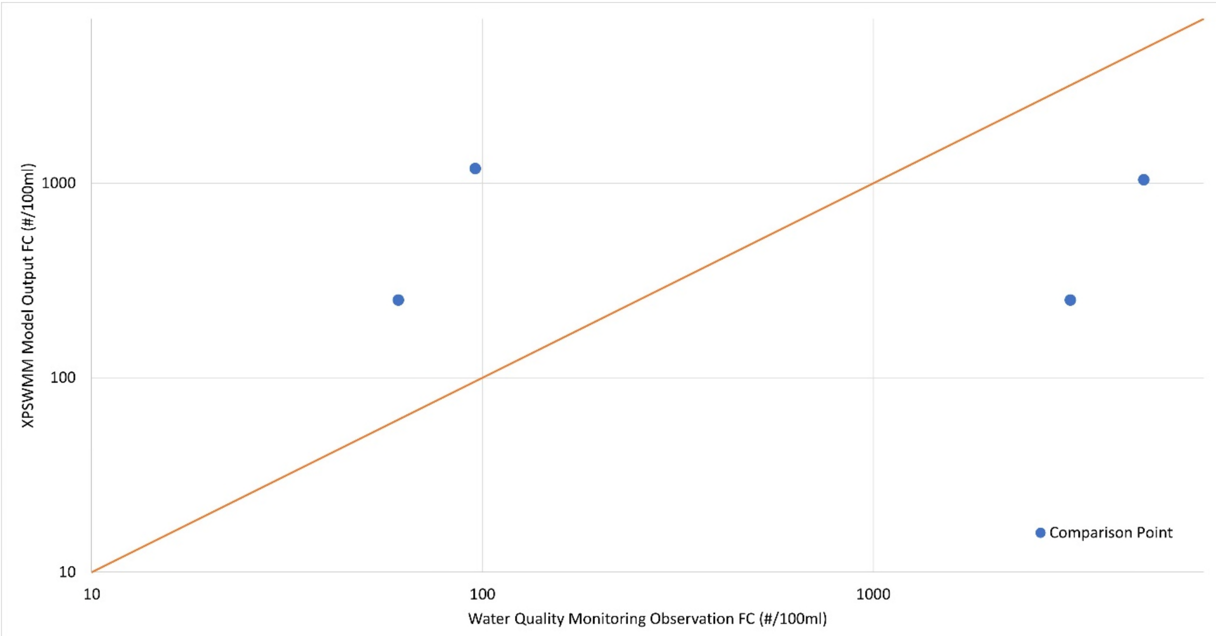


Figure 25. USGS 02176713 Observed vs. Modeled Fecal Concentrations – Baseline Conditions 2002 (Palmetto Bluff)

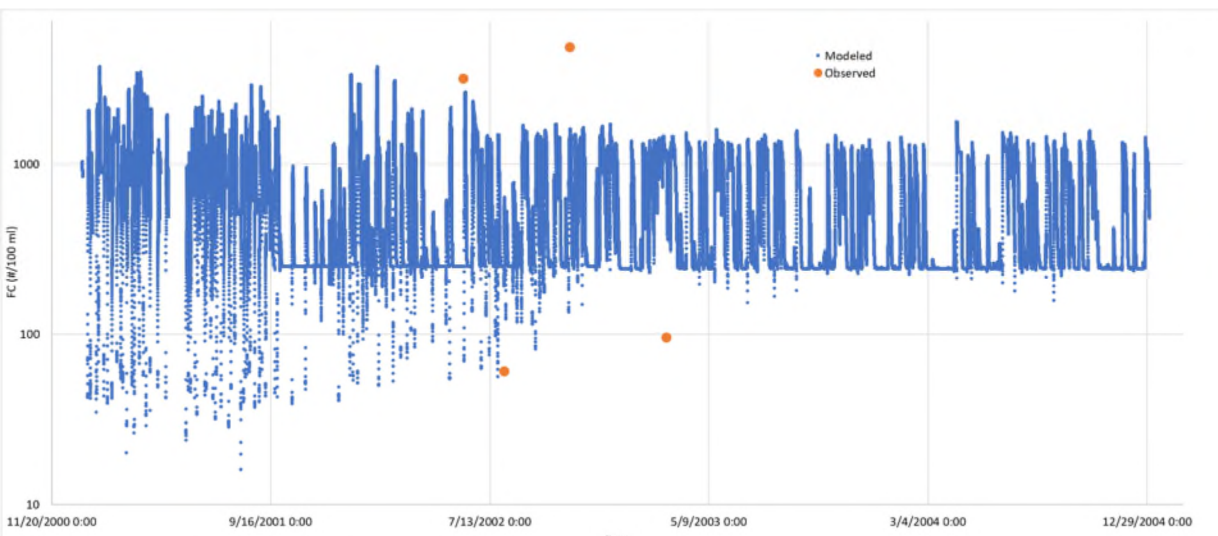


Figure 26. USGS 02176713 Observed and Modeled Fecal Concentrations – Baseline Conditions 2002 (Palmetto Bluff)

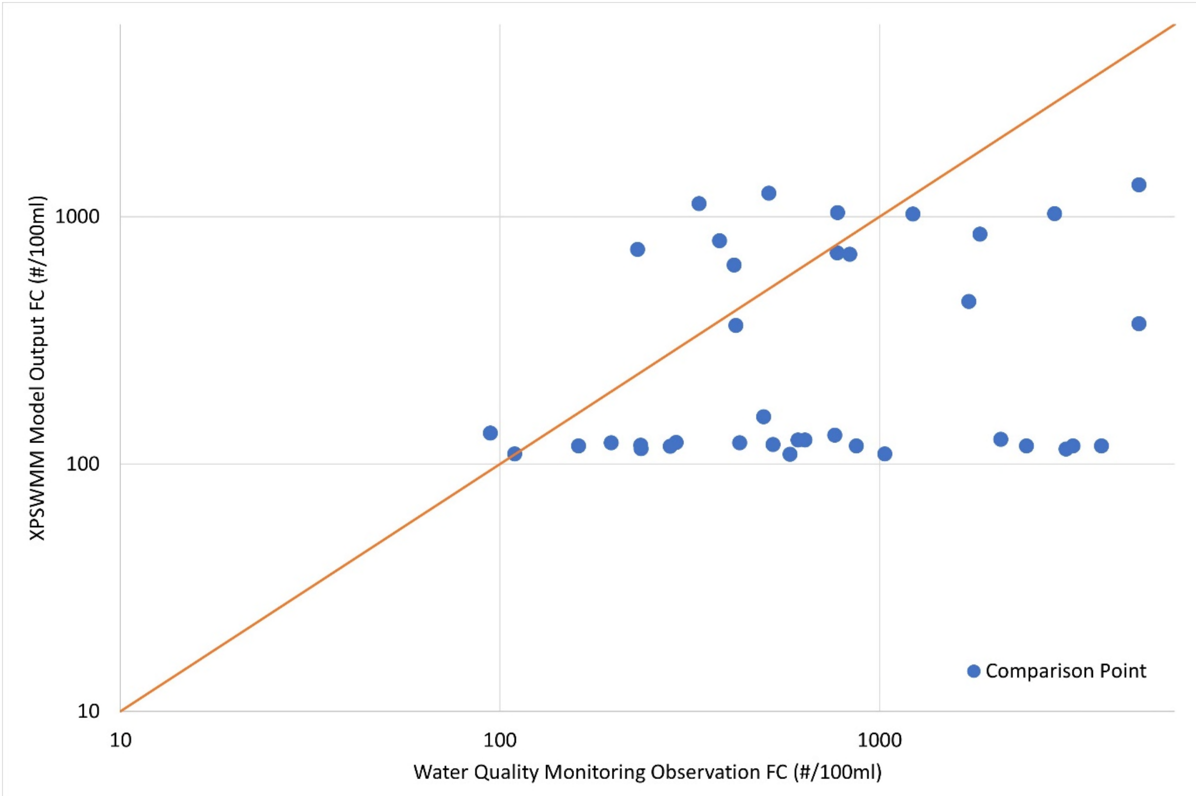


Figure 27. MRR06 Observed vs. Modeled Fecal Concentrations – Current Conditions 2018 (Rose Dhu Creek)

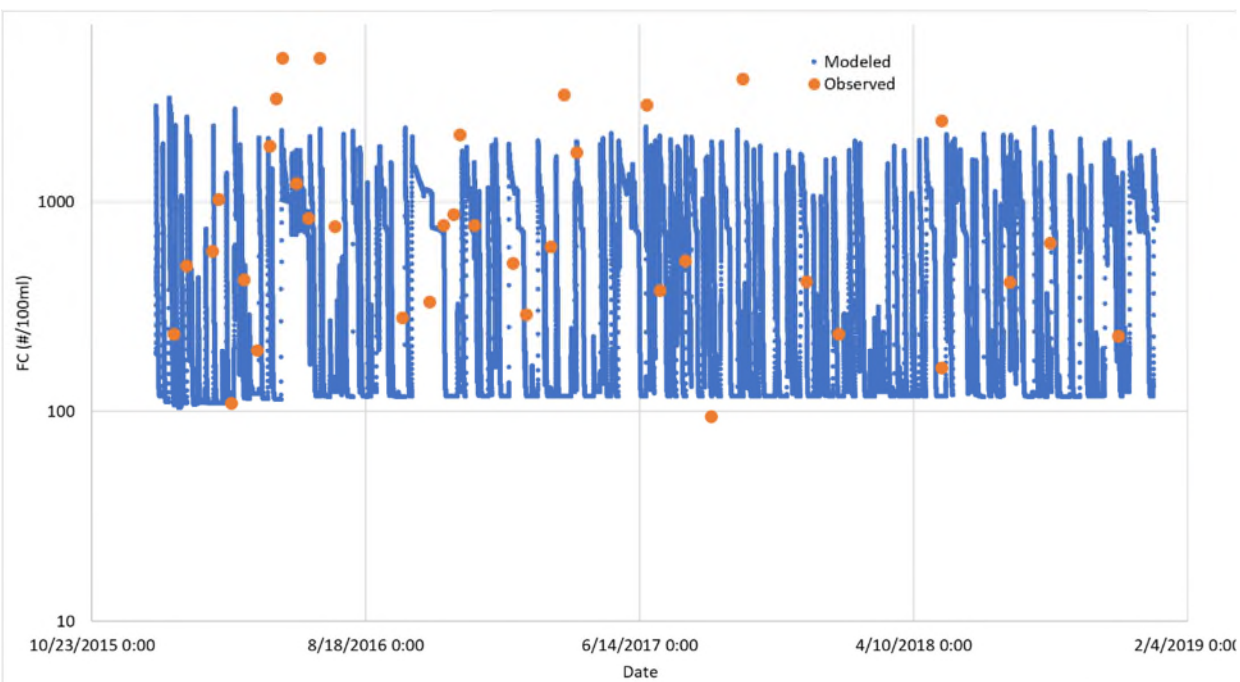


Figure 28. MRR06 Observed and Modeled Fecal Concentrations – Current Conditions 2018 (Rose Dhu Creek)

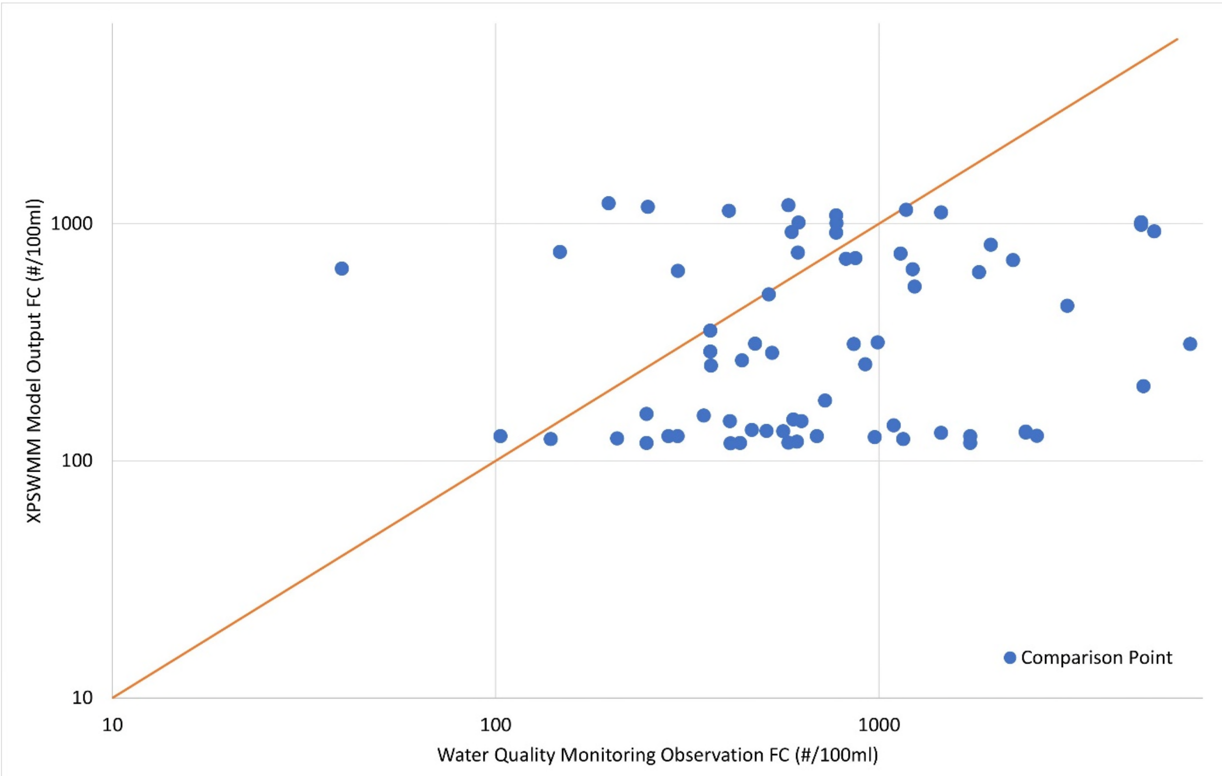


Figure 29. HH9 Observed vs. Modeled Fecal Concentrations – Current Conditions 2018 (Rose Dhu Creek)

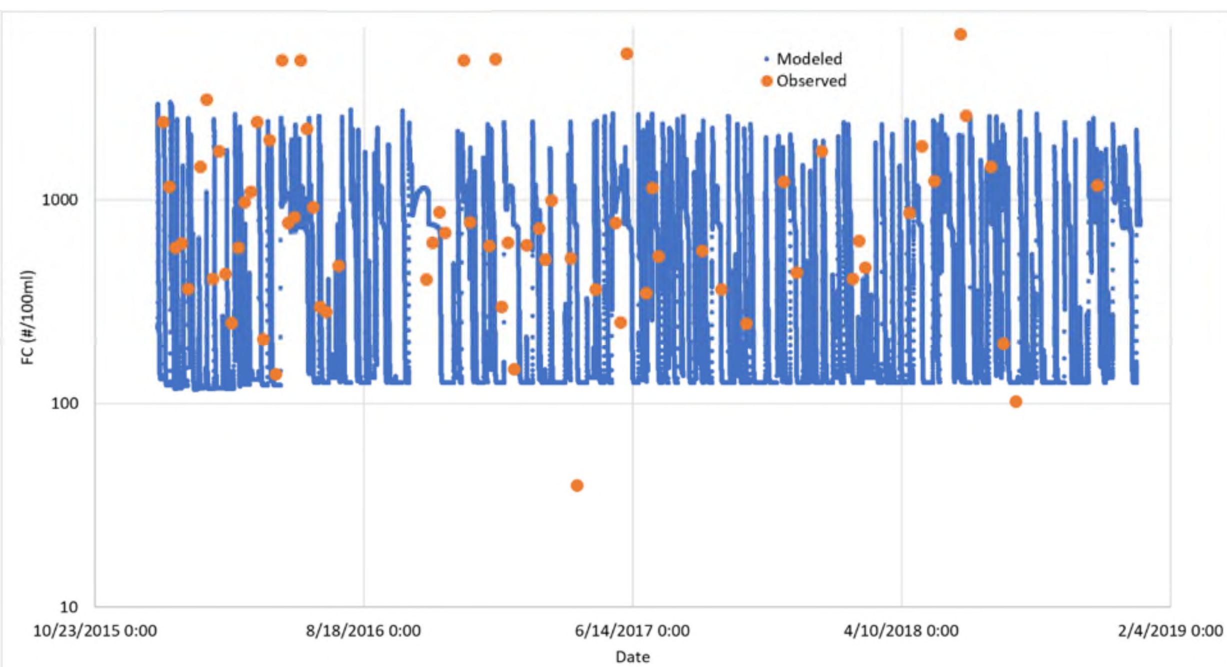


Figure 30. HH9 Observed and Modeled Fecal Concentrations – Current Conditions 2018 (Rose Dhu Creek)

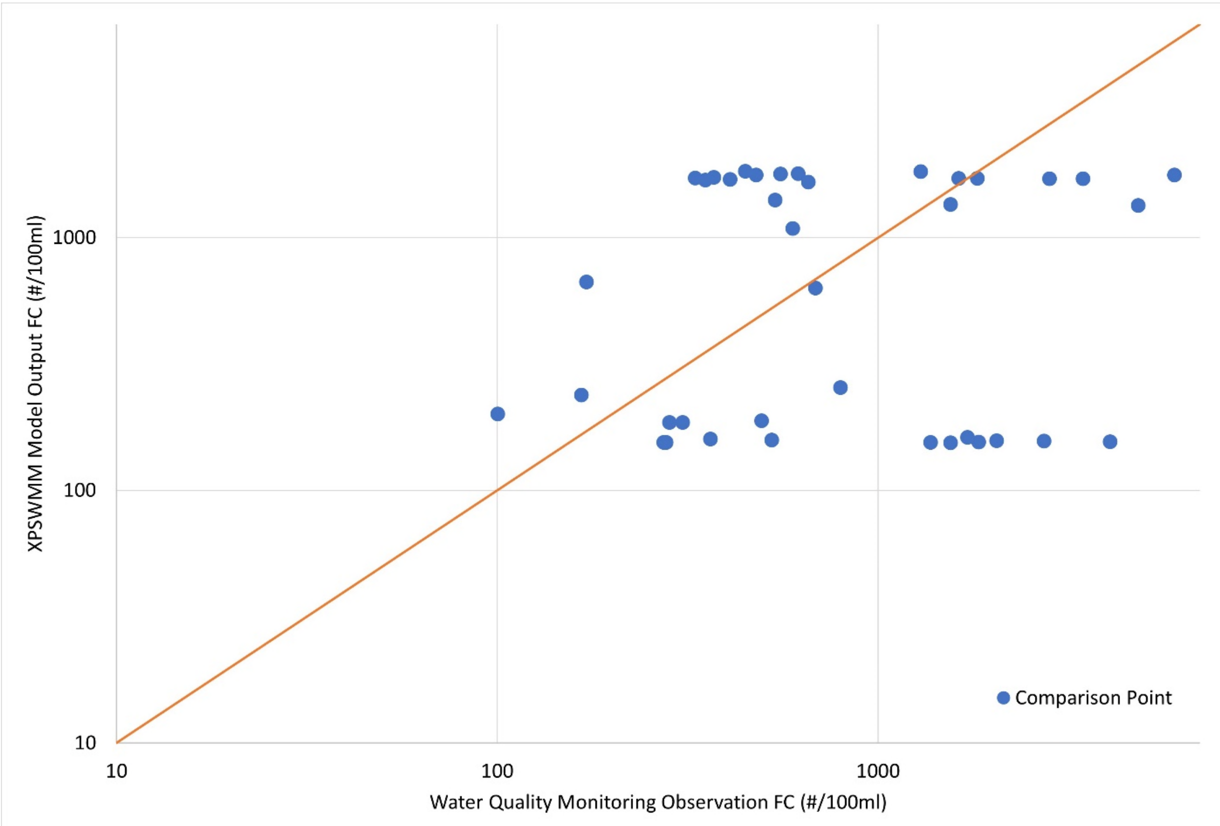


Figure 31. MRR10 Observed vs. Modeled Fecal Concentrations – Current Conditions 2018 (Stoney Creek)

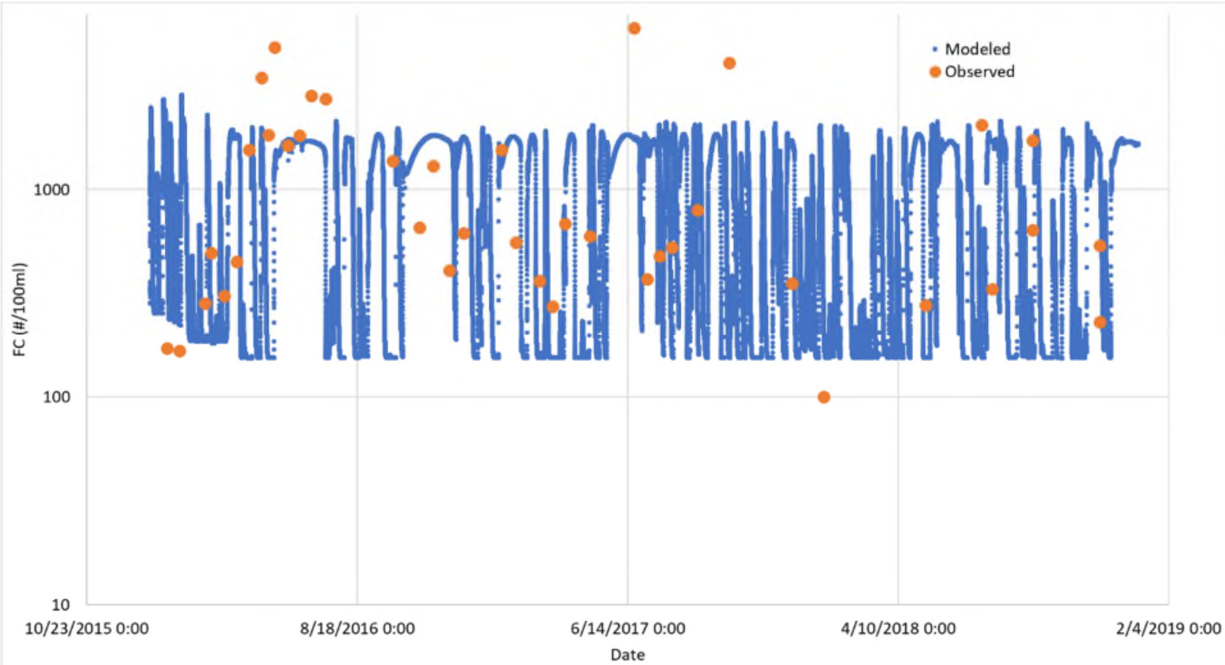


Figure 32. MRR10 Observed and Modeled Fecal Concentrations – Current Conditions 2018 (Stoney Creek)

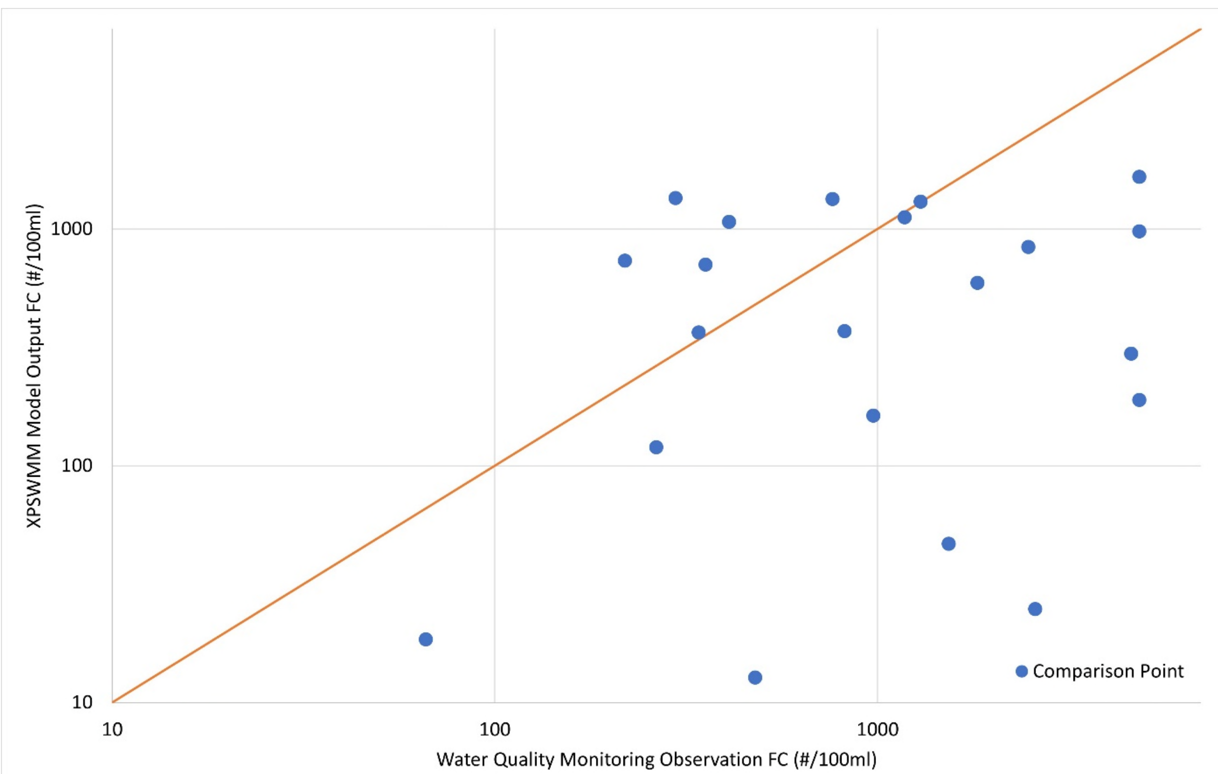


Figure 33. PBR9 Observed vs. Modeled Fecal Concentrations – Current Conditions 2018 (Stoney Creek)

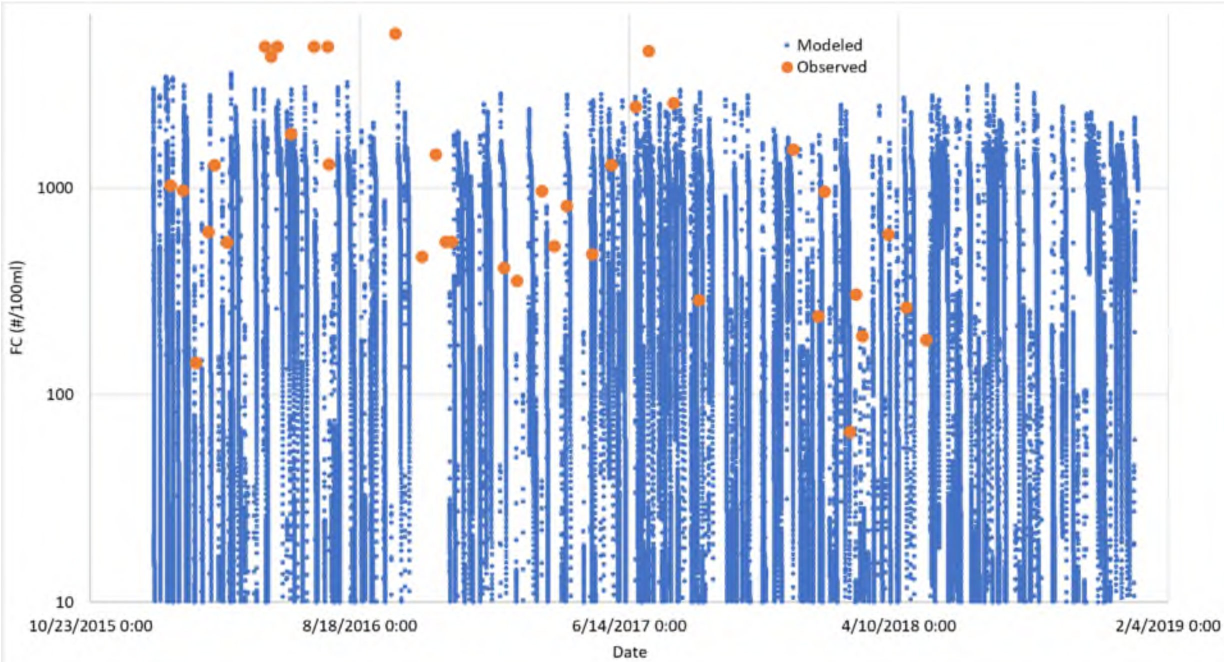


Figure 34. PBR9 Observed and Modeled Fecal Concentrations – Current Conditions 2018 (Stoney Creek)

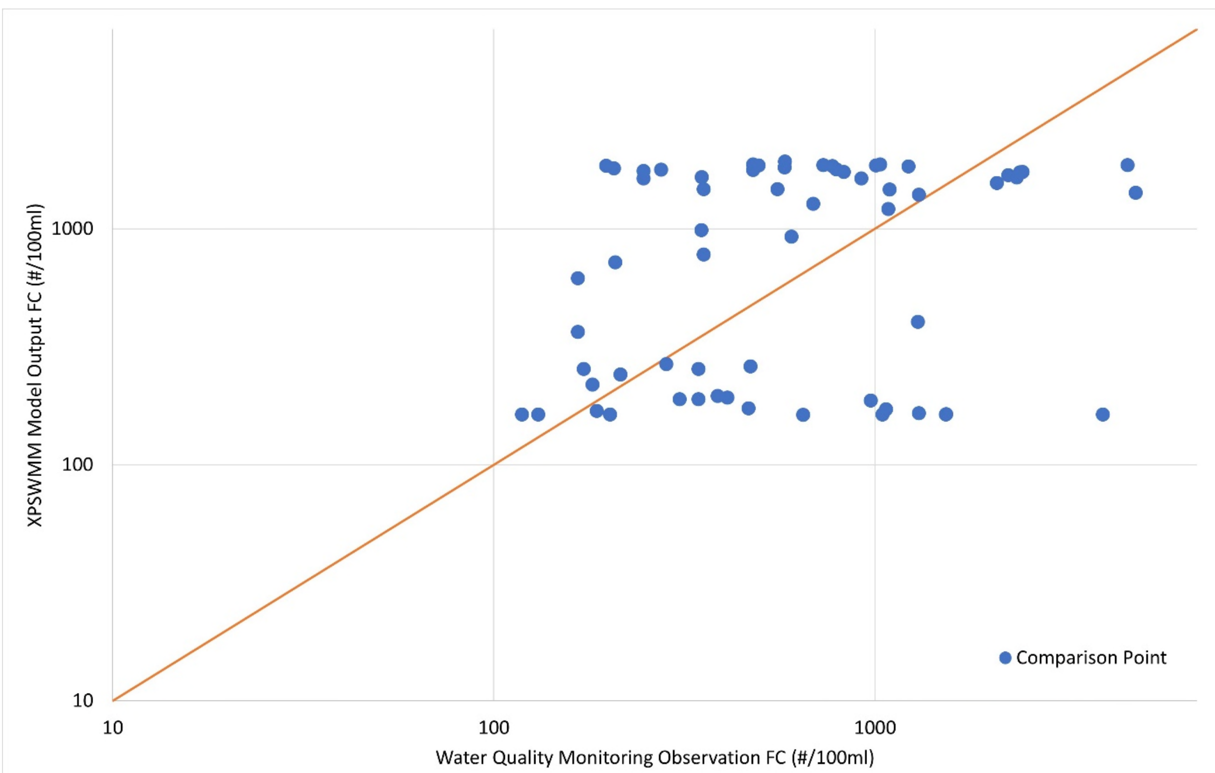


Figure 35. SC4 Observed vs. Modeled Fecal Concentrations – Current Conditions 2018 (Stoney Creek)

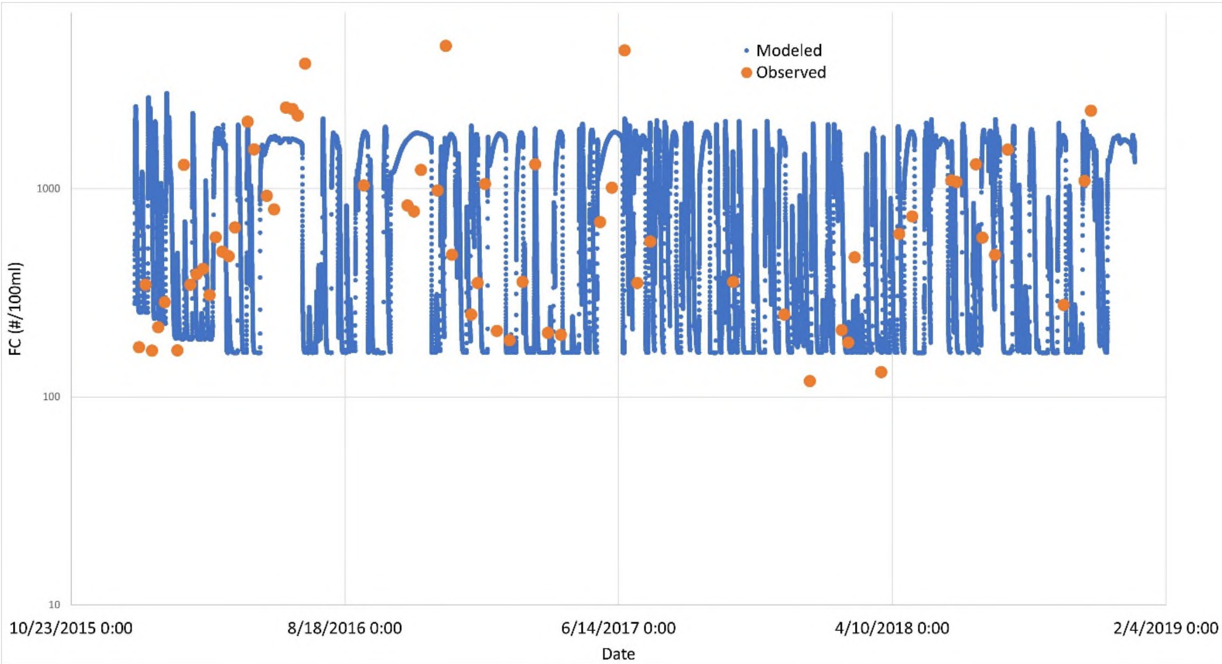


Figure 36. SC4 Observed and Modeled Fecal Concentrations – Current Conditions 2018 (Stoney Creek)

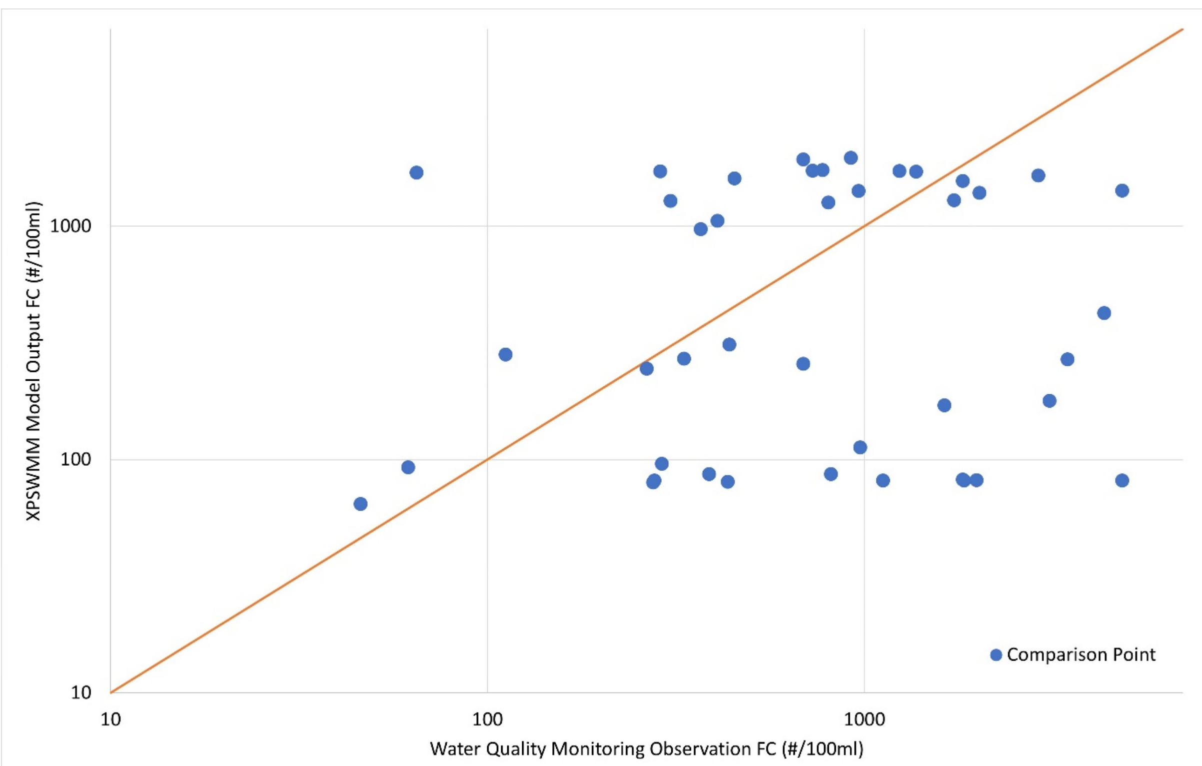


Figure 37. SC6 Observed vs. Modeled Fecal Concentrations – Current Conditions 2018 (Stoney Creek)

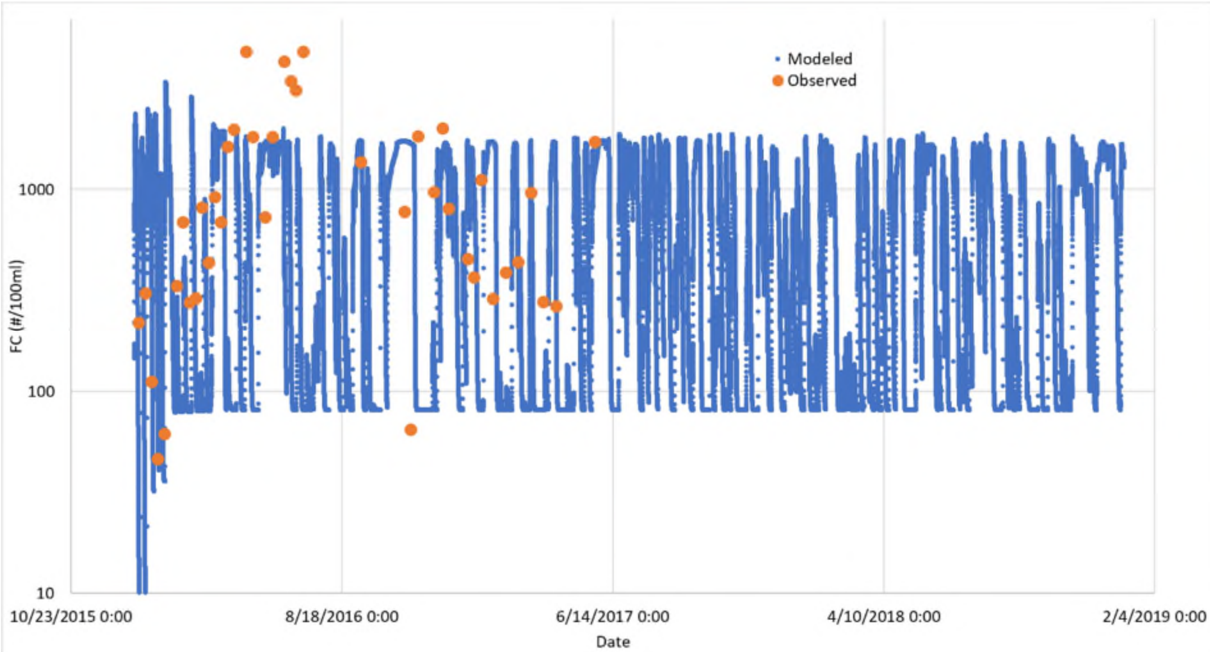


Figure 38. SC6 Observed and Modeled Fecal Concentrations – Current Conditions 2018 (Stoney Creek)

Table 34: Summary of Model Setup and Calibration Parameters

Model Input and Calibration Data	Data Gap	Assumption(s)	Recommendations for Future Work to Resolve Data Gap and Keep Model Current
Subcatchment Delineation	N/A	Subcatchment delineations did not change from 2002 to 2018; some subcatchments were aggregated for modeling purposes while maintaining appropriate level of detail.	Periodically update subcatchment delineations as data becomes available (e.g. newer LiDAR, updated stormwater infrastructure)
Channel Network	Cross-section dimensions	Used LiDAR to approximate dimensions of channels, based on drainage network GIS information provided by Town/County	Survey representative channel cross-sections for link input for the model
Channel Network	Cross-section roughness	Used aerial imagery and NLCD data to estimate Manning's roughness coefficients	Survey representative channel cross-sections and use field observations to estimate roughness
Channel Network	Channel invert elevations	Estimated from the "LevelDEM79_40" raster provided by the Town	Survey channel inverts
Impervious Cover	N/A	Data received from the Town for 2018; impervious cover for 2002 was created by removing areas from the 2018 dataset using aerial imagery and land use data	Ensure Town's database of building footprints, walkways and pathways, parking areas, driveways, roads and curbs, and ponds is current for each subcatchment
Connected/Disconnected Impervious Cover	N/A	The percentage of impervious area that is disconnected versus connected was estimated for each land use type using literature-supported disconnection fractions and previous experience/professional modeling	

Model Input and Calibration Data	Data Gap	Assumption(s)	Recommendations for Future Work to Resolve Data Gap and Keep Model Current
		judgement. The amount of connected impervious area was calculated as the total impervious area minus the disconnected impervious area.	
Precipitation	Local 15-minute data	Bennett's Point was too far away; KSAV only had hourly data and is ~20 miles from the May River watershed	Establish meteorological station in May River watershed/Town of Bluffton with capability of continuous, long-term monitoring at desired frequency
Evaporation	N/A	Calculated using meteorological data from KSAV; assumed weather at KSAV is the same as or similar to weather in the May River watershed	Update/adjust values based on changing meteorological conditions (i.e. changes in daily average temperature)
Subcatchment Parameters: area, % impervious, width, slope	N/A	Assumed accurate impervious cover and subcatchment delineation data	Update/adjust these values for the subcatchments in XPSWMM if any changes to watershed delineation and/or impervious area
Subcatchment Infiltration Parameters: depression storage, Manning's n, infiltration rates	N/A	Calculated using NLCD land use data from 2001 and 2016 and NRCS soils information	Update for changes in land use
Groundwater Parameters	N/A	Calculated using NRCS soil data, available USGS groundwater data, and SWMM guidance	Update if soils or groundwater data is updated by NRCS, USGS
Land Use	Local parcel-based land use/zoning information was not complete and	Used NLCD land use data (30 m resolution); assumed 2001 NLCD data was representative of 2002 time period,	Update for changes in land use

Model Input and Calibration Data	Data Gap	Assumption(s)	Recommendations for Future Work to Resolve Data Gap and Keep Model Current
	readily available for model use	and 2016 NLCD data was representative of 2018 time period	
Septic versus Sewer Parcels	N/A	Town septic information is representative of whether parcels utilize septic or sewer	Ensure that current septic information is accurate; update if septic/sewer information changes
Fecal Coliform EMCs	No local EMC data available	The EMCs are established for a maximum of 5 land use categories in XPSWMM; this is a limitation of the XPSWMM model—there is no ability to provide additional categories in this model; EMCs for the May River model were based on literature and adjusted to fit data.	May need to adjust or refine FC concentrations to reflect future conditions (in future the Town may discover that land use FC concentrations may shift due to policies and practices such as increased monitoring)
Local Water Quality and Flow Data	Limited flow data in the headwater subwatersheds; limited concomitant water quality and flow data	Calibration for flow was based on achieving reasonable water balance appropriate for the region and some limited comparison to flows in neighboring watersheds	Collect additional flow data at select locations both near outlets and upstream in the watershed using a cost-effective combination of continuous and instantaneous/event-based flow; also collect water quality data where possible

4.0 Water Quality Model Results

The XPSWMM water quality simulation model calculated FC concentrations for the outfalls at each of the four major subwatersheds every seven minutes for an entire year (2002 and 2018). Laboratory measurements of FC are typically given as "most probable number" (MPN) per 100/mL or as colony forming units (CFU) per 100 mL. Both units are equivalent but reflect different EPA approved methodologies for counting bacteria cells. For purposes of this report, to distinguish modeled estimates for bacteria, all results were given as "number of FC" (#) per 100/mL. In Regulation 61-68 Water Classifications and Standards, SCDHEC provides limits for FC concentrations for all water use designations. For shellfish harvesting in ORW, such as the May River, these limits are either for a daily maximum concentration (43 MPN/100 mL) or a monthly average (14 MPN/100 mL).

4.1 FC Daily Maximum Concentrations

The maximum daily FC concentration is plotted in Figure 39 (Baseline condition) and Figure 40 (Current condition). Table 35 summarizes the average of the maximum daily FC concentration for each of the subwatersheds for the entire year for 2002 and 2018. The regulated daily maximum water quality standards for shellfish harvesting (43 MPN/100 mL represented by the dotted red line in Figures 39 and 40) is provided for reference. Although the FC concentrations are generally higher in 2002 than 2018 (Table 35), the total modeled bacteria load (as will be discussed in §4.2) is lower in 2002 as a result of a very large increase in flow in 2018 (Table 36). The average maximum daily FC concentrations calculated by the model for both 2002 and 2018 consistently appear to be in excess of the shellfish water quality standard for ORW.

The Project Team also evaluated what load reduction would be required to reduce the concentrations of FC from the 2018 average conditions for Stoney Creek and Rose Dhu Creek. First, the average modeled FC concentration (FC average) for each subwatershed was calculated (average concentration = total load/total volume). For Rose Dhu Creek, the FC average was 1096.6 #/100 mL and for Stoney Creek it was 1481.8 #/100 mL. Next, the required reduction was calculated as (FC average – 43)/(FC average). This indicates that a 96.1% and 97% reduction in FC concentration is required for Rose Dhu Creek and Stoney Creek, respectively, to meet the daily maximum concentration threshold for shellfish harvesting (43 MPN/100 mL).

Table 35: Average Daily Maximum FC Concentration (#/100mL)

	Duck Pond	Palmetto Bluff	Rose Dhu Creek	Stoney Creek
2002 Baseline Condition	827	749	583	995
2018 Current Condition	538	687	650	932
Shellfish Harvesting Limit	43	43	43	43

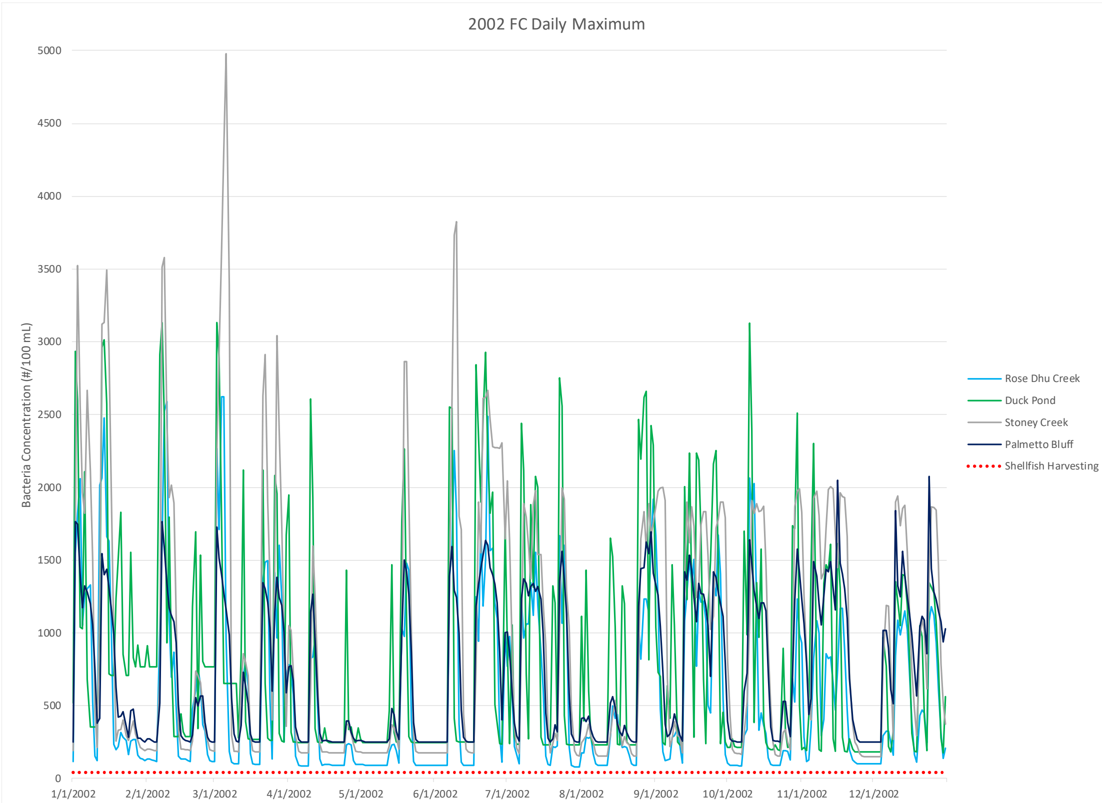


Figure 39. Water Quality Standards and Modeled Daily Maximum FC Concentrations for 2002

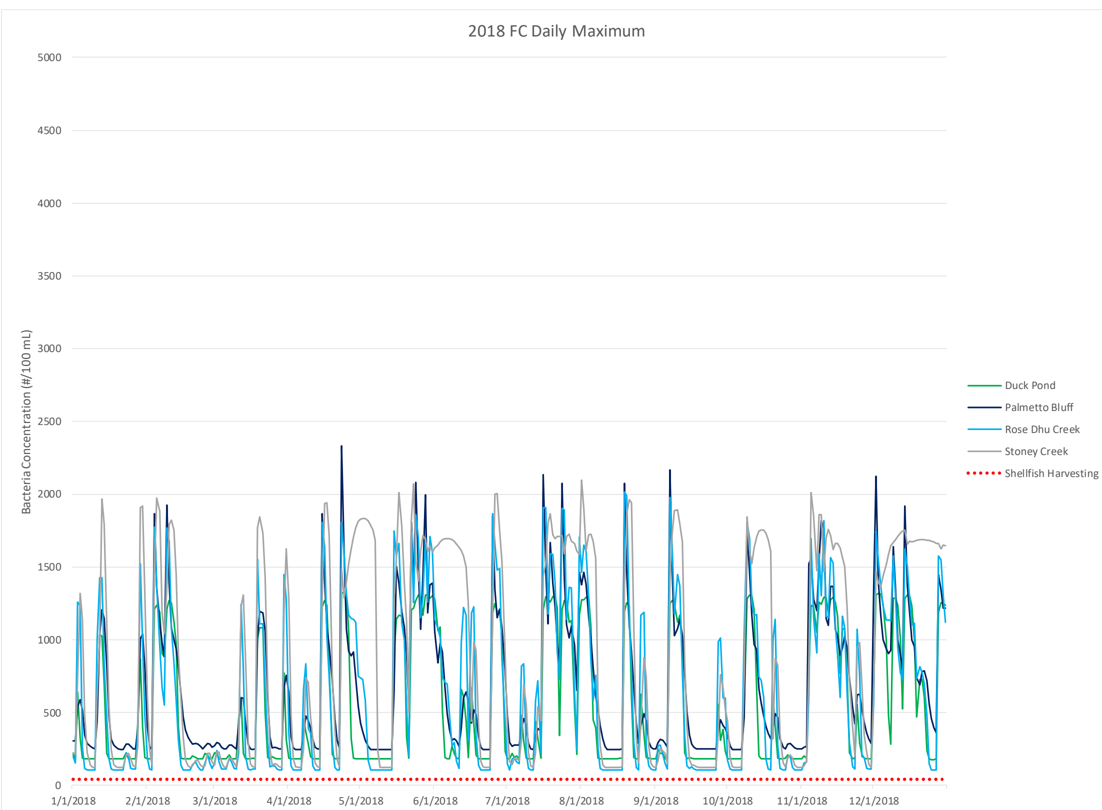


Figure 40. Water Quality Standards and Modeled Daily Maximum FC Concentrations for 2018

4.2 FC Loading

The FC load for each subcatchment in each subwatershed is calculated by multiplying the concentration by the corresponding water volume at each time step in the model. Table 36 summarizes the total annual volume of water that the model calculates exiting each subwatershed's outlet in 2002 and 2018. The volume is a combination of baseflow and stormwater runoff. Note that the total annual precipitation was 45.04 inches in 2002 and 42.95 inches in 2018; therefore, the increase in water volume in 2018 is not a result of increased precipitation, on an annual basis, but rather a result of conversion of forested land to impervious surfaces (as shown previously in Table 1, the impervious areas in the May River Headwaters have increased from 708 acres in 2002 to 1,876 acres in 2018). Impervious surfaces generate more stormwater runoff, which is reflected in the increases in water volume produced in all four subwatersheds in the May River Headwaters.

Table 36: Total Annual Water Volume at Each Subwatershed Outlet

Subwatershed	Baseline 2002 (ft^3)	Current 2018 (ft^3)	% Increase
Duck Pond	5,406,495	66,434,813	1,129%
Palmetto Bluff	38,830,300	182,059,967	369%
Rose Dhu Creek	31,131,373	450,413,444	1,347%
Stoney Creek	105,883,853	540,149,533	410%
Total	181,252,021	1,239,057,757	584%

4.2.1 Total Load Per Subcatchment

One way to evaluate the modeling results is to look at the total annual load (number of FC bacteria) the model estimates for each subwatershed for the 2002 and 2018 condition, as summarized in Table 37. The Stoney Creek subwatershed had the greatest FC load in 2002 and 2018. Table 37 also summarizes the minimum, maximum, and average loads calculated for each subcatchment within the four main subwatersheds. In 2002, Stoney Creek had the subcatchment with the greatest FC load and the average overall FC load was greatest in Stoney Creek subcatchments. In 2018, Rose Dhu Creek had the largest subcatchment load and average load. In general, the total FC load for each subwatershed, as well as the average subcatchment load, increased by one to two orders of magnitude from 2002 to 2018. This model output is supported by an analysis of SCDHEC monitoring data from 1999 to 2017 in the May River (Montie et al., 2019) which found that fecal coliform levels at SCDHEC monitoring locations closest to the Headwaters were well above the approved FC maximum of 14 MPN/100 mL (geometric mean per R61-68). Additionally, the data showed that fecal coliform levels were higher when salinity levels were lower, and this relationship is strongest at SCDHEC sampling stations closest to the Headwaters. Finally, fecal coliform levels in the Headwaters increased as population levels grew in the Town of Bluffton, and this relationship was strongest at SCDHEC sampling stations closest to the Headwaters.

Figures 41 and 42 illustrate the increase in bacteria loading from 2002 to 2018 for the May River Headwaters subwatersheds. Areas with darker red shading indicate a higher total FC load. In both 2002 and 2018, the subcatchments with the darker shading (higher load) are located within Stoney Creek and Rose Dhu Creek subwatersheds.

Table 37: Total Annual Loading (# FC/year) by Subwatershed

	Duck Pond	Palmetto Bluff	Rose Dhu Creek	Stoney Creek
2002 Baseline Condition:				
Total Subwatershed Load	1.78E+12	1.26E+13	6.79E+12	**4.93E+13**
Min Subcatchment Load	3.43E+09	6.32E+08	1.58E+09	0.00E+00
Max Subcatchment Load	8.45E+11	2.90E+12	2.02E+12	**1.26E+13**
Avg Subcatchment Load	2.96E+11	4.51E+11	3.23E+11	**8.80E+11**
2018 Current Condition:				
Total Subwatershed Load	2.18E+13	5.84E+13	1.48E+14	**2.47E+14**
Min Subcatchment Load	0.00E+00	5.67E+10	1.20E+11	1.25E+11
Max Subcatchment Load	7.79E+12	7.89E+12	**3.09E+13**	2.51E+13
Avg Subcatchment Load	3.63E+12	2.08E+12	**7.05E+12**	4.41E+12
Values in bold represent the largest value for each condition				

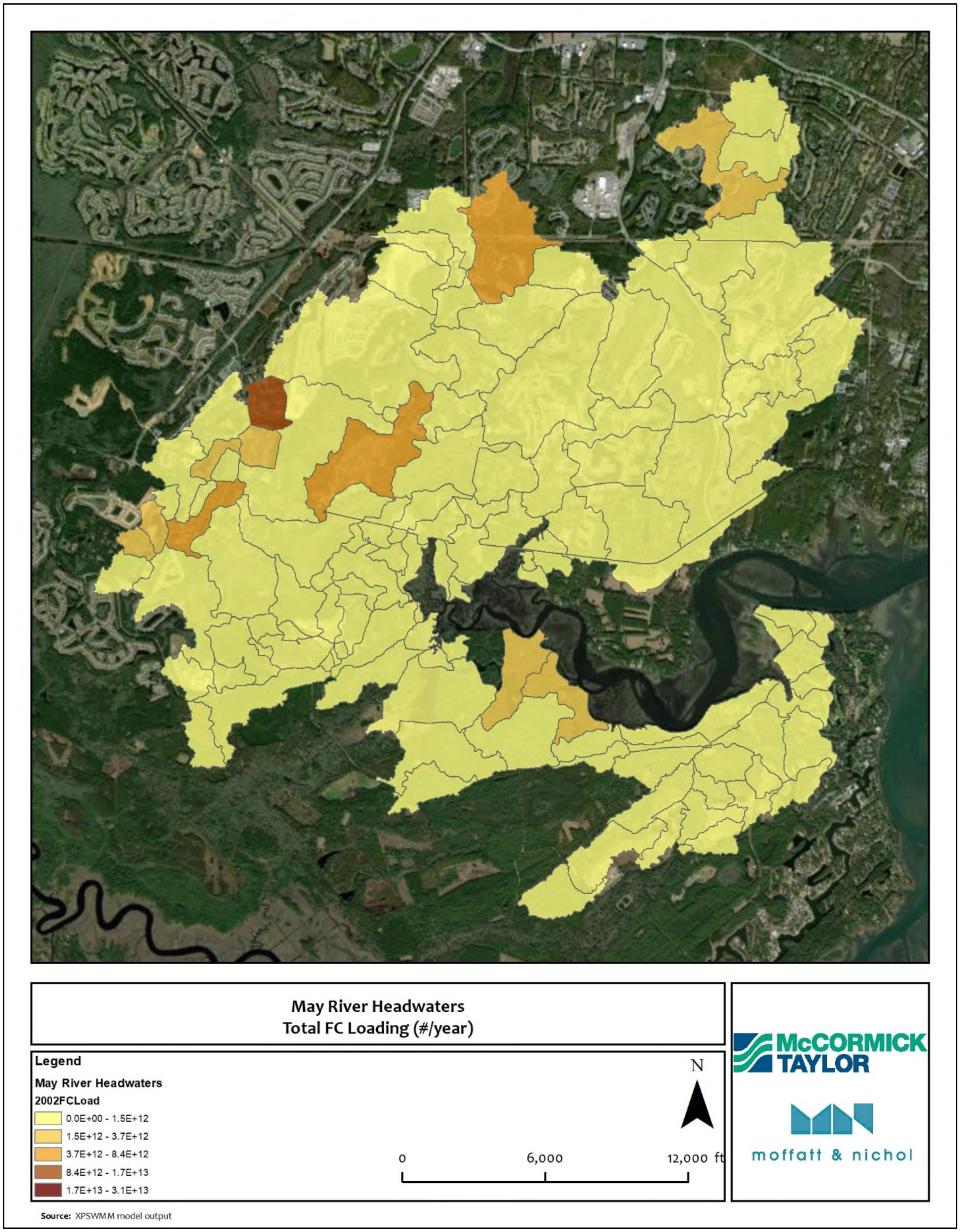


Figure 41. Total Bacteria Load of each Subcatchment in 2002 condition

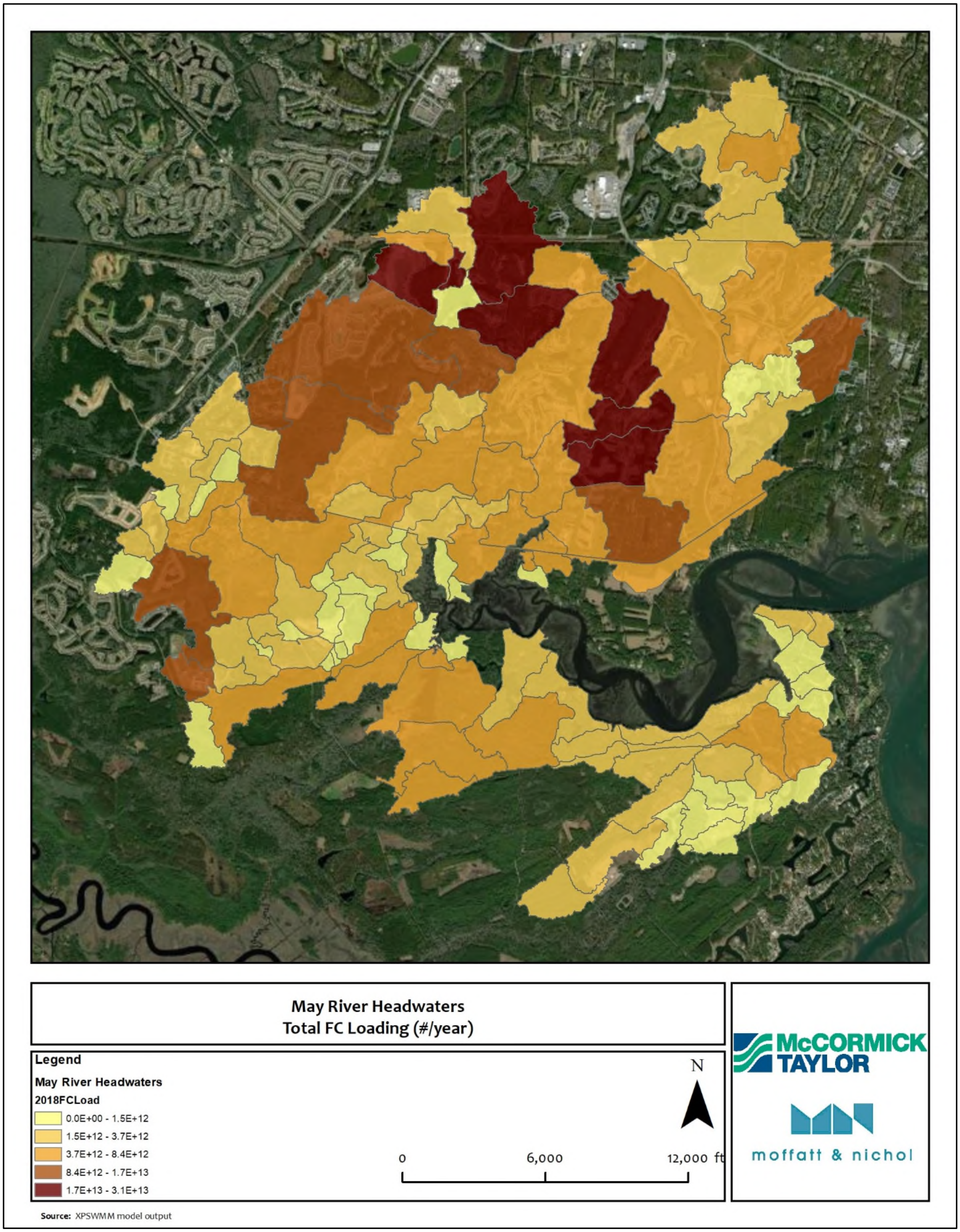


Figure 42. Total Bacteria Load of each Subcatchment in 2018 condition

4.2.2 Normalized Load Per Subcatchment

An additional way to interpret the modeling results is to calculate how much bacteria is generated per acre in each subcatchment, which allows for comparisons between subcatchments of varying sizes (Table 38, Figures 43 and 44). A large subcatchment may produce a larger overall total load than a smaller subcatchment; however, the amount of bacteria generated per acre in each could be equivalent. These normalized loads were calculated by dividing the modeled load of bacteria for each subcatchment by its respective area in acres. In 2002, the normalized loading for all four subwatersheds was at the same order of magnitude. Rose Dhu Creek had the lowest total normalized load for the entire subwatershed (1.63E+09 FC/acre) and Stoney Creek had the highest (9.18 E+09 FC/acre). Comparing subcatchments, Stoney Creek had the smallest minimum value (0 bacteria/acre), the largest maximum value (1.96 E+11 FC/acre), and the largest average value (1.55 E+10 FC/acre). Note that monitoring data from various agencies report FC concentrations (#/100 ml) and not loads, and there are no other published load data to compare with the results of this model.

In 2018, the normalized loading for all four subwatersheds was at the same order of magnitude; however, the totals were also ten times higher (one order of magnitude greater) than in 2002. Once again, Stoney Creek had the highest maximum and average normalized loading in a subcatchment. Duck Pond and Palmetto Bluff had the lowest normalized loadings at both the subwatershed and subcatchment level for all categories (total, min, max, and average).

Table 38: Normalized FC Loading (#/acre) by Subwatershed

	Duck Pond	Palmetto Bluff	Rose Dhu Creek	Stoney Creek
2002 Baseline Condition:				
Total Subwatershed	2.60E+09	6.55E+09	1.63E+09	**9.18E+09**
Min Subcatchment	1.05E+08	5.66E+07	1.02E+07	0.00E+00
Max Subcatchment	4.78E+09	6.64E+10	9.69E+09	**1.96E+11**
Avg Subcatchment	2.05E+09	8.33E+09	1.68E+09	**1.55E+10**
2018 Current Condition:				
Total Subwatershed	3.19E+10	3.03E+10	3.55E+10	**4.61E+10**
Min Subcatchment	0.00E+00	9.99E+08	5.14E+09	1.62E+10
Max Subcatchment	4.77E+10	9.84E+10	1.25E+11	**1.95E+11**
Avg Subcatchment	2.67E+10	3.48E+10	3.69E+10	**5.01E+10**
Values in bold represent the largest value for each condition				

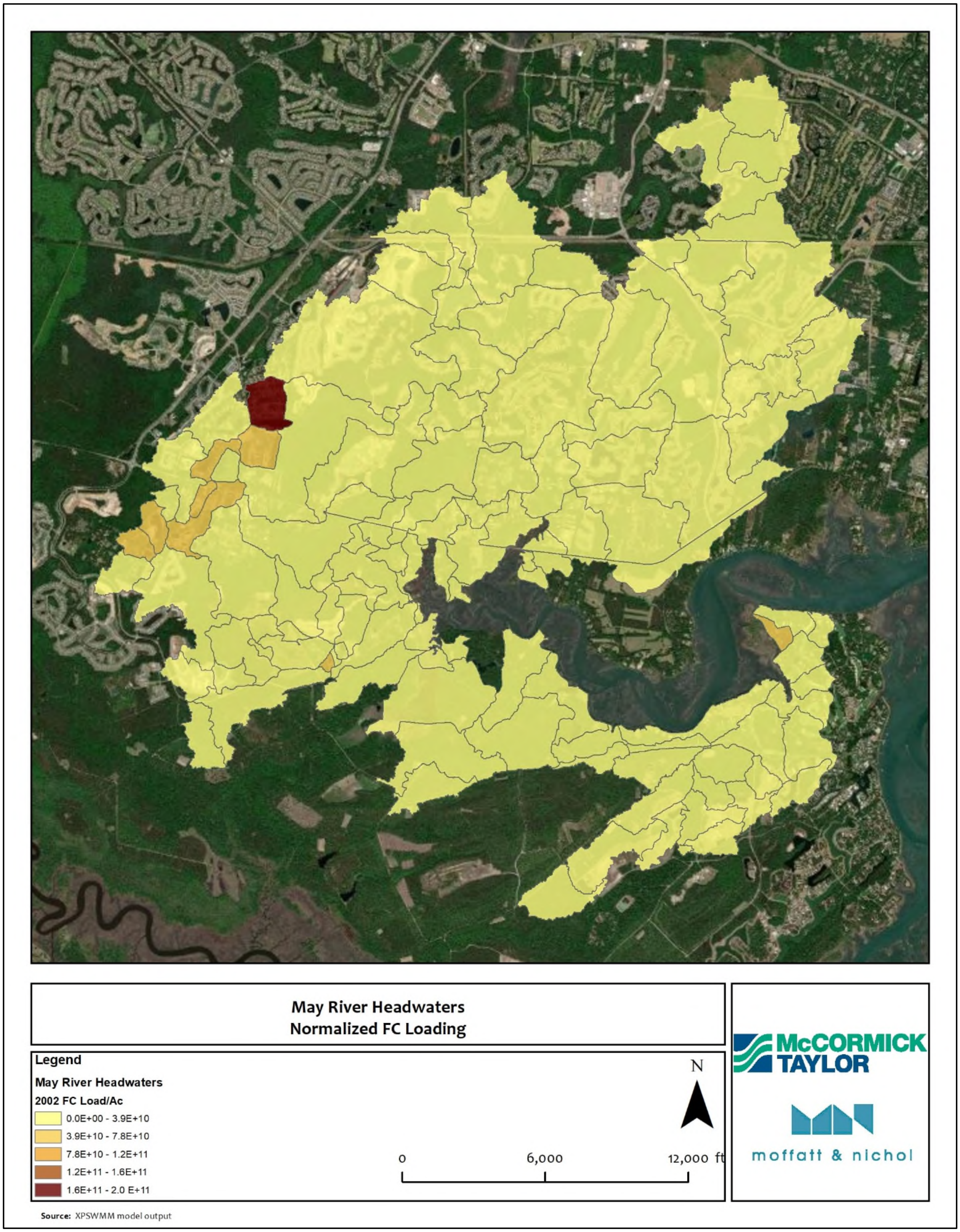


Figure 43. Bacteria Load per Acre of each Subcatchment in 2002 condition

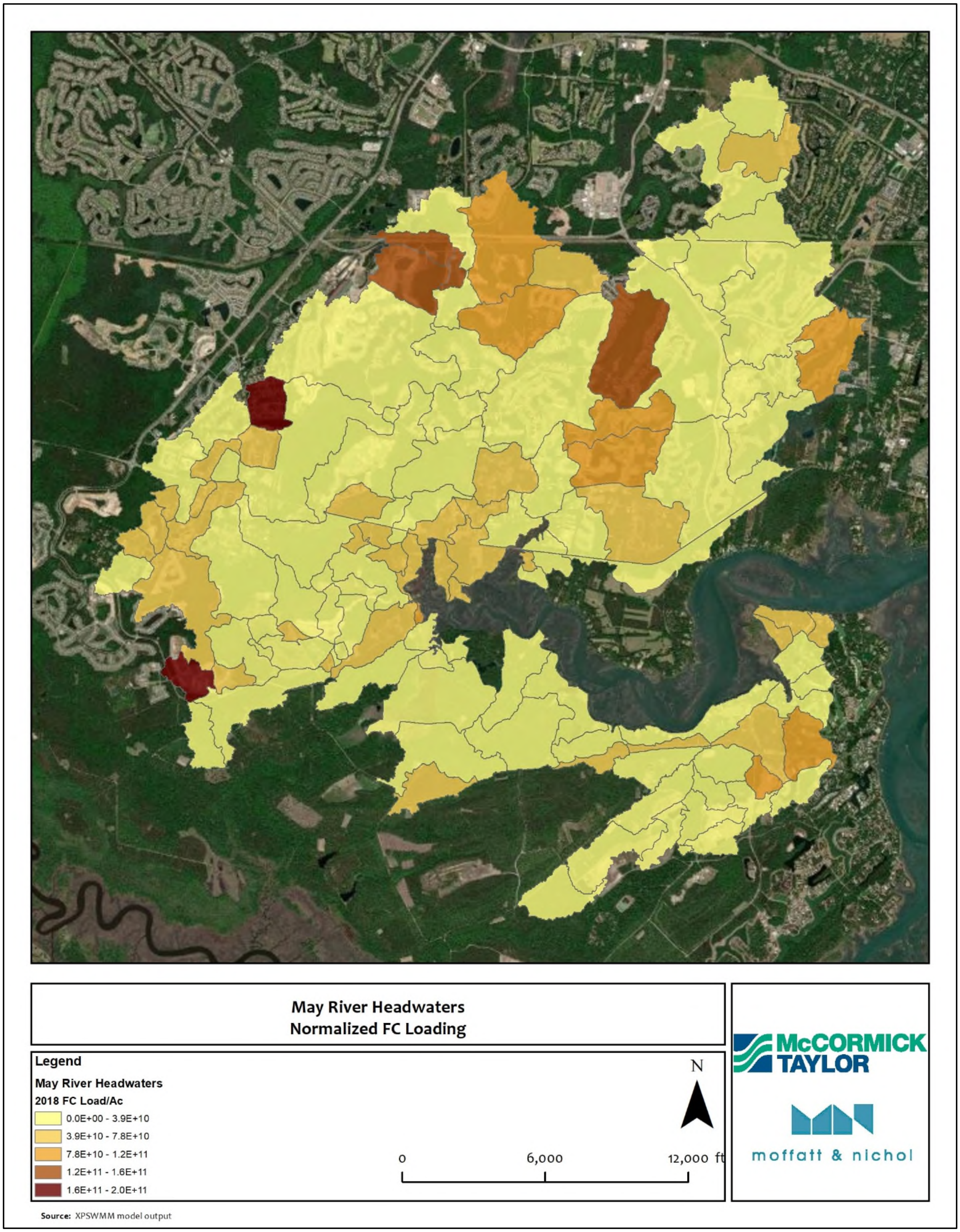


Figure 44. Bacteria Load per Acre of each Subcatchment in 2018 condition

4.2.3 Bacterial Hotspots

Table 39 summarizes the ten subcatchments that had the highest overall annual FC loading in the May River Headwaters. All of the highest loads are found in subcatchments in the Stoney Creek or Rose Dhu Creek subwatersheds, and all were the same order of magnitude (10^{13}). Data from an existing monitoring station (HH9) is located near the SUB-RD-11 subcatchment and was used for calibrating the model (refer to Figures 25 and 26 in Section 3.2). Note that SUB-RD-09 and SUB-RD-11 (shaded gray) are included in all three lists for priority ranking based on bacteria load: overall, normalized, and rate of increase, Tables 39 – 41, respectively.

Table 39: Highest 2018 FC Load

Subcatchment	Development Phase	Area	2018 IA (acres)	IA %	FC Load (# FC)
SUB-RD-09	Hampton Hall 4, IA, IB	247.10	50.48	20%	3.09E+13
SUB-RD-11[a]	Hampton Hall 2, 4A, CA, GC, I-B, I-C,	292.79	29.75	10%	2.66E+13
SUB-RD-17	Hampton Hall 2, 2A,-2, 2B-1, 2C, 2D, CA, I-B, I-C,	292.79	76.46	26%	2.66E+13
SC106	Hampton Lake 1, 1B, 1B-1, 2, 3 Baynard Park 2	260.56	54.48	21%	2.51E+13
SC103	Hampton Lake 4, 7, 8A, 8B	157.29	6.58	4%	2.17E+13
SC108	Hampton Lake 4	157.29	12.39	8%	2.17E+13
SC112	Hampton Lake 1, 1B, 1B-1, 2	201.66	58.95	29%	2.06E+13
SC116	Lawton Station 1, 3, 3C, 4C, Hampton Lake 1A, 1C, 2, 2B, 2C, 3, 3C, 5, 6, 11, Lake Estates	741.45	163.72	22%	1.71E+13
SC162	Hampton Lake 1, 1A	741.45	59.92	8%	1.71E+13
SUB-RD-12	Pinecrest 3, 4, 5, 6, 7, 8	155.28	34.38	22%	1.64E+13

[a] Located near station used for calibration (HH9)

The subcatchments with the highest normalized FC loading are listed in Table 40. Note that SC103, 106, and 112 are listed on both Table 39 and 40.

Table 40: Highest 2018 Normalized FC Load

Subcatchment	Development Phase	Area	2018 Impervious Area (acres)	Impervious Area %	FC Load (#/acre)
SC142	May River HS	60.72	23.58	39%	1.95E+11
SC124	(county)	64.47	19.39	30%	1.83E+11
SC104	Hampton Lakes 8B Bluffton Pkwy	49.46	7.37	15%	1.47E+11
SC103	Hampton Lake 4, 7, 8A, 8B	157.29	6.58	4%	1.38E+11
SC108	Hampton Lake 4	157.29	12.39	8%	1.38E+11
SUB-RD-09	Hampton Hall 4, IA, IB	247.10	50.48	20%	1.25E+11
SUB-RD-12	Pinecrest 3, 4, 5, 6, 7, 8	155.28	34.38	22%	1.06E+11
SC112	Hampton Lake 1, 1B, 1B-1, 2	201.66	58.95	29%	1.02E+11
PB17	Palmetto Bluff Village	35.30	2.18	6%	9.84E+10
SC106	Hampton Lake 1, 1B, 1B-1, 2, 3 Baynard Park 2	260.56	54.48	21%	9.62E+10

Table 41: Highest FC Load Rate of Increase

Subcatchment	Development Phase	2002 FC Load	2018 FC Load	Rate of Increase
SC125[a]	(county)	2.18E+06	2.59E+12	1,189,492
SUB-RD-12	Pinecrest 3, 4, 5, 6, 7, 8	1.58E+09	1.64E+13	10,366
SC158	No PUD	4.15E+08	1.76E+12	4,233
SC159	Palmetto Bluff	4.15E+08	1.76E+12	4,233
SC129[b]	New Riverside (Parcel 9)	1.97E+09	2.78E+12	1,410
SUB-RD-01	Buckwalter PUD	3.89E+09	3.72E+12	956
SUB-RD-09	Hampton Hall 4, IA, IB	3.51E+10	3.09E+13	879
SC155	New Riverside (Parcel 9)	1.87E+09	1.12E+12	599
SUB-RD-07	Buckwalter PUD	2.92E+09	1.59E+12	544
PB27	Palmetto Bluff Ph 1, Palmetto Bluff Village	1.82E+10	7.89E+12	432

[a] Located near station used for calibration (SC6)

[b] Located near station used for calibration (PBR9)

5.0 Recommendations

5.1 Strategies for Assessing Problems (Monitoring, Mitigation, and Modeling)

The Project Team provides the following suggestions for the Town of Bluffton to improve upon their existing monitoring program for bacteria (concentration and source typing) and flow.

5.1.1 In-House Microbial Source Tracking

The Town of Bluffton has purchased equipment and supplies that allows them to conduct advanced quantification of molecular fecal markers to identify sources of fecal contamination in environmental waters. The system is a quantitative polymerase chain reaction (qPCR) system from Bio-Rad. The system allows the quantifications of bacterial and viral pathogens as well as molecular markers. Quantifying and identifying these markers can be used in monitoring and experimental studies to understand the dispersion, quantity, and any reductions of fecal contamination to the Town of Bluffton systems to facilitate in-house qPCR for source typing. Dr. Rachel Noble provided guidance for implementation of molecular approaches for microbial source tracking (MST) based assessments in a memo dated June 10, 2020 (Appendix B) and summarized in the below recommendations. Dr. Rachel Noble is available to work with the Town of Bluffton to develop their capacity for this type of work, to train the Town personnel in the use of the equipment following standardized procedures and controls, and to implement the quantitative testing in specific areas for prioritization of water quality management scenarios.

Recommendations for Town of Bluffton:

1. Combine the benefits of new technological advancements for the combination of geographic information system approaches, traditional fecal indicator bacteria monitoring, and quantification of molecular markers of specific sources of fecal contamination (Li et al. 2019).
2. Focus on the use of multiple, coincident, molecular library-independent markers of human fecal contamination first. An approach to use multiple fecal *Bacteroides* based markers such as HF183 in addition to the newly published sewage-associated *Bacteroides* marker (Feng et al. 2019) to identify, quantify and confirm the likely incidence of human fecal contamination across sites (e.g. Hart et al., 2020). The combined application of HF183 and the sewage-associated marker can be high utility tools that would allow the Town to not only quantify human fecal contamination in the system, but confirm its source from sewage infrastructure, permitting additional infrastructure testing to take place.
3. The Town could consider the quantification of human pathogenic markers such as adenovirus or enterovirus to quantify human viruses that are very specific to the presence of human contamination (Steele et al., 2018). The human viruses also provide important information as to the presence of "fresh" fecal contamination, because they are not likely to persist in the stormwater and receiving water environments for long periods of time. In particular, it may be useful to pair quantification of human pathogens to existing monitoring approaches, given the concept that reservoir populations of FIB are contributing to overall loading. USEPA is considering standardization of microbial source tracking approaches that permit States to assess the potential for natural sources of both Enterococcus sp. and fecal coliforms, if they can be demonstrated using scientifically credible approaches (Boehm et al. 2015).

4. Use a "tracer screen" approach. At first, based upon localized results, it is recommended that the Town should incorporate HF183 and BacHum into stormwater assessments. Use human adenovirus quantification for the human pathogenic virus because of its relevance in the southeast. Use the qPCR assay for *Catellicoccus marimammalian* to quantify bird fecal contamination. Analyze at least 10 sewage influent and 8 scat fecal samples (from each species) to characterize the utility of animal markers. If the area of interest is dominated by septic systems and package treatment plants, it may be fruitful to capture a composite sample from septic system distribution boxes if possible. Conducting the repeat sample analysis will allow the Town to assess the true cross-reactivity, sensitivity and specificity of each applied marker. For viral pathogens, it also allows assessment of the seasonal nature of specific molecular targets (Steele et al. 2018). It is far better to devote attention to doing the work up front to assess specificity of markers rather than to worry about cross reactivity later in the project. For example, in FL, the HF183 marker cross reacts with deer fecal contamination across most of the aquatic systems, causing a low level of HF183 to be quantified across the landscape, but with little relationship to the presence of human fecal contamination. Without repeat assessment of known fecal sources with markers of specific types of contamination, these patterns would have never been revealed. The fecal markers that are recommended at first for assessment are DogBact. A review of the literature is taking place to assess the best ruminant markers and canine markers, but at this time, most of them still have serious cross reactivity issues.
5. Pay close attention to sample design issues, following the lead of well-designed previous studies by sampling over a wide array of events, monthly sampling with additional focus on wet weather events (>0.5" precipitation over a 24 hour period (Gonzalez et al. 2014; Hart et al., 2020)). Use statistically rigorous approaches and quantify samples across enough events to ensure confidence in the results. It is optimal to collect samples during or immediately after the rainfall event, with attention paid to tidal cycle (low to mid-tide is typically suggested for low-lying coastal systems).
6. To determine whether a stormwater system contains human fecal contamination, you need a sampling design that permits the science to 1) statistically defend negative results, and 2) interpret heterogeneity in storms. For the first, there must be a plan in place that allows the researcher to defend negative or "non-detect" results in a system. For the qPCR analysis of molecular markers for water quality management, consider 11 repeat sampling events to be the minimum level of statistical rigor, i.e. with 11 sampling events over the course of 11 storms, expecting a positive response rate of 10% for any one of the measured markers, you would have an 90% confidence that the results reported were correct within a 15% +/- confidence interval. As the sample size increases, of course, the confidence in interpreting the results (i.e. increased sampling effort increases confidence) increases. This 90% confidence is likely acceptable for this study. Furthermore, this is expecting only a 10% "response rate" for the tests. As the test response rate increases, there is actually a need for greater number of sampling events to preserve the confidence interval. However, given that the question posed for this project, is focused on whether the fecal contamination is human, the statistical attributes of this power analysis are correct. As confidence decreases (as sampling effort decreases), one decreases their ability to have confidence when only negative results are observed, thereby lowering the confidence in the results. For any qPCR data to be considered as quantitative, remember that appropriate controls must be used to avoid false-negative or false-positive results. For example, using a no-template control allows the researcher to assess the potential for cross contamination stemming from poor lab practices (false positive). Conversely, it is necessary to always use an inhibition control and an extraction control to

verify that the procedures are working, so as to avoid false negatives. A full set of guidelines for qPCR reporting can be found at Bustin et al. 2009.

7. MST marker assessments for stormwater are dependent upon a wide range of conditions being assessed over the course of your study. In sequence, the character of discharge from linked storms are dependent upon one another and antecedent rainfall and the delivery of rainfall are extremely important to microbial loading patterns. This is the justification for not sampling only across one or two storms, but instead a wide range of storm conditions over time to determine whether human fecal contamination is being delivered and if so, if multiple succession storms show a human fecal contamination pattern. Sampling throughout the duration of storms can provide very valuable information by understanding discharge patterns that are dominated by landscape delivery (early in the storm) or groundwater influx (delivery during the tail end of the storm).

8. Dry weather sampling should be conducted as a part of any implementation of molecular analyses for MST markers. The reason is that many groups have detailed important changes or construction to be conducted after wet weather sampling, but in some cases, the signal would have persisted there even during dry weather, showing that the signal is not stormwater dependent. For baseline sampling, a repeat analysis of at least 5 different time periods is required to assess the presence of human fecal contamination in the system in the absence of rainfall. This is the minimum baseline sampling required to rule out the dry weather human fecal contamination influence.

9. Use a weight of evidence approach for your results interpretation. When results interpretation involves a weight of evidence approach, there is no one marker that stands alone in the determination of human fecal contamination. This allows decision making at the infrastructure, BMP and policy making to be more robust. A typical scheme might be to confirm human fecal contamination only with repeat quantification of both HF183 and BacHum through multiple storms in order for infrastructure changes to be recommended (e.g. Hart et al. 2020). When incorporating human viral pathogens into your interpretation scheme, make certain that controls are in place to ensure that all quantification is occurring, and that the controls are being implemented at concentrations that are relevant to risk associated with sewage-based sources of pathogens.

10. It can be valuable to incorporate the use of predictive modelling approaches such as those observed in the literature previously. Multiple linear regressions modelling approaches that take into account data collected for FIB, molecular markers of fecal sources, environmental parameters (Gonzalez et al. 2014), and even elevation and tidal influence are highly valuable to understanding the drivers of stormwater movement in the estuarine system.

5.1.2 Future (new) Bacteria Monitoring Locations

The results from the water quality model could be improved upon if an increased amount of fecal indicator bacteria, MST, and pathogen data were available in these areas of the watersheds. Unfortunately, using the fecal indicator bacteria approach has its limitations for understanding risk in the receiving water environment. For example, once analysis of multiple classes of microbial contaminants takes place, the manager can create linear models to compare HF183, E. coli, fecal coliforms, or Enterococcus and 12-hr rainfall (as well as incremental aggregate rainfall analyses). Once the analysis is completed, the relationships across markers can illustrate patterns of fecal contamination delivery and conveyance. For example, if the HF183 signal is directly and strongly correlated to recent rainfall, it may be that sewage systems are becoming compromised during specific rainfall conditions. This type of information can be useful in prioritizing areas requiring multiple infrastructure fixes. This information would be used to refine the calibration of the model developed as part of this project.

In the face of climate change and sea level rise, it has been important to begin to place tidal influence into the context of stormwater conveyance. The impact of higher tidal elevations in low-lying states such as SC cannot be overstated. This is because the extreme high tides, also known as perigean or king tides, interfere with the conveyance of stormwater to receiving waters. The rising tides have the capability of interfering with stormwater conveyance into receiving waters; adversely impacting sanitary sewer pump station functionality; creating more frequent or longer duration flooding during storm events; inundating water, wastewater, and stormwater infrastructure by daily high tide (which promotes corrosion and pipe damage); and elevating groundwater levels and increasing saltwater intrusion. During periods when the groundwater table is high, the impact of tidal influx paired with saturated soil conditions can exacerbate issues related to exfiltration from the sewage system, causing contamination to reach the groundwater subsurface and be conveyed to receiving waters (Amick and Burgess, 2000). Because low-lying coastal communities depend on gravity to help water move through the stormwater system the absence of gradient with flat topography can cause outfalls to be partially or fully submerged. Exacerbated and repeat high water events can cause the groundwater levels in the coastal communities to be high, further reducing the amount of area available for stormwater infiltration. At the moment, communities are not engineering our coastal plain stormwater or sewage systems to adapt to these conditions.

There are multiple ways to address tidal influence at the outset, including installing check valves, locating force mains in specific locations of interest, removing debris in problem areas, and promoting infiltration in creek and watershed restoration plans. Of initial importance are identifying thresholds at which the performance of the stormwater conveyance system is compromised. Understanding storm scenarios, wind direction, and tidal influence in specific locations can build a local understanding of current and future vulnerabilities. In particular, there will be a need to address the revision of monitoring approaches to best assess the impacts of tidal influence on any particular watershed or subwatershed. Previous studies have sometimes incorporated tide into their sampling methods. But the majority of these studies have been conducted in the western United States or in highly developed watersheds in coastal areas with lower tidal intrusion and greater financial resources to combat coastal flooding. In this circumstance, we are concerned with the risks of increased flooding in low-lying, suburban populations. Therefore, it will be important that we monitor systems in the context of tide in order to gain an accurate representation of tidal inundation and its impact on microbial contaminants conveyed to receiving waters in the Town of Bluffton. If the Town is able to address stormwater conveyance including tidal influence, the Town may have greater success in developing a more-inclusive framework for stormwater management in the face of sea level rise and coastal change.

Key attributes that will benefit a regular monitoring program geared at addressing tidal inundation in the Town of Bluffton are:

- Flow data (e.g. collected using a SonTek-IQ Doppler current meter), automated sampling equipment (such as ISCO samplers), rainfall tracking through the use of tipping rain gauges, anemometers, and other sensors may be useful to employ at specific sites of concern. In tidally influenced areas, however, measurements of flow need to account for tidal influx using other more complicated dispersion models, as negative flows cannot simply be removed from the discharge data (e.g. Stumpf et al. 2010).

- Intra-agency coordination and conversations about engineering and BMP selection in the context of tidal inundation. Partners include federal, state, and local jurisdictions and non-government organizations:
  - United States Geological Survey (USGS)
  - South Carolina Department of Environmental Health and Control (SCDHEC)
  - South Carolina Department of Natural Resources (SCDNR)
  - Beaufort County Public Works/Stormwater Management
  - Beaufort-Jasper Water and Sewer Authority (BJWSA)
- Derivation of all key data for assessing the role of tide in the conveyance of stormwater and sanitary sewer systems, including elevation of all inlets, outfalls, sewer pump stations, and BMPs
- Assessment of adaptive capacity using current scenarios, future scenarios, and in particular with emphasis on concurrent events such as hurricanes where wind-driven forcing and water levels cause combined effects
- Volume reduction and promotion of infiltration, particularly in key subwatershed areas,
- Potential investment in groundwater drawdown approaches in particularly problematic areas (e.g. http://www.wpoa.org/wp-content/uploads/2011/04/WPOA-FloodingStormwater-ManagementPlan.pdf)
- Molecular approaches for assessment of specific sources of fecal contamination (paired with tidal inundation-based monitoring), will assist in prioritizing those locations for immediate action.

5.1.3 Future (new) Water Flow Monitoring Locations

The results from the water quality model could be better calibrated if continuous, non-tidal flow data was available in key areas of the watersheds. This information would be used to refine the calibration of the model.

The Town should set up gages for multiple conditions (baseflow, stormflow, wet seasons, dry seasons). A combination of continuous, long-term (one to two years) and shorter-duration monitoring should be conducted. This would allow the model to be compared to an entire hydrograph and sequential hydrographs rather than a single point (a single flow measurement). After about two years of data collection, the Town should have enough information to create rating curves for these channels, which would allow the Town to know the flow for a given channel depth. Over this 2-year period, it would also be possible to understand seasons with maximum and minimum flow conditions and calibrate this according to rainfall amounts in ensuing years.

1. Establish at least one continuous flow monitoring site in a headwater subwatershed, nearest the outlet but with no or very minimal tidal influence. Potential candidates include upstream from MRR06 (Rose Dhu Creek) or MRR10 (Stoney Creek). At this same station, perform regular bacteria monitoring using a combination of weekly or biweekly (i.e., every other week) grab samples and if possible composite storm sampling.
2. Take flow measurements and bacteria samples (flow and water quality at the same time) at two or three stations farther up in the watersheds and where significant development occurs. Sampling every two weeks is recommended, if possible. Possible candidates include:

a. Duck Pond: add flow monitoring to PBR8B
b. Palmetto Bluff: create a new flow/bacteria monitoring station along the main channel upstream of USGS 02176713 (perhaps near Old Palmetto Bluff Road or Mt. Pelia Rd.)
c. Rose Dhu Creek: add flow monitoring to HH1A, HH2A, and HH8
d. Stoney Creek: add flow monitoring to HL12, HL11, SC7, SC4, BECY1.5
e. It may be of interest to characterize a sewage spill overflow in any of these locations to understand the distribution of fecal contamination and persistence characteristics. Conducting this exercise in the Shingle Creek region of the Nansemond River permitted an ability to characterize the fate and transport of contaminants.

3. Options for flow monitoring equipment:
   a. Sontek iQ units can be anchored into a streambed or deployed temporarily. If temporary, a rating curve should be developed as a QA/QC. The iQ is for 2.5 m or less; the iQ Plus is for up to 5m depths. A diver will be needed for anything deeper than 1.5 m for safety reasons. https://www.sontek.com/sontek-iq-series
   b. For a deep/large reach of a river, especially if there is a good location near a bridge, the Town can consider renting a unit and installing a temporary station in a sideways orientation on a bridge pier. Suggested equipment include:
      i. Teledyne Workhorse
      ii. Sontek Hydrosurveyor
      iii. Sontek Riversurveyor
   c. It may be possible to rent this equipment rather than purchase it. For example, the Geology Department at the College of Charleston has rented an older iQ for a project in Stringer Creek and deployed it for a three-week stretch once or twice per year. It was about $1,000 per month rental fee.

5.2 Strategies and Best Management Practices for Bacteria Reduction

Residential land uses, which are predominant in the May River Headwaters, tend to produce high bacteria loading from a myriad of contributing factors including leaking septic tanks, pet waste pick-up behaviour, as well as turf management and erosion control practices (Wood, 2018). Pollutants in stormwater runoff, such as bacteria, can be managed through both structural and non-structural methods. Structural stormwater BMPs include items such as stormwater ponds, Infiltration BMPs, Filtration BMPs, pervious pavement, bioretention, and stormwater wetlands. Reduction of bacteria varies by BMP and location (site-specific removal efficiencies), and is accomplished through filtration, ultraviolet (UV) or sun exposure, and biological processes. Strategies beyond stormwater BMPs include policies such as septic system inspection, maintenance, and/or conversion to sanitary sewer; street sweeping; pet waste removal education; wildlife management; and prevention of sanitary sewer overflows (discouraging flushing wipes or washing fats oils and grease into sanitary sewer systems; encouraging regular pipe inspections/maintenance; and supporting illicit discharge detection and elimination programs).

On May 29, 2020 Project Team members from McCormick Taylor and Moffatt & Nichol hosted a roundtable discussion with Town of Bluffton staff and Dr. Rachel Noble to strategize approaches to reduce FC populations within the watershed. Dr. Noble emphasized that traditional FIB do not correlate well with the occurrence of pathogens, and they do not identify the source of the contamination. Additionally, many studies – including monitoring efforts by the Town of Bluffton – have documented that FIB can colonize and regrow in biofilms and sediments in the storm drainage system. These constraints of FIB further limit the ability to track the original source of contamination (Burkhart, 2012).

In general, human sewage contamination presents the greatest health risk and is a controllable source; Dr. Noble recommends that this should be the first target of remediation efforts (Nobel and Weisberg, 2005, Steele et al. 2018). This can be accomplished through the use of FIB based routine monitoring. In this particular case, even though fecal coliform are the FIB group of active management, it is prudent to include both fecal coliform and *Enterococcus sp*. FIB as part of the monitoring program. Membrane filtration, IDEXX defined substrate technologies, and multiple-tube fermentation are all appropriate methods to use for this combined assessment. This is because quantification of both targets provides valuable information on inputs of fecal contamination, particularly from sewage systems (see Hart et al. 2020, Gonzalez et al. 2014). In the references cited, routine monitoring was being conducted weekly, but in the case of establishing a new monitoring program, a balance between routine, dry weather sampling and wet weather adaptive sampling must be found. FIB-based monitoring data can be used to rank the sites analyzed, using a concentration-based ranking system. Once this is done, the next step would be to identify sites which ranked highly for both fecal coliform and Enterococcus sp. concentrations. Once FIB-based monitoring data is evaluated, proceed to identification of hot spots for contamination due to either dry or wet-weather or both types of conditions (https://core.ac.uk/download/pdf/84414928.pdf). Based upon available flow information, FIB-based monitoring can be used to then re-rank the hot spots in the context of loading. Once ranking is complete, the top hot spots can be selected for MST-based assessments. These assessments can incorporate human and animal fecal sources in order to build knowledge of the sources of contamination. In some cases, implementation of real-time tracking approaches may be useful in the stormwater and sewage conveyance systems (Virginia Department of Health, Hampton Roads Sanitation District, 2018). It may be valuable in this example provided to attend to the number of SSO events occurring at a particular location or in a particular watershed, because if known wastewater compromises occur, those could be driving patterns observed with the ranking, and those issues are likely to be already being attended to for infrastructure repairs.

When selecting a BMP for bacterial removal, many studies indicate that most BMP data is quite variable and site-specific, which makes it difficult to select a single BMP solution to incorporate into a watershed management plan. Additionally, high removal efficiency does not always guarantee attainment of bacteria standards when inflow concentrations are high (Wood, 2018). For example, if a BMP has 80% removal efficiency, but the inflow is 650 #/100mL, the outflow concentration would be 130 #/100mL – a concentration that is higher than the shellfish water quality standard.

As part of the meeting, Dr. Noble provided an academic review of regional case studies and best practices related to bacteria. The results of this discussion and recommendations will be described in Section 5.4.

5.2.1 Regional Stormwater BMP Design Guidance

Across the nation, and the southeastern region in particular, there is a movement away from stormwater ponds in favor of emphasizing other practices that encourage runoff reduction, which is defined as "the total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainfall harvesting, engineered infiltration, or extended filtration." Table 42 summarizes the various measures of BMP performance (runoff reduction and removal efficiencies for nutrients, suspended sediments, and bacteria/pathogens) for three design manuals applicable in the Town of Bluffton: *Low Impact Development in Coastal SC: a Planning and Design Guide* (Ellis et al., 2014); the *Southern Lowcountry Stormwater Design Manual* (Center for Watershed Protection and McCormick Taylor, 2020); and the *South Carolina DHEC Storm Water Management BMP Handbook* (SCDHEC, 2005). Still it cannot be denied that stormwater ponds represent stormwater control measures that are capable of nitrogen and solids reductions, and often play important roles in both nitrogen fixation and denitrification, providing useful services (Gold et al. 2019). In the future, there may be modifications to existing wet stormwater ponds such as aerobic mixing or other factors that could promote both bacterial reductions and nitrogen reductions more effectively.

Table 42: Summary of BMP Performance Crediting by Various Authorities

BMP	Runoff Reduction	Total Nitrogen	Total Phosphorus	Total Suspended Solids	Bacteria
Bioretention					
Coastal SC LID Manual	60-100%	65-90%	55-90%	80-90%	55-90%
SoLoCo Manual	60-100%	75-100%	N/A	85-100%	80-100%
SCDHEC	N/A	35-55%	55-70%	50-85%	10-60%
Permeable Pavement					
Coastal SC LID Manual	50-100%	60-80%	60-80%	80%	45-75%
SoLoCo Manual	30-100%	45-100%	N/A	80-100%	30-100%
SCDHEC	N/A	N/A	N/A	N/A	N/A
Infiltration					
Coastal SC LID Manual	100%	55-90%	65-95%	80-95%	65-95%
SoLoCo Manual	100%	100%	N/A	100%	100%
SCDHEC	N/A	35-55%	50-60%	80-90%	90-98%
Green Roof					
Coastal SC LID Manual	100%	45-60%	45-60%	80%	45-60%
SoLoCo Manual	50-100%	50-100%	N/A	50-100%	50-100%
SCDHEC	N/A	N/A	N/A	N/A	N/A
Rainwater Harvesting					
Coastal SC LID Manual	100%	Varies	Varies	Varies	N/A
SoLoCo Manual	100%	100%	100%.	100%	100%
SCDHEC	N/A	N/A	N/A	N/A	N/A

BMP	Runoff Reduction	Total Nitrogen	Total Phosphorus	Total Suspended Solids	Bacteria
Disconnection					
Coastal SC LID Manual	25-75%	25-50%	25-50%	80%	N/A
SoLoCo Manual	40%	40%	N/A	80%	40%
SCDHEC	N/A	N/A	N/A	N/A	N/A
Grass Channel					
Coastal SC LID Manual	10-20%	20-35%	40-45%	40%	N/A
SoLoCo Manual	10-20%	25-35%	N/A	50%	30%
SCDHEC	N/A	N/A	N/A	N/A	N/A
Dry Swale/Bioswale					
Coastal SC LID Manual	60%	20-35%	40-45%	40%	N/A
SoLoCo Manual	10-20%	25-35%	N/A	50%	30%
SCDHEC	N/A	40-60%	35-50%	70-80%	10-60%
Filtering Systems					
Coastal SC LID Manual	0	45%	65%	90%	80%
SoLoCo Manual	0	30%	N/A	80%	80%
SCDHEC	N/A	N/A	N/A	N/A	N/A
Dry Detention					
Coastal SC LID Manual	0	N/A	N/A	N/A	N/A
SoLoCo Manual	0	10%	N/A	60%	60%
SCDHEC	N/A	19-29%	14-25%	45-68%	20-50%
Wet Detention Pond					
Coastal SC LID Manual	0	40%	75%	85%	70%
SoLoCo Manual	0	30%	N/A	80%	60%
SCDHEC	N/A	30-45%	50-70%	65-80%	45-75%
Stormwater Wetland					
Coastal SC LID Manual	0	30%	50%	80%	70%
SoLoCo Manual	0	25%	N/A	80%	60%
SCDHEC	N/A	28-39%	42-53%	66-78%	58-78%

5.2.2 State of Knowledge of Bacteria Reduction Strategies and BMPs

In order to make recommendations for best management practices (BMPs) for the May River Headwaters, the Team researched current information from academia and the public utilities sector to understand the current state of the knowledge related to reducing FIB. Recognizing that human sewage contamination presents the greatest health risk and is a controllable source, the first recommendation is to identify sources of human sewage and then fix underperforming septic systems and/or sanitary sewer conveyance systems (see Section 5.1). Any recommendations for structural stormwater BMPs will not have an impact if the actual bacteria source is from failing septic and sewer infrastructure. Failing septic and sewer systems can be the result of age, maintenance issues (clogs), or even tidal influence. Rising tides have the capability to interfere with both stormwater and sewer infrastructure, by impeding flow and promoting corrosion. An additional complicating factor to address bacteria, as the Town has documented with its monitoring program, is that FIB can colonize and regrow in biofilms and sediments in the storm drainage system. Therefore, even if a BMP is successful at reducing the concentration of FIB in the effluent, there is still a problem of FIB persisting in hospitable environments.

The research also indicated that BMP efficiency is variable and dependent on the design, maintenance, and other factors. For example, in some cases a net export of microbes can result due to improper maintenance, regrowth of microbes in the BMP, resuspension during storm events, or direct wildlife deposits (Characklis et al., 2009). Information regarding removal rates of FIB in the International BMP Database (Clary et al., 2010) are variable and dependent on the following, 1) season in which the FIB were quantified; 2) stormwater volume and flows; and 3) the type of FIB being measured. For example, lower values of removal efficiency have been reported for *Enterococcus* bacteria because this genus is saprophytic (plant-loving) and can persist and grow in vegetated systems. This trait is of importance as *Enterococcus* is a subset of FC bacteria. Several systems reported the best removal efficiencies in systems with low turbidity as sunlight penetration enhances UV degradation of bacteria, and this process is reduced in high turbidity conditions (Noble et al., 2002). Dr. Noble advised the Project Team and Town that removal values in coastal SC will most likely be lower than those included in the International BMP Database, which has many studies based on the West Coast. This is primarily due to the following, 1) SC temperature is higher during most seasons than in west coast environments; 2) SC water sources tend to be blackwater and tannic water, which reduces light penetration; and 3) persistent forms of FC are known to grow in the sediments of systems in SC.

Wet Ponds, whether as stormwater BMPs or as community amenities, have become a dominant feature in the landscape in the May River Headwaters (Table 25). GIS shapefiles of ponds provided by the Town of Bluffton were compared to historic aerial images in 2002 and 2018. Although ponds are a reliable flood prevention practice, their ability to treat bacteria is variable. Weinstein et al. (2008) demonstrated that bacterial levels in ponds were positively correlated with the size of the pond's drainage area, pond surface area, concentrations of total organic carbon, and percent clay particles. Local design guidance manuals (SCDHEC, 2005 and Ellis et al., 2014) estimate bacteria removal efficiencies in wet ponds to be 45-75%. A more conservative range might be 50 to 60%. The higher removal efficiency is likely to be appropriate for fall and winter months, and the lower removal efficiency values are likely to be more appropriate for the spring and summer months, where organic matter and primary productivity values are expected to be greater.

There are very few fully quantitative evaluations of wet pond removal efficiency of FIB (Appendix B. Noble, 2020). Many studies evaluated for this report state that FIB removal efficiencies are not well established for wet ponds/retention ponds/retention basins. The Town of Bluffton does have water quality monitoring and statistical analysis of the results that evaluate the effectiveness of a 1.25 acre wet pond (with a drainage area of 300 acres) that was constructed as a recommended project in the 2011 Action Plan (New Riverside Pond, or Area A in Figure 16 of this report). The New Riverside Pond (NRP) was completed with 319 grant funding in 2013. The Town monitored FC concentrations at locations immediately prior to treatment (influent site NRP-IN-N), after treatment (effluent site NRP-OUT), and at locations approximately 600 ft (BECY1.5) and 1,320 ft (PBR9, outfall to May River). In 2015, Dr. Warren from the University of South Carolina provided a statistical review of the Town's NRP FC data. The results of this analysis (Warren, 2015) showed that there was a statistically significant reduction in bacteria concentrations between the pond influent (NRP-IN-N) and pond effluent (NRP-OUT). Additionally, there was a statistically significant reduction in FC concentrations at BECY1.5 for observations before and after the pond was constructed. However, at the outfall to the May River (PBR9), the was no statistically significant reduction in FC concentrations before and after the pond was constructed. In other words, even though a large stormwater treatment BMP was installed and effectively removed FC, there was not a benefit to the May River because the bacteria levels still increased downstream of the pond. As a result, the Town decided to utilize Microbial Source Tracking (MST) to evaluate what is the source of FC and inform new actions that could be taken to improve the efficacy of the BMP. As a result of MST, the Town identified 5 failing septic systems in the Headwaters of the May River (Jones and Lewis, 2019).

One study (Hathaway, 2008; Hathaway et al., 2009) conducted in Charlotte, NC evaluated the performance of nine stormwater BMPs, including one wet pond, two stormwater wetlands, two dry detention basins, one bioretention area, and three proprietary devices. The data from this study was conflicted and sometimes confusing. The authors reported a greater than 50% removal efficiency for fecal coliform and *E. coli* in the wet pond, wetlands, bioretention area, and the proprietary device. However, only the wetlands and the bioretention area had significantly different influent and effluent concentrations. The authors called attention to the nature of temperature-warm, nutrient-rich, stagnant BMPs systems that appear to serve as a reservoir of FIB and at times may also preferentially grow the fecal indicator bacteria (Van Donsel et al., 1967).

In Australia, there is a reasonable similarity between their waste stabilization ponds and retention ponds in SC. A recent study (Sheludchenko et al., 2016) studied FIB removal rates in four waste stabilization ponds. One of the ponds had baffles to promote surface area in the ponds in areas where space is a constraining factor. The waste stabilization pond with baffles showed a reduction in both pathogens and FIB. When FIB studies were conducted with more replicates at a later time, the team found a ten-fold reduction in the total number of E. coli in the system, indicating a removal efficiency of roughly 90% of the system.

The International Stormwater BMP database contains approximately 600 pairs of influent and effluent data for fecal coliforms and *E. coli*. across multiple states. Clary et al. (2008) analyzed the fecal coliform and *E. coli* data and showed that swales and detention basins did not appear to effectively reduce FIB in effluent samples. Datasets for wetlands and manufactured devices were not of adequate size to draw meaningful conclusions, but sometimes these systems showed bacterial growth. The authors concluded that the ability of BMPs to reduce FIB varies widely across BMPs. No single BMP appears to consistently reduce FIB concentrations. Among the BMPs, retention pond and media filters appeared to show some positive trends, but these were not across the board. Chandrasena et al. (2016) studied the removal of *E. coli* and *Campylobacter spp*. from urban stormwater by field-scale biofilters.

Additionally, high removal efficiency does not always guarantee attainment of bacteria standards when inflow concentrations are high (Wood, 2018). As a result, across the southeastern region and nation, there is a movement away from stormwater ponds in favor of emphasizing other practices that encourage runoff reduction, which is defined as "the total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainfall harvesting, engineered infiltration, or extended filtration."

5.2.3 Future Strategies to Consider

Based on the understanding of the state of knowledge and approaches used by watershed managers to minimize and mitigate the effects of development on water quality, the Project Team held discussions with the Town of Bluffton to develop the following list of strategies for addressing FC in the May River Headwaters. In general, the strategies involve Four Ps: Partnerships, Policies, Programs, and Projects. Overall, the goal will be to follow Better Site Design principles to conserve natural areas including tree canopy, reduce impervious cover, and manage designated stormwater reduction volumes by infiltration and/or filtration techniques as first priority, or other approved volume reduction techniques as second priority. These strategies are in agreement with local research (Holland et al., 2004; Sanger et al., 2008; Sanger and Blair et al., 2015; Sanger and Tweel et al., 2015; Montie, 2019) pertaining to the negative impacts of impervious surfaces in southeastern estuarine environments and are supported with design guidance (such as *Low Impact Development in Coastal South Carolina: A Planning and Design Guide*) and in local ordinances. The Town of Bluffton is currently in the process of adopting a new regional stormwater design manual and ordinance with Beaufort County, Jasper County, the City of Beaufort, City of Hardeeville, and Towns of Port Royal and Yemassee.

Partner organizations to protect and improve water quality in the May River watershed include:

1. Beaufort County – Public Works, Stormwater, Parks & Recreation, Rural & Critical Lands
2. Beaufort-Jasper Water and Sewer Authority (BJWSA)
3. Clemson Extension/Lowcountry Stormwater Partners
4. South Carolina Department of Natural Resources (SCDNR)
5. South Carolina Department of Health and Environmental Control (SCDHEC)
6. United States Environmental Protection Agency (USEPA)
7. National Oceanic and Atmospheric Administration (NOAA)
8. United States Geological Service (USGS)
9. University of South Carolina Beaufort (USC-B)
10. University of South Carolina
11. Clemson University
12. Public Schools/Board of Education
13. Non-governmental organizations, e.g. Lowcountry Institute, Port Royal Sound Foundation, Open Land Trust
14. Private Commercial Properties
    a. Residential HOAs/Communities
    b. Religious Institutions
    c. Apartment Complexes
    d. Private Education Campuses
    e. Shopping Centers
    f. Others

Policies to protect and improve water quality in the May River watershed include:

1. Adopt proposed regional Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual.
    a. The Town should incorporate volume reduction BMPs (those that encourage infiltration) within existing and future CIP projects to the maximum extent practical, especially for project locations with well-drained soils (HSG A or B)

2. Eliminate clear cutting approach within developed areas.
3. Increase buffer areas and requirements.
4. Increase conservation and open space requirements and require recorded conservation easements.
5. Reduce planned density/re-zone.
6. Increase tree protection/conservation areas and requirements
    a. Increase tree protection area from drip line to an additional 25' from drip line.
7. Offer incentives to renegotiate existing land development agreements to reduce density and meet current environmental objectives.
8. Develop strategies to effectively execute public/private partnerships.

Programs to protect and improve water quality in the May River watershed include:

1. Continue to support the Municipal Separate Storm Sewer System (MS4) program in the Town and County as they work to achieve the six (6) Minimum Control Measures, including:
    a. Public education and outreach
    b. Public participation/involvement
    c. Illicit discharge detection and elimination
    d. Construction site runoff control
    e. Post-construction site runoff control
    f. Pollution prevention/good housekeeping
2. Neighborhood Assistance Program
    a. Septic System Assistance Program to assist Town residents with septic system maintenance to ensure proper functioning until sanitary sewer connections are available.
    b. Septic to Sewer Conversion Program to assist Town residents with offsetting the potential costs to abandon existing septic systems and connect to available public sanitary sewer.
3. Establish an Impervious Area Restoration/Retrofit Program in areas where development pre-dated stormwater management requirements or failed to meet on-site retention of the 95th percentile storm. The purpose of this Program is to target large impervious areas to be retrofitted to meet 95th percentile storm retention of impervious surfaces with infiltration/filtration BMP to the maximum extent possible.
4. Water Quality Monitoring Program modifications include
    a. Developing in-house microbial source tracking
    b. Recommendations for future bacteria monitoring locations
    c. Recommendations for future water flow monitoring locations

Projects to protect and improve water quality in the May River watershed include a variety of stormwater BMP structures. Consideration of site-specific factors, such as in-situ soils, site stability, seasonal high-water table, cost, utilities, and even aesthetics will factor into selection of appropriate practices for a given site. For example, practices that focus on infiltration will not be feasible in areas with high groundwater levels, poorly drained soils, steep slopes, and utility conflicts. Additionally, these structures will require dedicated maintenance to ensure a long and effective service life. Information related to maintenance requirements can be found for individual BMPs in Chapter 4 of the *Southern Lowcountry Stormwater Design Manual* along with checklists in Appendix F and maintenance agreement template in Appendix O. Recommended types of projects include:

1. Impervious Surface Rehabilitation/Retrofit: As development increases in response to population growth, there are measurable anthropogenic impacts on natural systems and tidal creeks in particular (Holland et al., 2004; Sanger et al., 2008; Sanger and Blair et al., 2015; Sanger and Tweel et al., 2015). Regional research has demonstrated that when the impervious cover exceeded 10-20% in a watershed, measurable physical and chemical changes were observed, such as altered hydrography, increased salinity variance, altered sediment characteristics, increased chemical contaminants, and increased fecal coliform loadings. Furthermore, measurable impacts were observed in living resources and ecological processes when impervious cover exceeded 20–30%. Health risks and flooding vulnerability of a headwater region becomes a concern when impervious cover exceeds 10-30%.

   Converting impervious surfaces to pervious or removing excess impervious surface is recommended to the maximum extent practicable in accordance with the new *Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual.* If pavement cannot be removed or converted, street sweeping is a recommended strategy for removing sediment from the surfaces to prevent pollutants and bacteria (which adsorb to the sediment particles) from entering stormwater ponds and conveyance systems.

   Potential Impervious Surface Rehabilitation/Retrofit project types include:

   a. Permeable Pavement allows for stormwater volume reduction through infiltration, and is ideal for parking areas, shoulders, and travel lanes. Stormwater passes through various pervious layers and is stored in a gravel reservoir prior to infiltration. In areas of poor soils, an underdrain can be installed to provide detention of stormwater with a managed discharge into a receiving storm drain. Permeable pavements can be constructed from concrete, asphalt, gravels, and various pavers. In some cases, a pervious trench can be installed along a gutter pan or road edge to capture stormwater flow. Varying in width up to four feet wide, these infiltration trench systems results in reduced costs as only a portion of the road needs to be reconstructed. Opportunities for permeable pavement include
      i. Pervious driveways: explore opportunities to retrofit existing residential driveways by removing the paved surfaces and replacing with gravel, pavers, grass grids, etc.
      ii. Pervious parking lanes/gutters: convert a portion of low-traffic lanes or on-street parking to pervious material.
      iii. Note there are several publicly owned roadways in the May River Headwaters, including Bluffton Parkway, Buckwalter Parkway, Grande Oak Drive, Heartstone Circle, Morningside Drive, and Lake Point Drive. As these roadways are repaired and maintained, the Town should coordinate with Beaufort County to consider incorporating projects such as bioswales, infiltration trenches, and permeable pavement strips for future roadway capital improvement projects.
   b. Pavement reduction: look for opportunities to shrink parking lots by providing compact car spaces, minimizing stall dimensions, and providing shared parking. Review existing parking ratios to determine if a lower ratio would be warranted or feasible.
   c. Incentives to improve Planned Unit Development (PUD) agreements: reduce the amount of developed area and preserve natural areas to the maximum extent possible, increase buffer areas; reduce density; design residential streets for the minimum required pavement width needed to support travel lanes, on-street parking, and emergency vehicles; reduce the total

length of residential streets by utilizing alternative layouts to maximize number of homes per unit length; and minimize cul-de-sacs.

2. On-site Volume Reduction: This technique requires stormwater to be managed on-site, either during development or as a retrofit, rather than conveyed to a downstream BMP or receiving water. This is achieved through infiltration and evapotranspiration to mimic the pre-development hydrology of the site. The new *Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual* (Center for Watershed Protection and McCormick Taylor, 2020) require development or redevelopment in watersheds designated for shellfish harvesting, or under water quality impairments, to retain the 95th percentile storm (1.95") on-site through use of infiltration or filtration practices to the maximum extent practicable (MEP).

   In areas where development pre-dated stormwater management requirements or failed to meet on-site retention of the 95th percentile storm, it is recommended the Town of Bluffton institute an Impervious Area Restoration/Retrofit Program (as described above) in which large impervious areas are targeted to be retrofitted to meet 95th percentile storm retention of impervious surfaces with infiltration/filtration BMP to the maximum extent possible. Most BMP and engineering construction practices will benefit from a vision to include BMP modification, dredging and maintenance over a five-year performance period. The maintenance of the BMP should include incorporation of expected (e.g. dredging of sediment during high rain periods and unexpected costs (i.e. saltwater inundation of a vegetated wet pond during a hurricane).

   Potential On-site Volume Reduction project types include the following:

   a. Bioretention/Rain Gardens: these are practices that capture and store stormwater runoff in shallow vegetated basins containing engineered soil media. They are designed to infiltrate runoff through an engineered media of sand, soil, and organic matter that is 18" deep; the water can then be returned to a conveyance system via an underdrain if surrounding soils do not support infiltration. These are easily incorporated into new development and retrofit projects. They are a good choice for small, highly paved drainage areas such as parking lots or alongside roadways. Additionally, the footprint of these practices can be adjusted to accommodate existing utilities and other site constraints.
   b. Bioswales/Dry swales: a type of open channel system designed to function like shallow, linear bioretention units. They can be covered with elaborate landscaping, simple turf or other surface material. Bioswales use identical soil filter media as bioretention and can be equipped with an underdrain or allow runoff to infiltrate into surrounding soils. Check dams should be constructed to encourage ponding.
   c. Filtering Systems/Trench: These practices temporarily store stormwater runoff and pass it through a filter bed of sand media. They are useful in small drainage areas, especially those with high impervious areas or as retrofits to existing developments. The *Southern Lowcountry Design Manual* recognizes several variations in types of filters: non-structural sand filters, surface sand filters, underground sand filter, three-chamber underground sand filter, and perimeter sand filter. These practices do not receive credit for reducing stormwater volume; however, they can be highly effective at removing bacteria from stormwater runoff.

d. Cisterns/Rain Barrels: Rainwater harvesting is a technique that captures and stores rainfall (in tanks above or below ground) in order to release it for future use. Advantages of this strategy include reducing the rate and volume of stormwater runoff and providing water for non-potable uses such as irrigation and toilet flushing. In order to maintain capacity, the stored water must be used on a regular basis. Ideal in residential areas as a grassroot effort within a community, local jurisdictions (Town of Bluffton, Beaufort County) and other organizations (e.g. Lowcountry Stormwater Partners) can support distribution of rain barrels to neighborhoods. Harvested rainwater can be used for non-potable water uses and on-site stormwater disposal/infiltration. Non-potable uses include landscape irrigation, exterior washing, flushing of toilets and urinals, fire suppression (sprinkler systems), evaporative coolers, and replenishment of water features/fountains. Additionally, rainwater harvesting can be combined with a secondary (down-gradient) stormwater practice to enhance stormwater retention and/or provide treatment of overflow from the rainwater harvesting system. This could include disconnection to a pervious or conservation area (disconnection) or overflow to practices such as bioretention, infiltration, or grass channels/dry swales (Ellis et al., 2014).

   i. A related practice is utilizing stormwater ponds for irrigation purposes. The pond acts as the cistern, storing water until it is utilized for irrigation. Anecdotally, this practice has been used by golf course communities to irrigate turf, but it can also be applied in other areas such as HOA common space such as in the Town's Pine Ridge project. This practice fulfills the objective to retain stormwater volume on-site, but the amount of bacteria reduction associated with it has not been documented.

e. Green Roofs: These practices capture and store rainfall in an engineered growing media installed over a waterproof membrane on a building or other structure. They have moderate to high water quality improvement because they can reduce runoff volume and pollutant loads. They provide additional benefits such as energy savings and potential for amenity space for users. There are modular green roof units available on the market (for example, Green Roof Outfitters) that make retrofits of existing buildings easier.

f. Infiltration Facilities: These storage practices are a type of underground detention vault or tank with an open bottom to allow for infiltration. The units can be made from a variety of materials (plastic, concrete), shapes (domed, square) and sizes (from about 30 inches to 15 feet in depth), allowing them to be configured to adapt to many site conditions. With adequate soil types (minimum infiltration rate of 0.5 in/hr), subsurface infiltration results in stormwater volume reduction. Paired with underdrain or a low flow orifice, these systems provide stormwater detention and peak discharge reduction.

   i. An example project in the City of St. Paul diverted water from an existing stormwater pipe (draining 63 acres of land) into an infiltration basin constructed under an existing golf course fairway: https://www.capitolregionwd.org/projects/como-golf-course/ Note that there are three golf course communities in the May River Headwaters, including Hampton Hall (SUB-RD-08, 09, 10, 11, 17), Old Carolina (SUB-RD-06), and Pinecrest (SUB-RD-06, 12, 13).

Table 43: Volume Reduction Site Selection Criteria

Criteria	Description
Property Ownership	Public>HOA>Religious>Commercial>Private Property
Soils	• HSG A/B soils preferred over C/D; however, it is still possible to achieve infiltration in soils with a permeability as low as 0.5 in/hr. • In poorly drained soils, utilize an underdrain. The *Southern Lowcountry Stormwater Design Manual* gives several BMPs runoff reduction and bacteria removal credits even if an underdrain is used. For example, bioretention with an underdrain has 60% runoff reduction and 80% bacteria removal.
Groundwater Table	• Most BMPs require a minimum depth of 6 inches below the bottom of practice and the seasonal high water table. Maximizing the distance between the groundwater table and the bottom of the practice should allow for more storage and infiltration of stormwater.
Impervious Area	• Most BMPs perform best (are less prone to clogging) if most of the contributing drainage area is impervious. • Potential project sites will be prioritized based on the impervious area treated (projects with more impervious area or located in a subcatchment with high impervious area % should be considered first)
Available space	• A detailed site survey should take into account utilities and other natural resources (such as trees) in order to avoid impacts. This may change the conceptual layout of the projects. • Existing stormwater ponds reduce available space for structural BMP retrofit projects. These may be opportunities for irrigation reuse or other modifications to make ponds bacteria neutral.

3. Modifications to Make Ponds Bacteria Neutral (Pond Retrofit)
    a. Sedimentation to Minimize Dissolved Organic Material: There is a difference between bacterial growth and bacterial persistence. The bacteria cannot grow in the system without a growth substrate, so maximizing the removal of dissolved organics by physical removal, or by additions of nonreactive material (clay) for flocculation is a potential strategy to reduce bacterial growth. Additionally, bacteria that attached to sediment particles can be settled out using the same method. Systems in which non-reactive material or flocculation is to be

promoted need to consider the additional services of the BMP, so as to ensure that management of bacterial concentrations does not come at the cost of expected nitrogen or solids reductions (e.g. Gold et al. 2019).

b. Low Flow Orifice Manipulation: Discharge from existing ponds can be adjusted to retain more water. In some instances, the discharge structure can be retrofitted with an additional orifice that would allow for the lowering of the permanent pool elevation prior to a rain event. This would allow the capture of additional runoff, and residency time to allow for UV disinfection, settlement of solids, and evaporation prior to the engagement of the standard low flow orifice or weir. This would also allow the peak discharge to be lowered reducing the freshwater volume contributed into the downstream tributaries. This would only be suitable in instances where the outfall elevation is lower than the permanent pool, or where groundwater levels are not influencing pool elevation. Consideration should be given to hydrograph peaks and inadvertently overlapping peak discharges that may result in downstream flooding.

c. Pond Lining for Groundwater Separation: Stormwater ponds may interact with the groundwater table. Interaction with ground water may be the original design intent, or a result of over excavation of the ponds to a depth greater than displayed in the permit drawings. As a result, the groundwater fills the ponds, which may cause a constant discharge of freshwater out of the pond and into the receiving conveyance system. This creates two problems: a pond that does not provide adequate treatment (hydraulic residence time is too short to allow bacteria to be eliminated by sedimentation or UV treatment) and additional freshwater that encourages bacterial growth downstream of the BMP. There are several approaches to segregate groundwater from wet ponds and in some instances a combination of several may be needed. If a pond was found to be over excavated, it could be backfilled to an elevation above the ground water interface. A liner can be installed, though this would require draining of the pond. Pond liners are usually made with a "concrete cloth" that hardens on hydration to form a waterproof layer, a rubber or plastic type membrane, or clay material. They tend to be expensive, and there is a chance that if the pond is already being fed by a groundwater source that it would be difficult to get the material to set properly. Paired with a pond liner, a curtain drain can be constructed around the pond perimeter to capture and redirect groundwater to the outfall.

d. UV Light or Ozonation Treatment: Both methods are expensive but may be effective options to reduce bacteria concentrations. Several examples of these systems' (e.g. https://www.waterworld.com/home/article/16190542/uv-disinfection-facility-treats-stormwater-runoff), https://www.smgov.net/uploadedFiles/Departments/OSE/Categories/Urban_Runoff/UR_SMURRF_Info_Sheets.pdf) observed results exhibit significant reductions of bacteria. However, this approach is probably not feasible given the flows observed in the May River Headwaters Watershed. An ideal situation for these types of systems involves small dry weather flows to very high recreational use areas (such as public beaches) to make the costs worthwhile.

Note that before a stormwater pond retrofit can occur, more data is required to evaluate, rank, and prioritize projects. Stormwater ponds are often designed to meet a minimum requirement that meets water quality and quantity storage and management guidelines. This storage volume, either a wet pool or temporary detention volume above the permanent wet pool is based on the contributing drainage area and difference between pre-developed and developed land use. However, there may be opportunities to increase the permanent pool or temporary storage volumes to provide stormwater volume reduction or enhanced water quality management through retrofitting existing ponds. Retrofitting can take the form of several approaches. By calculating the water quality volume required based on enhanced design guidelines, or utilizing a wooded, good condition, pre-developed land use, a water quality storage volume can be determined that exceeds the pond's original design volumes. Trough grading or modification of the discharge control structure additional storage volume can be added to a stormwater pond. Additional water quality storage from the permanent wet pool can be obtained by drawing down the permanent wet pool prior to a rain event. This can be achieved through two methods: an automated low flow orifice that opens prior to the storm event, draining down the permanent pool to allow more runoff to be capture before the original low flow orifice engages, alternatively, the pond water can be used for irrigation and withdrawn via pump. Stormwater withdrawn for irrigation purposes will infiltrate into the ground resulting in true volume reduction. The other methods may reduce the overall peak discharge, but primary benefit is a result of increased retention times for UV disinfection, sedimentation, and evapotranspiration.

Table 44: Pond Retrofit Site Selection Criteria

Criteria	Description
Property Ownership	Public>HOA>Religious>Commercial>Private Property
Are As-Builts Available?	• Yes – would allow for more efficient review for retrofit potential • No – survey of pond would be needed to evaluate for retrofit potential o Area could be flown by drone, with key points picked up with traditional survey.
What is the original pond design?	• Water surface elevation (Permanent pool, design storm events, 100-year) • Pool volume (Permanent, design storms) • Water quality volume (based on requirements when pond was permitted)
Is depth of pond known?	• Is a bathymetric survey needed?
What would the water quality volume be if based on the *Southern Lowcountry (SoLoCo) Stormwater Design Manual* Guidelines?	• Can this difference be treated within existing pond?
Can pond be enlarged through grading or weir modification to store this increase in volume?	• Based on surface area of pond, modification of side slopes or open space area may accommodate the desired additional water quality volume.

	• Would raising or manipulating the low flow orifice to increase water quality storage volume result in acceptable change to pond dynamics (water surface elevation, inundation elevations during rain events)
What is the ground water elevation in relationship to bottom of pond?	• If ground water elevation is equivalent or higher then pond bottom, limits ability to retrofit pond. Investigate feasibility of installing liner to separate pond. Typically cost prohibitive or difficult and very impactive construction methodology to install. • If there is separation between ground water and pond bottom, potential to efficiently retrofit pond through techniques discussed below.
Permanent pool elevation versus elevation of downstream channel	• Advance draw down would create additional storage to capture and treat more runoff from a rain event before the low flow orifice is engaged. • Is there adequate elevation change to draw down permanent pool by gravity before rain event through automated low flow orifice valve? • If there is not enough elevation change, would installing a pump to draw down the permanent pool be feasible? • If ground water is intercepted by pond, this method may not produce noticeable affects to water surface elevation due to the ground water make up.
Evaluate potential to install irrigation withdraw from pond:	• Does the pond currently have irrigation withdraw? o No – proceed to concept design o Yes – investigate expanding system or modifying frequency of irrigation to increase withdraw amount. • What are the Infiltration rates of land to be irrigated? How much water can be applied in a reasonable rate that would infiltrate and not create a detriment to vegetation or land use. • Is there an existing irrigation system (pipes and spray heads) that can be utilized, or would new system be required? • Can private property within neighborhood be included in the pond-based irrigation system? Or would it be limited to HOA common areas. • Can the irrigation be extended to public ROW along roads outside of the neighborhood?

	• If ground water is intercepted by pond, this method may not produce noticeable affects to water surface elevation due to the ground water make up.
Other Approaches:	• Can the area around the pond be planted to increase evapotranspiration? • Can tree canopy be introduced in open space areas • Increase pond riparian buffer to filter overland runoff into ponds and uptake additional nutrients, etc. • Will improved post-construction inspections and maintenance fix problem? (Partnerships with Carolina Clear and Lowcountry Stormwater Partners can provide support and tools)

4. Proprietary Products to eliminate bacteria. There are many manufactured stormwater treatment practices that utilize settling, filtration, absorptive/adsorptive materials, vegetative components, and/or other technology to manage the impacts of stormwater runoff. The actual performance varies based on the manufacturer's design.
    a. Biosoil Filter Media: various proprietary blends, including amendments such as biochar (Afrooz and Boehm, 2016), can be added to the soil media used for bioretention and other Low Impact Development (LID) practices to help enhance bacteria removal.
    b. Urban Tree Filter Box: These practices function like a smaller bioretention unit installed in the sidewalk zone near the street where urban trees are normally planted. The soil volume for the tree pit is increased and used to capture and treat stormwater. Treatment is increased by using a series of connected tree planting areas sequentially in a row. Sometimes the filter media can be covered with pervious pavers or cantilevered sidewalks.
    c. Filter tubes with bacteria inhibitors such as Bactoloxx filter media: a product marketed by Filtrexx that is used in their EnviroSoxx product to reduce up to 99% of coliform bacteria (including *E. coli* and fecal coliforms) loads in stormwater runoff, particularly around sensitive watersheds and receiving waters. Rather than incorporating the media into the actual BMP, the filter tubes can be placed at inlets or within channels to filter water as it passes through the conveyance system.

5. Nature-Based Solutions
    a. Tree Planting/Reforestation/Urban Tree Canopy: This practice is recommended in the new *Southern Lowcountry Stormwater Design Manual*. Runoff reductions are based on the size of the tree. Tree plantings and preservation have high community acceptance, relatively low maintenance requirements, and are easily incorporated with other practices. Tree planting and preservation provides stormwater interception, beauty, and shade while simultaneously increasing community aesthetics and property values. Tree canopies intercept rainfall before it becomes runoff and can be especially helpful in areas where the canopy covers impervious

surfaces (e.g. street trees). Trees can reduce stormwater runoff volumes and improve water quality through the processes of evapotranspiration and nutrient uptake. Additionally, as the trees' roots grow, they improve the infiltration capacity of the soils where they are planted.

b. Land Purchase/Conservation Areas: Conservation of natural areas is one of the principles of Better Site Design and will contribute to a watershed approach to stormwater management. The *Southern Lowcountry Stormwater Design Manual* provides four scenarios where conservation can qualify for a stormwater retention credit (removal of the area from the site for purposes of calculating the stormwater retention volume, SWRv). These include the following:
    i. Natural conservation area: subtract 100% of the protected area from SWRv calculation if a portion of the post-developed area is left in its natural condition and protected in perpetuity by a conservation easement.
    ii. Reforestation/revegetation: subtract 50% of an area that is reforested/revegetated and placed under a conservation easement from the SWRv calculation.
    iii. Soil restoration: subtract 50% of an area that is restored and placed under a conservation easement from the SWRv calculation
    iv. Reforestation/revegetation and soil restoration: subtract 100% of the acres of development with restored soils and revegetated area from the total site area when calculating the SWRv.

c. Floodplain Restoration: Natural channels and ditches (previous natural channels that have been heavily modified by man) can input pollutant loads into the May River through erosion of fresh and reservoir FIB within the conveyance channel. In this case, the FIB population has become decoupled from any respective pathogens, but the loading remains and is a concern. Due to erosion or continued dredging of these channels, runoff no longer has the ability to access floodplains and adjoining wetlands. Restoration and reconnection of the stream to the floodplain prior to reforestation will promote nutrient and sediment attenuation, reduce flow and scour, and encourage natural hydrological functions in the stream corridor (Ellis et al., 2014). Correcting an incised channel has the potential to increase infiltration, UV penetration (depending on location), and slow down the flow of water to allow sediments/FC to settle out. Several options exist to retrofit these channels which include stabilization of eroded areas through the use of natural stabilization methodologies, re-establishment of flood plains to slow down and encourage evapotranspiration of rain events or the construction of regenerative stormwater structures within ditches and ephemeral channels. In order to make recommendations for restoration of natural channels or ditches, more information is needed at this time, as summarized in Table 45.

Table 45: Ditch/Channel Retrofit Site Selection Criteria

Criteria	Description
Property Ownership	Public>HOA>Religious>Commercial>Private Property
What data is available? (allows for cost efficient concept development)	• GIS (contours, utilities, drainage infrastructure) • As builts or stormwater management plans within the watershed • Previous studies
Site Access	• Adjoining areas heavily forested would affect access • Proximity to public road or right of way • Utility/infrastructure constraints
Adjacent environmental features (such as wetlands)	• Potential to limit site access, create additional permitting complications and potential for mitigation based on impacts (permanent or temporary)
Stream Channel Geometry	• Cross section dimensions, • channel length, • inverts
Current Condition	• Is there erosion/scouring • What kind of substrate: sediment, vegetation (what type: herbaceous, woody, sparse), other (e.g. concrete)? • Is there evidence of tidal influence (flow in both directions or only one?) • Sediment build up within channel
Identify the cause or sources of pollution or subject of concern	• Hot spot • Development • Lack of watershed stormwater management
Natural resources inventory	• Are there RTEs? • Historical impacts?
Ground water separation	• If separation is present, possible for regenerative stormwater style bmp within channel
Mitigation bank credits	• Is there the potential for project to gain wetland or stream mitigation bank credits, allows for funding source?
Condition of outfalls	• Can be significant source of sediment transport
Complete Rapid Stream Assessment by identifying	• Fish blockages • Bank erosion • Outfalls

	• Channel alterations • Flood or infrastructure concerns • Potential for habitat enhancement
Site Prioritization Parameters	• Constructability o Access o Forest / Tree Cover o Utilities (Visible) — Constraints o Proximity to State/County Road o Bank Erodibility Potential • Watershed Characteristics o Stream Length (LF) – longer stream lengths are typically more cost effective and result in increased nutrient/sediment reductions o Drainage area – smaller drainage areas (< 1 square mile) have higher probability for success. o Stream order – 1st order systems are optimal o % Impervious – optimal is < 10% impervious, however many urban systems fall in suboptimal category of 10-29% o Biologic Uplift – look for streams that have potential for biologic uplift or habitat improvements in addition to stabilization • Other o Bank Erodibility Potential – Are there active headcuts or high potential for new headcut migration? High channel incision? o Stream Bank Erosion Potential Percentage – Higher percentage of bank erosion provides greatest pollutant reductions. Need to look at both banks. o Sediment Storage / Nutrient Treatment Potential – includes treatment of upstream sources, floodplain storage and/or nutrient treatment potential o Potential to incorporate other BMP strategies – strategies could include reforestation, wetland creation, trash removal, outfall restoration, upland BMPs o Flooding/Drainage history: impact on conveyance efficiency and increased flood risk

5.3 Evaluation of 2011 May River Watershed Action Plan Recommendations

As part of Task 2 of this project, the Team evaluated the recommendations put forth in the 2011 Action Plan. The purpose was to determine the status of the projects and policies and to make recommendations and adjustments that would align with current state of knowledge as described in Section 5.2 of this report.

Table 46: Action Plan Status and Recommendations

2011 Action Plan Initiative	**Reference**	**Status**	**2020 Recommendations**
Monitoring Data and Plan/Program	Table 3-3		
• Continue implementing monitoring program to monitor pollutant trends and evaluate effectiveness of BMPs		On-going	• Section 5.1 of May River Headwaters Model Report Strategies for Assessing Problems including in-house microbial source tracking, new bacteria monitoring locations, and new water flow monitoring
• Town of Bluffton Impervious Surface Delineation Project		On-going	• Continuously update impervious surface data (building footprints, roadways, paths, parking lots, stormwater ponds) to keep current
Town Policy and Ordinance Assessment	§3.3		
• Town of Bluffton Stormwater Design Manual • Beaufort County Stormwater Manual for Stormwater Best Management Practices	§3.3.1	In progress	• Adopt regional *Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual* (2020) which places greater emphasis on managing stormwater based on watershed concerns related to water quality and flood prevention
Current Ordinances & Comprehensive Planning Review			
• Town of Bluffton Unified Development Ordinance		In progress	• Adopt and incorporate new regional *Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual*
• Town of Bluffton Comprehensive Plan 2007 (Amended 2014)		In progress	• Prioritize conserving area to maintain low impervious areas in undeveloped sections of May River Headwaters. In Figure 10 of the May River Headwaters Modeling Report, there are 62 subcatchments that are currently 0-10% impervious area. • In redevelopment or CIP projects, consider tree planting as priority. Refer to Section 4.14 Tree Planting & Preservation in *Southern Lowcountry Stormwater Design Manual*
• Recommended Actions: o Continue coordination with the County to implement cohesive design requirements o Town to provide additional design information for runoff reduction (as opposed to a main focus on retention/detention)		In progress	• Adopt and incorporate new regional *Southern Lowcountry Stormwater Design Manual*. Included in the new guidance are requirements that pertain to channel erosion and culvert design: o The 10% Rule will require application of channel protection requirements downstream of development sites. Culvert and bridge conveyance capacities may need to be increased under the new 10%

o Enhance section regarding culverts and bridge design to prevent the loss of natural in-stream or wetland attenuation that can reduce bacteria loads to May River o Protect channels and ditches from erosion by providing extended detention for the 1-year storm event			Rule and may result in daylighting existing conveyance and restoring previous lost wetland attenuation. o Post-development peak runoff control of the 2, 10, and 25-year 24-hour storms o Runoff reduction for the 95th percentile storm (1.95") • Develop program with the County to implement stormwater retrofit projects that fall outside of the Town's jurisdiction
Incentives to encourage volume or other water quality controls	§3.3.2		
• Promoting private entities (e.g. HOAs) to implement stormwater improvements • Reduce user fee via tax breaks/SW utility fee breaks to those who exceed the stormwater treatment requirements by a specific percentage • Increase quality of development/quality of life incentive by providing less nuisance flooding, cleaner water, increased pride, and more sustainable/green infrastructure		On-going	• Promote Stormwater Utility Fee Credit to private communities that implement BMPs above requirements • Establish public-private partnerships to implement projects/retrofits in areas identified by Water Quality Model outputs
Sustainable Development and Transfer or Purchase of Development Rights (TDR) Policies	§3.3.3		
• Encouragement of smart, sustainable, and environmentally-conscious growth within targeted locations of the Growth Framework Map • Provide more TDR opportunities to reduce impervious area introduced into the May River watershed • Ensure natural ground cover is maintained		On-going	• Continue to encourage protection of natural areas, especially forested areas, in concert with recommendations from the Historical Analysis of Water Quality, Climate Change Endpoints, and Monitoring of Natural Resources in the May River (Montie et al., 2019) and the regional *Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual* (2020)
Land Acquisition Strategy/Condemnation Policy	§3.3.4		
• Develop land acquisition strategy for future potential stormwater projects		On-going	• Include parcel acquisition into 5-yr CIP Forecast based upon Water Quality Model outputs for targeted projects and for open space • Align with Beaufort County Green Space Plan

o Property acquisition will support a wide range of projects from pond modifications, new pond construction, and/or right of way expansion			
Sewer Policy	§3.3.5		

• Septic systems may be a source of bacteria loading
• The Town should create a septic system ordinance to ensure long-term maintenance
• Conduct a survey of septic users in the watershed
• The Town should partner with Beaufort County and Beaufort-Jasper Water & Sewer Authority (BJWSA) to provide incentives for homeowners
  o Upgrading/replacing or retiring/converting systems
• The Town should develop a program for inspections and education for homeowners on septic
  o Grant funding for pump outs and repair septic systems
		Sewer Connection & Extension Policy (completed 2017)
		Septic to Sewer Conversion Program (completed 2018)
		Sewer Connection Ordinance and Amendment to require connection within 1 year of notification of available sewer (completed 2015 and 2018, respectively)
			• XPSWMM model estimated the loading reduction in four project areas within the May River Headwaters where septic systems are proposed to be replaced by sanitary sewer. Even though two of the proposed projects had larger areas outside of the May River Headwaters, the model provides support for the recommendations to convert these areas.
			• The Town should regularly update the GIS recordkeeping for areas that are connected to sanitary sewer in order to get a more accurate representation of what areas remain on septic.
			• The Town should continue its joint efforts with BJWSA and Beaufort County to eliminate septic systems throughout the May River watershed.

Design Storm Recommendations for Development	§3.3.6		
• Discuss desire/feasibility for implementing an Aquatic Protection Standard • Perform more detailed monitoring throughout the watershed to determine outfall and rainfall volumes at various locations, to assist in determining actual runoff volumes versus predicted runoff volumes		Completed On-going	• Adoption of new regional *Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual* will provide more restrictive requirements based on watershed impairment status and overall goal for Better Site Design • Specific monitoring recommendations included in the Headwaters Model Report for both bacteria, MST, and flow data
Wildlife Management Policy	§3.3.7		

• Perform a wildlife survey to determine the count/species of deer, hogs, raccoons, and coyotes within the watershed • Use the determined EMCs and loading information to obtain specific loading rates/concentrations throughout various portions of the watershed		Initial wildlife screening performed with USDA for deer population determined to not be nuisance level (completed 2012)	• Calibration for Headwaters model assigned fecal coliform EMCs by land use and were adjusted to fit model output to measured values from monitoring data. FC concentrations were also introduced into groundwater during calibration. In order of magnitude from least to greatest: Natural/open water, developed high intensity (sewer), developed open space, developed low/med intensity (sewer), and developed low/med intensity (septic).
Watershed Inventory	§3.4		
• Delineate May River Watershed	§3.4.1	Completed	• Headwaters model made use of delineated subwatersheds and subcatchments • Prepare a detailed GIS dataset of existing stormwater BMPs and their design criteria (drainage areas, water quality volume provided, etc.) to inform future XPSWMM model updates • Update subcatchment delineations as they may change with new development and modifications to site grading/topography
• Impervious surface map	§3.4.2	On-going	• The impervious surface map will need to be constantly updated as development increases. It may also be beneficial to indicate which impervious surfaces have been "restored" with practices such as permeable pavement retrofits. o Note that with the new *Southern Lowcountry Post Construction Stormwater Design Manual*, the surface area of a non-infiltrating BMP or its permanent pool shall be calculated as part of the impervious cover (See Eq. 3.2 in manual).
• Watershed Analysis o Use numerical modeling for prioritizing projects and assessing their anticipated improvements on the May River. This can include simple wash-off modeling through spreadsheets and/or complex hydrodynamic models that include event-mean concentrations, runoff volumes, and pollutant fate/transport mechanisms	§3.4.3	In progress	• Headwaters model utilized XPSWMM to identify bacteria hotspots based on land use and available monitoring data; this model can be improved and refined with future monitoring efforts as outlined in recommendations. • Periodically update XPSWMM model with completed stormwater projects and compare to water monitoring results • Consider recalibrating XPSWMM model with additional monitoring data collected in the future

o Long-term modeling approach should include dynamic modeling that can be calibrated to the water quality monitoring stations in the May River.			• Benefits of specific best management practices (structural and nonstructural) were modeled using the Center for Watershed Protection's Watershed Treatment Model (WTM)
Assessment and Implementation	§4.0		
• May River Watershed Indicators o Inventory of watershed sub-drainage basins and based on testing and sampling efforts	§4.1	Complete for FC	• While FC is the primary indicator of concern, additional indicators of watershed health should be considered, especially for MS4 compliance and based on SCDNR recommendations in the 2011 Action Plan to include nutrients and turbidity
• May River Water Quality Monitoring Program	§4.2		
o May River Water Quality Trend Analysis	§4.2.1		
▪ DNR Recommended Sampling Stations and Map ▪ DNR recommended Parameters: FC, TN, TP, turbidity ▪ DNR recommended sampling regimen	§4.2.1.1 §4.2.1.2 §4.2.1.3	Completed	• Modified for MS4 compliance
o Hot Spot Identification and Targeted Retrofits ▪ Hot spot identification map ▪ Hot spot attributes ▪ Matrix of types of targeted project/retrofit options • Septic/Sewer/Reuse Programs Projects • Wildlife Programs/Projects • Stormwater BMPs to address runoff from altered hydrology • Agricultural programs/projects • Pet waste programs • Runoff reduction • Education programs • Ordinance	§4.2.2 §4.2.2.1 §4.2.2.2 §4.2.2.3	On-going for hot spot map and attributes On-going for matrix and in progress as outputs of Water Quality Model	• Assess if additional hot spots exist for other pollutants, e.g. nutrients and turbidity • Focus for stormwater retrofit projects should be infiltration BMPs

• Incentives • Land acquisition			
o Pollutant Source: Septic ▪ Connect septic areas to sewer ▪ Septic inspection program ▪ Septic maintenance program ▪ Septic policy/ordinance ▪ Property owner association covenants and restrictions ▪ Septic system cleaning incentive program ▪ Septic retrofits	Table 4-1	Completed for ordinance and policies In progress for Town jurisdiction sewer extensions & connections In progress with County and BJWSA for watershed	• Continue to pursue projects and policies that will improve (through inspection, education, and upgrades) or replace existing septic systems.
o Pollutant Source: Wildlife/Domestic Animals ▪ Physical barriers ▪ Dog waste signs ▪ Expand forest buffers ▪ Reduce food sources in developed areas (e.g. trash cans); include in nuisance ordinance ▪ Re-introduction of predators of problem species ▪ Hunting/culling ▪ Wildlife corridors	Table 4-1	Initial wildlife screening performed with USDA for deer population and determined to not be nuisance level (completed 2012) On-going domestic pet education	• Continue programs with Lowcountry Stormwater Partners to reduce pet waste in the watershed (providing waste stations and bags)
o Pollutant Source: Altered Hydrology ▪ Regional pond ▪ Wetland restoration/retrofit ditching ▪ Retrofit lagoons/ponds ▪ Incentives to encourage LID/retrofits ▪ Runoff reduction ▪ Design storm recommendations/alternative design storms	Table 4-1	In progress with Water Quality Model outputs	• Adoption of new regional *Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual* will provide more restrictive requirements based on watershed impairment status and overall goal for Better Site Design. Additionally, the new requirements emphasize utilizing BMPs that promote infiltration and evapotranspiration to reduce the volume of stormwater leaving a site (and stormwater ponds will not provide runoff reduction credit).

o Pollutant Source: Varying ▪ Education ▪ Horse manure management & BMPs ▪ Individual homeowner BMPs ▪ Unified Development Ordinance Amendments ▪ Land Acquisition ▪ Development Agreements/Incentives ▪ Transfer of Development Rights ▪ Solar Aerators for existing ponds	Table 4-1	On-going education for all sources via Lowcountry Stormwater Partners	• Partner with Clemson Extension agents to provide educational programming and resources for small horse farms in May River Headwaters (teach about proper disposal and/or composting of manure) • Partner with Clemson Extension to encourage homeowners to certify their properties as a Carolina Yard by planting natives, reducing fertilizer application, and utilizing rainwater harvesting as an irrigation source. • Partner with Clemson Extension to encourage homeowners to install rain gardens to help manage stormwater on their properties. • Work with HOAs and golf course communities to maximize the use of stormwater ponds as irrigation sources.
o Map of Targeted Project/Retrofit Options, ▪ Smaller sized waterbodies under tidal influence ▪ Undeveloped sub-watersheds ▪ Developed areas	§4.2.2.4	In progress with Water Quality Model outputs	• Target project areas include those with high bacteria loading, high impervious areas, and septic systems. See Section 5.4 in May River Model Report for details.
• Retrofit Opportunities	§4.3		
o Identification of Types of Projects	§4.3.1	In progress with Water Quality Model outputs	• See section 5.2 of May River Watershed Model Report
o Prioritizing of Structural Projects in Need of Retrofit ▪ BMPs effectiveness ▪ Adjacent sampling station water quality data ▪ Ease of implementation ▪ Available area ▪ Construction costs ▪ Schedule ▪ Partnering ▪ Feasibility ▪ Ability to complement local culture ▪ Cooperation/incentives for private property owners	§4.3.2	In progress with Water Quality Model outputs	• See Section 5.4.3 of May River Watershed Model Report

o Prioritizing of Non-Structural Projects ▪ Similar to structural project prioritization process	§4.3.3	In progress with Water Quality Model outputs	• Section 5.2.3 of the May River Watershed Model Report describes Policies, Programs, and Partners for non-structural controls to address bacteria impairments
o Identification of Specific Projects for Retrofit	§4.3.4	In progress with Water Quality Model outputs	• See Section 5.4.2 of the May River Watershed Model Report describes 11 stormwater retrofit project opportunities
o Recommended BMPs ▪ A: Future New Riverside area (3 new ponds) ▪ B: Kenzie Park Outfall (new pond) ▪ C: Rose Dhu Creek (new pond) ▪ D: Buckwalter Community Park/The Farm (ditch modifications) ▪ E: Stoney Crest (earthen ditch blocks/wetland restoration) ▪ F: Hampton Lake Retrofit (pond modification) ▪ G: Lakepoint Drive (pond modifications) ▪ H: Pinecrest (pond modifications) ▪ I: Pinecrest (pond modifications) ▪ J: Town Property (expand existing pond) ▪ K: Guerrard/Wharf Street (modify existing pond/construct new ponds) ▪ L: Gascoigne Bluff (construct new ponds) ▪ M: Traver Tract (modify existing ponds) ▪ N: Ditch in Hampton Lake (construct earthen ditch blocks/wetland restoration)	Table 4-2	In progress with Water Quality Model outputs	• This report does not recommend construction of new ponds, but rather presents information for how existing ponds can be evaluated to be made more "bacteria neutral." • This report recommends that the Town conduct further field investigations to collect more detailed information for existing ponds and ditches for retrofit opportunities. See Tables 43 and 44 • Coordinate with Department of Transportation (local, county, state) to implement additional stormwater retrofits within limits of roadway improvement or maintenance projects.
o General Stormwater Project Concepts ▪ Oscar Frazier Community Park: pet waste management, vegetates swales and rain gardens, additional pervious pavement, rain tank ▪ General Town & County Facilities: rain gardens, rain barrels & cistern, pervious pavement,	Table 4-3	In progress with Water Quality Model outputs	• Stormwater BMP Retrofit Projects described in Section 5.4 of the May River Headwaters Modeling Report

disconnect downspouts from storm drains, native vegetation ▪ Road BMPs: retrofit medians and swales to increase perviousness			
o Projects Included in FY2012 Town Plan	Table 4-4	On-going	• Based upon Water Quality Model outputs, new projects included in 5-yr. CIP Forecast
o Projects for Newer Neighborhood Developments: The Farm, Hampton Hall, Hampton Lakes, Rose Dhu Creek Plantation ▪ Pond retrofit ▪ Wildlife controls ▪ Rainwater harvesting ▪ Pet waste stations/other pet waste programs	Table 4-5	In progress with Water Quality Model outputs	• Coordinate with property management companies to identify capital improvement projects that are forecasted, to allow for incorporation of stormwater retrofit opportunities • Offer discounted trees to residents to encourage "reforestation" of their yards
o Projects for Older Neighborhood Developments: Gascoigne Bluff, May River Plantation ▪ Wildlife controls ▪ Septic programs ▪ Rainwater harvesting ▪ Regional ponds ▪ Retrofit ditches ▪ End of pipe retrofits ▪ Pet waste stations/other pet waste programs ▪ Wetland retrofit	Table 4-6	In progress with Water Quality Model outputs	• Coordinate with property management companies to identify capital improvement projects that are forecasted, to allow for incorporation of stormwater retrofit opportunities • Offer discounted trees to residents to encourage "reforestation" of their yards
o Project Development in all Neighborhoods ▪ Promote water conservation practices ▪ Provide community education for pet waste pick up ▪ Promote individual LID projects such as rain barrels and rain gardens on residential lots ▪ Hold stakeholder meetings to encourage HOAs to periodically and consistently review regulations and promote new regulations	Table 4-7	In progress with Water Quality Model outputs On-going education via Lowcountry Stormwater Partners	• Continue education efforts with Lowcountry Stormwater Partners

o Review/Update Development Policies ▪ Include a temporal clearing guide ▪ Reduce overall imperviousness by implementing pervious pavement ▪ Promote implementation of stormwater harvesting ▪ Coordinate with developers and landowners to promote transfer or purchase of development rights transactions	Table 4-8	On-going	• Adoption of new regional *Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual* will provide more restrictive requirements based on watershed impairment status and overall goal for Better Site Design • Address how predevelopment silviculture impacts hydrology pre and post conditions analysis.

5.4 Development of 2020 May River Watershed Action Plan Project Recommendations

The purpose of this section is to quantify the potential benefits of 2020 May River Headwaters Watershed projects on bacteria loading in the May River Headwaters watersheds.

5.4.1 State of Knowledge

Fecal indicator bacteria (FIB) do not correlate well with the occurrence of pathogens, and they do not identify the source of the contamination. Additionally, many studies – including monitoring efforts by the Town of Bluffton – have documented that FIB can colonize and regrow in biofilms and sediments in the storm drainage system. These constraints of FIB further limit the ability to track the original source of contamination (Burkhart, 2012). In general, human sewage contamination presents the greatest health risk and is a controllable source (fix underperforming septic systems and/or sanitary sewer conveyance systems).

Residential land uses, which are predominant in the May River Headwaters, tend to produce high bacteria loading for a myriad of contributing factors including leaking septic tanks, pet waste pick-up behavior, as well as turf management and erosion control practices (Wood, 2018). Pollutants in stormwater runoff, such as bacteria, can be managed through both structural and non-structural methods.

Available information from research indicates that BMP efficiency is variable and dependent on the design, maintenance, and other factors. For example, in some cases a net export of microbes can result due to improper maintenance, regrowth of microbes in the BMP, resuspension during storm events, or direct wildlife deposits (Characklis et al., 2009). Information regarding removal rates of FIB in the International BMP Database (Clary et al., 2010) are variable and dependent on the following, 1) season in which the FIB were quantified; 2) stormwater volume and flows; and 3) the type of FIB being measured. Removal values in coastal SC will most likely be lower than those included in the International BMP Database, which has many studies based on the West Coast. This is primarily due to the following, 1) SC temperature is higher during most seasons than in west coast environments; 2) SC water sources tend to be blackwater and tannic water, which reduces light penetration; and 3) persistent forms of FC are known to grow in the sediments of systems in SC. Furthermore, research has called attention to the nature of temperature-warm, nutrient-rich, stagnant BMPs systems that appear to serve as a reservoir of FIB and at times may also preferentially grow the fecal indicator bacteria.

The International Stormwater BMP database contains approximately 600 pairs of influent and effluent data for fecal coliforms and E. coli. across multiple states. Clary et al. (2008) analyzed the fecal coliform and E. coli data and showed that swales and detention basins did not appear to effectively reduce FIB in effluent samples. Datasets for wetlands and manufactured devices were not of adequate size to draw meaningful conclusions, but sometimes these systems showed bacterial growth. The authors concluded that the ability of BMPs to reduce FIB varies widely across BMPs. No single BMP appears to consistently reduce FIB concentrations. Among the BMPs, retention pond and media filters appeared to show some positive trends, but these were not across the board.

Additionally, high removal efficiency does not always guarantee attainment of bacteria standards when inflow concentrations are high (Wood, 2018). Across the southeastern region, there is a movement away from stormwater ponds in favor of emphasizing other practices that encourage runoff reduction, which is defined as "the total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainfall harvesting, engineered infiltration, or extended filtration."

5.4.2 Process to Determine Recommended Projects

Subcatchments within each of the four major subwatersheds (Duck Pond, Palmetto Bluff, Rose Dhu Creek, and Stoney Creek) were targeted for analysis based on concerns related to geospatial data (such as existence of septic systems or large impervious areas) as well as results from the XPSWMM water quality model (largest total FC loading or loading normalized for the subcatchment area). Table 46 lists the top ten subcatchments for each of four categories: total annual load, normalized annual load, total impervious area (acres) and total impervious area (as a percent). In total, 23 subcatchments are included in Table 46. Several subcatchments, such as SC112, were included in several categories. This exercise served as an initial screening for potential project sites. However, an initial screening of these 23 subcatchments revealed that the potential for retrofit projects would be limited due to a variety of factors, including perceived difficulty gaining permission to alter private property and existing large water features. One anomaly on the list was PB17; although the Palmetto Bluff subwatershed had good water quality overall, the normalized load was high and most likely due to the relatively small size of the watershed and large area of developed open space (e.g. turfgrass). Developed open space has the third highest calibrated FC loading rate (refer to Table 32 in §3.2.2 of this report).

Furthermore, large ponds constitute large impervious areas in several subcatchments (such as SC103, SC110, SC112, SC119, SC143, SC162, SUB-RD-17). There are several problems associated with ponds. First, they do not promote the infiltration of precipitation, and thus do not provide any runoff reduction. Stormwater enters the system and leaves at a controlled flowrate, which is advantageous for flood protection but may promote the persistence of FIB downstream of the practice (as has been documented in the literature and the Town's monitoring data). Secondly, when the amenity ponds are very large in a subcatchment, there may not be sufficient room to allow for other infiltration practices to be retrofitted on site.

Table 47: Top XPSWMM Model Result Concerns by Subcatchment

Subcatchment	Total Annual Load (# FC)	Normalized Annual Load (# FC/acre)	Total Impervious Area (acres)	Total Impervious Area (%)
PB17		9.84E+10		
SC103	2.17E+13	1.38E+11		
SC104		1.47E+11		
SC106	2.51E+13	9.62E+10	54.48	
SC108 [B]	2.17E+13	1.38E+11		56
SC110				66
SC111 [B]				28
SC112	2.06E+13	1.02E+11	58.95	29
SC116	1.71E+13		163.72	
SC119				33
SC124 [A]		1.83E+11		
SC142 [B]		1.95E+11		39
SC143 [B]				29
SC162	1.71E+13		59.92	39
SUB-RD-06 [B]			100.14	
SUB-RD-08 [B]			67.19	
SUB-RD-09	3.09E+13	1.25E+11		
SUB-RD-10			105.56	
SUB-RD-11	2.66E+13			
SUB-RD-12	1.64E+13	1.06E+11		
SUB-RD-13 [B]			53.49	40
SUB-RD-15 [B]			87.68	
SUB-RD-17	2.66E+13		76.46	46

A: subcatchment included in septic-to-sewer conversion project analysis
B: subcatchment included in stormwater BMP retrofit project analysis

In order to identify other potential projects, the project team then targeted the largest non-BMP impervious areas in the Headwaters watershed, such as parking lots and building footprints (48 and 49). The importance of mitigating impervious surfaces in a tidal creek watershed (such as the Headwaters of the May River) is underscored by local research (Holland et al, 2004; Sanger et al., 2008; Sanger et al., 2015). As previously noted, these studies have documented measurable anthropogenic impacts on natural systems and tidal creeks as a result of increases in impervious area in response to population growth.

Table 48: Largest Parking Lots in May River Headwaters

Location	Size (acres)	Ownership	Subcatchment	Hydrologic Soil Group (HSG)
Bluffton HS	4.88	Public	SUB-RD-13	A/D
Kings Summer Isle Apartments	4.15	Private	SUB-RD-03	A, A/D
Bluffton Elementary/HE McCracken MS	3.46	Public	SUB-RD-13/14	A/D
Lowcountry Community Church	2.75	Private	SUB-RD-6/13	A/D
Hampton Hall Club 1	2.71	Private	SUB-RD-17	A, B/D
Hampton Hall Club 2	2.51	Private	SUB-RD-17	A, B/D
Buckwalter Recreation Center	2.68	Public	SUB-RD-8	A/D
SCE&G/Dominion Energy	2.56	Private	SC-111	A
Cross Schools	2.54	Private	SUB-RD-5/8	A/D
Bluffton Fire Station 37	1.98	Private	PB20/27	A/D, B

Table 49: Largest Building Footprints in May River Headwaters

Location	Size (acres)	Ownership	Subcatchment	HSG
May River High School*	4.27	Public	SC-142	B/D
Bluffton High School*	3.35	Public	SUB-RD-13	A/D
H.E. McCracken Middle School*	3.29	Public	RD-8, 13, 14, 15	A/D
Calvary Training Center (stables)*	2.04	Private	SC157	A/D, B
Bluffton Elementary*	1.99	Public	RD-13, 14	A/D
Pritchardville Elementary*	1.77	Public	SC111	A
Cross Schools	1.75	Private	SUB-RD-05	A/D
Lowcountry Community Church*	1.49	Private	SUB-RD-06	A/D
Benton House of Bluffton*	1.34	Private	SC105	B/D
Arena near Longfield Stables	1.20	Private	PB-10	A/D
Bluffton Early Learning Center	1.14	Public	SUB-RD-14	A/D
Buckwalter Recreation Center*	1.1	Public	SUB-RD-08	A/D
Boys and Girls Club of Bluffton	0.56	Public	SUB-RD-14	A/D

After utilizing GIS analysis to screen potential projects, based on subcatchment FC loads, soils, impervious areas, and parcel ownership, the Project Team in consultation with the Town selected eleven (11) project sites for analysis of potential retrofit options, and four (4) septic to sewer conversion projects in the May River Headwaters (Table 50).

Table 50: Selected Projects for Analysis of Septic to Sewer Conversion and Stormwater Retrofits

Project Type	Name
Septic to Sewer	Cahill
Septic to Sewer	Gascoigne
Septic to Sewer	Stoney Creek
Septic to Sewer	Pritchardville
Stormwater Retrofit	Bluffton Early Learning Center (BELC)
Stormwater Retrofit	Boys and Girls Club of Bluffton (BGC)
Stormwater Retrofit	Benton House (BH)
Stormwater Retrofit	Bluffton High School (BHS)
Stormwater Retrofit	Buckwalter Recreation Center (BRC)
Stormwater Retrofit	Lowcountry Community Church (LCC)
Stormwater Retrofit	McCracken Middle School/Bluffton Elementary School (MMSBES)
Stormwater Retrofit	May River High School (MRHS)
Stormwater Retrofit	One Hampton Lake Apartments (OHLA)
Stormwater Retrofit	Pritchardville Elementary School
Stormwater Retrofit	Palmetto Pointe Townes (PPT)

5.4.3 Septic to Sewer Conversion Projects

Section 3.3.5 Sewer Policy of the Action Plan includes discussions about how septic systems may be a source of bacteria loading in the May River watershed. Recommended actions included discussion of septic policies, such as required maintenance and repairs, as well as converting to sanitary sewer. Additional projects the Town has undertaken include the May River Watershed Sewer Master Plan to convert septic to sewer throughout the May River watershed regardless of Town or County jurisdiction. There is concern that converting areas with septic systems to sanitary sewer could facilitate future development – the results of which could mean increased development (loss of natural areas and increases in impervious areas). The Project Team believes the Town and Beaufort County are already well-situated to discourage these types of unintended consequences by enforcing the new *Southern Lowcountry Stormwater Design Manual* and its stringent requirements for new development and redevelopment in watersheds that include bacteria impairments and/or shellfish harvesting. Additionally, Beaufort County, in conjunction with property owners, established the May River and Alljoy Community Preservation Districts to protect current density regardless of sewer extension.

An analysis of the potential FC reduction impact of four of these septic to sewer conversion projects (Cahill, Gascoigne, Stoney Creek, and Pritchardville, as shown in Figure 45) was conducted using the XPSWMM model. These projects would overlap with 42 subcatchments in the Stoney Creek watershed and 11 in Rose Dhu Creek.

The estimated cost of these projects provided by Beaufort-Jasper Water and Sewer Authority (BJWSA) was $20.8 million. All sewer projects in the County's jurisdiction assume a 3-party cost share between BJWSA, Beaufort County, and the Town of Bluffton.

As described in Section 2.8 in this report, the land use categories for low and medium density development are separated into two categories to distinguish between areas that are connected to sanitary sewer or septic systems. The analysis of the impact of the septic to sewer projects involved altering the inputs for low/medium intensity development land use in the XPSWMM model: first, removing the land use in the "low/medium septic" category and then adding that area to the "low/medium sewer" category.

Based upon the model outputs of FC load reductions, the Project Team recommends the Town continue to partner with Beaufort County and Beaufort-Jasper Water & Sewer Authority (BJWSA) to systematically eliminate septic systems throughout the watershed in the areas beyond the scope of this project and ensure critical infrastructure is located or designed with possible future sea level rise scenarios in mind.

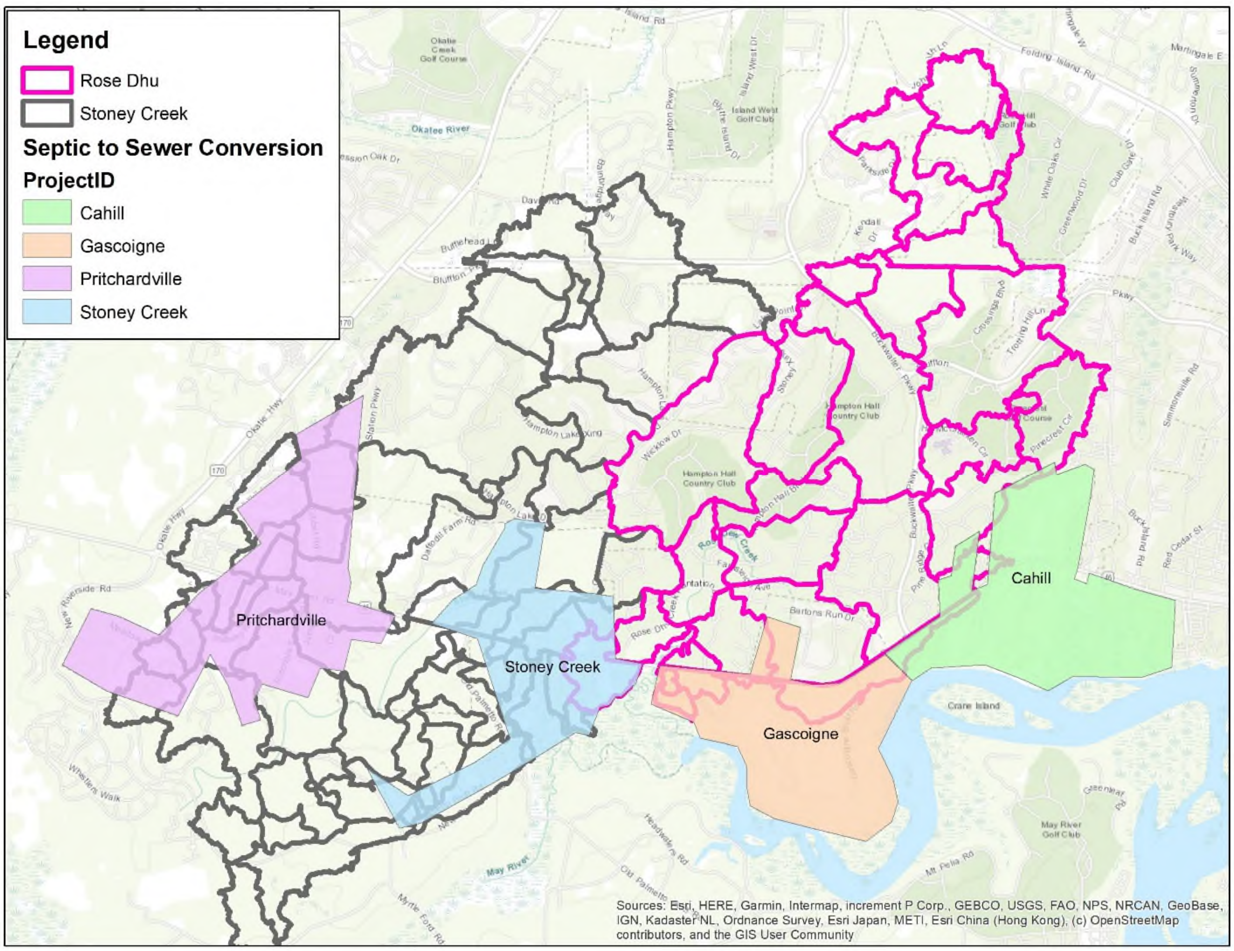


Figure 45. Septic to Sewer Conversion Projects in the May River Headwaters

5.4.3.1 Cahill

The Cahill area (820 acres) overlaps with a small section (78 acres) of the Rose Dhu Creek subwatershed, specifically three subcatchments as listed in Table 51. Of those three subcatchments, only one has properties with septic systems according to available data (see Figure 12 in Section 2.4.3 of this report). The XPSWMM model predicts that conversion of these properties to sanitary sewer would result in a reduction of 1.09×10^{10} FC bacteria (or about 0.11% of the FC load in these three subcatchments). Please note that the overall Cahill project impacts a much larger area outside of Rose Dhu Creek, in section of the Town that were not included as part of the Headwaters analysis in this study. There are 114 parcels in the Cahill project area, of which 75 parcels (including parts of 12 parcels in the Rose Dhu Creek subwatershed specifically) are not currently connected to sanitary sewer. Therefore, this calculation does not completely capture the full benefit of FC reduction for the entire Cahill septic to sewer project.

Table 51: Bacteria Load Reduction for Cahill Septic to Sewer Conversion Projects

Subcatchment	2018 Load with Septic (# FC)	2018 Load with Sewer (# FC)	Load Reduction (# FC)
SUB-RD-14	1.90E+12	1.90E+12	0.00E+00
SUB-RD-15	4.17E+12	4.17E+12	0.00E+00
SUB-RD-22	4.19E+12	4.18E+12	1.09E+10
Total	1.03E+13	1.02E+13	1.09E+10

5.4.3.2 Gascoigne

Similarly, the Gascoigne area (721 acres) overlaps with a small area (187 acres) of the Rose Dhu Creek subwatershed along May River Road, as listed in Table 52. All but one of these subcatchments include properties with septic systems according to available data (see Figure 12 in Section 2.4.3 of this report). The XPSWMM model predicts that conversion of these properties to sanitary sewer would result in a reduction of 3.32×10^{11} FC bacteria (or about 1.03% of the FC load in these three subcatchments). Please note that the overall Gascoigne project includes additional areas outside of Rose Dhu Creek, in section of the Town that were not included as part of the Headwaters analysis in this study. There are 78 parcels in the Gascoigne project area, and all parcels (including parts of 40 parcels in the Rose Dhu Creek subwatershed specifically) are not currently connected to sanitary sewer. Therefore, this calculation does not completely capture the full benefit of FC reduction for the entire Gascoigne septic to sewer project.

Table 52: Bacteria Load Reduction for Gascoigne Septic to Sewer Conversion Projects

Subcatchment	2018 Load with Septic (# FC)	2018 Load with Sewer (# FC)	Load Reduction (# FC)
SUB-RD-16	1.23E+13	1.21E+13	2.23E+11
SUB-RD-18; SUB-RD-19	6.08E+12	6.02E+12	6.00E+10
SUB-RD-20; SUB-RD-21; SUB-RD-23	4.75E+12	4.74E+12	1.30E+10
SUB-RD-22	4.19E+12	4.18E+12	1.09E+10
SUB-RD-24; SUB-RD-27	4.66E+12	4.63E+12	2.46E+10
SUB-RD-28	1.20E+11	1.20E+11	0.00E+00
Total	3.21E+13	3.17E+13	3.32E+11

5.4.3.3 Stoney Creek

The Stoney Creek conversion project area (687 acres) is completely contained within the water quality model area and includes 141 parcels. These parcels overlap with 26 subcatchments in the Stoney Creek subwatershed and six subcatchments in the Rose Dhu Creek subwatershed, as listed in Table 53. Thirteen of these subcatchments did not have septic systems according to available data (see Figure 12 in Section 2.4.3 of this report). The XPSWMM model predicts that conversion of these properties to sanitary sewer would result in a reduction of 1.00×10^{13} FC bacteria (or about 15% of the FC load in these specific subcatchments).

Table 53: Bacteria Load Reduction for Stoney Creek Septic to Sewer Conversion Projects

Subcatchment	2018 Load with Septic (# FC)	2018 Load with Sewer (# FC)	Load Reduction (# FC)
SC101	5.45E+11	5.45E+11	0.00E+00
SC102	1.62E+12	7.09E+11	9.13E+11
SC117	1.73E+12	1.73E+12	8.95E+08
SC118; SC147	6.63E+12	4.54E+12	2.09E+12
SC125	2.59E+12	1.31E+12	1.28E+12
SC126	1.15E+12	5.70E+11	5.78E+11
SC127	2.54E+11	2.08E+11	4.59E+10
SC128	1.93E+12	6.95E+11	1.24E+12
SC129	2.78E+12	2.78E+12	0.00E+00
SC130	5.13E+12	1.74E+12	3.39E+12
SC136; SC138	3.32E+12	3.32E+12	0.00E+00
SC137	7.77E+11	7.77E+11	0.00E+00
SC141	1.43E+12	1.43E+12	0.00E+00
SC145	4.54E+12	4.49E+12	5.00E+10
SC146	3.98E+11	3.98E+11	0.00E+00
SC148	5.49E+12	5.49E+12	0.00E+00
SC149	2.27E+12	2.26E+12	6.77E+09
SC150	1.19E+12	1.19E+12	0.00E+00
SC151	4.53E+11	7.91E+10	3.74E+11
SC152	1.25E+11	1.25E+11	0.00E+00
SC154	1.90E+11	1.90E+11	0.00E+00

Subcatchment	2018 Load with Septic (# FC)	2018 Load with Sewer (# FC)	Load Reduction (# FC)
SC155	1.12E+12	1.12E+12	0.00E+00
SC156	5.66E+12	5.66E+12	5.30E+09
SC158; SC159	1.76E+12	1.76E+12	0.00E+00
SUB-RD-20; SUB-RD-21; SUB-RD-23	4.75E+12	4.74E+12	1.30E+10
SUB-RD-22	4.19E+12	4.18E+12	1.09E+10
SUB-RD-24; SUB-RD-27	4.66E+12	4.63E+12	2.46E+10
Total	6.67E+13	5.67E+13	1.00E+13

5.4.3.4 Pritchardville

The Pritchardville conversion project area (997 acres, including 539 parcels) is completely contained in the water quality model area, and overlaps with 20 subcatchments in the Stoney Creek subwatershed, as listed in Table 54. Nine of these subcatchments did not have septic systems according to available data (see Figure 12 in Section 2.4.3 of this report). The XPSWMM model predicts that conversion of these properties to sanitary sewer would result in a reduction of 2.43×10^{13} FC bacteria (or about 26% of the FC load in these specific subcatchments).

Table 54: Bacteria Load Reduction for Pritchardville Septic to Sewer Conversion Projects

Subcatchment	2018 Load with Septic (# FC)	2018 Load with Sewer (# FC)	Load Reduction (# FC)
SC-107	8.88E+11	6.46E+11	2.42E+11
SC-109	2.01E+12	1.94E+12	7.55E+10
SC-111	1.69E+12	1.69E+12	0.00E+00
SC-114-120	1.15E+13	1.15E+13	0.00E+00
SC-115	1.12E+12	1.05E+12	7.33E+10
SC-116-162	1.71E+13	1.71E+13	0.00E+00
SC-121	3.30E+12	1.14E+12	2.16E+12
SC-122	4.88E+12	1.39E+12	3.49E+12
SC-123	1.75E+12	1.75E+12	0.00E+00
SC-124	1.18E+13	4.80E+11	1.13E+13
SC-131	1.27E+12	1.27E+12	0.00E+00
SC-132	8.37E+12	4.77E+12	3.61E+12
SC-133-140	1.12E+13	1.07E+13	4.58E+11
SC-148	5.49E+12	5.49E+12	0.00E+00
SC-156	5.66E+12	5.66E+12	5.30E+09
SC-157	2.16E+12	8.58E+11	1.30E+12
SC-160	1.08E+12	1.08E+12	0.00E+00
SC-161	2.17E+12	6.14E+11	1.56E+12
Total	9.35E+13	6.92E+13	2.43E+13

5.4.4 Stormwater BMP Retrofit Projects

These projects were selected in consultation with the Town and evaluated using the Watershed Treatment Model (WTM). The project team in consultation with the Town decided that this spreadsheet-based model allowed for flexibility to quickly analyze and evaluate a variety of stormwater BMPs, including permeable pavement, bioretention, green roofs, rainwater harvesting, filters, and infiltration trenches and chambers. The decision not to model BMPs in XPSWMM was the result of extensive consultation with the software developer's technical support advisors, who emphasized that the many processes that affect bacteria, such as temperature, light, nutrients, wind, etc., are not part of XPSWMM. Sanitary mode, which was utilized for the May River Headwaters Water Quality Model, has better water quality capabilities, but the hydraulics routing is simplified.

Adding BMPs to the XPSWMM model does not deliver a user-friendly model. Ultimately, if the model is forced to represent various BMPs, the resultant model would be difficult for an end-user to understand and to adjust. For example, infiltration BMPs are simply input as another sub-area within a given subcatchment that have flow directed to it; a user unfamiliar with the development of the model would not intuitively be able to distinguish between a BMP and an open space. Furthermore, the subcatchments that were established for the May River Headwaters subwatersheds (Duck Pond, Palmetto Bluff, Rose Dhu Creek, and Stoney Creek) were small enough to provide accurate representations of runoff and bacteria loading in the subwatersheds, but were too large to make distinctions for site-scale projects. In order to allow all users to evaluate the effectiveness of BMPs it was determined that use of the WTM would be the most accommodating option.

In contrast, the WTM is a simple, spreadsheet-based tool that evaluates loads from a wide range of pollutant sources (sediment, nutrients, and runoff volume) on an annual basis and incorporates a full suite of watershed treatment options (Caraco, 2013). Additionally, the model incorporates many simplifying assumptions that allow the watershed manager to assess various programs and sources that are not typically tracked in more complex models (such as public education efforts related to pet waste or street sweeping).

For each project site, the first step before setting up the WTM was to calculate the stormwater retention volume (SWRv) for these sites. The SWRv requirement is defined in the new *Southern Lowcountry Stormwater Design Manual* (see Section 3.5 and 3.7 in the design manual). The May River watershed is located in a Bacteria and Shellfish Watershed Protection Area, which requires the 95th percentile storm (1.95") to be retained on site. The equation for calculating the required SWRv is listed below, and the coefficients are listed in Table 55.

$$SWRv = \frac{P \times [(Rv_I \times I) + (Rv_c \times C) + (Rv_N \times N)]}{12}$$

Where:

$SWRv$ =	Volume required to be retained (cubic feet)
P =	Depth of rainfall event for the designated watershed protection area (85th or 95th percentile rain event)
Rv_I =	Runoff coefficient for impervious cover and BMP cover based on SCS hydrologic soil group (HSG) or soil type
I =	Impervious cover surface area (square feet)

Rv_C = Runoff coefficient for compacted cover based on soil type

C = Compacted cover surface area (square feet)

Rv_N = Runoff coefficient for forest/open space based on soil type

N = Natural cover surface area (square feet)

12 = Conversion factor (inches to feet)

Table 55: Runoff Coefficients for Land Use and Soil Type

	Rv Coefficients			
	A soils	**B Soils**	**C Soils**	**D Soils**
Forest/Open Space (Rv_N)	0.02	0.03	0.04	0.05
Managed Turf (Rv_C)	0.15	0.20	0.22	0.25
Impervious Cover (Rv_I)	0.95	0.95	0.95	0.95
BMP	0.95	0.95	0.95	0.95

Table 56 summarizes both the full SWRv (as a product of impervious surfaces, compacted cover, and natural areas on the sites) and a reduced SWRv (that only considers the impervious surfaces that are part of the hardscape, e.g. building footprints, sidewalks, roads, and parking lots, and not ponds). Because these projects are retrofits, the Town desired flexibility in mitigating the negative impacts of impervious surfaces and adhering to the new design standards.

Table 56: Stormwater Retention Volume Calculations

Project	HSG	Drainage Area (ft^2)	Impervious Surfaces (I) (ft^2)	Compacted Cover (C) (ft^2)	Natural Areas (N) (ft^2)	Full SWRv (ft^3)	Reduced SWRv (ft^3)
BELC	D	347,609	127,988	99,752	119,869	24,784	19,250
BGC	D	514,444	151,578	74,923	287,942	28,783	12,874
BH	D	309,712	124,102	52,272	133,337	22,365	16,227
BHS	D	2,358,774	1,190,871	377,665	790,238	205,604	176,167
BRC	D	4,653,079	371,316	621,601	3,660,162	112,313	54,820
LCC	D	707,850	278,385	341,946	87,519	57,578	41,262
MMSBES	D	1,799,464	777,728	179,032	842,704	134,182	110,628
MRHS	D	2,498,166	1,006,027	687,812	804,326	189,783	146,295
OHLA	D	1,287,198	530,987	687,812	68,399	110,469	81,799
PES	A	1,068,527	327,096	60,984	680,447	54,193	46,549
PPT	A	807,167	314,078	226,948	266,141	54,883	44,853

After the required SWRv was calculated, the next step was to evaluate the potential structural stormwater BMPs that could be integrated into the site. The goal of the stormwater BMP retrofit projects was to try to achieve the reduction of the SWRv to the maximum extent practicable; however, it should be noted that the actual designs of these projects may have more or less capacity depending on site constraints (infiltration rate, utility conflicts, etc.). A conceptual sketch of suitable BMPs was created showing the relative size and location of each practice. The potential water quality volume was calculated based on surface area and storage space (e.g. pore space in filter media or stone reservoir). This value was optimized to provide treatment of the SWRv, with the assumption that only two sites had in-situ soil infiltration rates that would support fully-infiltrating BMPs (HSG A and B soils); the remaining nine sites were assumed to require an underdrain, which results in a lower runoff reduction. For example, in HSG C and D soils, permeable pavement (30% runoff reduction) and bioretention (60% runoff reduction) can still be utilized.

The final step was to evaluate benefits of these projects in WTM. Because the XPSWMM model had already calculated the loads for each of the subwatersheds, and some project sites crossed multiple subcatchment boundaries (see BGC, BH, MMSBES, and OHLA) , the WTM model was only used to evaluate the potential benefits (load reductions) associated with 11 selected project sites. This procedure was followed to set up the WTM spreadsheet for each retrofit project site:

1. Delineate the project boundary in GIS by tracing the parcel boundary. Input as watershed area (acres) on "sources" tab in WTM.
2. Input annual rainfall (inches) as 42.95 (the same amount used for 2018 XPSWMM model) on "sources tab" in WTM.
3. Determine the land use (from 2016 NLCD) and soil hydrologic groups (from NRCS soils). Note, these are required initial parameters in WTM to calculate loads associated with land use; however, the calibrated XPSWMM load for the entire subcatchment will be the reference for the benefits associated with BMP retrofits calculated in WTM.
    a. On "Sources" tab, under "Primary Sources – Land Use" input area in acres for each land use category.
    b. On "Sources" tab, under "Soils Information" input the fraction of soils (as a percent) in each of the four hydrologic soils groups; assume that average depth to ground water is 3-5 feet for all project areas.
4. On Defaults tab – all BMP efficiencies were adjusted, in consultation with the Center for Watershed Protection (CWP), to reflect the values from Table 3.3 (Pollutant Removal Efficiencies of Structural BMPs) in the *Southern Lowcountry Stormwater Design Manual*. This involved the assumption that a specific BMP will have the same runoff reduction regardless of Hydrologic Soil Group (HSG), and a conversion table provided by CWP (because the off-the-shelf version of WTM assumes that removal efficiency is a combination of soil HSG and BMP, whereas the *Southern Lowcountry Stormwater Design Manual* assumes that runoff reduction and BMP performance are the same regardless of soil).
    a. Four BMPs have identical performance efficiencies as a result of being credited with 100% removal of TSS, TN, and bacteria and 100% runoff reduction: bioretention with no underdrain, enhanced permeable pavement, rainwater harvesting, and infiltration practices. All four of these practices were modeled as "infiltration" in WTM but labeled discretely on conceptual plans and summary tables.
5. On "Future Practices" tab, under "Stormwater Retrofit Options"

a. The design storm of 1.95" was selected (WTM rounds to 2") to reflect performance requirements for Bacteria and Shellfish Watershed Protection Area (Section 3.5.2 in *Southern Lowcountry Stormwater Design Manual*)

b. Water Quality Volume was assumed to be 100%

c. Discount Factors: The WTM requires users to input information about the effectiveness and level of implementation of various programs and practices. These discount factors are used to reduce the ideal (literature value) load reductions for a practice that can rarely be achieved. For example, structural practices may have poor maintenance that can reduce effectiveness over time. The WTM provides guidance to select appropriate values. For the May River, we have selected:

    i. Design Factor: applied based on the adequacy of existing design standards (Specific, Legally Binding Standards = 100%)

    ii. Maintenance Factor: based on the type of maintenance conducted on treatment practices (Regular maintenance specified and enforced = 90%)

d. Basic Site Information/assumptions to calculate Water Quality Volume (WQv)

    i. WTM allows the user to either input the area captured/impervious percentage that a given practice treats and it will calculate a Target WQv; or if the practice is sized differently, the user can manually input the WQv Provided. These are the general assumptions with calculating the water quality volumes for each type of recommended BMP in this report:

        1. bioretention target WQv calculated assuming 1 ft ponding, 1.5ft filter media, 1 ft gravel (n =0.4)
        2. infiltration trench target WQv assumed to be 4 ft wide x 4 ft deep x length x porosity (n =0.4)
        3. pervious strip target WQv assumed to be 4 ft wide x 4 ft deep x length x porosity (n =0.4)
        4. infiltration chamber/vault target WQv assumed to be SA x 3ft depth x porosity (0.4)
        5. permeable pavement contributing drainage area assumed to be 2x surface area
        6. irrigation reuse calculated as 1" over athletic fields
        7. conservation area credit calculated according to Section 4.16 in *Southern Lowcountry Stormwater Design Manual*

Table 57 summarizes the pollution load reductions associated with the Full SWRv projects, and Table 58 summarizes the benefits if only the impervious areas were treated (the reduced SWRv amount). The reduced SWRv projects did not include expensive BMPs (such as green roofs and underground infiltration chambers) and reduced the size of other proposed BMPs (such as bioretention and permeable pavement). The figures illustrating each Stormwater BMP Retrofit Project are included in the following sections (5.4.4.1 – 5.4.4.11).

Table 57: WTM Estimates for Potential Benefits of Full Retrofit Projects

Project	Potential SWRv (ft^3)	TN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Bacteria (billion/yr)	Runoff Reduction (ac-ft/yr)
BELC	29,620.76	97.04	18.37	2,904.84	5,035.91	12.42
BGC	28,784.95	79.15	13.67	2158.08	3547.71	11.17
BH	22,844.32	65.82	11.31	1787.84	2985.28	9.15
BHS	205,705.37	646.87	119.69	18,918.83	32,440.85	86.57
BRC	112,415.53	207.85	32.78	5,179.43	9,123.64	34.80
LCC	57,583.44	158.44	27.15	4,290.37	6,774.20	24.16
MMSBES	136,611.95	424.40	78.79	12,454.48	20,531.34	57.31
MRHS	191,082.46	572.06	100.08	15,819.40	25,510.45	80.10
OHLA	110,767.11	358.98	83.55	9,372.56	15,256.38	46.50
PES	54,711.33	215.04	62.92	3,015.62	5,609.68	22.69
PPT	51,301.38	121.44	17.93	2,833.57	5,271.04	21.32

Table 58: WTM Estimates for Potential Benefits of Reduced Retrofit Projects

Project	Potential SWRv (ft^3)	TN (lbs/yr)	TP (lbs/yr)	TSS (lbs/yr)	Bacteria (billion/yr)	Runoff Reduction (ac-ft/yr)
BELC	19,242.48	66.65	13.34	2,109.71	3,640.14	8.07
BGC	13,051.61	52.28	12.01	1897.49	3164.04	5.51
BH	16,426.31	56.02	15.48	1364.53	2245.89	6.91
BHS	189,363.67	607.71	113.91	18,005.00	30,740.94	79.69
BRC	55,116.42	141.8	23.02	3638.26	6256.74	23.2
LCC	42,005.74	121.22	21.66	3421.84	5158.56	17.62
MMSBES	111,428.11	361.43	69.23	10,941.75	17,759.05	46.75
MRHS	146,410.69	436.73	76.44	12,084.13	19,438.33	61.38
OHLA	81,912.35	267.99	62.94	7,119.78	11,321.50	34.56
PES	47,041.77	186.09	54.71	2592.88	4823.31	19.51
PPT	45,131.95	106.84	15.78	2492.82	4637.16	18.76

The following subsections provide summarized data pertaining to each of the project sites, including the subcatchment (or subcatchments) the project is located in, the amount of impervious area, and the detailed breakdown of WTM estimates of performance for individual BMP types at each site. Note that the project boundary and area was based on the available parcel delineation. Also, the Full SWRv scenario is shown in the corresponding figures for each project and are intended for conceptual sketches for potential locations of structural BMPs; the Reduced SWRv scenario would involve removing or reducing the size of specified BMPs. The figures are provided to give general suggestions for locations of BMPs, but the actual placement and surface areas are subject to a more detailed site investigation including soil testing and location of underground utilities.

5.4.4.1 Bluffton Early Learning Center (BELC)

Subcatchment: SUB-RD-14

HSG: D

Bacteria hotspot subcatchment: No

Subcatchment imperviousness: 23%

Site Area: 7.98 acres

Site impervious area: 2.94 acres

Site imperviousness: 37%

Note: use of "offsite bioretention" refers to MMSBES-3a

Table 59: WTM Summary for Bluffton Early Learning Center Full SWRv Scenario ($916,551.01)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	8.69	3.42	540.51	1,005.46	-
bioretention - standard	60%	7,422.62	22.21	3.71	587.08	1,025.44	3.11
bioretention (offsite)	60%	20,412.22	61.07	10.21	1,614.48	2,819.97	8.56
permeable pavement	30%	685.92	2.44	0.64	101.50	71.07	0.29
rainwater harvesting	100%	1,100.00	2.63	0.39	61.27	113.97	0.46
TOTAL:		29,620.76	97.04	18.37	2,904.84	5,035.91	12.42
SWRv goal		24,784.48					
SWRv remaining		(4,836.28)					

Table 60: WTM Summary for Bluffton Early Learning Center Reduced SWRv Scenario ($649,804.68)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	8.69	3.42	540.51	1,005.46	-
bioretention - standard	60%	7,422.62	22.21	3.71	587.08	1,025.44	3.11
bioretention (offsite)	60%	11,133.94	33.31	5.57	880.62	1,538.17	4.67
permeable pavement	30%	685.92	2.44	0.64	101.50	71.07	0.29
rainwater harvesting	100%						
TOTAL:		19,242.48	66.65	13.34	2,109.71	3,640.14	8.07
SWRv goal		19,250.05					
SWRv remaining		7.57					

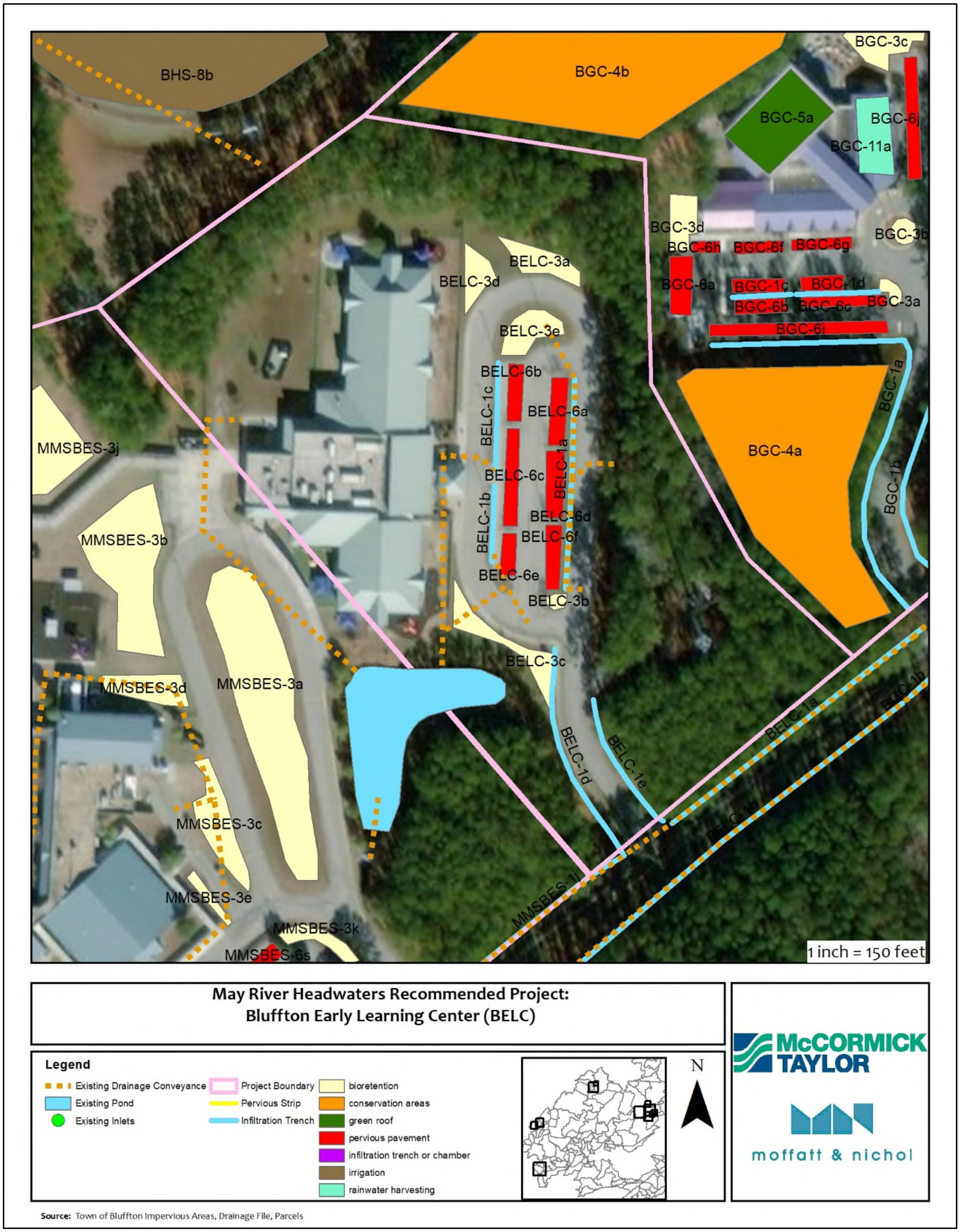


Figure 46. Bluffton Early Learning Center Proposed Stormwater BMP Retrofits

5.4.4.2 Boys and Girls Club of Bluffton (BGC)

Subcatchment: SUB-RD-13 & SUB-RD-14

HSG: D

Bacteria hotspot subcatchment: no

Subcatchment imperviousness: 40% & 23%

Site Area: 11.81 acres

Site impervious area: 3.48 acres

Site imperviousness: 29%

Note: linear bioswale from Full Scenario converted to be part filtering trench in Reduced Scenario to reduce cost

Table 61: WTM Summary for Boys and Girls Club of Bluffton Full SWRv Scenario ($947,830.40)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
bioretention - standard	60%	6,272.63	18.89	3.16	499.33	872.17	2.65
bioswale	60%	16,451.07	49.54	8.29	1309.59	2287.43	6.94
conservation		2,339.53					
green roof	100%	1,008.70	2.42	0.36	56.55	105.19	0.43
permeable pavement	30%	1,513.02	5.42	1.43	225.34	157.78	0.64
rainwater harvesting	100%	1,200.00	2.88	0.43	67.27	125.14	0.51
TOTAL:		28,784.95	79.15	13.67	2158.08	3547.71	11.17
SWRv goal		28,783.17					
SWRv remaining		(1.78)					

Table 62: WTM Summary for Boys and Girls Club of Bluffton Full SWRv Scenario ($718,527.75)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	12.11	4.77	753.62	1401.89	0
bioretention - standard	60%	6,272.63	18.89	3.16	499.33	872.17	2.65
bioswale	60%	5,265.96	15.86	2.65	419.2	732.2	2.22
permeable pavement	30%	1,513.02	5.42	1.43	225.34	157.78	0.64
TOTAL:		13,051.61	52.28	12.01	1897.49	3164.04	5.51
SWRv goal		12,874.19					
SWRv remaining		(177.42)					

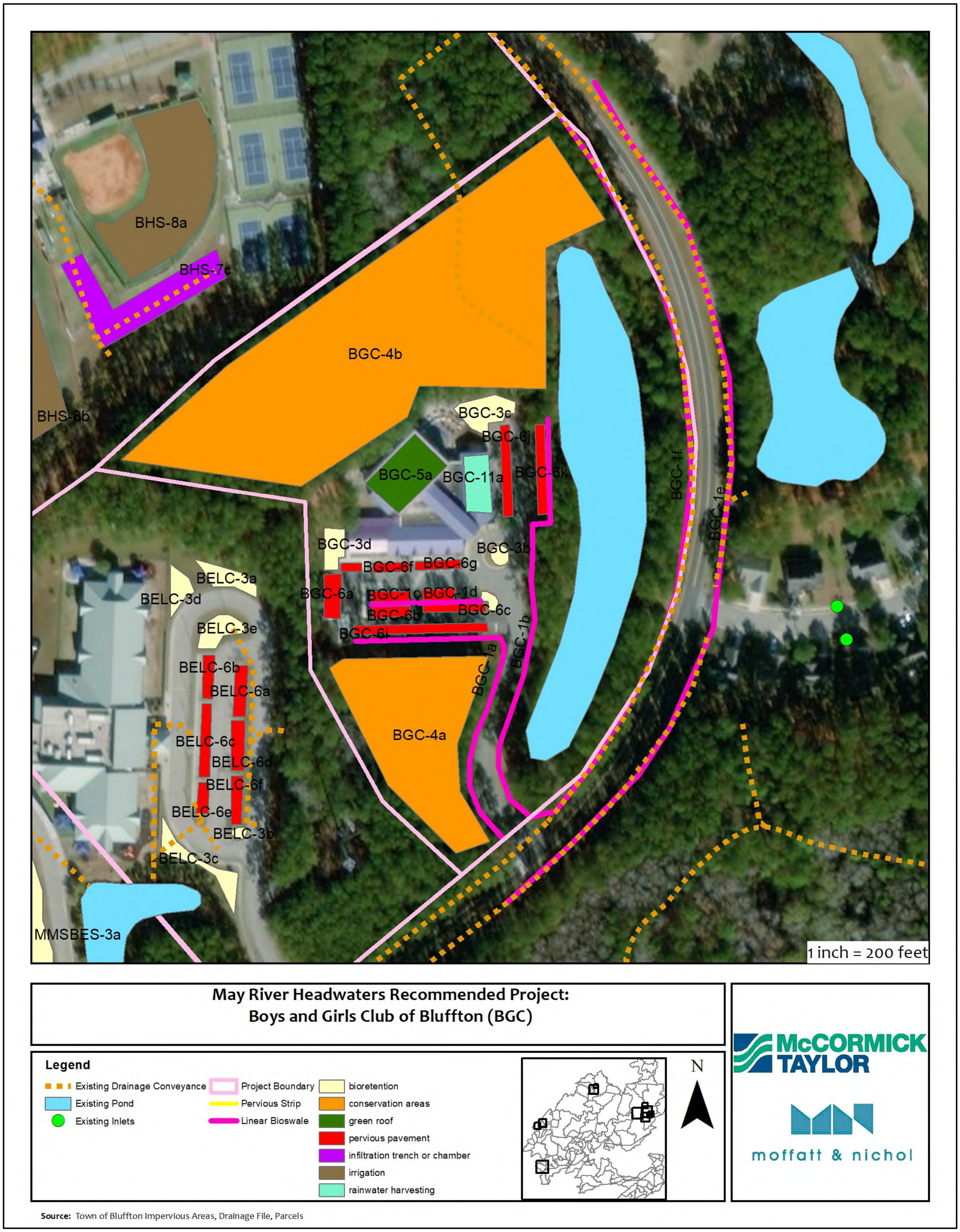


Figure 47. Boys and Girls Club of Bluffton Proposed Stormwater BMP Retrofits

5.4.4.3 Benton House (BH)

Subcatchment: SC105/SC106

HSG: D

Bacteria hotspot subcatchment: yes (SC106)

Subcatchment imperviousness: 16% & 20%

Site Area: 7.11 acres

Site impervious area: 2.85 acres

Site imperviousness: 40%

Note: Pond retrofit to convert existing wet pond to bioretention

Table 63: WTM Summary for Benton House Full SWRv Scenario ($587,355.04)

			Annual Practice Effectiveness				
Practice	RR credit	SWRv	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Bacteria (billion/yr)	Runoff Reduction (ac-ft/yr)
pervious strip	100%	332.44	1.19	0.31	49.35	34.56	0.14
bioretention - standard	60%	6,958.71	20.89	3.49	552.14	964.42	2.93
conservation	100%	1,083.00					
permeable pavement	30%	552.75	1.97	0.52	82.06	57.46	0.23
pond retrofit (0.44 ac)	60%	13,917.42	41.77	6.99	1104.29	1928.84	5.85
TOTAL:		22,844.32	65.82	11.31	1787.84	2985.28	9.15
SWRv goal		22,365.23					
SWRv remaining		(479.09)					

Table 64: WTM Summary for Benton House Reduced SWRv Scenario ($445,750.88)

			Annual Practice Effectiveness				
Practice	RR credit	SWRv	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Bacteria (billion/yr)	Runoff Reduction (ac-ft/yr)
pervious strip	100%	332.44	1.19	0.31	49.35	34.56	0.14
bioretention - standard	60%	6,958.71	20.89	3.49	552.14	964.42	2.93
permeable pavement	30%	552.75	1.97	0.52	82.06	57.46	0.23
pond retrofit (0.44 ac)	60%	8,582.41	31.97	11.16	680.98	1189.45	3.61
TOTAL:		16,426.31	56.02	15.48	1364.53	2245.89	6.91
SWRv goal		16,227.22					
SWRv remaining		(199.09)					

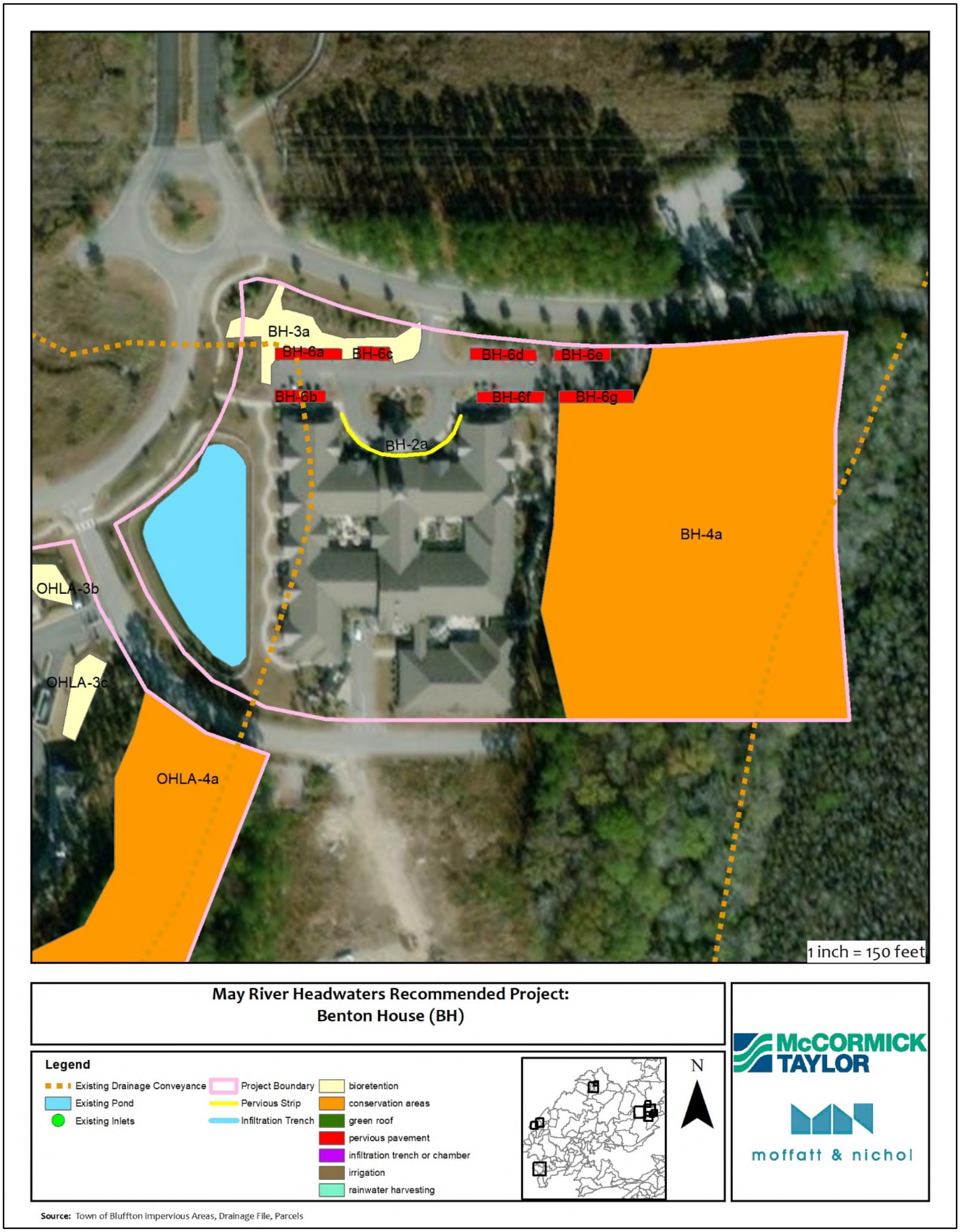


Figure 48. Benton House Proposed Stormwater BMP Retrofits

5.4.4.4 Bluffton High School (BHS)

Subcatchment: SUB-RD-13

HSG: D

Bacteria hotspot subcatchment: no

Subcatchment imperviousness: 40%

Site Area: 54.2 acres

Site impervious area: 27.34 acres

Site imperviousness: 50%

Table 65: WTM Summary for Bluffton High School Full SWRv Scenario ($4,602,142.12)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	47.04	18.52	2,927.07	5,444.97	0
bioretention - standard	60%	161,442.07	484.92	81.1	12,819.47	22,391.49	67.94
green roof	100%	4,841.70	11.6	1.71	270.75	503.65	2.04
permeable pavement	30%	7,524.81	26.87	7.07	1,117.88	782.75	3.17
infiltration chamber	100%	11,500.00	27.56	4.07	643.08	1,196.26	4.84
irrigation reuse	100%	20,396.79	48.88	7.22	1,140.58	2,121.73	8.58
TOTAL:		205,705.37	646.87	119.69	18,918.83	32,440.85	86.57
SWRv goal		205,604.01					
SWRv remaining		(101.36)					

Table 66: WTM Summary for Bluffton High School Reduced SWRv Scenario ($4,602,142.12)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	47.04	18.52	2,927.07	5,444.97	0
bioretention - standard	60%	161,442.07	484.92	81.1	12,819.47	22,391.49	67.94
permeable pavement	30%	7,524.81	26.87	7.07	1,117.88	782.75	3.17
irrigation reuse	100%	20,396.79	48.88	7.22	1,140.58	2,121.73	8.58
TOTAL:		189,363.67	607.71	113.91	18,005.00	30,740.94	79.69
SWRv goal		176,167.01					
SWRv remaining		(13,196.66)					

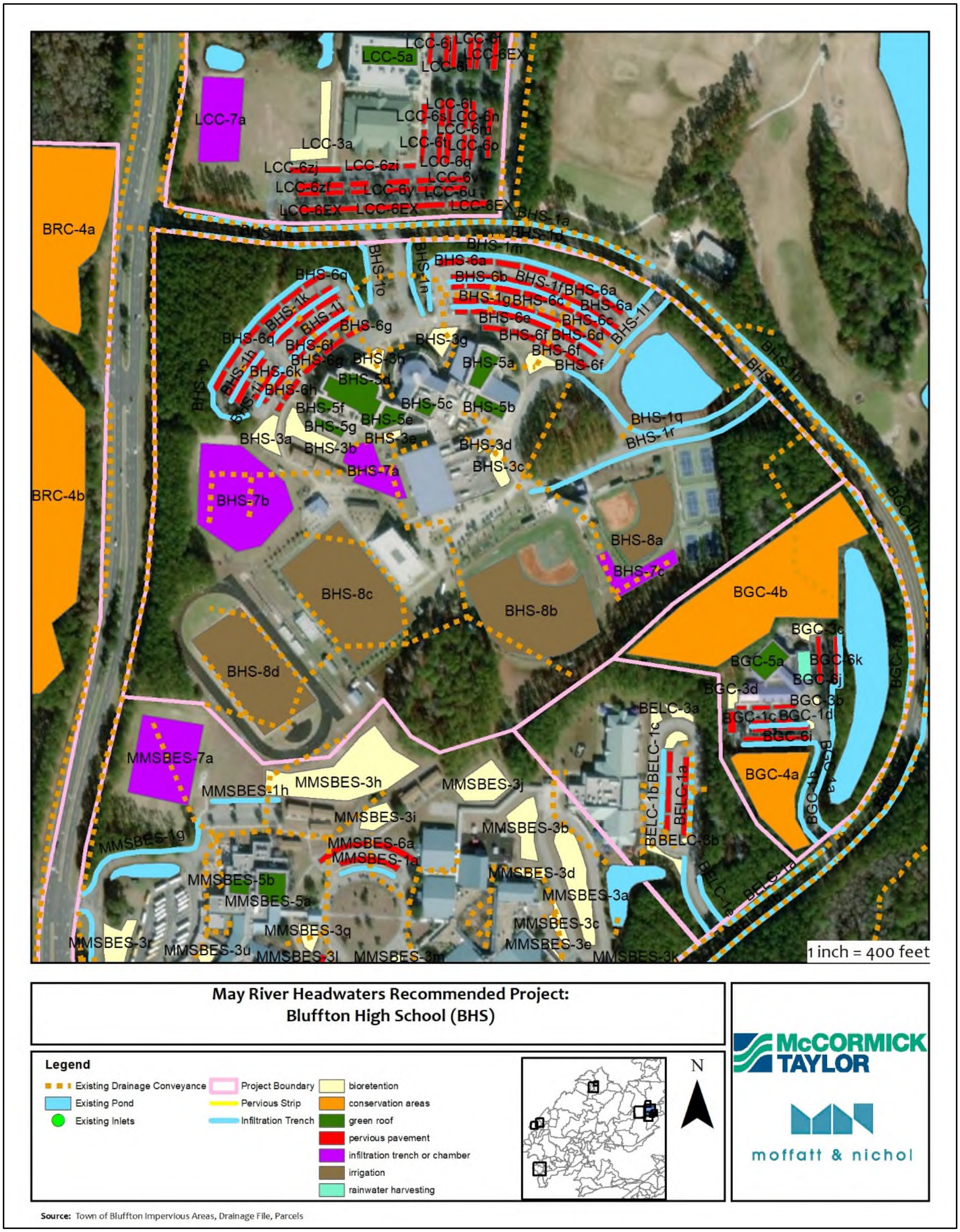


Figure 49. Bluffton High School Proposed Stormwater BMP Retrofits

5.4.4.5 Buckwalter Recreation Center (BRC)

Subcatchment: SUB-RD-8

HSG: D

Bacteria hotspot subcatchment: no

Subcatchment imperviousness: 17%

Site Area: 106.8 acres

Site impervious area: 8.52 acres

Site imperviousness: 8%

Table 67: WTM Summary for Buckwalter Recreation Center Full SWRv Scenario ($4,377,471.99)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	2.44	0.96	151.65	282.1	0
bioretention - standard	60%	6,958.71	20.9	3.5	552.56	965.15	2.93
conservation		29,738.81					
green roof	100%	1,815.60	4.35	0.64	101.53	188.87	0.76
permeable pavement	30%	2,602.41	9.29	2.45	386.61	270.71	1.1
infiltration chamber	100%	69,500.00	166.56	24.59	3886.42	7229.57	29.25
rainwater harvesting	100%	1,800.00	4.31	0.64	100.66	187.24	0.76
TOTAL:		112,415.53	207.85	32.78	5,179.43	9,123.64	34.80
SWRv goal		112,313.34					
SWRv remaining		(102.19)					

Table 68: WTM Summary for Buckwalter Recreation Center Reduced SWRv Scenario ($2,694,173.79)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	2.44	0.96	151.65	282.1	0
bioretention - standard	60%	6,958.71	20.9	3.5	552.56	965.15	2.93
permeable pavement	30%	2,602.41	9.29	2.45	386.61	270.71	1.1
infiltration chamber	100%	43,000.00	103.05	15.21	2404.55	4472.97	18.09
rainwater harvesting	100%	2,555.30	6.12	0.9	142.89	265.81	1.08
TOTAL:		55,116.42	141.8	23.02	3638.26	6256.74	23.2
SWRv goal		54,820.41					
SWRv remaining		(296.01)					

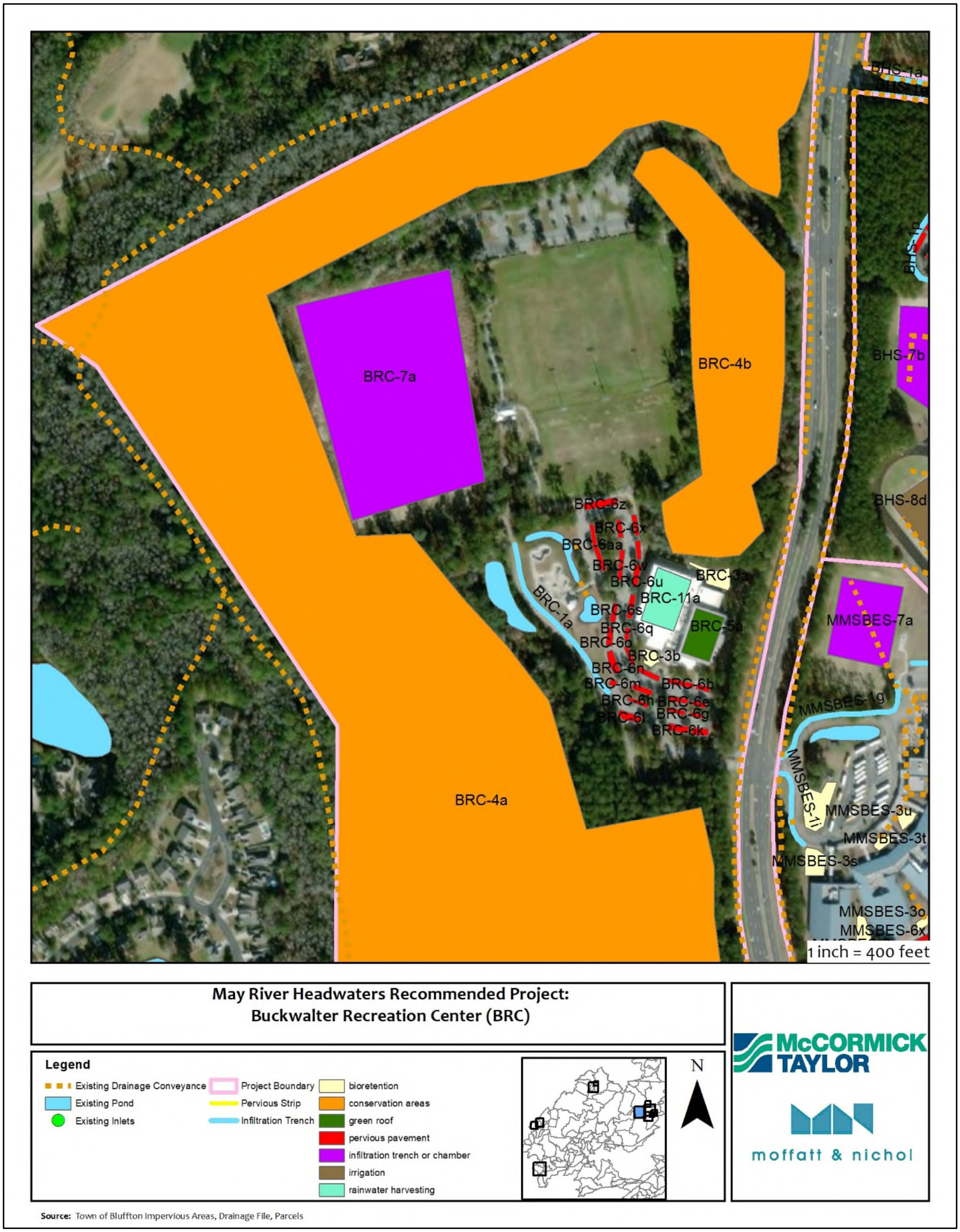


Figure 50. Buckwalter Recreation Center Proposed Stormwater BMP Retrofits

5.4.4.6 Lowcountry Community Church (LCC)

Subcatchment: SUB-RD-6

HSG: D

Bacteria hotspot subcatchment: no

Subcatchment imperviousness: 24%

Site Area: 16.25 acres

Site impervious area: 6.39 acres

Site imperviousness: 39%

Note: site already has some existing pervious parking spaces

Table 69: WTM Summary for Lowcountry Community Church Full SWRv Scenario ($2,773,224.00)

			Annual Practice Effectiveness				
Practice	RR credit	SWRv	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Bacteria (billion/yr)	Runoff Reduction (ac-ft/yr)
bioretention - standard	60%	23,195.70	69.47	11.62	1836.44	3207.67	9.73
green roof	100%	1,277.70	3.05	0.45	71.24	132.51	0.54
permeable pavement	30%	1,492.86	5.32	1.4	221.12	154.83	0.63
ex. permeable pvmnt	30%	4,317.18	15.37	4.05	639.47	447.76	1.81
infiltration chamber	100%	27,300.00	65.23	9.63	1522.1	2831.43	11.45
TOTAL:		57,583.44	158.44	27.15	4290.37	6774.2	24.16
SWRv goal		57,578.35					
SWRv remaining		(5.09)					

Table 70: WTM Summary for Lowcountry Community Church Reduced SWRv Scenario ($1,797,828.48)

			Annual Practice Effectiveness				
Practice	RR credit	SWRv	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Bacteria (billion/yr)	Runoff Reduction (ac-ft/yr)
bioretention - standard	60%	23,195.70	69.47	11.62	1836.44	3207.67	9.73
permeable pavement	30%	1,492.86	5.32	1.4	221.12	154.83	0.63
ex. permeable pvmnt	30%	4,317.18	15.37	4.05	639.47	447.76	1.81
infiltration chamber	100%	13,000.00	31.06	4.59	724.81	1348.3	5.45
TOTAL:		42,005.74	121.22	21.66	3421.84	5158.56	17.62
SWRv goal		41,261.68					
SWRv remaining		(744.06)					

Figure 51. Lowcountry Community Church Proposed Stormwater BMP Retrofits

5.4.4.7 McCracken Middle School/Bluffton Elementary School (MMSBES)

Subcatchment: SUB-RD-8, 13, 14, 15

HSG: D

Bacteria hotspot subcatchment: no

Subcatchment imperviousness: 17, 40, 23, 25%

Site Area: 41.31 acres

Site impervious area: 17.85 acres

Site imperviousness: 43%

Table 71: WTM Summary for McCracken Middle School/Bluffton Elementary School Full SWRv Scenario ($7,033,323.84)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	24.49	9.64	1523.68	2834.37	0
bioretention - standard	60%	102,061.08	305.65	51.12	8,080.23	14,113.56	42.82
green roof	100%	1,344.90	3.21	0.47	74.98	139.49	0.56
permeable pavement	30%	10,006.17	35.62	9.38	1482.11	1037.78	4.2
infiltration chamber	100%	23,199.80	55.43	8.18	1293.48	2406.14	9.73
TOTAL:		136,611.95	424.40	78.79	12,454.48	20,531.34	57.31
SWRv goal		134,181.89					
SWRv remaining		(2,430.06)					

Table 72: WTM Summary for McCracken Middle School/Bluffton Elementary School Reduced SWRv Scenario ($4,338,876.48)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	24.49	9.64	1523.68	2834.37	0
bioretention - standard	60%	97,421.94	291.76	48.80	7,712.94	13,472.04	40.87
permeable pavement	30%	10,006.17	35.62	9.38	1482.11	1037.78	4.2
infiltration chamber	100%	4,000.00	9.56	1.41	223.02	414.86	1.68
TOTAL:		111,428.11	361.43	69.23	10,941.75	17,759.05	46.75
SWRv goal		110,627.54					
SWRv remaining		(800.57)					

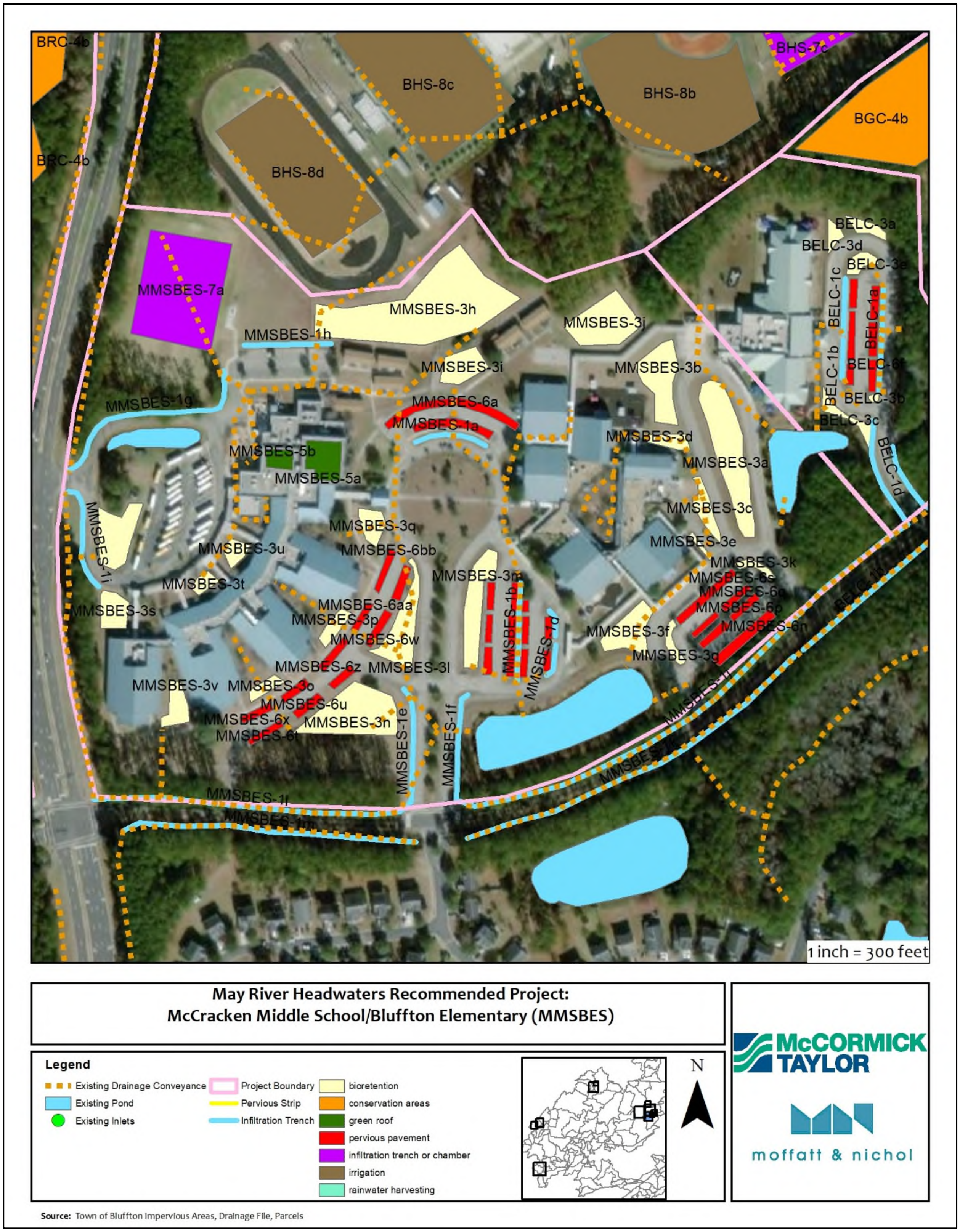


Figure 52. McCracken Middle School/Bluffton Elementary School Proposed Stormwater BMP Retrofits

5.4.4.8 May River High School (MRHS)

Subcatchment: SC142

HSG: D

Bacteria hotspot subcatchment: yes

Subcatchment imperviousness: 39%

Site Area: 59.0 acres

Site impervious area: 23.1 acres

Site imperviousness: 39%

Table 73: WTM Summary for May River High School Full SWRv Scenario ($4,891,503.46)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	0.84	0.33	52.46	97.59	-
pervious strip	100%	14,319.51	50.94	13.41	2,119.46	1,484.06	6.00
bioretention - standard	60%	162,369.90	485.91	81.27	12,845.59	22,437.12	68.07
irrigation reuse	100%	14,393.05	34.37	5.07	801.89	1,491.68	6.03
TOTAL:		191,082.46	572.06	100.08	15,819.40	25,510.45	80.10
SWRv goal		189,783.00					
SWRv remaining		(1,299.46)					

Table 74: WTM Summary for May River High School Reduced SWRv Scenario ($3,729,151.15)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	0.84	0.33	52.46	97.59	-
pervious strip	100%	11,400.00	40.56	10.67	1,687.34	1,181.48	4.78
bioretention - standard	60%	120,617.64	360.96	60.37	9,542.44	16,667.58	50.57
irrigation reuse	100%	14,393.05	34.37	5.07	801.89	1,491.68	6.03
TOTAL:		146,410.69	436.73	76.44	12,084.13	19,438.33	61.38
SWRv goal		146,295.27					
SWRv remaining		(115.42)					

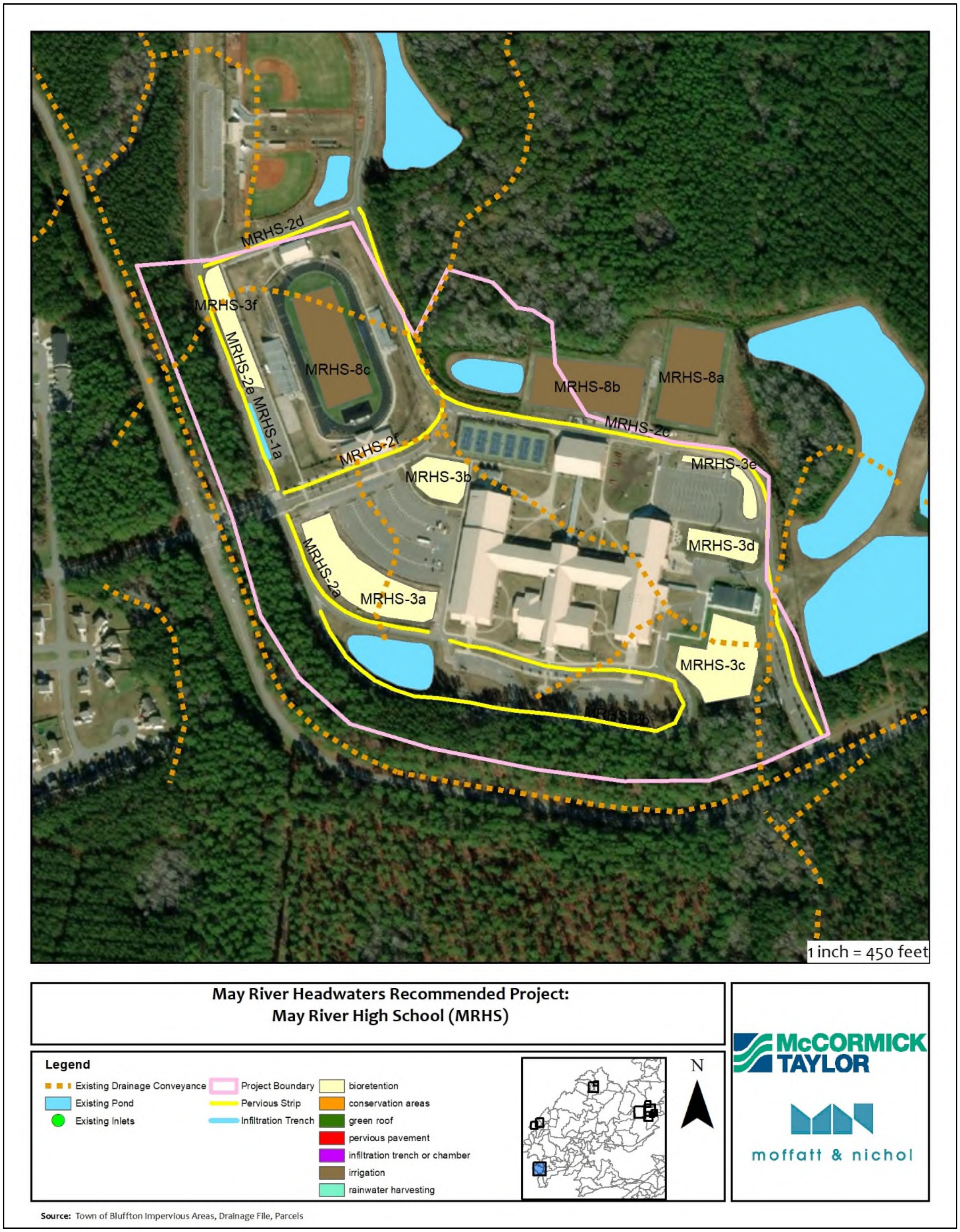


Figure 53. May River High School Bluffton Elementary School Proposed Stormwater BMP Retrofits

5.4.4.9 One Hampton Lake Apartments (OHLA)

Subcatchment: SC106/108

HSG: D

Bacteria hotspot subcatchment: yes

Subcatchment imperviousness: 20/50%

Site Area: 29.55 acres

Site impervious area: 12.19 acres

Site imperviousness: 41%

Table 75: WTM Summary for One Hampton Lakes Apartments Full SWRv Scenario ($3,339,004.19)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	1.99	1.69	98.29	182.83	-
bioretention - standard	60%	102,988.91	331.14	75.05	8,198.63	14,320.38	43.45
conservation		556.00					
permeable pavement	30%	7,222.20	25.85	6.81	1,075.64	753.17	3.05
TOTAL:		110,767.11	358.98	83.55	9,372.56	15,256.38	46.50
SWRv goal		110,469.23					
SWRv remaining		(297.88)					

Table 76: WTM Summary for One Hampton Lakes Apartments Reduced SWRv Scenario ($2,738,800.35)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
filtering trench	0%	-	1.99	1.69	98.29	182.83	-
bioretention - standard	60%	74,690.15	240.15	54.44	5,945.85	10,385.50	31.51
permeable pavement	30%	7,222.20	25.85	6.81	1,075.64	753.17	3.05
TOTAL:		81,912.35	267.99	62.94	7,119.78	11,321.50	34.56
SWRv goal		81,799.21					
SWRv remaining		(113.14)					

Figure 54. One Hampton Lake Apartments Proposed Stormwater BMP Retrofits

5.4.4.10 Pritchardville Elementary School (PES)

Subcatchment: SC111

HSG: A

Bacteria hotspot subcatchment: no

Subcatchment imperviousness: 28%

Site Area: 24.53 acres

Site impervious area: 7.51 acres

Site imperviousness: 31%

Table 77: WTM Summary for Pritchardville Elementary School Full SWRv Scenario ($2,249,108.30)

			Annual Practice Effectiveness				
Practice	RR credit	SWRv	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Bacteria (billion/yr)	Runoff Reduction (ac-ft/yr)
filtering trench	100%	6,377.30	25.23	7.42	351.51	653.88	2.65
bioretention - standard	100%	9,381.04	37.11	10.91	517.07	961.86	3.89
green roof	100%	874.20	2.07	0.3	48.18	89.63	0.36
permeable pavement	100%	4,102.00	16.23	4.77	226.1	420.59	1.7
infiltration chamber	100%	33,976.80	134.40	39.52	1,872.76	3,483.72	14.09
TOTAL:		54,711.33	215.04	62.92	3,015.62	5,609.68	22.69
SWRv goal		54,193.35					
SWRv remaining		(517.98)					

Table 78: WTM Summary for Pritchardville Elementary School Reduced SWRv Scenario ($1,719,070.22)

			Annual Practice Effectiveness				
Practice	RR credit	SWRv	TN (lb/yr)	TP (lb/yr)	TSS (lb/yr)	Bacteria (billion/yr)	Runoff Reduction (ac-ft/yr)
filtering trench	100%	6,377.30	25.23	7.42	351.51	653.88	2.65
bioretention - standard	100%	9,381.04	37.11	10.91	517.07	961.86	3.89
permeable pavement	100%	4,102.00	16.23	4.77	226.1	420.59	1.7
infiltration chamber	100%	27,181.44	107.52	31.61	1498.2	2786.98	11.27
TOTAL:		47,041.77	186.09	54.71	2592.88	4823.31	19.51
SWRv goal		46,549.45					
SWRv remaining		(492.32)					

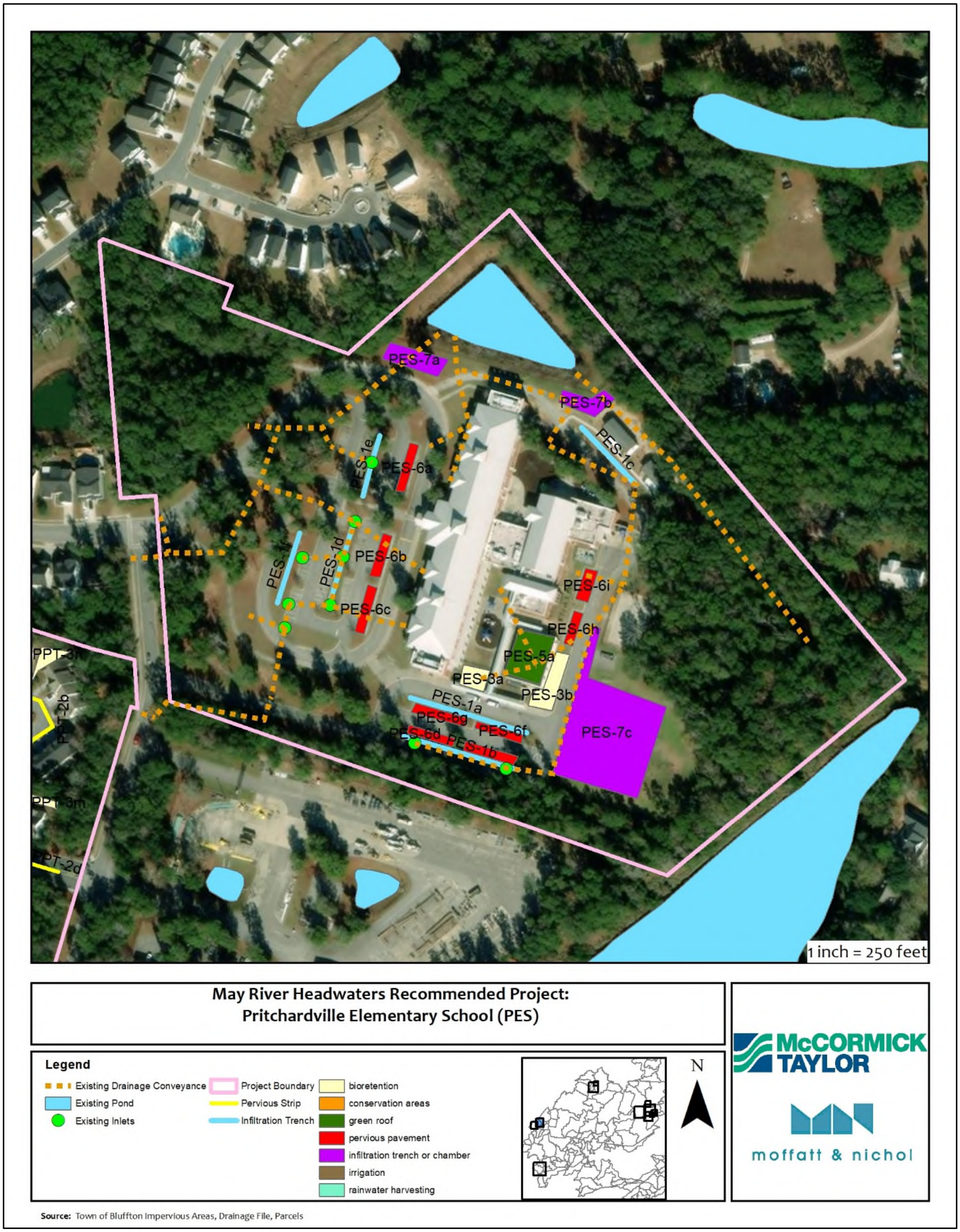


Figure 55. Pritchardville Elementary School Proposed Stormwater BMP Retrofits

5.4.4.11 Palmetto Pointe Townhomes (PPT)

Subcatchment: SC111

HSG: A

Bacteria hotspot subcatchment: no

Subcatchment imperviousness: 28%

Site Area: 18.53 acres

Site impervious area: 7.21 acres

Site imperviousness: 39%

Note: rainwater harvesting assumed 50 gallon rain barrels at 113 homes

Table 79: WTM Summary for Palmetto Pointe Townes Full SWRv Scenario ($933,991.48)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
pervious strip	100%	9,060.48	21.45	3.17	500.45	930.93	3.77
bioretention - standard	100%	38,659.50	91.51	13.51	2,135.31	3,972.14	16.07
permeable pavement	100%	2,824.30	6.69	0.99	156	290.19	1.17
rainwater harvesting	100%	757.10	1.79	0.26	41.81	77.78	0.31
TOTAL:		51,301.38	121.44	17.93	2,833.57	5,271.04	21.32
SWRv goal		51,069.96					
SWRv remaining		(231.42)					

Table 80: WTM Summary for Palmetto Pointe Townes Reduced SWRv Scenario ($827,834.40)

			Annual Practice Effectiveness				
Practice	**RR credit**	**SWRv**	**TN (lb/yr)**	**TP (lb/yr)**	**TSS (lb/yr)**	**Bacteria (billion/yr)**	**Runoff Reduction (ac-ft/yr)**
pervious strip	100%	9,060.48	21.45	3.17	500.45	930.93	3.77
bioretention - standard	100%	33,247.17	78.7	11.62	1836.37	3416.04	13.82
permeable pavement	100%	2,824.30	6.69	0.99	156	290.19	1.17
TOTAL:		45,131.95	106.84	15.78	2492.82	4637.16	18.76
SWRv goal		44,852.92					
SWRv remaining		(279.03)					

Figure 56. Palmetto Pointe Townes Proposed Stormwater BMP Retrofits

5.4.5 Ranking and Prioritization of Stormwater BMP Retrofit Projects

In order to narrow down the extensive list of potential restoration projects to highlight priorities for the May River Headwaters watersheds, an evaluation matrix was developed (Table 68). Each project was scored with respect to feasibility for cost (20 points), location within a subcatchment flagged as a bacteria hotspot (10), subcatchment imperviousness (10), potential bacteria load reduction (20), potential runoff reduction (15), maintenance requirements (15), potential for agreeable partnerships with landowners (10), amount of effort required for permitting (15), how well the surrounding community will respond to the project's installation (10), and ease of access to the site for both construction and maintenance (10). Projects located in subcatchments that have the highest bacteria loadings, received an additional ten (10) points due to their importance to the overall improvement to the May River.

Impervious area (for subwatersheds, subcatchments, and project sites) was calculated according using the current Town of Bluffton records for impervious surfaces, which include building footprints, roadways, sidewalks, and parking lots, as well as the footprint of non-infiltrating stormwater BMPs or their permanent pool (e.g. stormwater ponds and lagoons). This definition of impervious area is also consistent with the new *Southern Lowcountry Post Construction Stormwater Ordinance and Design Manual.*

The cost metric is based on the potential water quality volume possible per BMP type at each site divided by the total cost of the BMP type projects located on each site. The total cost includes the Town's project management, designer fee, construction, and a 20% contingency to account for unknowns at this time, as summarized in Table 80 below. The water quality volume possible is based upon the conceptual footprint of the BMP with assumed BMP design criteria. This cost per acre-ft treated normalizes the projects for appropriate ranking.

Table 81: Unit Cost Estimates for BMPs

Project Type	Unit	Cost
Bioretention	Acre	$987,264.00
Conservation Area	Acre	Variable
Green Roof	Acre	$1,568,160.00
Permeable Pavement	Acre	$627,264.00
Infiltration Chamber	Acre	$2,509,056.00
Irrigation Reuse	Acre	$8,640.00
Rainwater Harvesting	Cubic Foot Stored	$14.40
Infiltration/Filtering Trench	Linear Foot	$97.92
Pervious Pavement Strip	Linear Foot	$187.20

It is important to view these stormwater retrofit projects as a flexible framework for selecting potential projects; the final design will be contingent upon a more formal analysis of site conditions. For example, the ability to achieve runoff reduction through infiltration practices was considered based on NRCS mapping (hydrologic soil groups A and B were assumed to permit infiltration, whereas C and D may require an underdrain). Alternative methods such as green roofs and rainwater harvesting should be considered as a feasible option to achieve runoff reduction in these poorly drained soils. It should be noted that the scoring was erred on the conservative side when considering infiltration potential. It is imperative that site specific infiltration tests be completed to see if runoff reduction potential scoring can be increased. An actual geotechnical survey, including an infiltration test, will be required to finalize the conceptual plans. For example, it may be possible to install bioretention or pervious pavement with an enhanced design that allows for more infiltration in HSG C and D locations. In addition to achieving a greater reduction of bacteria, the ability for infiltration will also allow for a smaller BMP footprint, which would further reduce the total cost of the project. Conversely, a survey on site may reveal underground utilities or other conflicts that would reduce the available space for proposed BMPs.

Table 82: Project Evaluation and Ranking Criteria

Metric	Total Score	Potential Points Awarded					
Cost	20	> $10 mil = 1	$5 mil – < $10 mil = 5	$1 mil – <5 mil = 10	$500k – < $1 mil = 15	<$500k = 20	
Located in Bacteria Hotspot Subcatchment	10	Top 10 FC load = 10					
Subcatchment Imperviousness	10	> 30% = 10	20-30% = 8	10-20% = 4	< 10% = 0		
Bacteria Load Reduction (billion FC/year)	20	<1,000 = 5	1,000 to 4,999 = 10	5,000 to 9,999 = 15	>10,000 = 20		
Runoff Reduction	15	> 1,000 ac-ft = 15	500 – 1000 ac-ft = 10	< 500 ac-ft = 5			
Maintenance Burden	15	BI = 15	AN = 12	IL = 8	DALS = 4		
Landowner Cooperation	10	PUB, MIN = 10	PUB, MAJ = 8	ROAD = 5	PRIV, MIN = 4	PUB, MAJ = 2	PRIV, MAJ = 0
Permitting Burden	15	NP = 15	TP = 13	T+E = 10	T+B = 8	EIP = 5	
Acceptance/Visibility	10	HI, PUB = 10	HI, PRIV = 8	LOW = 6	HI, CI = 5		
Accessibility	10	NAI = 10	MAI = 8	MULT = 4	MJAI = 1		
TOTAL	**135**						
Notes:		*BI = minimal biannual maintenance* *AN = minimal annual maintenance* *IL = intensive landscaping* *DALS = difficult access, intensive landscaping* *PUB = public owned property* *MIN = minimal impact on property* *ROAD = within roadway adjoining private property* *PRIV = privately owned property* *MAJ = major impact on property* *NP = no permits*			*TP = typical permits* *T+E = typical plus environmental permits* *T+B = typical plus building permits* *EIP = environmental impacts permitting* *HI = high visibility* *LOW = low visibility* *CI = conflict of interest/goals* *NAI = no access impediments (ROW)* *MAI = minor access impediments* *MULT = multiple private access points* *MJAI = major access impediments*		

Utilizing the project evaluation and ranking matrix information, the eleven (11) stormwater retrofit projects were scored as described in Table 82. Keep in mind that the proposed BMPs are different for each project site (for example, while every project has bioretention, only about half have green roofs or conservation areas). Interestingly, the two projects (PES and PPT) that had the assumption of well-drained soils (HSG A or B) were not the top-ranked projects. This may be due to the presence of two relatively expensive/low priority BMP types at PES (infiltration chamber and green roof for the Full SWRv scenario), and the lower ranking associated with private property (such as PPT).

Table 83: Stormwater Retrofit Project Rankings by Location

FULL SWRv			REDUCED SWRv		
Location	**Score[1]**	**Total Cost**	**Location**	**Score[1]**	**Total Cost**
MRHS	96.5	$4,891,503.46	MRHS	96.5	$3,729,151.15
OHLA	88.5	$3,339,004.19	BGC	93.7	$649,804.68
BGC	85	$947,830.40	BHS	90.3	$2,905,392.99
BELC	82	$916,551.28	OHLA	88.0	$2,738,800.40
BHS	78.8	$4,602,142.11	MMBES	84.0	$4,338,876.48
BH	77.8	$587,355.04	BELC	81.7	$649,804.68
PPT	76.8	$933,991.48	BRC	77.2	$2,694,173.79
MMBES	75.6	$7,033,323.84	PES	77.0	$1,719,070.22
BRC	72.7	$4,377,471.68	BH	76.0	$445,750.88
PES	68.6	$2,249,108.30	PPT	72.3	$827,834.40
LCC	61.8	$2,773,224.00	LCC	71.3	$1,797,828.48
[1]Score is the average score of all projects recommended for each location (e.g. bioretention, rainwater harvesting, pervious strip, and permeable pavement)					

Table 84 ranks the average scores for the different BMP types across all project sites. Irrigation reuse and conservation areas ranked the highest with infiltration chambers and green roofs ranking lowest overall. The two projects that included irrigation reuse were high schools with athletic fields that were assumed to 1) require irrigation and 2) have the capacity/infrastructure to allow for it to be installed. The four projects with the potential for conservation areas were BGC, BH, BRC, and OHLA. One of the assumptions for CPA projects was that the typical cost of easements would be between $5,000 - $20,000 depending on the size of the tract and how much the land trust will require for the stewardship fee; for the purpose of this evaluation, the lower end of fee was assumed. The ranking of bioretention near the middle of the projects reflects that the majority of the BMPs were specified with an underdrain, so there was a reduced potential for bacteria load reduction. Furthermore, the landscaping costs associated with bioretention have the potential to make it a more expensive BMP than a simple rainwater harvesting cistern. Because these stormwater retrofit projects would involve modifying existing impervious surfaces, both permeable pavement and pervious strips would require removing and replacing asphalt (an additional cost) and installing an underdrain (assuming limited infiltration potential and thus reduced bacteria removal efficiency). Green roofs scored lowest, due to cost; however, they should still be considered in areas with large building footprints and/or poorly drained soils where in-ground BMPs are not as feasible. There are additional benefits to green roofs (such as prolonged roof life and building energy savings) that are not accounted for in the ranking matrix in Table 82.

Table 84: BMP Type Rankings

FULL SWRv			REDUCED SWRv		
Type	Avg. Score[1]	Count[2]	Type	Avg. Score	Count
IRRIGATION REUSE	95.0	2	IRRIGATION REUSE	95	2
CONSERVATION AREA	90.8	4	RAINWATER HARVESTING	94	1
FILTERING TRENCH	89.2	6	FILTERING TRENCH	91	7
RAINWATER HARVESTING	88.0	4	BIORETENTION	86	11
BIORETENTION	86.3	11	INFILTRATION TRENCH	84	1
INFILTRATION TRENCH	84.0	1	PERVIOUS STRIP	79	3
PERVIOUS STRIP	78.7	3	PERMEABLE PAVEMENT	76	10
PERMEABLE PAVEMENT	76.3	10	INFILTRATION CHAMBER	70	4
INFILTRATION CHAMBER	73.8	5	CONSERVATION AREA		0
GREEN ROOF	36.7	6	GREEN ROOF		0

[1]Average score was calculated from the total scores for each project type (e.g. bioretention) divided by the count (number of project locations with that project type).

[2]Count: number of project locations with that project type. Note that project locations may have multiple suggested locations for a specific individual project type. For example, a school may have 5 different areas identified for bioretention; however, that only counts as 1 project type (bioretention).

Table 85: Cost and Ranking of Proposed Stormwater Retrofit BMPs (Full SWRv) by Project ID and Type

Project ID	Project Type	Subcatchment	Cost (Project Management, Design, Construction)	Target WQv (CFT)	Cost per WQv AC-CFT Treated	Cost Score	Located in Hotspot Sub Catchment (Yes / No)	Hot Spot Score	Subcatchment Percent Impervious	Subcatchment Percent Impervious Score	Bacteria Load Reduction (billion/yr)	Load Reduction Score	Maintenance Burden	Maintenance Burden Score	landowner Cooperation	landowner Cooperation Score	Permitting Burden	Permitting Burden Score	Acceptance/Visibility	Acceptance/Visibility Score	Accessibility	Accessibility Score	Total Score
BELC	FILTERING TRENCH	RD-14	$185,590	12,130	$666,472	15	NO	0	23	8	1,005.46	10	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	89
BELC	BIORETENTION	RD-14	$608,486	46,391	$571,349	15	NO	0	23	8	3,845.41	10	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	80
BELC	RAINWATER HARVESTING	RD-14	$15,840	1,100	$627,264	15	NO	0	23	8	113.97	5	AN	12	PUB/MIN	10	NP	15	HI/PUB	10	MAI	8	83
BELC	PERMEABLE PAVEMENT	RD-14	$106,635	2,286	$2,031,585	10	NO	0	23	8	71.07	5	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	76
BGC	PERMEABLE PAVEMENT	RD-13, 14	$194,452	5,043	$1,679,486	10	YES	10	40/23	10	157.78	5	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	88
BGC	BIORETENTION	RD-13, 14	$501,155	37,873	$576,410	15	YES	10	40/23	10	872.17	5	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	87
BGC	RAINWATER HARVESTING	RD-13, 14	$12,000	1,200	$435,600	20	YES	10	40/23	10	49.09	5	AN	12	PUB/MIN	10	NP	15	HI/PUB	10	MAI	8	100
BGC	CONSERVATION AREA	RD-13, 14	$5,000	2,340	$93,096	20	YES	10	40/23	10		5	BI	15	PUB/MAJ	8	NP	15	HI/PUB	10	NAI	10	103
BGC	GREEN ROOF	RD-13, 14	$235,224	1,009	$10,157,983	1	YES	10	40/23	10	105.19	5	DALS	4	PUB/MAJ	2	T+B	8	LOW	6	MJAI	1	47
BH	BIORETENTION	SC105,106	$462,125	34,794	$578,560	15	YES	10	16/23	8	964.42	5	IL	8	PRIV/MAJ	0	TP	13	HI/PRIV	8	MAI	8	75
BH	PERVIOUS STRIP	SC105,106	$32,413	1,108	$1,274,137	10	YES	10	16/23	8	34.56	5	AN	12	PRIV/MIN	4	TP	13	HI/PRIV	8	MUL	4	74
BH	CONSERVATION AREA	SC105.206	$5,000	1,083	$201,108	20	YES	10	16/23	8		5	BI	15	PRIV/MAJ	0	NP	15	HI/CL	5	NAI	10	88
BH	PERMEABLE PAVEMENT	SC105.207	$87,817	1,843	$2,076,150	10	YES	10	16/23	8	57.46	5	AN	12	PRIV/MAJ	0	TP	13	HI/PRIV	8	MAI	8	74
BHS	BIORETENTION	RD-13	$728,223	269,070	$117,893	20	NO	0	40	10	22,391.49	20	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	97
BHS	FILTERING TRENCH	RD-13	$961,902	65,430	$640,385	15	NO	0	40	10	5,444.97	15	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	96
BHS	IRRIGATION REUSE	RD-13	$48,557	20,397	$103,699	20	NO	0	40	10	2,121.73	10	AN	12	PUB/MIN	10	T+E	10	HI/PUB	10	MAI	8	90
BHS	PERMEABLE PAVEMENT	RD-13	$1,166,711	25,083	$2,026,175	10	NO	0	40	10	782.75	5	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	78
BHS	INFILTRATION CHAMBER	RD-13	$551,992	11,500	$2,090,851	10	NO	0	40	10	1,196.26	10	AN	12	PUB/MIN	10	TP	13	LOW	6	MULT	4	75
BHS	GREEN ROOF	RD-13	$1,144,757	4,842	$10,299,194	1	NO	0	40	10	503.65	5	DALS	4	PUB/MAJ	2	T+B	8	LOW	6	MJAI	1	37
BRC	RAINWATER HARVESTING	RD-8	$25,920	2,555	$441,856	20	YES	10	17	4	265.81	5	AN	12	PUB/MIN	10	NP	15	HI/PUB	10	MAI	8	94
BRC	FILTERING TRENCH	RD-8	$51,864	3,390	$666,463	15	NO	0	17	4	282.10	5	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	80
BRC	PERMEABLE PAVEMENT	RD-8	$401,449	8,675	$2,015,876	10	NO	0	17	4	270.71	5	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	72
BRC	BIORETENTION	RD-8	$157,882	11,598	$592,983	15	NO	0	17	4	965.15	5	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	71
BRC	INFILTRATION CHAMBER	RD-8	$3,311,954	69,500	$2,075,809	10	NO	0	17	4	72,229.57	20	AN	12	PUB/MIN	10	TP	13	LOW	6	MULT	4	79
BRC	CONSERVATION AREA	RD-8	$5,000	29,739	$7,324	20	NO	0	17	4			BI	15	PUB/MAJ	8	NP	15	HI/PUB	10	NAI	10	82
BRC	GREEN ROOF	RD-8	$423,403	1,816	$10,158,319	1	NO	0	17	4	188.87	5	DALS	4	PUB/MAJ	2	T+B	8	LOW	6	MJAI	1	31

Project ID	Project Type	Subcatchment	Cost (Project Management, Design, Construction)	Target WQv (CFT)	Cost per WQv AC-CFT Treated	Cost Score	Located in Hotspot Sub Catchment (Yes / No)	Hot Spot Score	Subcatchment Percent Impervious	Subcatchment Percent Impervious Score	Bacteria Load Reduction (billion/yr)	Load Reduction Score	Maintenance Burden	Maintenance Burden Score	landowner Cooperation	landowner Cooperation Score	Permitting Burden	Permitting Burden Score	Acceptance/Visibility	Acceptance/Visibility Score	Accessibility	Accessibility Score	Total Score
LCC	BIORETENTION	RD-6	$499,392	38,630	$38,660	20	NO	0	24	8	3,207.67	10	IL	8	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	79
LCC	PERMEABLE PAVEMENT	RD-6	$671,172	14,391	$2,031,623	10	NO	0	24	8	447.76	5	AN	12	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	68
LCC	INFILTRATION CHAMBER	RD-6	$1,304,709	27,300	$2,081,800	10	NO	0	24	8	2,831.43	10	AN	12	PRIV/MIN	4	TP	13	LOW	6	MULT	4	67
LCC	GREEN ROOF	RD-6	$297,950	1,278	$10,157,877	1	NO	0	24	8	132.51	5	DALS	4	PRIV/MAJ	0	T+B	8	LOW	6	MJAI	1	33
MMSBES	BIORETENTION	RD-8,13,14,15	$2,158,157	170,102	$552,665	15	NO	0	17, 40, 23, 25%	10	14,113.56	20	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	92
MMSBES	FILTERING TRENCH	RD-8,13,14,15	$521,955	34,161	$665,569	15	NO	0	17, 40, 23, 25%	10	2,834.37	10	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	91
MMSBES	PERMEABLE PAVEMENT	RD-8,13,14,15	$1,555,615	33,354	$2,031,624	10	NO	0	17, 40, 23, 25%	10	1,037.78	10	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	83
MMSBES	INFILTRATION CHAMBER	RD-8,13,14,15	$2,483,965	23,200	$4,663,899	10	NO	0	17, 40, 23, 25%	10	2,406.14	10	AN	12	PUB/MIN	10	TP	13	LOW	6	MULT	4	75
MMSBES	GREEN ROOF	RD-8,13,14,15	$313,632	1,345	$10,158,235	1	NO	0	17, 40, 23, 25%	10	139.49	5	DALS	4	PUB/MAJ	2	T+B	8	LOW	6	MJAI	1	37
MRHS	BIORETENTION	SC142	$3,426,624	270,617	$551,569	15	YES	10	39	10	22,437.12	20	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	102
MRHS	IRRIGATION REUSE	SC142	$34,301	14,393	$103,810	20	YES	10	39	10	1,491.68	10	AN	12	PUB/MIN	10	T+E	10	HI/PUB	10	MAI	8	100
MRHS	FILTERING TRENCH	SC142	$34,428	1,177	$1,274,102	10	YES	10	39	10	97.59	5	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	91
MRHS	PERVIOUS STRIP	SC142	$1,396,151	47,732	$1,274,129	10	YES	10	39	10	1,484.06	10	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	93
OHLA	BIORETENTION	SC106,108	$2,177,672	171,648	$552,638	15	YES	10	20%/56%	10	14,320.38	20	IL	8	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	96
OHLA	FILTERING TRENCH	SC106,108	$33,530	2,192	$666,469	15	YES	10	20%/56%	10	182.83	5	BI	15	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	88
OHLA	PERMEABLE PAVEMENT	SC106,108	$1,122,803	24,074	$2,031,622	10	YES	10	20%/56%	10	753.17	5	AN	12	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	80
OHLA	CONSERVATION AREA	SC106,108	$5,000	556	$391,727	20	YES	10	20%/56%	10			BI	15	PRIV/MAJ	0	NP	15	HI/PUB	10	NAI	10	90
PES	INFILTRATION TRENCH	SC11	$97,573	6,377	$666,468	15	NO	0	28	8	653.88	5	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	84
PES	PERMEABLE PAVEMENT	SC11	$188,179	4,102	$1,998,314	10	NO	0	28	8	420.59	5	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	76
PES	BIORETENTION	SC11	$128,609	9,381	$597,185	15	NO	0	28	8	961.86	5	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	75
PES	INFILTRATION CHAMBER	SC11	$1,630,886	38,473	$1,846,520	10	NO	0	28	8	3,483.72	10	AN	12	PUB/MIN	10	TP	13	LOW	6	MULT	4	73
PES	GREEN ROOF	SC11	$203,861	874	$10,158,060	1	NO	0	28	8	89.63	5	DALS	4	PUB/MAJ	2	T+B	8	LOW	6	MJAI	1	35
PPT	BIORETENTION	SC11	$499,392	103,898	$209,374	20	NO	0	28	8	3,972.14	20	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	95
PPT	RAINWATER HARVESTING	SC11	$37,855	757	$2,178,000	15	NO	0	28	8	77.78	5	AN	12	PRIV/MIN	4	NP	15	HI/PRIV	8	MAI	8	75
PPT	PERVIOUS STRIP	SC11	$265,019	17,178	$672,019	15	NO	0	28	8	930.93	5	AN	12	PRIV/MIN	4	TP	13	HI/PRIV	8	MUL	4	69
PPT	PERMEABLE PAVEMENT	SC11	$131,725	2,824	$2,031,640	10	NO	0	28	8	290.19	5	AN	12	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	68

Table 86: Cost and Ranking of Proposed Stormwater Retrofit BMPs (Reduced SWRv) by Project ID and Type

Project ID	Project Type	Subcatchment	Cost (Project Management, Design, Construction)	Target WQv (CFT)	Cost per WQv AC-CFT Treated	Cost Score	Located in Hotspot Sub Catchment (Yes / No)	Hot Spot Score	Subcatchment Percent Impervious	Subcatchment Percent Impervious Score	Bacteria Load Reduction (billion/yr)	Load Reduction Score	Maintenance Burden	Maintenance Burden Score	landowner Cooperation	landowner Cooperation Score	Permitting Burden	Permitting Burden Score	Acceptance/Visibility	Acceptance/Visibility Score	Accessibility	Accessibility Score	Total Score
BELC	FILTERING TRENCH	RD-14	$185,589	12,130	$666,468	15	NO	0	23	8	1,005.46	10	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	89
BELC	BIORETENTION	RD-14	$357,581	30,928	$503,635	15	NO	0	23	8	2,563.61	10	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	80
BELC	PERMEABLE PAVEMENT	RD-14	$106,635	2,286	$2,031,585	10	NO	0	23	8	71.07	5	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	76
BGC	PERMEABLE PAVEMENT	RD-13, 14	$194,452	5,043	$1,679,486	10	YES	10	40/23	10	157.78	5	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	88
BGC	BIORETENTION	RD-13, 14	$266,976	19,231	$604,726	15	YES	10	40/23	10	1,604.37	10	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	92
BGC	FILTERING TRENCH	RD-13, 14	$257,100	16,804	$666,468	15	YES	10	40/23	10	1,401.89	10	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	101
BH	BIORETENTION	SC105,106	$325,521	25,902	$547,439	15	YES	10	16/23	8	2,153.87	10	IL	8	PRIV/MAJ	0	TP	13	HI/PRIV	8	MAI	8	80
BH	PERVIOUS STRIP	SC105,106	$32,413	1,108	$1,274,137	10	YES	10	16/23	8	34.56	5	AN	12	PRIV/MIN	4	TP	13	HI/PRIV	8	MUL	4	74
BH	PERMEABLE PAVEMENT	SC105.207	$87,817	1,843	$2,076,150	10	YES	10	16/23	8	57.46	5	AN	12	PRIV/MAJ	0	TP	13	HI/PRIV	8	MAI	8	74
BHS	BIORETENTION	RD-13	$728,223	269,070	$117,893	20	NO	0	40	10	22,391.49	20	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	97
BHS	FILTERING TRENCH	RD-13	$961,902	65,430	$640,385	15	NO	0	40	10	5,444.97	15	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	96
BHS	IRRIGATION REUSE	RD-13	$48,557	20,397	$103,699	20	NO	0	40	10	2,121.73	10	AN	12	PUB/MIN	10	T+E	10	HI/PUB	10	MAI	8	90
BHS	PERMEABLE PAVEMENT	RD-13	$1,166,711	25,083	$2,026,175	10	NO	0	40	10	782.75	5	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	78
BRC	RAINWATER HARVESTING	RD-8	$25,553	2,555	$435,600	20	YES	10	17	4	265.81	5	AN	12	PUB/MIN	10	NP	15	HI/PUB	10	MAI	8	94
BRC	FILTERING TRENCH	RD-8	$51,864	3,390	$666,467	15	NO	0	17	4	282.10	5	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	80
BRC	PERMEABLE PAVEMENT	RD-8	$401,449	8,675	$2,015,876	10	NO	0	17	4	270.71	5	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	72
BRC	BIORETENTION	RD-8	$157,882	11,598	$592,983	15	NO	0	17	4	965.15	5	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	71
BRC	INFILTRATION CHAMBER	RD-8	$2,057,426	43,000	$2,084,220	10	NO	0	17	4	4,472.97	10	AN	12	PUB/MIN	10	TP	13	LOW	6	MULT	4	69
LCC	BIORETENTION	RD-6	$499,392	38,630	$38,660	20	NO	0	24	8	3,207.67	10	IL	8	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	79
LCC	PERMEABLE PAVEMENT	RD-6	$671,172	14,391	$2,031,623	10	NO	0	24	8	447.76	5	AN	12	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	68
LCC	INFILTRATION CHAMBER	RD-6	$627,264	13,000	$2,101,817	10	NO	0	24	8	1,348.30	10	AN	12	PRIV/MIN	4	TP	13	LOW	6	MULT	4	67

Project ID	Project Type	Subcatchment	Cost (Project Management, Design, Construction)	Target WQv (CFT)	Cost per WQv AC-CFT Treated	Cost Score	Located in Hotspot Sub Catchment (Yes / No)	Hot Spot Score	Subcatchment Percent Impervious	Subcatchment Percent Impervious Score	Bacteria Load Reduction (billion/yr)	Load Reduction Score	Maintenance Burden	Maintenance Burden Score	landowner Cooperation	landowner Cooperation Score	Permitting Burden	Permitting Burden Score	Acceptance/Visibility	Acceptance/Visibility Score	Accessibility	Accessibility Score	Total Score
MMSBES	BIORETENTION	RD-8,13,14,15	$2,060,582	162,370	$552,805	15	NO	0	17, 40, 23, 25%	10	13,472.04	20	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	92
MMSBES	FILTERING TRENCH	RD-8,13,14,15	$521,955	34,161	$665,569	15	NO	0	17, 40, 23, 25%	10	2,834.37	10	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	91
MMSBES	PERMEABLE PAVEMENT	RD-8,13,14,15	$1,555,615	33,354	$2,031,624	10	NO	0	17, 40, 23, 25%	10	1,037.78	10	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	83
MMSBES	INFILTRATION CHAMBER	RD-8,13,14,15	$200,724	4,000	$2,185,890	10	NO	0	17, 40, 23, 25%	10	414.86	5	AN	12	PUB/MIN	10	TP	13	LOW	6	MULT	4	70
MRHS	BIORETENTION	SC142	$2,548,454	201,029	$552,211	15	YES	10	39	10	16,667.58	20	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	102
MRHS	IRRIGATION REUSE	SC142	$34,301	14,393	$103,810	20	YES	10	39	10	1,491.68	10	AN	12	PUB/MIN	10	T+E	10	HI/PUB	10	MAI	8	100
MRHS	FILTERING TRENCH	SC142	$34,428	1,177	$1,274,102	10	YES	10	39	10	97.59	5	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	91
MRHS	PERVIOUS STRIP	SC142	$1,111,968	38,000	$1,274,666	10	YES	10	39	10	1,181.48	10	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	93
OHLA	BIORETENTION	SC106,108	$1,582,468	124,484	$553,746	15	YES	10	20%/56%	10		20	IL	8	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	96
OHLA	FILTERING TRENCH	SC106,108	$33,530	2,192	$666,469	15	YES	10	20%/56%	10	182.83	5	BI	15	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	88
OHLA	PERMEABLE PAVEMENT	SC106,108	$1,122,803	24,074	$2,031,622	10	YES	10	20%/56%	10	753.17	5	AN	12	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	80
PES	INFILTRATION TRENCH	SC11	$97,573	6,377	$666,468	15	NO	0	28	8	653.88	5	BI	15	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	84
PES	PERMEABLE PAVEMENT	SC11	$188,179	4,102	$1,998,314	10	NO	0	28	8	420.59	5	AN	12	PUB/MIN	10	TP	13	HI/PUB	10	MAI	8	76
PES	BIORETENTION	SC11	$128,609	9,381	$597,185	15	NO	0	28	8	961.86	5	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	75
PES	INFILTRATION CHAMBER	SC11	$1,304,709	27,181	$2,090,880	10	NO	0	28	8	2,786.98	10	AN	12	PUB/MIN	10	TP	13	LOW	6	MULT	4	73
PPT	BIORETENTION	SC11	$431,090	33,247	$564,808	15	NO	0	28	8	3,416.04	10	IL	8	PUB.MAJ	8	TP	13	HI/PUB	10	MAI	8	80
PPT	PERVIOUS STRIP	SC11	$265,019	17,178	$672,019	15	NO	0	28	8	930.93	5	AN	12	PRIV/MIN	4	TP	13	HI/PRIV	8	MUL	4	69
PPT	PERMEABLE PAVEMENT	SC11	$131,725	2,824	$2,031,640	10	NO	0	28	8	290.19	5	AN	12	PRIV/MIN	4	TP	13	HI/PRIV	8	MAI	8	68

6.0 Conclusions

6.1.1 Water Quality Model Results in Context

Watershed loading models are subject to high levels of variability and uncertainty. The model itself is an approximation of reality and the model parameters can be estimated based on available data, established modeling protocols, and assumptions based on professional judgment. There is natural variability in land use and cover, meteorology, and management across the watershed. Furthermore, monitoring data provide an imprecise target for model calibration, as laboratory results are typically grab samples, which may not be fully representative of daily average model predictions. Calibration thus consists of comparing two uncertain numbers, the monitored value and model value. This model was calibrated using available monitoring data. This report discusses ways that the Town can enhance and improve existing flow and bacteria monitoring efforts, which can be used in the future to recalibrate and refine the existing XPSWMM model.

The XPSWMM water quality simulation model calculated FC concentrations for the outfalls at each of the four major Headwaters subwatersheds (Duck Pond, Palmetto Bluff, Rose Dhu Creek, and Stoney Creek) every seven minutes for an entire year (2002 and 2018). Laboratory measurements of FC are typically given as "most probable number" (MPN) per 100/mL or as colony forming units (CFU) per 100 mL. Both units are equivalent but reflect different EPA approved methodologies for counting bacteria cells. For purposes of this report, to distinguish modeled estimates for bacteria, all results were given as "number of FC" (#) per 100/mL. In Regulation 61-68 Water Classifications and Standards, SCDHEC provides limits for FC concentrations for waters designated for shellfish harvesting, such as the May River. These limits are either for a daily maximum concentration (43 MPN/100 mL) or a monthly average (14 MPN/100 mL). The modeled average daily maximum FC concentration in all four subwatersheds was above the SCDHEC standards. In 2002, the XPSWMM water quality model estimated the average maximum daily FC concentrations (the yearly average of the highest predicted FC concentration for each day) as 583 #/100mL for Rose Dhu Creek; 749 #/100mL for Palmetto Bluff; 827 #/100mL for Duck Pond; and 995 #/100mL for Stoney Creek. In 2018 the model estimated daily maximum FC concentrations in the four subwatersheds as 538 #/100mL for Duck Pond; 650 #/100mL for Rose Dhu Creek; 687 #/100mL for Palmetto Bluff; and 932 #/100mL for Stoney Creek.

The results from the water quality model for the May River Headwaters confirms findings from local and relevant studies (Holland et al., 2004; Sanger et al., 2008; and Sanger and Blair et al., 2015) that development (conversion of forested to impervious cover) increases stormwater runoff, which in turn increases pollutant loads, lowers the salinity of receiving water bodies, and promotes the survival of FIB.

- A combination of increased development and climate change may have led to decreased salinity levels (and increased variability) observed in the Headwaters of the May River. Developed and deforested lands have higher levels of freshwater inputs into estuaries, which leads to decreased salinity levels and increased salinity variability (Holland et al., 2004; Montie et al., 2019). Furthermore, studies have shown that lower salinity levels increase the survival rate of fecal coliform bacteria (Chigbu et al., 2014; Lipp et al., 2001; Solic and Krstulovic, 1991).

- Average fecal coliform levels are highest in the Headwaters and decrease moving towards the mouth of the May River (Montie et al., 2019). The fecal coliform levels at SCDHEC shellfish monitoring stations closest to the Headwaters were well above the approved SCDHEC fecal coliform maximum monthly average of 14 MPN/100 mL.
- Fecal coliform levels were higher when salinity levels were lower, and this relationship is strongest at SCDHEC sampling stations closest to the Headwaters (Montie et al., 2019).
- Fecal coliform levels in the Headwaters increased as population levels grew in the Town of Bluffton, and this relationship was strongest at SCDHEC sampling stations closest to the Headwaters (Montie et al., 2019).
- In addition to septic leakage, research (Montie et al., 2019) suggests that the rising levels of fecal coliform in the May River are associated with the loss of forested land and the increase of impervious surfaces and associated stormwater runoff within the watershed. Furthermore, the synergistic nature of urbanization and climate change may lead to further increases in fecal coliform levels in the May River.

There are no loads calculated for these headwater watersheds, and thus these modeled results will serve as a benchmark for future monitoring efforts. The FC load for each subcatchment in each subwatershed is calculated by multiplying the concentration by the corresponding water volume at each time step in the model. Although the modeled FC concentrations are generally higher in 2002 than 2018, the total modeled bacteria load is lower in 2002 as a result of a very large increase in water volume in 2018 (585% increase in annual water volume for the entire Headwaters Watershed region). The increase in runoff is a result of the changes in land use such as the conversion of undeveloped, natural areas to those with more impervious surfaces (in the May River Headwaters, the total amount of impervious surfaces increased from 708 acres in 2002 to 1,876 acres in 2018).

Table 87: Summary of 2018 Fecal Coliform Loadings for Subwatersheds

Subwatershed	2018 FC Load (# FC)
Duck Pond	2.18E+13
Palmetto Bluff	5.84E+13
Rose Dhu Creek	1.48E+14
Stoney Creek	2.47E+14
Total:	4.75E+14

The Project Team also evaluated what load reduction would be required to reduce the concentrations of FC from the 2018 average conditions for Stoney Creek and Rose Dhu Creek. This analysis indicated that a 96.1% and 97% reduction in FC is required for Rose Dhu Creek and Stoney Creek, respectively, to meet the daily maximum concentration threshold for shellfish harvesting (43 MPN/100 mL).

6.1.2 Summary of State of Knowledge

Monitoring bacteria concentrations and calculating loads are the first step in management. Unfortunately, there are many factors that make reduction of bacteria difficult. Residential land uses, which are predominant in the May River Headwaters, tend to produce high bacteria loading for a myriad of contributing factors including leaking septic tanks, pet waste pick-up behavior, as well as turf management and erosion control practices (Wood, 2018). In general, human sewage contamination presents the greatest health risk and is a controllable source (the Town and appropriate partners can fix underperforming septic systems and/or sanitary sewer conveyance systems). However, fecal indicator bacteria (FIB) do not correlate well with the occurrence of pathogens, and they do not identify the source of the contamination. Additionally, many studies – including monitoring efforts by the Town of Bluffton – have documented that FIB can colonize and regrow in biofilms and sediments in the storm drainage system. In other words, it is possible to find FIB in areas where there are not pathogens present; this means the Town could be using resources to treat a problem that may not actually present a human health risk.

Pollutants in stormwater runoff, such as bacteria, can be managed through both structural and non-structural methods. Available information from research indicates that BMP efficiency is variable and dependent on the design, maintenance, and other factors. For example, in some cases a net export of microbes can result due to improper maintenance, regrowth of microbes in the BMP, resuspension during storm events, or direct wildlife deposits (Characklis et al., 2009). Information regarding removal rates of FIB in the International BMP Database (Clary et al., 2010) are variable and dependent on the following, 1) season in which the FIB were quantified; 2) stormwater volume and flows; and 3) the type of FIB being measured. Removal values in coastal SC will most likely be lower than those included in the International BMP Database, which has many studies based on the West Coast. This is primarily due to the following, 1) SC temperature is higher during most seasons than in west coast environments; 2) SC water sources tend to be blackwater and tannic water, which reduces light penetration; and 3) persistent forms of FC are known to grow in the sediments of systems in SC. Furthermore, research has called attention to the nature of temperature-warm, nutrient-rich, stagnant BMPs systems that appear to serve as a reservoir of FIB and at times may also preferentially grow the fecal indicator bacteria.

The International Stormwater BMP database contains approximately 600 pairs of influent and effluent data for fecal coliforms and E. coli. across multiple states. Clary et al. (2008) analyzed the fecal coliform and E. coli data and concluded that the ability of BMPs to reduce FIB varies widely across BMPs. No single BMP appears to consistently reduce FIB concentrations. Additionally, high removal efficiency does not always guarantee attainment of bacteria standards when inflow concentrations are high (Wood, 2018). Across the southeastern region, there is a movement away from stormwater ponds in favor of emphasizing other practices that encourage runoff reduction, which is defined as "the total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainfall harvesting, engineered infiltration, or extended filtration."

The effectiveness of the New Riverside Pond has been studied by the Town and researchers at USC-Beaufort. The results of this analysis showed that there was a statistically significant reduction in bacteria concentrations between the pond influent and pond effluent. Additionally, there was a statistically significant reduction in FC concentrations at a short distance downstream of the pond outlet, for observations before and after the pond was constructed. However, at the outfall to the May River, the was no statistically significant reduction in FC concentrations before and after the pond was constructed. In other words, even though a large stormwater treatment BMP was installed and effectively removed FC, there was not a benefit to the May River because the bacteria levels still increased downstream of the pond.

In particular, in the face of climate change and sea level rise, it has been important to begin to place tidal influence into the context of stormwater conveyance. The impact of higher tidal elevations in low-lying states such as SC cannot be overstated. This is because the extreme high tides, also known as perigean or king tides, interfere with the conveyance of stormwater to receiving waters. The rising tides have the capability of elevating groundwater levels and increasing saltwater intrusion which can create more frequent or longer duration flooding during storm events; interfere with stormwater conveyance into receiving waters; inundate water, wastewater, and stormwater infrastructure by daily high tide (which promotes corrosion and pipe damage that could cause sewage to seep out of the conveyance system); and adversely impact sanitary sewer pump station functionality. There are multiple ways to address tidal influence at the outset, including installing check valves, locating force mains in specific locations of interest, removing debris in problem areas, and promoting infiltration in creek and watershed restoration plans. Of initial importance are identifying thresholds at which the performance of the stormwater conveyance system is compromised.

The new *Southern Lowcountry Stormwater Design Manual* (Center for Watershed Protection and McCormick Taylor, 2020) will provide the Town with tools, standards, and requirements to help mitigate the effects of future redevelopment and new development in the Headwaters of the May River and in other watersheds in the jurisdiction. Requirements for watersheds in shellfish harvesting areas, like the May River, are the most stringent and necessitate a natural resources inventory, Better Site Design, and retention of the 95th percentile storm (1.95”) on-site.

6.1.3 Project Evaluations

Four septic to sewer conversion projects were evaluated in the Rose Dhu Creek and Stoney Creek subwatersheds: Cahill, Gascoigne, Stoney Creek, and Pritchardville. These projects would overlap with 42 subcatchments in the Stoney Creek watershed and 11 in Rose Dhu Creek. Completion of these projects helps eliminate known sources of human FIB from the May River Headwaters Watershed.

The project team in consultation with the Town decided that the WTM spreadsheet-based model allowed for flexibility to quickly analyze and evaluate a variety of stormwater BMPs, including permeable pavement, bioretention, green roofs, rainwater harvesting, filters, and infiltration trenches and chambers. Eleven project sites (incorporating various individual BMPs) were selected in consultation with the Town (prioritizing subcatchments with bacteria hotspot and/or large impervious areas). All 11 projects were in Rose Dhu Creek (6 projects) and Stoney Creek (5 projects). The prioritized ranking of these projects, based on the Full SWRv is as follows:

1. May River High School (MRHS)
2. One Hampton Lake Apartments (OHLA)
3. Boys and Girls Club of Bluffton (BGC)
4. Bluffton Early Learning Center (BELC)
5. Bluffton High School (BHS)

6. Benton House (BH)
7. Palmetto Pointe Townes (PPT)
8. McCracken Middle School/Bluffton Elementary School (MMSBES)
9. Buckwalter Recreation Center (BRC)
10. Pritchardville Elementary School (PES)
11. Lowcountry Community Church (LCC)

The potential benefits of recommended projects was estimated to be 3.46×10^{13} FC reduction for septic to sewer conversion (only calculates benefits to sewer conversions within the Headwaters), 2.99×10^{14} FC reduction for the Full SWRv stormwater retrofit projects, and 2.53×10^{14} FC reduction for the Reduced SWRv projects. The 2020 estimated costs of these projects is $20.8 million for four septic to sewer conversion projects; $32.7 million for the Full SWRv projects; and $22.6 million for the Reduced SWRv projects.

Table 88: Summary of Estimated Benefits of Projects

Project Type	**Potential FC Reduction (#/yr)**	**Potential FC Reduction (#/yr)**
Septic to Sewer Conversion		
Cahill	1.09E+10	1.09E+10
Gascoigne	3.32E+11	3.32E+11
Pritchardville	1.00E+13	1.00E+13
Stoney Creek	2.43E+13	2.43E+13
Stormwater BMP Retrofits	*Full SWRv*	*Reduced SWRv*
Bluffton Early Learning Center	5.04E+12	3.64E+12
Boys and Girls Club of Bluffton	3.55E+12	3.16E+12
Benton House	2.99E+12	2.25E+12
Bluffton High School	3.24E+13	3.07E+13
Buckwalter Recreation Center	9.12E+12	6.26E+12
Lowcountry Community Church	6.77E+12	5.16E+12
McCracken MS/Bluffton ES	2.05E+13	1.78E+13
May River High School	2.55E+13	1.94E+13
One Hampton Lakes Apartments	1.53E+13	1.13E+13
Pritchardville Elementary School	5.61E+12	4.82E+12
Palmetto Pointe Townes	5.27E+12	4.64E+12
Total Bacteria Reduction	**1.67E+14**	**1.44E+14**

If all 15 of the proposed projects were implemented, the XPSWMM and WTM model results indicate there is the potential to remove 1.67×10^{14} FC bacteria/year from stormwater (for Full SWRv) or 2.53×10^{14} FC bacteria/year (Reduced SWRv scenario). This is about 35% and 30% of the 2018 FC load for all four subwatersheds in the May River Headwaters.

All of the septic to sewer conversion projects and stormwater retrofit projects were located in the Rose Dhu Creek and Stoney Creek subwatersheds. The total FC load in 2018 for these two subwatersheds was 3.95×10^{14} FC bacteria/year, which accounts for about 83% of the bacteria load for the entire May River Headwaters. The estimated goals for FC reduction in these two subwatersheds is 96.1% and 97% for Rose Dhu Creek and Stoney Creek, respectively, to meet the daily maximum concentration threshold for shellfish harvesting (43 MPN/100 mL). The combination of septic to sewer conversion with the Full SWRv provides about 50% reduction, which is about half of what would be necessary in these watersheds.

Table 89: Potential Load Reductions in Rose Dhu Creek and Stoney Creek Subwatersheds

Project Type	Potential FC Reduction (#/yr)	Potential FC Reduction (%)
Septic to Sewer Load Reduction	3.46E+13	9%
Full SWRv Load Reduction	1.67E+14	42%
Reduced SWRv Load Reduction	1.44E+14	36%

6.1.4 Recommendations to Reduce FC in the May River Headwaters

Overall, the goal for the Town of Bluffton should be incorporate strategies through Partnerships, Policies, Programs, and Projects in order to implement Better Site Design principles outlined in the new *Southern Lowcountry Stormwater Design Manual.* These strategies include conservation of natural areas, reduction of impervious cover, and management of designated stormwater reduction volumes by infiltration and/or filtration techniques as first priority, or other approved volume reduction techniques as second priority. These recommendations are in agreement with local research (Holland et al., 2004; Sanger et al., 2008; and Sanger and Blair et al., 2015; Sanger and Tweel et al., 2015; Montie, 2019) pertaining to the negative impacts of impervious surfaces in southeastern estuarine environments and are supported with design guidance (such as *Low Impact Development in Coastal South Carolina: A Planning and Design Guide*) and in local ordinances.

Recognizing how expensive these projects are, especially in light of how much load reduction (97%) is estimated to be required, the Town can utilize the process described in Section 5.4.2 in this report as part of the ongoing Water Quality Improvement Program to re-assess areas developed prior to adoption of the *Southern Lowcountry Stormwater Design Manual* guidelines. These projects may be viewed as a "triage" to stop bacteria problems from spreading farther downstream and causing closures of additional shellfish harvesting areas.

In areas where development pre-dated stormwater management requirements or failed to meet on-site retention of the 95th percentile storm, it is recommended the Town of Bluffton should institute an Impervious Area Restoration/Stormwater Retrofit Program in which large impervious areas are targeted to be retrofitted to meet

95th percentile storm retention of impervious surfaces with infiltration BMPs to the maximum extent possible. Additionally, the Town should incorporate Volume Reduction BMPs within existing and future CIP projects to the maximum extent practical, especially for project locations in A/B soils.

In a departure from the recommendations from the 2011 Action Plan, ponds and ditches are not recommended as BMP practices to address bacteria impairment in the May River. Although they do provide important services for flood attenuation and some pollutant removal, they do not promote the infiltration of precipitation, and thus do not provide any runoff reduction (refer to *Southern Lowcountry Stormwater Design Manual*). Stormwater enters the system and leaves at a controlled flowrate, which is advantageous for flood protection but may promote the persistence of FIB downstream of the practice (as has been documented in the literature and the Town's monitoring data).

The Town should also plan projects, policies, programs and partnerships geared at addressing human sources of FIB and mitigating impacts of tidal influence in both the stormwater and wastewater conveyance systems. Strategies for future monitoring projects included in-house microbial source tracking; future bacteria monitoring locations; and water flow monitoring locations. Of initial importance are identifying thresholds at which the performance of the stormwater conveyance system is compromised due to tides and sea level rise. Through analysis of multiple classes of microbial contaminants, the Town can create linear models to compare HF183 (human feces marker), *E. coli*, fecal coliforms, or *Enterococcus* and 12-hr rainfall (as well as incremental aggregate rainfall analyses). When the analysis is completed, the relationships across markers can illustrate patterns of fecal contamination delivery and conveyance. If tidal influence is determined to influence sanitary, septic, and stormwater systems there are several solutions the Town can pursue, including installing check valves, evaluating the location of force mains, removing debris in problem areas, and promoting infiltration in creek and watershed restoration plans.

In the future, the results from the water quality model can be better calibrated if continuous, non-tidal flow data becomes available in key areas of the watersheds. The Town should set up gages for multiple conditions (baseflow, stormflow, wet seasons, dry seasons). A combination of continuous, long-term (one to two years) and shorter-duration monitoring should be conducted. This would allow the model to be compared to an entire hydrograph and sequential hydrographs rather than a single point (a single flow measurement).

As the Town refines the XPSWMM water quality model to reflect enhanced monitoring and completed projects, it will be a useful tool for continuously measuring progress towards achieving FC load reduction in the May Rivers Headwaters and for adaptively managing to changing conditions and knowledge with future Action Plan Updates.

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APPENDIX A:
2019 Technical Report: Historical Analysis of Water Quality, Climate Change Endpoints, and Monitoring of Natural Resources in the May River.

APPENDIX B:
Technical Memo from Dr. Rachel Noble

APPENDIX C:
WTM Spreadsheets

APPENDIX D:
Cost Estimate Spreadsheets

ATTACH
Recommended Motion

RECOMMENDED MOTION LANGUAGE

"I move to approve a Resolution to adopt the May River Watershed Action Plan Update as a supporting document to the Comprehensive Plan."

TOWN COUNCIL

STAFF REPORT
Engineering Department

MEETING DATE:	February 9, 2021
PROJECT:	Consideration of a Resolution to Adopt the *Southern Lowcountry Stormwater Design Manual* as a Supporting Document to Unified Development Ordinance Article 5 – Design Standards, Sec. 5.10 Stormwater Management
PROJECT MANAGER:	Bryan McIlwee, P.E., Director of Engineering

RECOMMENDATION:

Staff recommends that Town Council approve a Resolution to adopt the *Southern Lowcountry Stormwater Design Manual* as a supporting document to Unified Development Ordinance Article 5 – Design Standards, Sec. 5.10 Stormwater Management.

BACKGROUND/DISCUSSION:

Southern Lowcountry Regional Board
Elected officials from the Towns of Bluffton, Ridgeland and Hilton Head Island, City of Hardeeville, and Beaufort and Jasper Counties re-established the Southern Lowcountry Regional Board (SoLoCo) on August 29, 2017. The Mission of SoLoCo is "to create a regional think tank that will identify the problems and opportunities that face the entire southern Lowcountry, as defined by the members and regardless of municipal or county boundaries; to discuss the zoning, housing, employment, quality of life and social issues; and to propose action plans to the appropriate legislative bodies."

SoLoCo prioritized the need for a uniform set of stormwater standards and design guidelines to meet the goal of protecting the region's sensitive environment, residents' quality of life, and future economic development opportunities. Seven (7) jurisdictions (Town of Bluffton, Beaufort County, City of Hardeeville, Jasper County, City of Beaufort, Town of Port Royal, and Town of Yemassee, referred to as the "Project Partners") agreed to work with a consultant team of Center for Watershed Protection and McCormick Taylor to draft a regional model stormwater ordinance and design manual.

The consultant team and the Project Partners received local stakeholder input from the project's outset and garnered feedback from the professional design community during local, statewide, regional, and national presentations as well as three (3) local Public Meetings in early 2020, and a formal Public Review and Comment period of the Final Draft documents.

Upon completion of the Public Meetings and Public Comment period, comments were reviewed and evaluated by the consultant team and the Project Partners resulting in the final version the model *Southern Lowcountry Post Construction Stormwater Ordinance* (SoLoCo Stormwater Ordinance) and *Southern Lowcountry Stormwater Design Manual* (*Design Manual*), as presented for adoption today.

Town of Bluffton Strategic Plan
On May 8, 2018, the Town of Bluffton Town Council approved a Resolution adopting the Strategic Plan for Fiscal Years 2019-2020 ("Strategic Plan"). Updating the Town's stormwater design standards was a priority project relating to Strategic Focus Areas of May River & Surrounding Rivers and Watersheds and Community Quality of Life, which includes updating policies and ordinances to sustain the Town's "unique and authentic" character, as well as preserving its natural resources, culture, and history.

The proposed stormwater regulatory amendments receiving Public Hearing and being considered by Town Council for Final Reading on February 9, 2021 relate to incorporating the SoLoCo Stormwater Ordinance into the Town's Code of Ordinances – Chapter 23 Unified Development Ordinance (UDO), Article 5 (Design Standards), Section 10 (Stormwater). These standards will regulate new construction and redevelopment within the Town of Bluffton. Further stormwater design detail guidance is provided in the *Design Manual* which is why it is intended to be a supporting document.

MAY RIVER WATERSHED ACTION PLAN ADVISORY COMMITTEE and PLANNING COMMISSION RECOMMENDATIONS:

As part of the Town's formal code amendment and document adoption process, additional public review has included:

- Planning Commission Workshop on August 26, 2020;
- May River Watershed Action Plan Advisory Committee review and formal recommendation for adoption on August 27, 2020;
- Town Council Workshop on October 13, 2020; and
- Planning Commission Public Hearing and formal recommendation for adoption of the ordinance amendments and *Design Manual* on October 28, 2020.

Following the recommendations of the May River Watershed Action Plan Advisory Committee and Planning Commission, Town Council voted unanimously to adopt the ordinance amendments at First Reading on December 8, 2020.

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NEXT STEPS:

UDO Text Amendment Procedure & Adoption of *Southern Lowcountry Stormwater Design Manual*	Date	Complete
Step 1. SoLoCo – Recommendation for Adoption by All Seven (7) Partner Organizations	July 28, 2020	✓
Step 2. Planning Commission – Workshop	August 26, 2020	✓
Step 3. May River Watershed Action Plan Advisory Committee – Recommendation to Adopt	August 27, 2020	✓
Step 4. Town Council – Workshop	October 13, 2020	✓
Step 5. Planning Commission – Public Hearing and Recommendation to Town Council	October 28, 2020	✓
Step 6. Town Council – 1st Reading	December 8, 2020	✓
Step 7. Town Council Meeting – Public Hearing & Final Reading of Ordinance Amendments *(Anticipated)*	February 9, 2020	✓
Step 8. Town Council Meeting – Resolution to Adopt *Southern Lowcountry Stormwater Design Manual* as a supporting document to the UDO Sec. 5.10 Stormwater *(Anticipated)*	February 9, 2020	✓

SUMMARY:

The adoption of the *Southern Lowcountry Stormwater Design Manual* is consistent with the Comprehensive Plan and supports the May River and Surrounding Rivers and Watersheds Focus Area as a priority within the Strategic Action Plan for Fiscal Years 2019 - 2020. Thus, Town Staff recommends that Town Council approve a Resolution to adopt the *Southern Lowcountry Stormwater Design Manual* as a supporting document to the Unified Development Ordinance, Article 5 – Design Standards, Sec. 5.10 Stormwater Management.

ATTACHMENTS:

1. Resolution to Adopt the *Southern Lowcountry Stormwater Design Manual* as a Supporting Document to Unified Development Ordinance Article 5 – Design Standards, Sec. 5.10 Stormwater Management
    a. Exhibit A - *Southern Lowcountry Stormwater Design Manual*
2. Recommended Motion

RESOLUTION TO ADOPT THE *SOUTHERN LOWCOUNTRY STORMWATER DESIGN MANUAL* AS A SUPPORTING DOCUMENT TO UNIFIED DEVELOPMENT ORDINANCE, ARTICLE 5 – DESIGN STANDARDS, SEC. 5.10 STORMWATER MANAGEMENT

WHEREAS, the Town of Bluffton desires to improve the general safety, welfare, health and properties of the citizens of the Town of Bluffton; and

WHEREAS, to establish the necessary provisions to accomplish the above, the Town of Bluffton has authority to enact resolutions, ordinances, regulations, and procedures pursuant to South Carolina Code of Laws 1976, Section 5-7-30; and,

WHEREAS, the Town of Bluffton's Town Code and Ordinances provide guidance and requirements for development within the Town of Bluffton through regulations set forth to protect and promote the health, safety, and welfare of the Town's citizens, as espoused through the provisions of the Town of Bluffton Comprehensive Plan and as authorized by the South Carolina Local Government Comprehensive Planning Enabling Act of 1994, Title 6, Chapter 29 of the Code of Laws for South Carolina; and

WHEREAS, the Town of Bluffton Town Council adopted the aforementioned standards, which are known as the Unified Development Ordinance (UDO), Chapter 23 of the Code of Ordinances for the Town of Bluffton, South Carolina on October 11, 2011 through Ordinance 2011-15; and

WHEREAS, the UDO unifies the subdivision, land use, development/design regulations including stormwater design standards into a single set of integrated, updated, and streamlined standards; and

WHEREAS, the Town Council shall from time to time examine ordinances and supporting documents to ensure that they are properly regarded, enforced, sufficient and satisfactory to the needs of the community and can further suggest changes as deemed appropriate; and,

WHEREAS, the Town Council adopted a *Stormwater Best Practices Manual* as a supporting document that provided guidance in the preparation, construction, monitoring, repairs, and maintenance of elements of the Town of Bluffton Stormwater Ordinance by Resolution on June 19, 2007; and

WHEREAS, the *Stormwater Best Practices Manual*, re-titled the *Stormwater Design Manual*, was amended by Resolution on November 20, 2008; and

WHEREAS, the *Stormwater Design Manual* was further amended to add guidance for meeting volumetric requirements of the Stormwater Ordinance which was adopted by Resolution on July 20, 2010; and

WHEREAS, the *Stormwater Design Manual* was last amended to remove redundancies which provided a more user friendly document on November 9, 2011; and

WHEREAS, to protect water quality and citizen quality of life, an update of both UDO "Article 5.10 Stormwater" and the referenced *Stormwater Design Manual* to current stormwater management State of the Knowledge practices were identified in the Fiscal Years (FY) 2019 – 2020 Strategic Plan Focus Area "May River & Surrounding Rivers and Watersheds" as priority initiatives; and

WHEREAS, elected officials from City of Hardeeville, Towns of Bluffton, Ridgeland, and Hilton Head Island, Beaufort County, and Jasper County, known as the Southern Lowcountry (SoLoCo) Regional Board, prioritized and requested a uniform set of stormwater standards and design guidelines to meet the goal of protecting the Lowcountry region's sensitive environment, residents' quality of life, and future economic development opportunities; and

WHEREAS, understanding the importance of a regional, collaborative, watershed-based approach to stormwater management, the Towns of Bluffton, Port Royal and Yemassee, Cities of Hardeeville and Beaufort, and Beaufort and Jasper Counties partnered with a consultant team with stakeholder input to develop a model "Southern Lowcountry Post Construction Stormwater Ordinance" and *Southern Lowcountry Stormwater Design Manual* based on current State of the Knowledge; and

WHEREAS, incorporation of the model "Southern Lowcountry Post Construction Stormwater Ordinance" language and requirements into the Town's UDO establishes the regulatory framework to preserve, protect, and revitalize the critical watersheds of the May River, Okatie/Colleton Rivers, and New River; and

WHEREAS, the Town of Bluffton Town Council has amended the Unified Development Ordinance, Article 3 – Application Process, Article 5 – Design Standards, Sec. 5.10 Stormwater Management, and Article 9 – Definitions and Interpretation to incorporate the model "Southern Lowcountry Post Construction Stormwater Ordinance"; and

WHEREAS, the *Southern Lowcountry Stormwater Design Manual* is in conformance with the UDO and shall serve as a supplement to the UDO to provide the standards for design of stormwater management facilities/stormwater systems within the Town.

NOW, THEREFORE, BE IT RESOLVED BY THE TOWN COUNCIL OF THE TOWN OF BLUFFTON, SOUTH CAROLINA AS FOLLOWS:

1. The Town Council hereby approves, confirms and adopts the *Southern Lowcountry Stormwater Design Manual*, which is attached and incorporated as "Exhibit A" hereto.
2. The Town Council hereby grants the Unified Development Ordinance Administrator the authority to amend the Applications Manual as necessary to administer and implement the UDO.

THIS RESOLUTION SHALL TAKE FULL FORCE AND EFFECT ON MARCH 1, 2021.

SIGNED, SEALED AND DELIVERED AS OF THIS 9TH DAY OF FEBRUARY 2021.

____
Lisa Sulka, Mayor
Town of Bluffton, South Carolina

____
Kimberly Chapman
Town Clerk, Town of Bluffton, South Carolina

Southern Lowcountry Stormwater Design Manual

Stormwater Best Management Practices

Prepared by

Center for Watershed Protection

McCormick Taylor

March 2020

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Acronym Definitions

Acronym/Abbreviation	Definition
ARC	Antecedent Runoff Condition
BMP	Best Management Practice
BSD	Better Site Design
CDA	Contributing Drainage Area
CN	Curve Number
C-SWPPP	Construction Stormwater Pollution Prevention Plan
EGL	Energy Grade Line
EPA	United States Environmental Protection Agency
ESC	Erosion and Sediment Control
FHWA	Federal Highway Administration
GI	Green Infrastructure
HDS	Hydraulic Design Services
HGL	Hydraulic Grade Line
HUC	Hydrologic Unit Code
IWS	Internal Water Storage
LID	Low-Impact Development
LOD	Limits of Disturbance
MEP	Maximum Extent Practicable
MS4	Municipal Separate Storm Sewer System
NC DEQ	North Carolina Department of Environmental Quality
NEH	National Engineering Handbook
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PROW	Public Right-of-Way
PUD	Planned Unit Development
SC DHEC	South Carolina Department of Health and Environmental Control
SC DOT	South Carolina Department of Transportation
SDA	Site Drainage Area
SWMP	Stormwater Management Plan
SWRv	Stormwater Retention Volume

Chapter 1. Introduction, Background, Purpose, and Administration

1.1 Introduction

Upon passage of the Southern Lowcountry Stormwater Ordinance as amended and adopted by <*local jurisdiction*>, participating municipalities/jurisdictions will follow the design and permitting requirements of the *Southern Lowcountry Stormwater Design Manual*. The Ordinance directs residents, land developers, redevelopment, and government permit applicants to submit details and plans that comply with this Manual. It is the intent of the Ordinance that all proposed development, redevelopment, and major substantial improvement shall provide stormwater quality control for the stormwater retention volume (SWRv) for Watershed Protection Areas and/or Special Watershed Protection Areas. In the following chapters, Better Site Design (BSD) practices, green infrastructure/low impact development practices (GI/LID), and stormwater best management practices (BMPs) are described in detail to support the stormwater retention requirements. Through in-line and off-line application of these practices, the cumulative impact is reduction of the runoff and the retention on site of design storms.

This Manual and the design criteria presented within represent good engineering practice and should be used in the preparation of stormwater management plans. The criteria are intended to establish requirements, minimum standards, and methods for a sound planning, design, and review process. It is intended to guide the stormwater design review of proposed work done by developers, private parties, and governmental agencies.

1.2 Background

The U.S. Environmental Protection Agency (EPA) recommends that the Phase II Small Municipal Separate Storm Sewer System (MS4) permit require the permittee to adopt a planning process that identifies the municipality's program goals (e.g., minimize water quality impacts resulting from post-construction runoff from new development and redevelopment), implementation strategies (e.g., adopt a combination of structural and/or non-structural BMPs), operation and maintenance policies and procedures, and enforcement procedures. In developing the program, EPA states that the permit should also require the permittee to assess existing ordinances, policies, programs and studies that address stormwater runoff quality. These policy assessments should include the following:

- Policies and ordinances that:
  - provide requirements and standards to direct growth to identified areas,
  - protect sensitive areas such as wetlands and riparian areas,
  - maintain and/or increase open space (including a dedicated funding source for open space acquisition),
  - provide buffers along sensitive water bodies,
  - minimize impervious surfaces, and
  - minimize disturbance of soils and vegetation;
- Policies or ordinances that encourage infill development in higher density urban areas and areas with existing infrastructure;
- Education programs for developers and the public about project designs that minimize water quality impacts; and
- Measures such as minimization of percent impervious area after development and minimization of directly connected impervious areas (81 Federal Register 237).

1.3 Purpose

This Manual's purpose is to provide a framework for designing a stormwater management system to:

- Improve water quality through runoff reduction to the maximum extent practicable (MEP);
- Prevent downstream stream bank and channel erosion;
- Reduce downstream overbank flooding; and
- Safely pass or reduce the runoff from extreme storm events.

This Manual presents a unified approach for sizing stormwater best management practices (BMPs) in the Southern Lowcountry to meet pollutant removal goals, reduce peak discharges, and pass extreme floods. Additionally, it follows a watershed approach for their size and specification. Based on the site's watershed, stormwater design criteria specific to each must be met for development permit approval.

1.4 Applicability and Exemptions

1.4.1 Applicability

Design criteria in this Manual are applicable to any new development or redevelopment activity that meets one or more of the following criteria, or is a major substantial improvement, unless exempt pursuant to Section 1.4.2 below:

1. New development that involves the creation of 5,000 square feet of impervious surface or that involves other land disturbing activities of one acre or more.
2. Redevelopment that involves the creation, addition, or replacement of 5,000 square feet or more of impervious surface or that involves other land disturbing activities of one acre or more.
3. New development or redevelopment, regardless of size, that is part of a larger common plan of development, even though multiple, separate and distinct land disturbing activities may take place at different times and on different schedules.
4. A major substantial improvement of an existing property, which is defined as a renovation or addition to a structure that meets both of the following cost and size thresholds: a) construction costs for the building renovation/addition are greater than or equal to 50% of the pre-project assessed value of the structure as developed using current Building Valuation Data of the International Code Council, and b) project size where the combined footprint of structure(s) exceeding the cost threshold and any land disturbance is greater than or equal to 5,000 square feet.

The design criteria are applicable for infill development of platted lots, whether they are new development or redevelopment sites if the work involves creation, addition or replacement of 5,000 square feet or more of impervious surface or that involves other land disturbing activities of one acre or more.

1.4.2 Exemptions

The following activities are exempt from the permitting requirements of this Manual:

1. Any maintenance, alteration, renewal, or improvement as approved by *<local jurisdiction>* which does not alter existing drainage pattern, does not result in change or adverse impact on adjacent property, or create adverse environmental or water quality impacts, and does not increase the temperature, rate, quality, volume, or location of stormwater runoff discharge.
2. Projects that are exclusively for agricultural or silvicultural activities within areas zoned for these agricultural and silvicultural uses;
3. Agricultural activity not involving relocation of drainage canals;

4. Redevelopment that constitutes the replacement of the original square footage of impervious cover and original acreage of other land development activity when the original development is wholly or partially lost due to natural disaster or other acts of God occurring after <*date of adoption*>; and,
5. Work by agencies or property owners required to mitigate emergency flooding conditions. If possible, emergency work should be approved by the duly appointed officials in charge of emergency preparedness or emergency relief. Property owners performing emergency work will be responsible for any damage or injury to persons or property caused by their unauthorized actions. Property owners will stabilize the site of the emergency work within 60 days, or as soon as reasonable, following the end of the emergency period.

1.5 Administration

1.5.1 Approval Requirements

Before the <*local jurisdiction*> may issue a stormwater permit for any project requiring stormwater management, the <*local jurisdiction*> must approve a Stormwater Management Plan (SWMP) meeting the requirements of the Southern Lowcountry Stormwater Ordinance and receive all fees required by the <*local jurisdiction*> for site and building development plans.

A complete SWMP submittal includes a completed engineer's certification statement, a submittal checklist, plans and design that are signed and sealed by a registered professional engineer licensed in South Carolina. Erosion and sediment control for sites below the South Carolina Department of Health and Environmental Control (SC DHEC) National Pollutant Discharge Elimination System (NPDES) General Permit for Stormwater Discharges from Construction Activities (SCR100000) thresholds must obtain permit coverage under this stormwater permit. All construction stormwater permit applications above the SC DHEC thresholds are reviewed by the DHEC Office of Coastal Resources Management, or the reviews are delegated to the <*local jurisdiction*> to determine compliance with the requirements of SCDHEC's NPDES General Permit for Stormwater Discharges from Construction Activities (SCR100000) and of the Construction Stormwater Pollution Prevention Plan (C-SWPPP). These permit applications must be approved, issued, and provided to <*local jurisdiction*> prior to the issuance of the stormwater management plan approval.

1.5.2 Fees

An applicant is responsible for paying fees that provide for the cost of review, administration, and management of the stormwater permitting process and inspection of all projects subject to the requirements of <*the local jurisdiction*>. These fees are posted by the <*local jurisdiction*>*.*

Chapter 2. Design, Review, & Permitting Process

2.1 Satisfying the Stormwater Management, Site Planning, & Design Criteria

2.1.1 Overview

This chapter presents a comprehensive set of site planning and design and post-construction criteria that must be applied to new development and redevelopment activities occurring within the Southern Lowcountry region. Satisfying these criteria promotes the systematic development of acceptable stormwater management plans, and a successful integration of natural resource protection and stormwater management through the site planning and design process (Figure 2.1).

Through the use of Better Site Design, as described in detail below, the integration of natural resource protection and stormwater management can be achieved by:

- Identifying and protecting valuable natural resources;
- Limiting land disturbance, new impervious cover, and disturbed pervious cover; and
- Reducing and managing post-construction stormwater runoff rates, volumes, and pollutant loads.

This approach involves the use of two distinct but complementary groups of natural resource protection and stormwater management techniques:

- Green Infrastructure Practices: Natural resource protection and stormwater management practices and techniques (i.e., better site planning and design techniques, low impact development practices) that can be used to help prevent increases in post-construction stormwater runoff rates, volumes and pollutant loads.
- Stormwater Management Practices: Stormwater management practices (e.g., wet ponds, swales) that can be used to manage post-construction stormwater runoff rates, volumes and pollutant loads.

Natural resource protection and stormwater management techniques help control and minimize the negative impacts of the land development process while retaining and, perhaps, even enhancing a developer's vision for a development site. When applied during the site planning and design process, they can be used to create more natural and aesthetically pleasing development projects and create more cost-effective post-construction stormwater management systems (ARC, 2001). The use of these techniques, particularly the green infrastructure practices, can even reduce overall development costs while maintaining or increasing the resale value of a development project (MacMullan and Reich, 2007; US EPA, 2007; Winer-Skonovd et al., 2006).

2.1.2 Better Site Design in the Planning Process

Better Site Design (BSD) refers to planning land development using certain principles to minimize stormwater impacts. Integral to low impact development design, proper application of BSD principles can allow for smaller required stormwater BMP storage and retention volumes, and can help provide significant reductions in post-construction peak flows and pollutant loads. These principles include reduction/restoration of impervious cover, conservation of natural cover areas, stream restoration, and integration of both structural and non-structural stormwater management within site design. The principles of Better Site Design are referenced in the sections below.

Fundamental to the application of Better Site Design is the correlation between impervious surface area in a watershed and negative impacts on receiving water resources. On a national level, the Impervious

Cover Model (ICM) estimates stream quality based on percentage of impervious cover (Schueler and Fraley-McNeal, 2009). This model demonstrates that streams follow a continuous gradient of degradation in response to increasing impervious cover in a watershed. Local studies have supported this paradigm, and report that changes in the rate and volume of stormwater runoff were primary causes of ecological impairment in headwater tidal creeks, such as those found in Beaufort and Jasper Counties. These studies have shown that physical and chemical characteristics such as altered hydrography, increased salinity variance, increased chemical contaminants, and increased fecal coliform loadings of tidal creeks were negatively impacted with as little as 10 to 20% impervious cover. When impervious cover exceeded 30% of the watershed, measurable impacts to living resources were observed, indicating the ecological processes in the creek ecosystems were impaired (Holland et al., 2004).

Such findings are of consequence to Beaufort and Jasper Counties. Increasing pressure for development in response to population growth, and land development practices of the Lowcountry result in significant tree removal and loss of vegetative cover from land grading and storm pond construction and increases in impervious surfaces. According to the NOAA C-CAP Land Cover Analysis (https://coast.noaa.gov/ccapatlas/), from 1996 to 2010, the percent net increase in impervious surface area was 60% for Beaufort County and 59% for Jasper County. Table 2. 1 below summarizes the findings of this NOAA report. Although the percentage of total wetlands lost is relatively low for both counties, the actual wetland types have been converted from palustrine forested wetlands to palustrine scrub/shrub and palustrine emergent wetlands, which may alter ecosystem processes and hydrology in these areas.

Table 2.1. Summary of land cover changes in Southern Lowcountry from 1996 to 2010.

	Beaufort County[1]			Jasper County[1]		
Land Cover %	**1996**	**2010**	**% Change**	**1996**	**2010**	**% Change**
Development	3.87	6.16	+59.12	1.62	2.52	+55.15
Forested Area	25.28	21.5	-14.98	62.50	48.37	-22.60
Wetlands	33.85	33.20	-1.93	45.24	44.74	-1.11

[1] Percent of County under each land cover type.

Given the rapid growth the Southern Lowcountry experienced in the past 20 years, the goals of Better Site Design should resonate with those charged with managing stormwater and its release into the area watersheds. Succinctly, the goals of Better Site Design include the following:

- Preventing stormwater impacts rather than mitigating them;
- Managing stormwater (quantity and quality) as close to the point of origin as possible and minimizing collection and conveyance;
- Utilizing simple, nonstructural methods for stormwater management that are lower cost and lower maintenance than structural controls;
- Creating a multifunctional landscape; and
- Using hydrology as a framework for site design.

The Center for Watershed Protection's Better Site Design Handbook outlines 22 model development principles for site design that act to reduce impervious cover, conserve open space, prevent stormwater pollution, and reduce the overall cost of development (CWP, 2017). The principles can provide notable reductions in post-construction stormwater runoff rates, volumes and pollutant loads (ARC, 2001). Better Site Design across the country is implemented through review of existing planning and development codes, and streets, parking and stormwater engineering criteria. Within the context of a stormwater management document and this Manual, the Better Site Design techniques of greatest application include protection of existing natural areas, incorporation of open space into new development, effective sediment and erosion control practices, and stormwater management that mimics natural systems. The following sections apply Better Site Design to the Southern Lowcountry Watershed Protection Areas and Special Watershed Protection Areas to help mitigate the effects of development to the watersheds. Therefore, the conservation principles below are part of an overall watershed approach to stormwater management and will complement the Watershed Protection Area approach in this Manual. Their application is subject to *<local jurisdiction>* requirements and/or standards.

2.1.3 Natural Resources Inventory

The first step to conserve natural resources is properly documenting existing assets. An up-to-date natural resources inventory map can provide geospatial information for water resources, soils, sensitive natural resource areas, critical habitats, and other unique resources (Ellis et al., 2014).

An application for new development requires a natural resources inventory prior to the start of any land disturbing activities. A natural resources inventory prepared by a qualified person shall be used to identify and map the most critical natural resources identified on the property that would be best to preserve, such as those listed in Table 2.2, as they exist predevelopment. Qualified persons include individuals with a working knowledge of hydrology, wetlands, plant taxonomy, and field survey methods. Qualified individuals include but are not limited to licensed foresters, professional wetland scientists, and geographic information professionals. A thorough assessment of the natural resources, both terrestrial and aquatic, found on a development site shall be submitted in the development application.

Table 2.2. Resources to be identified and mapped during the Natural Resources Inventory.

Resource Group	Resource Type
General Resources	• Topography • Natural Drainage Divides • Natural Drainage Patterns • Natural Drainage Features (e.g., Swales, Basins, Depressional Areas) • Soils • Erodible Soils • Steep Slopes (e.g., Areas with Slopes Greater Than 15%) • Trees and Other Existing Vegetation
Freshwater Resources	• Rivers • Perennial and Intermittent Streams • Freshwater Wetlands
Estuarine Resources	• Tidal Rivers and Streams • Tidal Creeks • Coastal Marshlands • Tidal Flats • Scrub-Shrub Wetlands
Marine Resources	• Near Coastal Waters • Beaches
Groundwater Resources	• Groundwater Recharge Areas • Wellhead Protection Areas
Terrestrial Resources	• Dunes • Maritime Forests • Marsh Hammocks • Evergreen Hammocks • Canebrakes • Bottomland Hardwood Forests • Beech-Magnolia Forests • Pine Flatwoods • Longleaf Pine-Wiregrass Savannas • Longleaf Pine-Scrub Oak Woodlands
Other Resources	• Shellfish Harvesting Areas • Floodplains • Aquatic Buffers • Other High Priority Habitat Areas as described by South Carolina Department of Natural Resources

2.1.4 Conservation Development

Conservation development, also known as open space development or cluster development, is a site planning and design technique used to concentrate structures and impervious surfaces in a small portion of a development site, leaving room for larger conservation areas and managed open spaces elsewhere on the site (Figure 2.1). Alternative lot designs are typically used to “cluster” structures and other impervious surfaces within these conservation developments.

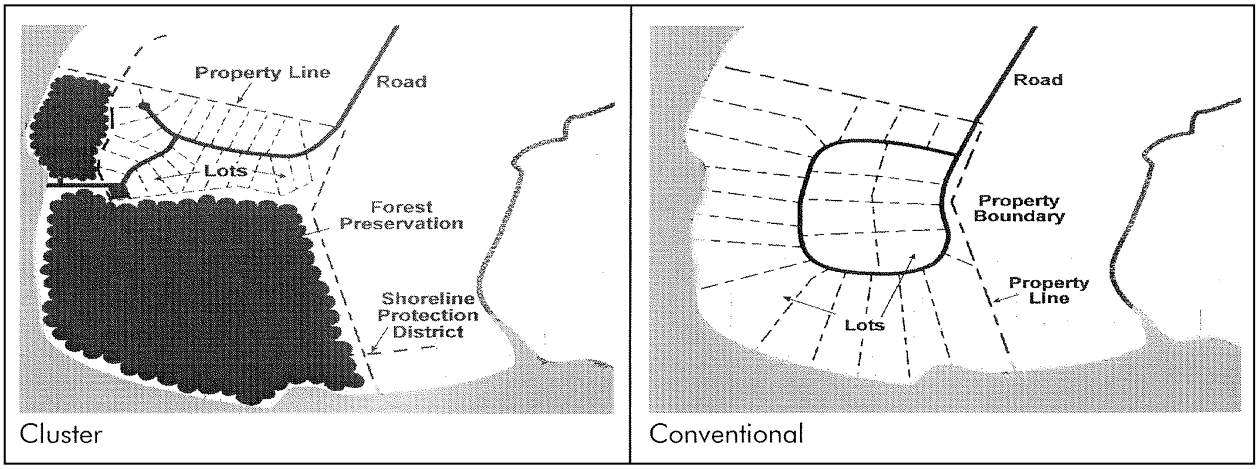

Figure 2.1. Conservation (i.e., cluster) development versus conventional development.

Conservation development projects provide a host of environmental benefits that are typically more difficult to achieve with conventional site design techniques. They provide for better natural resource protection on development sites and inherently limit increases in site imperviousness, sometimes by as much as 40 to 60 percent (CWP, 1998). Reduced site imperviousness results in reduced post-construction stormwater runoff rates, volumes and pollutant loads, which helps better protect both on-site and downstream aquatic resources from the negative impacts of the land development process. Reduced stormwater runoff rates, volumes and pollutant loads also help reduce the size of and need for storm drain systems and stormwater management practices on development sites.

As a number of recent studies have shown (MacMullan and Reich, 2007; US EPA, 2007; Winer-Skonovd et al., 2006), conservation development projects can also be significantly less expensive to build than more conventional development projects. Most of the cost savings can be attributed to the reduced amount of infrastructure (e.g., roads, sidewalks, post-construction stormwater management practices) needed on these development projects. And while these projects are frequently less expensive to build, developers often find that the lots located within conservation developments command higher prices and sell more quickly than those located within more conventional developments (ARC, 2001).

Table 2. 3 provides suggestions for Better Site Design techniques that will help protect valuable resources such as buffers, trees, wetlands, and open space.

Table 2.3. Better Site Design principles for conservation.

Principle	Description
Vegetated Buffer System	Create a variable width, naturally vegetated buffer system along all streams that also encompasses critical environmental features such as the 100-year floodplain, steep slopes, and freshwater wetlands. *Recommended buffer widths are included in Table 3.2-4 in Ellis et al., 2014*
Buffer Maintenance	The riparian buffer should be preserved or restored with native vegetation that can be maintained through delineation, plan review, construction, and occupancy stages of development.
Clearing and Grading	Clearing and grading of forests and native vegetation should be limited to the minimum amount needed to build lots, allow access, and provide fire protection. A fixed portion of any community open space should be managed as protected green space in a consolidated manner.
Tree Conservation	Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native plants. Wherever practical, manage community open space, street rights-of-way, parking lot islands, and other landscaped areas to promote natural vegetation.
Land Conservation	Open space development should be encouraged to promote conservation of stream buffers, forests, meadows, and other areas of environmental value. In addition, off-site mitigation consistent with locally-adopted watershed plans should be encouraged.
Stormwater Outfalls	New stormwater outfalls should not discharge unmanaged into jurisdictional wetlands, sole-source aquifers, or sensitive areas.

2.1.5 Residential Streets & Parking Lots

Up to 65% of the total impervious cover in a watershed can be the attributed to streets, parking lots, and driveways (CWP, 1998). Table 2.4 describes Better Site Design principles related to techniques to reduce the impervious surfaces associated with these hardscapes.

Table 2.4. Better Site Design principles for streets and parking to meet <*local jurisdiction*> requirements.

Principle	Description
Street Width	Design residential streets for the minimum required pavement width needed to support travel lanes; on-street parking; and emergency, maintenance, and service vehicles.
Street Length	Reduce the total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length.
Right-of-Way Width	Wherever possible, residential street right-of-way widths should reflect the minimum required to accommodate the travel-way, the sidewalk, and vegetated open channels. Utilities and storm drains should be located within the pavement section of the right-of-way wherever feasible.
Cul-de-sacs	Minimize the number of residential cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.
Vegetated Open Channels	Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat stormwater runoff.
Parking Ratios	The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a minimum in order to curb excess parking space construction. Existing parking ratios should be reviewed for conformance, taking into account local and national experience to see if lower ratio is warranted and feasible.
Parking Lots	Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in spillover parking areas.
Structured Parking	Utilize structured (e.g., parking garage) and shared parking to reduce impervious surface area.
Parking Lot Runoff	Wherever possible, provide stormwater treatment for parking lot runoff using bioretention areas, filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.

2.1.6 Lot Development Principles to Meet Requirements

Development of lots follows similar guidelines for reducing impervious cover and protecting natural areas, such as open space. Table 2. 5 summarizes Better Site Design principles for lot development. Preserving open space is critical to maintaining water quality at the regional level. Compared to traditional development, open space development can reduce the annual runoff volume from a site by 40%–60%, nitrogen loads by 42%–81%, and phosphorus loads by 42%–69% (CWP, 1998). Large, continuous areas of open space reduce and slow runoff, absorb sediments, serve as flood control, and help maintain aquatic communities. Open space can be provided by minimizing lot sizes, setbacks, and frontage distances.

Table 2. 5. Better Site Design principles for lot development.

Principle	Description
Open Space Development	Utilize open space development that incorporates smaller lot sizes to minimize total impervious area, reduce total construction costs, conserve natural areas, provide community recreational space, and promote watershed protection.
Setbacks and Frontages	Consider minimum setbacks allowed by *<local jurisdiction>*. Relax side yard setbacks and allow narrower frontages to reduce total road length in the community and overall site imperviousness. Relax front setback requirements to minimize driveway lengths and reduce overall lot imperviousness.
Sidewalks	Where practical, consider locating sidewalks on only one side of the street and providing common walkways linking pedestrian areas.
Driveways	Reduce overall lot imperviousness by promoting alternative driveway surfaces and shared driveways that connect two or more homes together.
Rooftop Runoff	Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas and avoid routing rooftop runoff to the roadway and the stormwater conveyance system.
Open Space Management	Clearly specify how community open space will be managed and designate a sustainable legal entity responsible for managing both natural and recreational open space.

For more detailed descriptions of these techniques, please reference *Better Site Design: A Handbook for Changing Development Rules in Your Community* (CWP, 1998) and Chapter 3 of *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al., 2014).

2.1.7 Site Planning & Design Process

Figure 2.2 depicts the site planning and design process that is captured in *Low Impact Development in Coastal South Carolina: A Planning and Design Guide* (Ellis et al., 2014) and is applicable to the *<local jurisdiction>*. The site planning and design checklist of the Southern Lowcountry Design Manual does not make each of the phases of the process a submittal requirement. The checklist, however, gives the *<local jurisdiction>* the opportunity to ask whether each of these steps have been considered. The actual document submittal begins with the preliminary plan when considered in context of the planning process below:

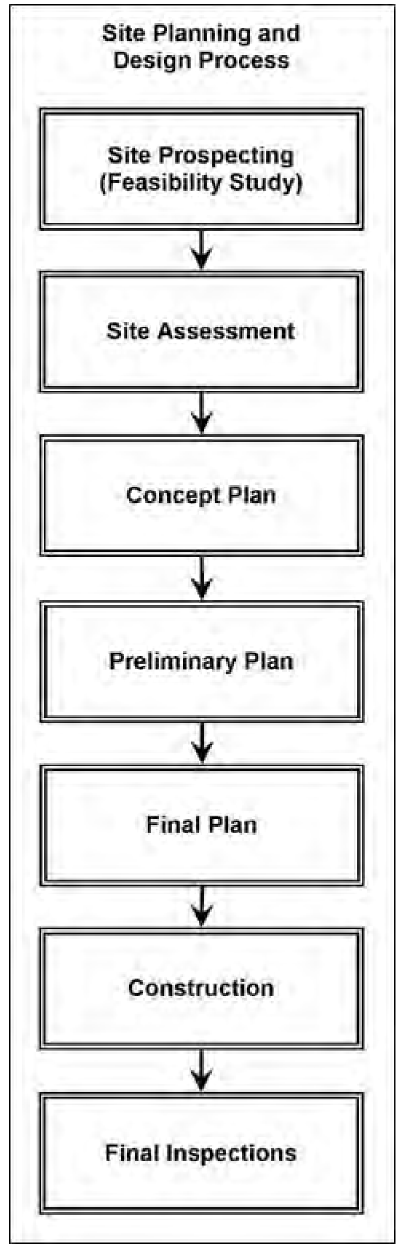

Figure 2.2. Site planning & design process (source: Center for Watershed Protection, Inc.)

- Site Prospecting: During the site prospecting phase, some basic information is used to evaluate the feasibility of completing a development or redevelopment project. A *feasibility study* is typically used to evaluate the many factors that influence a developer's decision about whether or not to move forward with a potential development project. Factors that are typically evaluated during a *feasibility study* include information about site characteristics and constraints, applicable local, state and federal stormwater management and site planning and design requirements, adjacent land uses and access to local infrastructure (e.g., water, sanitary sewer).

- Site Assessment: Once a potential development or redevelopment project has been deemed feasible, a more thorough assessment of the development site is completed. The site assessment, which is typically completed using acceptable site reconnaissance and surveying techniques, provides additional information about a development site's characteristics, its natural resource inventory and constraints. Once the assessment is complete, a developer can identify and analyze the natural, man-made, economic and social aspects of a potential development project, define the actual buildable area available on the development site and begin making some preliminary decisions about the layout of the proposed development project.

- Concept Plan: The results of the site assessment are typically used to create a concept plan (also known as a *sketch plan*) for the proposed development project. A concept plan is used to illustrate the basic layout of the proposed development project, including lots and roadways, and is usually reviewed with the local development review authority before additional resources are used to create a more detailed plan of development. During this phase, several alternative concept plans can be created and compared with one another to craft a plan of development that best “fits” the character of the development site (Figure 2.3, Figure 2.4, and Figure 2.5). It is at this point in the planning and design process that a Maximum Extent Practicable demonstration described in Section 3.9 is required for development projects that will seek a waiver from requirements of this Manual.

- Preliminary Plan: A preliminary plan presents a more detailed layout of a proposed development project. It typically includes information about lots, buildings, roadways, parking areas, sidewalks, conservation areas, utilities and other infrastructure, including the post-construction stormwater management system. After the preliminary plan has been reviewed and approved by the local development review authority, a final plan may be prepared. There may be several iterations of the preliminary plan between the time that it is submitted and the time that it is approved by the local development review authority.
- Final Plan: The final plan adds further detail to the preliminary plan and reflects any changes to the plan of development that were requested or required by the local development review authority. The final plan typically includes all of the information that was included in the preliminary plan, as well as information about landscaping, pollution prevention, erosion and sediment control and long-term operation and maintenance of the site’s post-construction stormwater management system. There may be several iterations of the final plan between the time that it is submitted and the time that it is approved by the local development review authority.
- Construction: Once the final plan has been reviewed and approved, performance bonds are set and placed, contractors are retained, and construction begins. During the construction phase, a development project may be inspected on a regular basis by the local development review authority to ensure that all roadways, parking areas, buildings, utilities and other infrastructure, including the post-construction stormwater management system, are being built in accordance with the approved final plan and that all primary and secondary conservation areas have been protected from any land disturbing activities.
- Final Inspections: Once construction is complete, final inspections take place to ensure that all roadways, parking areas, buildings, utilities and other infrastructure, including the post-construction stormwater management system, were built according to the approved final plan. As-built plans are also typically prepared and executed during this phase. If a development project passes all final inspections, an occupancy permit may be issued for the project.

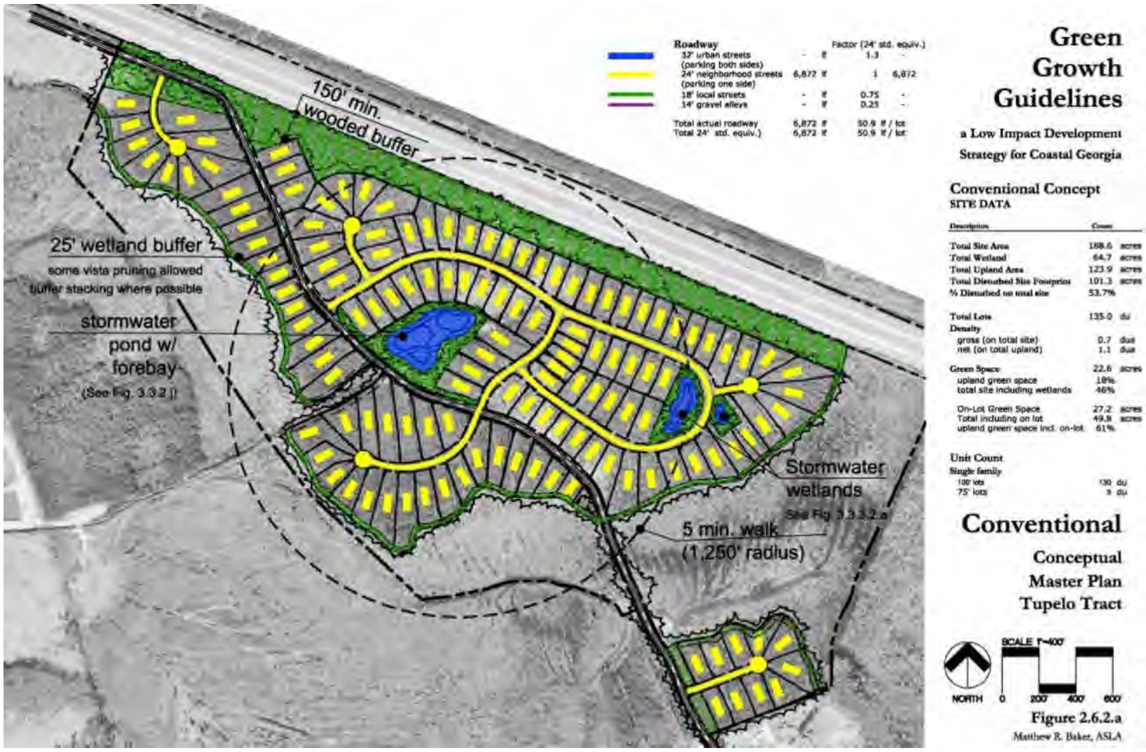

Figure 2.3. Conventional Site Design (source: Merrill et al., 2006).

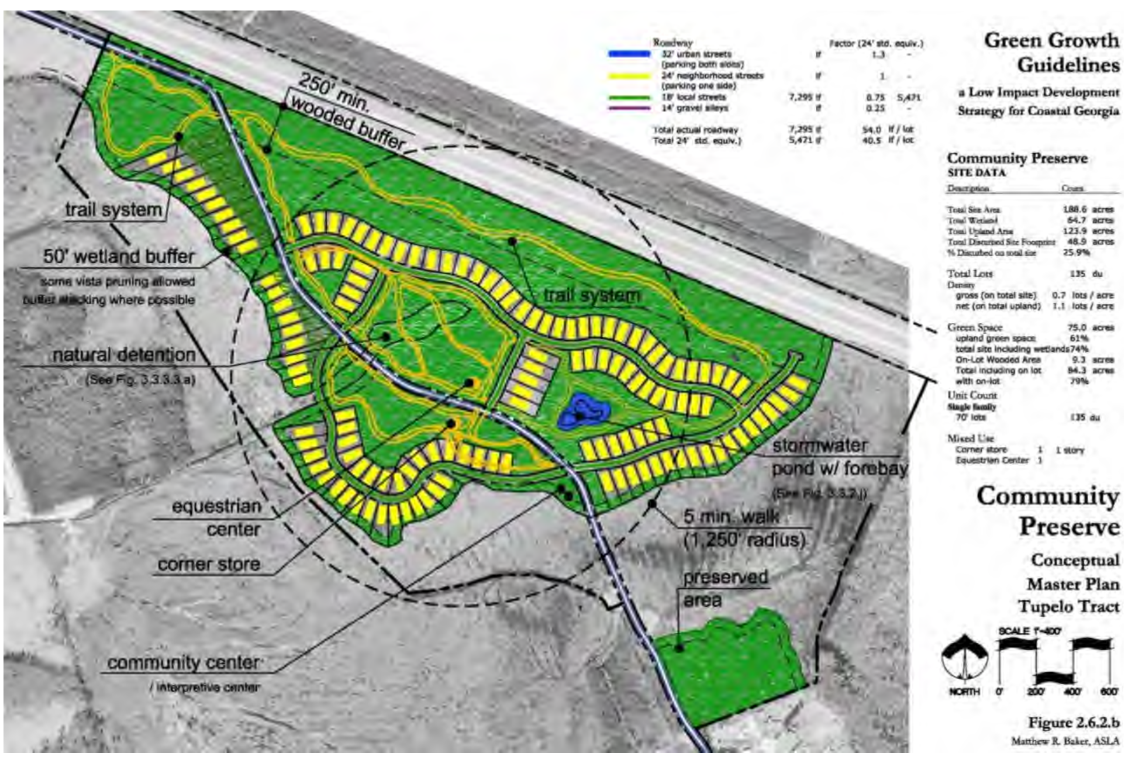

Figure 2.4. Conservation Site Design (source: Merrill et al., 2006).

Figure 2.5. New Urbanist Site Design (source: Merrill et al., 2006).

2.1.8 Integrating Natural Resource Protection & Stormwater Management with the Site Planning & Design Process

In order to successfully *integrate* natural resource protection and stormwater management with the site planning and design process, site planning and design teams are encouraged to consider following questions at the beginning of the process:

- What valuable natural resources, both terrestrial and aquatic, can be found on the development site?
- How can better site planning techniques be used to protect these valuable natural resources from the direct impacts of the land development process?
- How can better site design techniques be used to minimize land disturbance and the creation of new impervious and disturbed pervious cover?
- What low impact development practices can be used to help preserve pre-development site hydrology and *reduce* post-construction stormwater runoff rates, volumes and pollutant loads?
- What stormwater management practices can be used to *manage* post-construction stormwater runoff rates, volumes and pollutant loads?
- Are there any site characteristics or constraints that prevent the use of any particular low impact development or stormwater management practices on the development site?

Although answering these questions is no easy task, they can be readily obtained within the context of the six-step *stormwater management planning and design process* outlined in Figure 2.6, and the steps are described in more detail below.

- **Step 1: Pre-Application Meeting**

It is recommended that a pre-application meeting between the applicant's site planning and design team and the *<local jurisdiction>* development review authority occur at the very beginning of the stormwater management planning and design process. This meeting, which should occur during the site prospecting phase of the overall site planning and design process (Figure 2.6), helps establish a relationship between the site planning and design team and the *<local jurisdiction>* development review authority. The pre-application meeting also provides an opportunity to discuss the local site planning and stormwater management design criteria that will apply to the proposed development project, which increases the likelihood that the remainder of the site planning and design process will proceed both quickly and smoothly.

- **Step 2: Review of Local, State, and Federal Stormwater Management, Site Planning, & Design Requirements**

Once a pre-application meeting has been completed, it is recommended that the site planning and design team review the local, state and federal requirements that will apply to the proposed development project. This review should occur during the site prospecting phase of the overall site planning and design process (Figure 2.6), while the feasibility study is still being completed.

During their review of stormwater management and site planning and design requirements, the applicant's site planning and design teams should also investigate opportunities and incentives for land conservation, and opportunities and incentives for conservation development as illustrated earlier in Figure 2.1.

- **Step 3: Natural Resources Inventory**

Once the potential development or redevelopment project has been deemed feasible, acceptable site reconnaissance and surveying techniques must be used to complete a thorough assessment of the natural resources, both terrestrial and aquatic, found on the development site. The identification and subsequent preservation and/or restoration of these natural resources helps reduce the negative impacts of the land development process "by design." The natural resources inventory should be completed during the site assessment phase of the overall site planning and design process (Figure 2.6). A map that is created to illustrate the results of the natural resources inventory, known as a site fingerprint, should be used to prepare a stormwater management concept plan for the proposed development project.

Once the natural resources inventory has been completed and a site fingerprint has been created, the site planning and design team should have a better understanding of a development site's characteristics and constraints. This information can be used to identify primary and secondary conservation areas (Figure 2.7) and define the actual buildable area available on the development site. Along with information about adjacent land uses and available infrastructure (e.g., roads, utilities), the site fingerprint can also be used to make some preliminary decisions about the layout of the proposed development project and to guide the creation of the stormwater management concept plan.

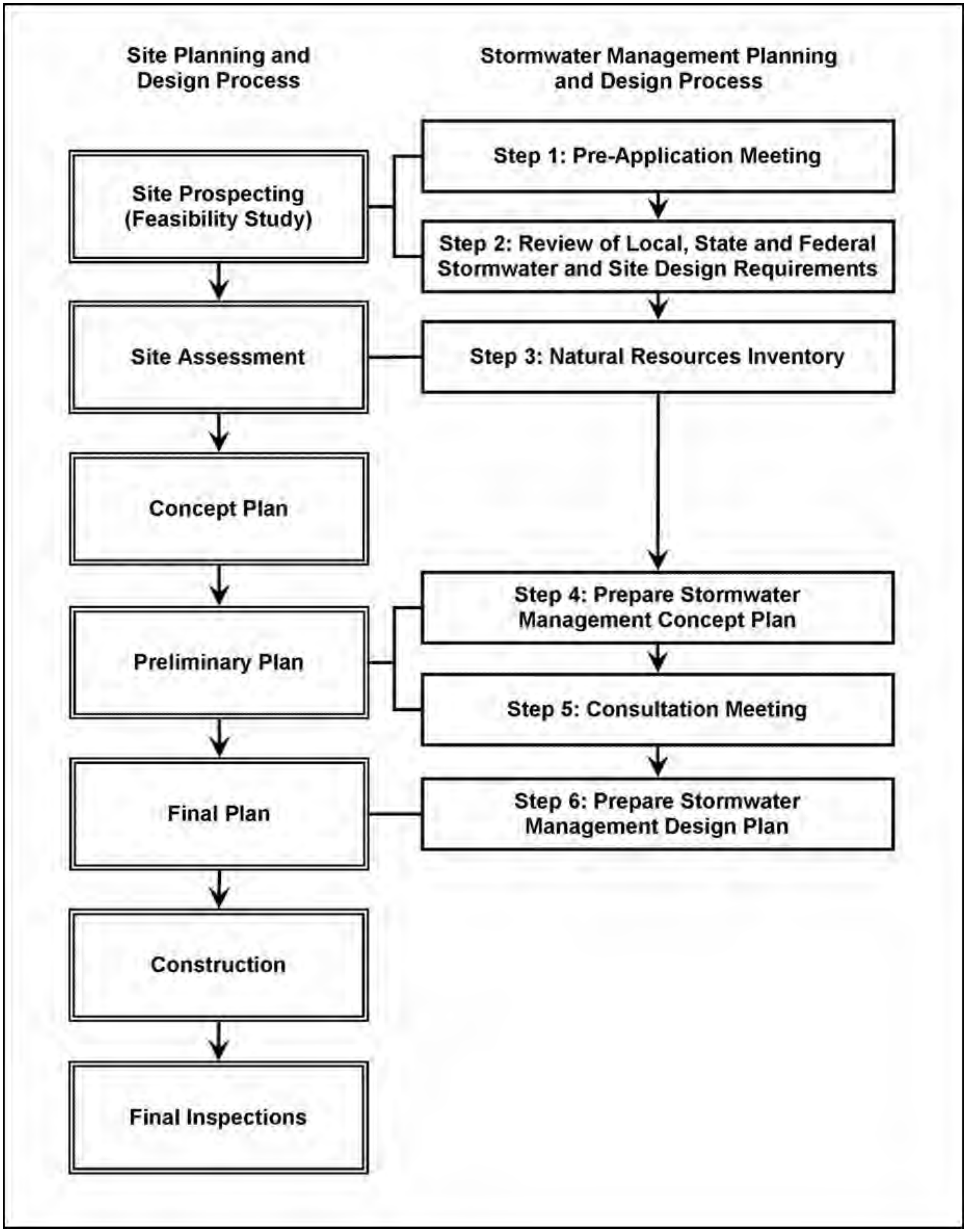

Figure 2.6. Integrating Natural Resource Protection & Stormwater Management with the Site Planning & Design Process (source: Center for Watershed Protection, Inc.).

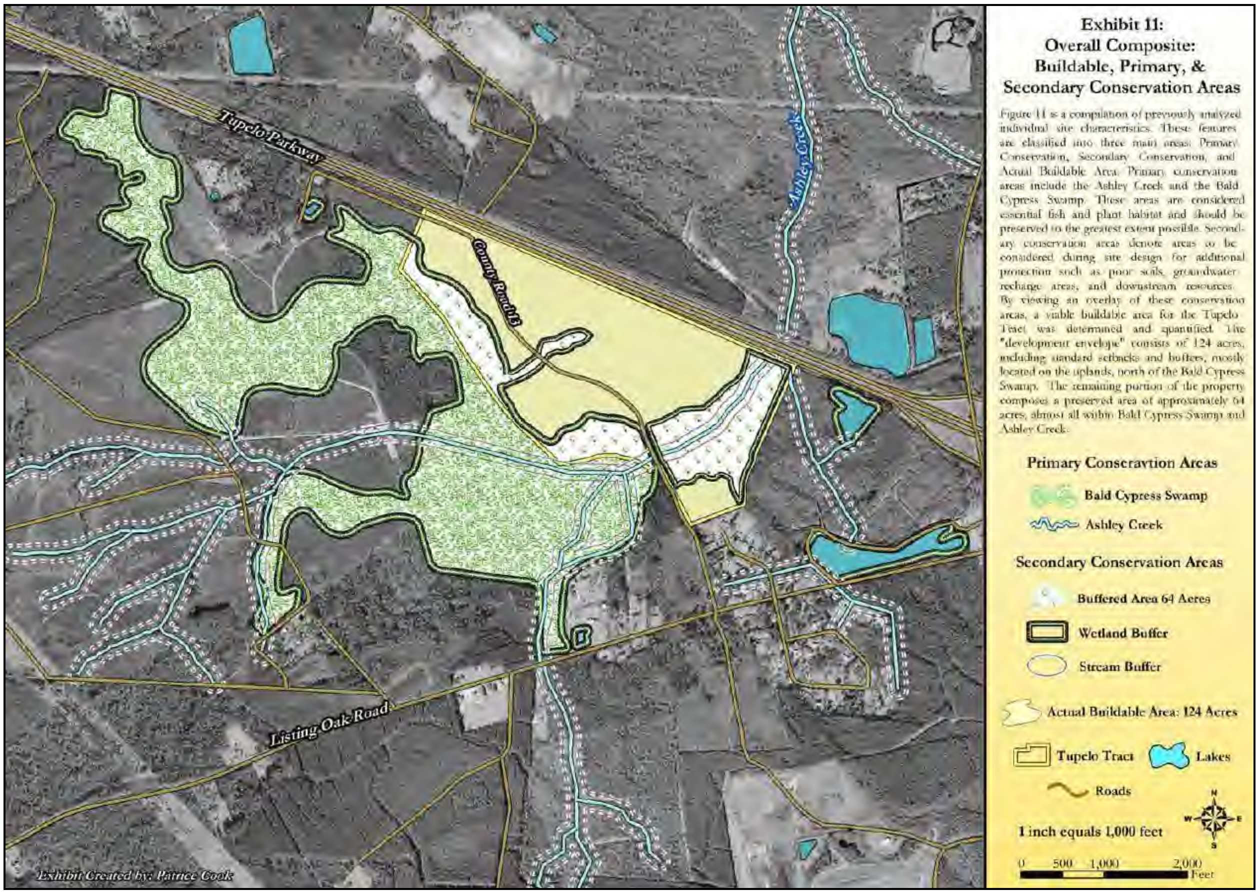

Figure 2.7. Buildable Area and Primary/Secondary Conservation Areas (source: Merrill et al., 2006).

- **<u>Step 4: Prepare Stormwater Management Concept Plan</u>**

After the natural resources inventory has been completed, it is recommended that the site fingerprint be used to develop a stormwater management concept plan for the proposed development project. The stormwater management concept plan should illustrate the layout of the proposed development project and should show, in general, how post-construction stormwater runoff will be managed on the development site.

The creation of a stormwater management concept plan allows the applicant's site planning and design team to make some preliminary decisions about the layout of the proposed development project. If it is submitted to the local development review authority prior to the preparation and submittal of the stormwater management design plan, it can also be used to solicit early feedback on the project and on the green infrastructure and stormwater management practices that will be used to manage post-construction stormwater runoff on the development site.

During the creation of the stormwater management concept plan, most of the site layout, including the layout of lots, buildings, roadways, parking areas, sidewalks and green infrastructure and stormwater management practices, will be completed. Therefore, it is very important that natural resource protection and stormwater management be considered throughout this part of the stormwater management planning and design process.

- **Step 5: Consultation Meeting**

Once a stormwater management concept plan has been created, it is recommended that the applicant's site planning and design team hold a consultation meeting with the *<local jurisdiction>* development review authority. This meeting, which should occur right after completion of the stormwater management concept plan, provides an opportunity to discuss the proposed development project and the approach that was used to satisfy the stormwater management and site planning and design criteria that apply to the development site. It may be advantageous for the consultation meeting to take place on the development site after the concept plan submittal, but prior to approval. This meeting can be used to verify site conditions and feasibility of the proposed stormwater management concept plan.

- **Step 6: Prepare Stormwater Management Design Plan**

Subsequent to review and approval of the stormwater management concept plan, the site planning and design team should prepare a stormwater management design plan. The stormwater management design plan should detail how post-construction stormwater runoff will be managed on the development site and should include maps, narrative descriptions and design calculations (e.g., hydrologic and hydraulic calculations) that show how the stormwater management and site planning and design criteria that apply to the development project have been met. The stormwater management design plan should be submitted to the local development review authority for review and approval.

2.2 Submittal & Review Process of Stormwater Management Plans

The Stormwater Management Plan (SWMP) consists of the entire submittal package and includes the following components:

- Project description and narrative;
- Description of selected stormwater management systems;
- Erosion and sediment control plans;
- Sufficient information to evaluate the environmental characteristics of the affected areas, the potential impacts of the proposed development on water resources, the effectiveness and acceptability of stormwater best management practices (BMPs), and land covers for managing stormwater runoff;
- Supporting computations and drawings; and
- Construction, inspection, and maintenance schedules.

All SWMPs must include the Stormwater submittal checklist (Appendix D) and calculations summary. The plans must include the calculated stormwater retention volume (SWRv) for each BMP and for the overall project, the pre and post development peak flow comparison, extreme flood requirements, and any off-site retention or detention volume obligation.

The SWMP and accompanying documentation may be submitted electronically according to the *<local jurisdiction>* process, but the applicant must also submit one paper copy of the SWMP carrying the stamp of a registered professional engineer licensed in the State of South Carolina with all supporting documentation to *<local jurisdiction>*.

Upon acceptance of a complete application (which includes payment of filing fees), the *<local jurisdiction>* will review the SWMP and make a determination to approve, approve with conditions, or disapprove the SWMP. Relatively large and/or complicated projects tend to require a longer review time than smaller and less complicated projects. A written response of approval or disapproval will be provided to the applicant. If it is determined that more information is needed or that a significant number of changes must be made before the SWMP can be approved, the applicant must resubmit the applications with the revisions required and certified by the registered professional engineer according to the plan resubmittal process of the *<local jurisdiction>*.

When a SWMP approval is granted, a final submission package is required, including the following:

- One PDF copy of the SWMP, certified by a registered professional engineer licensed in the State of South Carolina,
- A declaration of covenants that has been approved for legal sufficiency by the *<local jurisdiction>*, and
- All supporting documents specified within this Manual or as requested during the review process according to the *<local jurisdiction>* requirements.

2.2.1 Components of a Stormwater Management Plan

As itemized in the SWMP checklist in Appendix D Design Checklists, a SWMP includes the following:

Site Plan

The following information must be formatted to print as a standard drawing size of 24 by 36 inches. The site drawing will provide details of existing and proposed conditions:

- A cover page that contains a blank space measuring 7 inches wide by 9.5 inches high. The blank space must be located 1 inch below the top edge and 1 inch from the left edge of the page;
- A plan showing property boundaries and the complete address of the property;
- Lot number or property identification number designation (if applicable);
- North arrow, scale, and date;
- Property lines (include longitude and latitude);
- Location of easements (if applicable);
- Existing and proposed structures, utilities, roads, and other paved areas;
- Existing and proposed topographic contours;
- Soil information for design purposes;
- Area(s) of soil disturbance;
- Drainage area(s) within the limits of disturbance (LOD) and contributing to the LOD;
- Contributing drainage area (CDA) to each BMP;
- Location(s) of BMPs, marked with the BMP ID Numbers to agree with the BMP design summary list;
- Delineation of existing and proposed land covers including natural cover, compacted cover, and impervious surfaces. Consult Appendix G Compliance Calculator Instructions for details;
- Natural resources inventory with site fingerprint map;
- All plans and profiles must be drawn at a scale of 1 in. = 10 ft, 1 in. = 20 ft, 1 in. = 30 ft, 1 in. = 40 ft, 1 in. = 50 ft, or 1 in. = 100 ft. Although, 1 in. = 10 ft, 1 in = 20 ft, and 1 in. = 30 ft, are the most commonly used scales. Vertical scale for profiles must be 1 in. = 2 ft, 1 in. = 4 ft, 1 in. = 5 ft, or 1 in. = 10 ft;
- Drafting media that yield first- or second-generation, reproducible drawings with a minimum letter size of No. 4 (1/8 inch);
- Location and size of existing utility lines including gas lines, sanitary lines, telephone lines or poles, electric utilities and water mains;

- A legend identifying all symbols used on the plan;
- Applicable flood boundaries and FEMA map identification number for sites lying wholly or partially within the 100-year floodplain;
- Site development plan and stormwater management narrative;
- 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. The following site information and practices shall be considered:
    - Soil type (from Soil Study);
    - Depth of ground water on site;
    - Whether the type of development proposed is a hotspot as defined by the Ordinance and Design Manual and address how this influences the concept proposal;
    - Protection of primary and secondary conservation areas;
    - Reduced clearing and grading limits;
    - Reduced roadway lengths and widths;
    - Reduced parking lot and building footprints to minimize impervious surface;
    - Soil restoration;
    - Site reforestation/revegetation;
    - Impervious area disconnection;
    - Green roof (for redevelopment, infill and major substantial improvement projects); and
    - Permeable pavements.
- Stormwater Pollution Prevention Plan (SWPPP) or Erosion and Sediment Control narrative (for projects disturbing over an acre);
- Information regarding the mitigation of any off-site impacts anticipated as a result of the proposed development;
- Construction specifications;
- Design and As-Built Certification, including the following:

    Certification by a registered professional engineer licensed in the State of South Carolina seal that the site design, land covers, and design of the BMPs conforms to the standard of care applicable to the treatment and disposal of stormwater pollutants and that the Facility has been designed in accordance with the specifications required under the stormwater ordinance of the *<local jurisdiction>.*

    Submission one set of the As-Built drawings sealed by a registered professional engineer licensed in the State of South Carolina within 21 days after completion of construction of the site, all BMPs, land covers, and stormwater conveyances.

    For a project consisting entirely of work in the public right-of-way (PROW), the submission of a Record Drawing certified by an officer of the project contracting company is acceptable if it details the as-built construction of the BMP and related stormwater infrastructure.
- Maintenance sheet for stormwater BMPs, including the following:

    i A maintenance plan that identifies routine and long-term maintenance needs and a maintenance schedule;

    ii A maintenance agreement and schedule for all post construction best management practices in a form and manner that meets the *<local jurisdiction>* requirements.

    iii For applicants using Rainwater Harvesting, submission of third-party testing of end-use water quality may be required at equipment commissioning as determined by the requirements in Appendix J Rainwater Harvesting Treatment and Management

Requirements. Additional regular water quality reports certifying compliance for the life of the BMP may also be required in Appendix J Rainwater Harvesting Treatment and Management Requirements.

Stormwater Retention Volume Computations

The following summary calculations must be included on the plan set. Supporting documentation and the South Carolina DHEC C-SWPPP are not in the plan set but provided separately.

- Calculation(s) of the required SWRv for the entire site within the LOD and each site drainage area (SDA) within the LOD;
- Calculation(s) for each proposed BMP demonstrating retention value towards SWRv in accordance with Chapters 2 and 4;
- For Rainwater Harvesting BMP, calculations demonstrating the annual water balance between collection, storage, and demand, as determined using the Rainwater Harvesting Retention Calculator;
- For proprietary and non-proprietary BMPs follow the guidance in Chapter 4.13 to identify/receive approval or denial to use these practice(s); and
- Off-site stormwater volume requirement.

Pre-/Post-Development Hydrologic Computations

Include in the plan set a summary of the pre-/post-runoff analysis with the following information at a minimum:

- A summary of soil conditions and field data;
- Pre- and post-project curve number summary table;
- Pre and post construction peak flow summary table for the 2-, 10-, 25- and 50-year 24-hour storm events for each SDA within the project's LOD; and
- Flow control structure elevations.

Hydraulic Computations

Hydraulic computations for the final design of water quality and quantity control structures may be accomplished by hand or through the use of software using equations/formulae as noted in Chapters 3 and 4. The summary of collection or management systems will include the following:

- Existing and proposed SDA must be delineated on separate plans with the flow paths used for calculation of the times of concentration;
- Hydraulic capacity and flow velocity for drainage conveyances, including ditches, swales, pipes, inlets, and gutters. Plan profiles for all open conveyances and pipelines, with energy and hydraulic gradients for the 25-year and 100-year, 24-hour storms;
- The proposed development layout including the following:
    - Location and design of BMP(s) on site, marked with the BMP ID Numbers;
    - Stormwater lines and inlets;
    - A list of design assumptions (e.g., design basis, 2 through 50-year return periods);
    - The boundary of the CDA to the BMP;
    - Schedule of structures (a listing of the structures, details, or elevations including inverts); and

- Manhole to manhole profile, listing of pipe size, pipe type, slope, (i.e., a storm drain pipe schedule) computed velocity, and computed flow rate, energy grade line (EGL) and hydraulic grade line (HGL).

Supporting Documentation
Provide a written report with the following supporting documentation:

- Pre- and post-project curve number selection
- Time of concentration calculation;
- Travel time calculation;
- Hydrologic computations supporting peak discharges assumed for each SDA within the project's LOD for the 2-, 10-, 25-, and 100-year, 24-hour storm events;
- SC DHEC's Construction Stormwater Pollution Prevention Plan (C-SWPPP).

A professional engineer registered in the State of South Carolina must also submit the following:

1. Elevation and topographic data illustrating changes in topography and drainage;
2. Impacts upon local flood flows (25- and 100-yr storm events;
3. Identify areas where stormwater flows are discharged off-site or off-property;
4. For proposed off-site/property discharge points, perform analysis of receiving off-site conveyance systems to confirm safe conveyance from the proposed developed property, no negative impact to adjacent properties, and adequacy of the receiving, existing conveyance system for 25-yr storm flows. Such analysis shall be taken to point where the 25-yr storm conveyance is determined to be adequate in the public stormwater conveyance/infrastructure system; and
5. Documentation supporting safe passage of the 100-yr post development flow according to the 10% Rule (see Section 3.8);

2.2.2 Resubmission of Stormwater Management Plans

If changes occur in the design or construction of an accepted SWMP, the applicant may be required to resubmit the SWMP for approval. Examples of changes during design and construction that will require SWMP resubmission for review include the following:

1. Revision to the property boundary, property size, or LOD boundaries that may require redesigning BMPs;
2. Any change to SWRv through land cover designation change;
3. Change in compaction or infiltration rates due to construction activities;
4. Encountering contaminated soil or other underground source of contamination;
5. Changes to floodplain designation or requirements;
6. Changes in any component of the BMP that may adversely affect the intended capacity of the approved BMP, such as the following:
    a. Modification to approved BMP selection, dimensions, or location
    b. Modification to approved material specification
    c. Changes to the size, invert, elevation, and slopes of pipes and conveyances
    d. Installation of new drains and conveyance structures
    e. Need for a new storm sewer outlet connection to the sanitary/storm sewer main
    f. Changes to the amount of off-site requirements
    g. Changes to the CDA to a BMP
7. Revision to the approved grading and drainage divides and that may require redesigning BMPs;

8. Relocation of an on-site storm sewer or conveyance; or
9. Abandonment, removal, or demolition of a BMP.

If the applicant resubmits an SWMP after making changes, the resubmission must contain a list of the changes made and may be in the form of a response to comments. The resubmittal plans and calculations must include the stamp of the registered professional engineer in South Carolina.

However, if any of the following minor changes are made to the SWMP, resubmission is not required. These minor changes may be made anytime during inspection or at the as-built submittal by the *<local jurisdiction>*.

1. Changes to SWM components that do not adversely affect BMP capacity while in consultation with the *<local jurisdiction>*. The inspector should review the appropriate manufacturer's documentation to his/her satisfaction before approving such a change and should ensure that such changes are recorded as red line changes or deviations in the as-built plans. These changes include the following:
    a. Changes to parts type of similar function (e.g. dewatering valve)
    b. Change in hole pattern or size of underdrain pipe perforations
    c. Change in project address, ownership, permit status, or zoning

2.2.3 Design Certifications

The engineer shall certify that this Plan satisfies all requirements of the Southern Lowcountry Ordinance and Stormwater Design Manual. The following statement with engineer's seal is required in the Plan submittal.

> The engineering features of all stormwater best management practices (BMPs), stormwater infrastructure, and land covers (collectively the "Facility") have been designed/examined by me and found to be in conformity with the standard of care applicable to the treatment and disposal of stormwater pollutants. The Facility has been designed in accordance with the specification required under Ordinance XXX of *<local jurisdiction>.*

2.2.4 Performance Bonds

Bonding for the cost of stormwater facilities approved for the proposed development shall be provided in accordance with the *<local jurisdiction>* bonding and permit issuance process. It is recommended that the bond be in the amount of 125% of the approved estimated cost (labor, equipment, material and incidentals) for construction/installation of the approved stormwater management facilities. The *<local jurisdiction>* shall require from the developer a surety or cash bond, irrevocable letter of credit, or other means of security acceptable to the *<local jurisdiction>* prior to the issuance of any building and/or grading permit for any land development or redevelopment activity requiring a permanent stormwater management system. The bond required shall include provisions relative to forfeiture for failure to complete work specified in the approved stormwater management design plan, compliance with all of the provisions of this ordinance, other applicable laws and regulations, and any time limitations. The bond shall not be fully released without a final inspection of the completed work by the *<local jurisdiction>*, a recorded inspection and maintenance agreement and plan, and submission of "as-built" plans containing certifications provided by the Applicant and Engineer, including the following:

1. Certification that facilities were constructed in accordance with the submitted and approved design and will function as designed.

2. As-built certification to be on as-built drawing submitted by Engineer after construction and prior to Certificate of Project Completion and confirming line, size, elevation and grade of constructed stormwater BMPs and drainage/conveyance systems.

A procedure may be used to release parts of the bond held by the *<local jurisdiction>* after various stages of construction have been completed and accepted by the *<local jurisdiction>*. Partial Bond release will be determined for the portion of work being accepted and construction work has been approved by <*<local jurisdiction* >. All requirements pertaining to this portion of work have been satisfied to include, but not be limited to, as-builts plans, all certifications and approvals for that portion of work related to the partial bond release have been provided by applicant's Engineer and approved by <*local jurisdiction* >.The procedures used for partially releasing performance bonds must be specified by the *<local jurisdiction>* in writing prior to the approval of a stormwater management design plan.

2.3 Construction Inspection Requirements

2.3.1 Inspection Schedule & Reports

Prior to the approval of a SWMP, the applicant will submit a proposed construction inspection schedule. The *<local jurisdiction>* will review the schedule to determine if changes are required. The construction schedule should reflect the construction sequences defined in each BMP section Stormwater Best Management Practices (BMPs) of this Manual. The construction and inspection schedule must be included in the SWMP. The *<local jurisdiction>* will conduct inspections and file reports of inspections during construction of BMPs and site stormwater conveyance systems to ensure compliance with the approved plans.

Note: No stormwater management work may proceed past the stage of construction that the *<local jurisdiction>* has identified as requiring an inspection unless

- the *<local jurisdiction>* has issued an "approved" or "passed" report;
- the *<local jurisdiction>* has approved a plan modification that eliminates the inspection requirement; or
- the *<local jurisdiction>* has eliminated or modified the inspection requirement in writing.

The *<local jurisdiction>* may require that the professional engineer responsible for sealing the approved SWMP, the professional engineer responsible for certifying the as-built SWMP, or, for a project entirely in the PROW, the officer of the contracting company responsible for certifying the Record Drawing be present during inspections.

If the *<local jurisdiction>* conducts an inspection and finds work that is not in compliance with the SWMP, the *<local jurisdiction>* will issue a written notice, and the applicant must take prompt corrective action. The written notice provides details on the nature of corrections required and the time frame within which corrections must be made.

2.3.2 Inspection Requirements Before & During Construction

The *<local jurisdiction>* construction stormwater inspection form is provided in Appendix E Construction Inspection Form.

Preconstruction Meetings. These meetings are required prior to the commencement of any land-disturbing activities and prior to the construction of any BMPs. The applicant is required to contact the *<local jurisdiction>* to schedule preconstruction meetings three (3) days prior to beginning any construction activity subject to the requirements the *<local jurisdiction>*.

Inspections During Construction. The applicant is required to contact the *<local jurisdiction>* to schedule inspection three (3) days prior to any stage of BMP construction, or other construction activity, requiring an inspection. For large, complicated projects, the applicant and the *<local jurisdiction>* may agree during the preconstruction meeting to an alternative approach such as a weekly notification schedule. Any such agreement must be made in writing and signed by all parties. The *<local jurisdiction>* will revert to the 3-day notification procedure if the agreement is not followed.

During construction, the *<local jurisdiction>* **may require the presence of the professional engineer responsible for sealing the approved SWMP; the professional engineer responsible for certifying the as-built SWMP; or for a project entirely in the PROW, the officer of the contracting company responsible for certifying the Record Drawing.**

Final Inspection. The applicant is required to contact the *<local jurisdiction>* to schedule a final inspection one week prior to the completion of a BMP construction to schedule a final inspection of the BMP. Upon completion of the BMP, *<local jurisdiction>* will conduct a final inspection to determine if the completed work was constructed in accordance with approved plans.

Inspection Requirements by BMP Type. Chapter 4 Stormwater Best Management Practices (BMPs) of this Manual provides details about the construction sequences for each BMP. After holding a preconstruction meeting, regular inspections will be made at the following specified stages of construction:

- **Infiltration Systems and Bioretention Areas** shall be inspected at the following stages to ensure proper placement and allow for infiltration into the subgrade:
    - During on-site or off-site percolation or infiltration tests;
    - Upon completion of stripping, stockpiling, or construction of temporary sediment control and drainage facilities;
    - Upon completion of excavation to the subgrade;
    - Throughout the placement of perforated PVC/HDPE pipes (for underdrains and observation wells) including bypass pipes (where applicable), geotextile materials, gravel, or crushed stone course and backfill; and
    - Upon completion of final grading and establishment of permanent stabilization;
- **Flow Attenuation Devices**, such as open vegetated swales upon completion of construction;
- **Retention and Detention Structures**, at the following stages:
    - Upon completion of excavation to the sub-foundation and, where required, installation of structural supports or reinforcement for structures, including but not limited to the following:
    - During testing of the structure for watertightness;
    - During placement of structural fill and concrete and installation of piping and catch basins;
    - During backfill of foundations and trenches;
    - During embankment construction; and
    - Upon completion of final grading and establishment of permanent stabilization.
- Stormwater Filtering Systems, at the following stages:

- Upon completion of excavation to the sub-foundation and installation of structural supports or reinforcement for the structure;
- During testing of the structure for watertightness;
- During placement of concrete and installation of piping and catch basins;
- During backfill around the structure;
- During prefabrication of the structure at the manufacturing plant;
- During pouring of floors, walls, and top slab;
- During installation of manholes/trap doors, steps, orifices/weirs, bypass pipes, and sump pit (when applicable);
- During placement of the filter bed; and
- Upon completion of final grading and establishment of permanent stabilization.

- Green Roof Systems, at the following stages:
  - During placement of the waterproofing layer, to ensure that it is properly installed and watertight;
  - During placement of the drainage layer and drainage system;
  - During placement of the growing media, to confirm that it meets the specifications and is applied to the correct depth (certification for vendor or source must be provided);
  - Upon installation of plants, to ensure they conform to the planting plan (certification from vendor or source must be provided); and
  - At the end of the first or second growing season, to ensure desired surface cover specified in the Care and Replacement Warranty has been achieved.

2.3.3 Final Construction Inspection Reports

The *<local jurisdiction>* will conduct a final inspection to determine if the completed work is constructed in accordance with approved plans and the intent of this Manual and the Stormwater Ordinance. Within 21 days of the final inspection, the applicant must submit an as-built package, including one PDF copy of the as-built SWMP certified by a registered professional engineer licensed in the State of South Carolina. For a project consisting entirely of work in the PROW, the submission of a Record Drawing certified by an officer of the project contracting company is acceptable if it details the as-built construction of the BMPs, related stormwater infrastructure, and land covers.

A registered professional engineer licensed in South Carolina is required to certify as-built SWMPs and state that all activities including clearing, grading, site stabilization, the preservation or creation of pervious land cover, the construction of drainage conveyance systems, the construction of BMPs, and all other stormwater-related components of the project were accomplished in strict accordance with the approved SWMP and specifications. As stated in Section 2.2.2 Resubmission of Stormwater Management Plans, all plan changes are subject to the *<local jurisdiction>* approval. The as-built certification must be on the original SWMP.

Upon completion, these plans will be submitted to the *<local jurisdiction>* for processing. The estimated time for processing will be two weeks (10 working days), after which the plans will be returned to the engineer. The *<local jurisdiction>* will provide the applicant with written notification of the final inspection results.

2.3.4 Inspection for Preventative Maintenance

The Stormwater Ordinance requires maintenance inspections for BMPs and landcovers to ensure their ongoing performance is in compliance with their original design. The inspection will occur at least once every three (3) years. Maintenance inspection forms are provided in Appendix F Maintenance Inspection Checklists. The *<local jurisdiction>* will conduct these maintenance inspections, though it may, in certain circumstances, allow a property to self-inspect and provide documentation.

The *<local jurisdiction>* will maintain maintenance inspection reports for all BMPs. The reports will evaluate BMP functionality based on the detailed BMP requirements of Stormwater Best Management Practices (BMPs) and inspection forms found in Appendix F Maintenance Inspection Checklists.

If, after an inspection by the *<local jurisdiction>*, the condition of a BMP presents an immediate danger to the public safety or health because of an unsafe condition or improper maintenance, the *<local jurisdiction>* will take such action as may be necessary to protect the public and make the BMP safe. Any costs incurred by the *<local jurisdiction>* will be assessed against the owner(s).

2.4 Inspections & Maintenance

2.4.1 Inspections & Maintenance Responsibilities

A site with an approved SWMP must also have a responsible party inspect and maintain the BMPs and land covers according to the inspections and maintenance schedule in the SWMP and this Manual. Land covers must be maintained in type and extent as approved. Approved BMPs must be kept in good condition, including all the engineered and natural elements of each practice, as well as conveyance features (e.g., grade surfaces, walls, drains, structures, vegetation, soil erosion and sediment control measures, and other protective devices). All repairs or restorations must be in accordance with the approved SWMP.

A declaration of covenants including an exhibit stating the owner's specific maintenance responsibilities must be recorded with the property deed at the Record of Deeds. An inspection and maintenance schedule for any BMP will be developed for the life of the project and shall state the inspection and maintenance to be completed, the time for completion, and who will perform the inspections and maintenance. The schedule will be printed on the SWMP and will appear as an exhibit in the declaration of covenants.

2.4.2 Inspection & Maintenance Agreements

Inspection and maintenance obligations are binding on current and future owners of a property subject to recorded covenants. The *<local jurisdiction>* will not issue final approval of a complete set of the SWMP for private parcels until the applicant has executed a declaration of covenants providing notice of this obligation to current and subsequent owners of the land served by the BMP(s) and land covers. Inspection and maintenance agreements by regulated projects include providing access to the site and the BMP(s) at reasonable times for regular inspection by the *<local jurisdiction>* and for regular or special assessments of property owners, as needed, to ensure that the BMP(s) is maintained in proper working condition and the land covers are retained as approved in the SWMP. An example of the declaration of covenants/maintenance agreement for a site with BMPs and designated land covers is provided at the end of this chapter.

The applicant must record the agreement as a declaration of covenants with the *<local jurisdiction>* Recorder of Deeds. The agreement must also provide that, if after written notice by the *<local jurisdiction>* to correct a violation requiring maintenance work, satisfactory corrections are not made by the owner(s) of the land served by the BMP within a reasonable period of time, not to exceed 45 to 60 days unless an extension is approved in writing by the *<local jurisdiction>.* The *<local jurisdiction>* may perform all necessary work to place the BMP in proper working condition. The owner(s) of property served by the BMP will be assessed the cost of the work and any penalties, and there will be a lien on any property served by the BMP, which may be placed on the tax bill and collected as ordinary taxes by the State.

2.5 As-Built Submittals

One set of As-Built drawings sealed by a registered professional engineer licensed in the State of South Carolina must be submitted within 21 days after completion of construction of the site, all BMPs, land covers, and stormwater conveyances as required by the procedure for handling close out documents for private development projects by the *<local jurisdiction>.*

The following items must be completed and provided:

General Information:

- Words As-Built in or near the project title
- As-Built Signature/Approval block on each sheet
- As-builts shall have a coordinate system based on the South Carolina Coordinate System North American Datum of 1983 (NAD83).
- Elevations shown shall be based on the North American Vertical Datum of 1988 (NAVD88).
- Vicinity map
- Sheets numbered correctly
- Project ID number, Project Name, Permit number and name, address and contact information of project engineer
- All measurements and coordinates shall be shown on all drainage structures, detention and BMP structure outlets, outlet control structures and manholes.
- Any change to BMP capacities, dimensions, specifications or location shall be shown as mark-through of the original design on the drawings
- Elevations to the nearest 0.1 ft.

Basins:

- At least two benchmarks on the plans
- Profile of the top of berm
- Cross-section of emergency spillway at the control section
- Profile along the centerline of the emergency spillway
- Cross-section of berm at the principle spillway
- Elevation of the principle spillway crest or top of structure elevations
- Elevation of the principle spillway inlet and outlet invert
- Riser diameter/dimensions and riser base size
- Diameter, invert elevation and sizes of any stage orifices, weirs or storm drain pipes
- Barrel diameter, length, and slope
- Types of material used
- Outfall protection length, width, depth, size of rip rap and filter cloth
- Size, location, and type of anti-vortex and trash rack device (height and diameter, elevations and spacing)
- Pipe cradle information
- On plan view show length, width and depth of pond and contours of the basin area so that design volume is specified
- As-built spot elevations with the disturbed area required for basin construction in sufficient detail to provide accurate as-built contours

- Core trench limits and elevation s of bottom of cut off trench
- Show length width and depth of outfall rip rap
- Certification by a Geotechnical Engineer for compact and unified soil classes
- Vegetation cover certification
- Show location of planted landscaping
- Utility locations and elevations encountered, test pitted and/or relocation during contract work

Storm Drain Piping:

- At least two benchmarks on the plans
- Diameter and class of pipe
- Invert of pipe at outfall, structures and/or field connections
- Slope of pipe
- Pipe lengths (show stationing)
- Types of materials
- Location of all pipes and structures horizontally on the plan
- Length, width and depth of all rip rap and other outfall protection as specified
- Elevation of rip rap at outfall and at changes in grade
- Utility locations and elevations encountered, test pitted and/or relocation during contract work

Post construction BMP Specific details:

- Provide as-built details as described for each best management practice in Chapter 4.

2.6 References

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Chapter 3. Minimum Control Requirements

3.1 Introduction

This chapter establishes the minimum stormwater control standards necessary to implement the Southern Lowcountry Stormwater Ordinance within the <*local jurisdiction*>. The term "runoff reduction" is used throughout this chapter to describe the retention of the stormwater on site. The SWRv is used to describe the volume of stormwater to be retained on site.

Two levels of stormwater retention are prescribed, the 85th and the 95th percentile storm, and are assigned based on a site's subwatershed as identified by the U.S. Geological Survey Hydrologic Unit Code 12 (HUC-12) presented in Section 3.5.1 below. In addition, peak discharge control of the post-development 2-, 10- and 25-year, 24-hour storms to their predevelopment flow shall be provided by a combination of structural controls, GI/LID practices and other non-structural BMPs. As well, requirements to manage the 100-yr, 24-hour storm event are provided in the extreme flood event section below. Further, this Manual and Appendices provide the framework and necessary tools to document the methods proposed by development plans to comply with these requirements. It should be noted that stormwater ponds are considered the least favorable structural best management practice to meet the SWRv and water quality requirements of this Manual.

3.2 Regulated Site Definition

According to the Stormwater Ordinance, the design criteria of this Manual shall be applicable to any new development, redevelopment or major substantial improvement activity, including, but not limited to, site plan applications, public improvement projects, and subdivision applications that meet the applicability standards found in Chapter 1.4.

The Southern Lowcountry stormwater design requirements are applied according to the flow chart in Figure 3.1 and should be determined as follows:

1) In sequence, first determine which HUC-12 watershed that the project is in according to Table 3.1. Stormwater design criteria for the development follows the watershed area in which it is located. Next, determine the square feet of impervious area to be created, added or replaced as a part of the development or redevelopment. Does it equal or exceed 5,000 square feet? Or will the project disturb greater than 1 acre? If the answer is "yes" to either of these questions, the project plan must meet the requirements for stormwater management in this Manual for their respective watershed area.

2) If a project is a major substantial improvement, it must meet the water quality criteria for its respective watershed protection area to the maximum extent practicable (MEP) or obtain off-site stormwater credit. The terms MEP and off-site stormwater credit are further explained in Section 3.9 and 3.10 below. <u>Peak control requirements do not apply to major substantial improvement projects.</u>

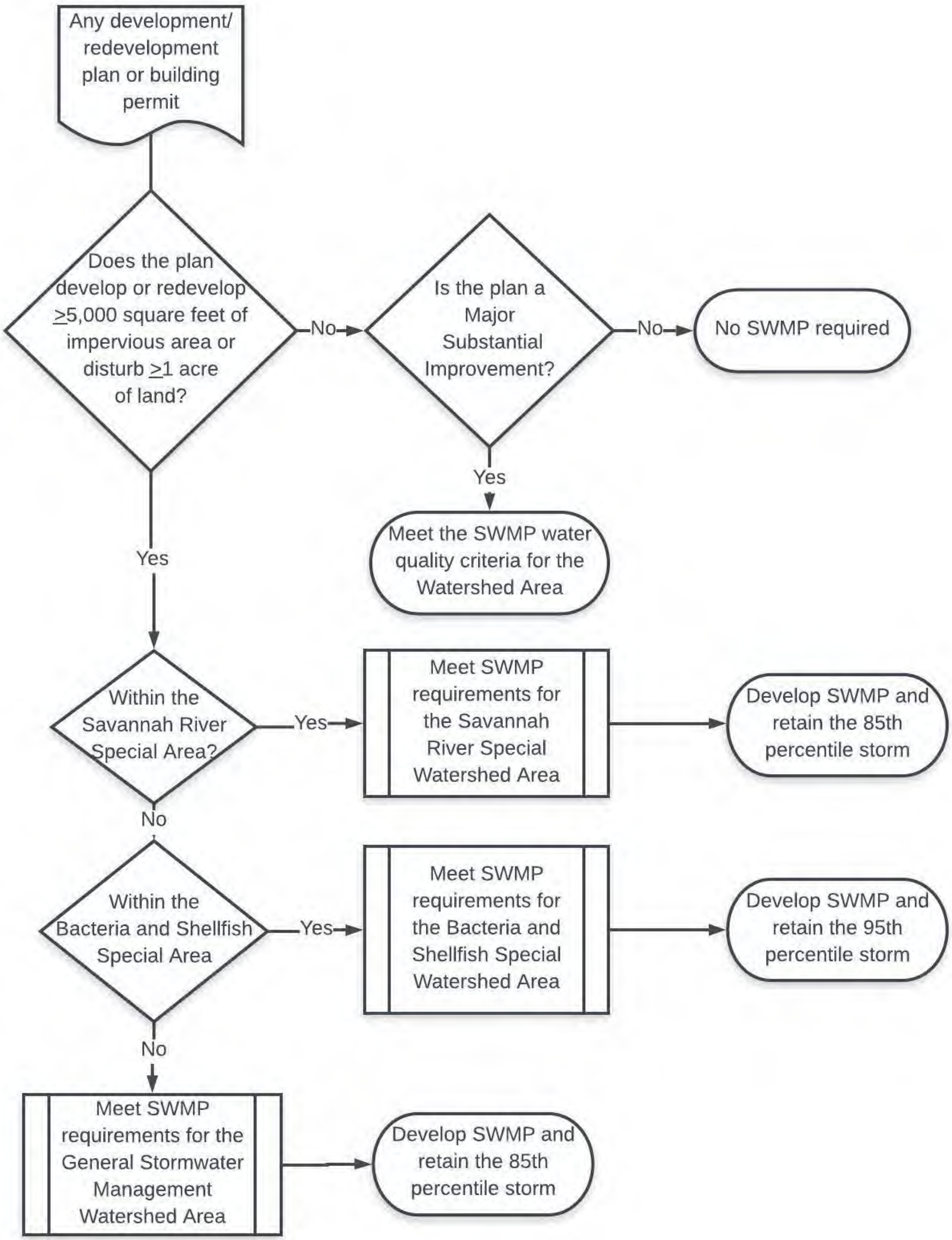

Figure 3.1. Southern Lowcountry Stormwater Design Manual applicability diagram.

3.3 Infill & Redevelopment

An infill project is one on a previously platted property that may or may not have stormwater management capacity in its original development plan. Regardless of size, infill that is part of a larger common plan of development, even through multiple, separate, and distinct land disturbing activities that may take place at different times and on different schedules must comply with this Manual. Such projects may include Planned Unit Developments (PUDs) that have stormwater systems built that do not meet the requirements of this Manual. If the proposed project meets the applicability criteria of Section 1.4.1, the stormwater plan review in this Manual is necessary. If the development's original stormwater management plan is sufficient to meet the current requirements of this Manual and is documented through approved plans and as-built drawings, or current field measurements and engineering calculations, no further stormwater requirements must be met. When the infill project is part of an original plan that does not meet the current stormwater requirements, the level of stormwater management that is provided in the current development may be credited toward the current volume and hydrologic analysis. Infill locations that, due to the municipal jurisdiction's zoning or land use requirements or site conditions, cannot meet the requirements of this Manual must complete the maximum extent practicable (MEP) evaluation in Section 3.9 for project approval.

Similarly, redevelopment may be credited for the level of stormwater in place. If the redevelopment's original stormwater management plan is sufficient to meet the current requirements of this Manual and is documented through approved plans and as-built drawings, or current field measurements and engineering calculations, no further stormwater requirements must be met. When the redevelopment is part of an original plan that does not meet the current stormwater requirements, the level of stormwater management that is provided in the current development may be credited toward the current volume and hydrologic analysis. Redevelopment projects that, due to the municipal jurisdiction's zoning or land use requirements or site conditions, cannot meet the requirements of this Manual must complete the maximum extent practicable (MEP) evaluation in Section 3.9 for project approval.

3.4 Stormwater Runoff Quality & Peak Discharge Control

Since its inception, the Clean Water Act was designed to address the water quality impacts of stormwater runoff. As it has been applied through successive stormwater permit cycles, the Act's requirements have been interpreted to mean application of stormwater best management practices to the maximum extent practicable. The U.S. Environmental Protection Agency (EPA) has stated that such conditions include specific tasks or best management practices (BMPs), BMP design requirements, and performance requirements (EPA, 81 Fed. Reg. 3).

Consistent with the EPA's Phase II MS4 permit, this Manual requires that stormwater runoff shall be adequately treated before it is discharged from a development site. A stormwater management system is assumed to meet the stormwater runoff quality criteria by satisfying the stormwater runoff volume criteria for its respective Watershed Area presented in this Manual. If any of the required stormwater runoff volume cannot be reduced on the site, due to impractical site characteristics or constraints, the following questions shall be addressed in the permitting process:

1. Can the required stormwater volume be obtained from an adjacent site owned or available for stormwater retention purposes;
2. Is there available stormwater retention volume within the adjacent right-of-way and available through fee-in-lieu arrangements within this jurisdiction; and

3. Is a waiver granted based on a maximum extent practicable evaluation?

Further, a stormwater management system is presumed to comply with these criteria if:

- It intercepts and treats stormwater runoff in stormwater management practices that have been selected, designed, constructed and maintained in accordance with this Manual;
- It is provided with documentation 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;
- It is designed to provide the amount of stormwater load reduction specified in the latest edition of this Manual; and
- It manages the peak flow and extreme flood event storms in accordance with this Manual.

3.5 Southern Lowcountry Stormwater Management Performance Requirements

Stormwater management requirements of this Manual are intended to enhance the quality of development, protect and enhance stormwater quality and management, protect aquatic resources from the negative impacts of the land development process, address water quality impairments or a total maximum daily load, as identified by the South Carolina Department of Health and Environmental Control (DHEC), or address localized flooding issues.

3.5.1 Watershed Protection Area Designations

Not all watersheds of the Southern Lowcountry region require the same level of post-construction stormwater management. Currently, three watershed protection areas are designated with specific unique stormwater management requirements based on the current and anticipated water quality control measures for their contributing watersheds. The Southern Lowcountry Stormwater Ordinance provides the *<local jurisdiction>* the flexibility and authority to designate subwatersheds or drainage areas as Special Watershed Protection Areas that lead to more restrictive requirements or special criteria. Such special designations and criteria will be provided as Appendix P to this Manual.

In the Southern Lowcountry, impairments include recreational water use impairment from bacteria (*Enterococcus* for saltwater and *E. coli* for freshwater), aquatic life use impairment from turbidity or dissolved oxygen, and shellfish harvesting use impairment from fecal coliform bacteria. Stormwater best management practices for these types of impairments include erosion and sediment control for turbidity impairments, illicit discharge detection, vegetated conveyances, vegetated buffers, pet waste programs, and post-construction runoff control. Currently, Southern Lowcountry water quality impairments do not include nutrient impairments, but nutrients can also be addressed through erosion and sediment control and the stormwater best management practices outlined in this Manual.

Most of Beaufort County and the lower reaches of the Jasper County watersheds have shellfish receiving waters or are recreational waters and are therefore sensitive to bacteria impairments. Land development and redevelopment projects in these watersheds require greater scrutiny to ensure that low impact development methods are designed, implemented and maintained to be protective of these water uses.

Watersheds tributary to the Savannah River in the Southern Lowcountry include most of the freshwater wetlands of the region. River water quality is excellent and is a supply for drinking water for the City of Savannah and the Beaufort Jasper Water and Sewer Authority. Savannah River impairments downstream of the I-95 bridge are primarily aquatic life use due to low dissolved oxygen. Since the

Savannah River is the boundary of Georgia and South Carolina, it is reasonable to align stormwater requirements within Jasper County with those in Chatham and Effingham Counties, GA. Stormwater permits for the Georgia jurisdictions require use of the Georgia Coastal Stormwater Supplement to the Georgia Stormwater Management Manual, which is primarily a green infrastructure/low impact development (GI/LID) design Manual with requirements specific to the Georgia coastal counties.

The remaining watersheds of the Southern Lowcountry are more upland areas and in agricultural or silvicultural use or are conservation lands. For these areas new development is subject to stormwater management requirements similar to previous county requirements. This Manual unifies stormwater management standards across the designated watersheds rather than differing across county or jurisdictional lines.

The map in Figure 3.2 outlines the boundaries of the three watershed protection areas of the Southern Lowcountry. Requirements specific to each area are further developed in this chapter. Table 3.1 lists the US Geological Survey 12-Digit Hydrologic Unit Code (HUC-12) for the watersheds in each area. To identify a site's HUC-12, refer to the South Carolina DHEC Watershed Atlas, available online at https://gis.dhec.sc.gov/watersheds/. After identifying the site's HUC 12, use Table 3.2 to identify the watershed protection area.

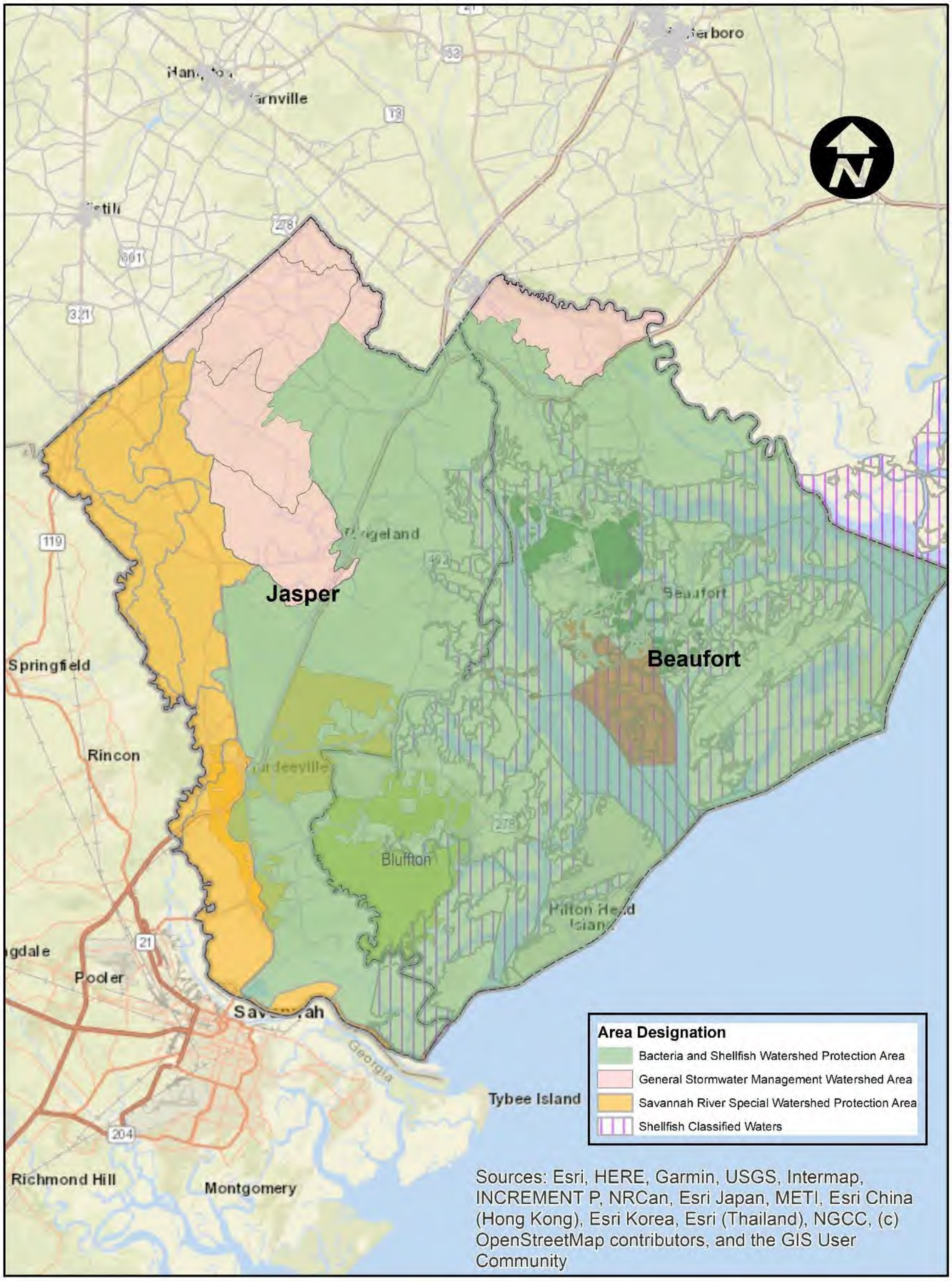

Figure 3.2. Watershed Protection Areas of the Southern Lowcountry.

Table 3.1. Watershed Protection Area HUC-12 Codes.

General Stormwater Management Watershed Areas		Savannah River Watershed Protection Area	
HUC-12 No.	Watershed Name	HUC-12 No.	Watershed Name
030502070704	Middle Combahee River	030601090107	Hog Branch-Savannah River
030502080301	Johns Pen Creek	030601090301	Cypress Branch
030502080302	Cypress Creek	030601090302	Black Swamp
030502080404	Mcpherson Creek-Coosawhatchie River	030601090303	Coleman Run
030502080405	Early Branch-Coosawhatchie River	030601090304	Sand Branch
030601100101	Gillison Branch	030601090305	Dasher Creek-Savannah River
030601100102	Upper Great Swamp	030601090307	Outlet Savannah River
Bacteria and Shellfish Watershed Protection Area			
HUC-12 No.	Watershed Name	HUC-12 No.	Watershed Name
030502070706	Lower Combahee River	030502080605	Boyd Creek-Broad River
030502071101	Wimbee Creek	030502080606	Colleton River
030502071102	Coosaw River	030502080607	Chechessee River
030502071103	Morgan River	030502080608	Broad River-Port Royal Sound
030502071104	Coosaw River-St. Helena Sound	030502100101	Harbor River-St. Helena Sound
030502080406	Bees Creek	030502100102	Harbor River-Trenchards Inlet
030502080407	Tulifiny River-Coosawhatchie River	030601090306	Wright River
030502080501	Battery Creek	030601100103	Lower Great Swamp
030502080502	Upper Beaufort River-Atlantic Intracoastal Waterway	030601100201	Upper New River-Atlantic Intracoastal Waterway
030502080503	Lower Beaufort River-Atlantic Intracoastal Waterway	030601100202	Lower New River-Atlantic Intracoastal Waterway
030502080601	Pocotaligo River-Broad River	030601100301	May River
030502080602	Huspa Creek	030601100302	Broad Creek
030502080603	Whale Branch	030601100303	Cooper River-Calibogue Sound
030502080604	Euhaw Creek	030601100304	Calibogue Sound

3.5.2 Overall Performance Requirements

Based on the watershed water quality criteria, its impairment status, or stormwater permit requirements, development and redevelopment stormwater management performance requirements will differ. These requirements are interpreted in terms of sizing and performance criteria. Table 3.2 presents a summary of the sizing criteria used to achieve the stormwater management performance requirements for each watershed protection area.

Table 3.2. Watershed Area Overall Performance Requirements.

<table>
<tr><th>General Stormwater Management
Watershed Protection Areas</th><th>Savannah River Watershed Protection Area</th></tr>
<tr><td>Overall Performance Requirements</td><td>Overall Performance Requirements</td></tr>
<tr><td>• Water Quality: Implement Better Site Design, maintain pre-development hydrology of the site to the Maximum Extent Practicable (MEP) for the 85th percentile storm event.
• Peak Control: Control post-development peak runoff discharge rate to pre-development rate for: 2-, 10- and 25-year, 24-hour design storm events.
• Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.
• As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.
• Complete a natural resources inventory for new site development applications.</td><td>• Water Quality: Implement Better Site Design, retain the 85th percentile storm event on-site to the MEP or obtain off-site credit.
• Peak Control: Control post-development peak runoff discharge rate to pre-development rate for: 2-, 10- and 25-year, 24-hour design storm events.
• Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.
• As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.
• Complete a natural resources inventory for new site development applications.</td></tr>
<tr><td>Rationale</td><td>Rationale</td></tr>
<tr><td>The previous Jasper County stormwater design manual specified these overall performance requirements.</td><td>The Savannah River watershed adjoins Georgia counties that are subject to similar overall performance requirements as outlined in the Georgia Coastal Stormwater Supplement.</td></tr>
<tr><td colspan="2">Bacteria and Shellfish Watershed Protection Area</td></tr>
<tr><td colspan="2">Overall Performance Requirements</td></tr>
<tr><td>• Water Quality: Implement Better Site Design and retain the 95th percentile storm on-site with approved infiltration/filtering BMPs. Fulfill MEP requirements or, as a last resort, fulfill off-site credit and/or fee-in-lieu requirements.
• As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.</td><td>• Peak control: Control the post-development peak runoff discharge rate for the 2, 10 and 25-year, 24-hour design storm events to the pre-development discharge rates.
• Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.
• Complete a natural resources inventory for new site development applications.</td></tr>
<tr><td colspan="2">Rationale</td></tr>
<tr><td colspan="2">The Bacteria and Shellfish Watershed Protection Areas are either impaired or have TMDLs, or the receiving waters are classified for shellfish harvesting. These watersheds require greater protection due to their Clean Water Act status or water quality classification. The site's natural resource inventory is a necessary component of permit application.</td></tr>
</table>

3.5.3 Southern Lowcountry Stormwater Precipitation & Runoff

As in the natural environment, a site's stormwater runoff volume depends upon soil conditions and land cover. To evaluate each site's development plan, this Manual relies on the rainfall runoff estimating methods of the Natural Resources Conservation Service National Engineering Handbook (NEH). Sometimes referred to as the curve number method or soil cover complex method, NEH chapter 9 describes the runoff response to rainfall events based on hydrologic soil group (HSG A, B, C or D) and land cover type with an integer between 29 and 100 (NRCS, 2004). Accordingly, information documenting the site's soils, their permeability, predeveloped land use or natural cover, and post-developed land cover, as well as the shallow groundwater table, are required in development plans in order to review and permit the development activity.

Precipitation event size and distribution are set by this Manual for the three watershed protection areas that make up the Southern Lowcountry.

The precipitation event distribution terms used in this Manual are defined as follows:

> **85th Percentile Storm** is the 24-hour rainfall amount that according to the National Oceanic and Atmospheric Administration records for the past 30 years in which 85% of all rainfall events do not exceed at the nearest US Weather Service station to the County seat. For the General Stormwater Management Watershed Areas and the Savannah River Watershed Protection Areas, this number is 1.16 inches of rainfall.
>
> **95th Percentile Storm** is the 24-hour rainfall amount that according to the National Oceanic and Atmospheric Administration records for the past 30 years in which 95% of all rainfall events do not exceed at the nearest US Weather Service station to the County seat. For the Bacteria and Shellfish Watershed Protection Areas this is 1.95 inches of rainfall.

Plans submitted for new development or redevelopment must demonstrate through accepted hydrologic methods that the development at post-construction will attenuate and treat the prescribed storm events. This includes volume reduction, peak flow management and extreme flood protection both on site and downstream.

3.5.4 Savannah River Watershed Protection Area

Upon implementation of this Manual, any applicable new development, redevelopment or major substantial improvement in the designated HUC-12 watersheds that are part of the Savannah River watershed shall meet the following requirements:

- Complete a natural resources inventory for new site development applications.
- Document use of Better Site Design.
- Retain the 85th percentile storm event on-site to the MEP or obtain off-site credit.
- Control the post-development peak runoff discharge rate for the 2, 10 and 25-year, 24-hour design storm events to the pre-development discharge rates.
- Accommodate 100-year, 24-hour storm event through the development without causing damage to the on-site and offsite structures. Provide 10% rule analysis.
- At a minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.

3.5.5 Bacteria & Shellfish Watershed Protection Area

Upon implementation of this Manual, any applicable new development, redevelopment or major substantial improvement in the designated HUC-12 watersheds that are part of the Bacteria and Shellfish Watershed Protection Area shall meet the following requirements:

- Complete a natural resources inventory for new site development applications.
- Document use of Better Site Design.
- Retain the 95th percentile storm on-site with approved infiltration/filtering BMPs.
- Fulfill MEP requirements or, as a last resort, fulfill off-site credit and/or fee-in-lieu requirements.
- At a minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.
- Control the post-development peak runoff discharge rate for the 2, 10 and 25-year, 24-hour design storm events to the pre-development discharge rates.
- Accommodate the 100-year, 24-hour storm event conveyance through the site and downstream without causing damage/inundation to structures. Provide 10% rule analysis.

3.5.6 General Stormwater Management Watershed Area

Upon implementation of this Manual, any applicable new development, redevelopment or major substantial improvement in the designated HUC-12 watersheds for the General Stormwater Management Watershed Area shall meet the following requirements:

- Complete a natural resources inventory for new site development applications.
- Document use of Better Site Design.
- Maintain pre-development hydrology of the site to the Maximum Extent Practicable (MEP) for the 85th percentile storm event.
- Control post-development peak runoff discharge rate for the 2, 10 and 25-year, 24-hour design storm events to pre-development discharge rates.
- Accommodate 100-year, 24-hour storm event through the development without causing damage to the on-site and offsite structures. Provide 10% rule analysis.
- As a pollutant removal minimum, intercept and treat stormwater runoff volume to at least an 80 percent reduction in total suspended solids load, 30 percent reduction of total nitrogen load and 60 percent reduction in bacteria load.

3.5.7 Runoff Reduction & Pollutant Removal

It is the minimum criteria of this Manual that a site's stormwater best management practices shall retain the precipitation event size for its watershed protection area as summarized in Section 3.5.2. Through successive application of the practices below and that are described in detail in Chapter 4, provide at least an 80% reduction in total suspended solids loads, 30% reduction of total nitrogen load, and 60% reduction in bacteria load (Jasper County, 2011).

Stormwater best management practices, when built according to the standards in Chapter 4 and maintained according to the site's maintenance agreement, can be expected to achieve runoff reduction and pollutant removal efficiencies according to Table 3.3. These values are to be used in the pollutant removal documentation and are used within the stormwater runoff reduction calculator in Appendix H. Other water quality credits may be assigned for BMPs based on the determination by the *<local jurisdiction>* and valid study results presented with the Stormwater Management Plan submittal.

Table 3.3. Pollutant Removal Efficiencies of Structural BMPs.

BMP	Water Quality Credits			
	Runoff Reduction	TSS % Removal	Total N % Removal	Bacteria % Removal
Bioretention - No Underdrain	100%[1]	100%[1]	100%[6]	100%[6]
Bioretention – Internal Water Storage	75%[1]	85%[1]	85%[4]	80%[5]
Bioretention - Standard	60%[2]	85%[1]	75%[4]	80%[5]
Permeable Pavement - Enhanced	100%[1]	100%[1]	100%[6]	100%[6]
Permeable Pavement - Standard	30%[2]	80%[1]	45%[4]	30%[6]
Infiltration	100%[1]	100%[1]	100%[6]	100%[6]
Green Roof	100%[3]	100%[6]	100%[6]	100%[6]
Green Roof - Irrigated	50%[3]	50%[6]	50%[6]	50%[6]
Rainwater Harvesting	100%[3]	100%[6]	100%[6]	100%[6]
Impervious Surface Disconnection	40%[2]	80%[1]	40%[4]	40%[6]
Grass Channel	10%[2]	50%[1]	25%[4]	30%[5]
Grass Channel - Amended Soils	20%[2]	50%[1]	35%[4]	30%[5]
Dry Swale	60%[2]	85%	70%[4]	80%[5]
Wet Swale	0%[1]	80%[1]	25%[4]	60%[5]
Regenerative Stormwater Conveyance	0%[1]	80%[1]	40%[6]	80%[6]
Filtering Systems	0%[3]	80%[1]	30%[4]	80%[6]
Storage Practices	0%[3]	60%[1]	10%[4]	60%[5]
Stormwater Ponds	0%[1]	80%[1]	30%[4]	60%[5]
Stormwater Wetlands	0%[1]	80%[1]	25%[4]	60%[5]
Tree Planting and Preservation	see section 4.12			
Proprietary Practices	see section 4.13			
Conservation Areas	see section 4.14			

Notes:
The following resources were used to develop the runoff reduction and pollutant removal values in the above table.

1. (ARC, 2016).
2. (Hirschman, 2018).
3. (DOEE. 2013)
4. (Hirschman, 2018). Nitrogen removal values from this source were applied to the remaining volume after runoff reduction was applied. The values provided in the table above represent the results of this application.
5. (Chesapeake Stormwater Network, 2018)
6. Best professional judgement was used where a BMP's pollutant removal values were not available in the above sources, or conflicts were present. In all cases, a BMP's pollutant removal value must be at least as high as its runoff reduction values (for example, if a BMP is assigned a runoff reduction value of 100%, it will also have TSS, nitrogen, and bacteria removal rates of 100%). In addition, it was assumed that a Regenerative Stormwater Conveyance (RSC) will have similar nitrogen removal to bioretention systems, so the nitrogen removal value from the Runoff Reduction Method was applied as described in reference 4, above. It was also assumed that both RSCs and filtering systems will have the same bacterial removal rate as bioretention (with no runoff reduction).

3.6 Erosion & Sediment Control (ESC) Requirements

The design and management of construction site runoff control measures for all qualifying developments as defined in the Ordinance shall be in accordance with SCDHEC NPDES General Permit for Stormwater Discharges from Construction Activities, the SCDHEC Erosion and Sediment Reduction and Stormwater Management regulations and its most current version of standards, where applicable. The *<local jurisdiction>* reserves the right to require additional erosion and sediment control or a higher standard of measure and make their requirement a condition of a development permit approval.

3.7 Retention Standard & Volume

This section provides the formulas and rationale for use of the runoff reduction method to compare predeveloped and post-development hydrology for projects submitted for approval to the Southern Lowcountry jurisdictions.

Runoff reduction is defined as "the total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainfall harvesting, engineered infiltration, or extended infiltration" (Hirschman, 2008). The formula to calculate the volume reduced through successive application of stormwater best management practices originates with the Natural Resources Conservation Service (NRCS) method of estimating direct runoff from storm rainfall and the curve number method of NEH Chapter 9 (NEH, 2004). As shown in Equation 3.1, rainfall event runoff (Q) is a function of depth of event rainfall (P) over the watershed, the initial abstraction (I_a) and the maximum potential retention (S).

Equation 3.1. Curve number runoff equation.

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

$$I_a = 0.2S$$

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

$$Q - R = \frac{(P - 0.2S)^2}{(P = 0.8S)}$$

$$S = \frac{100}{CN} - 1$$

Where:

Q =	Runoff depth (in)
P =	Depth of rainfall event for the designated watershed protection area (85th or 95th percentile rain event)
I_a =	Initial abstraction (in)
S =	Potential maximum retention after runoff begins (in)
CN =	Runoff curve number
R =	Retention storage provided by runoff reduction practices (in)

Not all stormwater BMPs provide runoff reduction equally. Through the crediting procedures of the Compliance Calculator found in Appendix H and the retention volumes required in this section, designers will be able to evaluate their proposed designs and submit for approval in a unified process across the Southern Lowcountry jurisdictions.[1]

Supplemental information on the terms below can be found in the *Low Impact Development in Coastal South Carolina: Planning and Design Guide*, and the Georgia Stormwater Management Manual (Ellis, K. et al., 2014; ARC, 2016).

The Stormwater Retention Volume (SWRv) is the volume of stormwater runoff that is required to be retained, post-development. It is calculated as shown in Equation 3.2 for the entire site and for each site drainage area (SDA). The SDA is defined as the area that drains to a single discharge point from the site or sheet flows from a single area of the site. A development site may have multiple SDAs and runoff coefficients.

Equation 3.2. Stormwater retention volume (SWRv) equation

$$\boldsymbol{SWRv = \frac{P \times [(Rv_I \times I) + (Rv_C \times C) + (Rv_N \times N)]}{12}}$$

Where:

SWRv =	Volume required to be retained (cubic feet)
P =	Depth of rainfall event for the designated watershed protection area (85th or 95th percentile rain event)
Rv_I =	Runoff coefficient for impervious cover and BMP cover based on SCS hydrologic soil group (HSG) or soil type
I =	Impervious cover surface area (square feet)
Rv_C =	Runoff coefficient for compacted cover based on soil type
C =	Compacted cover surface area (square feet)
Rv_N =	Runoff coefficient for forest/open space based on soil type
N =	Natural cover surface area (square feet)
12 =	Conversion factor (inches to feet)

	Rv Coefficients			
	A soils	**B Soils**	**C Soils**	**D Soils**
Forest/Open Space (R_{VN})	0.02	0.03	0.04	0.05
Managed Turf (Rv_C)	0.15	0.20	0.22	0.25
Impervious Cover (R_{vI})	0.95	0.95	0.95	0.95
BMP	0.95	0.95	0.95	0.95

The surface area of a non-infiltrating BMP or its permanent pool shall be calculated as part of the impervious cover.

The Compliance Calculator in Appendix H uses best available pollutant removal efficiencies for total suspended solids, total nitrogen and fecal indicator bacteria. Use of the compliance calculator allows the designer to evaluate alternative designs to arrive at compliance with the runoff reduction and pollutant

[1] Compliance Calculator instructions are found in Appendix G

removal requirements and clearly summarize them for the local plan reviewer. The compliance calculator output is a necessary submittal for a plan reviewer to evaluate selected BMPs to demonstrate compliance with the watershed protection area standards of this Manual.

3.7.1 Total Suspended Solids, Nutrients, & Bacteria

The minimum pollutant removal performance requirements for all watersheds of the Southern Lowcountry include the interception and treatment of stormwater runoff volume to at least an 80% reduction in total suspended solids load, 30% reduction of total nitrogen load, and 60% reduction in bacteria load. These requirements are established for the following reasons.

Stormwater in the Lowcountry conveys the plant nutrients nitrogen and phosphorus. Nitrogen tends to dissolve in water, but phosphorus is adsorbed to suspended solids predominantly. Control of total suspended solids through the BMPs in this Manual will also remove a proportional amount of phosphorus. Relying on the judgement of stormwater researchers and other state design manuals, the approach for the Southern Lowcountry is similar. If a BMP is effective at runoff reduction or retention of stormwater, it is similarly effective at removal of the initial volume of suspended solids (NCDEQ, 2014).

Many of the Southern Lowcountry watersheds at the HUC-12 size are directly tributary to bacteria and shellfish impaired waters. As these watersheds develop with rooftops, roads and other impervious surfaces, there is an increasing potential for bacteria in the stormwater from wildlife populations (deer, racoons, waterfowl), pet waste, septic system discharges and sanitary sewer system malfunctions. Similarly, nutrients can be expected to increase due to fertilizer use in erosion control practices, managed turf and landscaping, septic system leachate, and atmospheric deposition on impervious surfaces. Best management practices, along with better site design practices, can be used to reduce bacteria and nutrients in stormwater to the benefit and restoration of Southern Lowcountry water quality.

3.7.2 Hydrologic & Hydraulic Analysis

In order to prevent an increase in the duration, frequency and magnitude of downstream overbank flooding and scouring, this Manual requires that enough stormwater detention be provided on a development site to control the post-development peak runoff discharge to the predevelopment runoff rates for the 2, 10, and the 25 -year, 24-hour storm events. The capacity of the existing downstream receiving conveyance system for all off-site discharge points must be determined to be adequate. An analysis of the downstream conveyance capacity to accommodate the site's post development 25- and 100-year, 24-hour peak flow shall be provided in the engineering report. Discharge to the public right-of-way of the SC State highway system shall comply with the SCDOT Requirements for Hydraulic Design Studies. Necessary upgrades within the public right-of-way due to inadequate capacity for the post-development 25-yr flow must be identified during the permit application process. Upgrades to the downstream system to accommodate the 100-yr 24-hour flow must be considered through the MEP process outlined in Section 3.9. Documentation supporting safe passage of the 100-yr post development flow to the downstream point where the detention or storage area comprises 10% of the total drainage area, and an analysis of the surrounding neighborhood area to identify any existing capacity shortfalls or drainage blockages is required for plan approval. This analysis is called the 10% analysis rule in Section 3.8 of this Manual.

The recommended 2, 10, 25, and 100-year, 24-hour storm event values from Appendix F of the South Carolina DHEC Storm Water Management BMP Handbook, July 31, 2005 for Beaufort and Jasper Counties are in Table 3.4[2].

Table 3.4. Rainfall depth (inches) for the Southern Lowcountry.

Return Period (years)				
County	**2**	**10**	**25**	**100**
Beaufort	4.5	6.9	8.4	11.0
Jasper	4.2	6.4	7.8	10.2

In this Manual, Appendix I General Design Criteria and Guidelines provides the acceptable methodologies and computer models for estimating runoff hydrographs before and after development, as well as design criteria for stormwater collection systems and land cover designations. The following are the acceptable methodologies and computer models for estimating runoff hydrographs before and after development. These methods are used to predict the runoff response from given rainfall information and site surface characteristic conditions. The design storm frequencies used in all of the hydrologic engineering calculations will be based on design storms required in this Manual unless circumstances make consideration of another storm intensity criterion appropriate:

- Rational Method (limited to sites under 10 acres)
- Urban Hydrology for Small Watersheds TR-55
- Storage-Indication Routing
- HEC-1, WinTR-55, TR-20, ICPR v3 or 4 and SWMM computer models

These methods are given as valid in principle and are applicable to most stormwater management design situations in the Southern Lowcountry.

The following conditions should be assumed when developing predevelopment, pre-project, and post-development hydrology, as applicable:

- The design storm duration shall be the 24-hour rainfall event, using the NRCS (SCS) Type III rainfall distribution with a maximum six-minute time increment.
- The predeveloped peaking factor shall be 200 for new development (Blair et al., 2012).
- The post development peaking factor shall be 323.
- For new development sites the predeveloped condition shall be calculated as a composite CN based on the HSG and meadow conditions (NEH, 2004).
- For infill and redevelopment sites, the predeveloped condition shall be calculated as a composite CN based on the HSG and the land cover type and hydrologic condition at the time of the project's initial submittal.
- Antecedent Runoff Condition (ARC) II is the average adjustment factor for calculations using TR-55. ARC III is to be used for wetter conditions such as areas that receive irrigation water harvested from stormwater ponds and for poorly drained soils.

[2] Until SCDHEC updates its Stormwater Management BMP Handbook rainfall table to the NOAA Atlas 14 values, the Southern Lowcountry region shall use the Handbook Appendix F rainfall table for 24 hour storm events.

Project designs must include supporting data and source information. All storm sewer systems shall be analyzed for both inlet and outlet control (including tailwater effects) by using the following:

a. Equations and nomographs as shown in the Federal Highway Administration (FHWA) Hydraulic Design Services (HDS) publication No. 5.

b. Computer programs that calculate the actual hydraulic grade line for the storm sewer system can be used, provided all losses (friction, bend, junction, etc.) are taken into account using the appropriate loss coefficient (K) values.

c. Design tailwater condition elevation shall be supported by a reasonable resource and/or analysis.

d. Allowable headwater. The allowable headwater of all culverts, pipe systems, open channels, bridges and roadway culverts shall be established following the SCDOT Requirements for Hydraulic Design Studies.

All culverts, pipe systems, and open channel flow systems shall be sized in accordance with the design criteria found in Appendix I Hydrology and Hydraulics Design Requirements.

3.7.3 Maintenance Easements

Maintenance easements are provided for the protection and legal maintenance of stormwater management facilities not within a right-of-way. Drainage easements shall be required in subdivisions over any portion of a stormwater management facilities not within a right-of-way and necessary for the functioning of the system. Drainage easements for all facilities must be shown on construction drawings and approved by the stormwater manager. The easements shall be designated on the plan prior to issuance of a development permit and recorded in public records with copy of recorded easement submitted prior to <*local jurisdiction*> permit termination. The minimum allowable width of drainage easements shall be as shown in Table 3.5.

Table 3.5. Drainage maintenance access easements.

Stormwater Management Facility	Minimum Easement Width
Closed systems (storm sewers/pipes/culverts)	diameter + 4 ft + 2D(20-ft minimum)*
Open drainage systems	
Bottom width 20 ft or less	15 ft + BW + 2SD (30 ft minimum)**
Bottom width 20 ft to 40 ft	30 ft + BW + 2SD**
Bottom width greater than 40 ft	40 ft + BW + 2SD**
Retention/detention BMPs	20 ft around facility***
Pond Maintenance Access	A 20’ maintenance access easement between lot lines and top of bank shall be provided for stormwater ponds with a permanent pool. The easement shall be provided for boat trailer access, and for all structure maintenance and repair. No permanent structures (mechanical, electrical, phone, fences) or landscaping are allowed within the 20’ pond maintenance access easement.
*Where: D = Depth from grade to pipe invert **Where: BW = Bottom width S = Side slope D = Depth of opening	
Note: The minimum required width and configuration of drainage easements may be modified if deemed necessary by the stormwater manager for justifiable reasons.	

3.8 Extreme Flood Requirement: 10% Rule

The peak discharge generated by the 100-year, 24-hour storm event under post-development conditions is considered the extreme peak discharge. The intent of the extreme flood protection is to prevent flood damage from infrequent but large storm events, maintain the boundaries of the mapped 100-year floodplain, and protect the physical integrity of the best management practices as well as downstream stormwater and flood control facilities. The 100-yr flow is to be used in the routing of runoff through the drainage system and stormwater management facilities to determine the effects on the facilities, adjacent property, and downstream. Emergency spillways of best management practices should be designed appropriately to pass the resulting flows safely.

Documentation supporting safe passage of the 100-year post-development flow shall be provided by the applicant/engineer. In order to prevent an increase in the duration, frequency and magnitude of downstream extreme flooding over existing conditions, an evaluation must be provided to include downstream analysis to the point where the project comprises 10% of the total contributing drainage area. The 10% rule evaluation must address existing conveyance system capacity and “pinch points” where a pipe/culvert would be overtopped and where the pipe/culvert will need to be upgraded or the peak discharge rate will need to be limited to the capacity of the downstream system.

The 10% rule recognizes the fact that a structural BMP control providing detention has a “zone of influence” downstream where its effectiveness can be felt. Beyond this zone of influence, the structural control becomes relatively small and insignificant compared to the runoff from the total drainage area at that point. Based on studies and master planning results from a large number of sites, that zone of influence is considered to be the point where the drainage area controlled by the detention or storage facility comprises 10% of the total drainage area. For example, if the drainage control drains 10 acres, the zone of influence ends at a point where the total drainage area is 100 acres or greater (ARC, 2016).

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. Safe passage to the receiving water also requires that there be no additional downstream flooding or other environmental impacts (e.g., stream channel enlargement, degradation of habitat).

Typical steps in the application of the 10% rule are:

1. Determine the target peak flow for the site for predevelopment conditions.
2. Using a topographic map, determine the lower limit of the zone of influence (10% point)
3. Using a hydrologic model, determine the predevelopment peak flows and timing of those peaks at each tributary junction beginning at the pond outlet and ending at the next tributary junction beyond the 10% point.
4. Change land use on the site to post-development and rerun the model.
5. Design the structural control facility such that the overbank flood protection (25-year) post-development flow is adequately conveyed to the lower limit of the zone of influence and the Extreme Flood (100-year) post-development flow does not impact any existing structures within the area of zone of influence.
6. If the overbank flood protection (25-year) post-development flow is not adequately conveyed to the lower limit of the zone of influence and/or Extreme Flood (100-year) post-development flow is shown to impact any structure, the structural control facility must be redesigned or one of the following options considered:
    a. Work with the *<local jurisdiction>* to reduce the flow elevation through channel or flow conveyance structure improvements downstream.
    b. Obtain a flow easement from downstream property owners to the 10% point.
    c. Request a detention waiver from *<local jurisdiction>.* This waiver would be for water quantity control only and best management practices to achieve water quality goals will still be required.

3.9 Maximum Extent Practicable

Maximum extent practicable (MEP) is the language of the Clean Water Act that sets the standards to evaluate efforts pursued to achieve pollution reduction to the Waters of the United States. The MEP refers to management practices; control techniques; and system, design, and engineering methods for the control of pollutants. It allows for considerations of public health risks, societal concerns, and social benefits, along with the gravity of the problem and the technical feasibility of solutions. The MEP for stormwater management is achieved, in part, through a process of selecting and implementing different design options with various structural and non-structural stormwater best management practices (BMPs), where ineffective BMP options may be rejected, and replaced when more effective BMP options are found (DOEE, 2019).

There must be a serious and demonstrated attempt to comply with this Manual, and practical solutions may not be lightly rejected. If project applicants implement and demonstrate only a few of the least expensive BMPs, and the regulated volume has not been retained, it is likely that the MEP standard has not been met. If, on the other hand, a project applicant implements all applicable and effective BMPs except those shown to be technically infeasible, then the project applicant would have achieved retention to the MEP.

Major land-disturbing activities, infill and redevelopment projects, and projects in the existing public right-of-way, must achieve the SWRv, and meet peak flow requirements for channel and extreme flood protection to the MEP. Through application of stormwater best management practices on site or at an off-site property within the same stormwater drainage catchment, land development projects should be able to comply with the Southern Lowcountry Stormwater Ordinance. It is the applicant's responsibility to demonstrate to the greatest extent that the requirements of this Manual can be met for the proposed development. The applicant must fully demonstrate that the requirements of the Manual are not possible or feasible before entering into a MEP analysis, and only after the concurrence of the *<local jurisdiction>* based on the project submittals, documentation and discussions. The applicant must realize that if the requirements of the Manual cannot be met, the site may not be conducive for development, as proposed, in the interest of public safety and welfare.

When a new land development project, infill or redevelopment cannot meet the volume and peak flow requirements of this Manual, the following design and review process is required to comply with the MEP requirement. This evaluation is intended to be completed during the concept review stage of plan development.

1) Demonstrate how BSD has been implemented to the maximum extent practicable or document site restrictions that prevent BSD application.
2) List the site restrictions that prevent the on-site use of the stormwater BMPs of this Manual.
3) Cite justification for not being able to retain the SWRv and attain the required peak discharge limits.
4) Is there off-site capacity in the same drainage catchment as defined by the *<local jurisdiction>* to meet the volume and/or peak flow requirements for the site's contributing drainage area(s)?
5) Does the publicly maintained stormwater drainage system have sufficient capacity for the development site's extreme flood peak flow?
6) Develop a cost versus aggregated stormwater retention volume achieved curve for the site's contributing drainage area. A minimum of five cost points with three of the BMP alternatives in series as a treatment train are necessary for the curve. Include the evaluation off-site capacity cost. Identify the inflection point of the cost curve to identify the optimal solution where increased cost does not result in increased effectiveness.
7) The optimum aggregated retention value and BMP selection and size analysis must be submitted as a part of the stormwater management plan for the project.
8) Offsite stormwater volume retention credit or fee-in-lieu documents will be required for project completion.

The MEP submittal must provide documentable evidence of the process the applicant has performed that demonstrates the restrictions to the use and implementation of BMPs to meet the requirements of this Manual in whole or in part.

3.10 Off-Site Stormwater Management

All stormwater management design plans shall include on-site stormwater management practices, unless post-construction stormwater runoff in an off-site or regional stormwater management practice is approved according to this Section.

The off-site or regional stormwater management practice must be located on property legally dedicated to that purpose, be designed and sized to meet the post-construction stormwater management criteria presented in this Manual, provide a level of stormwater quality and quantity control that is equal to or greater than that which would be provided by on-site green infrastructure and stormwater management practices, be in the same drainage catchment, as defined by the *<local jurisdiction>*, as the project area, and have an associated inspection and maintenance agreement and plan. In addition, appropriate stormwater management practices shall be installed, where necessary, to protect properties and drainage channels that are located between the development site and the location of the off-site or regional stormwater management practice.

To be eligible for compliance through the use of off-site stormwater management practices, the applicant must submit a stormwater management design plan to the *<local jurisdiction>* that demonstrates the adequacy of the off-site or regional stormwater management practice, and demonstrates, to the satisfaction of the *<local jurisdiction>* that the off-site or regional stormwater management practice will not result in any of the following impacts:

(1) Increased threat of flood damage or endangerment to public health or safety;

(2) Deterioration of existing culverts, bridges, dams, and other structures;

(3) Accelerated streambank or streambed erosion or siltation;

(4) Degradation of in-stream biological functions or habitat; or,

(5) Water quality impairment in violation of state water quality standards and/or violation of any other state or federal regulations.

3.11 Fee-in-Lieu

Fee-in-lieu is, as the name suggests, a program where an entity with the responsibility of managing stormwater runoff pays a fee in lieu of physically managing and maintaining stormwater on site or off site. Based on the cost of treatment, long term maintenance/repair/replacement and inspection costs, a representative cost of treating stormwater can be established, and that money can go to larger scale and more efficient practices being implemented (ARC, 2016). The developer provides a fee to the <*local jurisdiction*> (or its assigned entity) that will help cover cost of installation and long-term operation and maintenance of the stormwater practice. A fee-in-lieu program can be administered through the <*local jurisdiction*>, a public/private initiative, or a private bank. Any fee-in-lieu program must have an Enterprise Fund and ability to oversee construction activities (e.g. programs managed by the <l*ocal jurisdiction*>) or be able to collect fees and dedicate those funds to stormwater related projects. In-lieu fees typically need to cover higher municipal prevailing wage and public bidding costs. The off-site mitigation practices must be implemented in the same HUC-12 watershed as the original project (or more restrictive limits, at the discretion of the local authority). Therefore, careful accounting must take place to ensure that each site using off-site mitigation to meet pollutant removal requirements has corresponding off-site controls in the same watershed (CWP, 2012).

3.12 Waivers

Individuals seeking a waiver from the requirements of this Ordinance may submit to the *(administrator)* a request for a waiver in accordance with the Southern Lowcountry Stormwater Design Manual.

(1) Request of a Waiver at Staff Level
A written request for a waiver is required and shall state the specific waiver sought and the reasons, with supporting data, a waiver should be granted. The request shall include all information necessary to evaluate the proposed waiver. Requests must outline the need for such a waiver, such as site constraints, soil characteristics, or similar engineering limitations. Cost shall not be considered cause for a waiver. The applicant will address the criteria below for consideration of a waiver approval:

a. What exceptional circumstances to the site are evident that on-site or off-site stormwater management requirements cannot be met?
b. What unnecessary hardship is being caused?
c. How will denial of the waiver be inconsistent with the intent of the Ordinance?
d. How will granting the waiver comply with the intent of the Ordinance?
e. How are state and federal regulations still being met?

(2) Review of Waivers
The <*administrator*> will conduct a review of the request and will issue a decision within thirty (30) working days of receiving the request.

(3) Fee-in-Lieu Requirement
a. If a Waiver is granted, the applicant must submit a fee in lieu of meeting stormwater requirements as determined by <*local jurisdiction*> for regional stormwater management projects.

(4) Appeal of Decision
Any person aggrieved by the decision of the (*administrator*) concerning a waiver request may appeal such decision in accordance with the <*local jurisdiction*> established process.

3.13 References

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Chapter 4. Stormwater Best Management Practices (BMPs)

4.1 Standard Stormwater BMP Design Sections

This chapter summarizes and outlines performance criteria for 13 stormwater best management practice (BMP) categories that include:

- Bioretention
- Permeable Pavements
- Infiltration
- Green Roofs
- Rainwater Harvesting
- Impervious Surface Disconnection
- Open Channel Systems
- Filtering Systems
- Storage Practices
- Ponds
- Stormwater Wetlands
- Tree Planting and Preservation
- Proprietary Practices

Following these criteria is the criteria to credit for stormwater benefit the use of conservation areas and open space preservation.

4.1.1 Format of Standard Stormwater BMP Design Sections

BMP performance criteria are based on several critical design factors to ensure effective and long-lived BMPs. For each BMP, the following factors are discussed:

- General Feasibility
- Conveyance
- Pretreatment
- Design and Sizing
- Landscaping
- Construction Sequencing
- Maintenance
- Stormwater Compliance Calculations

Design components that differ from these specifications, but meet their intent, may be included at <*local jurisdiction*>'s discretion.

4.1.2 Standard Nomenclature

In this chapter, and throughout the guidebook, the terms, *must* or *shall*, denote required aspects of BMPs or their design and implementation. The term, *should*, denotes a recommendation, however, justification may be necessary for design or implementation that does not correspond to certain recommendations.

4.2 Summary of BMP Stormwater Management Capabilities, Site Applicability, & Physical Feasibility

Stormwater management requirements for a given site vary based on the site's location, and minimum control requirements discussed in detail in Section 3.5.

4.2.1 Stormwater Retention & Water Quality Treatment

It is important to note that this Manual, and the associated compliance calculators, make a distinction between stormwater retention volume and stormwater water quality treatment. Not all BMPs achieve stormwater retention and/or water quality treatment equally, as was summarized in Table 3.3. The level to which a BMP provides stormwater retention and water quality treatment is provided in the BMP summary table of each BMP. The stormwater runoff reduction (SWRv) rates are expressed as a percentage of the storage volume provided by the BMP. Calculations for determining storage volume are included in each BMP's specifications. Each BMP's performance on the water quality parameters of total suspended solids, nitrogen and bacteria are also included in the BMP summary table. Note that many BMPs whose main purpose is water quality treatment typically do not have enough volume control to manage larger storm events.

4.2.2 Site Applicability

Certain BMPs are more appropriate than others in certain land uses. Table 4.1 describes the site applicability for each BMP for the following factors:

- Rural Use: This column indicates whether or not the stormwater management practice is typically suited for use in rural areas and on low-density development sites.
- Suburban Use: This column indicates whether or not the stormwater management practice is typically suited for use in suburban areas and on medium-density development sites.
- Urban Use: This column identifies the stormwater management practices that are typically suited for use in urban and ultra-urban areas where space is at a premium.
- Construction Cost: This column assesses the relative construction cost of each of the stormwater management practices.
- Maintenance: This column assesses the relative maintenance burden associated with each stormwater management practice. Note that all stormwater management practices require routine inspection and maintenance.

Table 4.1. Site applicability for BMPs.

BMP	Rural Use	Suburban Use	Urban Use	Construction Cost	Maintenance
Bioretention	Yes	Yes	Yes	Medium	Medium
Permeable Pavement	Maybe	Yes	Yes	High	High
Infiltration	Yes	Yes	Yes	Medium	Medium
Green Roof	Maybe	Yes	Yes	High	Low
Rainwater Harvesting	Yes	Yes	Yes	Medium	Medium
Disconnection	Yes	Yes	Maybe	Low	Low
Open Channels	Yes	Yes	No	Low-Medium	Medium
Filtration	Maybe	Yes	Yes	High	High
Dry Ponds	Yes	Yes	No	Low	Low
Wet Ponds	Yes	Yes	No	Low	Low
Stormwater Wetlands	Yes	Yes	No	Low	Medium

4.2.3 Site Conditions & Physical Feasibility

While some BMPs can be applied almost anywhere, others require specific conditions to be most effective. Physical feasibility refers to the physical site conditions necessary to effectively design and install a BMP. Table 4.2 includes the feasibility factors listed below.

- Contributing Drainage Area (CDA): Volume of water received by a practice can affect BMP performance. This column indicates the contributing drainage areas that typically apply for each BMP.
- Slope: This column describes the influence that site slope can have on the performance of the BMP. It indicates the maximum slope on which the BMP should be installed.
- Minimum Head: This column provides an estimate of the minimum amount of elevation difference needed within the BMP, from the inflow to the outflow, to allow for gravity operation.
- Minimum Depth to Seasonal High Water Table: This column indicates the minimum distance that should be provided between the bottom of the stormwater management practice and the top of the water table.
- Soils: This column describes the influence that the underlying soils (i.e., hydrologic soil groups) can have on the performance of the stormwater management practice.

Table 4.2. Feasibility limitations for BMPs.

BMP	Contributing Drainage Area	Slope	Minimum Head	Minimum Depth to Water Table	Soils
Bioretention	Up to 2.5 acres	Up to 5%[2]	4 - 5 feet	0.5 feet	All soils[3]
Permeable Pavement	Up to 5 times practice surface area	Up to 5%	1 – 4 feet	0.5 feet	All soils[3]
Infiltration	Up to 2 acres	Up to 6%[2]	2 feet	0.5 feet	Must drain within 72 hours
Green Roof	Green roof area + 100%	Up to 30%[4]	N/A	N/A	N/A
Rainwater Harvesting	No limit	No limit	N/A	N/A	N/A
Disconnection	Up to 1,000 ft^2 per downspout	Up to 5%	N/A	N/A	All soils
Open Channels	Up to 2.5 acres	Up to 4%[2]	Varies	Varies	All soils
Filtration	Up to 5 acres	Up to 6%	2 – 10 feet	0.5 feet	All soils
Storage Practices	Varies	No limit	5 feet	0.5 feet	All soils
Ponds	Greater than 10 acres[1]	Up to 15%	6 – 8 feet	No limit	Slow-draining soils preferred
Stormwater Wetlands	Varies	Up to 8%[2]	2 – 4 feet	No limit	Slow-draining soils preferred

[1] *CDA can be smaller if practice intersects the water table.*
[2] *Check dams may be necessary to create sufficient ponding volume.*
[3] *Slow-draining soils may require an underdrain.*
[4] *Roof slope.*

Irrigation from ponds is not included as a specific best management practice in this M*anual* but is included as Rainwater Harvesting (§4.5). Requirements and guidance for irrigation use of retained stormwater have been included in Hydrologic and Hydraulic Analysis (ARC requirements in §3.7.2); Ponds (§4.10); and Rainwater Harvesting Treatment and Management Requirements (Appendix J). The Rainwater Harvesting Calculator in Appendix K will be used to determine the SWRv credit for ponds used for irrigation, and then these ponds are entered in the Compliance Calculator in Appendix H as rainwater harvesting. Instructions for these entries are included in Appendix G Compliance Calculator Instructions.

4.3 Bioretention

Bioretention
Definition: Practices that capture and store stormwater runoff and pass it through a filter bed of engineered filter media composed of sand, soil, and organic matter. Filtered runoff may be collected and returned to the conveyance system or allowed to infiltrate into the soil.

Site Applicability		BMP Performance Summary		
Land Uses	**Required Footprint**	**WQ Improvement:** Moderate to High		
▪ Urban ▪ Suburban ▪ Rural	Small to Large	**TSS**[1]	**Total N**[1,]	**Bacteria**[1,2]
		85%–100%	75%–100%	80%–100%
		Runoff Reduction		
Construction Costs	**Maintenance Burden**	**Volume**		
Moderate	Moderate	High		
Maintenance Frequency:		***SWRv***		
Routine	**Non-Routine**	No Underdrain	IWS	Standard
Quarterly	Every 2–3 years	100% of Sv	75% of Sv	60%

Advantages/Benefits	Disadvantages/Limitation
▪ Easily incorporated into new development ▪ High community acceptance ▪ Good for small, highly paved drainage areas (i.e. parking lots)	▪ Maximum CDA is 1 to 2.5 acres ▪ Requires pretreatment to prevent clogging ▪ Requires detailed landscape planning ▪ Not appropriate for steep slopes

Components	Design considerations
▪ Pretreatment ▪ Conveyance system ▪ Ponding area ▪ Soils/Filter Media/Mulch ▪ Observation Well/Monitoring Port ▪ Plants	▪ Maximum ponding depth 18 inches ▪ Minimum filter media bed depth 18 inches ▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice ▪ Underdrain system may be needed

Maintenance Activities	
▪ Mow turf cover periodically ▪ Replace mulch as needed to maintain depth of mulch	▪ Replace plant material, as needed ▪ Replace soil if it becomes clogged ▪ Clean conveyance system(s)

[1]*Credited pollutant load removal*
[2]*In order to receive the full credit for bacteria removal a minimum media depth of 24" is required.*

Bioretention areas, shallow depressional areas that are filled with an engineered soil media and are planted with trees, shrubs, and other herbaceous vegetation, are one of the most effective stormwater management practices that can be used to reduce post-construction stormwater runoff rates, volumes, and pollutant loads. They also provide a number of other benefits, including improved aesthetics, wildlife habitat, urban heat island mitigation, and improved air quality. See Figure 4.1 for an example image.

They are designed to capture and temporarily store stormwater runoff in the engineered soil media, where it is subjected to the hydrologic processes of evaporation and transpiration, before being conveyed back into the storm drain system through an underdrain or allowed to infiltrate into the surrounding soils. The engineered soil media is comprised of sand, soil, and organic matter.

Typically, bioretention systems are not designed to provide stormwater detention of larger storms (e.g., 2-, 10-, 25-year), but in some circumstances that may be possible. Bioretention practices should generally be combined with a separate facility to provide those controls.

Figure 4.1. Bioretention in parking lot (photo credit: Center for Watershed Protection, Inc.).

Definition. Practices that capture and store stormwater runoff and pass it through a filter bed of engineered filter media composed of sand, soil, and organic matter. Filtered runoff may be collected and returned to the conveyance system or allowed to infiltrate into the soil. Design variants include the following:

B-1 Bioretention

B-2 Streetscape bioretention

B-3 Engineered tree pits

B-4 Stormwater planters

B-5 Residential rain gardens (for single family homes)

There are three different bioretention design configurations:

1) **No Underdrain**. Practices that can infiltrate the design storm volume within 72 hours, and therefore need no underdrain (see Figure 4.2).
2) **Internal Water Storage (IWS)**. Practices that include an infiltration sump/storage layer (see Figure 4.3) below the underdrain.
3) **Standard**. Practices with underdrains (see Figure 4.4).

The particular design configuration to be implemented on a site is typically dependent on specific site conditions and the characteristics of the underlying soils. These criteria are further discussed in this chapter.

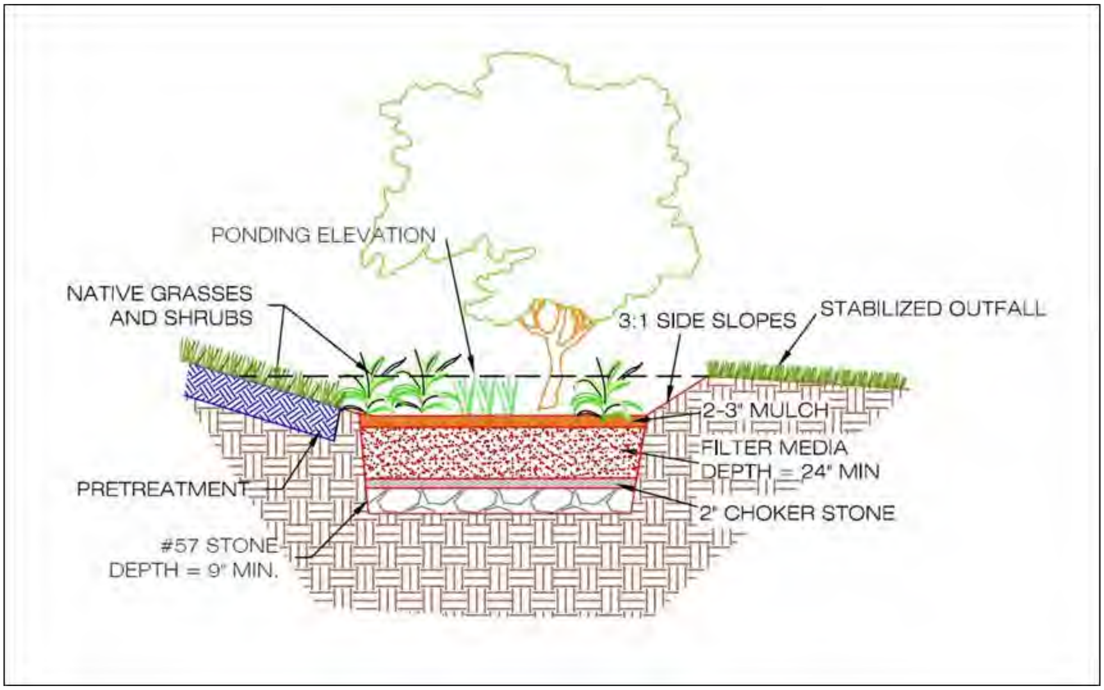

Figure 4.2. Example bioretention design without an underdrain.

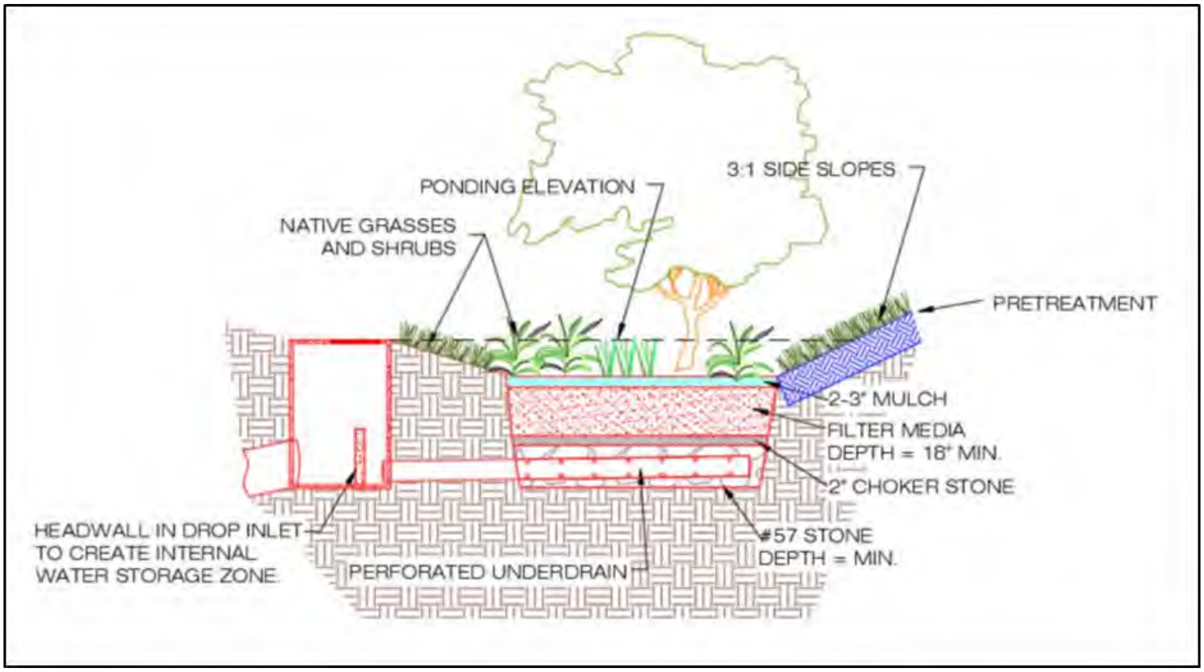

Figure 4.3. Example bioretention design with internal water storage (IWS).

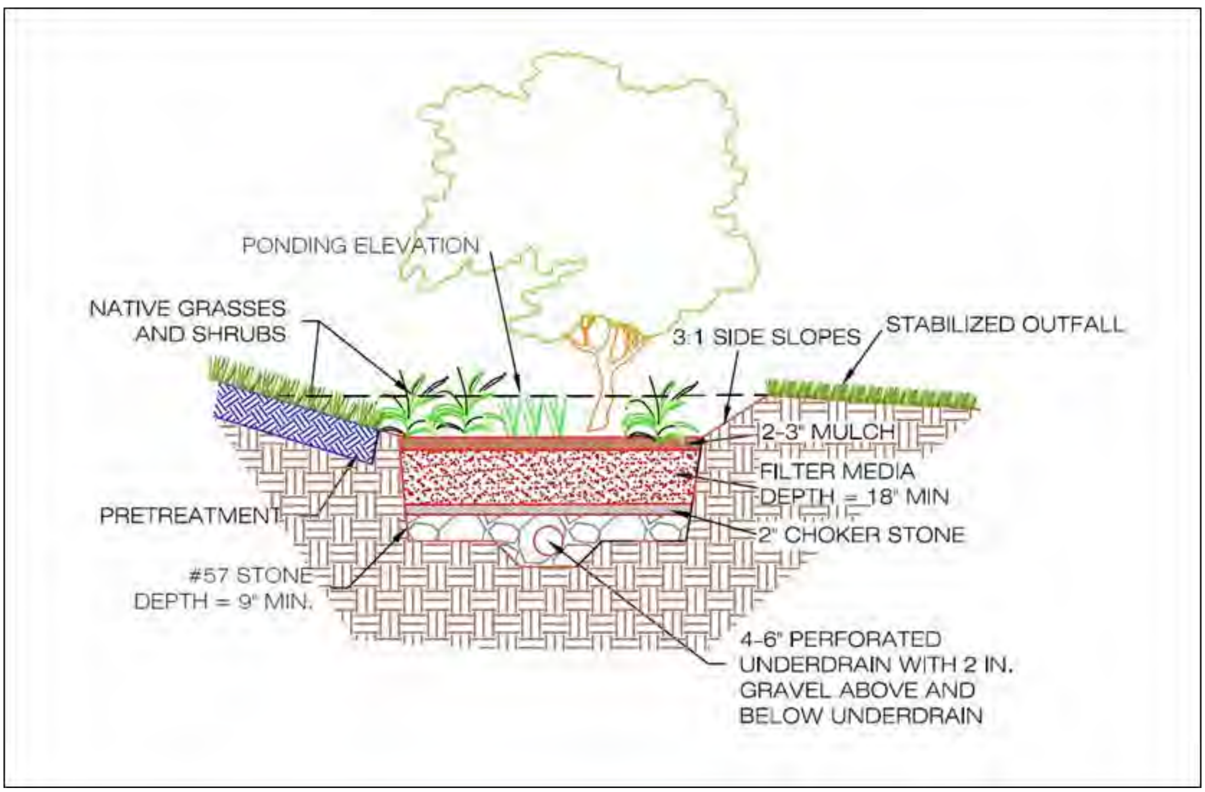

Figure 4.4. Example standard bioretention design.


Figure 4.5. Example streetscape bioretention.

4.3.1 Bioretention Feasibility Criteria

Bioretention can be applied in most soils or topography, since runoff simply percolates through an engineered soil bed and is infiltrated or returned to the stormwater system via an underdrain. Key constraints with bioretention include the following:

Required Space

Planners and designers can assess the feasibility of using bioretention facilities based on a simple relationship between the CDA and the corresponding bioretention surface area. The surface area is recommended to be approximately 3 to 6% of CDA, depending on the imperviousness of the CDA and the desired bioretention ponding depth.

Site Topography

Bioretention can be used for sites with a variety of topographic conditions, but it is best applied when the grade of the area immediately adjacent to the bioretention practice (within approximately 15 to 20 feet) is greater than 1% and less than 5%.

Available Hydraulic Head

Bioretention is fundamentally constrained by the invert elevation of the existing conveyance system to which the practice discharges (i.e., the bottom elevation needed to tie the underdrain from the bioretention area into the storm drain system). In general, 4 to 5 feet of elevation above this invert is needed to accommodate the required ponding and filter media depths. If the practice does not include an underdrain or if an inverted or elevated underdrain design is used, less hydraulic head may be adequate.

Water Table
Bioretention must be separated from the water table to ensure that groundwater does not intersect the filter bed. Mixing can lead to possible groundwater contamination or failure of the bioretention facility. A separation distance of no less than 0.5 feet is required between the bottom of the excavated bioretention area and the seasonally high groundwater table.

Tidal Impacts
For systems with an underdrain, the underdrain should be located above the tidal mean high water elevation. For entirely infiltration-based systems, the bottom of the stone reservoir should be located above the mean high water elevation. Where this is not possible, portions of the practice below the tidal mean high water elevation cannot be included in the volume calculations. Also, salt-tolerant vegetation may be necessary in these areas.

Soils and Underdrains
Soil conditions do not typically constrain the use of bioretention, although they do determine whether an underdrain is needed. Underdrains may be required if the measured permeability of the underlying soils is less than 0.3 inches per hour. When designing a bioretention practice, designers must verify soil permeability by using the on-site soil investigation methods provided in Appendix B for Geotechnical Information Requirements for Underground BMPs. Impermeable soils will require an underdrain.

For fill soil locations, geotechnical investigations are required to determine if it is necessary to use an impermeable liner and underdrain.

Contributing Drainage Area
Bioretention cells work best with smaller CDAs, where it is easier to achieve flow distribution over the filter bed. The maximum CDA to a standard bioretention area (B-1) is 2.5 acres and can consist of up to 100% impervious cover. The CDA for smaller bioretention practices (B-2, B-3, B-4, and B-5) is a maximum of 1 acre. However, if hydraulic considerations are adequately addressed to manage the potentially large peak inflow of larger CDAs, such as off-line or low-flow diversions, or forebays, there may be case-by-case instances where the maximum CDAs can be adjusted. summarizes typical recommendations for bioretention CDAs.

Table 4.3. Maximum contributing drainage area (CDA) to bioretention.

Bioretention Type	Design Variants	Maximum CDA (acres of impervious cover)
Standard	B-1	2.5
Small-scale bioretention	B-2, B-3, B-4, and B-5	1.0

Pollutant Hotspot Land Uses
Bioretention may not be an appropriate stormwater management practice for certain pollutant-generating sites. In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from

industrial processes), appropriate pretreatment, such as an oil- water separator or filtering device must be provided. These pretreatment facilities should be monitored and maintained frequently to avoid negative impacts to the bioretention area and subsequent water bodies.

On sites with existing contaminated soils, infiltration is not allowed. An impermeable bottom liner and an underdrain system must be employed when a bioretention area will receive untreated hotspot runoff, and the No Underdrain design configuration cannot be used.

Bioretention can still be used to treat parts of the site that are outside of the hotspot area. For instance, roof runoff can go to bioretention while vehicular maintenance areas would be treated by a more appropriate hotspot practice.

No Irrigation or Baseflow
The planned bioretention area should not receive baseflow, irrigation water, chlorinated wash-water or any other flows not related to stormwater. During the establishment period of the bioretention area, irrigation is allowed, however, to ensure plant survival. In addition, rain gardens or bioretention practices may be incorporated into the design of a Rainwater Harvesting System (See Section 4.7).

Setbacks
To avoid the risk of seepage, stormwater cannot flow from the bioretention area reservoir layer to the traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties.

Bioretention areas should be located at least:

10 feet from building foundations*
10 feet from property lines
150 feet from private water supply wells
50 feet from septic systems

*For building foundations, where the 10-foot setback is not possible, an impermeable liner may be used along the sides and bottom of the bioretention area (extending from the surface to the bottom of the practice and outward to meet the 10-foot setback) to prevent seepage or foundation damage.

Proximity to Utilities
Designers should ensure that future tree canopy growth in the bioretention area will not interfere with existing overhead utility lines. When large site development is undertaken the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the PROW. Consult with each utility company on recommended offsets, which will allow utility maintenance work with minimal disturbance to the bioretention system. Where conflicts cannot be avoided, follow these guidelines:

- Consider altering the location or sizing of the bioretention to avoid or minimize the utility conflict. Consider an alternate BMP type to avoid conflict.
- Use design features to mitigate the impacts of conflicts that may arise by allowing the bioretention and the utility to coexist. The bioretention design may need to incorporate impervious areas, through geotextiles or compaction, to protect utility crossings.
- Work with the utility to evaluate the relocation of the existing utility and install the optimum placement and sizing of the bioretention.

- If utility functionality, longevity, and vehicular access to manholes can be assured, accept the bioretention design and location with the existing utility. Incorporate into the bioretention design sufficient soil coverage over the utility or general clearances or other features such as an impermeable liner to assure all entities the conflict is limited to maintenance.

When accepting utility conflict into the bioretention location and design, it is understood the bioretention will be temporarily impacted during utility work but the utility owner will replace the bioretention or, alternatively, install a functionally comparable bioretention according to the specifications in the current version of this Manual. If the bioretention is located in the PROW, the bioretention restoration will also conform with the State of South Carolina Department of Transportation design specifications.

Minimizing External Impacts

Urban bioretention practices may be subject to higher public visibility, greater trash loads, pedestrian traffic, vandalism, and even vehicular loads. Designers should design these practices in ways that prevent, or at least minimize, such impacts. In addition, designers should clearly recognize the need to perform frequent landscaping maintenance to remove trash, check for clogging, and maintain vigorous vegetation. The urban landscape context may feature naturalized landscaping or a more formal design. When urban bioretention is used in sidewalk areas of high foot traffic, designers should not impede pedestrian movement or create a safety hazard. Designers may also install low fences, grates, or other measures to prevent damage from pedestrian short-cutting across the practices.

When bioretention will be included in public rights-of-way or spaces, design manuals and guidance developed by agencies or organizations other than *<local jurisdiction>* may also apply (e.g., State Department of Transportation).

Economic Considerations

Bioretention areas can be particularly cost effective when they are included in areas of the site already planned for landscaping.

4.3.2 Bioretention Conveyance Criteria

There are two basic design approaches for conveying runoff into, through, and around bioretention practices:

1. Off-line: Flow is split or diverted so that only the design storm or design flow enters the bioretention area. Larger flows bypass the bioretention treatment.
2. On-line: All runoff from the CDA flows into the practice. Flows that exceed the design capacity exit the practice via an overflow structure or weir.

If runoff is delivered by a storm drain pipe or is along the main conveyance system, the bioretention area should be designed off-line so that flows do not overwhelm or damage the practice.

Off-line Bioretention

Overflows are diverted from entering the bioretention cell. Optional diversion methods include the following:

1) Create an alternate flow path at the inflow point into the structure such that when the maximum ponding depth is reached, the incoming flow is diverted past the facility. In this case,

the higher flows do not pass over the filter bed and through the facility, and additional flow is able to enter as the ponding water filters through the filter media. With this design configuration, an overflow structure in the bioretention area is not required.

2) Utilize a low-flow diversion or flow splitter at the inlet to allow only the design storm volume (i.e., the SWRv) to enter the facility (calculations must be made to determine the peak flow from the 85th or 95th percentile storm). This may be achieved with a weir, curb opening, or orifice for the target flow, in combination with a bypass channel or pipe. Using a weir or curb opening helps minimize clogging and reduces the maintenance frequency. With this design configuration, an overflow structure in the bioretention area is required (see on-line bioretention below).

On-line Bioretention

An overflow structure must be incorporated into on-line designs to safely convey larger storms through the bioretention area (see Figure 4.6). The following criteria apply to overflow structures:

1) An overflow shall be provided within the practice to pass storms greater than the design storm storage to a stabilized water course. A portion of larger events may be managed by the bioretention area so long as the maximum depth of ponding in the bioretention cell does not exceed 18 inches.
2) The overflow device must convey runoff to a storm sewer, stream, or the existing stormwater conveyance infrastructure, such as curb and gutter or an existing channel.
3) Common overflow systems within bioretention practices consist of an inlet structure, where the top of the structure is placed at the maximum ponding depth of the bioretention area, which is typically 6 to 18 inches above the surface of the filter bed.
4) The overflow device should be scaled to the application. This may be a landscape grate or yard inlet for small practices or a commercial-type structure for larger installations.
5) Sufficient depth must be provided between the top of the overflow device and the top of the bioretention area to ensure that the 25-year storm can be safely conveyed through the overflow device.
6) The overflow associated with the 2- to 25-year design storms must be controlled so that velocities are non-erosive (generally less than 6 feet per second) at the outlet point, to prevent downstream erosion.

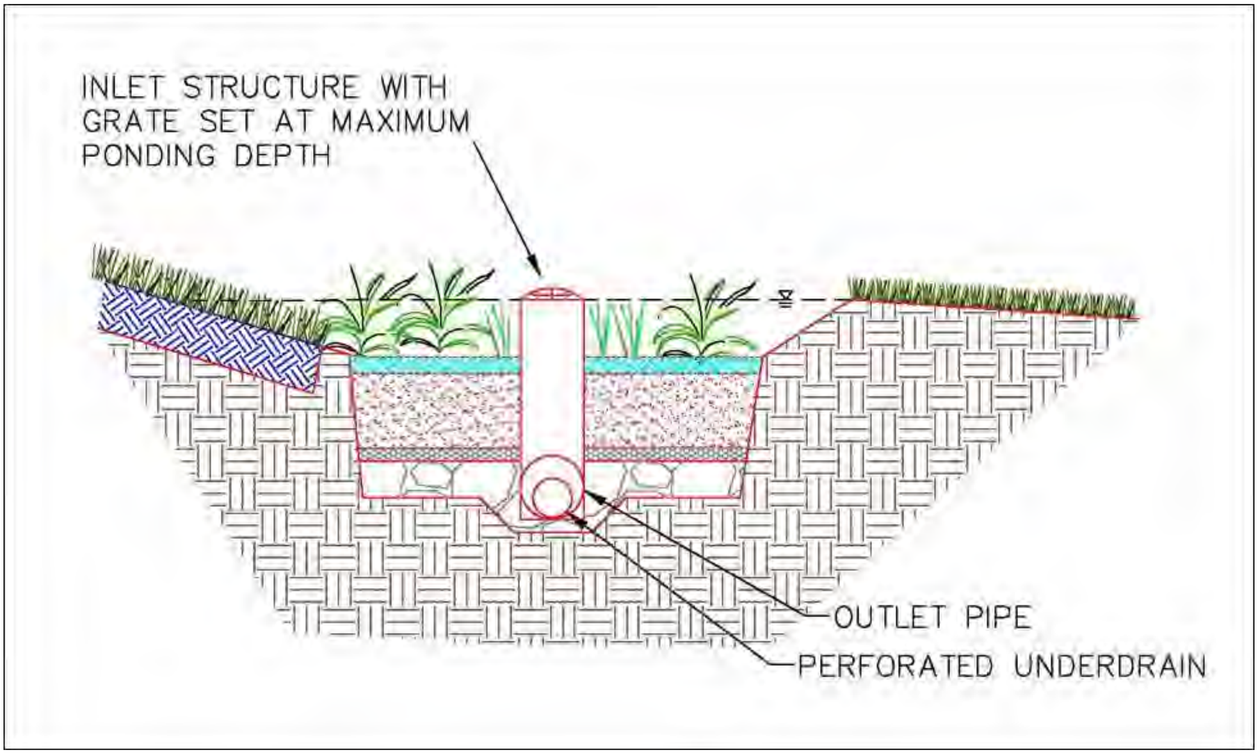

Figure 4.6. Example design of an on-line bioretention with an overflow structure.

4.3.3 Bioretention Pretreatment Criteria

Pretreatment of runoff entering bioretention areas is necessary to trap coarse sediment particles before they reach and prematurely clog the filter bed. Pretreatment measures must be designed to evenly spread runoff across the entire width of the bioretention area. Several pretreatment measures are feasible, depending on the type of the bioretention practice and whether it receives sheet flow, shallow concentrated flow, or deeper concentrated flows. The following are appropriate pretreatment options:

Standard Bioretention (B-1)

1) **Pretreatment Cells** (for channel flow). Similar to a forebay, this cell is located at piped inlets or curb cuts leading to the bioretention area and consists of an energy dissipator sized for the expected rates of discharge. It has a storage volume equivalent to at least 15% of the total storage volume (inclusive) with a recommended 2:1 length-to-width ratio. The cell may be formed by a wooden or stone check dam or an earthen or rock berm. Pretreatment cells do not need underlying engineered filter media, in contrast to the main bioretention cell. However, if the volume of the pretreatment cell will be included as part of the bioretention storage volume, the pretreatment cell must de-water between storm events. It cannot have a permanent ponded volume.

2) **Grass Filter Strips** (for sheet flow). Grass filter strips that are perpendicular to incoming sheet flow extend from the edge of pavement, with a slight drop at the pavement edge, to the bottom of the bioretention basin at a 5H:1V slope or flatter. Alternatively, if the bioretention basin has side slopes that are 3H:1V or flatter, a 5-foot grass filter strip can be used at a maximum 5% (20H:1V) slope.

3) **Stone Diaphragms** (for sheet flow). A stone diaphragm located at the edge of the pavement should be oriented perpendicular to the flow path to pretreat lateral runoff, with a 2- to 4-inch drop from the pavement edge to the top of the stone. The stone must be sized according to the expected rate of discharge.

4) **Gravel or Stone Flow Spreaders** (for concentrated flow). The gravel flow spreader is located at curb cuts, downspouts, or other concentrated inflow points, and should have a 2- to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The gravel must extend the entire width of the opening and create a level stone weir at the bottom or treatment elevation of the basin.

5) **Filter System** (see Section 4.10 Filtering Systems). If using a filter system as a pretreatment facility, the filter will not require a separate pretreatment facility.

6) **Innovative or Proprietary Structure**. An approved proprietary structure with demonstrated capability of reducing sediment and hydrocarbons may be used to provide pretreatment. Refer to Section 0 Proprietary Practices for information on approved proprietary structures.

Other pretreatment options may be appropriate, but they must trap coarse sediment particles and evenly spread runoff across the entire width of the bioretention area.

Small-Scale Bioretention (B-2, B-3, B-4, and B-5)

- **Leaf Screens**. A leaf screen serves as part of the gutter system to keep the heavy loading of organic debris from accumulating in the bioretention cell.
- **Pretreatment Cells** (for channel flow). Pretreatment cells are located above ground or covered by a manhole or grate. Pretreatment cells are atypical in small-scale bioretention and are not recommended for residential rain gardens (B-5).
- **Grass Filter Strips** (for sheet flow). Grass filter strips are applied on residential lots, where the lawn area can serve as a grass filter strip adjacent to a rain garden.
- **Stone Diaphragm** (for either sheet flow or concentrated flow). The stone diaphragm at the end of a downspout or other concentrated inflow point should run perpendicular to the flow path to promote settling.

  Note: stone diaphragms are not recommended for school settings.
- **Trash Racks** (for either sheet flow or concentrated flow). Trash racks are located between the pretreatment cell and the main filter bed or across curb cuts to allow trash to collect in specific locations and make maintenance easier.

4.3.4 Bioretention Design Criteria

Design Geometry

Bioretention basins must be designed with an internal flow path geometry such that the treatment mechanisms provided by the bioretention are not bypassed or short-circuited. So that the bioretention area to have an acceptable internal geometry, the travel time from each inlet to the outlet should be maximized by locating the inlets and outlets as far apart as possible. In addition, incoming flow must be distributed as evenly as possible across the entire filter surface area.

Inlets and Energy Dissipation

Where appropriate, the inlet(s) to streetscape bioretention (B-2), engineered tree boxes (B-3), and stormwater planters (B-4) should be stabilized using No. 3 stone, splash block, river stone, or other acceptable energy dissipation measures. The following types of inlets are recommended:

- Downspouts to stone energy dissipators.
- Sheet flow over a depressed curb with a 3-inch drop.
- Curb cuts allowing runoff into the bioretention area.
- Covered drains that convey flows across sidewalks from the curb or downspouts.
- Grates or trench drains that capture runoff from a sidewalk or plaza area.
- Drop structures that appropriately dissipate water energy.

Inlets must be designed with sufficient width and slope to avoid unintended bypass. This is of particular concern for curb cuts on streetscape bioretention designs.

Ponding Depth

The recommended surface ponding depth is 6 to 12 inches. Minimum surface ponding depth is 3 inches (averaged over the surface area of the BMP). Ponding depths can be increased to a maximum of 18 inches. However, when higher ponding depths are utilized, the design must consider carefully issues such as safety, fencing requirements, aesthetics, the viability and survival of plants, and erosion and scour of side slopes. This is especially true where bioretention areas are built next to sidewalks or other areas were pedestrians or bicyclists travel. Shallower ponding depths (typically 6 to 12 inches) are recommended for streetscape bioretention (B-2), engineered tree boxes (B-3), and stormwater planters (B-4).

Side Slopes

Traditional bioretention areas (B-1) and residential rain gardens (B-5) should be constructed with side slopes of 3H:1V or flatter. In space-constrained areas, a drop curb design or a precast structure can be used to create a stable, vertical side wall. These drop curb designs should not exceed a vertical drop of more than 12 inches, unless safety precautions, such as railings, walls, grates, etc. are included.

Filter Media

The filter media of a bioretention practice consists of an engineered soil mixture that has been carefully blended to create a filter media that maintains long-term permeability while also providing enough nutrients to support plant growth. The final filter media shall consist of a well-blended mixture of medium to coarse **sand**, **loam soil**, and an **organic amendment** (compost). The sand maintains the desired permeability of the media while the limited amount of loam soil and organic amendments are considered adequate to help support initial plant growth. It is anticipated that the gradual increase of organic material through natural processes will continue to support plant growth without the need to add fertilizer, and the root structure of maturing plants and the biological activity of the media will maintain sufficient long-term permeability.

The following is the recommended composition of the three media ingredients:

- **Sand (Fine Aggregate).** Sand should consist of silica-based medium to coarse sand and be angular or round in shape. The materials shall not be derived from serpentine, shall be free of surface coatings or any other deleterious materials, and shall contain less than 0.5% mica by weight when tested with ASTM C295, Standard Guide for Petrographic Examination of Aggregates for Concrete.

  ASTM C-33 concrete sand will typically meet the requirements for the sand to be used in filter media. However, some samples of ASTM C-33 sand may have too high a fraction of fine sand and silt- and clay-sized particles to meet the final filter media particle size distribution requirements. In general, coarser gradations of ASTM C-33 will better meet the filter media particle size distribution and hydraulic conductivity requirements.

  Any other materials, such as manufactured sand, limestone-based sands, or crushed glass, shall meet the required particle size distribution (of final filter media mixture) and be demonstrated as adequately durable when tested by AASHTO T-103 or T-104.

- **Loam Soil.** Loam soil is generally defined as the combination of sand-sized material, fines (silt and clay), and any associated soil organic matter. Since the objective of the specification is to carefully establish the proper blend of these ingredients in the final filter media, the designer (or contractor or materials supplier) must carefully select the topsoil source material so as not exceed the amount of any one ingredient.

  Generally, a natural loamy sand, sandy loam, or loam (per the USDA Textural Triangle) A-horizon topsoil free of subsoil, large stones, earth clods, sticks, stumps, clay lumps, roots, viable noxious weed seed, plant propagules, brush, or other objectionable, extraneous matter or debris is suitable for the loam soil source material.

- **Organic Amendments.** Organic amendments shall consist of stable, well-composted, natural, carbon-containing organic materials such as leaf mulch, peat moss, humus, or yard waste (consistent with the material specifications found in Appendix C Soil Compost Amendment Requirements). The material shall be free of debris such as plastics, metal, concrete, stones larger than ½ inch, larger branches and roots, and wood chips over 1 inch in length or diameter.

<u>Complete Filter Media</u>

The complete filter media shall consist of a pug milled or mechanically blended mix of the three source materials. Mixing the filter media on site with excavation or loading equipment is not sufficient to achieve the required blending. The resulting filter media must meet the following particle size composition:

- 80%–90% sand
- 10%–20% silt and clay
- Maximum 10% clay

The particle size analysis must be conducted on the mineral fraction only or following appropriate treatments to remove organic matter before particle size analysis. Note: The above percentages are based on weight rather than volume.

Additionally, the final filter media mix must either meet the grain size distribution indicated in Table 4.4, or have a saturated hydraulic conductivity of 2 to 6 inches per hour according to test procedure ASTM

D2434 when compacted (at 60% to 80% optimum moisture content) to a minimum of 86% of the maximum density as determined by AASHTO T 99 (ASTM, 2006).

Table 4.4. Filter media grain size distribution.

Sieve Type	Particle Size (mm)	Percent Passing (%)
-	8.0	100
No. 5	4.0	92–100
No. 10	2.0	72–100
No. 18	1.0	43–95
No. 35	0.5	20–65
No. 60	0.25	11–37
No. 140	0.105	10–25
No. 270	0.053	10–20
-	0.002	0–10

The filter media shall also meet the following criteria (see summary in Table 4.5):

- Organic content shall be between 3.0% and 5.0% by weight;
- pH shall be between 6.0 and 7.5;
- Cation exchange capacity (CEC) shall be a minimum of 5 meq/100g or cmol+/kg;
- Phosphorus content shall meet one of the following:
    - P-Index between 10 and 30;
    - 15 mg/kg Mehlich I Extraction;
    - 18 to 40 mg/kg Mehlich III Extraction; and
- Soluble salts shall be less than 500 ppm or less than 0.5 mmhos/cm.

Notes:

P-Index is an agronomic test used in North Carolina to indicate the potential for P leaching from soil. The test method has been revised to add P concentration to facilitate local lab testing. The value of the P-Index is the correlation between the CEC and P concentrations: higher CEC indicates greater adsorption sites within the media, thus increasing the ability to fix P within the soil, thereby allowing higher P concentrations without leaching. While P-Index may be a better overall representation of P, the test method may not be readily available.

Tests for organic content, CEC, soluble salts, and pH are referenced to be in accordance with Recommended Soil Testing Procedures from the Southeastern United States, Current Edition, Southern Cooperative Series Bulletin No. 419. Use the following tests from Southern Cooperative Series Bulletin No. 419:

(a) Test for soil content by loss of weight on ignition

(b) Test for soil CEC by exchangeable acidity method

(c) Test for soluble salts shall be by the 1:2 (v:v) soil:water Extract Method

(d) Test for pH by the SMP method

Table 4.5. Summary of filter media criteria for bioretention.

Filter Media Criterion	Description	Standard(s)
General Composition	Filter media must have the proper proportions of sand, loam soil, and organic amendments to promote plant growth, drain at the proper rate, and filter pollutants.	80%–90% sand; 10%–20% soil fines; maximum of 10% clay; and 3%–5% organic content Must meet final filter media grain size distribution OR have a saturated hydraulic conductivity of 2–6 inches per hour
Sand	Medium to coarse aggregate	Based on final filter media grain size distribution
Loam Soil	Loamy sand, sandy loam, or loam	USDA Textural Triangle
Organic Amendments	Stable, well-composted, natural, carbon-containing organic materials such as leaf mulch, peat moss, humus, or yard waste.	Appendix C
P-Index or Phosphorus (P) Content	Filter media with high P levels will export P through the media and potentially to downstream conveyances or receiving waters.	P-Index of 10–30 or P content = 5–15 mg/kg (Mehlich I) or 18–40 mg/kg (Mehlich III)
Cation Exchange Capacity (CEC)	The CEC is determined by the amount of soil fines and organic matter. Higher CEC will promote pollutant removal.	CEC > 5 milliequivalents per 100 grams
pH	Soil pH influences nutrient availability and microbial populations.	Between 6.0 and 7.5
Soluble Salts	Filter media with high levels of soluble salts can injure or kill plants.	Less than 500 ppm or less than 0.5 mmhos/cm.

In cases where greater removal of specific pollutants is desired, additives with documented pollutant removal benefits, such as water treatment residuals, alum, iron, or other materials, may be included in the filter media if accepted by *<local jurisdiction>*.

Filter Media Depth

The filter media bed depth must be a minimum of 18 inches for the No Underdrain or Standard designs. The media depth must be 24 inches or greater for the IWS design. **In order to receive the full credit for bacteria removal a minimum media depth of 24" is required.** The media depth must not exceed 6.0

feet. Turf, perennials, or shrubs should be used instead of trees to landscape shallower filter beds. See Table 4.7 and Table 4.8 for a list of recommended native plants.

Surface Cover

Mulch is the recommended surface cover material, but other materials may be substituted, as described below:

- **Mulch**. A 2- to 3-inch layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed growth, pretreats runoff before it reaches the filter media, and prevents rapid evaporation of rainwater. Shredded hardwood bark mulch, aged for at least 6 months, is recommended/required for surface cover, as it retains a significant amount of pollutants and typically will not float away. The maximum depth of the mulch layer is 3 inches.
- **Alternative to Mulch Cover**. In some situations, designers may consider alternative surface covers, such as turf, native groundcover, erosion control matting (e.g., coir or jute matting), river stone, or pea gravel. The decision regarding the type of surface cover to use should be based on function, expected pedestrian traffic, cost, and maintenance. When alternative surface covers are used, methods to discourage pedestrian traffic should be considered. Stone or gravel are not recommended in parking lot applications, since they increase soil temperature and have low water-holding capacity.
- **Media for Turf Cover**. One adaptation suggested for use with turf cover is to design the filter media primarily as a sand filter with organic content only at the top. Compost, as specified in Appendix C Soil Compost Amendment Requirements, tilled into the top layers will provide organic content for the vegetative cover. If grass is the only vegetation, the ratio of organic matter in the filter media composition may be reduced.

Choking Layer

A 2- to 4-inch layer of choker stone (e.g., typically ASTM D448 No. 8 or No. 89 washed gravel) should be placed beneath the filter media and over the underdrain stone.

Geotextile

If the available head is limited, or the depth of the practice is a concern, geotextile fabric may be used in place of the choking layer. An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements, and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used. Geotextile fabric may be used on the sides of bioretention areas as well.

Underdrains

Many bioretention designs will require an underdrain (see Section 4.3.1 Bioretention Feasibility Criteria). The underdrain should be a 4- or 6-inch perforated schedule 40 PVC pipe, or equivalent corrugated HDPE for small bioretention BMPs, with three or four rows of 3/8-inch perforations at 6 inches on center. The underdrain must be encased in a layer of clean, double washed ASTM D448 No.57 or smaller (No. 68, 8, or 89) stone. The maximum depth of the underdrain stone layer combined with the choking layer is 12 inches, and it cannot extend beyond the surface dimensions of the bioretention filter media. The underdrain must be sized so that the bioretention BMP fully drains within 72 hours or less.

Multiple underdrains may be necessary for bioretention areas wider than 40 feet, and each underdrain is recommended to be located no more than 20 feet from the next pipe or the edge of the bioretention.

For long and narrow applications, a single underdrain running the length of the bioretention is sufficient. Each underdrain must include a cleanout pipe (minimum 4 inches in diameter).

All bioretention practices should include at least one observation well and/or cleanout pipe (minimum 4 inches in diameter). The observation wells should be tied into any of the Ts or Ys in the underdrain system and must extend upward above the surface of the bioretention area.

Internal Water Storage (IWS)

In cases where limited head is a site constraint and the bioretention must be designed to be relatively shallow (e.g., depth to groundwater, relatively flat sites, or other factors), or where increased nitrogen removal is desired, an internal water storage design that creates an infiltration sump below the underdrain can be used. The internal water storage zone may be created by an upturned elbow in the underdrain, a weir in the outlet structure, or other means that create a permanently saturated depth above the underdrain. The internal water storage zone must be kept at least 12 inches below the surface of the bioretention area. For more information on this design consult North Carolina Stormwater Design Manual Chapter C-2. (NCDEQ, 2017)

Observation Wells

All bioretention practices must include at least one observation well consisting of a well-anchored, 4- to 6-inch diameter PVC pipe (see Figure 4.7). For standard and IWS bioretention designs, the non-perforated observation wells should be tied into any of the Ts or Ys in the underdrain system and must extend upward above the ponding level. These observation wells can also double as cleanouts. Observation wells for bioretention designs without underdrains should be perforated in the gravel layer only and also must extend upward to the top of ponding.

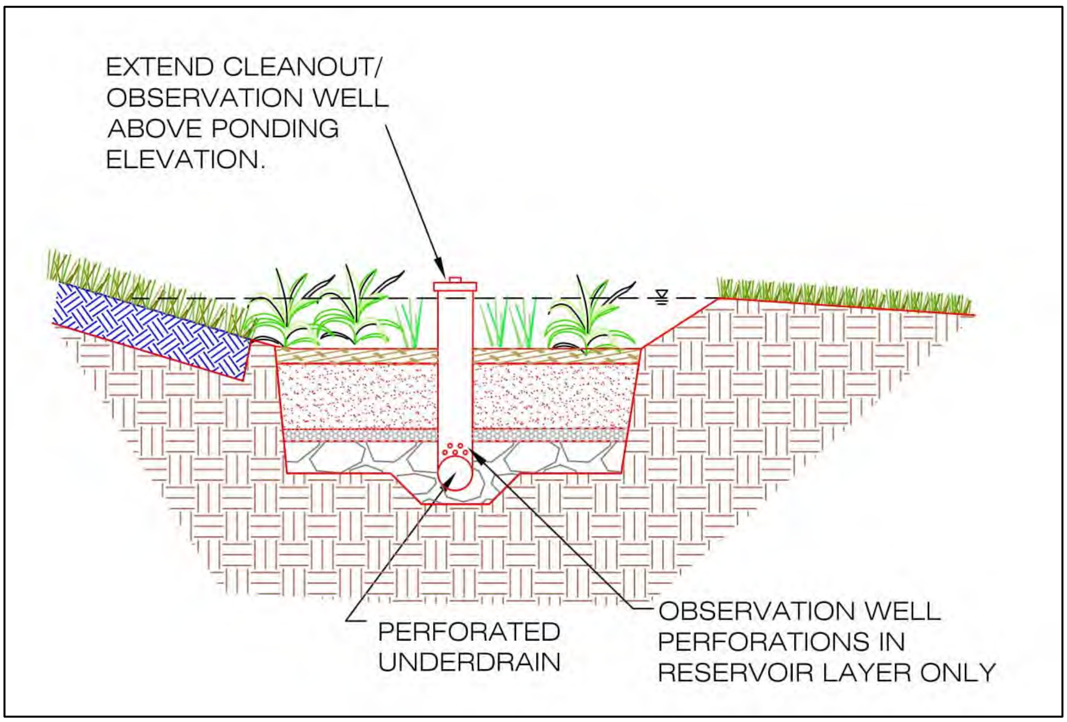

Figure 4.7. Example design of a bioretention with an observation well/cleanout device.

Underground Storage Layer (optional)

For IWS bioretention designs, an underground storage layer consisting of chambers, perforated pipe, stone, or other acceptable material can be incorporated below the filter media layer and underdrain to increase the storage for larger storm events. Unlike the underdrain stone layer, this storage layer can be extended beyond the surface dimensions of the bioretention filter media if additional storage volume is needed. The underground storage layer may be designed to provide detention for the 2- to 25-year, or 100-year storms, as needed. The depth and volume of the storage layer will depend on the target storage volumes needed to meet the applicable detention criteria. Suitable conveyance must also be provided to ensure that the storage is fully utilized without overflow of the bioretention area.

Impermeable Liner (optional)

An impermeable liner is not typically required, although it may be utilized for Standard designs in fill applications where deemed necessary by a geotechnical investigation, on sites with contaminated soils, or on the sides of the practice to protect adjacent structures from seepage. Use a PVC geomembrane liner or equivalent of an appropriate thickness (follow manufacturer's instructions for installation). Field seams must be sealed according to the liner manufacturer's specifications. A minimum 6-inch overlap of material is required at all seams.

Material Specifications

Recommended material specifications for bioretention areas are shown in Table 4. 6.

Table 4.6. Bioretention material specifications.

Material	Specification	Notes
Filter Media	▪ See Table 4.5 and Table 4.6	Minimum depth of 24 inches (18 inches for standard design). To account for settling/compaction, it is recommended that 110% of the plan volume be utilized.
Mulch Layer	Use aged, shredded hardwood bark mulch	Lay a 2- to 3-inch layer on the surface of the filter bed.
Alternative Surface Cover	Use river stone or pea gravel, coir and jute matting, or turf cover.	Lay a 2- to 3-inch layer of to suppress weed growth.
Topsoil for Turf Cover	Loamy sand or sandy loam texture, with less than 5% clay content, pH corrected to between 6 and 7, and an organic matter content of at least 2%.	3-inch tilled into surface layer.
Geotextile or Choking Layer	An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used	Can use in place of the choking layer where the depth of the practice is limited. Geotextile fabric may be used on the sides of bioretention areas as well.
	Lay a 2- to 4-inch layer of choker stone (e.g., typically No.8 or No.89 washed gravel) over the underdrain stone.	
Underdrain Stone	1-inch diameter stone must be double-washed and clean and free of all fines (e.g., ASTM D448 No. 57 or smaller stone).	At least 2 inches above and below the underdrain.
Storage Layer (optional)	To increase storage for larger storm events, chambers, perforated pipe, stone, or other acceptable material can be incorporated below the filter media layer.	
Impermeable Liner (optional)	Where appropriate, use a PVC Geomembrane liner or equivalent material of an appropriate thickness.	
Underdrains, Cleanouts, and Observation Wells	Use 4- or 6-inch rigid schedule 40 PVC pipe, or equivalent corrugated HDPE for small bioretention BMPs, with three or four rows of 3/8-inch perforations at 6 inches on center. Multiple underdrains may be necessary for bioretention areas wider than 40 feet, and each underdrain is recommended to be located no more than 20 feet from the next pipe or the edge of the bioretention.	Lay the perforated pipe under the length of the bioretention cell and install non-perforated pipe as needed to connect with the storm drain system or to daylight in a stabilized conveyance. Install T's and Y's as needed, depending on the underdrain configuration. Extend cleanout pipes to the surface of ponding.
Plant Materials	See Section 4.3.5 Bioretention Landscaping Criteria	Establish plant materials as specified in the landscaping plan and the recommended plant list.

Signage

Bioretention units in highly urbanized areas should be stenciled or otherwise permanently marked to designate it as a structural BMP. The stencil or plaque should indicate (1) its water quality purpose, (2) that it may pond briefly after a storm, and (3) that it is not to be disturbed except for required maintenance.

Specific Design Issues for Streetscape Bioretention (B-2)

Streetscape bioretention is installed in the road right-of-way either in the sidewalk area or in the road itself. In many cases, streetscape bioretention areas can also serve as traffic-calming or street-parking control devices. The basic design adaptation is to move the raised concrete curb closer to the street or in the street, and then create inlets or curb cuts that divert street runoff into depressed vegetated areas within the right-of-way. Roadway stability can be a design issue where streetscape bioretention practices are installed. Designers should consult design standards pertaining to roadway drainage. It may be necessary to provide an impermeable liner on the road-side of the bioretention area to keep water from saturating the road’s sub-base. Streetscape bioretention in the PROW should comply with State Department of Transportation requirements, where applicable.

Specific Design Issues for Engineered Tree Boxes (B-3)

Engineered tree boxes are installed in the sidewalk zone near the street where urban street trees are normally installed (see Figure 4.8). The soil volume for the tree pit is increased and used to capture and treat stormwater. Treatment is increased by using a series of connected tree planting areas together in a row. The surface of the enlarged planting area may be mulch, grates, permeable pavers, or conventional pavement. The large and shared rooting space and a reliable water supply increase the growth and survival rates in this otherwise harsh planting environment. Engineered tree boxes in the PROW should comply with State Department of Transportation requirements, where applicable.

When designing engineered tree boxes, the following criteria may apply.

- Engineered tree box designs sometimes cover portions of the filter media with pervious pavers or cantilevered sidewalks (see Figure 4.9). In these situations, the following design considerations must be incorporated:
    - The filter media must be connected beneath the surface so that stormwater and tree roots can share this space.
    - As with all bioretention areas, a minimum surface ponding depth of 3 inches, averaged over the surface area of the bioretention area, is required. For example, if the additional surface area under the pavement doubles the overall surface area, then the ponding depth will need to be at least 6 inches.
    - Sand based structural soil (SBSS) may be considered as bioretention filter media if it meets the same phosphorus content limits. However, if the SBSS is to be compacted beyond the State Standards’ maximum compaction for bioretention, it shall be assigned a porosity of 0.10. The State Standards call for bioretention soil to be compacted to 84% maximum dry density while SBSS is to be compacted to 93%.
- Installing an engineered tree pit grate over filter bed media is one possible solution to prevent pedestrian traffic and trash accumulation.

- Low, wrought iron fences can help restrict pedestrian traffic across the tree pit bed and serve as a protective barrier if there is a drop-off from the pavement to the micro-bioretention cell.
- A removable grate may be used to allow the tree to grow through it.
- Each tree needs a minimum rootable soil volume as described in Section 4.12 Tree Planting and Preservation.
- See Section 4.14.2 Planting Trees for further guidance and requirements on tree planting.

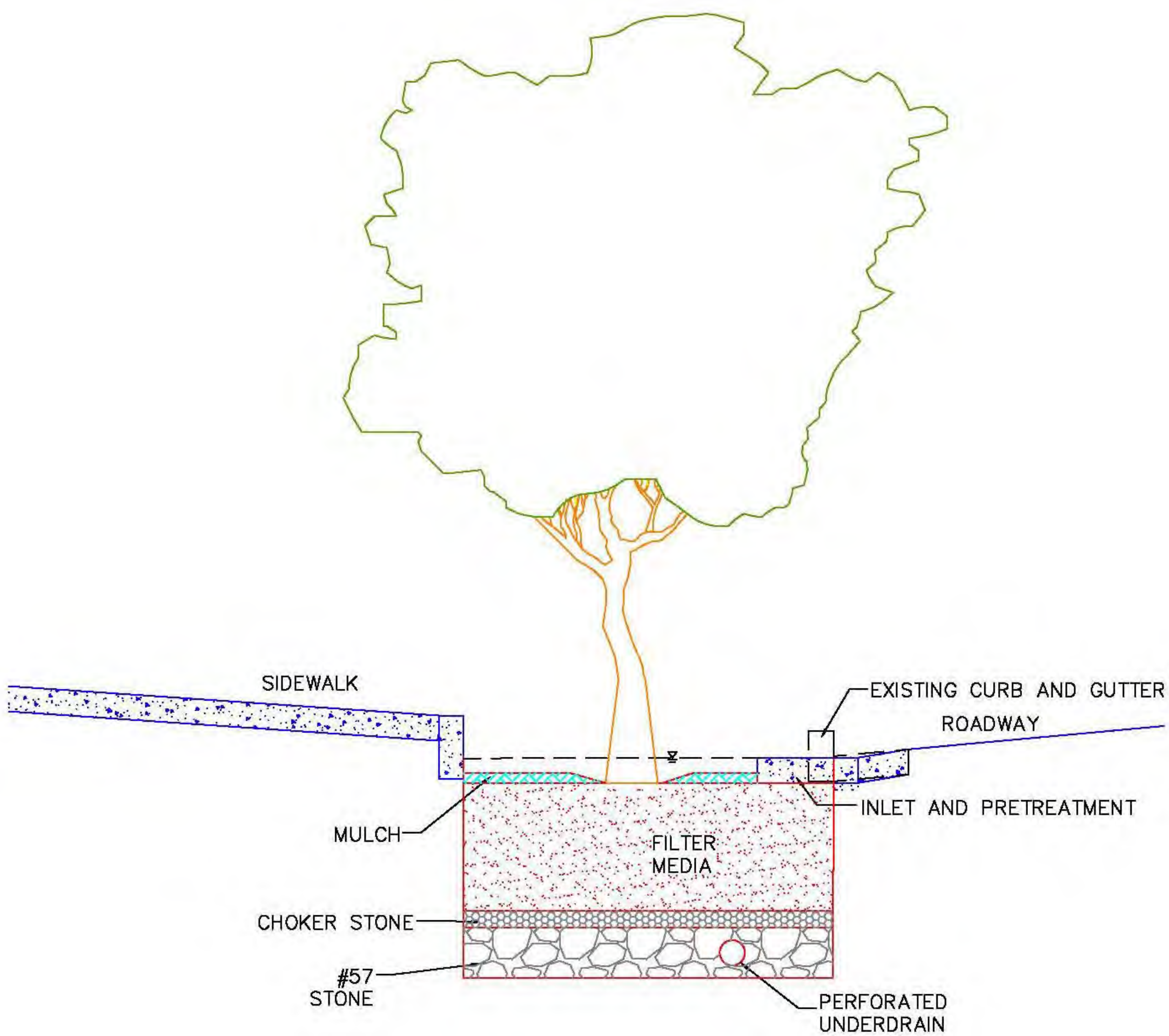

Figure 4.8. Example design of a tree box.

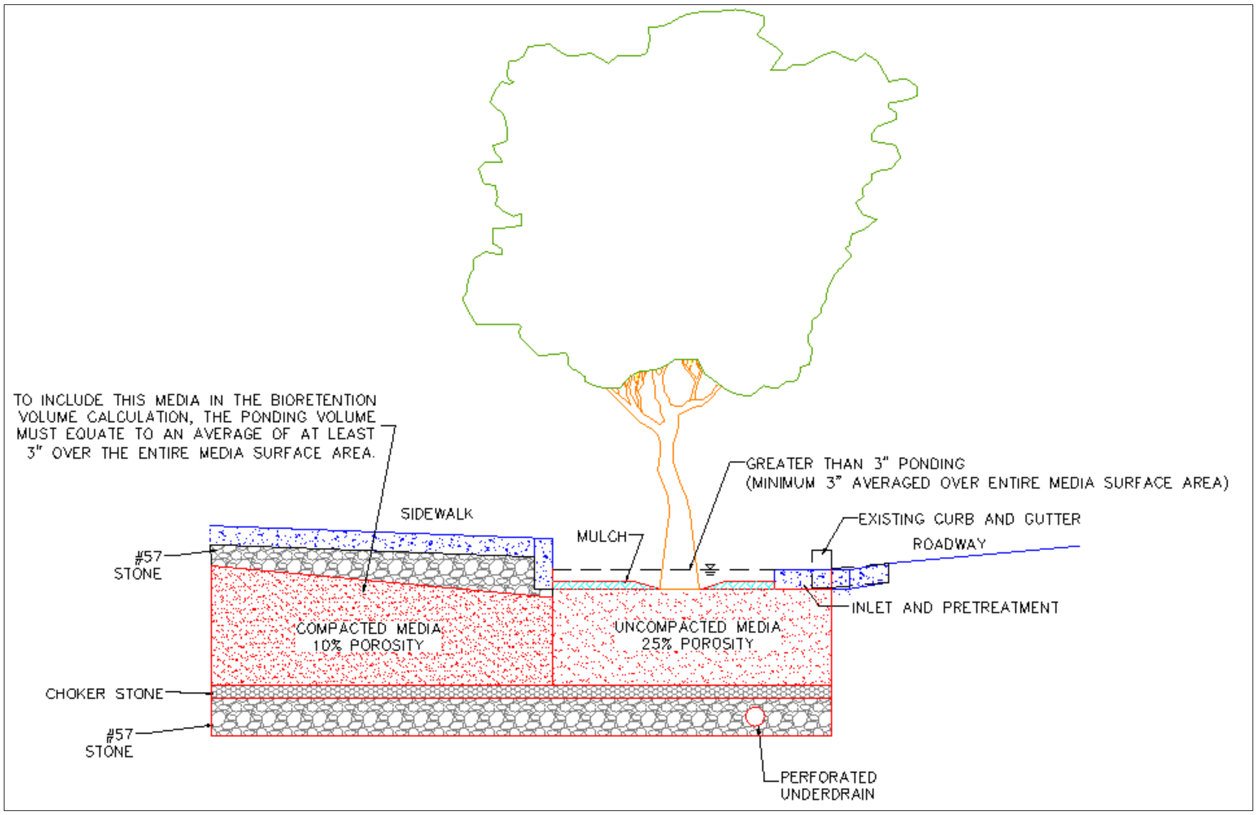

Figure 4.9. Example design of a tree box with compacted media extending below sidewalk.

Specific Design Issues for Stormwater Planters (B-4)

Stormwater planters are a useful option to disconnect and treat rooftop runoff, particularly in ultra-urban areas. Stormwater planters combine an aesthetic landscaping feature with a functional form of stormwater treatment. Stormwater planters generally receive runoff from adjacent rooftop downspouts and are landscaped with plants that tolerate periods of both drought and inundation. The two basic design variations for stormwater planters are the infiltration planter and the filter planter. A filter planter is illustrated in Figure 4.10.

An infiltration planter filters rooftop runoff through soil in the planter followed by infiltration into soils below the planter. Infiltration planters should be placed at least 10 feet away from a building to prevent possible flooding or basement seepage damage.

A filter planter does not allow for infiltration and is constructed with a watertight concrete shell or an impermeable liner on the bottom to prevent seepage. Since a filter planter is self-contained and does not infiltrate into the ground, it can be installed right next to a building. Runoff is captured and temporarily ponded above the planter bed. Overflow pipes are installed to discharge runoff when maximum ponding depths are exceeded, to avoid water spilling over the side of the planter. In addition, an underdrain is used to carry runoff to the storm sewer system.

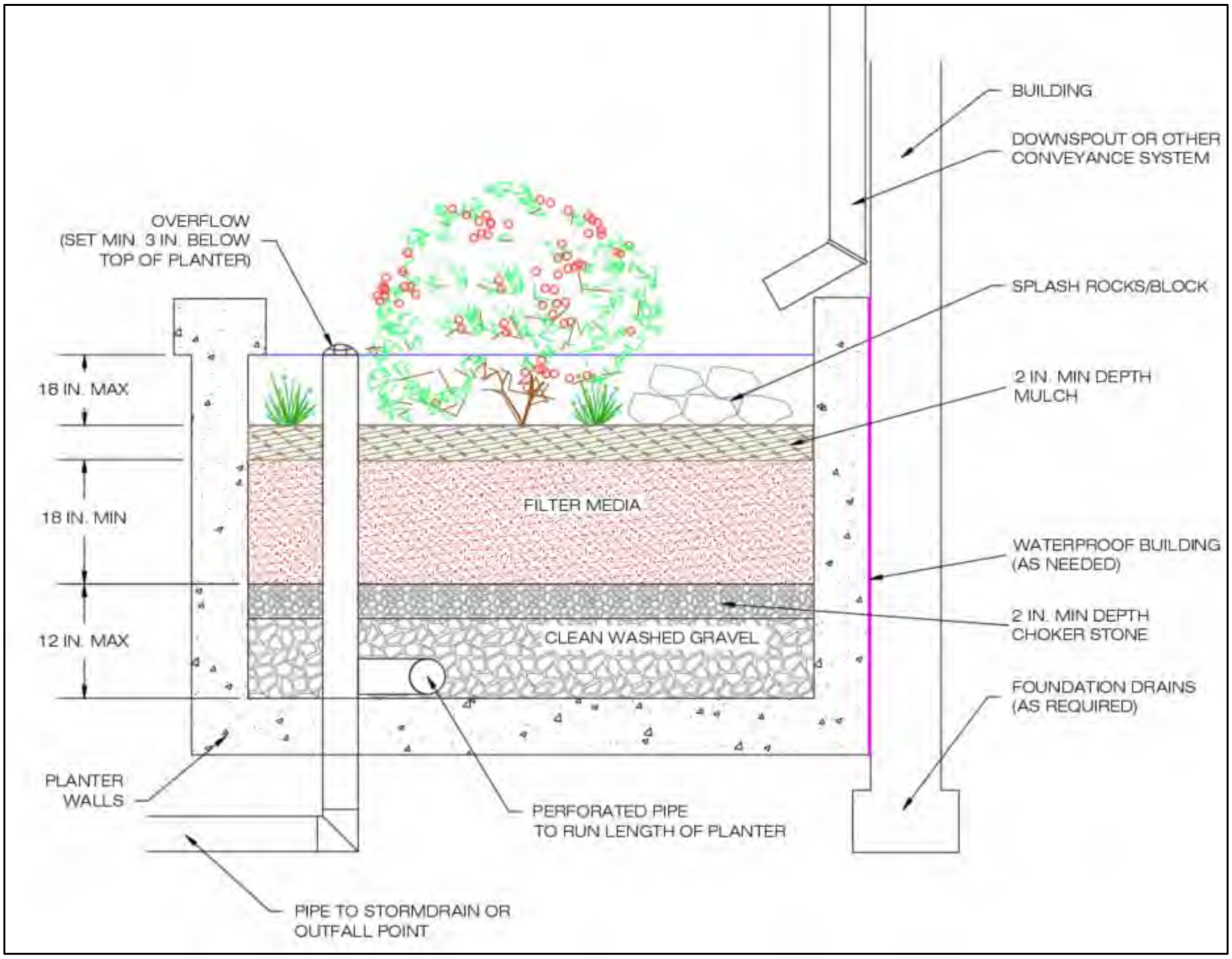

Figure 4.10. Example design of a stormwater planter (B-4).

Plant materials must be capable of withstanding moist and seasonally dry conditions. The planter can be constructed of stone, concrete, brick, wood, or other durable material. If treated wood is used, care should be taken so that trace metals and creosote do not leach out of the planter.

Specific Design Issues for Residential Rain Gardens (B-5)

For some residential applications, front, side, and/or rear yard bioretention may be an attractive option. This form of bioretention captures roof, lawn, and driveway runoff from low- to medium- density residential lots in a depressed area (i.e., 6 to 12 inches) between the home and the primary stormwater conveyance system (i.e., roadside ditch or pipe system).

BMP Sizing

Bioretention is typically sized to capture the SWRv or larger design storm volumes in the surface ponding area, filter media, and gravel reservoir layers of the BMP.

Total storage volume of the BMP is calculated using Equation 4.1.

Equation 4.1. Bioretention storage volume.

$$S_v = SA_{bottom} \times [(d_{media} \times \eta_{media}) + (d_{gravel} \times \eta_{gravel})] + (SA_{average} \times d_{ponding})$$

Where:

Sv =	Total storage volume of bioretention (cubic feet)
SA_{bottom} =	Bottom surface area of bioretention (square feet)
d_{media} =	Depth of filter media, including mulch later (ft)
η_{media} =	Effective porosity of the filter media (typically 0.25)
d_{gravel} =	Depth of the underdrain and underground storage gravel layer, including choker stone (ft)
η_{gravel} =	Effective porosity of the gravel layer (typically 0.4)
$SA_{average}$ =	Average surface area of the bioretention (square feet), where SA_{top} is the surface area of the top of the bioretention $$SA_{average} = \frac{SA_{bottom} + SA_{top}}{2}$$
$d_{ponding}$ =	Maximum ponding depth of bioretention (ft)

Equation 4.1 can be modified if the storage depths of the filter media, gravel layer, or ponded water vary in the actual design or with the addition of any surface or subsurface storage components (e.g., additional area of surface ponding, subsurface storage chambers, etc.). The maximum depth of ponding in the bioretention must not exceed 18 inches. If storage practices will be provided off-line or in series with the bioretention area, the storage practices should be sized using the guidance in Section 4.9 Storage Practices.

Note: In order to increase the storage volume of a bioretention area, the ponding surface area may be increased beyond the filter media surface area. However, the top surface area of the practice (i.e., at the top of the ponding elevation) may not be more than twice the size of the surface area of the filter media (SA_{bottom}).

For bioretention designs without an underdrain, the storage volume must infiltrate within 72 hours, as in Equation 4.2.

Equation 4.2. Bioretention infiltration rate check equation.

$$Sv_{infiltrate} = \frac{SA_{bottom}(K_{sat} \times t_d)}{12}$$

$Sv_{infiltrate}$ =	Storage volume that will infiltration within 72 hours (cubic feet)
SA_{bottom} =	Bottom surface area of bioretention (square feet)
K_{sat} =	Field-verified saturated hydraulic conductivity for the native soils (ft/day)
t_d =	Drawdown time (3 days)

If $Sv_{infiltrate}$ is greater than or equal to Sv, then the entire Sv will infiltrate within 72 hours. If it is not, the storage volume of the bioretention area should be reduced accordingly.

Bioretention can be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. The Sv can be counted as part of the 2- to 25-year runoff volumes to satisfy stormwater quantity control requirements.

4.3.5 Bioretention Landscaping Criteria

Landscaping is critical to the performance and function of bioretention areas. Therefore, a landscaping plan shall be provided for bioretention areas.

Minimum plan elements include the proposed bioretention template to be used, delineation of planting areas, and the planting plan including the following:

- Common and botanical names of the plants used
- Size of planted materials
- Mature size of the plants
- Light requirements
- Maintenance requirements
- Source of planting stock
- Any other specifications
- Planting sequence

It is recommended that the planting plan be prepared by a qualified landscape architect professional (e.g., licensed professional landscape architect, certified horticulturalist) to tailor the planting plan to the site-specific conditions.

Native plant species are preferred over non-native species, but some ornamental species may be used for landscaping effect if they are not aggressive or invasive. Some popular native species that work well in bioretention areas and are commercially available can be found in Table 4.7 and Table 4.8.

The degree of landscape maintenance that can be provided will determine some of the planting choices for urban bioretention areas. Plant selection differs if the area will be frequently mowed, pruned, and weeded, in contrast to a site that will receive minimum annual maintenance. In areas where less maintenance will be provided and where trash accumulation in shrubbery or herbaceous plants is a concern, consider a “turf and trees” landscaping model where the turf is mowed along with other turf areas on the site. Spaces for herbaceous flowering plants can be included.

Table 4.7. Bioretention-appropriate plants: perennial and grass

Scientific Name	Common Name	Wetland Indicator [1]	Inundation Tolerance	Salt Tolerance	Notes
Aletris farinosa	White Colicroot	FAC	Moist soil	None	
Andropogon gerardii	Big Bluestem	FAC	No	Moderate	
Aquilegia canadensis	Wild Columbine	FACU	No	None	
Asclepias incarnata	Swamp Milkweed	OBL	Saturated	None	
Asclepias lanceolata	Red Milkweed	OBL	Wet soils	Moderate / brackish	
Aster novae-angliae	New England Aster	FACW	Moist soils, yes	Yes	
Athyrium filix-femina	Lady Fern	FAC	Moist to wet soils	None	
Canna glauca	Water Canna	OBL	Moist to wet soils	None	
Canna flaccida	Golden Canna	OBL	Moist to wet soils	None	
Carex stricta	Tussock Sedge	OBL	Saturated, 0-6”	None	
Chasmanthium latifolium	River Oats	FAC	Moist soils	None	
Chelone glabra	White Turtlehead	OBL	Moist to wet soils		
Conoclinium coelestinum	Blue Mistflower	FAC	Moist to Wet soils		
Crinum americanum	Southern Swamp Lily	OBL	Saturated		
Dulichium arundinaceum	Threeway Sedge	OBL	Saturated, shallow	None	
Echinodorus cordifolius	Creeping Burhead	OBL	Saturated, shallow		
Equisetum hyemale	Scouring Rush	FACW	Saturated, shallow		
Eupatorium fistulosum	Joe Pye Weed	FACW	Moist to Wet Soils		
Geranium maculatum	Spotted Geranium	FACU	Moist Soils		
Helianthus angustifolius	Swamp Sunflower, Narrowleaf Sunflower	FACW	Wet Soils		

Scientific Name	Common Name	Wetland Indicator [1]	Inundation Tolerance	Salt Tolerance	Notes
Hibiscus coccineus	Scarlet Swamp Hibiscus	OBL	Saturated, shallow		
Hibiscus moscheutos	Rose Mallow, Hibiscus	OBL	Saturated, shallow	Low	
Hymenocallis caroliniana	Spider Lily	OBL	Saturated, shallow	None	
Iris versicolor	Virginia Iris	OBL	Shallow	None	
Juncus effuses	Common Rush	OBL	Shallow <6”	Low	
Liatris spicata	Gayfeather, Blazing Star	FAC	Moist Soils	Low	
Lobelia cardinalis	Cardinal Flower	FACW	Moist to Wet Soils	None	
Lobelia siphilitica	Blue Lobelia	OBL	Moist to wet soils		
Lysimachia ciliata	Fringed Loosestrife	FACW	Moist to wet soils, seasonal flooding		
Mimulus ringens	Allegheny Monkeyflower	OBL	Saturated, shallow		
Onoclea sensibilis	Sensitive Fern	FACW	Moist to wet soils		
Osmunda cinnamomea	Cinnamon Fern	FACW	Moist to wet soils	Low	
Osmunda spectabilis	Royal Fern	OBL	Moist to wet soils	None	
Orontium aquaticum	Golden Club	OBL	Up to 10”		
Panicum virgatum	Switch Grass	FAC	Moist soil	Moderate	
Peltandra virginica	Green Arrow Arum	OBL	Shallow < 1’	Low (< 2 ppt)	
Pontederia cordata	Pickerelweed	OBL	Shallow < 1’	Low (< 3 ppt)	
Physostegia virginiana	Obedient Plant	FACW	Moist soil		
Polygonatum biflorum	Great Solomon’s Seal	FACU	Moist soil		
Rhynchospora colorata	Starrush Whitetop	FACW	Saturated		
Rudbeckia laciniata	Cutleaf Coneflower	FACW	Moist soil	None	

Scientific Name	Common Name	Wetland Indicator [1]	Inundation Tolerance	Salt Tolerance	Notes
Sagittaria latifolia	Common Arrowhead, Duck Potato	OBL	Up to 2.0’	None	
Saururus cernuus	Lizard’s Tail	OBL	Shallow < 4”	None	
Schizachyrium scoparium	Little Bluestem	FACU	Moist soil	None	
Schoenoplectus tabernaemontani	Softstem Bulrush	OBL	Wet soil to standing water	Fresh or Brackish	
Solidago sempervirens	Seaside Goldenrod	FACW	Yes	High	
Sorghastrum nutans	Indiangrass	FACU	Moist soil	Moderate	
Spartina alterniflora	Saltmarsh Cordgrass	OBL	Yes	High	
Spartina bakeri	Sand cordgrass	FACW	Moist to wet soils	Fresh - Saline	
Spartina patens	Saltmeadow Cordgrass	FACW	Wet soils	High	
Thalia dealbata	Powdery Alligator-flag	OBL	up to 1.5’	Yes	
Tradescantia virginiana	Virginia Spiderwort	FAC	Moist soils	None	
Vernonia noveboracensis	Ironweed	FACW	Moist soils	None	

1. Wetland Indicator Notes:
FAC = Facultative, equally likely to occur in wetlands or non-wetlands (estimated probability 34%–66%).
FACU = Facultative Upland, usually occurs in non-wetlands (estimated probability 67%–99%), but occasionally found on wetlands (estimated probability 1%–33%).
FACW = FACW Facultative Wetland, usually occurs in wetlands (estimated probability 67%–99%), but occasionally found in non-wetlands.
OBL = Obligate Wetland, occurs almost always (estimated probability 99%) under natural conditions in wetlands

Table 4.8. Bioretention-appropriate plants: shrubs and bushes

Scientific Name	Common Name	Wetland Indicator [1]	Inundation Tolerance	Salt Tolerance	Notes
Baccharis halimifolia	Groundsel Tree, Salt Myrtle	FAC	Wet soils	High	
Callicarpa americana	Beautyberry	FACU	Moist soils	None	
Cephalanthus occidentalis	Button Bush	OBL	Up to 3 ft	Low	
Clethra alnifolia	Summersweet Sweet Pepperbush	FACW	Moist to wet soils	None	
Cyrilla racemiflora	Swamp Titi	FACW	Moist to wet soils	Low	
Hamamelis virginiana	Witch Hazel	FACU	Moist to wet soils	None	
Hypericum prolificum	Shrubby St. John's Wort	FAC	Moist soils, flood tolerant	None	
Ilex glabra	Inkberry	FACW	Wet soils, flood tolerant	Moderate	
Ilex verticillata	Winterberry Holly	FACW	Moist to wet soils	None	
Ilex vomitoria	Yaupon Holly	FAC	Moist soils	Moderate	
Itea virginica	Virginia Sweetspire	FACW	Moist to wet soils	None	
Kosteletzkya virginica	Seashore Mallow	OBL	Moist to wet soils	Moderate	
Lindera benzoin	Spicebush	FACW	Seasonal inundation	None	
Myrica cerifera	Wax Myrtle	FAC	Moist to wet soils	Moderate	
Photinia pyrifolia	Red Chokeberry	FACW	Moist soils	Low	
Rhododendron canescens	Dwarf Azalea	FACW	Moist soils	None	
Rhododendron viscosum	Swamp Azalea	OBL	Wet soil	None	
Rosa carolina	Carolina Rose	FACU	Moist to wet soils	Moderate	
Sabal minor	Dwarf Palmetto	FACW	Moist to wet soils	None	
Sambucus canadensis	Elderberry	FACW	Moist to wet soils	None	

Scientific Name	Common Name	Wetland Indicator [1]	Inundation Tolerance	Salt Tolerance	Notes
Serenoa repens	Saw Palmetto	FACU	Occasionally wet	None	
Vaccinium corymbosum	Highbush Blueberry	FACW	Wet soil	High	
Viburnum dentatum	Arrowwood	FAC	Moist to wet	None	

1. Wetland Indicator Notes:
FAC = Facultative, equally likely to occur in wetlands or non-wetlands (estimated probability 34%–66%).
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Planting recommendations for bioretention facilities are as follows:

- The primary objective of the planting plan is to cover as much of the surface areas of the filter bed as quickly as possible. Herbaceous or ground cover layers are as or more important than more widely spaced trees and shrubs.
- Native plant species should be specified over non-native species.
- Plants should be selected based on a specified zone of hydric tolerance and must be capable of surviving both wet and dry conditions ("Wet footed" species should be planted near the center, whereas upland species do better planted near the edge).
- Woody vegetation should not be located at points of inflow; trees should not be planted directly above underdrains but should be located closer to the perimeter.
- Shrubs and herbaceous vegetation should generally be planted in clusters and at higher densities (i.e., 5 feet on-center and 1 to 1.5 feet on-center, respectively).
- If trees are part of the planting plan, a tree density of approximately one tree per 250 square feet (i.e., 15 feet on-center) is recommended.
- Designers should also remember that planting holes for trees must be at least 3 feet deep to provide enough soil volume for the root structure of mature trees. This applies even if the remaining filter media layer is shallower than 3 feet.
- Tree species should be those that are known to survive well in the compacted soils and the polluted air and water of an urban landscape.
- If trees are used, plant shade-tolerant ground covers within the drip line.

4.3.6 Bioretention Construction Sequence

Soil Erosion and Sediment Controls

The following soil erosion and sediment control guidelines must be followed during construction:

All bioretention areas must be fully protected by silt fence or construction fencing.

Bioretention areas intended to infiltrate runoff must remain outside the limits of disturbance during construction to prevent soil compaction by heavy equipment and loss of design infiltration rate.

- Where it is infeasible keep the proposed bioretention areas outside of the limits of disturbance, there are several possible remedies for the impacted area. If excavation in the proposed bioretention area can be restricted, then the remediation can be achieved with deep tilling practices. This is only possible if in situ soils are not disturbed any deeper than 2 feet above the final design elevation of the bottom of the bioretention. In this case, when heavy equipment activity has ceased, the area is excavated to grade, and the impacted area must be tilled to a depth of 12 inches below the bottom of the bioretention.
- Alternatively, if it is infeasible to keep the proposed bioretention areas outside of the limits of disturbance, and excavation of the area cannot be restricted, then infiltration tests will be required prior to installation of the bioretention to ensure that the design infiltration rate is still present. If tests reveal the loss of design infiltration rates, then deep tilling practices may be used in an effort to restore those rates. In this case further testing must be done to establish design rates exist before the bioretention area can be installed.
- Finally, if it is infeasible to keep the proposed bioretention areas outside of the limits of disturbance, excavation of the area cannot be restricted, and infiltration tests reveal design rates cannot be restored, then a resubmission of the SWMP will be required.

Bioretention areas must be clearly marked on all construction documents and grading plans.

Large bioretention applications may be used as small sediment traps or basins during construction. However, these must be accompanied by notes and graphic details on the soil erosion and sediment control plan specifying that:

(1) the maximum excavation depth of the trap or basin at the construction stage must be at least 1 foot higher than the post-construction (final) invert (bottom of the facility), and
(2) the facility must contain an underdrain.

The plan must also show the proper procedures for converting the temporary sediment control practice to a permanent bioretention BMP, including dewatering, cleanout, and stabilization.

Bioretention Installation

The following is a typical construction sequence to properly install a bioretention basin. These steps may be modified to reflect different bioretention applications or expected site conditions:

1. Stabilize Contributing Drainage Area

Construction of the bioretention area may only begin after the entire CDA has been stabilized with vegetation. It may be necessary to block certain curb or other inlets while the bioretention area is being constructed. The proposed site should be checked for existing utilities prior to any excavation.

2. Preconstruction Meeting
The designer, the installer, and *<local jurisdiction>* inspector must have a preconstruction meeting, checking the boundaries of the CDA and the actual inlet elevations to ensure they conform to original design. Since other contractors may be responsible for constructing portions of the site, it is quite common to find subtle differences in site grading, drainage and paving elevations that can produce hydraulically important differences for the proposed bioretention area. The designer should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the installer and the inspector. Material certifications for aggregate, filter media, and any geotextiles must be submitted for approval to the inspector at the preconstruction meeting.

3. Install Soil Erosion and Sediment Control Measures to Protect the Bioretention
Temporary soil erosion and sediment controls (e.g., diversion dikes, reinforced silt fences) are needed during construction of the bioretention area to divert stormwater away from the bioretention area until it is completed. Special protection measures, such as erosion control fabrics, may be needed to protect vulnerable side slopes from erosion during the construction process.

4. Install Pretreatment Cells
Any pretreatment cells should be excavated first and then sealed to trap sediment.

5. Avoid Impact of Heavy Installation Equipment
Excavators or backhoes should work from the sides to excavate the bioretention area to its appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the bioretention area. Contractors should use a cell construction approach in larger bioretention basins, whereby the basin is split into 500- to 1,000-square foot temporary cells with a 10- to 15-foot earth bridge in between, so that cells can be excavated from the side.

6. Promote Infiltration Rate
It may be necessary to rip the bottom soils to a depth of 6 to 12 inches to promote greater infiltration.

7. Order of Materials
If using a geotextile fabric, place the fabric on the sides of the bioretention area with a 6-inch overlap on the sides. If a stone storage layer will be used, place the appropriate depth of No. 57 stone (clean, double washed) on the bottom, install the perforated underdrain pipe, pack No. 57 stone at least 2 inches above the underdrain pipe, and add the choking layer or appropriate geotextile layer as a filter between the underdrain and the filter media layer. If no stone storage layer is used, start with at least 2 inches of No. 57 stone on the bottom and proceed with the layering as described above.

8. Layered Installation of Media
Apply the media in 12-inch lifts until the desired top elevation of the bioretention area is achieved. Wait a few days to check for settlement and add additional media, as needed, to achieve the design elevation.

Note: The batch receipt confirming the source of the filter media must be submitted to the *<local jurisdiction>* inspector.

9. Prepare Filter Media for Plants
Prepare planting holes for any trees and shrubs, install the vegetation, and water accordingly. Install any temporary irrigation.

10. Planting
Install the plant materials as shown in the landscaping plan, and water them as needed.

11. Secure Surface Area
Place the surface cover (i.e., mulch, river stone, or turf) in both cells, depending on the design. If coir or jute matting will be used in lieu of mulch, the matting will need to be installed prior to planting (Step 10), and holes or slits will have to be cut in the matting to install the plants.

12. Inflows
If curb cuts or inlets are blocked during bioretention installation, unblock these after the CDA and side slopes have good vegetative cover. It is recommended that unblocking curb cuts and inlets take place after two to three storm events if the CDA includes newly installed asphalt, since new asphalt tends to produce a lot of fines and grit during the first several storms.

13. Final Inspection
Conduct the final construction inspection using a qualified professional, providing *<local jurisdiction>* with an as-built, then log the GPS coordinates for each bioretention facility, and submit them for entry into the maintenance tracking database.

14. Construction Supervision
Supervision during construction is recommended to ensure that the bioretention area is built in accordance with the approved design and this specification. Qualified individuals should use detailed inspection checklists that include sign-offs at critical stages of construction, to ensure that the contractor's interpretation of the plan is consistent with the designer's intentions.

Construction phase inspection checklist can be found in Appendix E Construction Inspection Checklists.

4.3.7 Bioretention Maintenance Criteria

When bioretention practices are installed, it is the owner's responsibility to ensure they, or those managing the practice:

(1) be educated about their routine maintenance needs,
(2) understand the long-term maintenance plan, and
(3) be subject to a maintenance covenant or agreement, as described below.

Maintenance of bioretention areas should be integrated into routine landscape maintenance tasks. If landscaping contractors will be expected to perform maintenance, their contracts should contain specifics on unique bioretention landscaping needs, such as maintaining elevation differences needed for ponding, proper mulching, sediment and trash removal, and limited use of fertilizers and pesticides.

Maintenance tasks and frequency will vary depending on the size and location of the bioretention, the landscaping template chosen, and the type of surface cover in the practice. A generalized summary of common maintenance tasks and their frequency is provided in Table 4.9.

Table 4.9. Typical maintenance tasks for bioretention practices.

Frequency	Maintenance Tasks
Upon establishment	▪ For the first 6 months following construction, the practice and CDA should be inspected at least twice after storm events that exceed 0.5 inch of rainfall. Conduct any needed repairs or stabilization. ▪ Inspectors should look for bare or eroding areas in the CDA or around the bioretention area and make sure they are immediately stabilized with grass cover. ▪ One-time, spot fertilization may be needed for initial plantings. ▪ Watering is needed once a week during the first 2 months, and then as needed during first growing season (April through October), depending on rainfall. ▪ Remove and replace dead plants. Up to 10% of the plant stock may die off in the first year, so construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.
At least 4 times per year	▪ Mow grass filter strips and bioretention with turf cover ▪ Check curb cuts and inlets for accumulated grit, leaves, and debris that may block inflow
Twice during growing season	▪ Spot weed, remove trash, and rake the mulch
Annually	▪ Conduct a maintenance inspection ▪ Supplement mulch in devoid areas to maintain a 3-inch layer ▪ Prune trees and shrubs ▪ Remove sediment in pretreatment cells and inflow points
Once every 2–3 years	▪ Remove sediment in pretreatment cells and inflow points ▪ Remove and replace the mulch layer
As needed	▪ Add reinforcement planting to maintain desired vegetation density ▪ Remove invasive plants using recommended control methods ▪ Remove any dead or diseased plants ▪ Stabilize the CDA to prevent erosion

Standing water is the most common problem outside of routine maintenance. If water remains on the surface for more than 72 hours after a storm, adjustments to the grading may be needed or underdrain repairs may be needed. The surface of the filter bed should also be checked for accumulated sediment or a fine crust that builds up after the first several storm events. There are several methods that can be used to rehabilitate the filter. These are listed below, starting with the simplest approach and ranging to more involved procedures (i.e., if the simpler actions do not solve the problem):

- Open the underdrain observation well or cleanout and pour in water to verify that the underdrains are functioning and not clogged or otherwise in need of repair. The purpose of this check is to see if there is standing water all the way down through the soil. If there is standing water on top, but not in the underdrain, then there is a clogged soil layer. If the underdrain and stand pipe indicates standing water, then the underdrain must be clogged and will need to be cleaned out.
- Remove accumulated sediment and till 2 to 3 inches of sand into the upper 6 to 12 inches of soil.

- Install sand wicks from 3 inches below the surface to the underdrain layer. This reduces the average concentration of fines in the media bed and promotes quicker drawdown times. Sand wicks can be installed by excavating or auguring (i.e., using a tree auger or similar tool) down to the top of the underdrain layer to create vertical columns that are then filled with a clean open-graded coarse sand material (e.g., ASTM C-33 concrete sand or similar approved sand mix for bioretention media). A sufficient number of wick drains of sufficient dimension should be installed to meet the design dewatering time for the facility.
- Remove and replace some or all of the filter media.

Maintenance Inspections

It is recommended that a qualified professional conduct a spring maintenance inspection and cleanup at each bioretention area. Maintenance inspections should include information about the inlets, the actual bioretention facility (sediment buildup, outlet conditions, etc.), and the state of vegetation (water stressed, dead, etc.) and are intended to highlight any issues that need or may need attention to maintain stormwater management functionality.

Maintenance inspection checklists for bioretention areas and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Waste Material

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.3.8 Bioretention Stormwater Compliance Calculations

Bioretention performance varies depending on the design configuration of the system.

No Underdrain

Bioretention designs with no underdrain are credited with100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (Table 4.10).

Table 4.10. Retention and pollutant removal for bioretention practices without underdrains.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

Internal Water Storage (IWS)

Bioretention designs with IWS are credited with75% retention for the storage volume (Sv) provided by the practice as well as 85% TSS, 85% TN, and 80% bacteria removal (Table 4.11).

Table 4.11. Retention and pollutant removal for bioretention practices with IWS design.

Retention	= 75%
TSS Removal	= 85%
TN Removal	= 85%
Bacteria Removal	= 80%

Standard

Standard bioretention designs are credited with 60% retention for the storage volume (Sv) provided as well as 85% TSS, 75% TN, and 80% bacteria removal. (Table 4.12).

Table 4.12. Retention and pollutant removal for standard bioretention practices.

Retention	= 60%
TSS Removal	= 85%
TN Removal	= 75%
Bacteria Removal	= 80%

The practice must be sized using the guidance detailed in Section 4.1.4 Bioretention Design Criteria. Note: Additional retention can be achieved if trees are utilized as part of a bioretention area (see Section 4.14 Tree Planting and Preservation).

Bioretention also contributes to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) from the total runoff volume for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

4.3.9 References

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4.4 Permeable Pavement Systems

<table>
<tr><th colspan="6">Permeable Pavement Systems</th></tr>
<tr><td colspan="6">Definition: Paving systems that capture and temporarily store the SWRv by filtering runoff through voids in an alternative pavement surface into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system or allowed to partially (or fully) infiltrate into the soil.</td></tr>
<tr><th colspan="2">Site Applicability</th><th colspan="4">BMP Performance Summary</th></tr>
<tr><th>Land Uses</th><th>Required Footprint</th><th colspan="4">WQ Improvement: Moderate to High</th></tr>
<tr><td rowspan="3">▪ Urban
▪ Suburban
▪ Rural</td><td rowspan="3">Small</td><th>TSS[1]</th><th colspan="2">Total N[1]</th><th>Bacteria[1]</th></tr>
<tr><td>80-100%</td><td colspan="2">45-100%</td><td>30-100%</td></tr>
<tr><th colspan="4">Runoff Reduction</th></tr>
<tr><th>Construction Costs</th><th>Maintenance Burden</th><th colspan="4">Volume</th></tr>
<tr><td>High</td><td>High</td><td colspan="4">Moderate</td></tr>
<tr><th colspan="2">Maintenance Frequency:</th><th colspan="4">SWRv</th></tr>
<tr><th>Routine</th><th>Non-Routine</th><th colspan="2">Standard Design</th><th colspan="2">Enhanced Design</th></tr>
<tr><td>2-4 times per year</td><td>Every 2-3 years</td><td colspan="2">30%</td><td colspan="2">100%</td></tr>
<tr><th colspan="2">Advantages/Benefits</th><th colspan="4">Disadvantages/Limitation</th></tr>
<tr><td colspan="2">▪ Reduces runoff volume, attenuates peak runoff rate and outflow
▪ Reduces slick surfaces during rain
▪ Water quality enhancement from filtration of stormwater</td><td colspan="4">▪ Sediment-laden runoff can clog pervious pavement, causing it to fail
▪ Incorrect installation practices can clog pores</td></tr>
<tr><th colspan="2">Components</th><th colspan="4">Design considerations</th></tr>
<tr><td colspan="2">▪ Open graded pavement mix or pavers with open surfaces
▪ Bedding course
▪ Open-graded base material
▪ Underdrain (where required)
▪ Subgrade with minimal compaction</td><td colspan="4">▪ Same basic considerations as any paved area
▪ Infiltration rate of native soil determines applicability and need for underdrain
▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice
▪ Not appropriate for heavy or high traffic areas
▪ Accessibility, aesthetics, maintainability</td></tr>
<tr><th colspan="2">Installation Considerations</th><th colspan="4">Maintenance Activities</th></tr>
<tr><td colspan="2">▪ Proper construction sequencing and installation is crucial to ensure proper functioning
▪ Subgrade cannot be overly compacted</td><td colspan="4">▪ Vacuum or jet wash to increase pavement life and avoid clogging
▪ Ensure that contributing area is clear of debris and sediment.</td></tr>
</table>

[1]*Credited pollutant load removal*

Permeable pavement systems represent alternative paving surfaces that capture and temporarily store the design volume by filtering runoff through voids in the pavement surface into an underlying stone reservoir (see Figure 4.11). Filtered runoff may be collected and returned to the conveyance system, or it may be allowed to infiltrate into the soil**.** Permeable pavement systems may also provide stormwater detention of larger storms (e.g., 2- to 25-year).

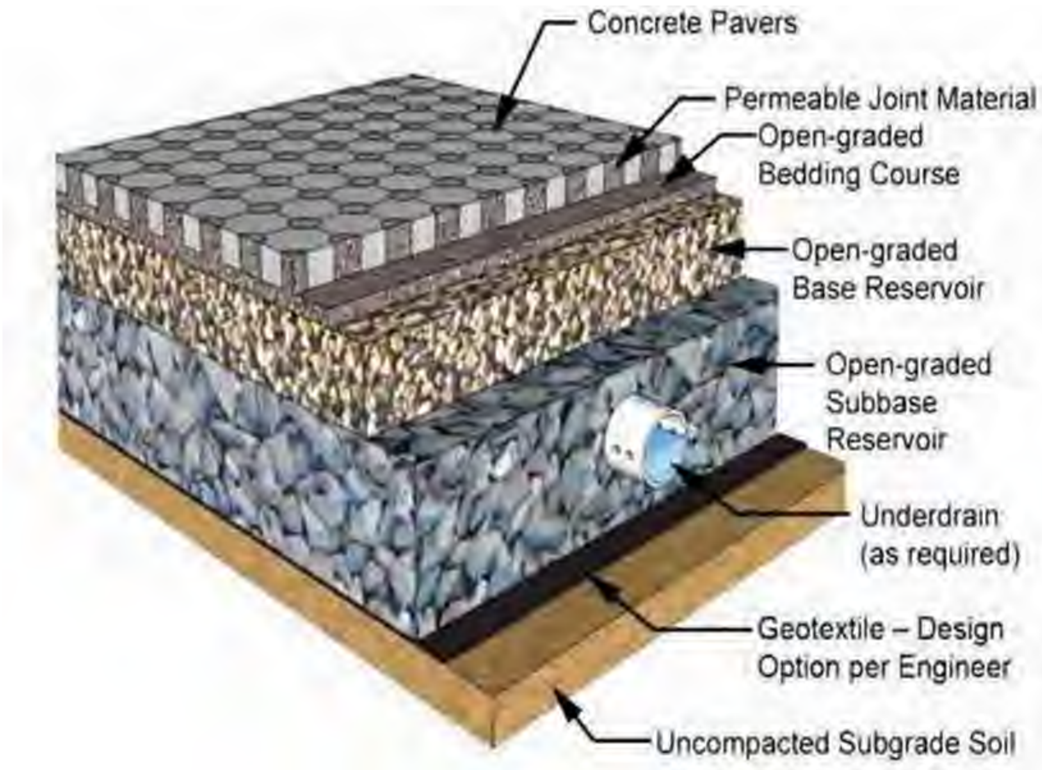

Figure 4.11. Cross-section of permeable pavement (source: ICPI).

Definition

This is a paving system that captures and temporarily stores the SWRv by filtering runoff through voids in an alternative pavement surface into an underlying stone reservoir. Filtered runoff may be collected and returned to the conveyance system or allowed to infiltrate into the soil.

Design variants include the following:

P-1 Porous asphalt (PA)
P-2 Pervious concrete (PC)
P-3 Permeable pavers (PP)

Other surface material variations of permeable pavement that can be part of a permeable pavement system, such as porous rubber, plastic grid pavers, and synthetic turf systems are also encompassed in this section.

Porous Asphalt

Porous asphalt (also known as pervious asphalt) consists of a special open-graded surface course bound together by asphalt cement. The open-graded surface course in a typical porous asphalt installation is 3 to 7 inches thick and has a void ratio of between 15% and 20%. Porous asphalt is thought to have a limited ability to maintain its structure and permeability during hot summer months and, consequently, is currently not recommended for use in coastal South Carolina. If it is used on a development site in the coastal region, it should be carefully monitored and maintained over time.

Pervious Concrete

Pervious concrete (also known as porous concrete) is similar to conventional concrete in structure and form but consists of a special open-graded surface course, typically 4 to 8 inches thick, that is bound together with Portland cement. This open-graded surface course has a void ratio of 15% to 25% (conventional concrete pavement has a void ratio of between 3% and 5%), which gives it a high permeability that is often many times more than that of the underlying native soils, and allows rainwater and stormwater runoff to rapidly pass through it and into the underlying stone reservoir. Although this particular type of permeable pavement surface may not require an underlying base layer to support traffic loads, site planning and design teams may wish to provide it to increase the stormwater storage capacity provided by a pervious concrete system.

Permeable Pavers

Permeable pavers (PP) are solid structural units (e.g., blocks, bricks) that are installed in a way that provides regularly spaced openings through which stormwater runoff can rapidly pass through the pavement surface and into the underlying stone reservoir. The regularly spaced openings, which generally make up between 8% and 20% of the total pavement surface, are typically filled with pea gravel (i.e., ASTM D 448 Size No. 8, 3/8 inch to 1/8 inch). Typical PP systems consist of the pavers, a 1.5- to 3-inch thick fine gravel bedding layer and an underlying stone reservoir.

Design Configurations

There are two types of permeable pavement design configurations:

- **Standard Design**
  Practice with a standard underdrain design and no infiltration sump or water quality filter (see Figure 4.12).
- **Enhanced Design**
  Practice with underdrains that contain a water quality filter layer and an infiltration sump beneath the underdrain sized to drain the design storm in 48 hours (see Figure 4.13) or practices with no underdrains that can infiltrate the entire design storm volume in 48 hours (see Figure 4.14).

The particular design configuration to be implemented on a site is typically dependent on specific site conditions and the characteristics of the underlying soils. These criteria are further discussed below.

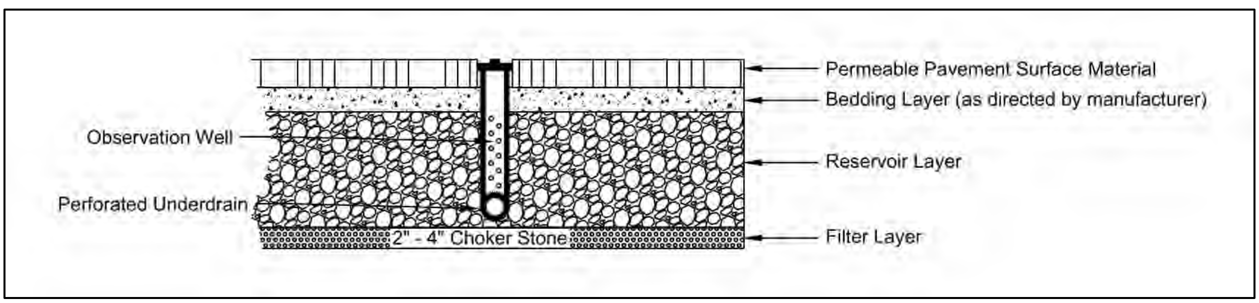

Figure 4.12. Cross-section of a standard permeable pavement design.

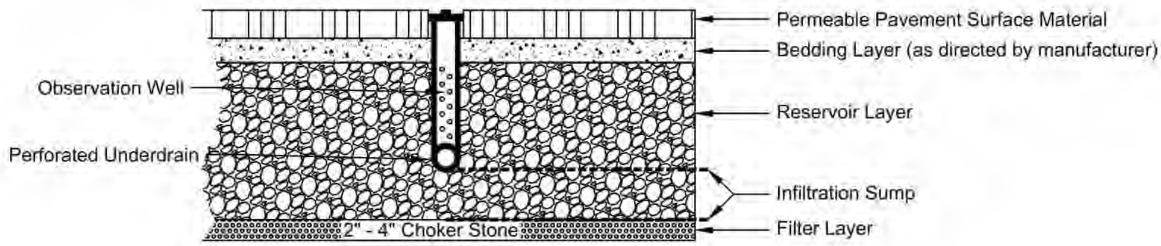

Figure 4.13. Cross-section of an enhanced permeable pavement design with an underdrain.

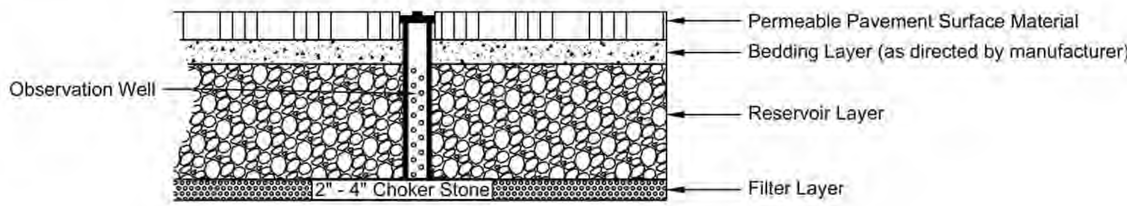

Figure 4.14. Cross-section of an enhanced permeable pavement design without an underdrain.

4.4.1 Permeable Pavement Feasibility Criteria

Since permeable pavement has a very high retention capability, it should always be considered as an alternative to conventional pavement. Permeable pavement is subject to the same feasibility constraints as most infiltration practices, as described below.

Required Space

A prime advantage of permeable pavement is that it does not normally require additional space at a new development or redevelopment site, which can be important for tight sites or areas where land prices are high.

Soils

Soil conditions do not typically constrain the use of permeable pavement, although they do determine whether an underdrain is needed. Underdrains may be required if the measured permeability of the underlying soils is less than 0.5 inches per hour (although utilization of an infiltration sump may still be feasible). When designing an infiltrating permeable pavement practice, designers must verify soil permeability by using the on-site soil investigation methods provided in Appendix B Geotechnical Information Requirements for Underground BMPs. Impermeable soils will require an underdrain.

In fill soil locations, geotechnical investigations are required to determine if the use of an impermeable liner and underdrain are necessary or if the use of an infiltration sump is permissible (see Section 4.4.4 Permeable Pavement Design Criteria).

Contributing Drainage Area

The portion of the CDA that does not include the permeable pavement may not exceed 5 times the surface area of the permeable pavement (2 times is recommended) and it should be as close to 100% impervious as possible to reduce sediment loading.

Pavement Surface Slope

Steep pavement surface slopes can reduce the stormwater storage capability of permeable pavement and may cause shifting of the pavement surface and base materials. The permeable pavement slope must be less than 5%. Designers may consider using a terraced design for permeable pavement in areas with steeper slopes (3%–5%). In all cases, designs must ensure that the slope of the pavement does not lead to flow occurring out of the stone reservoir layer onto lower portions of the pavement surface.

Minimum Hydraulic Head

The elevation difference needed for permeable pavement to function properly is generally nominal, although 1 to 4 feet of head from the pavement surface to the underdrain outlet is typically necessary. This value may vary based on several design factors, such as required storage depth and underdrain location.

Minimum Depth to Water Table

A high groundwater table may cause runoff to pond at the bottom of the permeable pavement system. Therefore, a minimum vertical distance of 0.5 feet (preferably 2 feet) must be provided between the bottom of the permeable pavement installation (i.e., the bottom invert of the reservoir layer) and the seasonal high water table.

Tidal Impacts

For systems with an underdrain, the underdrain should be located above the tidal mean high water elevation. For entirely infiltration-based systems, the bottom of the stone reservoir should be located above the mean high water elevation. Where this is not possible, portions of the practice below the tidal mean high water elevation cannot be included in the volume calculations.

Setbacks

To avoid the risk of seepage, stormwater cannot flow from the permeable pavement reservoir layer to the traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties. Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements. Where the 10-foot setback is not possible, an impermeable liner may be used along the sides and bottom of the permeable pavement practice (extending from the surface to the bottom of the practice and outward to meet the 10-foot setback).

Proximity to Utilities

Interference with underground utilities should be avoided if possible. When large site development is undertaken the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the public right-of-way (PROW). Consult with each utility company on recommended offsets, which will allow utility maintenance work with minimal disturbance to the permeable pavement. Permeable pavement in the public right-of-way (PROW) must conform with the State of South Carolina Department of Transportation design specifications. Where conflicts cannot be avoided, follow these guidelines:

- Consider altering the location or sizing of the permeable pavement to avoid or minimize the utility conflict. Consider an alternate BMP type to avoid conflict.
- Use design features to mitigate the impacts of conflicts that may arise by allowing the permeable pavement and the utility to coexist. The permeable pavement design may need to incorporate impervious areas, through geotextiles or compaction, to protect utility crossings.
- Work with the utility company to evaluate the relocation of the existing utility and install the optimum placement and sizing of the permeable pavement.
- If utility functionality, longevity, and vehicular access to manholes can be assured, accept the permeable pavement design and location with the existing utility. Design sufficient soil coverage over the utility or general clearances or other features, such as an impermeable liner, to assure all entities that the conflict is limited to maintenance.

When accepting utility conflict into the permeable pavement location and design, it is understood the permeable pavement will be temporarily impacted during utility work, but the utility owner will replace the permeable pavement or, alternatively, install functionally comparable permeable pavement according to the specifications in the current version of this guidebook. Restoration of permeable pavement that is located in the PROW will also conform with the State of South Carolina Department of Transportation design specifications.

Pollutant Hotspot Land Uses

Permeable pavement is not appropriate for certain pollutant-generating sites. In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from industrial processes), appropriate pretreatment, such as an oil-water separator or filtering device must be provided, or the areas should be diverted from the permeable pavement.

On sites with existing contaminated soils, infiltration is not allowed. Permeable pavement areas must include an impermeable liner, and the Enhanced Design configuration cannot be used.

High Loading Situations

Permeable pavement is not intended to treat sites with high sediment or trash/debris loads, since such loads will cause the practice to clog and fail. Sites with considerable pervious area (e.g., newly established turf and landscaping) can be considered high loading sites and the pervious areas should be diverted if possible, from the permeable pavement area. If unavoidable, pretreatment measures, such as a gravel or a sod filter strip should be employed (see Section 4.4.3 Permeable Pavement Pretreatment Criteria).

High Speed Roads

Permeable pavement should not be used for high speed roads, although it has been successfully applied for low speed residential streets, parking lanes, and roadway shoulders.

Economic Considerations

Permeable pavement tends to be expensive relative to other practices, but when the cost of land and traditional paving are included in the calculations, permeable pavement becomes much more competitive. Permeable pavement is very space-efficient, since it combines a useful pavement surface with stormwater management for runoff and, in standard design configurations, water quality treatment.

4.4.2 Permeable Pavement Conveyance Criteria

Permeable pavement designs must include methods to convey larger storms (e.g., 2- to 25-year) to the storm drain system. Conveyance methods include the following:

- Place an overdrain—a horizontal perforated pipe near the top of the reservoir layer—to pass excess flows after water has filled the base.
- Increase the thickness of the top of the reservoir layer by as much as 6 inches to increase storage (i.e., create freeboard). The design computations used to size the reservoir layer often assume that no freeboard is present.
- Create underground detention within the reservoir layer of the permeable pavement system. Reservoir storage may be augmented by corrugated metal pipes, plastic or concrete arch structures, etc.
- Route overflows to another detention or conveyance system.
- Set the storm drain inlets flush with the elevation of the permeable pavement surface to effectively convey excess stormwater runoff past the system. The design should also make allowances for relief of unacceptable ponding depths during larger rainfall events.

4.4.3 Permeable Pavement Pretreatment Criteria

Pretreatment for most permeable pavement applications is not necessary. Additional pretreatment is recommended if the pavement receives runoff from adjacent pervious areas. For example, a gravel or sod filter strip can be placed adjacent to pervious (landscaped) areas to trap coarse sediment particles before they reach the pavement surface in order to reduce clogging.

4.4.4 Permeable Pavement Design Criteria

Type of Surface Pavement

The type of pavement should be selected based on a review of the pavement specifications and properties and designed according to the product manufacturer’s recommendations.

Pavement Bottom Slope

For unlined designs, the bottom slope of a permeable pavement installation should be as flat as possible (i.e., 0% longitudinal and lateral slopes) to enable even distribution and infiltration of stormwater. On sloped sites, internal check dams or barriers, as shown in Figure 4.15 can be incorporated into the subsurface to encourage infiltration. Barriers may be constructed of concrete, earthen berms, impermeable membranes, or low permeability geotextile. In this type of design, the depth of the infiltration sump would be the depth behind the check dams. The depth and spacing of the barriers are dependent upon the underlying slope and the saturated hydraulic conductivity, as any water retained by the flow barriers must infiltrate within 48 hours. If an underdrain will be used in conjunction with the flow barriers, it can be installed over the top of the barriers, or parallel to the barriers with an underdrain in each cell.

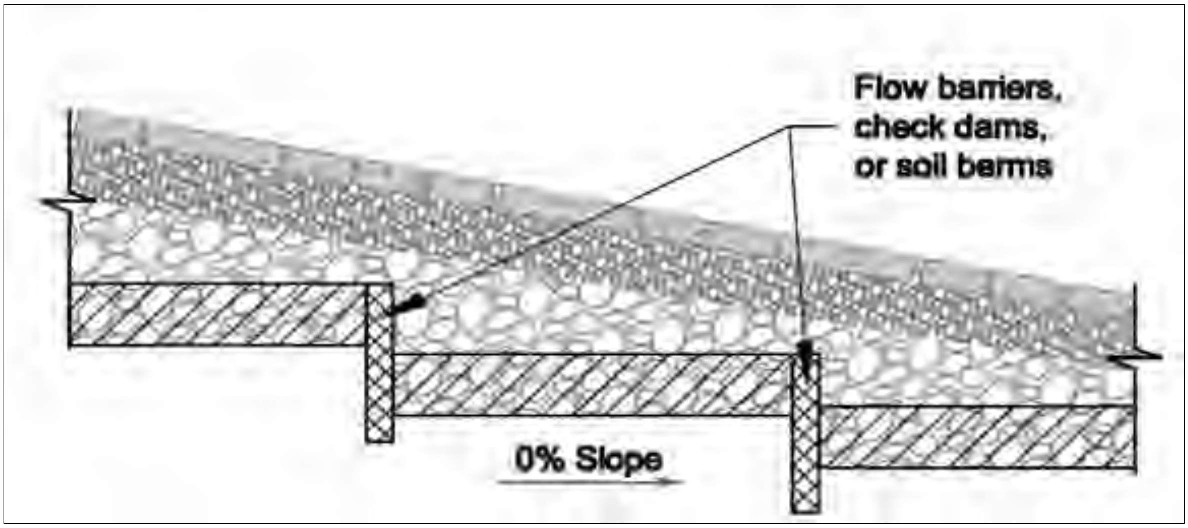

Figure 4.15. Use of flow barriers to encourage infiltration on sloped sites.

Internal Geometry and Drawdowns

- **Rapid Drawdown**
  Permeable pavement must be designed so that the target storage volume is detained in the reservoir for as long as possible, 36 to 48 hours, before completely discharging through an underdrain. A minimum orifice size of 1 inch is recommended regardless of the calculated drawdown time.

  Note: A 48-hour maximum drawdown time is utilized for permeable pavement rather than the 72-hour value used for other BMPs. This shorter drawdown time, in accordance with industry standards, is intended to ensure that the subgrade does not stay saturated for too long and cause problems with the pavement.

- **Infiltration Sump**
  To promote greater retention for permeable pavement located on marginal soils, an infiltration sump can be installed to create a storage layer below the underdrain invert. This design configuration is discussed further below.

Reservoir Layer

The reservoir layer consists of the stone underneath the pavement section and above the bottom filter layer or underlying soils, including the optional infiltration sump. The total thickness of the reservoir layer is determined by runoff storage needs, the saturated hydraulic conductivity of in-situ soils, structural requirements of the pavement sub-base, depth to water table, and frost depth conditions (see Section 4.4.1 Permeable Pavement Feasibility Criteria). A geotechnical engineer should be consulted regarding the suitability of the soil subgrade.

- The reservoir below the permeable pavement surface should be composed of clean, double-washed stone aggregate and sized for both the storm event to be treated and the structural requirements of the expected traffic loading. Additional chamber structures may also be used to create larger storage volumes.
- The storage layer may consist of clean, double-washed No. 57 stone, although No. 2 stone is preferred because it provides additional structural stability. Other appropriate materials may be used if accepted by the *<local jurisdiction>*.

- The bottom of the reservoir layer should be completely flat so that runoff will be able to infiltrate evenly through the entire surface. The use of terracing and check dams is permissible.

Underdrains

Most permeable pavement designs will require an underdrain (see Section 4.4.1 Permeable Pavement Feasibility Criteria). Underdrains can also be used to keep detained stormwater from flooding permeable pavement during extreme rain events. Multiple underdrains are typically necessary for permeable pavement wider than 40 feet, and each underdrain is recommended to be located 20 feet or less from the next pipe or the edge of the permeable pavement. For long and narrow applications, a single underdrain running the length of the permeable pavement is sufficient. The underdrain should be perforated schedule 40 PVC pipe (corrugated HDPE may be used for smaller load-bearing applications), with three or four rows of 3/8-inch perforations at 6 inches on center. The underdrain must be encased in a layer of clean, double-washed No. 57 stone, with a minimum 2-inch cover over the top of the underdrain. The underdrain system must include a flow control to ensure that the reservoir layer drains slowly (within 36 to 48 hours).

- The underdrain outlet can be fitted with a flow-reduction orifice within a weir or other easily inspected and maintained configuration in the downstream manhole as a means of regulating the stormwater detention time. The minimum diameter of any orifice is 1 inch. The designer should verify that the volume will draw down completely within 36 to 48 hours.
- On infiltration designs, an underdrain(s) can be installed and capped at the downstream structure as an option for future use if maintenance observations indicate a reduction in the soil permeability.

Observation Wells

All permeable pavement practices must include observation wells. The observation well is used to observe the rate of drawdown within the reservoir layer following a storm event and to facilitate periodic inspection and maintenance. The observation well should consist of a well-anchored, perforated 4- to 6-inch diameter PVC pipe. There should be no perforation within 1 foot of the surface. If the permeable pavement has an underdrain, tie the observation well into any Ts or Ys in the underdrain system. The observation well should extend vertically to the bottom of the reservoir layer and extend upwards to be flush with the surface (or just under pavers) with a lockable cap.

Infiltration Sump (optional, required for enhanced designs with an underdrain)

For unlined permeable pavement systems, an optional upturned elbow or elevated underdrain configuration can be used to promote greater retention for permeable pavement located on marginal soils. The infiltration sump must be installed to create a storage layer below the underdrain or upturned elbow invert. The depth of this layer must be sized so that the design storm can infiltrate into the subsoils in a 48-hour period. The bottom of the infiltration sump must be at least 0.5 feet above the seasonally high water table. The inclusion of an infiltration sump is not permitted for designs with an impermeable liner. In fill soil locations, geotechnical investigations are required to determine if the use of an infiltration sump is permissible.

Filter Layer (optional)

To protect the bottom of the reservoir layer from intrusion by underlying soils, a filter layer can be used. The underlying native soils should be separated from the stone reservoir by a 2- to 4-inch layer of choker stone (e.g., No. 8).

Geotextile (optional)
Geotextile fabric is another option to protect the bottom of the reservoir layer from intrusion by underlying soils, although some practitioners recommend avoiding the use of fabric beneath permeable pavements since it may become a future plane of clogging within the system. Geotextile fabric is still recommended to protect the excavated sides of the reservoir layer, in order to prevent soil piping. An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude higher (10 times) than the soil subgrade permeability must be used.

Impermeable Liner
An impermeable liner is not typically required, although it may be utilized in fill applications where deemed necessary by a geotechnical investigation, on sites with contaminated soils, or on the sides of the practice to protect adjacent structures from seepage. Use a PVC geomembrane liner or equivalent of an appropriate thickness (follow manufacturer's instructions for installation). Field seams must be sealed according to the liner manufacturer's specifications. A minimum 6-inch overlap of material is required at all seams.

Material Specifications
Permeable pavement material specifications vary according to the specific pavement product selected. A general comparison of different permeable pavements is provided in Table 4.13, but designers should consult manufacturer's technical specifications for specific criteria and guidance. Table 4.14 provides general material specifications for the component structures installed beneath the permeable pavement. Note that the size of stone materials used in the reservoir and filter layers may differ depending on the type of surface material.

Table 4.13. Permeable pavement specifications for a variety of typical surface materials.

Material	Specification	Notes
Permeable Pavers (PP)	Void content, thickness, and compressive strength vary based on type and manufacturer Open void fill media: aggregate, topsoil and grass, coarse sand, etc.	Reservoir layer required to support the structural load.
Pervious Concrete (PC)	Void content: 15%–20% Thickness: Typically 4–8 inches Compressive strength: 2.8–28 MPa Open void fill media: None	May not require a reservoir layer to support the structural load, but a layer may be included to increase the storage or infiltration. Requires certified supplier and installer.
Porous Asphalt (PA)	Void content: 15%–20% Thickness: Typically 3–7 inches (depending on traffic load) Open void fill media: None	Reservoir layer required to support the structural load. Requires certified supplier and installer.

Table 4.14. Material specifications for typical layers beneath the surface of permeable pavements.

Material	Specification	Notes
Bedding Layer	PC: 3–4 inches of No. 57 stone if No. 2 stone is used for Reservoir Layer PA: 3–4 inches of No. 57 stone PP: Follow manufacturer specifications	ASTM D448 size No. 57 stone (i.e., 1/2 to 1 1/2 inches in size). Must be double-washed and clean and free of all fines.
Reservoir Layer	PC: No. 57 stone or No. 2 stone PA: No. 2 stone PP: Follow manufacturer specifications	ASTM D448 size No. 57 stone (i.e., 1/2 to 1 1/2 inches in size); No. 2 Stone (i.e., 3/4 to 3 inches in size). Depth is based on the pavement structural and hydraulic requirements. Must be double-washed and clean and free of all fines. Other appropriate materials may be used if accepted by *<local jurisdiction>*.
Underdrain	Use 4- to 6-inch diameter perforated PVC pipe (or equivalent corrugated HDPE may be used for smaller load-bearing applications), with 3 or 4 rows of 3/8-inch perforations at 6 inches on center. Perforated pipe installed for the full length of the permeable pavement cell, and non-perforated pipe, as needed, is used to connect with the storm drain system. T's and Y's should be installed as needed, depending on the underdrain configuration. Extend cleanout pipes to the surface.	
Infiltration Sump (optional)	An aggregate storage layer below the underdrain invert. The material specifications are the same as Reservoir Layer.	
Filter Layer (optional)	The underlying native soils should be separated from the stone reservoir by a 2- to 4-inch layer of choker stone (e.g., No. 8).	
Geotextile (optional)	Use an appropriate geotextile fabric for both sides and/or bottom that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude higher than (10 times) the soil subgrade permeability. Low-permeability geotextile fabric may be used as a check dam material.	
Impermeable Liner (optional)	Where appropriate, use PVC geomembrane liner or equivalent.	
Observation Well	Use a perforated 4- to 6-inch vertical PVC pipe (AASHTO M-252) with a lockable cap, installed flush with the surface.	

Permeable Pavement Sizing
The thickness of the reservoir layer is determined by both a structural and hydraulic design analysis. The reservoir layer serves to retain stormwater and to support the design traffic loads for the pavement. Permeable pavement structural and hydraulic sizing criteria are discussed below.

Structural Design
If permeable pavement will be used in a parking lot or other setting that involves vehicles, the pavement surface must be able to support the maximum anticipated traffic load. The structural design process will vary according to the type of pavement selected, and the manufacturer's specific recommendations should be consulted. The thickness of the permeable pavement and reservoir layer must be sized to support structural loads and to temporarily store the design storm volume (i.e., the water quality,

channel protection, and/or flood control volumes). On most new development and redevelopment sites, the structural support requirements will dictate the depth of the underlying stone reservoir.

The structural design of permeable pavements involves consideration of four main site elements:

- Total traffic
- In situ soil strength
- Environmental elements
- Bedding and reservoir layer design

The resulting structural requirements may include the thickness of the pavement, filter, and reservoir layer. Designers should note that if the underlying soils have a low California Bearing Ratio (less than 4%), they may need to be compacted to at least 95% of the Standard Proctor Density, which may limit their use for infiltration.

Designers should determine structural design requirements by consulting transportation design guidance sources, such as the following:

- ASCE/T&DI/ICPI 68-18 Permeable Interlocking Concrete Pavement (2018)
- AASHTO Guide for Design of Pavement Structures (1993)
- AASHTO Supplement to the Guide for Design of Pavement Structures (1998)

Hydraulic Design. Permeable pavement is typically sized to store the SWRv or larger design storm volumes in the reservoir layer. The storage volume in the pavements must account for the underlying saturated hydraulic conductivity and outflow through any underdrains. The design storm should be routed through the pavement to accurately determine the required reservoir depth. The depth of the reservoir layer or infiltration sump needed to store the design storm can be determined by using Equation 4.3.

Equation 4.3. Reservoir layer or infiltration sump depth.

$$d_p = \frac{\left(\frac{P \times Rv_I \times CDA}{A_p}\right) - (K_{sat} \times t_f)}{\eta_r}$$

Where:

d_p = Depth of the reservoir layer, or depth of the infiltration sump for enhanced designs with underdrains (ft)
P = Rainfall depth for the SWRv or other design storm (ft)
Rv_I = 0.95 (runoff coefficient for impervious cover)
CDA = Total contributing drainage area, including permeable pavement surface area (square feet)
A_p = Permeable pavement surface area (square feet)
K_{sat} = Field-verified saturated hydraulic conductivity for subgrade soils (ft/day). If an impermeable liner is used in the design, then this value is 0
t_f = Time to fill the reservoir layer (days; assume 2 hours or 0.083 day)

η_r = 0.4 (effective porosity for the reservoir layer)

This equation makes the following design assumptions:

- The CDA does not contain pervious areas.
- If the subgrade will be compacted to meet structural design requirements of the pavement section, the measured saturated hydraulic conductivity shall be based on measurement of the subgrade soil subjected to the compaction requirements.

The depth of the reservoir layer cannot be less than the depth required to meet the pavement structural requirement. The depth of the reservoir layer may need to be increased to meet structural or larger storage requirements.

For infiltration designs without underdrains or designs with infiltration sumps, the captured volume must drain from the practice within 48 hours. Equation 4.4 can be used to determine the drawdown time in the reservoir layer or infiltration sump.

Equation 4.4. Drawdown time.

$$t_d = \frac{d_p \times \eta_r}{K_{sat}}$$

Where:

t_d = Drawdown time (days)
d_p = Depth of the reservoir layer, or depth of the infiltration sump for enhanced designs with underdrains (ft)
η_r = 0.4 (effective porosity for the reservoir layer)
K_{sat} = Field-verified saturated hydraulic conductivity for subgrade soils (ft/day). If an impermeable liner is used in the design, then this value is 0

For designs with underdrains, the captured volume must drain in 36-48 hours. The drawdown time should be determined using the hydrologic routing or modeling procedures used for detention systems with the depth and head adjusted for the porosity of the aggregate.

The total storage volume provided by the practice, Sv, should be determined using Equation 4.5.

Equation 4.5. Permeable pavement storage volume.

$$Sv = A_p[(d_p \times \eta_r) + K_{sat} \times t_f]$$

Where:

Sv = Storage volume (cubic feet)
d_p = Depth of the reservoir layer, or depth of the infiltration sump for enhanced designs with underdrains (ft)
η_r = 0.4 (effective porosity for the reservoir layer)
A_p = Permeable pavement surface area (square feet)

K_{sat} = Field-verified saturated hydraulic conductivity for subgrade soils (ft/day). If an impermeable liner is used in the design, then this value is 0
t_f = Time to fill the reservoir layer (days; assume 2 hours or 0.083 day)

Detention Storage Design
Permeable pavement can also be designed to address, in whole or in part, the detention storage for larger storm events. The designer can model various approaches by factoring in storage within the stone aggregate layer (including chamber structures that increase the available storage volume), expected infiltration, and any outlet structures used as part of the design. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

Once runoff passes through the surface of the permeable pavement system, designers should calculate outflow pathways to handle subsurface flows. Subsurface flows can be regulated using underdrains, the volume of storage in the reservoir layer, the bed slope of the reservoir layer, and/or a control structure at the outlet (see Section 4.4.2 Permeable Pavement Conveyance Criteria).

4.4.5 Permeable Pavement Landscaping Criteria
Permeable pavement does not have any landscaping needs. However, large-scale permeable pavement applications should be carefully planned to integrate the typical landscaping features of a parking lot, such as trees and islands, in a manner that maximizes runoff treatment and minimizes the risk that sediment, mulch, grass clippings, leaves, and other plant matter will inadvertently clog the paving surface. Bioretention areas (see Section 4.3 Bioretention) may be a good design option to meet these landscaping goals.

4.4.6 Permeable Pavement Construction Sequence
Experience has shown that proper installation is critical to the effective operation of a permeable pavement system.

Soil Erosion and Sediment Controls
The following soil erosion and sediment control guidelines must be followed during construction:

- All permeable pavement areas must be fully protected from sediment intrusion by silt fence or construction fencing, particularly if they are intended to infiltrate runoff.
- Permeable pavement areas intended to infiltrate runoff must remain outside the limits of disturbance during construction to prevent soil compaction by heavy equipment and loss of design infiltration rate (unless the area has been determined to have a low California Bearing Ratio and will require compaction during the permeable pavement construction phase). Where it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, there are several possible remedies for the impacted area.
- If excavation in the proposed permeable pavement areas can be restricted, then remediation can be achieved with deep tilling practices. This is only possible if in situ soils are not disturbed any deeper than 2 feet above the final design elevation of the bottom of the aggregate reservoir course. In this case, when heavy equipment activity has ceased, the area is excavated to grade, and the impacted area must be tilled to a depth of 12 inches below the bottom of the reservoir layer.
- Alternatively, if it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, and excavation of the area cannot be restricted, then infiltration tests will

be required prior to installation of the permeable pavement to ensure that the design infiltration rate is still present. If tests reveal the loss of design infiltration rates, then deep tilling practices may be used in an effort to restore those rates. In this case, further testing must be done before the permeable pavement can be installed to establish that design rates have been achieved.

- Finally, if it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, excavation of the area cannot be restricted, and infiltration tests reveal design rates cannot be restored, then a resubmission of the SWMP will be required.
- Permeable pavement areas must be clearly marked on all construction documents and grading plans.
- During construction, care should be taken to avoid tracking sediments onto any permeable pavement surface to avoid post-construction clogging and long-term maintenance issues.
- Any area of the site intended ultimately to be a permeable pavement area with an infiltration component should not be used as the site of a temporary sediment trap or basin. If locating a temporary sediment trap or basin on an area intended for permeable pavement is unavoidable, the remedies are similar to those discussed for heavy equipment compaction.
- If it is possible, restrict the invert of the sediment trap or basin to at least 1 foot above the final design elevation of the bottom of the aggregate reservoir course of the proposed permeable pavement. Then remediation can be achieved with proper removal of trapped sediments and deep tilling practices.
- An alternate approach to deep tilling is to use an impermeable linear to protect the in situ soils from sedimentation while the sediment trap or basin is in use.
- In each case, all sediment deposits in the excavated area must be carefully removed prior to installing the sub-base, base, and surface materials. The plan must also show the proper procedures for converting the temporary sediment control practice to a permeable pavement BMP, including dewatering, cleanout, and stabilization.

Permeable Pavement Installation

The following is a typical construction sequence to properly install permeable pavement, which may need to be modified depending on the particular type of permeable pavement that is being installed.

1. Stabilize Contributing Drainage Area

Construction of the permeable pavement should only begin after the entire CDA has been stabilized. The proposed site should be checked for existing utilities prior to any excavation. Do not install the system in rain.

2. Install Soil Erosion and Sediment Control Measures for the Permeable Pavement

As noted above, temporary soil erosion and sediment controls are needed during installation to divert stormwater away from the permeable pavement area until it is completed. Special protection measures, such as erosion control fabrics, may be needed to protect vulnerable side slopes from erosion during the excavation process. The proposed permeable pavement area must be kept free from sediment during the entire construction process. Construction materials contaminated by sediment must be removed and replaced with clean material.

3. Minimize Impact of Heavy Installation Equipment

Where possible, excavators or backhoes should work from the sides to excavate the reservoir layer to its appropriate design depth and dimensions. For small pavement applications, excavating equipment should have arms with adequate extension so they do not have to work inside the footprint of the permeable pavement area (to avoid compaction). Contractors can utilize a cell construction approach, whereby the proposed permeable pavement area is split into 500- to 1,000-square foot temporary cells with a 10- to 15-foot-wide earth bridge in between, so cells can be excavated from the side. Excavated material should be placed away from the open excavation so as to not jeopardize the stability of the side walls.

4. Promote Infiltration Rate
The native soils along the bottom of the permeable pavement system should be scarified or tilled to a depth of 3 to 4 inches prior to the placement of the filter layer or geotextile fabric. In large-scale paving applications with weak soils, the soil subgrade may need to be compacted to 95% of the Standard Proctor Density to achieve the desired load-bearing capacity.

Note: This may reduce or eliminate the infiltration function of the installation, and it must be addressed during hydrologic design.

5. Order of Materials
Geotextile fabric should be installed on the sides of the reservoir layer (and the bottom if the design calls for it). Geotextile fabric strips should overlap down-slope by a minimum of 2 feet and be secured a minimum of 4 feet beyond the edge of the excavation. Where the filter layer extends beyond the edge of the pavement (to convey runoff to the reservoir layer), install an additional layer of geotextile fabric 1 foot below the surface to prevent sediment from entering into the reservoir layer. Excess geotextile fabric should not be trimmed until the site is fully stabilized.

6. Install Base Material Components
Provide a minimum of 2 inches of aggregate above and below the underdrains. The up-gradient end of underdrains in the reservoir layer should be capped. Where an underdrain pipe is connected to a structure, there shall be no perforations within 1 foot of the structure. Ensure there are no perforations in clean-outs and observation wells within 1 foot of the surface.

7. Stone Media
Spread 6-inch lifts of the appropriate clean, double-washed stone aggregate (usually No. 2 or No. 57 stone). Place at least 4 inches of additional aggregate above the underdrain, and then compact it using a vibratory roller in static mode until there is no visible movement of the aggregate. Do not crush the aggregate with the roller.

8. Reservoir Media
Install the desired depth of the bedding layer, depending on the type of pavement, as indicated in Table 4.14.

9. Paving Media
Paving materials shall be installed in accordance with manufacturer or industry specifications for the particular type of pavement.

10. Installation of Porous Asphalt
The following has been excerpted from various documents, most notably Jackson (2007):

- Install porous asphalt pavement similarly to regular asphalt pavement. The pavement should be laid in a single lift over the filter course. The laying temperature should be between 230°F and 260°F, with a minimum air temperature of 50°F, to ensure the surface does not stiffen before compaction.
- Complete compaction of the surface course when the surface is cool enough to resist a 10-ton roller. One or two passes of the roller are required for proper compaction. More rolling could cause a reduction in the porosity of the pavement.

- The mixing plant must provide certification of the aggregate mix, abrasion loss factor, and asphalt content in the mix. Test the asphalt mix for its resistance to stripping by water using ASTM D1664. If the estimated coating area is not above 95%, additional anti-stripping agents must be added to the mix.
- Transport the mix to the site in a clean vehicle with smooth dump beds sprayed with a non-petroleum release agent. The mix shall be covered during transportation to control cooling.
- Test the full permeability of the pavement surface by application of clean water at a rate of at least 5 gallons per minute over the entire surface. All water must infiltrate directly, without puddle formation or surface runoff.
- Inspect the facility 18 to 30 hours after a significant rainfall (0.5 inch or greater) or artificial flooding to determine if the facility is draining properly.

11. Pervious Concrete Installation
The basic installation sequence for pervious concrete is outlined by the National Ready Mixed Concrete Association (NRMCA; NRMCA, 2004). Concrete installers are required to be certified by a recognized pervious concrete installers training program, such as the Pervious Concrete Contractor Certification Program offered by the NRMCA. The basic installation procedure is as follows:

- Drive the concrete truck as close to the project site as possible.
- Water the underlying aggregate (reservoir layer) before the concrete is placed, so the aggregate does not draw moisture from the freshly laid pervious concrete.
- After the concrete is placed, approximately 3/8 to 1/2 inches is struck off, using a vibratory screed. This is to allow for compaction of the concrete pavement.
- Compact the pavement with a steel pipe roller. Care should be taken to ensure over-compaction does not occur.
- Cut joints for the concrete to a depth of 1/4 inch.
- The curing process is very important for pervious concrete. Concrete installers should follow manufacturer specifications to the extent allowed by on-site conditions when curing pervious concrete. This typically requires covering the pavement with plastic sheeting within 20 minutes of the strike-off and may require keeping it covered for at least 7 days. Do not allow traffic on the pavement during the curing period.
- Remove the plastic sheeting only after the proper curing time. Inspect the facility 18 to 30 hours after a significant rainfall (0.5 inch or greater) or artificial flooding, to determine if the facility is draining properly.

12. Permeable Interlocking Concrete Paver Installation
The basic installation process is described in greater detail by Smith (2006):

- Place edge restraints for open-jointed pavement blocks before the bedding layer and pavement blocks are installed. Permeable interlocking concrete pavement systems require edge restraints to prevent vehicle loads from moving the paver blocks. Edge restraints may be standard curbs or gutter pans, or precast or cast-in-place reinforced concrete borders a minimum of 6 inches wide and 18 inches deep, constructed with Class A3 concrete. Edge restraints along the traffic side of a permeable pavement block system are recommended.

- Place the double-washed No. 57 stone in a single lift. Level the filter course and compact it into the reservoir course beneath with at least four passes of a 10-ton steel drum static roller until there is no visible movement. The first two passes are in vibratory mode, with the final two passes in static mode. The filter aggregate should be moist to facilitate movement into the reservoir course.
- Place and screed the bedding course material (typically No. 8 stone).
- Fill gaps at the edge of the paved areas with cut pavers or edge units. When cut pavers are needed, cut the pavers with a paver splitter or masonry saw. Cut pavers no smaller than 1/3 of the full unit size.
- Pavers may be placed by hand or with mechanical installers. Fill the joints and openings with stone. Joint openings must be filled with ASTM D448 No. 8 stone; although, No. 8P or No. 9 stone may be used where needed to fill narrower joints. Remove excess stones from the paver surface.
- Compact and seat the pavers into the bedding course with a minimum low-amplitude 5,000-pound-foot, 75- to 95-Hz plate compactor.
- Do not compact within 6 feet of the unrestrained edges of the pavers.
- The system must be thoroughly swept by a mechanical sweeper or vacuumed immediately after construction to remove any sediment or excess aggregate.
- Inspect the area for settlement. Any blocks that settle must be reset and re-inspected.
- Inspect the facility 18 to 30 hours after a significant rainfall (0.5 inch or greater) or artificial flooding to determine whether the facility is draining properly.

13. Construction Supervision
Supervision before, during, and after construction by a qualified professional is recommended to ensure permeable pavement is built in accordance with these specifications. ASTM test C1781 or C1701 must be performed to ensure initial pavement permeability of at least 6 inches per hour. Inspection checklists that require sign-offs by qualified individuals should be used at critical stages of construction to ensure the contractor's interpretation of the plan is consistent with the designer's intent.

Construction phase inspection checklist for permeable pavement practices can be found in Appendix E Construction Inspection Checklists.

Some common pitfalls can be avoided by careful construction supervision that focuses on the following key aspects of permeable pavement installation:

- Store materials in a protected area to keep them free from mud, dirt, and other foreign materials.
- The CDA should be stabilized prior to directing water to the permeable pavement area.
- Check the aggregate material to confirm it is clean and washed, meets specifications and is installed to the correct depth. Aggregate loads that do not meet the specifications or do not appear to be sufficiently washed may be rejected.
- Check elevations (i.e., the invert of the underdrain, inverts for the inflow, and outflow points) and the surface slope.

- Make sure the permeable pavement surface is even, runoff spreads evenly across it, and the storage bed drains within 48 hours.
- Ensure caps are placed on the upstream (but not the downstream) ends of the underdrains.
- Inspect the pretreatment structures (if applicable) to make sure they are properly installed and working effectively.
- Once the final construction inspection has been completed, log the GPS coordinates for each facility and submit them for entry into the BMP maintenance tracking database.

Runoff diversion structures are recommended to protect larger permeable pavement applications from early runoff-producing storms, particularly when up-gradient conventional asphalt areas drain to the permeable pavement. This can help reduce the input of fine particles often produced shortly after conventional asphalt is laid.

4.4.7 Permeable Pavement Maintenance Criteria

Maintenance is a required and crucial element to ensure the long-term performance of permeable pavement. The most frequently cited maintenance problem is surface clogging caused by organic matter and sediment. Periodic street sweeping will remove accumulated sediment and help prevent clogging; however, it is also critical to ensure that surrounding land areas remain stabilized.

The following tasks must be avoided on all permeable pavements:

- Sanding
- Resealing
- Resurfacing
- Power washing
- Storage of mulch or soil materials
- Construction staging on unprotected pavement

It is difficult to prescribe the specific types or frequency of maintenance tasks that are needed to maintain the hydrologic function of permeable pavement systems over time. The frequency of maintenance will depend largely on the pavement use, traffic loads, and the surrounding land use.

One preventative maintenance task for large-scale applications (e.g., parking lots) involves vacuum sweeping on a frequency consistent with the use and loadings encountered in the site. Many experts consider an annual, dry-weather sweeping in the spring months to be important. The contract for sweeping should specify that a vacuum sweeper be used that does not use water spray, since spraying may lead to subsurface clogging. Typical maintenance tasks are outlined in Table 4.15.

Table 4.15. Typical maintenance tasks for permeable pavement practices.

Frequency	Maintenance Tasks
After installation	▪ For the first 6 months following construction, the practice and CDA should be inspected at least twice after storm events that exceed 0.5 inch of rainfall. Conduct any needed repairs or stabilization.
Once every 1–2 months during the growing season	▪ Mow grass in grid paver applications (clippings should be removed from the pavement area).
As needed	▪ Stabilize the CDA to prevent erosion. ▪ Remove any soil or sediment deposited on pavement. ▪ Replace or repair any pavement surfaces that are degenerating or spalling.
2–4 times per year (depending on use)	▪ Mechanically sweep pavement with a standard street sweeper to prevent clogging.
Annually	▪ Conduct a maintenance inspection ▪ Remove weeds as needed.
Once every 2–3 years	▪ Remove any accumulated sediment in pretreatment cells and inflow points.
If clogged	▪ Conduct maintenance using a regenerative street sweeper or a vacuum sweeper ▪ Replace any necessary joint material.

When permeable pavements are installed on private residential lots, homeowners will need to (1) be educated about their routine maintenance needs and (2) understand the long-term maintenance plan.

It is recommended that a qualified professional conduct a spring maintenance inspection and cleanup at each permeable pavement site, particularly at large-scale applications. Maintenance inspection checklists for permeable pavements and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Waste Material

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.4.8 Permeable Pavement Stormwater Compliance Calculations

Permeable pavement retention credit varies depending on the design configuration of the system.

Enhanced Designs

These permeable pavement applications have an infiltration sump and water-quality filter, but no underdrain. Enhanced designs are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (Table 4.16).

Table 4.16. Retention and pollutant removal for enhanced permeable pavement practices.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

Note: If using an infiltration sump design, only the volume stored in the sump can be counted as the Enhanced Design Storage Volume (Sv). Any volume stored in the practice above the sump is counted as a standard design. When using the SoLoCo Compliance Calculator, the Sv of the infiltration sump should be entered into the cell "Storage Volume Provided by BMP" in the Permeable Pavement – Enhanced row. Permeable Pavement – Standard should then be selected as the downstream practice. Next, in the Permeable Pavement - Standard row, the Sv provided above the infiltration sump should be entered into the cell "Storage Volume Provided by BMP."

Standard Designs

These permeable pavement applications have an underdrain, but no infiltration sump or water quality filter. Standard designs are credited with 30% retention for the storage volume (Sv) provided as well as 80% TSS, 45% TN, and 30% bacteria removal. (Table 4.17).

Table 4.17. Retention and pollutant removal for standard permeable pavement practices.

Retention	= 30%
TSS Removal	= 80%
TN Removal	= 45%
Bacteria Removal	= 30%

The practice must be sized using the guidance detailed in Section 4.2.4 Permeable Pavement Design Criteria.

Permeable pavement also contributes to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) achieved by the practice from the total runoff volumes for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

4.4.9 References

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4.5 Infiltration Practices

<table>
<tr><th colspan="8">Infiltration</th></tr>
<tr><td colspan="8">Definition: Practices that capture and temporarily store the design storm volume before allowing it to infiltrate into the soil over a three-day period.</td></tr>
<tr><th colspan="2">Site Applicability</th><th colspan="6">BMP Performance Summary</th></tr>
<tr><th>Land Uses</th><th>Required Footprint</th><th colspan="6">WQ Improvement: Moderate to High</th></tr>
<tr><td rowspan="3">▪ Urban
▪ Suburban
▪ Rural</td><td rowspan="3">Small</td><th colspan="2">TSS[1]</th><th colspan="2">Total N[1]</th><th colspan="2">Bacteria[1]</th></tr>
<tr><td colspan="2">100%</td><td colspan="2">100%</td><td colspan="2">100%</td></tr>
<tr><th colspan="6">Runoff Reduction</th></tr>
<tr><th>Construction Costs</th><th>Maintenance Burden</th><th colspan="6">Volume</th></tr>
<tr><td>Moderate</td><td>Moderate</td><td colspan="6">High</td></tr>
<tr><th colspan="2">Maintenance Frequency:</th><th colspan="6">SWRv</th></tr>
<tr><th>Routine</th><th>Non-Routine</th><th colspan="3">Basin</th><th colspan="3">Trench</th></tr>
<tr><td>Quarterly</td><td>Every 5-10 years</td><td colspan="3">100%</td><td colspan="3">100%</td></tr>
<tr><th colspan="2">Advantages/Benefits</th><th colspan="6">Disadvantages/Limitation</th></tr>
<tr><td colspan="2">▪ Excellent in impervious CDAs
▪ Helps restore pre-development hydrologic conditions through groundwater recharge
▪ Reduces runoff rates, volumes, and pollutant loads
▪ Attractive landscaping features
▪ Good for small sites with porous soils</td><td colspan="6">▪ CDA should be less than 2 acres.
▪ Potential for groundwater contamination
▪ High clogging potential;
▪ Not for sites with fine soils (clays/silts) in CDA
▪ Geotechnical testing required</td></tr>
<tr><th colspan="2">Components</th><th colspan="6">Design considerations</th></tr>
<tr><td colspan="2">▪ Pretreatment
▪ Conveyance system
▪ Ponding area
▪ Soils/Filter Media/Mulch
▪ Observation Well/Monitoring Port
▪ Plants</td><td colspan="6">▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice
▪ Must infiltrate within 72 hours</td></tr>
<tr><th colspan="8">Maintenance Activities</th></tr>
<tr><td colspan="2">▪ Inspect for clogging</td><td colspan="6">▪ Replace soil/stone if it becomes clogged
▪ Clean conveyance system(s)</td></tr>
</table>

[1]*Credited pollutant load removal*

Infiltration practices are suitable for use in residential and other urban areas where field measured soil infiltration rates are sufficient. To prevent possible groundwater contamination, infiltration must not be utilized at sites designated as stormwater hotspots. If properly designed, they can provide significant reductions in post-construction stormwater runoff rates, volumes, and pollutant loads on development sites (Figure 4.16)

Figure 4.16. Infiltration practice in median strip.

Definition

Practices that capture and temporarily store the design storm volume before allowing it to infiltrate into the soil over a three-day period. Infiltration practices use temporary surface or underground storage to allow incoming stormwater runoff to exfiltrate into underlying soils. Runoff first passes through multiple pretreatment mechanisms to trap sediment and organic matter before it reaches the practice. As the stormwater penetrates the underlying soil, chemical and physical adsorption processes remove pollutants. Infiltration practices are suitable for use in residential and other urban areas where field-verified saturated hydraulic conductivity is sufficient.

Design variants include the following:

I-1 Infiltration trench

I-2 Infiltration basin

Infiltration Trenches
Infiltration trenches are excavated trenches filled with stone. Stormwater runoff is captured and temporarily stored in the stone reservoir, where it is allowed to infiltrate into the surrounding and underlying native soils. Infiltration trenches can be used to "receive" stormwater runoff from contributing drainage areas of up to 2 acres in size and should only be used on development sites where sediment loads can be kept relatively low (see Figure 4.17 and Figure 4.18).

Infiltration Basins
Infiltration basins are shallow, landscaped excavations filled with an engineered soil mix. They are designed to capture and temporarily store stormwater runoff in the engineered soil mix, where it is subjected to the hydrologic processes of evaporation and transpiration, before being allowed to infiltrate into the surrounding soils. They are essentially non-underdrained bioretention areas and should also only be used on drainage areas up to 5 acres where sediment loads can be kept relatively low (Figure 4.19).

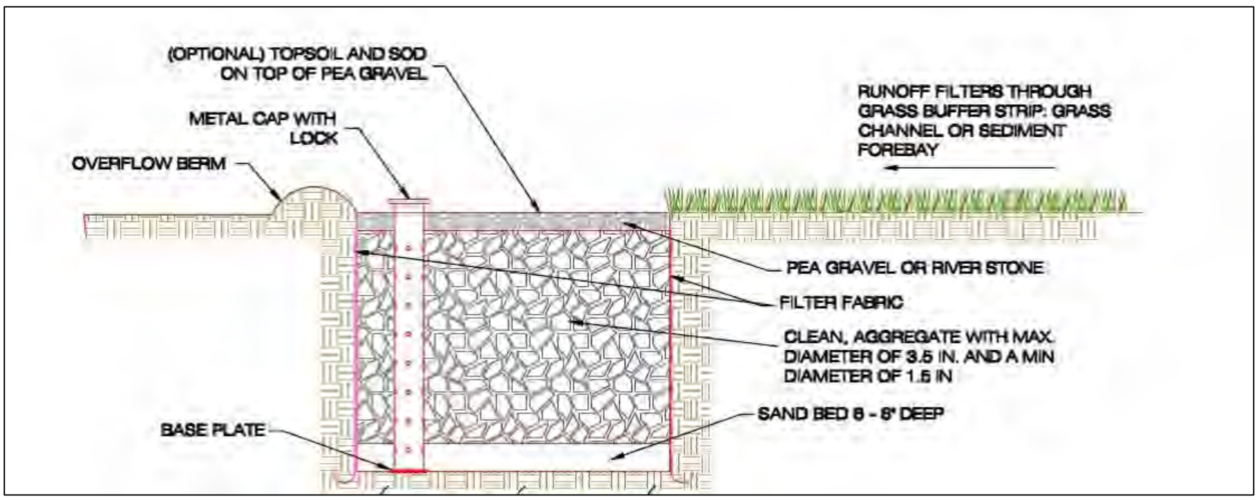

Figure 4.17. Example design of an infiltration trench.

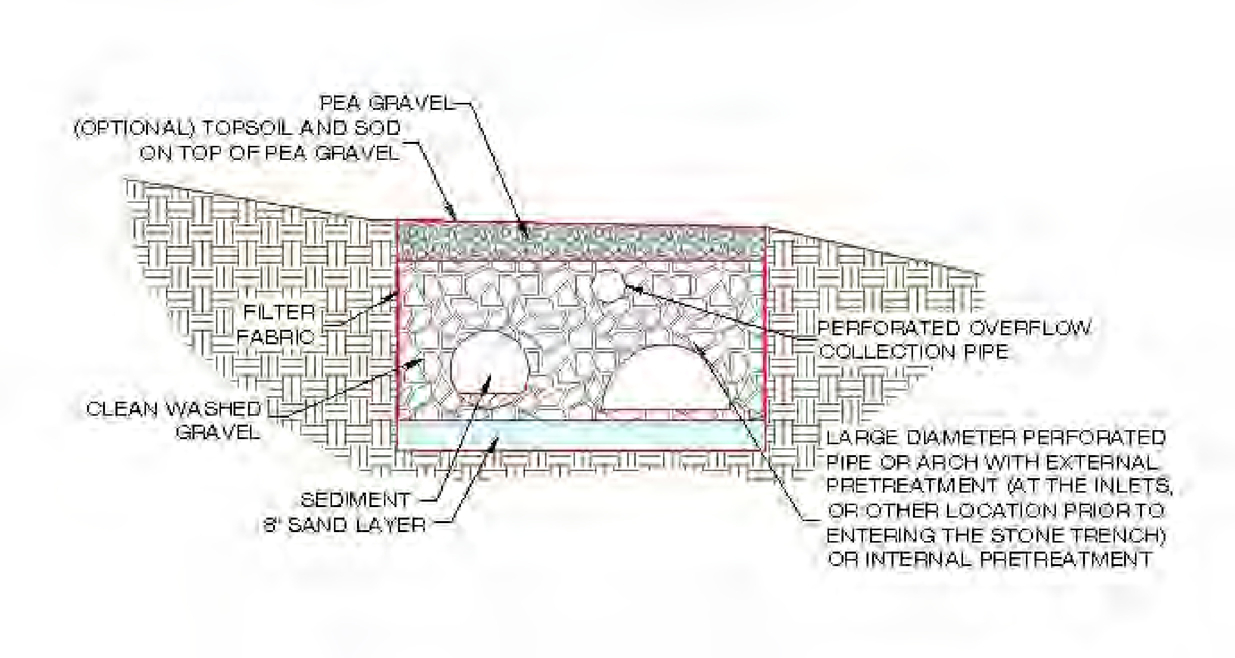

Figure 4.18. Example design of an infiltration practice with supplemental pipe storage.

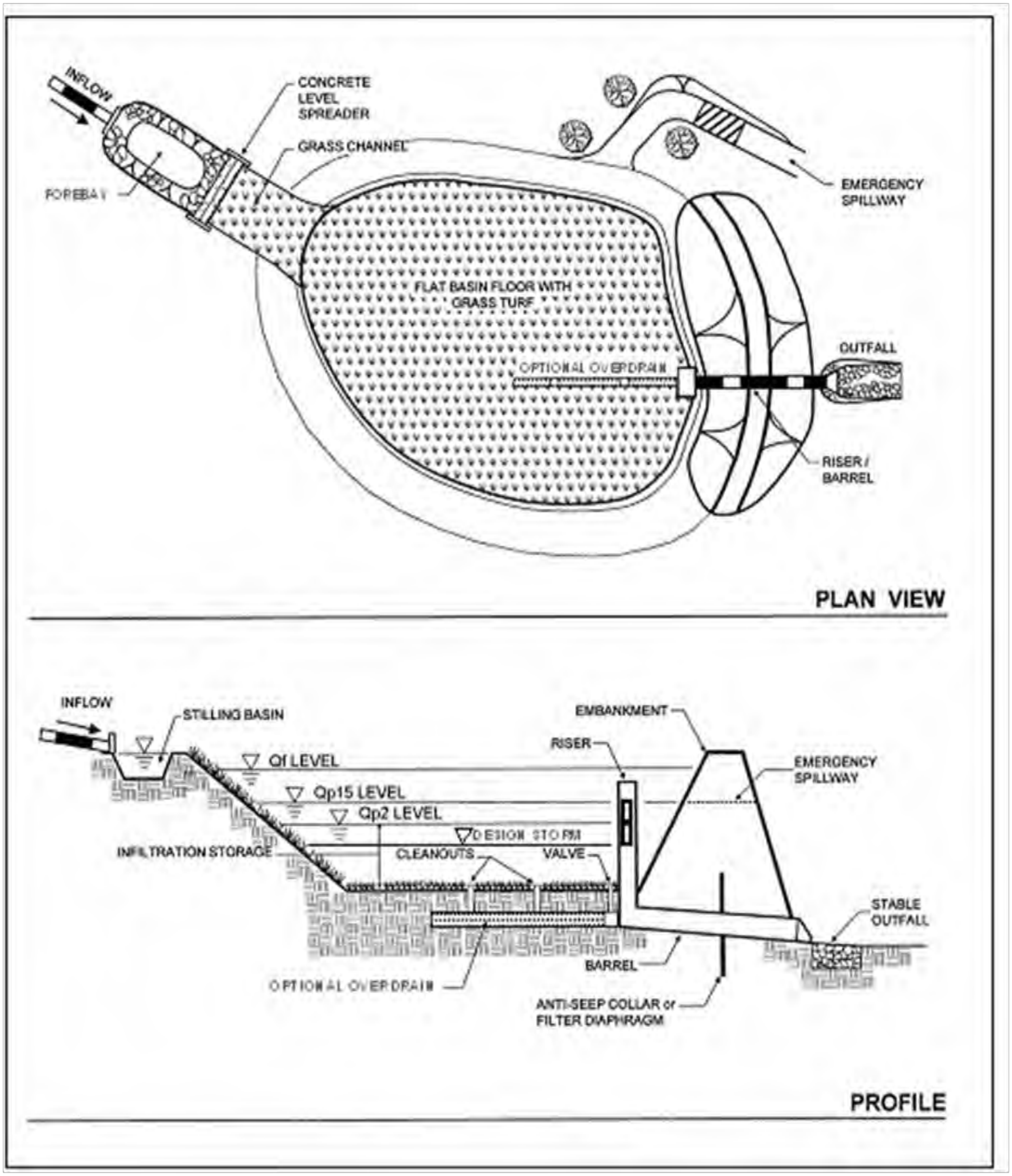

Figure 4.19. Example design of an infiltration basin.

4.5.1 Infiltration Feasibility Criteria

Infiltration practices have very high storage and retention capabilities when sited and designed appropriately. Designers should evaluate the range of soil properties during initial site layout and seek to configure the site to conserve and protect the soils with the greatest recharge and infiltration rates. In particular, areas of HSG A or B soils, shown on the U.S. Department of Agriculture's NRCS soil surveys, should be considered as primary locations for infiltration practices. Additional information about soil and infiltration are described in more detail later in this section. During initial design phases, designers should carefully identify and evaluate constraints on infiltration, as follows:

Underground Injection Control for Class V Wells

In order for an infiltration practice to avoid classification as a Class V well, which is subject to regulation under the Federal Underground Injection Control program, the practice must be wider than the practice is deep. If an infiltration practice is "deeper than its widest surface dimension" or if it includes an underground distribution system, then it will likely be considered a Class V injection well. Class V injection wells are subject to permit approval by the U.S. Environmental Protection Agency (EPA). For more information on Class V injection wells and stormwater management, designers should consult https://www.epa.gov/sites/production/files/2015-10/documents/epamemoinfiltrationclassvwells.pdf for EPA's clarification for stormwater infiltration.

Contributing Drainage Area

The maximum CDA to an individual infiltration practice should be less than 2 acres and as close to 100% impervious as possible. The design, pretreatment, and maintenance requirements will differ depending on the size of the infiltration practice.

Site Topography

The infiltration practice shall not be located on slopes greater than 6%, although check dams or other devices may be employed to reduce the effective slope of the practice. Further, unless slope stability calculations demonstrate otherwise, infiltration practices should be located a minimum horizontal distance of 200 feet from down-gradient slopes greater than 20%.

Minimum Hydraulic Head

Two or more feet of head may be needed to promote flow through infiltration practices.

Minimum Depth to Water Table

A minimum vertical distance of 0.5 feet must be provided between the bottom of the infiltration practice.

Tidal Impacts

The bottom of an infiltration practice should be located above the tidal mean high water elevation. Where this is not possible, portions of the practice below the tidal mean high water elevation cannot be included in the volume calculations.

Soils

Initially, soil infiltration rates can be estimated from NRCS soil data for feasibility purposes, but designers must verify soil permeability by using the on-site soil investigation methods provided in Appendix B Geotechnical Information Requirements for Underground BMPs for their design.

Use on Urban Fill Soils/Redevelopment Sites

Sites that have been previously graded or disturbed do not typically retain their original soil permeability due to compaction. Therefore, such sites are often not good candidates for infiltration practices unless the geotechnical investigation shows that a sufficient saturated hydraulic conductivity exists.

Dry Weather Flows

Infiltration practices should not be used on sites receiving regular dry-weather flows from sump pumps, irrigation water, chlorinated wash-water, or flows other than stormwater.

Setbacks

To avoid the risk of seepage, stormwater cannot flow from infiltration practices to traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties. Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements. Where the 10-foot setback is not possible, an impermeable liner may be used along the sides and bottom of the infiltration area (extending from the surface to the bottom of the practice and outward to meet the 10-foot setback). Areas where the liner blocks infiltration should be excluded from surface area calculations for the practice. In locations where the surface soil consists of highly permeable soils with little separation of the infiltration trench or basin bottom, the extent of ground water mounding should be considered. Mounding can occur in areas where infiltrating water intersects a groundwater table and the rate of water entering the subsurface is greater than the rate at which water is conveyed away from the infiltration system (MPCA, 2019). Ground water mounding may impact building foundations, soil stability, underground utilities and potentially on-site treatment systems (septic leach beds).

All setbacks must be verified by a professional geotechnical engineer registered in the State of South Carolina.

Proximity to Utilities

Interference with underground utilities should be avoided, if possible. When large site development is undertaken the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the PROW. Consult with each utility company on recommended offsets, which will allow utility maintenance work with minimal disturbance to the infiltration BMP. Infiltration BMPs in the PROW will also conform with the State of South Carolina Department of Transportation design specifications. Where conflicts cannot be avoided, follow these guidelines:

- Consider altering the location or sizing of the infiltration BMP to avoid or minimize the utility conflict. Consider an alternate BMP type to avoid conflict.
- Use design features to mitigate the impacts of conflicts that may arise by allowing the infiltration BMP and the utility to coexist. The infiltration BMP design may need to incorporate impervious areas, through geotextiles or compaction, to protect utility crossings. Other key design features may need to be moved, added, or deleted.
- Evaluate the relocation of the existing utility and install an optimally placed and sized infiltration BMP.
- If utility functionality, longevity and vehicular access to manholes can be assured, accept the infiltration BMP design and location with the existing utility. Incorporate into the infiltration BMP design sufficient soil coverage over the utility or general clearances or other features such as an impermeable linear to assure all entities the conflict is limited to maintenance.

Note: When accepting utility conflict into the infiltration BMP location and design, it is understood the infiltration BMP will be temporarily impacted during utility work. At the conclusion of this work, the utility owner will replace the infiltration BMP or, alternatively, install a functionally comparable infiltration BMP according to the specifications in the current version of this guidebook. If the infiltration BMP is located in the PROW the infiltration BMP restoration will also conform with the State of South Carolina Department of Transportation design specification.

Pollutant Hotspots and High Loading Situations

Infiltration practices are not intended to treat sites with high sediment or trash or debris loads, because such loads will cause the practice to clog and fail. Infiltration practices must be avoided at potential stormwater hotspots that pose a risk of groundwater contamination. In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from industrial processes), appropriate pretreatment, such as an oil-water separator or filtering device must be provided. These pretreatment facilities should be monitored and maintained frequently to avoid negative impacts to the infiltration area and groundwater.

On sites with existing contaminated soils, infiltration is not allowed.

Economic Considerations

Infiltration practices do require a designated space on the site, which in space-constrained areas, may reduce available building space. However, infiltration practices have a relatively low construction cost, and high space efficiency. In some cases, they can even be incorporated into the detention design or landscaped areas

4.5.2 Infiltration Conveyance Criteria

The nature of the conveyance and overflow to an infiltration practice depends on the scale of infiltration and whether the facility is on-line or off-line. Where possible, conventional infiltration practices should be designed off-line to avoid damage from the erosive velocities of larger design storms. If runoff is delivered by a storm drain pipe or along the main conveyance system, the infiltration practice shall be designed as an off-line practice. Pretreatment shall be provided for storm drain pipes and conveyance systems discharging directly to infiltration systems.

Off-line Infiltration

Overflows can either be diverted from entering the infiltration practice or dealt with via an overflow inlet. Optional overflow methods include the following:

- Utilize a low-flow diversion or flow splitter at the inlet to allow only the design SWRv to enter the facility. This may be achieved with a weir or curb opening sized for the target flow, in combination with a bypass channel. Using a weir or curb opening helps minimize clogging and reduces the maintenance frequency (further guidance on determining the peak flow rate will be necessary in order to ensure proper design of the diversion structure).
- Use landscaping type inlets or standpipes with trash guards as overflow devices.

On-line Infiltration

An overflow structure must be incorporated into on-line designs to safely convey the 25-year storm through the infiltration area. Mechanisms such as elevated drop inlets and overflow weirs are examples of how to direct high flows to a non-erosive down-slope overflow channel, stabilized water course, or storm sewer system designed to convey the 25-year design storm.

4.5.3 Infiltration Pretreatment Criteria

Every infiltration system shall have pretreatment mechanisms to protect the long-term integrity of the infiltration rate. One of the following techniques must be installed to pretreat 100% of the inflow in every facility:

- Grass channel
- Grass filter strip (minimum 20 feet and only if sheet flow is established and maintained)
- Forebay or sump pit (must accommodate a minimum 15% of the design storm volume)
- Gravel diaphragm (minimum 1 foot deep and 2 feet wide and only if sheet flow is established and maintained)
- Filter system (see Section 4.10 Filtering Systems) If using a filter system as a pretreatment facility, the sand filter will not require its own separate pretreatment facility.
- A proprietary structure with demonstrated capability of reducing sediment and hydrocarbons may be used to provide pretreatment. Refer to Section 0 Proprietary Practices.

If the basin serves a CDA greater than 20,000 square feet, a forebay, sump pit, filter system, or proprietary practice must be used for pretreatment.

Exit velocities from the pretreatment chamber shall not be erosive (above 6 fps) during the 25-year design storm and flow from the pretreatment chamber should be evenly distributed across the width of the practice (e.g., using a level spreader).

4.5.4 Infiltration Design Criteria

Geometry

Where possible, an infiltration practice should be designed to be wider than it is deep, to avoid classification as a Class V injection well. For more information on Class V wells see https://www.epa.gov/sites/production/files/2015-10/documents/epamemoinfiltrationclassvwells.pdf

Practice Slope

The bottom of an infiltration practice should be flat (i.e., 0% longitudinal and lateral slopes) to enable even distribution and infiltration of stormwater.

Infiltration Basin Geometry

The maximum vertical depth to which runoff may be ponded over an infiltration basin is 24 inches. The side-slopes should be no steeper than 4H:1V.

Surface Cover (optional)

Designers may choose to install a layer of topsoil and grass above the infiltration practice.

Surface Stone

A 3-inch layer of clean, washed river stone or No. 8 or 89 stone should be installed over the stone layer.

Stone Layer

Stone layers must consist of clean, washed aggregate with a maximum diameter of 3.5 inches and a minimum diameter of 1.5 inches.

Observation Wells

All infiltration practices must include at least one observation well. The observation well is used to observe the rate of drawdown within the infiltration practice following a storm event and to facilitate periodic inspection and maintenance. The observation well should consist of a well-anchored, perforated 4- to 6-inch diameter PVC pipe. There should be no perforation within 1 foot of the surface. The observation well should extend vertically to the bottom of the stone layer and extend upward to the top of ponding.

Underground Storage (optional)

In the underground mode, runoff is stored in the voids of the stones and infiltrates into the underlying soil matrix. Perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials can be used in conjunction with the stone to increase the available temporary underground storage. In some instances, a combination of filtration and infiltration cells can be installed in the floor of a dry extended detention (ED) pond.

Overflow Collection Pipe (Overdrain)

An optional overflow collection pipe can be installed in the stone layer to convey collected runoff from larger storm events to a downstream conveyance system.

Trench Bottom

To protect the bottom of an infiltration trench from intrusion by underlying soils, a sand layer must be used. The underlying native soils must be separated from the stone layer by a 6- to 8-inch layer of coarse sand (e.g., ASTM C-33, 0.02–0.04 inches in diameter).

Geotextile Fabric

An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used. This layer should be applied only to the sides of the practice.

Material Specifications

Recommended material specifications for infiltration areas are shown in Table 4.18.

Table 4.18. Infiltration practice material specifications.

Material	Specification	Notes
Surface Layer (optional)	Topsoil and grass layer	
Surface Stone	Install a 3-inch layer of river stone or pea gravel.	Provides an attractive surface cover that can suppress weed growth.
Stone Layer	Clean, double-washed aggregate with a maximum diameter of 3.5 inches and a minimum diameter of 1.5 inches.	
Observation Well	Install a vertical 6-inch Schedule 40 PVC perforated pipe, with a lockable cap and anchor plate.	Install one per 50 feet of length of infiltration practice.
Overflow Collection Pipe (optional)	Use 4- or 6-inch rigid schedule 40 PVC pipe, with three or four rows of 3/8-inch perforations at 6 inches on center.	
Trench Bottom	Install a 6- to 8-inch sand layer (e.g., ASTM C-33, 0.02–0.04 inches in diameter)	
Geotextile Fabric (sides only)	An appropriate geotextile fabric that complies with AASHTO M-288 Class 2, latest edition, requirements and has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability must be used.	

Practice Sizing

The proper approach for designing infiltration practices is to avoid forcing a large amount of infiltration into a small area. Therefore, individual infiltration practices that are limited in size due to soil permeability and available space need not be sized to achieve the full design storm volume (SWRv) for the CDA, as long as other stormwater treatment practices are applied at the site to meet the remainder of the design storm volume.

Several equations (see following page) are needed to size infiltration practices. The first equations establish the maximum depth of the infiltration practice, depending on whether it is a surface basin (Equation 4.6) or trench with an underground reservoir (Equation 4.7)

Equation 4.6. Maximum surface basin depth for infiltration basins.

$$d_{max} = K_{sat} \times t_d$$

Equation 4.7. Maximum underground reservoir depth for infiltration trenches.

$$d_{max} = \frac{(K_{sat} \times t_d)}{\eta_r}$$

Where:

d_{max} = Maximum depth of the infiltration practice (ft)
K_{sat} = Field-verified saturated hydraulic conductivity for the native soils (ft/day)
t_d = Maximum drawdown time (days, normally 3 days)
η_r = Available porosity of the stone reservoir (assume 0.4)

These equations make the following design assumptions:

- **Stone Layer Porosity**
  A porosity value of 0.4 shall be used in the design of stone reservoirs, although a larger value may be used if perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials are installed within the reservoir.
- **Rapid Drawdown**
  Infiltration practices must be sized so that the design volume infiltrates within 72 hours, to prevent nuisance ponding conditions.

Designers should compare these results to the maximum allowable depths in Table 4.19 and use whichever value is less for the subsequent design.

Table 4.19. Maximum facility depth for infiltration practices.

Mode of Entry	Scale of Infiltration		
	Micro Infiltration (250–2,500 ft^2)	Small Scale Infiltration (2,500–20,000 ft^2)	Conventional Infiltration (20,000–100,000 ft^2)
Surface Basin	1.0	1.5	2.0
Underground Reservoir	3.0	5.0	varies

Once the maximum depth is known, calculate the surface area needed for an infiltration practice using Equation 4.8 or Equation 4.9.

Equation 4.8. Surface basin surface area for infiltration basins.

$$\mathrm{SA} = \frac{\mathrm{DesignStorm}}{\mathrm{d} + (\mathrm{K_{sat}} \times \mathrm{t_f})}$$

Equation 4.9. Underground reservoir surface area for infiltration trenches.

$$SA = \frac{DesignStorm}{(\eta_r \times d) + (0.5 \times K_{sat} \times t_f)}$$

Where:

SA =	Surface area (square feet)
DesignStorm =	SWRv or other design storm volume (e.g., portion of the SWRv; cubic feet)
η_r =	Available porosity of the stone reservoir (assume 0.4)
d =	Infiltration depth (feet; maximum depends on the scale of infiltration and the results of Equation 4.6 or Equation 4.7)
K_{sat} =	Field-verified saturated hydraulic conductivity for the native soils (ft/day)
t_f =	Time to fill the infiltration facility (days; typically 2 hours or 0.083 days)

The storage volume (Sv) captured by the infiltration practice is defined as the volume of water that is fully infiltrated through the practice (i.e., no overflow). Designers may choose to infiltrate less than the full design storm (SWRv). In this case, the design volume captured must be treated as the Sv of the practice (see Section 4.5.4 Infiltration Design Criteria). Sv can be determined by rearranging Equation 4.8 and Equation 4.9 to yield Equation 4.10 and Equation 4.11.

Equation 4.10. Storage volume for surface basin area for infiltration basins.

$$Sv = SA \times [d + (K_{sat} \times t_f)]$$

Equation 4.11. Storage volume for underground reservoir surface area for infiltration trenches.

$$Sv = SA \times [(\eta_r \times d) + (K_{sat} \times t_f)]$$

Infiltration practices can also be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. The designer can model various approaches by factoring in storage within the stone aggregate layer, any perforated corrugated metal pipe, plastic pipe, concrete arch pipe, or comparable materials installed within the reservoir, expected infiltration, and any outlet structures used as part of the design. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

4.5.5 Infiltration Landscaping Criteria

Infiltration trenches can be effectively integrated into the site plan and aesthetically designed with adjacent native landscaping or turf cover, subject to the following additional design considerations:

- Infiltration practices should not be installed until all up-gradient construction is completed and pervious areas are stabilized with dense and healthy vegetation, unless the practice can be kept off-line so it receives no runoff until construction and stabilization is complete.
- Vegetation associated with the infiltration practice buffers should be regularly maintained to limit organic matter in the infiltration device and maintain enough vegetation to prevent soil erosion from occurring.

4.5.6 Infiltration Construction Sequence

Infiltration practices are particularly vulnerable to failure during the construction phase for two reasons. First, if the construction sequence is not followed correctly, construction sediment can clog the practice. Second, loading from heavy construction equipment can result in compaction of the soil, which can then reduce the soil’s infiltration rate. For this reason, a careful construction sequence needs to be followed.

During site construction, the following protective measures are absolutely critical:

- All areas proposed for infiltration practices should be fully protected from sediment intrusion by silt fence or construction fencing, particularly if they are intended to infiltrate runoff.
- Avoid excessive compaction by preventing construction equipment and vehicles from traveling over the proposed location of the infiltration practice. To accomplish this, areas intended to infiltrate runoff must remain outside the limits of disturbance during construction.
- When this is unavoidable, there are several possible remedies for the impacted area.
    - If excavation at the impacted area can be restricted then remediation can be achieved with deep tilling practices. This is only possible if in situ soils are not disturbed below 2 feet above the final design elevation of the bottom of the infiltration practice. In this case, when heavy equipment activity has ceased, the area is excavated to grade, and the impacted area must be tilled a minimum of 12 inches below the bottom of the infiltration practice.

- Alternatively, if it is infeasible to keep the proposed infiltration practice outside of the limits of disturbance, and excavation of the area cannot be restricted, then infiltration tests will be required prior to installation of the infiltration practice to ensure that the design infiltration rate is still present. If tests reveal the loss of design infiltration rates then deep tilling practices may be used in an effort to restore those rates. In this case further testing must be done to establish design rates exist before the infiltration practice can be installed.
- Finally, if it is infeasible to keep the proposed permeable pavement areas outside of the limits of disturbance, excavation of the area cannot be restricted, and infiltration tests reveal design rates cannot be restored, then a resubmission of the SWMP will be required.

- Any area of the site intended ultimately to be an infiltration practice should not be used as the site of a temporary sediment trap or basin. If locating a sediment trap or basin on an area intended for infiltration is unavoidable, the remedies are similar to those discussed for heavy equipment compaction. If it is possible, restrict the invert of the sediment trap or basin to at least 2 feet above the final design elevation of the bottom of the proposed infiltration practice. Then remediation can be achieved with proper removal of trapped sediments and deep tilling practices. An alternate approach to deep tilling is to use an impermeable linear to protect the in situ soils from sedimentation while the sediment trap or basin is in use. In each case, all sediment deposits must be carefully removed prior to installing the infiltration practice.
- Keep the infiltration practice off-line until construction is complete. Prevent sediment from entering the infiltration site by using super silt fence, diversion berms, or other means. In the soil erosion and sediment control plan, indicate the earliest time at which stormwater runoff may be directed to a conventional infiltration basin. The soil erosion and sediment control plan must also indicate the specific methods to be used to temporarily keep runoff from the infiltration site.
- Upland CDAs need to be completely stabilized with a well-established layer of vegetation prior to commencing excavation for an infiltration practice.

Infiltration Installation

The actual installation of an infiltration practice is done using the following steps:

1. Avoid Impact of Heavy Installation Equipment

Excavate the infiltration practice to the design dimensions from the side using a backhoe or excavator. The floor of the pit should be completely level, but equipment should be kept off the floor area to prevent soil compaction.

2. Hang Geotextile Walls

Install geotextile fabric on the trench sides. Large tree roots should be trimmed flush with the sides of infiltration trenches to prevent puncturing or tearing of the geotextile fabric during subsequent installation procedures. When laying out the geotextile, the width should include sufficient material to compensate for perimeter irregularities in the trench and for a 6-inch minimum overlap at the top of the trench. The geotextile fabric itself should be tucked under the sand layer on the bottom of the infiltration trench. Stones or other anchoring objects should be placed on the fabric at the trench sides, to keep the trench open during windy periods. Voids may occur between the fabric and the excavated sides of a trench. Natural soils should be placed in all voids, to ensure the fabric conforms smoothly to the sides of excavation.

3. Promote Infiltration Rate
Scarify the bottom of the infiltration practice and spread 6 inches of sand on the bottom as a filter layer.

4. Observation Wells
Anchor the observation well(s) and add stone to the practice in 1-foot lifts.

5. Stabilize Surrounding Area
Use sod, where applicable, to establish a dense turf cover for at least 10 feet around the sides of the infiltration practice, to reduce erosion and sloughing.

Construction Supervision
Supervision during construction is recommended to ensure that the infiltration practice is built in accordance with the approved design and this specification. Qualified individuals should use detailed inspection checklists to include sign-offs at critical stages of construction, to ensure that the contractor's interpretation of the plan is consistent with the designer's intentions.

4.5.7 Infiltration Maintenance Criteria

Maintenance is a crucial and required element that ensures the long-term performance of infiltration practices. The most frequently cited maintenance problem for infiltration practices is clogging of the stone layer by organic matter and sediment. The following design features can minimize the risk of clogging:

Stabilized CDA
Infiltration systems may not receive runoff until the entire CDA has been completely stabilized.

Observation Well
Infiltration practices must include an observation well to facilitate periodic inspection and maintenance. Design criteria must include an anchored 6-inch diameter perforated PVC pipe fitted with a lockable cap installed flush with the ground surface.

No Geotextile Fabric on Bottom
Avoid installing geotextile fabric along the bottom of infiltration practices. Experience has shown that geotextile fabric is prone to clogging. However, permeable geotextile fabric should be installed on the trench sides to prevent soil piping.

Direct Maintenance Access
Access must be provided to allow personnel and heavy equipment to perform atypical maintenance tasks, such as practice reconstruction or rehabilitation. While a turf cover is permissible for small-scale infiltration practices, the surface must never be covered by an impermeable material, such as asphalt or concrete.

Maintenance Inspections
Effective long-term operation of infiltration practices requires a dedicated and routine maintenance inspection schedule with clear guidelines and schedules, as shown in Table 4.20. Where possible, facility maintenance should be integrated into routine landscaping maintenance tasks.

Table 4.20. Typical maintenance activities for infiltration practices.

Schedule	Maintenance Activity
Quarterly	▪ Ensure that the CDA, inlets, and facility surface are clear of debris. ▪ Ensure that the CDA is stabilized. Perform spot-reseeding if where needed. ▪ Remove sediment and oil/grease from inlets, pretreatment devices, flow diversion structures, and overflow structures. ▪ Repair undercut and eroded areas at inflow and outflow structures.
Semi-annual inspection	▪ Check observation wells 3 days after a storm event in excess of 0.5 inch in depth. Standing water observed in the well after 3 days is a clear indication of clogging. ▪ Inspect pretreatment devices and diversion structures for sediment build-up and structural damage.
Annually	▪ Clean out accumulated sediment from the pretreatment cell.
As needed	▪ Replace pea gravel/topsoil and top surface geotextile fabric (when clogged). ▪ Mow vegetated filter strips as necessary and remove the clippings.

It is highly recommended that a qualified professional conduct annual site inspections for infiltration practices to ensure the practice performance and longevity of infiltration practices.

<local jurisdiction>'s maintenance inspection checklist for infiltration systems and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Waste Material

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.5.8 Infiltration Stormwater Compliance Calculations

Infiltration practices are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (Table 4.21).

Table 4.21. Retention and pollutant removal for infiltration practices.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

The practice must be sized using the guidance detailed in Section 4.3.4 Infiltration Design Criteria.

Infiltration practices also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) from the total runoff volume for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

4.5.9 References

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4.6 Green Roofs

Green Roofs					
Definition: Practices that capture and store rainfall in an engineered growing media installed over a waterproof membrane that is designed to support plant growth on the roof of a building or other structure.					
Site Applicability			**BMP Performance Summary**		
Land Uses		**Required Footprint**	**WQ Improvement:** Moderate to High		
▪ Urban ▪ Suburban		Small	**TSS[1]**	**Total N[1]**	**Bacteria[1]**
			100%	100%	100%
			Runoff Reduction		
Construction Costs		**Maintenance Burden**	**Volume**		
High		Low	High		
Maintenance Frequency:			***SWRv***		
Routine		**Non-Routine**	100% of *Sv*		
Semi-annually		As needed			

Advantages/Benefits	Disadvantages/Limitation
▪ Reduces runoff volume and pollutant loads ▪ Energy savings: keep buildings cool, prolongs roof life ▪ Possible amenity space for public or users ▪ Sound absorption ▪ Life cycle costs comparable to traditional roof	▪ For retrofits, strengthening structure may be required ▪ If roof leaks occur, may be harder to trace ▪ Design and installation require specialized knowledge ▪ Typically applied on flat roofs (1%–2% pitch) ▪ Installation costs higher than for traditional roof

Components	Design considerations
▪ Vegetation that thrives in rooftop climate. ▪ Engineered planting medium (not soil). ▪ Containment (Modular systems - plant containers; Non-modular systems - barriers at roof perimeter/drainage structures). ▪ Drainage layer, sometimes with built-in water reservoirs. ▪ Water proofing layer or roof membrane with root repellant.	▪ Good waterproofing material and installation are essential. ▪ Materials used must be lightweight. ▪ Building structure must be able to support saturated weight. ▪ Roofs with moderate to flat slopes are most appropriate. Maximum roof slope of 30%.

Maintenance Activities	
▪ Watering and fertilization until well-established ▪ Occasional weeding	▪ Inspection for proper drainage and plant health ▪ Ordinary life cycle roof replacement

[1]*Credited pollutant load removal*

Green roofs are practices that capture and store rainfall in an engineered growing media that is designed to support plant growth (see Figure 4.20). A portion of the captured rainfall evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites. Green roofs typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer towards the outlet. Extensive green roofs are designed to have minimal maintenance requirements. Plant species are selected so that the roof does not need supplemental irrigation or fertilization after vegetation is initially established.

Green roofs are typically not designed to provide stormwater detention of larger storms (e.g., 2 - 25-year) although some intensive green roof systems may be designed to meet these criteria. Green roof designs should generally be combined with a separate facility to provide large storm controls.

Figure 4.20. Green roof (photo: Center for Watershed Protection, Inc.)

Definition

Practices that capture and store rainfall in an engineered growing media installed over a waterproof membrane that is designed to support plant growth on the roof of a building or other structure. A portion of the captured rainfall evaporates or is taken up by plants, which helps reduce runoff volumes, peak runoff rates, and pollutant loads on development sites. Green roofs typically contain a layered system of roofing, which is designed to support plant growth and retain water for plant uptake while preventing ponding on the roof surface. The roofs are designed so that water drains vertically through the media and then horizontally along a waterproofing layer towards the outlet. Plant species are selected so that the roof does not need supplemental irrigation and requires minimal, infrequent fertilization after vegetation is initially established.

Design variants include extensive and intensive green roofs.

G-1 Extensive green roofs have a much shallower growing media layer that typically ranges from 3 to 8 inches thick and are designed to have minimal maintenance requirements.

G-2 Intensive green roofs have a growing media layer that typically ranges from 8 to 48 inches thick.

Green roofs are typically not designed to provide stormwater detention of larger storms (e.g., 2 - 25-year) although some intensive green roof systems may be designed to meet these criteria. Most green roof designs shall generally be combined with a separate facility to provide large storm controls.

This specification is intended for situations where the primary design objective of the green roof is stormwater management and, unless specified otherwise, addresses the design of extensive roof systems. While rooftop practices such as urban agriculture may provide some retention, their primary design objective is not stormwater management and is not addressed in this specification.

4.6.1 Green Roof Feasibility Criteria

Green roofs are ideal for use on commercial, institutional, municipal, and multi-family residential buildings. They are particularly well-suited for use on ultra-urban development and redevelopment sites. Key constraints with green roofs include the following:

Structural Capacity of the Roof

When designing a green roof, designers must not only consider the stormwater storage capacity of the green roof but also its structural capacity to support the weight of the additional water. A conventional rooftop should typically be designed to support an additional 15 to 30 pounds per square foot (psf) for an extensive green roof. As a result, a structural engineer, architect, or other qualified professional should be involved with all green roof designs to ensure that the building has enough structural capacity to support a green roof. See Section 4.6.4 Green Roof Design Criteria for more information on structural design considerations.

Hurricane-Prone Areas

As South Carolina is subject to hurricanes, some may be concerned about the durability of green roofs in high winds. Having good vegetative cover and root growth in the growing media is the most effective way to reduce wind erosion of the media during high winds. New green roofs where the plants have not yet deeply rooted are the most susceptible to plant damage and media blow-off in a hurricane. Therefore, it is best to install a green roof three or more months prior to hurricane season, to allow enough time for the plants to be established.

Roof Pitch

Green roof storage volume is maximized on relatively flat roofs (a pitch of 1% to 2%). Some pitch is needed to promote positive drainage and prevent ponding and/or saturation of the growing media. Green roofs can be installed on rooftops with slopes up to 30% if baffles, grids, or strips are used to prevent slippage of the media. These baffles must be designed to ensure the roof provides adequate storage for the design storm. Slopes greater than 30% would be considered a green wall, which is not specifically identified as a stormwater BMP. Green walls can be used to receive cistern discharge (calculations are necessary to determine demand).

Roof Access
Adequate, permanent access to the roof must be available to deliver construction materials and perform routine maintenance. A temporary ladder is not sufficient for access to the roof. Roof access can be achieved either by an interior stairway through a penthouse or by an alternating tread device with a roof hatch or trap door not less than 16 square feet in area and with a minimum dimension of 24 inches (NVRC, 2007). Designers should also consider how they will get construction materials up to the roof (e.g., by elevator or crane) and how the roof structure can accommodate material stockpiles and equipment loads. If material and equipment storage is required, rooftop storage areas must be identified and clearly marked based on structural load capacity of the roof.

Roof Type
Green roofs can be applied to most roof surfaces. Certain roof materials, such as exposed treated wood and uncoated galvanized metal, may not be appropriate for green rooftops due to pollutant leaching through the media (Clark et al., 2008).

Setbacks
Green roofs should not be located near rooftop electrical and HVAC systems. A 2-foot-wide vegetation-free zone is recommended along the perimeter of the roof with a 1-foot vegetation-free zone around all roof penetrations, to act as a firebreak. The 2-foot setback may be relaxed for small or low green roof applications where parapets have been properly designed.

Contributing Drainage Area
It is recommended that the contributing drainage area (CDA) to a green roof be limited to the green roof itself. In cases where there will be additional CDA, the designer must provide sufficient design detail showing distribution of this additional runoff throughout the green roof area to prevent erosion or overloading of the roof growing media with the use of level spreaders, splash pads, perforated piping, or other flow dissipation techniques. The absolute maximum CDA to a green roof shall be no more than 100% larger than the area of the green roof (e.g., a 1,000-square-foot green roof can have no more than 1,000 square feet of additional impervious cover draining to it).

Local Building Codes
The green roof design must comply with the local building codes with respect to roof drains and emergency overflow devices. Additionally, a structural engineer should certify that the design complies with structural building codes. For green roofs installed on historic buildings or in historic districts, consult local building codes and architectural review criteria to determine if any special requirements exist for green roof design or maintenance.

Additionally, a State of South Carolina registered structural engineer must certify that the design complies with State building structural codes. This is true for new construction as well as retrofit projects.

Economic Considerations
Green roofs tend to be one of the most expensive BMPs on a per cubic foot captured basis. However, a green roof allows stormwater management to be achieved in otherwise unused space, a major benefit in space-constrained locations. Further, green roofs provide many other non-stormwater services with economic benefits, including increased insulation and roof life expectancy

4.6.2 Green Roof Conveyance Criteria

The green roof drainage layer (refer to Section 4.4.4 Green Roof Design Criteria) must convey flow from under the growing media directly to an outlet or overflow system such as a traditional rooftop downspout drainage system. The green roof drainage layer must be adequate to convey the volume of stormwater equal to the flow capacity of the overflow or downspout system without backing water up onto the rooftop or into the green roof media. Roof drains immediately adjacent to the growing media should be boxed and protected by flashing extending at least 3 inches above the growing media to prevent clogging. However, an adequate number of roof drains that are not immediately adjacent to the growing media must be provided so as to allow the roof to drain without 3 inches of ponding above the growing media.

4.6.3 Green Roof Pretreatment Criteria

Pretreatment is not necessary for green roofs.

4.6.4 Green Roof Design Criteria

Structural Capacity of the Roof

Green roofs can be limited by the additional weight of the fully saturated soil and plants, in terms of the physical capacity of the roof to bear structural loads. The designer shall consult with a licensed structural engineer to ensure that the building will be able to support the additional live and dead structural load and to determine the maximum depth of the green roof system and any needed structural reinforcement. Typically, the green roof manufacturer can provide specific background specifications and information on their product for planning and design.

In most cases, fully saturated extensive green roofs have loads of about 15 to 30 pounds per square foot, which is fairly similar to traditional new rooftops (12 to 15 pounds per square foot) that have a waterproofing layer anchored with stone ballast. For a discussion of green roof structural design issues, consult Chapter 9 in Weiler and Scholz-Barth (2009) and ASTM E2397 / E2397M-15, Standard Practice for Determination of Dead Loads and Live Loads Associated with Vegetative (Green) Roof Systems (ASTM, 2015).

Functional Elements of a Green Roof System

A green roof is composed of up to nine different systems or layers that combine to protect the roof and maintain a vigorous cover (see Figure 4.21).

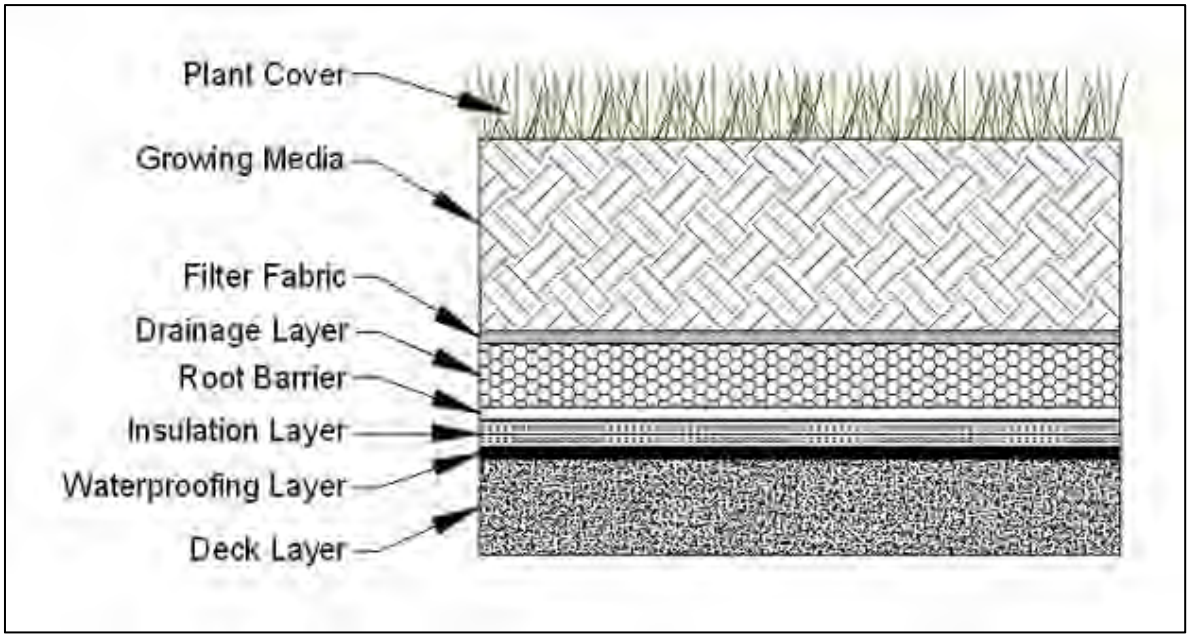

Figure 4.21. Green roof layers (note: the relative placement of various layers may vary depending on the type and design of the green roof system).

The design layers include the following:

Deck Layer. The roof deck layer is the foundation of a green roof. It may be composed of concrete, wood, metal, plastic, gypsum, or a composite material. The type of deck material determines the strength, load bearing capacity, longevity, and potential need for insulation in the green roof system.

Leak Detection System (optional). Leak detection systems are often installed above the deck layer to identify leaks, minimize leak damage through timely detection, and locate leak locations. Electric Field Vector Mapping (EFVM®) or other leak detection techniques are strongly recommended as part of the green roof installation process. In the case of EFVM, the deck material must be conductive. If it is not, an additional conductive medium may need to be added on top of the deck. Other leak detection systems may require additional materials between the deck layer and the waterproofing layer.

Waterproofing Layer. All green roof systems must include an effective and reliable waterproofing layer to prevent water damage through the deck layer. A wide range of waterproofing materials can be used, including hot applied rubberized asphalt, built up bitumen, modified bitumen, thermoplastic membranes, polyvinyl chloride (PVC), thermoplastic olefin membrane (TPO), and elastomeric membranes (EPDM) (see Weiler and Scholz-Barth, 2009, and Snodgrass and Snodgrass, 2006). The waterproofing layer must be 100% waterproof and have an expected life span as long as any other element of the green roof system. The waterproofing material may be loose laid or bonded (recommended). If loose laid, overlapping and additional construction techniques should be used to avoid water migration.

Insulation Layer. Many green rooftops contain an insulation layer, usually located above, but sometimes below, the waterproofing layer. The insulation increases the energy efficiency of the building and/or protects the roof deck (particularly for metal roofs). According to Snodgrass and Snodgrass (2006), the trend is to install insulation on the outside of the building, in part to avoid mildew problems. The designer should consider the use of open or closed cell insulation depending on whether the insulation layer is above or below the waterproofing layer (and thus exposed to wetness), with closed cell insulation recommended for use above the waterproofing layer.

Root Barrier. Another layer of a green roof system, which can be either above or below the insulation layer depending on the system, is a root barrier that protects the waterproofing membrane from root penetration. A wide range of root barrier options are described in Weiler and Scholz-Barth (2009). Chemical root barriers or physical root barriers that have been impregnated with pesticides, metals, or other chemicals that could leach into stormwater runoff must be avoided in systems where the root barrier layer will come in contact with water or allow water to pass through the barrier.

Drainage Layer and Drainage System. A drainage layer is placed between the root barrier and the growing media to quickly remove excess water from the vegetation root zone. The selection and thickness of the drainage layer type is an important design decision that is governed by the desired stormwater storage capacity, the required conveyance capacity, and the structural capacity of the rooftop. The effective depth of the drainage layer is generally 0.25–1.5 inches thick for extensive green roof system and increases for intensive designs. The drainage layer should consist of synthetic or inorganic materials (e.g., 1–2-inch layer of clean, washed granular material (ASTM D448 size No. 8 stone or lightweight granular mix), high density polyethylene (HDPE)) that are capable of retaining water and providing efficient drainage (ASTM, 2017). A wide range of prefabricated water cups or plastic modules can be used, as well as a traditional system of protected roof drains, conductors, and roof leaders. ASTM E2396 and E2398 can be used to evaluate alternative material specifications (ASTM E2396, 2015 and ASTM E2398, 2015).

Root-Permeable Filter Fabric. A semi-permeable needled polypropylene filter fabric is normally placed between the drainage layer and the growing media to prevent the media from migrating into the drainage layer and clogging it. The filter fabric must not impede the downward migration of water into the drainage layer.

Growing Media. The next layer in an extensive green roof is the growing media, which is typically 3–8 inches deep. The recommended growing media for extensive green roofs is typically composed of approximately 70%–80% lightweight inorganic materials, such as expanded slates, shales or clays; pumice; scoria; or other similar materials. The media must contain no more than 30% organic matter, normally well-aged compost (see Appendix C Soil Compost Amendment Requirements). The percentage of organic matter should be limited, since it can leach nutrients into the runoff from the roof and clog the permeable filter fabric. It is advisable to mix the media in a batch facility prior to delivery to the roof. Manufacturer’s specifications should be followed for all proprietary roof systems. More information on growing media can be found in Weiler and Scholz-Barth (2009) and Snodgrass and Snodgrass (2006).

The composition of growing media for intensive green roofs may be different (although the organic material limit still applies), and it is often much greater in depth (e.g., 8–48 inches). If trees are included in the green roof planting plan, the growing media must be sufficient to provide enough soil volume for the root structure of mature trees.

Plant Cover. The top layer of an extensive green roof typically consists of plants that are slow-growing, shallow-rooted, perennial, and succulent. These plants are chosen for their ability to withstand harsh conditions at the roof surface. Guidance on selecting the appropriate green roof plants can often be provided by green roof manufacturers and can also be found in Snodgrass and Snodgrass (2006). A mix of base ground covers (usually *Sedum* species) and accent plants can be used to enhance the visual amenity value of a green roof. See Section 4.6.4 Green Roof Design Criteria for additional plant information. The design must provide for temporary, manual, and/or permanent irrigation or watering systems, depending on the green roof system and types of plants. For most applications, some type of watering system should be accessible for initial establishment or drought periods. The use of water efficient designs and/or use of non-potable sources are strongly encouraged.

Material Specifications

Standard specifications for North American green roofs continue to evolve, and no universal material specifications exist that cover the wide range of roof types and system components currently available. The ASTM has recently issued several overarching green roof standards, which are described and referenced in Table 4.22 below.

Designers and reviewers should also fully understand manufacturer specifications for each system component, particularly if they choose to install proprietary "complete" green roof systems or modules.

Table 4.22. Extensive Green Roof Material Specifications

Material	Specification
Roof	Structural capacity must conform to ASTM E2397, *Standard Practice for Determination of Dead Loads and Live Loads Associated with Vegetative (Green) Roof Systems*. In addition, use standard test methods ASTM E2398, *Standard Test Method for Water Capture and Media Retention of Geocomposite Drain Layers for Vegetated (Green) Roof Systems* and ASTM E2399, *Standard Test Method for Maximum Media Density for Dead Load Analysis of Vegetative (Green) Roof Systems*.
Leak Detection System	Optional system to detect and locate leaks in the waterproof membrane.
Waterproof Membrane	See Chapter 6 of Weiler and Scholz-Barth (2009) for waterproofing options that are designed to convey water horizontally across the roof surface to drains or gutter. This layer may sometimes act as a root barrier.
Root Barrier	Impermeable liner that impedes root penetration of the membrane.
Drainage Layer	Depth of the drainage layer is generally 0.25–1.5 inches thick for extensive designs. The drainage layer should consist of synthetic or inorganic materials (e.g., gravel, HDPE, etc.) that are capable of retaining water and providing efficient drainage. A wide range of prefabricated water cups or plastic modules can be used, as well as a traditional system of protected roof drains, conductors, and roof leaders. Designers should consult the material specifications as outlined in ASTM E2396 and E2398. Roof drains and emergency overflow must be designed in accordance with the local construction codes.

Material	Specification
Filter Fabric	Generally, needle-punched, non-woven, polypropylene geotextile, with the following qualities: ▪ Strong enough and adequate puncture resistance to withstand stresses of installing other layers of the green roof. Density as per ASTM D3776 ≥ 8 oz/yd^2. Puncture resistance as per ASTM D4833 ≥ 130 lb. These values can be reduced with submission of a Product Data Sheet and other documentation that demonstrates applicability for the intended use. ▪ Adequate tensile strength and tear resistance for long-term performance. ▪ Allows a good flow of water to the drainage layer. Apparent Opening Size, as per ASTM D4751, of ≥ 0.06mm ≤ 0.2mm, with other values based on Product Data Sheet and other documentation as noted above. ▪ Allows at least fine roots to penetrate. ▪ Adequate resistance to soil borne chemicals or microbial growth both during construction and after completion since the fabric will be in contact with moisture and possibly fertilizer compounds.
Growth Media	70%–80% lightweight inorganic materials and a maximum of 30% organic matter (e.g., well-aged compost). Material makeup of the growing media must be provided. Media must provide sufficient nutrient and water holding capacity to support the proposed plant materials. Determine acceptable saturated water permeability using ASTM E2396. An acceptable emerging industry practice combines the drainage layer with the growing media layer.
Plant Materials	*Sedum*, herbaceous plants, and perennial grasses that are shallow-rooted, low maintenance, and tolerant of full and direct sunlight, drought, wind, and frost. See ASTM E2400, *Standard Guide for Selection, Installation, and Maintenance of Plants for Green Roof Systems*.

Solar Panels and Other Structures

Occasionally, structures such as solar panels or HVAC systems must be installed above a green roof. These structures can be incorporated into a green roof design with no adverse effects to the retention credit assigned to the green roof if specific design requirements for runoff disbursement, maintenance access, and sun/wind exposure are incorporated, including the following:

- Structures above the green roof must be no more than 6.5 feet wide.
- Structures must have a minimum 3-foot separation between them.
- The lower edge of the structure must be at least 1 foot above the top of the green roof, and the upper edge must be at least 2.5 feet above the top of the green roof. This allows for at least a 15-degree tilt. For flatter installations, the lower edge would need to be raised to ensure that the 2.5-foot minimum for the upper edge is met.

These design requirements are illustrated in Figure 4.22**.**

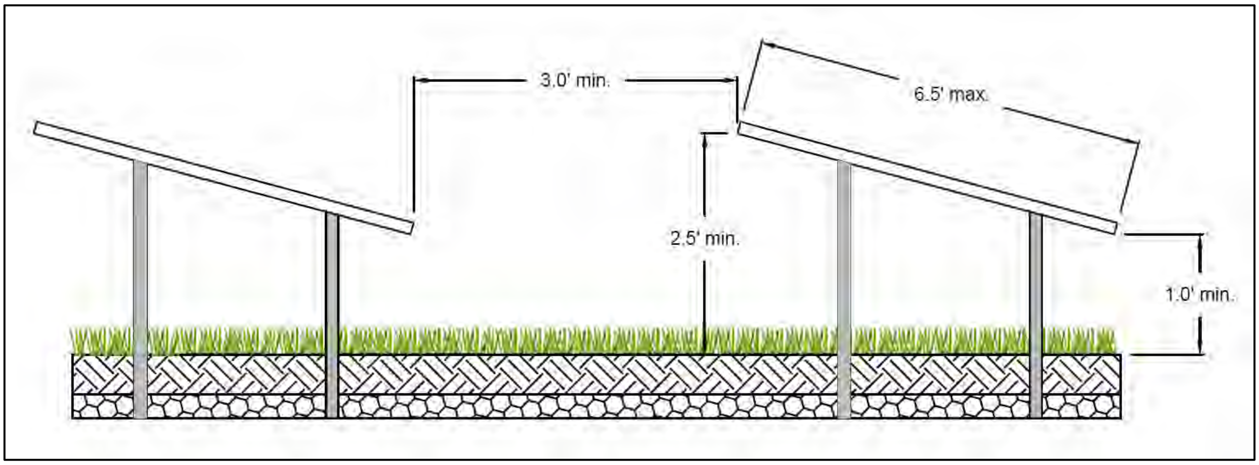

Figure 4.22. Design requirements for structures constructed above green roofs.

Green Roof Sizing

Green roof areas can be designed to capture the entire Stormwater Retention Volume (SWRv). In some cases, they could be designed to capture larger design storm volumes as well. The required size of a green roof will depend on several factors, including maximum water retention of the growing media and the underlying drainage and storage layer materials, if present (e.g., prefabricated water cups or plastic modules). As maximum water retention can vary significantly between green roof products, verification of this value must be included with the Stormwater Management Plan (SWMP). Verification shall be provided by an ASTM-certified lab using the methods described by ASTM tests E2396, E2397, E2398, or E2399, as appropriate. In the absence of laboratory test results, the baseline default values must be used. Equation 4.12 below shall be used to determine the storage volume retained by a green roof.

Equation 4.12. Storage Volume for Green Roofs

$$\mathrm{Sv} = \frac{\mathrm{SA} \times [(\mathrm{d} \times \mathrm{MWR}_1) + (\mathrm{DL} \times \mathrm{MWR}_2)]}{12} \times \mathrm{IF}$$

Where:

Sv	=	green roof storage volume (ft^3)
SA	=	green roof area (ft^2)
d	=	media depth (in.) (minimum 3 in.)
MWR_1	=	verified media maximum water retention (use 0.10 as a baseline default in the absence of verification data)
DL	=	drainage layer depth (in.) (if the drainage layer is combined with the media layer, then this value is 0)
MWR_2	=	verified drainage layer maximum water retention (use 0.0 as a baseline default in the absence of verification data)
IF	=	irrigation factor (0.5 for irrigated green roofs, 1.0 for unirrigated green roofs)

The appropriate Sv can then be compared to the required SWRv for the entire rooftop area (including all conventional roof areas) to determine the portion of the design storm captured.

Green roofs can have dramatic rate attenuation effects on larger storm events and may be used, in part, to manage a portion of the 2- to 25-year events. Designers can model various approaches by factoring in storage within the drainage layer. Routing calculations can also be used to provide a more accurate solution of the peak discharge and required storage volume.

4.6.5 Green Roof Landscaping Criteria

Plant selection, landscaping, and maintenance are critical to the performance and function of green roofs. Therefore, a landscaping plan shall be provided for green roofs.

A planting plan must be prepared for a green roof by a landscape architect, botanist, or other professional experienced with green roofs and submitted with the SWMP.

Plant selection for green roofs is an integral design consideration, which is governed by local climate and design objectives. The primary ground cover for most green roof installations is a hardy, low-growing succulent, such as *Sedum*, *Delosperma*, *Talinum*, *Semperivum*, or *Hieracium* that is matched to the local climate conditions and can tolerate the difficult growing conditions found on building rooftops (Snodgrass and Snodgrass, 2006).

A list of some common green roof plant species that work well in the can South Lowcountry region be found in Table 4.23 below.

Table 4.23. Ground Covers Appropriate for Green Roofs in the State of South Carolina

Plant	Light	Moisture Requirement	Notes
Delosperma cooperii	Full Sun	Dry	Pink flowers; grows rapidly
Delosperma 'Kelaidis'	Full Sun	Dry	Salmon flowers; grows rapidly
Delosperma nubigenum 'Basutoland'	Full Sun	Moist-Dry	Yellow flowers; very hardy
Sedum album	Full Sun	Dry	White flowers; hardy
Sedum lanceolatum	Full Sun	Dry	Yellow flowers; native to U.S.
Sedum oreganum	Part Shade	Moist	Yellow flowers; native to U.S.
Sedum stoloniferum	Sun	Moist	Pink flowers; drought tolerant
Sedum telephiodes	Sun	Dry	Blue green foliage; native to region
Sedum ternatum	Part Shade	Dry-Moist	White flowers; grows in shade
Talinum calycinum	Sun	Dry	Pink flowers; self-sows

Note: Designers should choose species based on shade tolerance, ability to sow or not, foliage height, and spreading rate. See Snodgrass and Snodgrass (2006) for a definitive list of green roof plants, including accent plants.

- Plant choices can be much more diverse for deeper intensive green roof systems. Herbs, forbs, grasses, shrubs, and even trees can be used, but designers should understand they may have higher watering, weeding, and landscape maintenance requirements.
- The species and layout of the planting plan must reflect the location of the building, in terms of its height, exposure to wind, heat stress, orientation to the sun, and impacts from surrounding buildings. Wind scour and solar burning have been observed on green roof installations that failed to adequately account for neighboring building heights and surrounding window reflectivity. In addition, plants must be selected that are fire resistant and able to withstand heat, cold, and high winds.
- Designers should also match species to the expected rooting depth of the growing media, which can also provide enough lateral growth to stabilize the growing media surface. The planting plan should usually include several accent plants to provide diversity and seasonal color. For a comprehensive resource on green roof plant selection, consult Snodgrass and Snodgrass (2006).
- It is also important to note that most green roof plant species will not be native to the Chesapeake Bay watershed (which contrasts with native plant recommendations for other stormwater practices, such as bioretention and constructed wetlands).
- Given the limited number of green roof plant nurseries in the region, it may be necessary for designers to order plants 6 to 12 months prior to the expected planting date. It is also advisable to have plant materials contract grown.
- Plants can be established using cuttings, plugs, mats, and, more rarely, containers. Several vendors also sell mats, rolls, or proprietary green roof planting modules. For the pros and cons of each method, see Snodgrass and Snodgrass (2006). To achieve 50% coverage after 1 year and 80% coverage after 2 years, the recommended minimum spacing for succulent plantings is 2 plugs per square foot and 10 pounds per 100 square feet.
- When planting cuttings, plugs, and mats, the planting window extends from the spring to early fall; although, it is important to allow plants to root thoroughly before the first killing frost. Green roof manufacturers and plant suppliers may provide guidance on planting windows as well as winter care. Proper planting and care may also be required for plant warranty eligibility.
- When appropriate species are selected, most green roofs will not require supplemental irrigation, except for temporary irrigation during drought or initial establishment. The use of water-efficient designs and/or use of non-potable sources is strongly encouraged. Permanent irrigation of extensive roof designs is prohibited. For intensive roofs, permanent irrigation may be included. However, permanent irrigation can adversely impact the rainfall retention capacity of the green roof. For this reason, soil moisture monitors are a required part of the irrigation system for all irrigated green roofs, and the calculated storage volume for green roofs with permanent irrigation must be reduced by 50%.
- The goal for green roof systems designed for stormwater management is to establish a full and vigorous cover of low-maintenance vegetation that is self-sustaining (not requiring fertilizer inputs) and requires minimal mowing, trimming, and weeding.

The green roof design should include non-vegetated walkways (e.g., paver blocks) to allow for easy access to the roof for weeding and making spot repairs (see Section 4.6.4 Green Roof Design Criteria).

4.6.6 Green Roof Construction Sequence

Green Roof Installation

Given the diversity of extensive vegetated roof designs, there is no typical step-by-step construction sequence for proper installation. The following general construction considerations are noted:

- Construct the roof deck with the appropriate slope and material.
- Install the waterproofing method, according to manufacturer's specifications.
- Conduct electric field vector mapping (EVFM®) or flood testing to ensure the system is watertight. Where possible, EVFM® is strongly recommended over the flood test, but not all impermeable membranes and deck systems are compatible with this method. Problems have been noted with the use of EFVM on black ethylene propylene diene terpolymer (EPDM) and with aluminized protective coatings commonly used in conjunction with modified bituminous membranes. If EVFM® or other leak detection systems are not possible, a flood test should be performed instead. The flood test is done by placing at least 2 inches of water over the membrane for 48 hours to confirm the integrity of the waterproofing system.
- Add additional system components (e.g., insulation, root barrier, drainage layer and interior drainage system, and filter fabric) per the manufacturer's specifications, taking care not to damage the waterproofing. Any damage occurring must be reported immediately. Drain collars and protective flashing should be installed to ensure free flow of excess stormwater.
- The growing media should be mixed prior to delivery to the site. Media must be spread evenly over the filter fabric surface as required by the manufacturer. If a delay between the installation of the growing media and the plants is required, adequate efforts must be taken to secure the growing media from erosion and the seeding of weeds. The growing media must be covered and anchored in place until planting. Sheets of exterior grade plywood can also be laid over the growing media to accommodate foot or wheelbarrow traffic. Foot traffic and equipment traffic should be limited over the growing media to reduce compaction beyond manufacturer's recommendations.
- The growing media should be moistened prior to planting, and then planted with the ground cover and other plant materials, per the planting plan or in accordance with ASTM E2400 (2015). Plants should be watered immediately after installation and routinely during establishment.
- It generally takes 2 to 3 growing seasons to fully establish the vegetated roof. The growing medium should contain enough organic matter to support plants for the first growing season, so initial fertilization is not required. Extensive green roofs may require supplemental irrigation during the first few months of establishment. Hand weeding is also critical in the first 2 years (see Table 10.1 of Weiler & Scholz-Barth (2009) for a photo guide of common rooftop weeds).
- Most construction contracts should contain a care and replacement warranty that specifies at least 50% coverage after 1 year and 80% coverage after 2 years for plugs and cuttings, and 90% coverage after 1 year for *Sedum* carpet/tile.

Construction Supervision

Supervision during construction is recommended to ensure that the vegetated roof is built in accordance with these specifications. Inspection checklists should be used that include sign-offs by qualified individuals at critical stages of construction and confirm that the contractor's interpretation of the plan is consistent with the intent of the designer and/or manufacturer.

An experienced installer should be retained to construct the vegetated roof system. The vegetated roof should be constructed in sections for easier inspection and maintenance access to the membrane and roof drains. Careful construction supervision/inspection is needed throughout the installation of a vegetated roof, as follows:

- During placement of the waterproofing layer, to ensure that it is properly installed and watertight.
- During placement of the drainage layer and drainage system.
- During placement of the growing media, to confirm that it meets the specifications and is applied to the correct depth (certification for vendor or source should be provided).
- Upon installation of plants, to ensure they conform to the planting plan (certification from vendor or source should be provided).
- Before issuing use and occupancy approvals.
- At the end of the first or second growing season to ensure desired surface cover specified in the Care and Replacement Warranty has been achieved.

Construction phase inspection checklist for green roof practices can be found in Appendix E Construction Inspection Checklists.

4.6.7 Green Roof Maintenance Criteria

<u>Maintenance Inspections</u>

A green roof should be inspected by a qualified professional twice a year during the growing season to assess vegetative cover and to look for leaks, drainage problems, and any rooftop structural concerns (see Table 4.24). In addition, the green roof should be hand weeded to remove invasive or volunteer plants, and plants and/or media should be added to repair bare areas (refer to ASTM E2400; ASTM, 2015).

If a roof leak is suspected, it is advisable to perform an electric leak survey (e.g., EVFM®), if applicable, to pinpoint the exact location, make localized repairs, and then reestablish system components and ground cover.

The use of herbicides, insecticides, and fungicides should be avoided, since their presence could hasten degradation of some waterproofing membranes. Check with the membrane manufacturer for approval and warranty information. Also, power washing and other exterior maintenance operations should be avoided so that cleaning agents and other chemicals do not harm the green roof plant communities.

Fertilization is generally not recommended due to the potential for leaching of nutrients from the green roof. Supplemental fertilization may be required following the first growing season, but only if plants show signs of nutrient deficiencies and a media test indicates a specific deficiency. Addressing this issue with the holder of the vegetation warranty is recommended. If fertilizer is to be applied, it must be a slow-release type, rather than liquid or gaseous form.

Maintenance inspection checklist for green roofs and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Table 4.24. Typical Maintenance Activities Associated with Green Roofs

Schedule (following construction)	**Activity**
As needed or As required by manufacturer	▪ Water to promote plant growth and survival. ▪ Inspect the green roof and replace any dead or dying vegetation.
Semi-annually	▪ Inspect the waterproof membrane for leaks and cracks. ▪ Weed to remove invasive plants and tree seedlings (do not dig or use pointed tools where there is potential to harm the root barrier or waterproof membrane). ▪ Inspect roof drains, scuppers, and gutters to ensure they are not overgrown and have not accumulated organic matter deposits. Remove any accumulated organic matter or debris. ▪ Inspect the green roof for dead, dying, or invasive vegetation. Plant replacement vegetation as needed.

Waste Material

Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.6.8 Green Roof Stormwater Compliance Calculations

Green roofs are credited with 100% retention for the storage volume (Sv) provided by the practice as well as 100% TSS, TN, and bacteria removal (see Table 4.25).

Table 4.25. Retention and pollutant removal of green roofs.

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

The practice must be designed using the guidance detailed in Section 4.4.4 Green Roof Design Criteria.

Green roofs also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume (Sv) from the total runoff volume for the design storms. The resulting reduced runoff volumes can then be used to calculate a reduced Natural Resource Conservation Service (NRCS) curve number (CN) for the site or site drainage area (SDA). The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

4.6.9 References

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4.7 Rainwater Harvesting

Rainwater Harvesting					
Definition: Rainwater harvesting systems store rainfall and release it for future use. Rainwater that falls on a rooftop or other impervious surface is collected and conveyed into an above- or below-ground tank (also referred to as a cistern) or settling pond, where it is stored for non-potable uses.					
Site Applicability		**BMP Performance Summary**			
Land Uses	**Required Footprint**	**WQ Improvement:** Moderate to High			
▪ Urban ▪ Suburban ▪ Rural	Small	**TSS[1]**	**Total N[1]**	**Bacteria[1]**	
		Varies*	Varies*	Varies*	
		Runoff Reduction			
Construction Costs	**Maintenance Burden**	**Volume**			
Low to Moderate	Moderate	Varies*			
Maintenance Frequency:		***SWRv***			
Routine	**Non-Routine**	100% of Available Storage Volume			
Quarterly	Every 3 years				
Advantages/Benefits		**Disadvantages/Limitation**			
▪ Reduces runoff rates and volume ▪ Can provide for/supplement irrigation needs		▪ Stored water must be used on regular basis to maintain capacity ▪ Stagnant water can breed mosquitos			
Components		**Design considerations**			
▪ Pretreatment ▪ Conveyance ▪ First flush diverter ▪ Cistern (storage tank) ▪ Overflow ▪ Low water cutoff		▪ Plumbing codes (for indoor tanks) ▪ Size based on CDA, local rainfall patterns, and projected harvest rainwater demand ▪ Location and elevation of cistern ▪ Tank manufacturer's specifications ▪ Irrigation system and application rates			
Maintenance Activities					
▪ Inspect/clean pretreatment devices and first flush diverts ▪ Clear gutter/downspouts		▪ Inspect and clean storage tank ▪ Maintenance log required			

[1]*Credited pollutant load removal*

**Varies according to rainwater harvesting storage capacity and demand*

Rainwater harvesting systems store rainfall for future, non-potable water uses and on-site stormwater disposal/infiltration. By providing a reliable and renewable source of water to end users, rainwater harvesting systems can also have environmental and economic benefits beyond stormwater management (e.g. increased water conservation, water supply during drought and mandatory municipal water supply restrictions, decreased demand on municipal or groundwater supply, decreased water costs for the end-user, potential for increased groundwater recharge, supply of water post storm/hurricane in case of failed municipal infrastructure etc.).

Definition

Rainwater harvesting systems store rainfall and release it for future use. Rainwater that falls on a rooftop or other impervious surface is collected and conveyed into an above- or below-ground tank (also referred to as a cistern) or settling pond where it is stored for non-potable uses or for on-site disposal or infiltration as stormwater. Cisterns can be sized for commercial as well as residential purposes (see Figure 4.23). Residential cisterns are commonly called rain barrels.

Figure 4.23. Example cistern application (photo: Marty Morganello).

The design includes the following:

R-1 Rainwater harvesting for non-potable uses

Non-potable uses of harvested rainwater may include the following:

- Landscape irrigation,
- Exterior washing (e.g., car washes, building facades, sidewalks, street sweepers, and fire trucks),
- Flushing of toilets and urinals,
- Fire suppression (e.g., sprinkler systems),
- Supply for cooling towers, evaporative coolers, fluid coolers, and chillers,
- Supplemental water for closed loop systems and steam boilers,
- Replenishment of water features and water fountains,
- Distribution to a green wall or living wall system, and
- Laundry.

Rainwater stored in a settling pond may only be used for landscape irrigation. Pond design criteria in Section 4.10 and landscaping criteria of Section 4.5.5 shall be followed.

The seven primary components of an enclosed rainwater harvesting system are discussed in detail in Section 4.5.4 Rainwater Harvesting Design Criteria. Some are depicted in Figure 4. 25 . The components include the following:

- CDA surface,
- Collection and conveyance system (e.g., gutter and downspouts; number 1 in Figure 4.24)
- Pretreatment, including prescreening and first flush diverters (number 2 in Figure 4.24)
- Cistern (no number, but depicted in Figure 4.24)
- Water quality treatment (as required by Appendix J Rainwater Harvesting Treatment and Management Requirements)
- Distribution system
- Overflow, filter path, or secondary stormwater retention practice (number 8 in Figure 4.24)

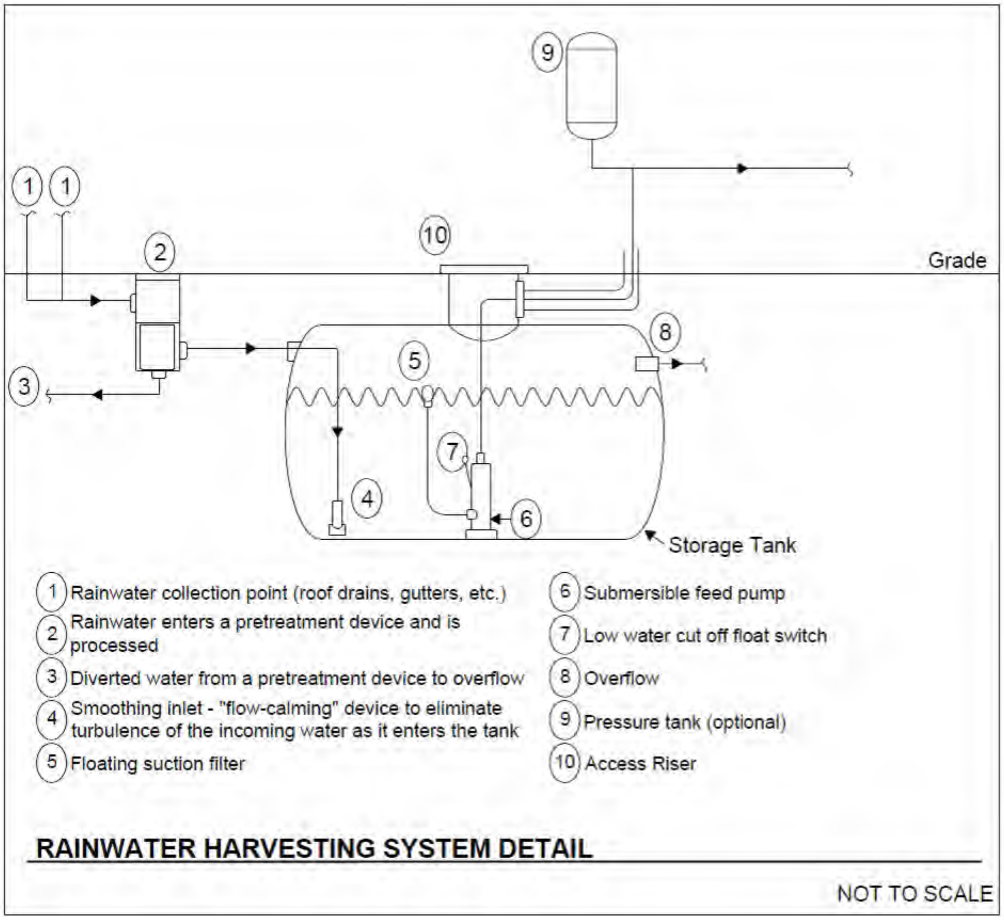

Figure 4.24. Example of a rainwater harvesting system detail.

4.7.1 Rainwater Harvesting Feasibility Criteria

Several site-specific features influence how rainwater harvesting systems are designed and/or utilized. The following are key considerations for rainwater harvesting feasibility. They are not comprehensive or conclusive; rather, they are recommendations to consider during the planning process to incorporate rainwater harvesting systems into the site design.

Plumbing Code

Designers and plan reviewers should consult with local construction codes to determine the allowable indoor uses and required treatment for harvested rainwater. This specification does not address indoor plumbing or disinfection issues. Designers and plan reviewers should refer to the 2012 Uniform Plumbing Code - Chapter 17 Non-potable Rainwater Catchment Systems, or local plumbing codes, as applicable.

Mechanical, Electrical, Plumbing

For systems that call for indoor use of harvested rainwater, the seal of a mechanical, electrical, and plumbing engineer is required.

Water Use

When rainwater harvesting will be used, the requirements in Appendix J Rainwater Harvesting Treatment and Management Requirements must be followed. This will outline the design assumptions and provide water quality end use standards.

Available Space

Adequate space is needed to house the cistern and any overflow. Space limitations are rarely a concern with rainwater harvesting systems if they are considered during the initial building design and site layout of a residential or commercial development. Cisterns can be placed underground, indoors, adjacent to buildings, and on rooftops that are structurally designed to support the added weight. Designers can work with architects and landscape architects to creatively site the cisterns. Underground utilities or other obstructions should always be identified prior to final determination of the cistern location.

Site Topography

Site topography and cistern location should be considered as they relate to every inlet and outlet invert elevation in the rainwater harvesting system.

The final invert of the cistern outlet pipe at the discharge point must match the invert of the receiving mechanism (e.g., natural channel, storm drain system) and be sufficiently sloped to adequately convey this overflow. The elevation drops associated with the various components of a rainwater harvesting system and the resulting invert elevations should be considered early in the design, to ensure that the rainwater harvesting system is feasible for the particular site.

Site topography and cistern location will also affect pumping requirements. Locating cisterns in low areas will make it easier to get water into the cisterns; however, it will increase the amount of pumping needed to distribute the harvested rainwater back into the building or to irrigated areas situated on higher ground. Conversely, placing cisterns at higher elevations may require larger diameter pipes with smaller slopes but will generally reduce the amount of pumping needed for distribution. It is often best to locate a cistern close to the building or SDA, to limit the amount of pipe needed.

Available Hydraulic Head

The required hydraulic head depends on the intended use of the water. For residential landscaping uses, the cistern may be sited up-gradient of the landscaping areas or on a raised stand. Pumps are commonly used to convey stored rainwater to the end use to provide the required head. When the water is being routed from the cistern to the inside of a building for non-potable use, often a pump is used to feed a much smaller pressure tank inside the building, which then serves the internal water demands. Cisterns can also use gravity to accomplish indoor residential uses (e.g., laundry) that do not require high water pressure.

Water Table

Underground storage tanks are most appropriate in areas where the tank can be buried above the water table. The tank should be located in a manner that does not subject it to flooding. In areas where the tank is to be buried partially below the water table, special design features must be employed, such as sufficiently securing the tank (to keep it from floating) and conducting buoyancy calculations when the tank is empty. The tank may need to be secured appropriately with fasteners or weighted to avoid uplift buoyancy. The combined weight of the tank and hold-down ballast must meet or exceed the buoyancy force of the cistern. The cistern must also be installed according to the cistern manufacturer's specifications.

Soils

Cisterns should only be placed on native soils or on fill in accordance with the manufacturer's guidelines. The bearing capacity of the soil upon which the cistern will be placed must be considered, as full cisterns can be very heavy. This is particularly important for above-ground cisterns, as significant settling could cause the cistern to lean or in some cases to potentially topple. A sufficient aggregate, or concrete foundation, may be appropriate depending on the soils and cistern characteristics. Where the installation requires a foundation, the foundation must be designed to support the cistern's weight when the cistern is full, consistent with the bearing capacity of the soil and good engineering practice. The pH of the soil should also be considered in relation to its interaction with the cistern material.

Proximity of Underground Utilities
All underground utilities must be taken into consideration during the design of underground rainwater harvesting systems, treating all of the rainwater harvesting system components and storm drains as typical stormwater facilities and pipes. The underground utilities must be marked and avoided during the installation of underground cisterns and piping associated with the system.

Contributing Drainage Area
The CDA to the cistern is the area draining to the cistern. Rooftop surfaces are what typically make up the CDA, but paved areas can be used with appropriate treatment (oil/water separators and/or debris excluders).

Contributing Drainage Area Material
The quality of the harvested rainwater will vary according to the roof material or CDA over which it flows. Water harvested from certain types of rooftops and CDAs, such as asphalt sealcoats, tar and gravel, painted roofs, galvanized metal roofs, sheet metal, or any material that may contain asbestos may leach trace metals and other toxic compounds. In general, harvesting rainwater from such surfaces should be avoided. If harvesting from a sealed or painted roof surface is desired, it is recommended that the sealant or paint be certified for such purposes to the NSF International NSF Protocol P151 standard.

Water Quality of Rainwater
Designers should also note that the pH of rainfall in the State tends to be acidic (ranging from 4.5 to 5.0), which may result in leaching of metals from roof surfaces, cistern lining, or water laterals, to interior connections. Once rainfall leaves rooftop surfaces, pH levels tend to be slightly higher, ranging from 5.5 to 6.0. Limestone or other materials may be added in the cistern to buffer acidity, if desired.

Pollutant Hotspot Land Uses
Harvesting rainwater can be an effective method to prevent contamination of rooftop runoff that would result from its mixing with ground-level runoff from a stormwater hotspot operation.

Setbacks from Buildings
Cistern overflow devices must be designed to avoid causing ponding or soil saturation within 10 feet of building foundations. While most systems are generally sited underground and more than 10 feet laterally from the building foundation wall, some cisterns are incorporated into the basement of a building or underground parking areas. In any case, cisterns must be designed to be watertight to prevent water damage when placed near building foundations.

Vehicle Loading
Whenever possible, underground rainwater harvesting systems should be placed in areas without vehicle traffic or other heavy loading, such as deep earth fill. If site constraints dictate otherwise, systems must be designed to support the loads to which they will be subjected.

Feasibility
Rainwater harvesting systems are very well suited to the warm environment of South Carolina and may help to relieve some of the pressure on drinking water aquifers, if applied on a wide scale. In areas with a high-water table, above ground installations will often be more appropriate.

Economic Considerations
Rainwater harvesting systems can provide cost savings by replacing or augmenting municipal water supply needs.

4.7.2 Rainwater Harvesting Conveyance Criteria

Collection and Conveyance
The collection and conveyance systems consist of the gutters, downspouts, and pipes that channel rainfall into cisterns. Gutters and downspouts should be designed as they would for a building without a rainwater harvesting system.

Pipes, which connect downspouts to the cistern, should be at a minimum slope of 1.5% and sized/designed to convey the intended design storm, as specified above. In some cases, a steeper slope and larger sizes may be recommended and/or necessary to convey the required runoff, depending on the design objective and design storm intensity. Gutters and downspouts should be kept clean and free of debris and rust.

Overflow
An overflow mechanism must be included in the rainwater harvesting system design in order to handle an individual storm event or multiple storms in succession that exceed the capacity of the cistern. The overflow pipe(s) must have a capacity greater than or equal to the inflow pipe(s) and have a diameter and slope sufficient to drain the cistern while maintaining an adequate freeboard height. The overflow pipe(s) must be screened to prevent access to the cistern by small mammals and birds and must include a backflow preventer if it connects directly to the combined sewer or storm sewer. All overflow from the system must be directed to an acceptable flow path that will not cause erosion during a 2-year storm event.

4.7.3 Rainwater Harvesting Pretreatment Criteria

Prefiltration is required to keep sediment, leaves, contaminants, and other debris from the system. Leaf screens and gutter guards meet the minimal requirement for prefiltration of small systems, although direct water filtration is preferred. The purpose of prefiltration is to significantly cut down on maintenance by preventing organic buildup in the cistern, thereby decreasing microbial food sources.

Various pretreatment devices are described below. In addition to the initial first flush diversion, filters have an associated efficiency curve that estimates the percentage of rooftop runoff that will be conveyed through the filter to the cistern. If filters are not sized properly, a large portion of the rooftop runoff may be diverted and not conveyed to the cistern at all. A design intensity of 1 inch per hour (for design storm = SWRv) must be used for the purposes of sizing pre-cistern conveyance and filter components. This design intensity captures a significant portion of the total rainfall during a large majority of rainfall events (NOAA, 2004). If the system will be used for channel and flood protection, the 2- to 25-year storm intensities must be used for the design of the conveyance and pretreatment portion of the system. The Appendix K Rainwater Harvesting Storage Volume Calculator, discussed in Section 4.5.4 Rainwater Harvesting Design Criteria, allows for input of variable filter efficiency rates for the design storm. To meet the requirements to manage the 2- to 25-year storms, a minimum filter efficiency of 90% must be met.

- **First Flush Diverters.** First flush diverters (see Figure 4.25) direct the initial pulse of rainfall away from the cistern. While leaf screens effectively remove larger debris such as leaves, twigs, and blooms from harvested rainwater, first flush diverters can be used to remove smaller contaminants such as dust, pollen, and bird and rodent feces.
- **Leaf Screens.** Leaf screens are mesh screens installed over either the gutter or downspout to separate leaves and other large debris from rooftop runoff. Leaf screens must be regularly cleaned to be effective; if not maintained, they can become clogged and prevent rainwater from flowing into the cisterns. Built-up debris can also harbor bacterial growth within gutters or downspouts (Texas Water Development Board, 2005).
- **Roof Washers.** Roof washers are placed just ahead of cisterns and are used to filter small debris from harvested rainwater (see Figure 4.26). Roof washers consist of a cistern, usually between 25 and 50 gallons in size, with leaf strainers and a filter with openings as small as 30 microns. The filter functions to remove very small particulate matter from harvested rainwater. All roof washers must be cleaned on a regular basis.
- **Hydrodynamic Separator.** For large-scale applications, hydrodynamic separators and other devices can be used to filter rainwater from larger CDAs.

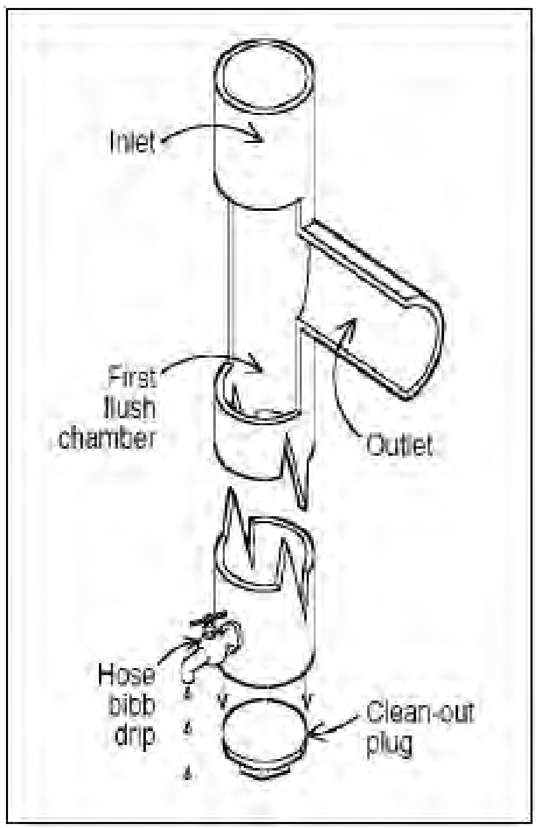

Figure 4.25. Diagram of a first flush diverter (photo: Texas Water Development Board, 2005).

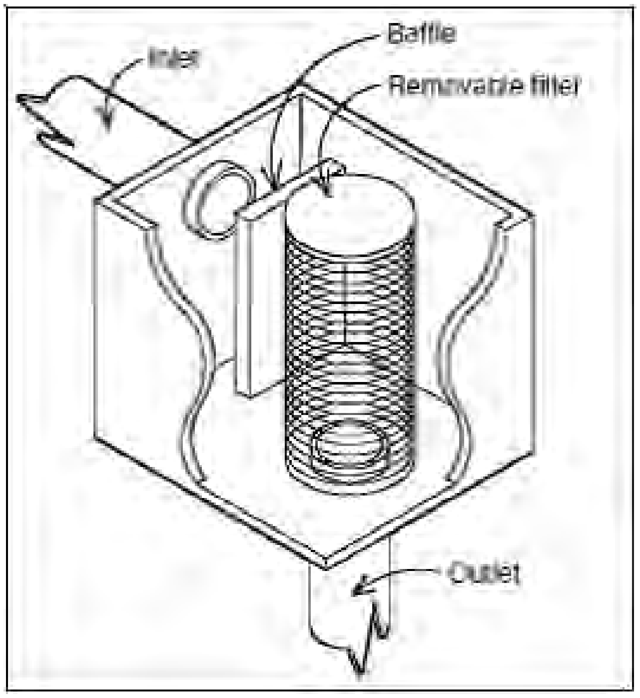

Figure 4.26. Diagram of a roof washer (photo: Texas Water Development Board, 2005).

4.7.4 Rainwater Harvesting Design Criteria

System Components: Seven primary components of a rainwater harvesting system require special considerations:

- CDA or CDA surface
- Collection and conveyance system (i.e., gutter and downspouts)
- Cisterns (Storage Tank)
- Pretreatment, including prescreening and first flush diverters
- Water quality treatment (as described in Appendix J Rainwater Harvesting Treatment and Management Requirements)
- Distribution systems
- Overflow, filter path, or secondary stormwater retention practice

The system components are discussed below:

CDA Surface

When considering CDA surfaces, smooth, non-porous materials will drain more efficiently. Slow drainage of the CDA leads to poor rinsing and a prolonged first flush, which can decrease water quality.

Rainwater can also be harvested from other impervious surfaces, such as parking lots and driveways; however, this practice requires more extensive pretreatment and treatment prior to use.

Collection and Conveyance System
See Section 4.7.2 Rainwater Harvesting Conveyance Criteria.

Pretreatment
See Section 4.7.3 Rainwater Harvesting Pretreatment Criteria.

Cisterns (Storage Tank)
Also known as the storage tank, the cistern is the most important and typically the most expensive component of a rainwater harvesting system. Cistern capacities generally range from 250 to 30,000 gallons, but they can be as large as 100,000 gallons or more for larger projects. Multiple cisterns can be placed adjacent to each other and connected with pipes to balance water levels and to tailor the storage volume needed. Typical rainwater harvesting system capacities for residential use range from 1,500 to 5,000 gallons. Cistern volumes are calculated to meet the water demand and stormwater storage volume retention objectives, as described further below in this specification.

While many of the graphics and photos in this specification depict cisterns with a cylindrical shape, the cisterns can be made of many materials and configured in various shapes, depending on the type used and the site conditions where the cisterns will be installed. For example, configurations can be rectangular, L-shaped, or step vertically to match the topography of a site. The following factors should be considered when designing a rainwater harvesting system and selecting a cistern:

- Aboveground cisterns should be ultraviolet and impact resistant.
- Underground cisterns must be designed to support the overlying sediment and any other anticipated loads (e.g., vehicles, pedestrian traffic).
- Underground rainwater harvesting systems must have a standard size manhole or equivalent opening to allow access for cleaning, inspection, and maintenance purposes. The access opening must be installed in such a way as to prevent surface- or groundwater from entering through the top of any fittings, and it must be secured/locked to prevent unwanted entry. Confined space safety precautions/requirements should be observed during cleaning, inspection, and maintenance.
- All rainwater harvesting systems must be sealed using a water-safe, non-toxic substance.
- Rainwater harvesting systems may be ordered from a manufacturer or can be constructed on site from a variety of materials. Table 4. 26 compares the advantages and disadvantages of different cistern materials.
- Cisterns must be opaque or otherwise protected from direct sunlight to inhibit growth of algae, and they must be screened to discourage mosquito breeding.
- Dead storage below the outlet to the distribution system and an air gap at the top of the cistern must be included in the total cistern volume. For gravity-fed systems, a minimum of 6 inches of dead storage must be provided. For systems using a pump, the dead storage depth will be based on the pump specifications.
- Any hookup to a municipal backup water supply must have a backflow prevention device to keep municipal water separate from stored rainwater; this may include incorporating an air gap to separate the two supplies.

Table 4.26. Advantages and Disadvantages of Typical Cistern Materials

Cistern Material	Advantages	Disadvantages
Fiberglass	Commercially available, alterable and moveable; durable with little maintenance; light weight; integral fittings (no leaks); broad application	Must be installed on smooth, solid, level footing; pressure proof for below-ground installation; expensive in smaller sizes
Polyethylene	Commercially available, alterable, moveable, affordable; available in wide range of sizes; can install above or below ground; little maintenance; broad application	Can be UV-degradable; must be painted or tinted for above-ground installations; pressure-proof for below-ground installation
Modular Storage	Can modify to topography; can alter footprint and create various shapes to fit site; relatively inexpensive	Longevity may be less than other materials; higher risk of puncturing of watertight membrane during construction
Plastic Barrels	Commercially available; inexpensive	Low storage capacity (20–50 gallons); limited application
Galvanized Steel	Commercially available, alterable, and moveable; available in a range of sizes; film develops inside to prevent corrosion	Possible external corrosion and rust; must be lined for potable use; can only install above ground; soil pH may limit underground applications
Steel Drums	Commercially available, alterable, and moveable	Small storage capacity; prone to corrosion, and rust can lead to leaching of metals; verify prior to reuse for toxics; water pH and soil pH may also limit applications
FerroConcrete	Durable and immoveable; suitable for above or below ground installations; neutralizes acid rain	Potential to crack and leak; expensive
Cast-in-Place Concrete	Durable, immoveable, and versatile; suitable for above or below ground installations; neutralizes acid rain	Potential to crack and leak; permanent; will need to provide adequate platform and design for placement in clay soils
Stone or Concrete Block	Durable and immoveable; keeps water cool in summer months	Difficult to maintain; expensive to build

Source: Cabell Brand Center, 2007; Cabell Brand Center, 2009

- **Water Quality Treatment**
  Depending upon the collection surface, method of dispersal, and proposed use for the harvested rainwater, a water quality treatment device may be required. Treatment requirements are described in Appendix J Rainwater Harvesting Treatment and Management Requirements.
- **Distribution Systems**
  Most distribution systems require a pump to convey harvested rainwater from the cistern to its final destination, whether inside the building, an automated irrigation system, or gradually discharged to a secondary stormwater treatment practice. The rainwater harvesting system should be equipped with an appropriately sized pump that produces sufficient pressure for all end-uses.

The typical pump and pressure tank arrangement consists of a multi-stage, centrifugal pump, which draws water out of the cistern and sends it into the pressure tank, where it is stored for distribution. Some systems will not require this two-tank arrangement (e.g., low-pressure and gravel systems). When water is drawn out of the pressure tank, the pump activates to supply additional water to the distribution system. The backflow preventer is required to separate harvested rainwater from the main potable water distribution lines.

A drain plug or cleanout sump must be installed to allow the system to be completely emptied, if needed. Above-ground outdoor pipes must be insulated or heat-wrapped to prevent freezing and ensure uninterrupted operation during winter if winter use is planned.

- **Overflow**
  See Section 4.7.2 Rainwater Harvesting Conveyance Criteria.

Rainwater Harvesting Material Specifications
The basic material specifications for rainwater harvesting systems are presented in Table 4.27. Designers should consult with experienced rainwater harvesting system and irrigation installers on the choice of recommended manufacturers of prefabricated cisterns and other system components.

Table 4.27. Design Specifications for Rainwater Harvesting Systems

Item	Specification
Gutters and Downspouts	Materials commonly used for gutters and downspouts include polyvinylchloride (PVC) pipe, vinyl, aluminum, and galvanized steel. Lead must not be used as gutter and downspout solder, since rainwater can dissolve the lead and contaminate the water supply. ▪ The length of gutters and downspouts is determined by the size and layout of the catchment and the location of the cisterns. ▪ Include needed bends and tees.
Pretreatment	At least one of the following (all rainwater to pass through pretreatment): ▪ First flush diverter ▪ Hydrodynamic separator ▪ Roof washer ▪ Leaf and mosquito screen (1 mm mesh size)
Cisterns	▪ Materials used to construct cisterns must be structurally sound. ▪ Cisterns should be constructed in areas of the site where soils can support the load associated with stored water. ▪ Cisterns must be watertight and sealed using a water-safe, non-toxic substance. ▪ Cisterns must be opaque or otherwise shielded to prevent the growth of algae. ▪ The size of the rainwater harvesting system(s) is determined through design calculations.

Note: This table does not address indoor systems or pumps.

Design Objectives and System Configuration

Rainwater harvesting systems can have many design variations that meet user demand and stormwater objectives. This specification provides a design framework to achieve the SWRv objectives that are required to comply with the regulations, and it adheres to the following concepts:

- Give preference to use of rainwater as a resource to meet on-site demand or in conjunction with other stormwater retention practices.
- Reduce peak flow by achieving volume reduction and temporary storage of runoff.

Based on these concepts, this specification focuses on system design configurations that harvest rainwater for internal building uses, seasonal irrigation, and other activities, such as cooling tower use and vehicle washing. While harvested rainwater will be in year-round demand for many internal building uses, some other uses will have varied demand depending on the time of year (e.g., cooling towers and seasonal irrigation). Thus, a lower retention volume is assigned to a type of use that has reduced demand.

Design Objectives & Cistern Design Set-Ups

Prefabricated rainwater harvesting cisterns typically range in size from 250 to over 30,000 gallons. Three basic cistern designs meet the various rainwater harvesting system configurations in this section.

Cistern Design 1. The first cistern set-up (Figure 4.27) maximizes the available storage volume to meet the desired level of stormwater retention. This layout also maximizes the storage that can be used to meet a demand. An emergency overflow exists near the top of the cistern as the only gravity release outlet device (not including the pump, manway, or inlets). It should be noted that it is possible to address 2- to 25-year storm volumes with this cistern configuration, but the primary purpose is to address the smaller SWRv design storm.

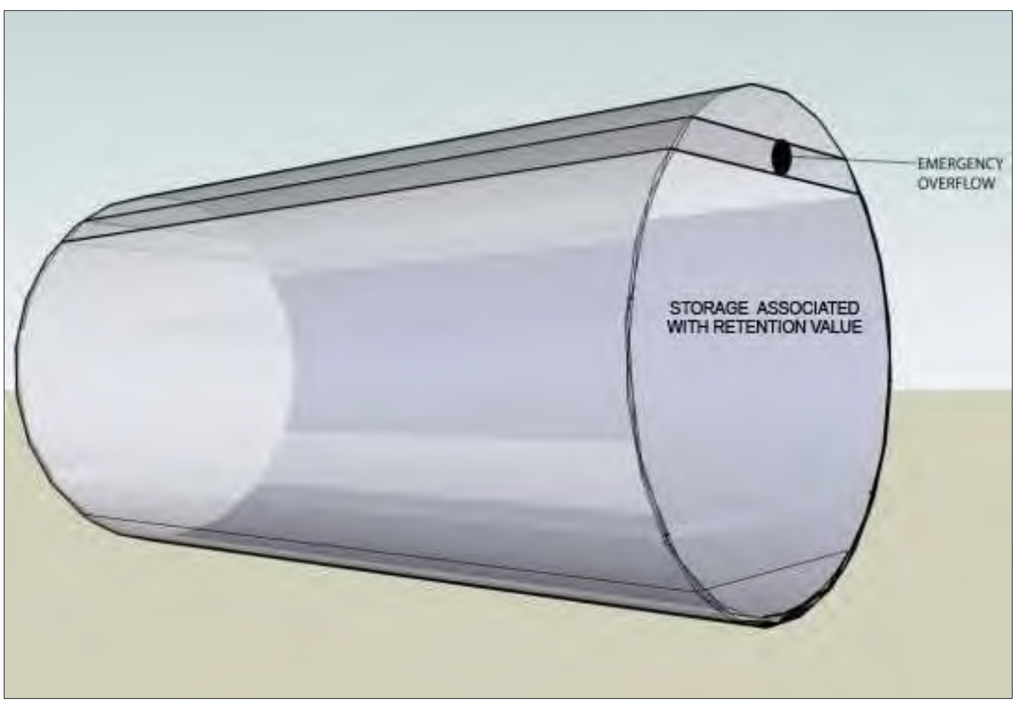

Figure 4.27. Cistern Design 1: Storage associated with the design storm volume only.

Cistern Design 2. The second cistern set-up (Figure 4.28) uses cistern storage to meet the SWRv retention objectives and also uses additional detention volume to meet some or all of the 2- to 25-year storm volume requirements. An orifice outlet is provided at the top of the design storage for the SWRv level, and an emergency overflow is located at the top of the detention volume level.

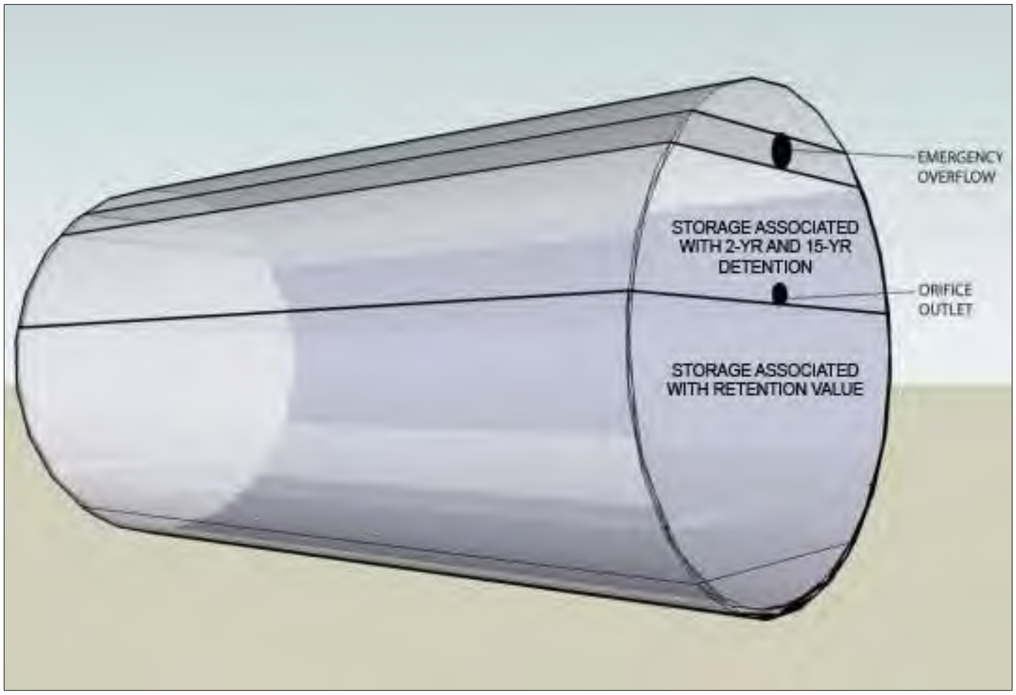

Figure 4.28. Cistern Design 2: Storage associated with design storm, channel protection, and flood volume.

Cistern Design 3. The third cistern set-up (Figure 4.29) creates a constant drawdown within the system. The small orifice at the bottom of the cistern needs to be routed to an appropriately designed secondary practice (i.e., bioretention, stormwater infiltration) that will allow the rainwater to be treated and allow for groundwater recharge over time. The release must not be discharged to a receiving channel or storm drain without treatment, and maximum specified drawdown rates from this constant drawdown should be adhered to, since the primary function of the system is not intended to be detention.

While a small orifice is shown at the bottom of the cistern in Figure 4.29, the orifice could be replaced with a pump that would serve the same purpose, conveying a limited amount of water to a secondary practice on a routine basis.

For this design, the secondary practice must be considered a component of the rainwater harvesting system with regard to the storage volume calculated in the General Retention Compliance Calculator in Appendix H. In other words, the storage volume associated with the secondary practice must not be included as a separate BMP because the secondary practice is an integral part of a rainwater harvesting system with a constant drawdown.

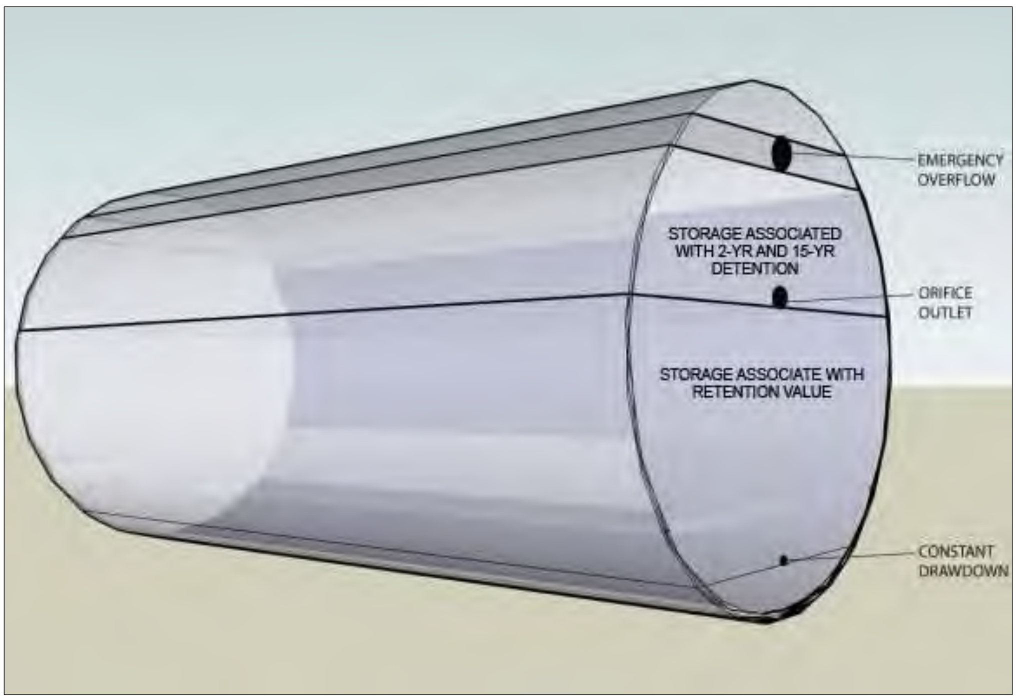

Figure 4.29. Cistern Design 3: Constant drawdown version where storage is associated with design storm, channel protection, and flood volume.

Sizing of Rainwater Harvesting Systems

The rainwater harvesting cistern sizing criteria presented in this section were developed using a spreadsheet model that used best estimates of indoor and outdoor water demand, long-term rainfall data, and CDA capture area data (Forasté 2011). The Rainwater Harvesting Storage Volume Calculator in Appendix J1 is used for cistern sizing guidance and to quantify the available storage volume achieved. This storage volume value is required for input into the General Retention Compliance Calculator and is part of the submission of a SWMP using rainwater harvesting systems for compliance. A secondary objective of the spreadsheet is to increase the beneficial uses of the stored stormwater, treating it as a valuable natural resource.

Rainwater Harvesting Storage Volume Calculator

The design specification provided in this section is follows the Rainwater Harvesting Storage Volume Calculator Appendix J1. The spreadsheet uses daily rainfall data from January 1, 2007 to December 31, 2019 to model performance parameters of the cistern under varying CDAs, demands on the system and cistern size.

The size of ponds used for irrigation, their irrigation area and characteristics of soil and land use can be entered in the calculator to determine stormwater volume retained. The runoff that reaches the cistern each day is added to the water level that existed in the cistern the previous day, with all of the total demands subtracted on a daily basis. If any overflow is realized, the volume is quantified and recorded. If the cistern runs dry (reaches the cut-off volume level), then the volume in the cistern is fixed at the low level. A summary of the water balance for the system is provided below.

Incremental Design Volumes within Cistern

Rainwater cistern sizing is determined by accounting for varying precipitation levels, captured CDA runoff, first flush diversion (through filters) and filter efficiency, low water cut-off volume, dynamic water levels at the beginning of various storms, storage needed for the design storm (permanent storage), storage needed for 2- to 25-year volume (temporary detention storage), seasonal and year-round demand use and objectives, overflow volume, and freeboard volumes above high water levels during very large storms. See Figure 4. 30 for a graphical representation of these various incremental design volumes.

The design specification described in this section does not provide guidance for sizing larger storms, but rather provides guidance on sizing for the 85th and 95th percentile design storms.

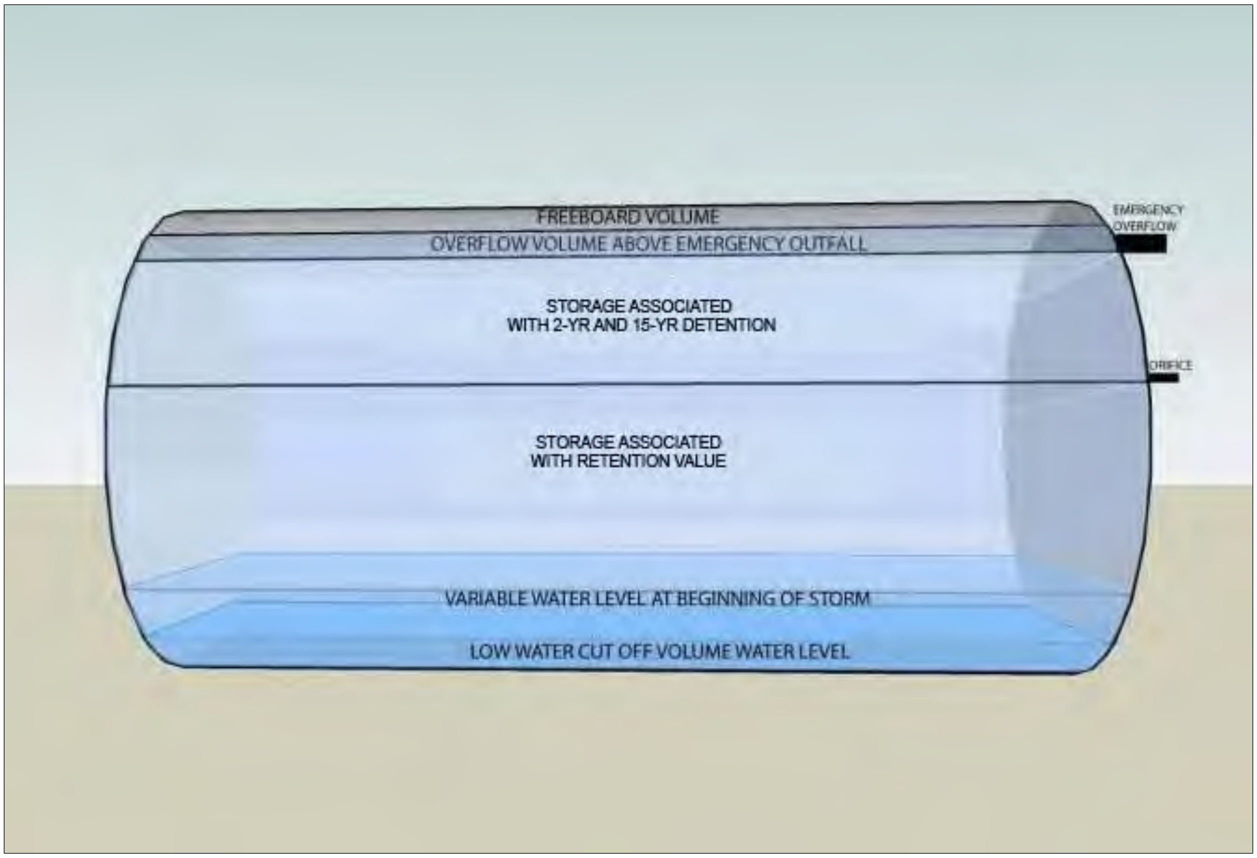

Figure 4.30. Incremental design volumes associated with cistern sizing.

The “Average Available Storage Volume” is the average storage within the cistern that is modeled and available to retain rainfall. While the SWRv will remain the same for a specific CDA, the “Average Available Storage Volume” is dependent on demand and cistern volume. It is the available space in the cistern between the average level at the beginning of a storm and the orifice outflow.

Water Contribution

- **Precipitation**
  The volume of water contributing to the rainwater harvesting system is a function of the rainfall and CDA, as defined by the designer.
- **Municipal Backup (optional)**
  In some cases, the designer may choose to install a municipal backup water supply to supplement cistern levels. Note that municipal backups may also be connected post-cistern (i.e., a connection is made to the non-potable water line that is used for pumping water from the cistern for reuse), thereby not contributing any additional volume to the cistern. Municipal backup designs that supply water directly to the cistern are not accounted for in the Rainwater Harvesting Storage Volume Calculator.

Water Losses

- **Contributing Drainage Area Runoff Coefficient**
  The CDA is assumed to convey 95% of the rainfall that lands on its surface (i.e., $Rv = 0.95$).
- **First Flush Diversion**
  The first 0.02 to 0.06 inches of rainfall that is directed to filters is diverted from the system in order to prevent clogging it with debris. This value is assumed to be contained within the filter efficiency rate.
- **Filter Efficiency**
  It is assumed that, after the first flush diversion and loss of water due to filter inefficiencies, the remainder of the design storm will be captured successfully. For the 85^{th} or 95^{th} percentile storms, a minimum of 95% of the runoff should be conveyed into the cistern. The minimum values are included as the filter efficiencies in the Rainwater Harvesting Storage Volume Calculator, although they can be altered (increased) if appropriate. The Rainwater Harvesting Storage Volume Calculator applies these filter efficiencies, or interpolated values, to the daily rainfall record to determine the volume of runoff that reaches the cistern. For the purposes of selecting an appropriately sized filter, a rainfall intensity of 1 inch per hour shall be used when the design storm is the SWRv. The appropriate rainfall intensity values for the 2- to 25-year storms shall be used when designing for larger storm events.
- **Drawdown (Storage Volume)**
  This is the stored water within the cistern that is reused or directed to a secondary stormwater practice. It is the volume of runoff that is reduced from the CDA. This is the water loss that translates into the achievable storage volume retention.

Overflow

For the purposes of addressing the SWRv (not for addressing larger storm volumes), orifice outlets for both detention and emergency overflows are treated the same. This is the volume of water that may be lost during large storm events or successive precipitation events.

Storage Volume Results

The Rainwater Harvesting Storage Volume Calculator determines the average daily volume of water in the cistern for a range of cistern sizes. From this value, the available storage volume for the 85th and 95th percentile storm can be calculated; it is simply the difference between the cistern size and the average daily volume. The available storage volume for the selected cistern size should be used as an input to the General Retention Compliance Calculator. Similarly, the pond used for irrigation stormwater volume is entered in the General Retention Compliance Calculator in the rainwater harvesting row rather than the stormwater pond row to produce runoff reduction and pollutant removal credit with the other BMPs for the stormwater plan.

- **Available Storage Volume (Sv)**
  The volume available for storage of the 85th and 95th percentile storm is calculated for multiple sizes of cisterns. A trade-off curve plots these results, which allows for a comparison of the retention achieved versus cistern size. While larger cisterns yield more retention, they are more expensive. The curve helps the user to choose the appropriate cistern size, based on the design objectives and site needs.

- **Overflow Volume**
The volume of the overflows resulting from the 85th or 95th percentile precipitation event is also reported in this sheet. The overflow volume is also plotted to illustrate the effects of cistern size on overflow volume. An example chart is shown in Figure 4.31. The effect of diminishing returns is clear. Beyond a cistern size of 9,000 gallons, the overflow volume drops to zero. So, while the available storage continues to increase, the 85th or95th percentile storm is entirely retained, and no additional retention will be possible.

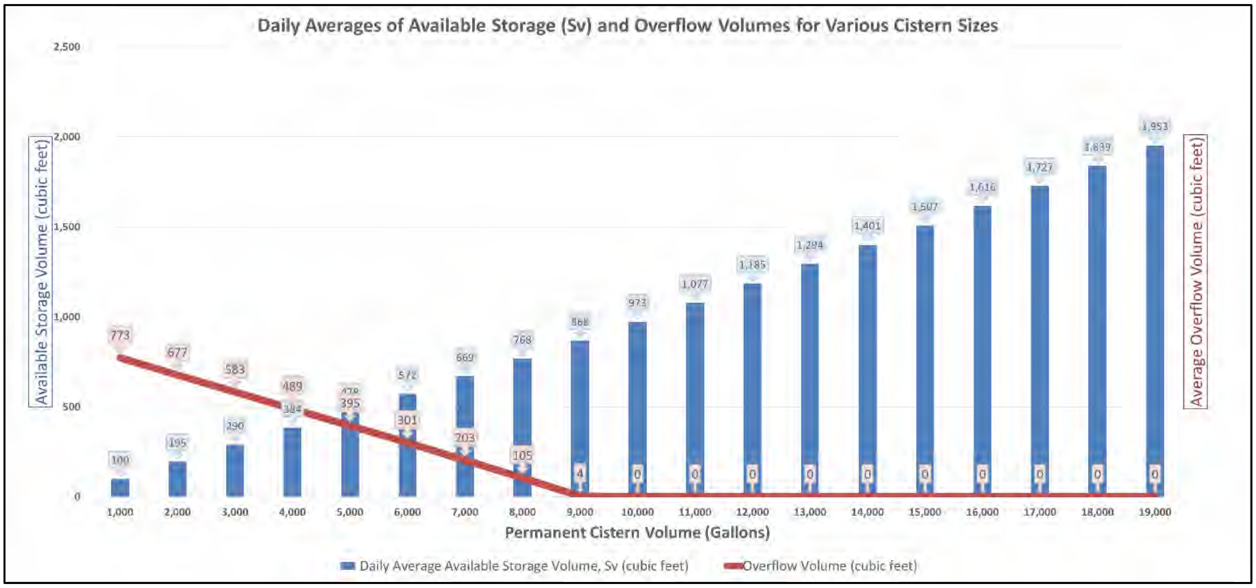

Figure 4.31. Example of graph showing Average Available Storage Volume and Overflow Volume for an example cistern design.

<u>Results from the Rainwater Harvesting Storage Volume Calculator to be Transferred to the Compliance Calculator</u>
There are two results from the Rainwater Harvesting Storage Volume Calculator that are to be transferred to the Compliance Calculator as follows:

- **Contributing Drainage Area**
Enter the CDA that was used in the Rainwater Harvesting Storage Volume Calculator into the appropriate columns in the “Rainwater Harvesting” row of the Compliance Calculator BMP sheet.

- **Available Storage Volume**
Once a cistern has been selected, enter the Available Storage Volume (ft^3) associated with that cistern into the Compliance Calculator column called “Storage Volume Provided by BMP” in the “Rainwater Harvesting” row of the BMP sheet.

<u>Completing the Sizing Design of the Cistern</u>
The total size of the cistern is the sum of the following four volume components:

- **Low Water Cutoff Volume (Included)**
A dead storage area must be included so the pump will not run the cistern dry. This volume is included in the Rainwater Harvesting Storage Volume Calculator’s modeled volume.

- **Cistern Storage Associated with Design Volume (Included)**
  This is the cistern design volume from the Rainwater Harvesting Storage Volume Calculator.
- **Adding Channel Protection and Flood Volumes (Optional)**
  Additional detention volume may be added above and beyond the cistern storage associated with the design storm volumes for the 2- to 25-year events. Typical routing software programs may be used to design for this additional volume.
- **Adding Overflow and Freeboard Volumes (Required)**
  An additional volume above the emergency overflow must be provided in order for the cistern to allow very large storms to pass. Above this overflow water level, there will be an associated freeboard volume that should account for at least 5% of the overall cistern size. Sufficient freeboard must be verified for large storms, and these volumes must be included in the overall size of the cistern.

4.7.5 Rainwater Harvesting Landscaping Criteria

If the harvested water is to be used for irrigation, the design plan elements must include the proposed delineation of planting areas to be irrigated, the planting plan, and quantification of the expected water demand. The default water demand for irrigation is 1.0 inches per week over the area to be irrigated during the months of May through October only. Justification must be provided if larger volumes are to be used.

4.7.6 Rainwater Harvesting Construction Sequence

Installation

It is advisable to have a single contractor to install the rainwater harvesting system, outdoor irrigation system, and secondary retention practices. The contractor should be familiar with rainwater harvesting system sizing, installation, and placement. A licensed plumber is required to install the rainwater harvesting system components to the plumbing system.

A standard construction sequence for proper rainwater harvesting system installation is provided below. This can be modified to reflect different rainwater harvesting system applications or expected site conditions.

1. Choose the cistern location on the site.
2. Route all downspouts or pipes to prescreening devices and first flush diverters.
3. Properly install the cistern.
4. Install the pump (if needed) and piping to end uses (indoor, outdoor irrigation, or cistern dewatering release).
5. Route all pipes to the cistern.
6. Stormwater must not be diverted to the rainwater harvesting system until the overflow filter path has been stabilized with vegetation.

Construction Supervision

The following items should be inspected by a qualified professional in the mechanical, electrical, or plumbing fields prior to final sign-off and acceptance of a rainwater harvesting system:

- Rooftop area matches plans
- Diversion system is properly sized and installed
- Pretreatment system is installed

- Mosquito screens are installed on all openings
- Overflow device is directed as shown on plans
- Rainwater harvesting system foundation is constructed as shown on plans
- Catchment area and overflow area are stabilized
- Secondary stormwater treatment practice(s) is installed as shown on plans
- System commissioning

Construction phase inspection checklist for rainwater harvesting practices and the Stormwater Facility Leak Test form can be found in Appendix E Construction Inspection Checklists.

4.7.7 Rainwater Harvesting Maintenance Criteria

Maintenance Inspections

Periodic inspections and maintenance shall be conducted for each system by a qualified professional.

Maintenance inspection checklists for rainwater harvesting systems and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Maintenance Schedule

Maintenance requirements for rainwater harvesting systems vary according to use. Systems that are used to provide supplemental irrigation water have relatively low maintenance requirements, while systems designed for indoor uses have much higher maintenance requirements. Table 4.28 describes routine maintenance tasks necessary to keep rainwater harvesting systems in working condition. It is recommended that maintenance tasks be performed by an “Inspector Specialist,” certified by the American Rainwater Catchment Association. Maintenance tasks must be documented and substantially comply with the maintenance responsibilities outlined in the maintenance agreement.

Table 4.28. Typical Maintenance Tasks for Rainwater Harvesting Systems

Responsible Person	Frequency	Activity
Owner	Four times a year	Inspect and clean prescreening devices and first flush diverters
	Twice a year	Keep gutters and downspouts free of leaves and other debris
	Once a year	▪ Inspect and clean storage cistern lids, paying special attention to vents and screens on inflow and outflow spigots. Check mosquito screens and patch holes or gaps immediately ▪ Inspect condition of overflow pipes, overflow filter path, and/or secondary stormwater treatment practices
	Every third year	Clear overhanging vegetation and trees over roof surface
Qualified Third-Party Inspector	According to Manufacturer	Inspect water quality devices
	As indicated in Appendix J Rainwater Harvesting Treatment and Management Requirements	Field verification and data logs must be available at all times and semiannual reports must be uploaded to the SW database annually.
	Every third year	▪ Inspect cistern for sediment buildup ▪ Check integrity of backflow preventer ▪ Inspect structural integrity of cistern, pump, pipe and electrical system ▪ Replace damaged or defective system components

Mosquitoes
In some situations, poorly designed rainwater harvesting systems can create habitat suitable for mosquito breeding. Designers must provide screens on above- and below-ground cisterns to prevent mosquitoes and other insects from entering the cisterns. If screening is not sufficient in deterring mosquitoes, dunks or pellets containing larvicide can be added to cisterns when water is intended for landscaping use.

Waste Material
Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.7.8 Rainwater Harvesting Stormwater Compliance Calculations

Rainwater harvesting practices are credited with 100% retention for the average available storage volume (Sv) available in the cistern as well as 100% TSS, TN, and bacteria removal (see Table 4.29). This average available storage volume is determined by using the Rainwater Harvesting Storage Volume Calculator, as described in Section 4.5.4 Rainwater Harvesting Design Criteria.

Table 4.29. Rainwater Harvesting Retention and Pollutant Removal

Retention	= 100%
TSS Removal	= 100%
TN Removal	= 100%
Bacteria Removal	= 100%

Rainwater harvesting practices also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume from the total runoff volume for the 2-year through the 100-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

4.7.9 References

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4.8 Impervious Surface Disconnection

<table>
<tr><th colspan="5">Impervious Surface Disconnection</th></tr>
<tr><td colspan="5">Definition: This strategy involves managing runoff close to its source by directing it from rooftops and other impervious surfaces to pervious areas.</td></tr>
<tr><th colspan="2">Site Applicability</th><th colspan="3">BMP Performance Summary</th></tr>
<tr><th>Land Uses</th><th>Required Footprint</th><th colspan="3">WQ Improvement: Moderate to High</th></tr>
<tr><td rowspan="3">▪ Suburban
▪ Rural</td><td rowspan="3">Small</td><th>TSS[1]</th><th>Total N[1]</th><th>Bacteria[1]</th></tr>
<tr><td>80%</td><td>40%</td><td>40%</td></tr>
<tr><th colspan="3">Runoff Reduction</th></tr>
<tr><th>Construction Costs</th><th>Maintenance Burden</th><th colspan="3">Volume</th></tr>
<tr><td>Low</td><td>Low</td><td colspan="3">Low</td></tr>
<tr><th colspan="2">Maintenance Frequency:</th><th colspan="3">SWRv</th></tr>
<tr><th>Routine</th><th>Non-Routine</th><td colspan="3" rowspan="2">40%</td></tr>
<tr><td>At least annually</td><td>As needed</td></tr>
<tr><th colspan="2">Advantages/Benefits</th><th colspan="3">Disadvantages/Limitation</th></tr>
<tr><td colspan="2">▪ Low cost construction and maintenance
▪ Reduces runoff volume
▪ Helps restore pre-development hydrologic conditions</td><td colspan="3">▪ Only applicable to small drainage areas
▪ Difficult to apply to treatment trains
▪ Requires pervious receiving area</td></tr>
<tr><th colspan="2">Components</th><th colspan="3">Design considerations</th></tr>
<tr><td colspan="2">▪ Conveyance
▪ Receiving area
▪ Vegetation
▪ Receiving soils</td><td colspan="3">▪ Maximum CDA of 1,000 ft^2 per disconnection
▪ Disconnection area should be at least 35 feet long and 10 feet wide.
▪ Slope of receiving area should be < 2% (with turf reinforcement, <5%)
▪ Building setback for areas with < 1% slope</td></tr>
<tr><th colspan="5">Maintenance Activities</th></tr>
<tr><td colspan="2">▪ Typical lawn/landscaping maintenance</td><td colspan="3">▪ Ensure receiving area remains uncompacted and pervious</td></tr>
</table>

[1]*Credited pollutant load removal*

In this practice, runoff from a rooftop or other small impervious surface is directed to a pervious surface or small practice to provide infiltration, filtering, or reuse (Figure 4.32)

Figure 4.32. Rooftop disconnection (photo: Center for Watershed Protection, Inc.)

Definition

This strategy involves managing runoff close to its source by directing it from rooftops and other impervious surfaces to pervious areas. Disconnection practices can be used to reduce the volume of runoff that enters the combined or separate sewer systems. Applicable practices include the following:

D-1 Disconnection to pervious areas with the compacted cover designation

D-2 Disconnection to conservation areas

Disconnection practices reduce a portion of the SWRv. In order to fully meet retention requirements, , disconnection practices must be combined with additional practices.

4.8.1 Impervious Surface Disconnection Feasibility Criteria

Impervious surface disconnections are ideal for use on commercial, institutional, municipal, multi-family residential, and single-family residential buildings. Key constraints with impervious surface disconnections include available space, soil permeability, and soil compaction. These and other feasibility criteria are described below and summarized in Table 4. 30.

- **Contributing Drainage Area.** For rooftop impervious areas, the maximum impervious area treated cannot exceed 1,000 square feet per disconnection. For impervious areas other than rooftop, the longest contributing impervious area flow path cannot exceed 75 feet.
- **Sizing.** The available disconnection area must be at least 10 feet wide and 35 feet long. For sheet flow from impervious areas, the disconnection area must be as wide as the area draining to it.
- **Site Topography.** Disconnection is best applied when the grade of the receiving pervious area is less than 2%, or less than 5% with turf reinforcement. The slope of the receiving areas must be graded away from any building foundations. Turf reinforcement may include erosion control matting or other appropriate reinforcing materials that are confirmed by the designer to be erosion resistant for the specific characteristics and flow rates anticipated at each individual application, and acceptable to the plan-approving authority.

- **Soils.** Impervious surface disconnection can be used on any post-construction hydrologic soil group (HSG). The disconnection area must be kept well-vegetated with minimal bare spots—at least 95% soil cover.
- **Building Setbacks.** If the grade of the receiving area is less than 1%, downspouts must be extended 5 feet away from building.

Discharge Across Property Lines. Disconnection areas must be designed such that runoff is not directed across property lines toward other sites.

Economic Considerations. Disconnection is one of the least expensive BMPs available.

Table 4.30. Feasibility Criteria for Disconnection

Design Factor	Disconnection Design
Contributing Drainage Area	1,000 square feet per rooftop disconnection. For impervious areas other than rooftop, the longest contributing impervious area flow path cannot exceed 75 feet.
Sizing	The available disconnection area must be at least 10 feet wide and 35 feet long. For sheet flow from impervious areas, the disconnection area must be as wide as the area draining to it.
Site Topography	Grade of the receiving pervious area is less than 2%, or less than 5% with turf reinforcement. The slope of the receiving areas must be graded away from any building foundations.
Soils	Impervious surface disconnection can be used on any post-construction HSG. The disconnection area must be kept well-vegetated with minimal bare spots.
Building Setbacks	5 feet away from building if the grade of the receiving area is less than 1%.

4.8.2 Impervious Surface Disconnection Conveyance Criteria

Receiving areas in disconnection practices (D-1, D-2, and D-3) require a design that safely conveys the 2- to 25-year storm events over the receiving area without causing erosion. In some applications, erosion control matting or other appropriate reinforcing materials may be needed to control flow rates anticipated for these larger design storms.

4.8.3 Impervious Surface Disconnection Pretreatment Criteria

Pretreatment is not needed for impervious surface disconnection.

4.8.4 Impervious Surface Disconnection Design Criteria

If the feasibility criteria presented in Section 4.6.1 are met for a disconnection area, the storage volume is equal to the SWRv for the impervious area draining to it. The disconnection area itself should be considered Compacted Cover or Open Space rather than BMP area and should not be considered as part of the contributing drainage area to the impervious surface disconnection.

The following additional design criteria apply to Disconnection to Conservation Areas:

- **(D-2) Disconnection to a Conservation Area.** Disconnection area cannot include regulated wetlands and buffer areas.

- Inflow must be conveyed via sheet flow or via a level spreader.
- If inflow is conveyed via a level spreader, the maximum flow path is 150 feet, and the level spreader must be designed with an appropriate width as specified below.

Level Spreaders. A level spreader can be used to disperse or "spread" concentrated flow thinly over a vegetated or forested area to promote greater runoff infiltration in the receiving area. A level spreader consists of a permanent linear structure constructed at a 0% grade that transects the slope. The influent concentrated runoff must be spread over an area wide enough area so that erosion of the receiving area does not result. Detailed information on the design and function of level spreaders can be found in Hathaway and Hunt (2006) and NCDWQ (2010).

The minimum required width of the level spreader is

- 13 linear feet per each 1 cubic foot/second of inflow if the receiving conservation area has a minimum 90% ground cover
- 40 linear feet per 1 cubic foot/second of inflow if the receiving conservation area is forested

4.8.5 Impervious Surface Disconnection Landscaping Criteria

All receiving disconnection areas must be stabilized to prevent erosion or transport of sediment to receiving practices or drainage systems according to the Erosion and Sediment Control seeding and vegetation requirements. Designers must ensure that the maximum flow velocities do not exceed the acceptable values for the selected grass species and the specific site slope.

4.8.6 Impervious Surface Disconnection Construction Sequence

Construction Sequence for Disconnection to Pervious Areas. For disconnection to a pervious area, the pervious area can be within the limits of disturbance (LOD) during construction. The following procedures should be followed during construction:

- Before site work begins, the receiving pervious disconnection area boundaries should be clearly marked.
- Construction traffic in the disconnection area should be limited to avoid compaction. The material stockpile area shall not be located in the disconnection area.
- Construction runoff should be directed away from the proposed disconnection area, using perimeter silt fence, or, preferably, a diversion dike.
- If existing topsoil is stripped during grading, it shall be stockpiled for later use.
- The disconnection area may require light grading to achieve desired elevations and slopes. This should be done with tracked vehicles to prevent compaction.
- Topsoil and or compost amendments should be incorporated evenly across the disconnection area, stabilized with seed, and protected by biodegradable erosion control matting or blankets.
- Stormwater must not be diverted into any topsoil or compost amended areas until the area is stabilized (establishment of 95% or greater groundcover).

Construction Sequence for Disconnection to Conservation Areas. For disconnection to a conservation area, the conservation area must be fully protected during the construction stage of development and kept outside the LOD on the soil erosion and sediment control plan.

- No staging, parking, clearing, grading, or heavy equipment access is allowed in the conservation area except temporary disturbances associated with incidental utility construction, restoration operations, or management of nuisance vegetation. Incidental utility construction includes protecting existing utilities, removing abandoned utilities, rearranging service lines, temporarily rearranging utilities, and adjusting utility appurtenances.
- Any conservation areas shall be protected by super silt fence, chain link fence, orange safety fence, or other measures to prevent sediment discharge consistent with soil erosion and sediment control standards and specifications.
- The LOD must be clearly shown on all construction drawings and identified and protected in the field by acceptable signage, silt fence or other protective barrier.
- If a level spreader is to be used in the design, construction of the level spreader shall not commence until the CDA has been stabilized and perimeter soil erosion and sediment control measures have been removed and cleaned out. Stormwater must not be diverted into the disconnection area until the level spreader is installed and stabilized.

Construction Supervision. Construction supervision is recommended to ensure compliance with design standards. A qualified professional should evaluate the performance of the disconnection after the first significant rainfall event to look for evidence of gullies, outflanking, undercutting, or sparse vegetative cover. Spot repairs should be made as needed.

Construction phase inspection checklist for impervious cover disconnection can be found in Appendix E Construction Inspection Checklists.

4.8.7 Impervious Surface Disconnection Maintenance Criteria

Maintenance of disconnected downspouts usually involves regular lawn or landscaping maintenance in the filter path from the roof to the street. In some cases, runoff from a disconnection may be directed to a more natural, undisturbed setting (i.e., where lot grading and clearing is “fingerprinted” and the proposed filter path is protected). Typical maintenance activities include erosion control of the receiving area and ensuring the receiving area remains uncompacted and pervious.

Maintenance inspection checklists for disconnection can be found in Appendix F Maintenance Inspection Checklists.

Waste Material. Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.8.8 Impervious Surface Disconnection Stormwater Compliance Calculations

Disconnection practices are credited with 40% retention for the SWRv as well as 80% TSS, 40% TN, and 40% bacteria removal (see Table 4.31).

Table 4.31. Disconnection Retention and Pollutant Removal

Retention	= 40%
TSS Removal	= 80%
TN Removal	= 40%
Bacteria Removal	= 40%

Impervious surface disconnection also contributes to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume from the total runoff volume for the 2- to 25-year, and 100-year storms. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

4.8.9 References

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Virginia DCR Stormwater Design Specification No. 1: Rooftop (Impervious Surface) Disconnection Version 1.8. 2010.

4.9 Open Channel Systems

<table>
<tr><th colspan="7">Open Channel Systems</th></tr>
<tr><td colspan="7">Definition: Vegetated open channels that are designed to capture and treat or convey the design storm volume (SWRv).</td></tr>
<tr><td colspan="2">Site Applicability</td><td colspan="5">BMP Performance Summary</td></tr>
<tr><td>Land Uses</td><td>Required Footprint</td><td colspan="5">WQ Improvement: Moderate to High</td></tr>
<tr><td rowspan="3">▪ Suburban
▪ Rural</td><td rowspan="3">Moderate</td><td colspan="2">TSS[1]</td><td colspan="2">Total N[1]</td><td>Bacteria[1]</td></tr>
<tr><td colspan="2">50-80%</td><td colspan="2">25-70%</td><td>30-80%</td></tr>
<tr><td colspan="5">Runoff Reduction</td></tr>
<tr><td>Construction Costs</td><td>Maintenance Burden</td><td colspan="5">Volume</td></tr>
<tr><td>Low</td><td>Low</td><td colspan="5">Low</td></tr>
<tr><td colspan="2">Maintenance Frequency:</td><td colspan="5">SWRv</td></tr>
<tr><td>Routine</td><td>Non-Routine</td><td>O-1a</td><td>O-1b</td><td>O-2</td><td>O-3</td><td>O-4</td></tr>
<tr><td>Quarterly</td><td>Every 10-15 years</td><td>10%</td><td>20%</td><td>60%</td><td>0%</td><td>0%</td></tr>
<tr><td colspan="2">Advantages/Benefits</td><td colspan="5">Disadvantages/Limitation</td></tr>
<tr><td colspan="2">▪ Less expensive than curb and gutter
▪ Relatively low maintenance requirements
▪ Provides pretreatment if used as part of runoff conveyance system
▪ Provides partial infiltration of runoff in some soils
▪ Good for small drainage areas</td><td colspan="5">▪ Must be carefully designed to achieve low flow rates in the channel (< 1.0 ft/s)
▪ May re-suspend sediment
▪ May not be acceptable for some areas because of standing water in channel</td></tr>
<tr><td colspan="2">Components</td><td colspan="5">Design considerations</td></tr>
<tr><td colspan="2">▪ Channel geometry
▪ Dense vegetation
▪ Check dams, as needed)</td><td colspan="5">▪ Maximum drainage area of 2.5 acres
▪ Slopes (<4% unless using O-4)
▪ Runoff velocities must be non-erosive
▪ Vegetation must withstand both relatively high velocity flows and wet/dry periods.</td></tr>
<tr><td colspan="7">Maintenance Activities</td></tr>
<tr><td colspan="2">▪ Mow grass to 3 or 4 inches high
▪ Inspect for, and correct, formation of rills and gullies</td><td colspan="5">▪ Clean out sediment accumulation in channel
▪ Ensure that vegetation remains well established</td></tr>
</table>

[1]*Credited pollutant load removal*

Often found along roadsides, parking lots, and property boundaries, open channels can provide stormwater conveyance, capture and/or treatment (Figure 4.33). One of the most visible stormwater BMPs, they are often part of stormwater conveyance systems.

Figure 4.33. Open channel (photo: Center for Watershed Protection, Inc.)

Definition. Vegetated open channels that are designed to capture and treat or convey the design storm volume (SWRv). Design variants include the following:

O-1 Grass channels

O-2 Dry swales/bioswales

O-3 Wet swales

O-4 Regenerative stormwater conveyance (RSC)

Open channel systems shall not be designed to provide stormwater detention except under extremely unusual conditions. Open channel systems must generally be combined with a separate facility to meet detention requirements.

Grass channels (O-1) can provide a modest amount of runoff filtering and volume attenuation within the stormwater conveyance system resulting in the delivery of less runoff and pollutants than a traditional system of curb and gutter, storm drain inlets, and pipes (see Figure 4.34). The performance of grass channels will vary depending on the underlying soil permeability. Grass channels, however, are not capable of providing the same stormwater functions as dry swales as they lack the storage volume associated with the engineered filter media. Their retention performance can be boosted when compost amendments are added to the bottom of the swale (see Appendix C Soil Compost Amendment Requirements). Grass channels are a preferable alternative to both curb and gutter and storm drains as a stormwater conveyance system, where development density, topography, and soils permit.

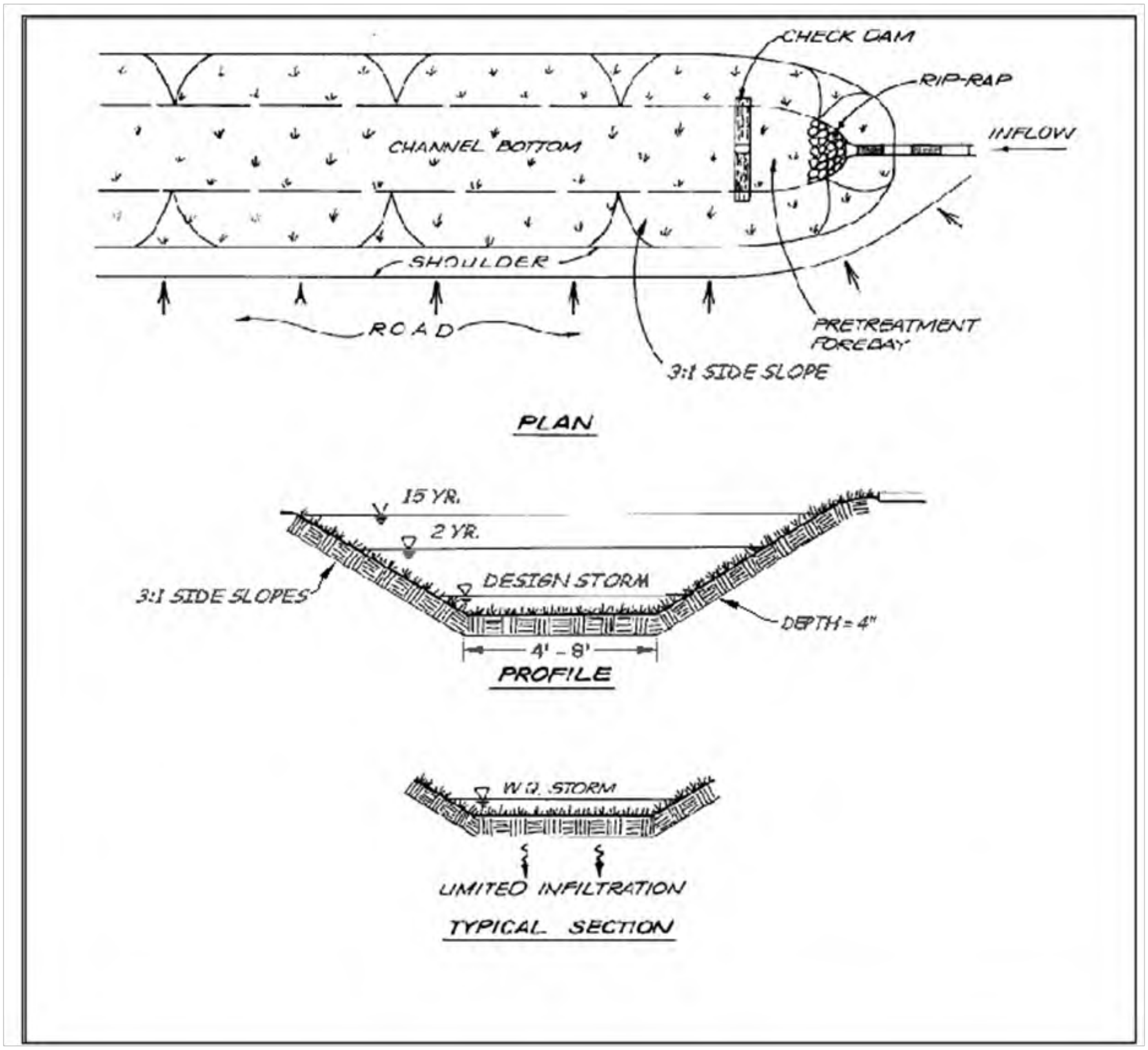

Figure 4.34. Grass channel typical plan, profile, and section views (O-1).

Dry swales (O-2), also known as bioswales, are essentially bioretention cells that are shallower, configured as linear channels, and covered with turf or other surface material (other than mulch and ornamental plants; see Figure 4.35. Example of a dry swale/bioswale (O-2).). The dry swale is a soil filter system that temporarily stores and then filters the desired design storm volume. Dry swales rely on a premixed filter media below the channel that is identical to that used for bioretention. In most cases, the runoff treated by the filter media flows into an underdrain, which conveys treated runoff back to the conveyance system further downstream. The underdrain system consists of a perforated pipe within a gravel layer on the bottom of the swale, beneath the filter media. However, if soils are permeable, runoff infiltrates into underlying soils and the dry swale can be designed without an underdrain as if it were an enhanced bioretention. In either case, check dams should be constructed to encourage ponding (see Site Topography). Dry swales may appear as simple grass channels with the same shape and turf cover, while others may have more elaborate landscaping. Swales can be planted with turf grass, tall meadow grasses, decorative herbaceous cover, or trees.

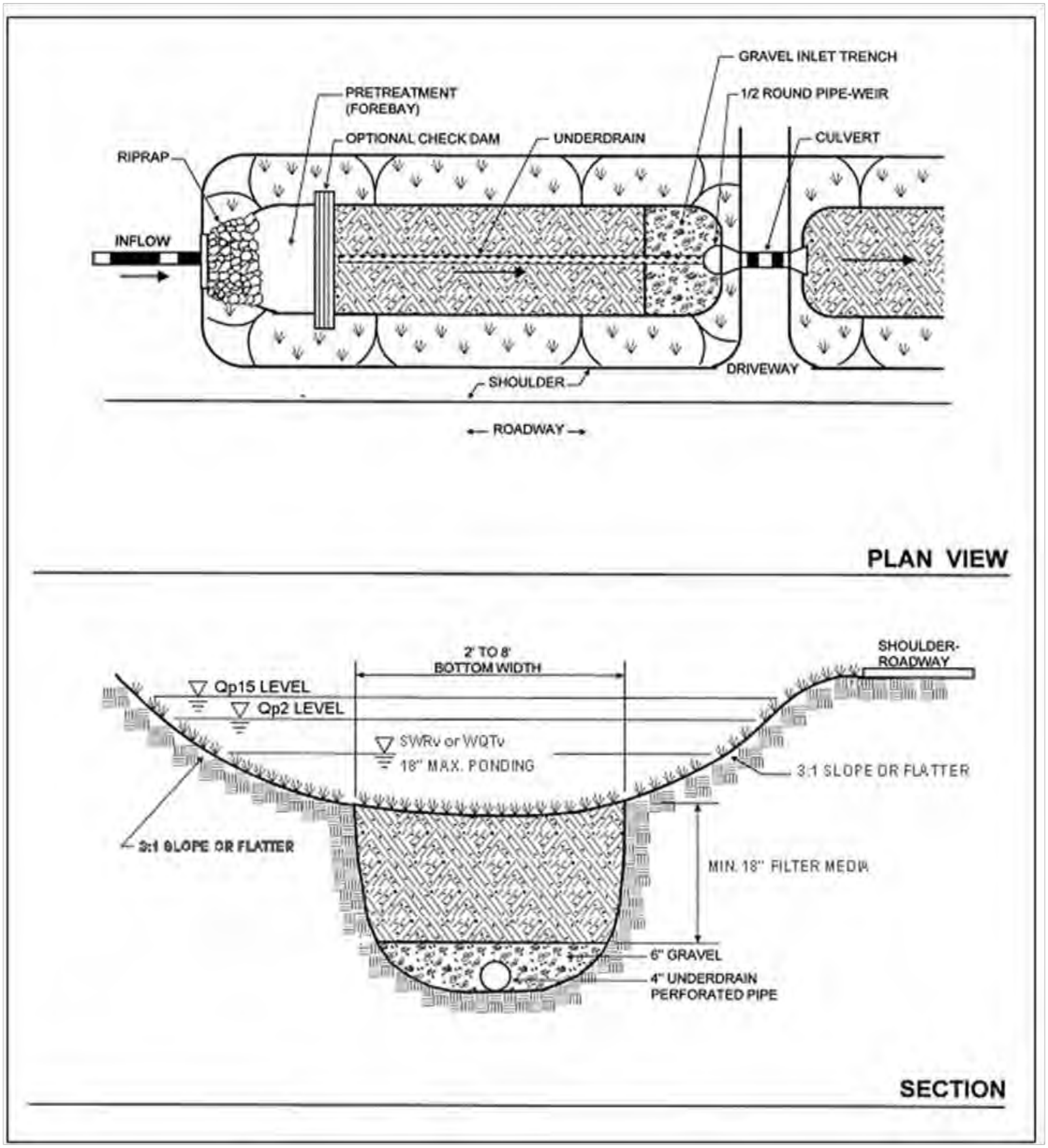

Figure 4.35. Example of a dry swale/bioswale (O-2).

Wet swales (O-3) can provide a modest amount of runoff filtering within the conveyance (see Figure 4.36). These linear wetland cells often intercept shallow groundwater to maintain a wetland plant community. The saturated soil and wetland vegetation provide an ideal environment for gravitational settling, biological uptake, and microbial activity. On-line or off-line cells are formed within the channel to create saturated soil or shallow standing water conditions (typically less than 6 inches deep).

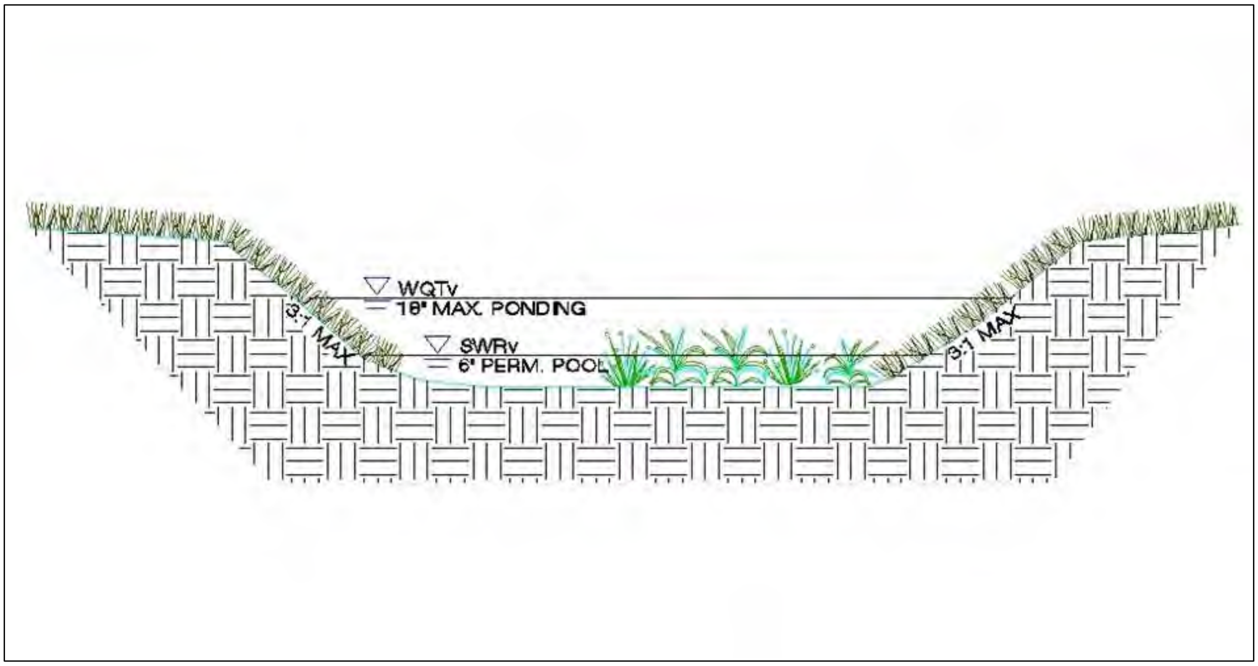

Figure 4.36. Example of a wet swale (O-3).

Regenerative Stormwater Conveyance (O-4). RSC is a unique conveyance practice that can be used in locations where other conveyance practices are infeasible, or as a restoration practice for eroded or degraded outfalls and drainage channels (Figure 4.37). RSC utilizes a series of shallow aquatic pools, riffle weir grade controls, native vegetation and underlying sand and woodchip beds to treat, detain, and convey storm flow. It can be used in places where grades make traditional stormwater practices difficult to implement. Because of the regional topography and waters of the state limitations, RSC Systems will have limited application in the Southern Lowcountry. RSC Systems combine features and treatment benefits of Swales, Infiltration, Filtering and Wetland practices. In addition, they are designed to convey flows associated with larger storm events in a non-erosive manner, which results in a reduction of channel erosion impacts commonly encountered at conventional stormwater outfalls and headwater stream channels.

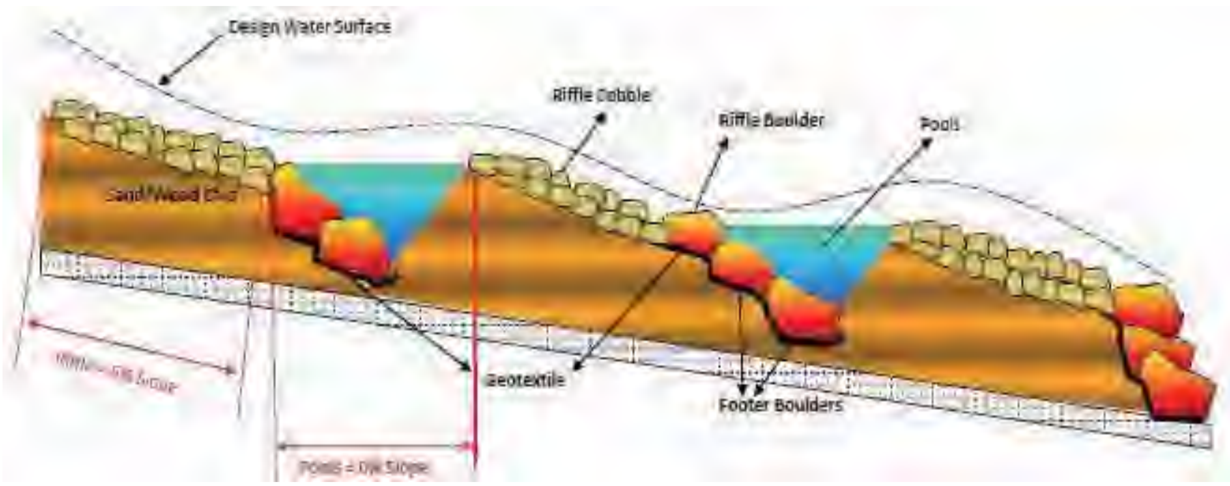

Figure 4.37. Example of Regenerative Stormwater Conveyance (O-4).

4.9.1 Open Channel Feasibility Criteria

Open channel systems are primarily applicable for land uses, such as roads, highways, and residential development. Some key feasibility issues for open channels include the following:

Contributing Drainage Area. The maximum CDA to an open channel should be 2.5 acres, preferably less. When open channels treat and convey runoff from CDAs greater than 2.5 acres, the velocity and flow depth through the channel often becomes too great to treat runoff or prevent erosion in the channel. The design criteria for maximum channel velocity and depth are applied along the entire length (see Section 4.9.4 Open Channel Design Criteria). Dry Swales should be approximately 3%–10% of the size of the CDA, depending on the amount of impervious cover. Wet swale footprints usually cover about 5%–15% of their CDA.

Available Space. Open channel footprints can fit into relatively narrow corridors between utilities, roads, parking areas, or other site constraints. Grass channels can be incorporated into linear development applications (e.g., roadways) by utilizing the footprint typically required for an open section drainage feature. The footprint required will likely be greater than that of a typical conveyance channel. However, the benefit of the retention may reduce the footprint requirements for stormwater management elsewhere on the development site.

Site Topography. Grass channels and wet swales should be used on sites with longitudinal slopes of less than 4%. Check dams can be used to reduce the effective slope of the channel and lengthen the contact time to enhance filtering and/or infiltration. Longitudinal slopes of less than 2% are ideal and may eliminate the need for check dams. However, channels designed with longitudinal slopes of less than 1% should be monitored carefully during construction to ensure a continuous grade so as to avoid flat areas with pockets of standing water.

For dry swales, check dams will be necessary regardless of the longitudinal slope to create the necessary ponding volume.

Land Uses. Open channels can be used in residential, commercial, or institutional development settings.

When open channels are used for both conveyance and water quality treatment, they should be applied only in linear configurations parallel to the contributing impervious cover, such as roads and small parking areas. The linear nature of open channels makes them well-suited to treat highway or low- and medium-density residential road runoff, if there is adequate right-of-way width and distance between driveways. Typical applications of open channels include the following, as long as CDA limitations and design criteria can be met:

- Within a roadway or bicycle path right-of-way;
- Along the margins of small parking lots;
- Oriented from the roof (downspout discharge) to the street;
- Disconnecting small impervious areas; and
- Used to treat the managed turf areas of parkland, sports fields, golf courses, and other turf-intensive land uses, or to treat CDAs with both impervious and managed turf cover (such as residential streets and yards).

Open channels are not recommended when residential density exceeds more than four (4) dwelling units per acre, due to a lack of available land and the frequency of driveway crossings along the channel.

Open channels can also provide pretreatment for other stormwater treatment practices.

Available Hydraulic Head. A minimum amount of hydraulic head is needed to implement open channels in order to ensure positive drainage and conveyance through the channel. The hydraulic head for wet swales and grass channels is measured as the elevation difference between the channel inflow and outflow point. The hydraulic head for dry swales is measured as the elevation difference between the inflow point and the storm drain invert (unless an infiltration-based design will be used). Dry swales typically require 3 to 5 feet of hydraulic head since they have both a filter bed and underdrain.

Hydraulic Capacity. Open channels are typically designed as on-line practices that must be designed with enough capacity to (1) convey runoff from the 25-year design storm at non-erosive velocities, and (2) contain the 25-year flow within the banks of the swale. This means that the swale's surface dimensions are more often determined by the need to pass the 25-year storm events, which can be a constraint in the siting of open channels within existing rights-of-way (e.g., constrained by sidewalks).

Depth to Water Table. The bottom of dry swales and grass channels must be at least 0.5 feet above the seasonally high groundwater table, to ensure that groundwater does not intersect the filter bed, since this could lead to groundwater contamination or practice failure. It is permissible for wet swales to intersect the water table.

Soils. Soil conditions do not constrain the use of open channels, although they do dictate some design considerations:

- Dry swales in soils with low infiltration rates may need an underdrain. Designers must verify site-specific soil permeability at the proposed location using the methods for on-site soil investigation presented in Appendix B Geotechnical Information Requirements for Underground BMPs to eliminate the requirements for a dry swale underdrain.
- Grass channels situated on low-permeability soils may incorporate compost amendments to improve performance (see Appendix C Soil Compost Amendment Requirements).
- Wet swales work best on the more impermeable HSG C or D soils.
- At infill soil locations, geotechnical investigations are required to determine if the use of an impermeable liner and underdrain are necessary for open channel designs.

Utilities. Typically, utilities can cross linear channels if they are specially protected (e.g., double-casing). Interference with underground utilities should be avoided, if possible. When large site development is undertaken, the expectation of achieving avoidance will be high. Conflicts may be commonplace on smaller sites and in the PROW. Where conflicts cannot be avoided, these guidelines shall be followed:

- Consult with each utility company on recommended offsets that will allow utility maintenance work with minimal disturbance to the BMP.
- Whenever possible, coordinate with utility companies to allow them to replace or relocate their aging infrastructure while BMPs are being implemented.
- BMP and utility conflicts will be a common occurrence in PROW projects. However, the standard solution to utility conflict should be the acceptance of conflict provided sufficient soil coverage over the utility can be assured.
- Additionally, when accepting utility conflict into the BMP design, it is understood that the BMP will be temporarily impacted during utility maintenance but restored to its original condition.

Avoidance of Irrigation or Baseflow. Open channels should be located so as to avoid inputs of springs, irrigation systems, chlorinated wash-water, or other dry weather flows.

Setbacks. To avoid the risk of seepage, stormwater cannot flow from the open channel reservoir layer or via baseflow to the traditional pavement base layer, existing structure foundations, or future foundations which may be built on adjacent properties Open channels should be set back at least 10 feet down-gradient from building foundations and property lines, 50 feet from septic system fields and 150 feet from public or private drinking water wells. The 10-foot building setback may be relaxed if an impermeable building liner is installed.

Pollutant Hotspot Land Use. In areas where higher pollutant loading is likely (i.e. oils and greases from fueling stations or vehicle storage areas, sediment from un-stabilized pervious areas, or other pollutants from industrial processes), appropriate pretreatment, such as an oil- water separator or filtering device must be provided. These pretreatment facilities should be monitored and maintained frequently to avoid negative impacts to the channel and subsequent water bodies.

Runoff from hotspot land uses must not be treated with infiltrating dry swales due to the potential interaction with the water table and the risk that hydrocarbons, trace metals, and other toxic pollutants could migrate into the groundwater. An impermeable liner must be used for filtration of hotspot runoff for dry swales.

Grass channels can typically be used to convey runoff from stormwater hotspots, but they do not qualify as a hotspot treatment mechanism. Wet swales are not recommended to treat stormwater hotspots, due to the potential interaction with the water table and the risk that hydrocarbons, trace metals, and other toxic pollutants could migrate into the groundwater.

On sites with existing contaminated soils, infiltration is not allowed; dry and wet swales on these hotspots must include an impermeable liner.

Feasibility. Open channels are ideally suited to the Southern Lowcountry environment, since open channel drainage is often the norm due to the flat topography. Depending on underlying soil and other characteristics, however, a specific open channel option may be the most appropriate. For example, the wet swale design option is most suited to areas with elevated groundwater tables, while dry swales and grassed channels are best suited for sandy soils of the coastal plain.

Economic Considerations. While most open channel designs provide relatively small water quality credits when compared with other stormwater practices, they nevertheless provide greater quality benefits than traditional conveyance designs, such as curb and gutter.

4.9.2 Open Channel Conveyance Criteria

The bottom width and slope of a grass channel must be designed such that the velocity of flow from the design storm provides a minimum hydraulic residence time (average travel time for a particle of water through a waterbody) of 9 minutes for the peak flows from the SWRv or design storm. Check dams may be used to achieve the needed retention volume, as well as to reduce the flow velocity. Check dams must be spaced based on channel slope and ponding requirements, consistent with the criteria in Section 4.7.4 Open Channel Design Criteria.

Open channels must also convey the 25-year storm at non-erosive velocities (generally less than 6 feet per second) for the soil and vegetative cover provided. The final designed channel shall provide 6 inches minimum freeboard above the designated water surface profile of the channel. The analysis must evaluate the flow profile through the channel at normal depth, as well as the flow depth over top of the check dams.

RSC systems are typically designed to convey larger storm events, up to and including the 100- year storm event.

4.9.3 Open Channel Pretreatment Criteria

Pretreatment is required for open channels to dissipate energy, trap sediments, and slow down the runoff velocity.

The selection of a pretreatment method depends on whether the channel will experience sheet flow or concentrated flow. Several options are as follows:

- **Check Dams (channel flow).** These energy dissipation devices are acceptable as pretreatment on small open channels with CDAs of less than 1 acre. The most common form is the use of wooden or stone check dams. The pretreatment volume stored must be 15% of the design volume.
- **Tree Check Dams (channel flow).** These are street tree mounds that are placed within the bottom of grass channels up to an elevation of 9 to 12 inches above the channel invert. One side has a gravel or river stone bypass to allow runoff to percolate through (Cappiella et al, 2006). The pretreatment volume stored must be 15% of the design volume.
- **Grass Filter Strip (sheet flow).** Grass filter strips extend from the edge of the pavement to the bottom of the open channel at a slope of 5H:1V or flatter. Alternatively, provide a combined 5 feet of grass filter strip at a maximum 5% (20H:1V) cross slope and 3H:1V or flatter side slopes on the open channel.
- **Gravel or Stone Diaphragm (sheet flow).** The gravel diaphragm is located at the edge of the pavement or the edge of the roadway shoulder and extends the length of the channel to pretreat lateral runoff. This requires a 2- to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The stone must be sized according to the expected rate of discharge.
- **Gravel or Stone Flow Spreaders (concentrated flow).** The gravel flow spreader is located at curb cuts, downspouts, or other concentrated inflow points, and should have a 2- to 4-inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The gravel should extend the entire width of the opening and create a level stone weir at the bottom or treatment elevation of the channel.
- **Initial Sediment Forebay (channel flow).** This grassed cell is located at the upper end of the open channel segment with a recommended 2:1 length to width ratio and a storage volume equivalent to at least 15% of the total design storm volume. If the volume of the forebay will be included as part of the dry swale storage volume, the forebay must de-water between storm events. It cannot have a permanent ponded volume.

4.9.4 Open Channel Design Criteria

Channel Geometry. Design guidance regarding the geometry and layout of open channels is provided below:

- Open channels should generally be aligned adjacent to and the same length as the CDA identified for treatment.
- Open channels should be designed with a trapezoidal or parabolic cross section. A parabolic shape is preferred for aesthetic, maintenance, and hydraulic reasons.
- The bottom width of the channel should be between 4 to 8 feet wide to ensure that an adequate surface area exists along the bottom of the swale for filtering. If a channel will be wider than 8 feet, the designer must incorporate benches, check dams, level spreaders, or multi-level cross sections to prevent braiding and erosion along the channel bottom.
- Open-channel side slopes should be no steeper than 3H:1V for ease of mowing and routine maintenance. Flatter slopes are encouraged, where adequate space is available, to enhance pretreatment of sheet flows entering the channel.
- RSC has several specific geometry requirements, which are outlined in RSC Sizing below.

Check dams. Check dams may be used for pretreatment, to break up slopes, and to increase the hydraulic residence time in the channel. Design requirements for check dams are as follows:

- Check dams should be spaced based on the channel slope, as needed to increase residence time, provide design storm storage volume, or any additional volume attenuation requirements. In typical spacing, the ponded water at a downhill check dam should not touch the toe of the upstream check dam. More frequent spacing may be desirable in dry swales to increase the ponding volume.
- The maximum desired check dam height is 12 inches, for maintenance purposes. However, for some sites, a maximum of 18 inches can be allowed, with additional design elements to ensure the stability of the check dam and the adjacent and underlying soils.
- Armoring may be needed at the downstream toe of the check dam to prevent erosion.
- Check dams must be firmly anchored into the side-slopes to prevent outflanking; check dams must also be anchored into the channel bottom so as to prevent hydrostatic head from pushing out the underlying soils.
- Check dams must be designed with a center weir sized to pass the channel design storm peak flow (25-year storm event for man-made channels).
- For grass channels, each check dam must have a weep hole, or similar drainage feature, so it can dewater after storms. This is not appropriate for dry swales.
- Check dams should be composed of wood, concrete, stone, compacted soil, or other non-erodible material, or should be configured with elevated driveway culverts.
- Individual channel segments formed by check dams or driveways should generally be at least 25 to 40 feet in length.

Check dams for grass channels must be spaced to reduce the effective slope to less than 2%, as indicated in Table 4.32.

Table 4.32. Typical Check Dam Spacing to Achieve Effective Channel Slope

Channel Longitudinal Slope (%)	Check Dam Spacing to Achieve Effective Slope [a, b, c]	
	Effective Slope of 2% (ft)	Effective Slope of 0%–1% (ft)
0.5	–	
1.0	–	
1.5	–	67–200
2.0	–	50–100
2.5	200	40–67
3.0	100	33–50
3.5	67	30–40
4.0	50	25–33
4.5[d]	40	20–30
5.0[d]	40	20–30

[a] All check dams require a stone energy dissipator at the downstream toe.
[b] Check dams require weep holes at the channel invert. Swales with slopes less than 2% will require multiple weep holes (at least 3) in each check dam.
[c] Assumed check dam height is 12 inches. The spacing dimension is half of the above distances if a 6-inch check dam is used.
[d] Open channels with slopes greater than 4% require special design considerations, such as drop structures to accommodate greater than 12-inch high check dams (and therefore a flatter effective slope), in order to ensure non-erosive flows.

Ponding Depth. Check dams must be used in dry swales to create ponding cells along the length of the channel. The maximum ponding depth in a dry swale must not exceed 18 inches. Minimum surface ponding depth is 3 inches (averaged over the surface area of the open channel). In order to increase the ponding depth, it may be necessary or desirable to space check dams more frequently than is shown in Table 4.32.

Dry Swale Filter Media. Dry swales require replacement of native soils with a prepared filter media. The filter media provides adequate drainage, supports plant growth, and facilitates pollutant removal within the dry swale. At least 18 inches of filter media must be added above the choker stone layer (and no more than 6 feet) to create an acceptable filter. The recipe for the filter media is identical to that used for bioretention and is provided in Section 4.1 Bioretention. The batch receipt confirming the source of the filter media must be submitted to the *<local jurisdiction>* inspector. One acceptable design adaptation is to use 100% sand for the first 18 inches of the filter and add a combination of topsoil and compost, as specified in Appendix C Soil Compost Amendment Requirements, for the top 4 inches, where turf cover will be maintained.

Dry Swale Drawdown. Dry swales must be designed so that the desired design storm volume is completely filtered within 72 hours, using the equations specified in Section 4.7.6 Open Channel Construction Sequence.

Dry Swale Underdrain. Some dry swale designs will not use an underdrain (where soil infiltration rates meet minimum standards). See Section 4.9.1 Open Channel Feasibility Criteria for more details. When underdrains are necessary, they should have a minimum diameter of 4 to 6 inches and be encased in a 12-inch deep gravel bed. Two layers of stone should be used. A choker stone layer, consisting of No. 8 or No. 89 stone at least 3 inches deep, must be installed immediately below the filter media. Below the choker stone layer, the underdrain must be encased (a minimum of 2 inches above and below the underdrain) in a layer of clean, double-washed ASTM D448 No.57 or smaller (No. 68, 8, or 89) stone. The maximum depth of the underdrain stone layer combined with the choking layer is 12 inches, and it cannot extend beyond the surface dimensions of the dry swale filter media.

Impermeable Liner. An impermeable liner is not typically required, although it may be utilized in fill applications where deemed necessary by a geotechnical investigation, on sites with contaminated soils, or on the sides of the practice to protect adjacent structures from seepage. Use a PVC geomembrane liner or an equivalent of an appropriate thickness (follow manufacturer's instructions for installation). Field seams must be sealed according to the liner manufacturer's specifications. A minimum 6-inch overlap of material is required at all seams.

Dry Swale Observation Well. A dry swale must include well-anchored, 4- to 6-inch diameter PVC pipe observation wells along the length of the swale. For a dry swale with an underdrain, the wells should be tied into any Ts or Ys in the underdrain system and must extend upward above the surface of the ponding. These observation wells may double as clean outs. For an infiltrating dry swale, the observation well should be perforated in the gravel layer only.

Grass Channel Material Specifications. The basic material specifications for grass channels are outlined in Table 4.33.

Table 4.33. Grass Channel Material Specifications

Component	Specification
Grass	A dense cover of water-tolerant, erosion-resistant grass. The selection of an appropriate species or mixture of species is based on several factors including climate, soil type, topography, and sun or shade tolerance. Grass species should have the following characteristics: ▪ A deep root system to resist scouring; ▪ A high stem density with well-branched top growth; ▪ Water-tolerance; ▪ Resistance to being flattened by runoff; ▪ An ability to recover growth following inundation; and
Check Dams	Check dams should be constructed of a non-erodible material such as wood, gabions, riprap, or concrete. Wood used for check dams should consist of pressure-treated logs or timbers or water-resistant tree species such as cedar, hemlock, swamp oak, or locust. Computation of check dam material is necessary, based on the surface area and depth used in the design computations.
Diaphragm	Pea gravel used to construct pretreatment diaphragms must consist of washed, open-graded, course aggregate between 3 and 10 mm in diameter.
Erosion Control Fabric	Where flow velocities dictate, biodegradable erosion control netting or mats that are durable enough to last at least two growing seasons must be used.

Dry Swale Material Specifications. For additional material specifications pertaining to dry swales, designers should consult Section 4.1.4 Bioretention Design Criteria and Table 4.34.

Table 4.34. Dry Swale Material Specifications

Material	Specification	Notes
Filter Media Composition	Filter Media to contain: • 80%–90% sand • 10%–20% soil fines • Maximum 10% clay • 3%–5% organic matter	To account for settling/compaction, it is recommended that 110% of the plan volume be utilized.
Filter Media Testing	P content = 5 to 15 mg/kg (Mehlich I) or 18 to 40 mg/kg (Mehlich III) CEC > 5 milliequivalents per 100 grams	See Section 4.3.4 Bioretention, for additional filter media information.
Geotextile	Geotextile fabric meeting the following specifications: • AASHTO M-288 Class 2, latest edition • Has a permeability of at least an order of magnitude (10 times) higher than the soil subgrade permeability. • Apply along sides of the filter media only and do not apply along the swale bottom.	
Choking Layer	A 2- to 4-inch layer of choker stone (typically No. 8 or No. 89 washed gravel) laid above the underdrain stone.	
Underdrain Stone Layer	Stone must be double-washed and clean and free of all fines (ASTM D448 No. 57 or smaller stone).	
Underdrains and Cleanouts	4-inch or 6-inch rigid schedule 40 PVC pipe, with 3 or 4 rows of 3/8-inch perforations at 6 inches on center.	Install perforated pipe for the full length of the dry swale cell. Use non-perforated pipe, as needed, to connect with the storm drain system.
Observation Wells	4-inch or 6-inch rigid schedule 40 PVC pipe	For dry swales with underdrains, tie the non-perforated observation well to the underdrain via T or Y connection. This observation well can double as a cleanout. For dry swales without an underdrain, the pipe should only be perforated in the gravel layer. The observation wells should extend to the top of ponding.
Impermeable Liner	Where appropriate, use a PVC geomembrane liner or equivalent.	
Vegetation	Plant species as specified on the landscaping plan.	
Check Dams	Use non-erosive material, such as wood, gabions, riprap, or concrete. Wood used for check dams should consist of pressure-treated logs or timbers, or water-resistant tree species, such as cedar, hemlock, swamp oak, or locust.	
Erosion Control Fabric	Where flow velocities dictate, use woven biodegradable erosion control fabric or mats (EC2) that are durable enough to last at least 2 growing seasons.	

RSC Material Specifications. RSC has several design elements that are unique to this practice. The practice includes riffle and pool segments, underlain with a sand/ wood chip bed, and with a top dressing of compost and plant material. Table 4.35 outlines the materials needed for this practice.

Table 4.35. Regenerative Stormwater Conveyance System Material Specifications

Material	Specification
Footer Boulders	Should have a natural appearance and be equivalent in size to Class 3 Rip Rap (aver- age diameter 26.4 inches)
Cobble	Should have a natural appearance and a minimum diameter of 6”
Sand/ Woodchip Bed	The sand component of the sand/wood chip bed should meet the AASHTO- M-6 or ASTM-C-33, 0.02 inches to 0.04 inches in size. Sand shall be a silica-based coarse aggregate. Substitutions such as Diabase and Gray- stone (AASHTO) #10 are not acceptable. No calcium carbonate or dolomitic sand substitutions are acceptable. No “rock dust” can be used for sand. Locally-approved pulverized glass may be substituted if the local authority undertakes testing to verify compliance with the particle size specification. No art glass shall be used for a pulverized glass material. For woodchips, use aged, shredded hardwood chips/mulch. The woodchips should be added to the sand mix, approximately 20 percent by volume, to increase the organic content and promote plant growth and sustainability.
Choker Stone	The choker stone layer between the sand bed and the bank run gravel should be clean, washed #8 or #78 stone.
Bank Run Gravel	The bank run gravel layer that is placed beneath and above the sand bed/choker stone layers should be constructed using clean, washed # 5 or # 57 coarse aggregate.
Compost	The compost used as a top dressing over the RSC System should consist of a 100% organic compost, with a pH of between 6.0 and 7.0, a moisture content of between 30 and 55%, and a particle size of 0.25 inches or less. (See Appendix C for compost specifications)
Wood Chips	The wood chips used within the sand bed should consist of double-shredded or double-ground hardwood mulch that is free of dyes, chromated copper arsenate and other preservatives.
Plant Materials	Plants should be native species, appropriate to the planting/wetness zone where they are located.

Wet Swale Design Issues. The following criteria apply to the design of wet swales:

- The average normal pool depth (dry weather) throughout the swale must be 6 inches or less.
- The maximum temporary ponding depth in any single wet swale cell must not exceed 18 inches at the most downstream point (e.g., at a check dam or driveway culvert).
- Check dams should be spaced as needed to maintain the effective longitudinal slope.
- Individual wet swale segments formed by check dams or driveways should generally be at least 25 to 40 feet in length.

- Wet swale side slopes should be no steeper than 4H:1V to enable wetland plant growth. Flatter slopes are encouraged where adequate space is available, to enhance pretreatment of sheet flows entering the channel. Under no circumstances are side slopes to steeper than 3H:1V.

Grass Channel Enhancement using Compost Soil Amendments. Soil compost amendments serve to increase the retention capability of a grass channel. The following design criteria apply when compost amendments are used:

- The compost-amended strip must extend over the length and width of the channel bottom, and the compost must be incorporated to a depth as outlined in Appendix C Soil Compost Amendment Requirements.
- For grass channels on steep slopes, it may be necessary to install a protective biodegradable erosion control mat to protect the compost-amended soils. Care must be taken to consider the erosive characteristics of the amended soils when selecting an appropriate erosion control mat.

Grass Channel Sizing. Unlike other BMPs, grass channels are designed based on a peak rate of flow. Designers must demonstrate channel conveyance and treatment capacity in accordance with the following guidelines:

- Hydraulic capacity should be verified using Manning's Equation or an accepted equivalent method, such as erodibility factors and vegetal retardance.
- The flow depth for the peak flow generated by the SWRv must be maintained at 4 inches or less.
- Manning's "n" value for grass channels is 0.2 for flow depths up to 4 inches, decreasing to 0.03 at a depth of 12 inches and above, which would apply to the 2- to 25-year storms if an on-line application (Haan et. al, 1994).
- Peak flow rates for the 25-year frequency storm must be non-erosive, in accordance with Table 4. 37 (see Section 4.9.5 Open Channel Landscaping Criteria), or subject to a site-specific analysis of the channel lining material and vegetation; and the 25-year peak flow rate must be contained within the channel banks (with a minimum of 6 inches of freeboard).
- Calculations for peak flow depth and velocity must reflect any increase in flow along the length of the channel, as appropriate. If a single flow is used, the flow at the outlet must be used.
- The hydraulic residence time (e.g., the average travel time for a particle of water through a waterbody) must be a minimum of 9 minutes for the peak flows from the SWRv or design storm (Mar et al., 1982; Barrett et al., 1998; Washington State Department of Ecology, 2005). If flow enters the swale at several locations, a 9-minute minimum hydraulic residence time must be demonstrated for each entry point, using Equation 4.13 through Equation 4.17.

The bottom width of the grass channel is therefore sized to maintain the appropriate flow geometry as follows:

Equation 4.13 Manning's Equation

$$V = \left(\frac{1.49}{n}\right) \times D^{2/3} \times S^{1/2}$$

Where:

V	=	flow velocity (ft/s)
n	=	roughness coefficient (0.2, or as appropriate)
D	=	flow depth (ft) (Note: D approximates hydraulic radius for shallow flows)
S	=	channel slope (ft/ft)

Equation 4.14 Continuity Equation

$$Q = V \times (W + 3 \times D) \times D$$

Where:

Q	=	design storm peak flow rate (cfs)
V	=	design storm flow velocity (ft/s)
W	=	channel bottom width (ft)
D	=	flow depth (ft)

(Note: Channel width (W) plus 3 times the depth (D) represents the average width of a trapezoidal channel with 3H:1V side slopes. Average width multiplied by depth equals the cross-sectional flow area.)

Combining Equation 4.13 and Equation 4.14, and rewriting them provides a solution for the minimum width (Equation 4.15):

Equation 4.15 Minimum Width

$$W = \frac{n \times Q}{1.49 \times D^{5/3} \times S^{1/2}} - (3 \times D)$$

Where:

W	=	channel bottom width (ft)
n	=	roughness coefficient (0.2, or as appropriate)
Q	=	design storm peak flow rate (cfs)
D	=	flow depth (ft)
S	=	channel slope (ft/ft)

Equation 4.16 provides the corresponding velocity:

Equation 4.16 Corresponding Velocity

$$V = \frac{Q}{(W + 3 \times D) \times D}$$

Where:

V	=	design storm flow velocity (ft/s)
Q	=	design storm peak flow rate (cfs)
W	=	channel bottom width (ft)
D	=	flow depth (ft)

The width, slope, or Manning's "n" value can be adjusted to provide an appropriate channel design for the site conditions. However, if a higher density of grass is used to increase the Manning's "n" value and decrease the resulting channel width, it is important to provide material specifications and construction oversight to ensure that the denser vegetation is actually established. Equation 4.17 can then be used to ensure adequate hydraulic residence time.

Equation 4.17 Grass Channel Length for Hydraulic Residence Time of 9 minutes (540 seconds)

$$L = 540 \times V$$

Where:

L	=	minimum swale length (ft)
V	=	flow velocity (ft/s)

The storage volume (Sv) provided by the grass channel is equal to the total runoff from the design storm (typically SWRv) used to size the channel (conveyed at a depth of 4 inches or less), as shown in Equation 4.18.

Equation 4.18 Grass Channel Storage Volume

$$Sv = DesignStorm$$

Where:

Sv	=	total storage volume of grass channel (ft^3)
DesignStorm	=	SWRv or other design storm volume (ft^3) (e.g., portion of the SWRv)

Dry Swale Sizing. Dry swales are typically sized to capture the SWRv or larger design storm volumes in the surface ponding area, filter media, and gravel reservoir layers of the dry swale.

Total storage volume of the BMP is calculated using Equation 4.19.

Equation 4.19 Dry Swale Storage Volume

$$Sv = SA_{bottom} \times \left[(d_{media} \times \eta_{media}) + \left(d_{gravel} \times \eta_{gravel}\right)\right] + (SA_{average} \times d_{ponding})$$

Where:

Sv	=	total storage volume of dry swale (ft^3)
SA_{bottom}	=	bottom surface area of dry swale (ft^2)
d_{media}	=	depth of the filter media, including mulch layer (ft)
η_{media}	=	effective porosity of the filter media (typically 0.25)
d_{gravel}	=	depth of the underdrain and underground storage gravel layer, including choker stone (ft)
η_{gravel}	=	effective porosity of the gravel layer (typically 0.4)
$SA_{average}$	=	average surface area of the dry swale (ft^2) typically, where SA_{top} is the top surface area of dry swale, $SA_{average} = \frac{SA_{bottom} + SA_{top}}{2}$
$d_{ponding}$	=	the maximum ponding depth of the dry swale (ft)

Equation 4.19 can be modified if the storage depths of the filter media, gravel layer, or ponded water vary in the actual design or with the addition of any surface or subsurface storage components (e.g., additional area of surface ponding, subsurface storage chambers, etc.). The maximum depth of ponding in the dry swale must not exceed 18 inches. If storage practices will be provided off-line or in series with the dry swale, the storage practices should be sized using the guidance in Section 0 Storage Practices.

Dry swales can be designed to address, in whole or in part, the detention storage needed to comply with channel protection and/or flood control requirements. The Sv can be counted as part of the 2- to 25-year runoff volumes to satisfy stormwater quantity control requirements.

Note: To increase the storage volume of a dry swale, the ponding surface area may be increased beyond the filter media surface area. However, the top surface of the BMP (at the top of the ponding elevation) may not be more than twice the size of surface area of the filter media (SA_{bottom}).

Wet Swale Sizing. Wet swales can be designed to capture and treat the SWRv remaining from any upstream stormwater retention practices. The storage volume is made up of the temporary and permanent storage created within each wet swale cell. This includes the permanent pool volume and up to 12 inches of temporary storage created by check dams or other design features that has 24 hours extended detention.

The storage volume (Sv) of the practice is equal to the volume provided by the pond permanent pool plus the 24-hour extended detention (ED) volume provided by the practice (Equation 4.20). The total Sv cannot exceed the design SWRv.

Equation 4.20 Wet Swale Storage Volume

$$Sv = Pond\ permanent\ pool\ volume + 24\ hour\ ED\ volume$$

RSC Sizing. RSC design is an iterative process in which the channel is sized to convey the 100-year storm event, using manning’s equation for parabolic channels as described in detail by Anne Arundel County, MD (2011). The following description provides an overview of this process, but designers should consult Anne Arundel County (2011) or the latest design variation for RSC for additional design guidelines. The

Anne Arundel County guidance can be found at
http://www.aacounty.org/DPW/Watershed/StepPoolStorm-Conveyance.cfm.

Some key RSC sizing considerations include the following:

- One control structure and pool (riffle-pool) combination is needed for each foot of elevation difference along the channel.
- The length of each grade control structure or pool is determined by Equation 4.21

Equation 4.21 Riffle Pool Length

$$L_{pool} = \frac{L_{riffle}}{(Elevation\ Change) \times 2}$$

Where:

L_{pool}	=	surface length of each pool (ft)
L_{riffle}	=	total length of riffle pool (ft)
Elevation Change	=	difference in elevation between pool and bottom pool (ft)

- In areas with steep slopes (10% or greater) the length of the pool or riffle may be small (<10'). In these locations, cascades may be needed as a part of the system design.
- The minimum width of grade control structures should be 8 ft and the width should be equal to 10 times the channel depth (Figure 4.38).
- The depth of flow in the riffle sections should be less than 4 inches.
- Cobbles in the riffle section should be sized so that the velocity of the 100-year storm is non-erosive (Table 4.36).

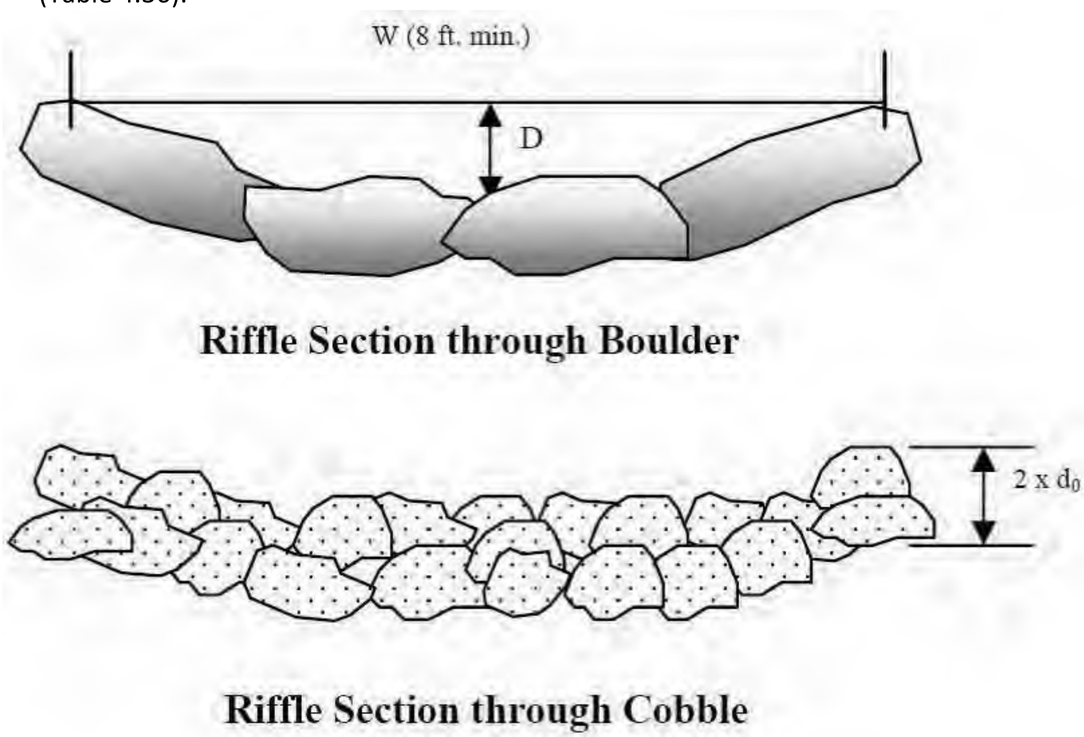

Figure 4.38. Typical Width and Depth of Riffle Sections (Anne Arundel County, 2011).

Table 4.36. Maximum Allowable Velocity

Cobble size (in)	Allowable velocity (ft/s)
4	5.8
5	6.4
6	6.9
7	7.4
8	7.9
9	8.4
10	8.8
11	9.2
12	9.6
15	10.4

- Pools should be between 1.5 and 3 feet deep, and equal to the width of the riffle sections.
- The RSC system is underlain with a sand bed with a 1–5 foot depth and a width between 4 and 14 feet.
- The downstream edge of the riffle should incorporate a series of boulders in a parabolic shape.
- Place a cobble apron below the riffle section to allow for a stable transition between the riffle section and the downstream pools when the pools are dry. The cobble apron should be approximately 5 feet wide and 3 feet long.

The total Sv in the RSC system (available for water quality treatment) is determined by Equation 4.22.

Equation 4.22 RSC Systems Storage Volume

$$Sv = V_{pool} + V_{sandbed}$$

Where:

Sv	=	total storage volume of RSC system (ft^3)
V_{pool}	=	volume in pools (ft^3)
$V_{sandbed}$	=	volume in sand bed (ft^3), use effective porosity of 0.25

4.9.5 Open Channel Landscaping Criteria

All open channels must be stabilized to prevent erosion or transport of sediment to receiving practices or drainage systems. There are several types of grasses appropriate for dry open channels (grass channels and dry swales). These are listed in Table 4.37. Designers should choose plant species that can withstand both wet and dry periods and relatively high velocity flows for planting within the channel. Designers should ensure that the maximum flow velocities do not exceed the values listed in the table for the selected grass species and the specific site slope. For more information on stabilization seeding, see the Charleston County Stabilization Specifications.

Table 4.37. Recommended Vegetation for Open Channels

Vegetation Type	Slope (%)	Maximum Velocity (ft/s)	
		Erosion Resistant Soil	Easily Eroded Soil
Bermuda Grass	0–5	8	6
	5–10	7	5
	>10	6	4
Kentucky Bluegrass	0–5	7	5
	5–10	6	4
	>10	5	3
Tall Fescue Grass Mixture	0–5	6	4
	5–10	4	3
Annual and Perennial Rye	0–5	4	3
Sod		4	3

Source: USDA, TP-61, 1954; Roanoke Virginia, Stormwater Design Manual, 2008

Wet swales should be planted with grass and wetland plant species that can withstand both wet and dry periods as well as relatively high velocity flows within the channel. For a list of wetland plant species suitable for use in wet swales, refer to the wetland panting guidance and plant lists provided in Section 0 Stormwater Wetlands.

Landscape design shall specify proper grass species based on site-specific soils and hydric conditions present along the channel.

Open channels should be seeded at such a density to achieve a 90% vegetated cover after the second growing season. Taller and denser grasses are preferable, although the species is less important than good stabilization and dense vegetative cover.

Grass channels should be seeded and not sodded. Seeding establishes deeper roots and sod may have muck soil that is not conducive to infiltration. Grass channels should be protected by a biodegradable erosion control fabric to provide immediate stabilization of the channel bed and banks.

4.9.6 Open Channel Construction Sequence

Design Notes. Channel invert and tops of banks are to be shown in plan and profile views. A cross sectional view of each configuration and completed limits of grading must be shown for proposed channels. For proposed channels, the transition at the entrance and outfall is to be clearly shown on plan and profile views.

Open Channel Installation. The following is a typical construction sequence to properly install open channels, although steps may be modified to reflect different site conditions or design variations. Grass channels should be installed at a time of year that is best to establish turf cover without irrigation. For more specific information on the installation of wet swales, designers should consult the construction criteria outlined in Section 0 Stormwater Wetlands.

1. **Protection During Site Construction.** Ideally, open channels should remain outside the limits of disturbance during construction to prevent soil compaction by heavy equipment. However, this is seldom practical, given that the channels are a key part of the drainage system at most sites. In these

cases, temporary soil erosion and sediment controls such as dikes, silt fences, and other erosion control measures should be integrated into the swale design throughout the construction sequence. Specifically, barriers should be installed at key check dam locations, and erosion control fabric should be used to protect the channel. Dry swales that lack underdrains (and rely on infiltration) must be fully protected by silt fence or construction fencing to prevent compaction by heavy equipment during construction.

2. **Installation.** Installation may only begin after the entire CDA has been stabilized with vegetation. Any accumulation of sediments that does occur within the channel must be removed during the final stages of grading to achieve the design cross section. Soil erosion and sediment controls for construction of the channel must be installed as specified in the soil erosion and sediment control plan. Stormwater flows must not be permitted into the channel until the bottom and side slopes are fully stabilized.

3. **Grading.** Grade the grass channel to the final dimensions shown on the plan. Excavators or backhoes should work from the sides to grade and excavate the open channels to the appropriate design dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the open channel area. If constructing a dry swale, the bottom of the swale should be ripped, rototilled or otherwise scarified to promote greater infiltration.

4. **Placing Stone Layer (for dry swales).** If constructing a dry swale, place an acceptable geotextile fabric on the underground (excavated) sides of the dry swale with a minimum 6-inch overlap. Place the stone needed for storage layer over the filter bed. Add the perforated underdrain pipe. Add the remaining stone jacket, and then pack No. 57 stone (clean, double-washed) to 3 inches above the top of the underdrain, and then add 3 inches of pea gravel as a filter layer. Add the filter media in 12-inch lifts until the desired top elevation of the dry swale is achieved. Water thoroughly and add additional media as needed where settlement has occurred.

5. **Add Amendments (optional, for grass channels).** Add soil amendments as needed. Till the bottom of the grass channel to a depth of 1 foot and incorporate compost amendments according to Appendix C Soil Compost Amendment Requirements.

6. **Install Check Dams**. Install check dams, driveway culverts and internal pretreatment features as shown on the plan. Fill material used to construct check dams should be placed in 8- to 12-inch lifts and compacted to prevent settlement. The top of each check dam must be constructed level at the design elevation.

7. **Hydro-seed.** Hydro-seed the bottom and banks of the open channel, and peg in erosion control fabric or blanket where needed. After initial planting, a biodegradable erosion control fabric should be used, conforming the South Carolina BMP Handbook (SDHEC, 2005).

8. **Plant.** Plant landscaping materials as shown in the landscaping plan, and water them weekly during the first 2 months. The construction contract should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction.

9. **Final Inspection.** A qualified professional should conduct the final construction inspection and develop a punch list for facility acceptance.

Open Channel Construction Supervision. Supervision during construction is recommended to ensure that the open channel is built in accordance with these specifications.

Construction phase inspection checklist is available in Appendix E Construction Inspection Checklists.

Some common pitfalls can be avoided by careful construction supervision that focuses on the following key aspects of dry swale installation:

- Make sure the desired coverage of turf or erosion control fabric has been achieved following construction, both on the channel beds and their contributing side-slopes.
- Inspect check dams and pretreatment structures to make sure they are at correct elevations, are properly installed, and are working effectively.
- For dry swale designs:

  Check the filter media to confirm that it meets specifications and is installed to the correct depth.

  Check elevations, such as the invert of the underdrain, inverts for the inflow and outflow points, and the ponding depth provided between the surface of the filter bed and the overflow structure.

  Ensure that caps are placed on the upstream (but not the downstream) ends of the underdrains.

  Check that outfall protection/energy dissipation measures at concentrated inflow and outflow points are stable.

The real test of an open channel occurs after its first big storm. The post-storm inspection should focus on whether the desired sheetflow, shallow concentrated flows or fully concentrated flows assumed in the plan actually occur in the field. Minor adjustments are normally needed as part of this post-storm inspection (e.g., spot reseeding, gully repair, added armoring at inlets, or realignment of outfalls and check dams). Also, a qualified professional should check that dry swale practices drain completely within the 72-hour drawdown period.

4.9.7 Open Channel Maintenance Criteria

Maintenance is a crucial and required element that ensures the long-term performance of open channels. Once established, grass channels have minimal maintenance needs outside of the spring cleanup, regular mowing, repair of check dams, and other measures to maintain the hydraulic efficiency of the channel and a dense, healthy grass cover. Dry swale designs may require regular pruning and management of trees and shrubs. The surface of dry swale filter beds can become clogged with fine sediment over time, but this can be alleviated through core aeration or deep tilling of the filter bed. Additional effort may be needed to repair check dams, stabilize inlet points, and remove deposited sediment from pretreatment cells. Table 4.38 provides a schedule of typical maintenance activities required for open channels.

Table 4.38.Typical Maintenance Activities and Schedule for Open Channels

Schedule	Maintenance Activity
As needed	▪ Mow grass channels and dry swales during the growing season to maintain grass heights in the 4- to 6-inch range.
Quarterly	▪ Ensure that the CDA, inlets, and facility surface are clear of debris. ▪ Ensure that the CDA is stabilized. Perform spot-reseeding if where needed. ▪ Remove accumulated sediment and oil/grease from inlets, pretreatment devices, flow diversion structures, and overflow structures. ▪ Repair undercut and eroded areas at inflow and outflow structures.
Annual inspection	▪ Add reinforcement planting to maintain 90% turf cover. Reseed areas of dead vegetation. ▪ Remove any accumulated sand or sediment deposits behind check dams. ▪ Inspect upstream and downstream of check dams for evidence of undercutting or erosion. Remove and trash or blockages at weep holes. ▪ Examine channel bottom for evidence of erosion, braiding, excessive ponding, or dead grass. ▪ Check inflow points for clogging and remove any sediment. ▪ Inspect side slopes and grass filter strips for evidence of any rill or gully erosion and repair. ▪ Look for any bare soil or sediment sources in the CDA and stabilize immediately.

Maintenance Inspections. Annual inspections by a qualified professional are used to trigger maintenance operations, such as sediment removal, spot revegetation, and inlet stabilization. Maintenance inspection checklists for disconnection and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Waste Material. Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.9.8 Open Channel Stormwater Compliance Calculations

Grass channels are credited with 10% retention for the storage volume (Sv) provided by the practice as well as 50% TSS, 25% TN, and 30% bacteria removal (see Table 4.39).

Table 4.39. Grass Channel Retention and Pollutant Removal

Retention	= 10%
TSS Removal	= 50%
TN Removal	= 25%
Bacteria Removal	= 30%

Grass channels with amended soils are credited with 20% retention for the storage volume (Sv) provided by the practice as well as 50% TSS, 35% TN, and 30% bacteria removal (Table 4.40).

Table 4.40. Grass Channel on Amended Soils Retention and Pollutant Removal

Retention	= 20%
TSS Removal	= 50%
TN Removal	= 35%
Bacteria Removal	= 30%

Dry swales are credited with 60% retention for the storage volume (Sv) provided by the practice as well as 85% TSS, 70% TN, and 80% bacteria removal (Table 4.41).

Table 4.41. Dry Swale Retention and Pollutant Removal

Retention	= 60%
TSS Removal	= 85%
TN Removal	= 70%
Bacteria Removal	= 80%

Wet Swales are credited with 0% retention, but they do receive 80% TSS, 25% TN, and 60% bacteria removal for the storage volume (Sv) provided by the practice (Table 4.42).

Table 4.42. Wet Swale Retention and Pollutant Removal

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 25%
Bacteria Removal	= 60%

RSCs are credited with 0% retention, but they do receive 80% TSS, 40% TN, and 80% bacteria removal for the storage volume (Sv) provided by the practice (Table 4.43).

Table 4.43. RSC Retention and Pollutant Removal

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 40%
Bacteria Removal	= 80%

All practices must be sized using the guidance detailed in Section 4.7.4 Open Channel Design Criteria.

Open channels also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the storage volume from the total runoff volume for the 2-year through the 50-year storm events. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

4.9.9 References

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4.10 Filtering Systems

Filtering Systems				
Definition: Practices that capture and temporarily store the design storm volume and pass it through a filter bed of sand media. Filtered runoff may be collected and returned to the conveyance system or allowed to partially infiltrate into the soil.				
Site Applicability		**BMP Performance Summary**		
Land Uses	**Required Footprint**	**WQ Improvement:** Moderate to High		
▪ Urban ▪ Suburban	Small	**TSS[1]**	**Total N[1]**	**Bacteria[1]**
		80%	30%	80%
		Runoff Reductions		
Construction Costs	**Maintenance Burden**	**Volume**		
High	High	Low		
Maintenance Frequency:		***SWRv***		
Routine	**Non-Routine**	0%		
At least annually	Every 5 years			
Advantages/Benefits		**Disadvantages/Limitation**		
▪ Applicable to small drainage areas ▪ Good for highly impervious areas ▪ Good for water quality retrofits to existing developments		▪ High maintenance burden ▪ Not recommended for areas with high sediment content in stormwater or clay/silt runoff areas ▪ Relatively costly ▪ Possible odor problems, if not maintained ▪ Limited volume and rate control		
Components		**Design considerations**		
▪ Conveyance ▪ Pretreatment ▪ Sand bed (or Filtration) chamber ▪ Spillway/outlet system(s) ▪ Liner, as needed		▪ Typically requires 2 to 10 feet of head ▪ Maximum CDA of 2-5 acres ▪ Must drain within 40 hours ▪ In karst areas, watertight structure required ▪ Maintenance access		
Maintenance Activities				
▪ Inspect for clogging—rake first inch of sand ▪ Remove sediment from pretreatment areas		▪ Replace filter media as needed ▪ Clean spillway/outlet system(s)		

[1]*Credited pollutant load removal*

Stormwater filters are a useful practice to treat stormwater runoff from small, highly impervious sites. Stormwater filters capture, temporarily store, and treat stormwater runoff by passing it through an engineered filter media, collecting the filtered water in an underdrain, and then returning it back to the storm drainage system. Stormwater filters are a versatile option because they consume very little surface land and have few site restrictions. They provide moderate pollutant removal performance at small sites where space is limited.

Definition. Practices that capture and temporarily store the design storm volume and pass it through a filter bed of sand media. Filtered runoff may be collected and returned to the conveyance system or allowed to partially infiltrate into the soil. Design variants include the following:

F-1 Nonstructural sand filter

F-2 Surface sand filter

F-3 Three-chamber underground sand filter

F-4 Perimeter sand filter

Filters have no retention capability, so designers should consider using up-gradient retention practices, which have the effect of decreasing the design storm volume and size of the filtering practices. Filtering practices are also suitable to provide special treatment at designated stormwater hotspots.

Filtering systems are typically not designed to provide stormwater detention, but they may be in some circumstances. Filtering practices are generally combined with separate facilities to provide this type of control. However, the three-chamber underground sand filter can be modified by expanding the first (or settling) chamber, or by adding an extra chamber between the filter chamber and the clear well chamber to handle the detention volume, which is subsequently discharged at a predetermined rate through an orifice and weir combination.

A nonstructural or surface sand filter is depicted in Figure 4.39, while Figure 4.40 through Figure 4.45 depict three-chamber underground sand filters.

Perimeter sand filters (Figure 4.46) are enclosed stormwater management practices that are typically located just below grade in a trench along the perimeter of parking lot, driveway, or other impervious surface. Perimeter sand filters consist of a pretreatment forebay and a filter bed chamber. Stormwater runoff is conveyed into a perimeter sand filter through grate inlets located directly above the system

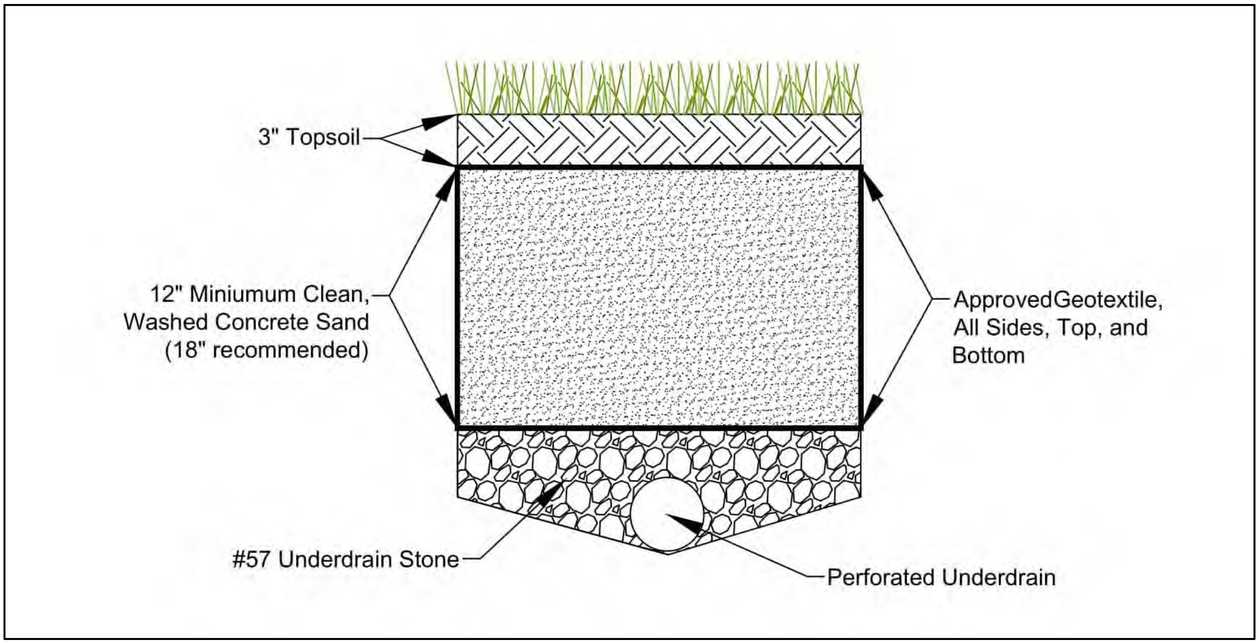

Figure 4.39. Typical schematic for a nonstructural or surface sand filter (note: material specifications are found in Table 4.44).

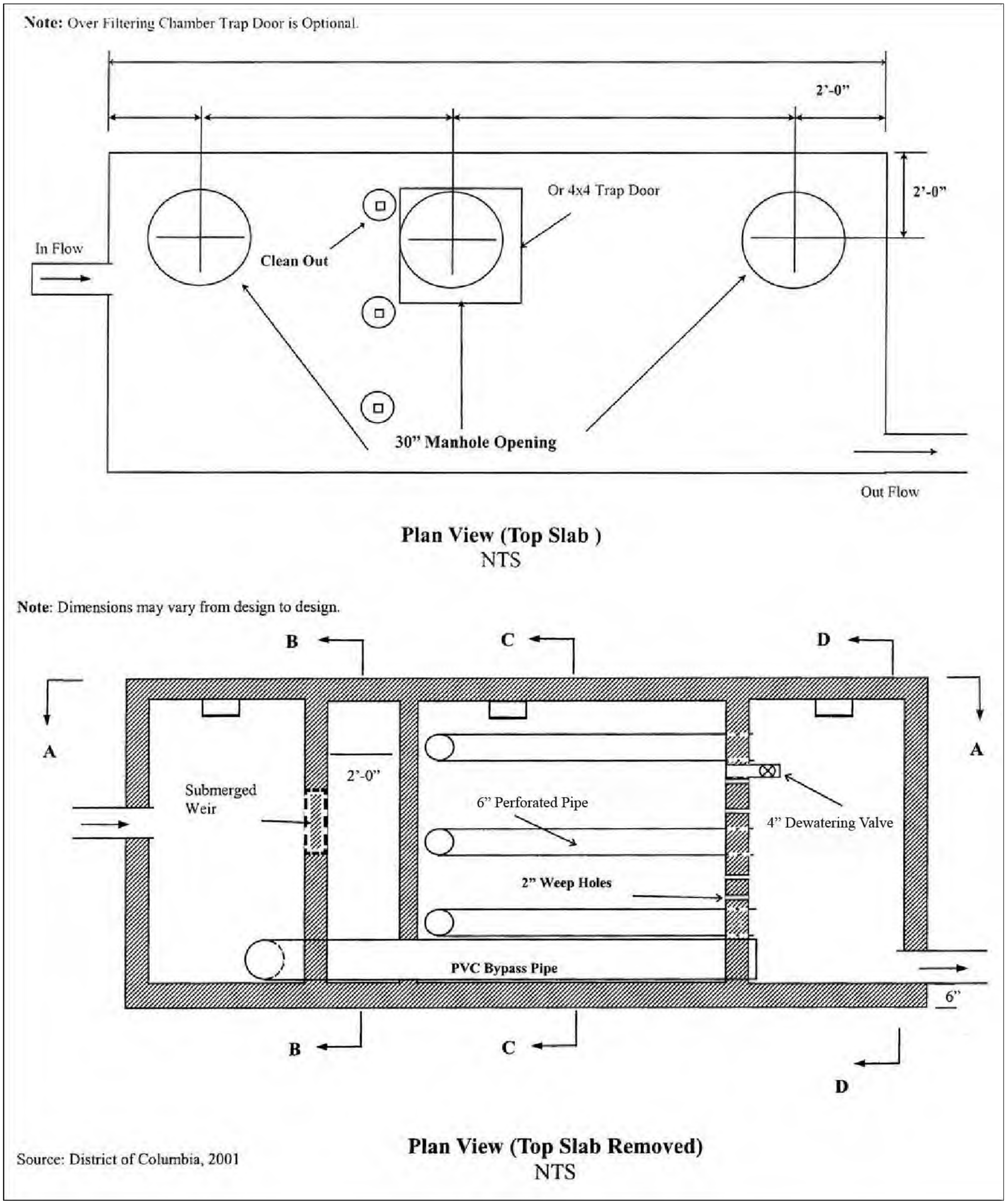

Figure 4.40. Example of a three-chamber underground sand filter (F-3) for separate sewer options. Part A. Note: material specifications are indicated in Table 4.44.

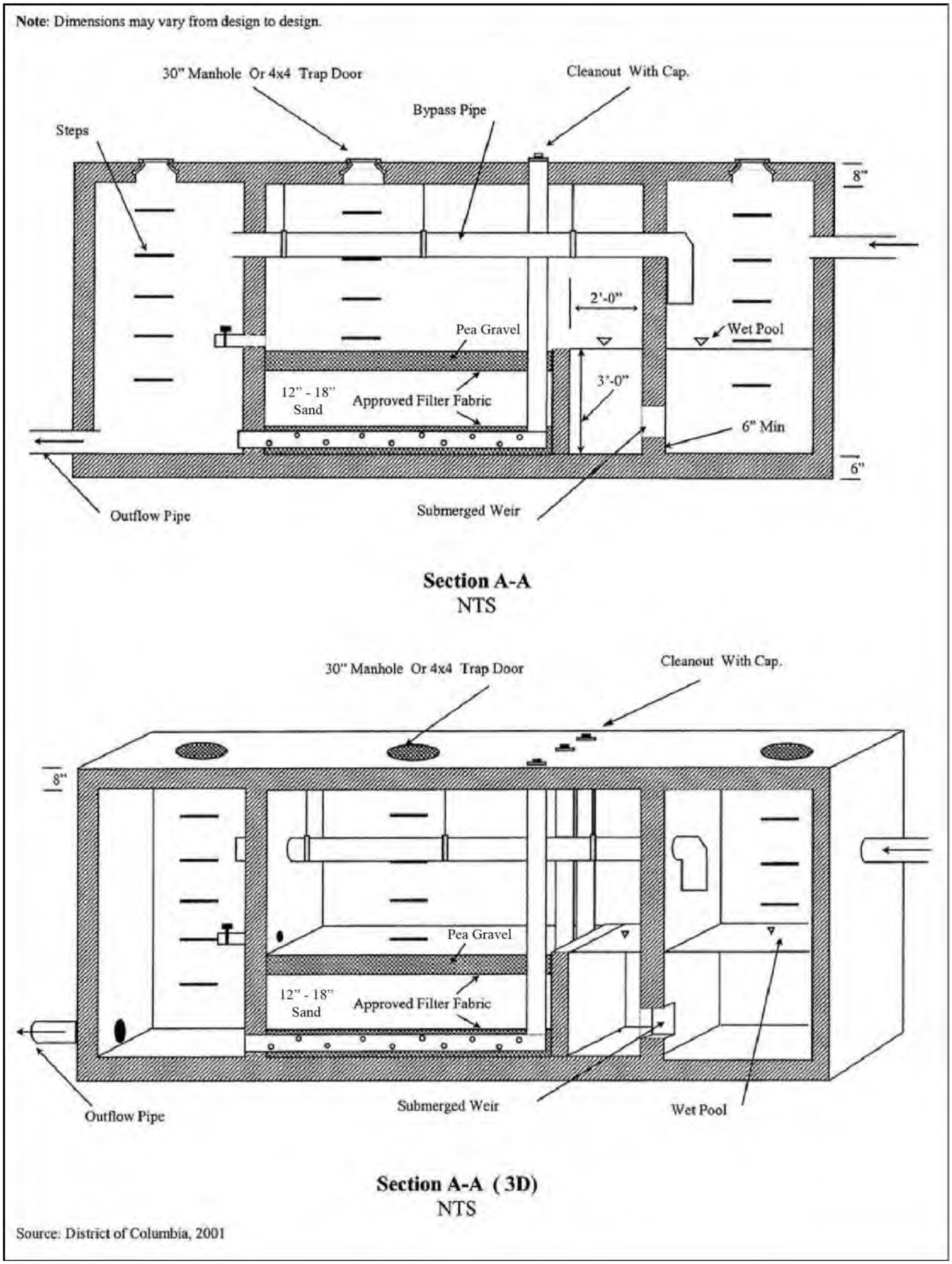

Figure 4.41. Example of a three-chamber underground sand filter (F-3) for separate sewer areas. Part B. Note: material specifications are indicated in Table 4.44.

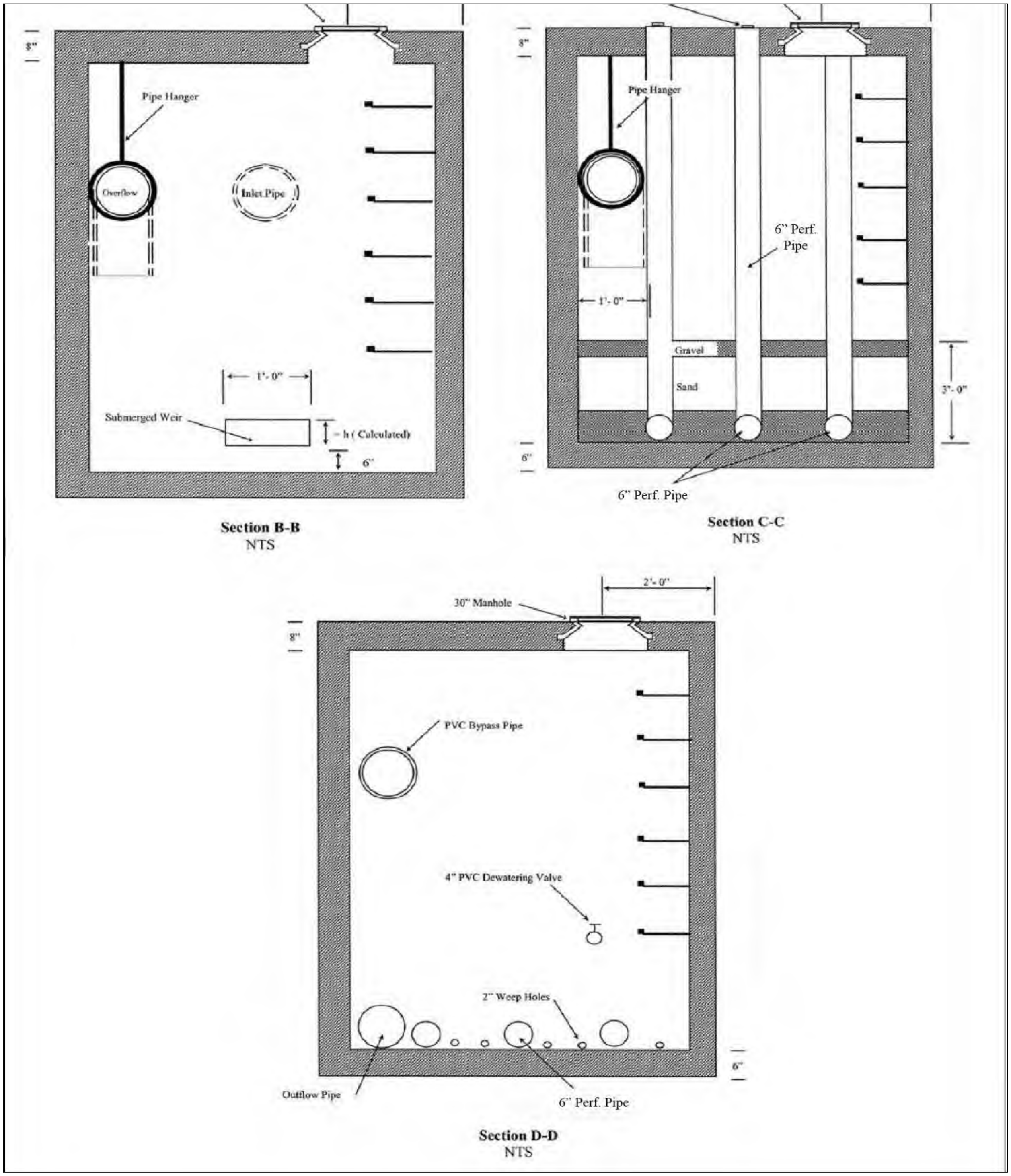

Figure 4.42. Example of a three-chamber underground sand filter (F-3) for separate sewer areas. Part C. Note: material specifications are indicated in Table 4.44.

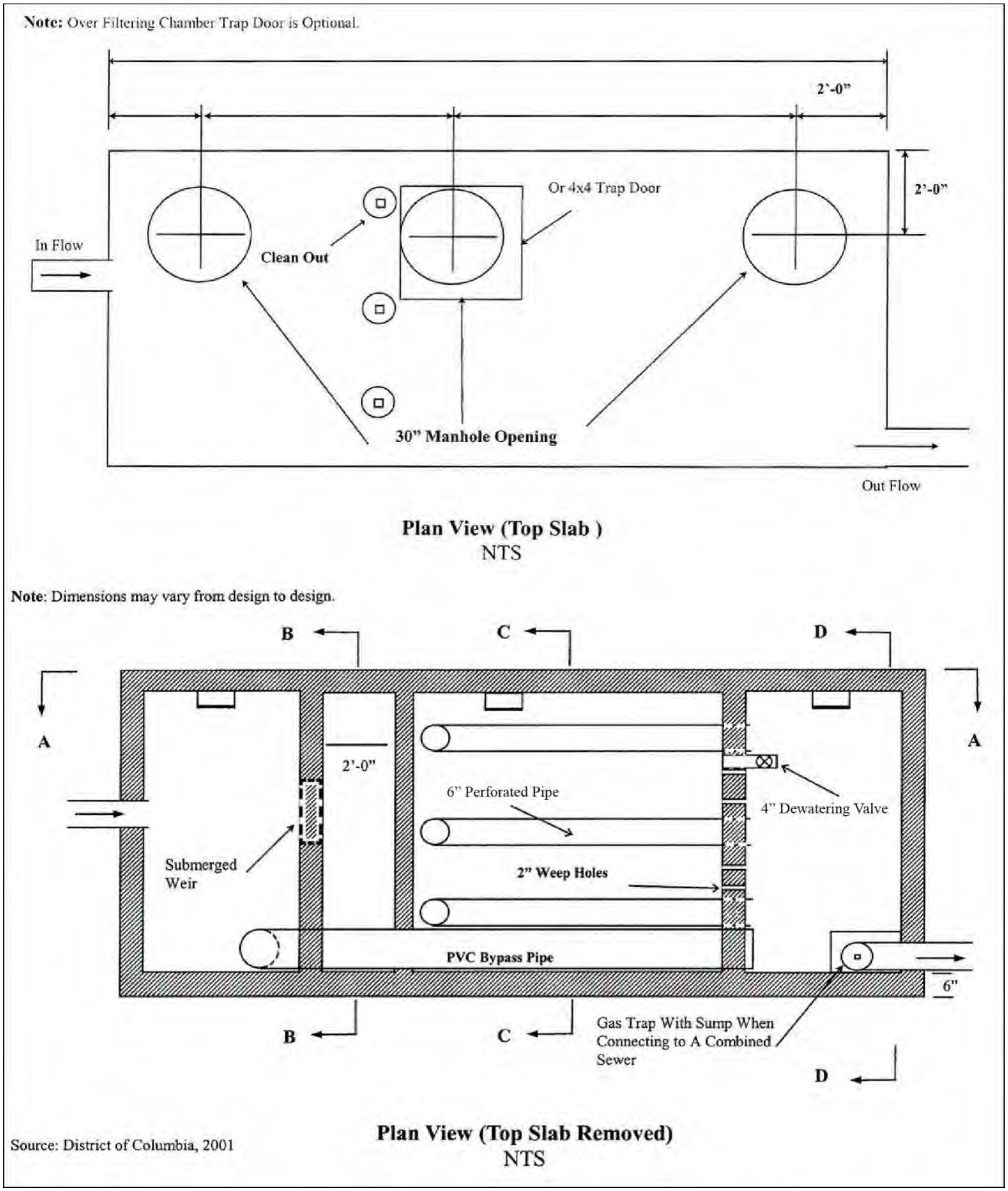

Figure 4.43. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part A. Note: Material specifications are indicated in Table 4.44.

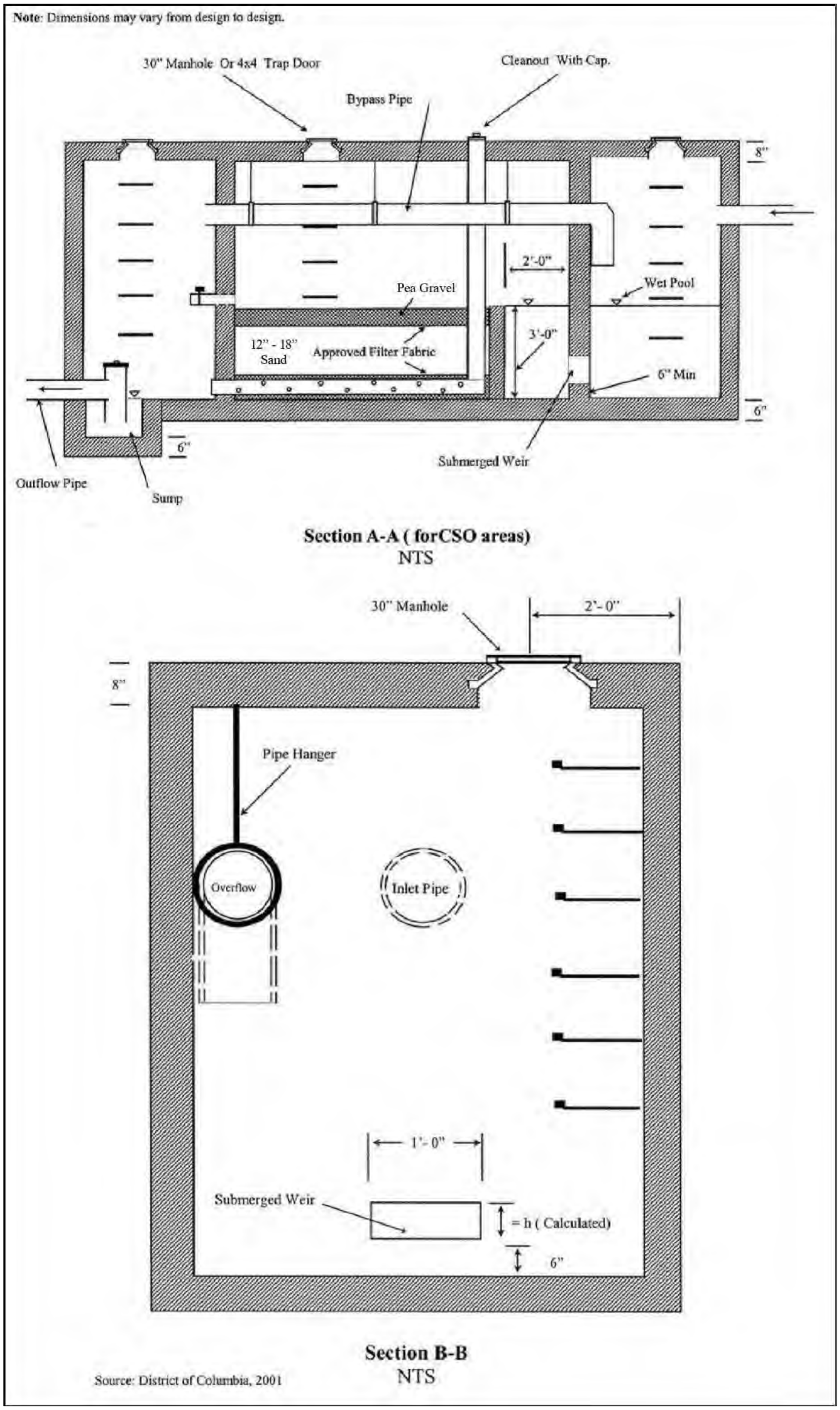

Figure 4.44. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part B. Note: Material specifications are indicated in Table 4.44.

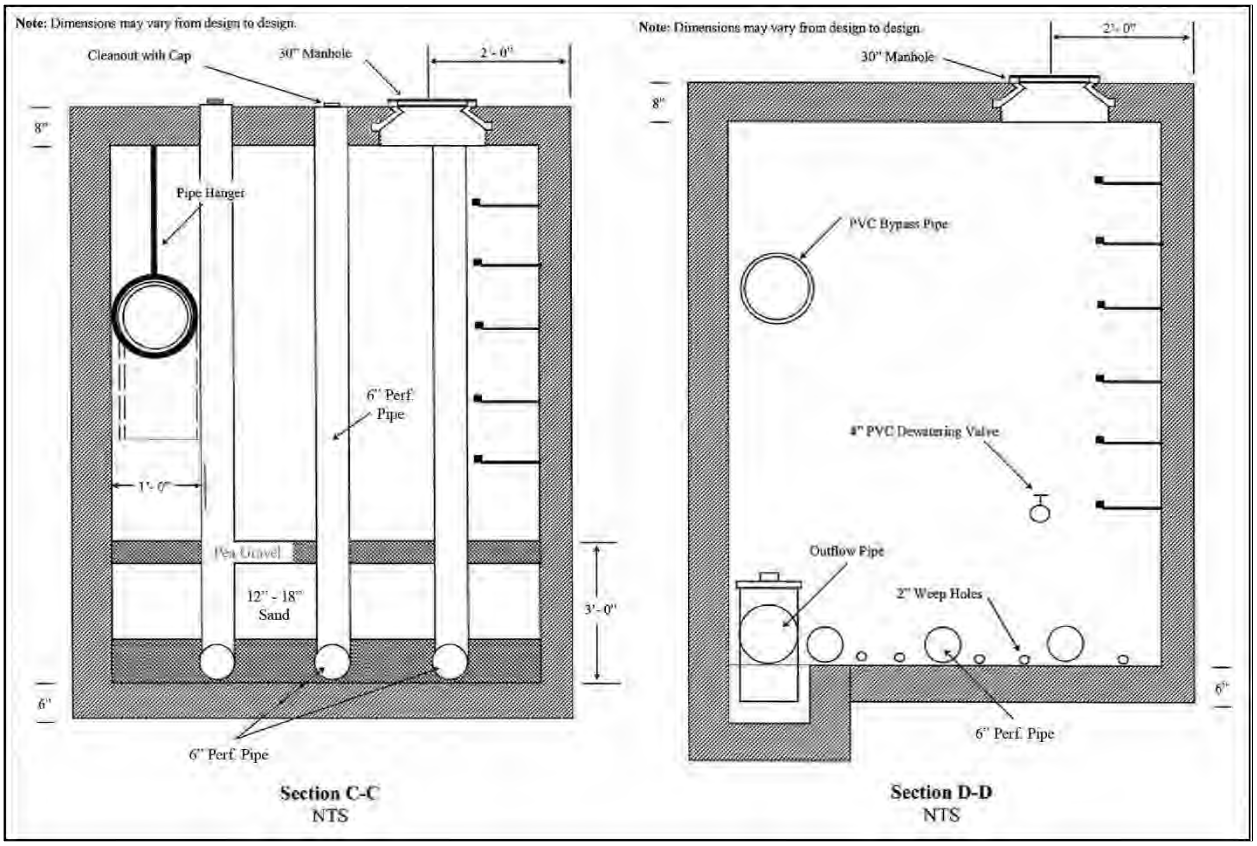

Figure 4.45. Example of a three-chamber underground sand filter (F-3) for combined sewer areas. Part C. Note: Material specifications are indicated in Table 4.44.

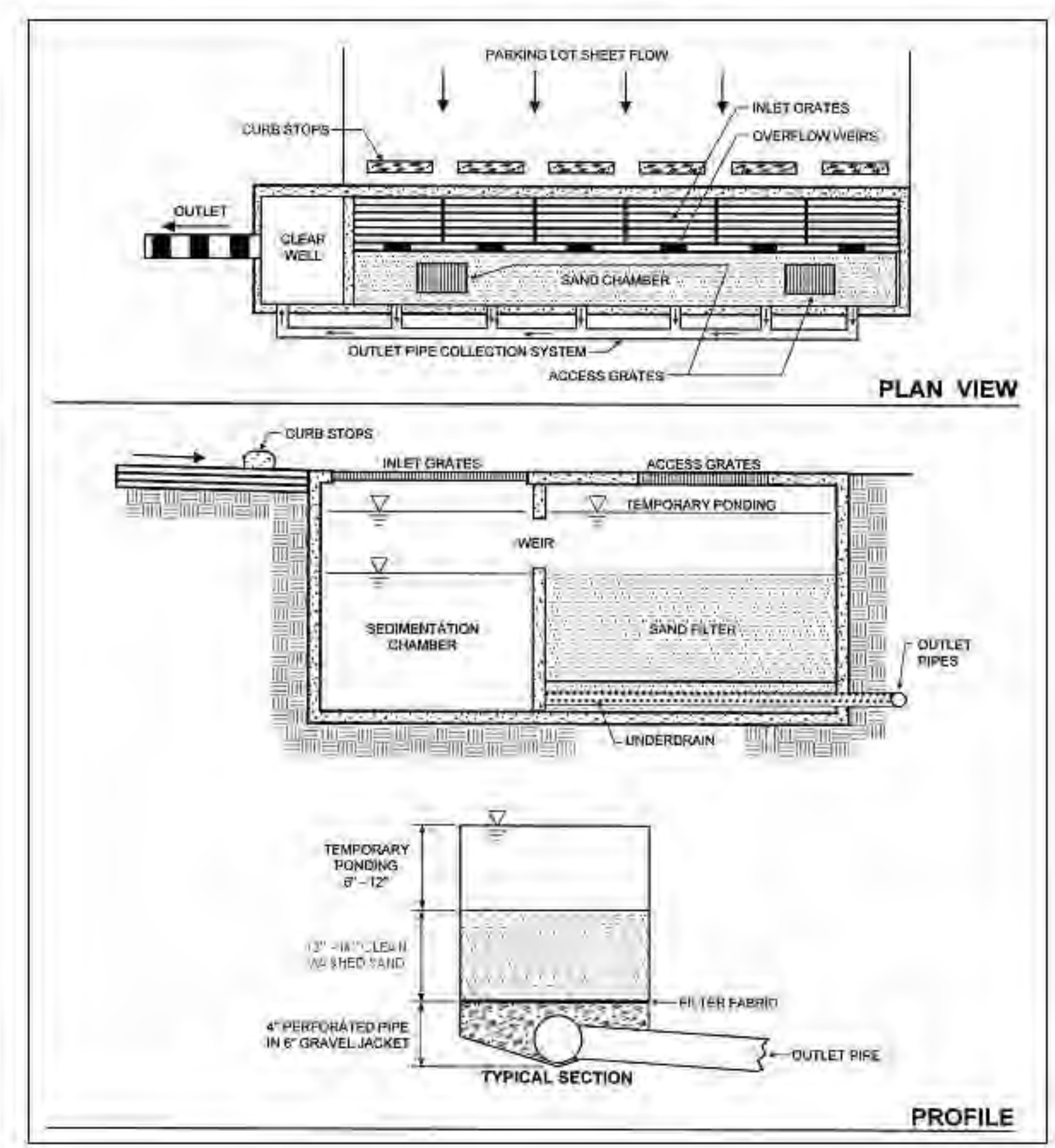

Figure 4.46. Example of a perimeter sand filter (F-4). Note: material specifications are indicated in Table 4.44.

4.10.1 Filtering System Feasibility Criteria

Stormwater filters can be applied to most types of urban land. They are not always cost-effective, given their high unit cost and small area served, but there are situations where they may clearly be the best option for stormwater treatment (e.g., hotspot runoff treatment, small parking lots, ultra-urban areas, etc.). The following criteria apply to filtering practices:

Available Hydraulic Head. The principal design constraint for stormwater filters is available hydraulic head, which is defined as the vertical distance between the top elevation of the filter and the bottom elevation of the existing storm drain system that receives its discharge. The head required for stormwater filters ranges from 2 to 10 feet, depending on the design variant. It is difficult to employ filters in extremely flat terrain, since they require gravity flow through the filter. The only exception is the perimeter sand filter, which can be applied at sites with as little as 2 feet of head.

Depth to Water Table. The designer must assure a standard separation distance of at least 0.5 feet between the groundwater table and the bottom invert of the filtering practice.

Contributing Drainage Area. Filters are best applied on small sites where the CDA is as close to 100% impervious as possible to reduce the risk that eroded sediment will clog the filter. If the CDA is pervious, then the vegetation must be dense and stable. Turf is acceptable (see Section 4.10.5 Filtering Landscaping Criteria). A maximum CDA of 5 acres is recommended for surface sand filters, and a maximum CDA of 2 acres is recommended for perimeter or underground filters. Filters have been used on larger CDAs in the past, but greater clogging problems have typically resulted.

Space Required. The amount of space required for a filter practice depends on the design variant selected. Surface sand filters typically consume about 2%–3% of the CDA, while perimeter sand filters typically consume less than 1%. Underground stormwater filters generally consume no surface area except their manholes.

Land Use. As noted above, filters are particularly well suited to treat runoff from stormwater hotspots and smaller parking lots. Other applications include redevelopment of commercial sites or when existing parking lots are renovated or expanded. Filters can work on most commercial, industrial, institutional, or municipal sites and can be located underground if surface area is not available.

Site Topography. Filters shall not be located on slopes greater than 6%.

Utilities. All utilities shall have a minimum 5-foot, horizontal clearance from the filtering practice.

Facility Access. All filtering systems shall be located in areas where they are accessible for inspection and for maintenance (by vacuum trucks).

Soils. Soil conditions do not constrain the use of filters. At least one soil boring must be taken at a low point within the footprint of the proposed filtering practice to establish the water table and evaluate soil suitability. A geotechnical investigation is required for all underground stormwater BMPs, including underground filtering systems. Geotechnical testing requirements are outlined in Appendix B Geotechnical Information Requirements for Underground BMPs.

Setbacks. Filters should be set back at least 10 feet from the property line, and the bottom of the practice should be separated from groundwater by at least 0.5 feet.

Economic Considerations. Perimeter sand filters are expensive relative to other treatment practices, but may be the only option to treat small hotspot drainage areas.

4.10.2 Filtering System Conveyance Criteria

Most filtering practices are designed as off-line systems so that all flows enter the filter storage chamber until it reaches capacity, at which point larger flows are then diverted or bypassed around the filter to an outlet chamber and are not treated. Runoff from larger storm events must be bypassed using an overflow structure or a flow splitter. Claytor and Schueler (1996) and ARC (2001) provide design guidance for flow splitters for filtering practices.

Some underground filters will be designed and constructed as on-line BMPs. In these cases, designers must indicate how the device will safely pass larger storm events (e.g., the 25-year event) to a stabilized water course without resuspending or flushing previously trapped material.

All stormwater filters must be designed to drain or dewater within 40 hours (1.67 days) after a storm event to reduce the potential for nuisance conditions.

4.10.3 Filtering System Pretreatment Criteria

Adequate pretreatment is needed to prevent premature filter clogging and ensure filter longevity. Dry or wet pretreatment shall be provided prior to filter media. Pretreatment devices are subject to the following criteria:

- Sedimentation chambers are typically used for pretreatment to capture coarse sediment particles before they reach the filter bed.
- Sedimentation chambers may be wet or dry but must be sized to accommodate at least 25% of the total design storm volume (inclusive).
- Sediment chambers should be designed as level spreaders such that inflows to the filter bed have near zero velocity and spread runoff evenly across the bed.
- Non-structural and surface sand filters may use alternative pretreatment measures, such as a grass filter strip, forebay, gravel diaphragm, check dam, level spreader, or a combination of these. The grass filter strip must be a minimum length of 15 feet and have a slope of 3% or less. The check dam may be wooden or concrete and must be installed so that it extends only 2 inches above the filter strip and has lateral slots to allow runoff to be evenly distributed across the filter surface. Alternative pretreatment measures must contain a non-erosive flow path that distributes the flow evenly over the filter surface. If a forebay is used, it must be designed to accommodate at least 25% of the total design storm volume (inclusive).

4.10.4 Filtering System Design Criteria

Detention time. All filter systems must be designed to drain the design storm volume from the filter chamber within 40 hours (1.67 days) after each rainfall event.

Structural Requirements. If a filter will be located underground or experience traffic loads, a licensed structural engineer must certify the structural integrity of the design.

Geometry. Filters are gravity flow systems that normally require 2 to 5 feet of driving head to push the water through the filter media through the entire maintenance cycle; therefore, sufficient vertical clearance between the inverts of the inflow and outflow pipes is required.

Type of Filter Media. The normal filter media consists of clean, washed AASHTO M-6/ASTM C-33 medium aggregate concrete sand with individual grains 0.02 to 0.04 inches in diameter.

Depth of Filter Media. The depth of the filter media plays a role in how quickly stormwater moves through the filter bed and how well it removes pollutants. The recommended filter bed depth is 18 inches. An absolute minimum filter bed depth of 12 inches above underdrains is required; although, designers should note that specifying the minimum depth of 12 inches will incur a more intensive maintenance schedule and possibly result in costlier maintenance.

Underdrain and Liner. Stormwater filters are normally designed with an impermeable liner and underdrain system that meet the criteria provided in Table 4. 44 below.

Underdrain Stone. The underdrain should be covered by a minimum 6-inch gravel layer consisting of clean, double washed No. 57 stone.

Type of Filter. There are several design variations of the basic filter that enable designers to use filters at challenging sites or to improve pollutant removal rates. The choice of which filter design to apply depends on available space, hydraulic head, and the level of pollutant removal desired. In ultra-urban situations where surface space is at a premium, underground sand filters are often the only design that can be used. Surface and perimeter filters are often a more economical choice when adequate surface area is available. The most common design variants include the following:

- **Non-Structural Sand Filter (F-1).** The non-structural sand filter is applied to sites less than 2 acres in size and is very similar to a bioretention practice (see Section 4.3 Bioretention), with the following exceptions:
  - The bottom is lined with an impermeable liner and always has an underdrain.
  - The surface cover is sand, turf, or pea gravel.
  - The filter media is 100% sand.
  - The filter surface is not planted with trees, shrubs, or herbaceous materials.
  - The filter has two cells, with a dry or wet sedimentation chamber preceding the sand filter bed.
  - The non-structural sand filter is the least expensive filter option for treating hotspot runoff. The use of bioretention areas is generally preferred at most other sites.
- **Surface Sand Filter (F-2).** The surface sand filter is designed with both the filter bed and sediment chamber located at ground level. The most common filter media is sand; however, a peat/sand mixture may be used to increase the removal efficiency of the system. In most cases, the filter chambers are created using precast or cast-in-place concrete. Surface sand filters are normally designed to be off-line facilities, so that only the desired design volume is directed to the filter for treatment. However, in some cases they can be installed on the bottom of a dry pond (see Section 4.11 Storage Practices).
- **Underground Sand Filter.** The underground sand filter is modified to install the filtering components underground and is often designed with an internal flow splitter or overflow device that bypasses runoff from larger stormwater events around the filter. Underground sand filters are expensive to construct, but they consume very little space and are well suited to ultra-urban areas.
- **Three-Chamber Underground Sand Filter (F-3).** The three-chamber underground sand filter is a gravity flow system. The facility may be precast or cast-in-place. The first chamber acts as a pretreatment facility removing any floating organic material such as oil, grease, and tree leaves. It should have a submerged orifice leading to a second chamber, and it should be designed to minimize the energy of incoming stormwater before the flow enters the second chamber (i.e., filtering or processing chamber).

  The second chamber is the filtering or processing chamber. It should contain the filter material consisting of gravel and sand and should be situated behind a weir. Along the bottom of the structure should be a subsurface drainage system consisting of a parallel perforated PVC pipe system in a stone bed. A dewatering valve should be installed at the top of the filter layer for safety release in cases of emergency. A bypass pipe crossing the second chamber to carry overflow from the first chamber to the third chamber is required.

The third chamber is the discharge chamber. It should also receive the overflow from the first chamber through the bypass pipe when the storage volume is exceeded.

Water enters the first chamber of the system by gravity or by pumping. This chamber removes most of the heavy solid particles, floatable trash, leaves, and hydrocarbons. Then the water flows to the second chamber and enters the filter layer by overtopping a weir. The filtered stormwater is then picked up by the subsurface drainage system that empties it into the third chamber.

Whenever there is insufficient hydraulic head for a three-chamber underground sand filter, a well pump may be used to discharge the effluent from the third chamber into the receiving storm or combined sewer. For three-chamber sand filters in combined-sewer areas, a water trap shall be provided in the third chamber to prevent the back flow of odorous gas.

- **Perimeter Sand Filter (F-4).** The perimeter sand filter also includes the basic design elements of a sediment chamber and a filter bed. The perimeter sand filter typically consists of two parallel trenches connected by a series of overflow weir notches at the top of the partitioning wall, which allows water to enter the second trench as sheet flow. The first trench is a pretreatment chamber removing heavy sediment particles and debris. The second trench consists of the sand filter layer. A subsurface drainage pipe must be installed at the bottom of the second chamber to facilitate the filtering process and convey filter water into a receiving system.

  In this design, flow enters the system through grates, usually at the edge of a parking lot. The perimeter sand filter is usually designed as an on-line practice (i.e., all flows enter the system), but larger events bypass treatment by entering an overflow chamber. One major advantage of the perimeter sand filter design is that it requires little hydraulic head and is therefore a good option for sites with low topographic relief.

Surface Cover. The surface cover for non-structural and surface sand filters should consist of a 3-inch layer of topsoil on top of the sand layer. The surface may also have pea gravel inlets in the topsoil layer to promote filtration. The pea gravel may be located where sheet flow enters the filter, around the margins of the filter bed, or at locations in the middle of the filter bed.

Underground sand filters should have a pea gravel or No. 57 stone layer on top of the sand layer. This gravel layer helps to prevent bio-fouling or blinding of the sand surface.

Maintenance Reduction Features. The following maintenance issues should be addressed during filter design to reduce future maintenance problems:

- **Observation Wells and Cleanouts.** Non-structural and surface sand filters must include an observation well consisting of a 6-inch diameter non-perforated PVC pipe fitted with a lockable cap. It should be installed flush with the ground surface to facilitate periodic inspection and maintenance. In most cases, a cleanout pipe will be tied into the end of all underdrain pipe runs. The portion of the cleanout pipe/observation well in the underdrain layer should be perforated. At least one cleanout pipe must be provided for every 2,000 square feet of filter surface area.

- **Access.** Good maintenance access is needed to allow crews to perform regular inspections and maintenance activities. "Sufficient access" is operationally defined as the ability to get a vacuum truck or similar equipment close enough to the sedimentation chamber and filter to enable cleanouts. Direct maintenance access shall be provided to the pretreatment area and the filter bed. For underground structures, sufficient headroom for maintenance should be provided. A minimum head space of 5 feet above the filter is recommended for maintenance of the structure. However, if 5 feet of headroom is not available, manhole access must be installed.
- **Manhole Access (for underground filters).** Access to the headbox and clearwell of Underground Filters must be provided by manholes at least 30 inches in diameter, along with steps to the areas where maintenance will occur.
- **Visibility.** Stormwater filters should be clearly visible at the site so inspectors and maintenance crews can easily find them. Adequate signs or markings must be provided at manhole access points for Underground Filters.
- **Confined Space Issues.** Underground filters are often classified as a confined space. Consequently, special OSHA rules apply, and training may be needed to protect the workers that access them. These procedures often involve training about confined space entry, venting, and the use of gas probes.

Filter Material Specifications. The basic material specifications for filtering practices that utilize sand as a filter media are outlined in Table 4.44.

Table 4.44. Filtering Practice Material Specifications

Material	Specification
Surface Cover	Non-structural and surface sand filters: 3-inch layer of topsoil on top of the sand layer. The surface may also have pea gravel inlets in the topsoil layer to promote filtration. Underground sand filters: Clean, double-washed pea gravel or No. 57 stone on top of the sand layer.
Sand	Clean AASHTO M-6/ASTM C-33 medium aggregate concrete sand with a particle size range of 0.02–0.04 inches in diameter.
Choker Stone and/or Geotextile/Filter Fabric	For choker stone, a 2- to 4-inch layer of choker stone (e.g., typically ASTM D448 No. 8 or No. 89 washed gravel) should be placed between the sand layer and the underdrain stone. Alternatively, if available head is limited, an appropriate geotextile fabric that meets AASHTO M-288 Class 2, latest edition, requirements may be used. The geotextile fabric must have a flow rate of > 125 gpm/ft^2 (ASTM D4491) and an Apparent Opening Size (AOS) equivalent to a US No. 70 or No. 80 sieve.
Underdrain/Perforated Pipe	4- or 6-inch perforated schedule 40 PVC pipe, with three or four rows of 3/8-inch perforations at 6 inches on center.
Underdrain Stone	Use No. 57 stone or the ASTM equivalent (1-inch maximum).
Impermeable Liner	Where appropriate, use a PVC Geomembrane liner or equivalent.

Filter Sizing. Filtering devices are sized to accommodate a specified design storm volume (typically SWRv). The volume to be treated by the device is a function of the storage depth above the filter and the surface area of the filter. The storage volume is the volume of ponding above the filter. For a given design volume, Equation 4.23 is used to determine the required filter surface area.

Equation 4.23 Minimum Filter Surface Area for Filtering Practices

$$SA_{filter} = \frac{DesignVolume \times d_f}{k \times (h_{avg} + d_f) \times t_d}$$

Where:

SA_{filter}	=	area of the filter surface (ft^2)
DesignVolume	=	design storm volume, typically the SWRv (ft^2)
d_f	=	filter media depth (thickness) (ft), with a minimum of 1 ft
k	=	coefficient of permeability (ft/day) (3.5 ft/day for partially clogged sand)
h_f	=	height of water above the filter bed (ft), with a maximum of 5 ft
h_{avg}	=	average height of water above the filter bed (ft), one half of the filter height (h_f)
t_d	=	allowable drawdown time (1.67 days)

The coefficient of permeability (ft/day) is intended to reflect the worst-case situation (i.e., the condition of the sand media at the point in its operational life where it is in need of replacement or maintenance). Filtering practices are therefore sized to function within the desired constraints at the end of the media's operational life cycle.

The entire filter treatment system, including pretreatment, shall temporarily hold at least 50% of the design storm volume prior to filtration (see Equation 4.24). This reduced volume takes into account the varying filtration rate of the water through the media, as a function of a gradually declining hydraulic head.

Equation 4.24 Required Ponding Volume for Filtering Practices

$$V_{ponding} = 0.50 \times DesignVolume$$

Where:

$V_{ponding}$	=	storage volume required prior to filtration (ft^3)
DesignVolume	=	design storm volume, typically the SWRv (ft^2)

The total storage volume for the practice (Sv) can be determined using Equation 4. 25 below.

Equation 4.25 Storage Volume for Filtering Practices

$$Sv = 2.0 \times V_{ponding}$$

Where:

Sv	=	total storage volume for the practice (ft^3)
$V_{ponding}$	=	storage volume required prior to filtration (ft^3)

4.10.5 Filtering System Landscaping Criteria

A dense and vigorous vegetative cover shall be established over the contributing pervious drainage areas before runoff can be accepted into the facility. Filtering practices should be incorporated into site landscaping to increase their aesthetics and public appeal.

Surface filters (e.g., surface and non-structural sand filters) can have a grass cover to aid in pollutant adsorption. The grass should be capable of withstanding frequent periods of inundation and drought.

4.10.6 Filtering System Construction Sequence

Soil Erosion and Sediment Control. No runoff shall be allowed to enter the filter system prior to completion of all construction activities, including revegetation and final site stabilization. Construction runoff shall be treated in separate sedimentation basins and routed to bypass the filter system. Should construction runoff enter the filter system prior to final site stabilization, all contaminated materials must be removed and replaced with new clean filter materials before a regulatory inspector approves its completion. The approved soil erosion and sediment control plan shall include specific measures to provide for the protection of the filter system before the final stabilization of the site.

Filter Installation. The following is the typical construction sequence to properly install a structural sand filter. This sequence can be modified to reflect different filter designs, site conditions, and the size, complexity, and configuration of the proposed filtering application.

1. Stabilize Contributing Drainage Area

Filtering practices should only be constructed after the CDA to the facility is completely stabilized, so sediment from the CDA does not flow into and clog the filter. If the proposed filtering area is used as a sediment trap or basin during the construction phase, the construction notes should clearly specify that, after site construction is complete, the sediment control facility will be dewatered, dredged, and regraded to design dimensions for the post-construction filter.

2. Install Soil Erosion and Sediment Control Measures for the Filtering Practice

Stormwater should be diverted around filtering practices as they are being constructed. This is usually not difficult to accomplish for off-line filtering practices. It is extremely important to keep runoff and eroded sediment away from the filter throughout the construction process. Silt fence or other sediment controls should be installed around the perimeter of the filter, and erosion control fabric may be needed during construction on exposed side-slopes with gradients exceeding 4H:1V. Exposed soils in the vicinity of the filtering practice should be rapidly stabilized by hydro-seed, sod, mulch, or other method.

3. Assemble Construction Materials on Site

Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.

4. Clear and Strip

Bring the project area to the desired subgrade.

5. Excavate and Grade

Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the filtering practice.

6. Install Filter Structure

Install filter structure in design location and check all design elevations (i.e., concrete vaults for surface, underground, and perimeter sand filters). Upon completion of the filter structure shell, inlets and outlets must be temporarily plugged and the structure filled with water to the brim to demonstrate water tightness. Maximum allowable leakage is 5% of the water volume in a 24-hour period. See Appendix E Construction Inspection Checklists for the Stormwater Facility Leak Test form. If the structure fails the test, repairs must be performed to make the structure watertight before any sand is placed into it.

7. Install Base Material Components

Install the gravel, underdrains, and choker layers of the filter.

8. Install Top Sand Component

Spread sand across filter bed in 1-foot lifts up to the design elevation. Backhoes or other equipment can deliver the sand from outside the filter structure. Sand should be manually raked. Clean water is then added until the sedimentation chamber and filter bed are completely full. The facility is then allowed to drain, hydraulically compacting the sand layers. After 48 hours of drying, refill the structure to the final top elevation of the filter bed.

9. Install Surface Layer (Surface Sand Filters only)

Add a 3-inch topsoil layer and pea gravel inlets and immediately seed with the permanent grass species. The grass should be watered, and the facility should not be switched on-line until a vigorous grass cover has become established.

10. Stabilize Surrounding Areas

Stabilize exposed soils on the perimeter of the structure with temporary seed mixtures appropriate for a buffer. All areas above the normal pool should be permanently stabilized by hydroseed, sod, or seeding and mulch.

11. Final Inspection. Conduct the final construction inspection

Multiple construction inspections by a qualified professional are critical to ensure that stormwater filters are properly constructed. Inspections are recommended during the following stages of construction:

- Initial site preparation, including installation of soil erosion and sediment control measures;
- Excavation/grading to design dimensions and elevations;
- Installation of the filter structure, including the water tightness test;
- Installation of the underdrain and filter bed;
- Check that turf cover is vigorous enough to switch the facility on-line; and

- Final inspection after a rainfall event to ensure that it drains properly and all pipe connections are watertight. Develop a punch list for facility acceptance. Log the filtering practice's GPS coordinates and submit them for entry into the BMP maintenance tracking database.

Construction phase inspection checklist for filters and the Stormwater Facility Leak Test form can be found in Appendix E Construction Inspection Checklists.

4.10.7 Filtering System Maintenance Criteria

Maintenance of filters is required and involves several routine maintenance tasks, which are outlined in Table 4.45. A cleanup should be scheduled at least once a year to remove trash and floatables that accumulate in the pretreatment cells and filter bed. Frequent sediment cleanouts in the dry and wet sedimentation chambers are recommended every 1 to 3 years to maintain the function and performance of the filter. If the filter treats runoff from a stormwater hotspot, crews may need to test the filter bed media before disposing of the media and trapped pollutants. Petroleum hydrocarbon contaminated sand or filter cloth must be disposed of according to State solid waste disposal regulations. Testing is not needed if the filter does not receive runoff from a designated stormwater hotspot, in which case the media can be safely disposed of in a landfill.

Table 4.45. Typical Annual Maintenance Activities for Filtering Practices

Frequency	Maintenance Tasks
At least 4 times per growing season	▪ Mow grass filter strips and perimeter turf around surface sand filters. Maximum grass heights should be less than 12 inches.
2 times per year (may be more or less frequently depending on land use)	▪ Check to see if sediment accumulation in the sedimentation chamber has exceeded 6 inches. If so, schedule a cleanout.
Annually	▪ Conduct inspection and cleanup. ▪ Dig a small test pit in the filter bed to determine whether the first 3 inches of sand are visibly discolored and need replacement. ▪ Check to see if inlets and flow splitters are clear of debris and are operating properly. ▪ Check concrete structures and outlets for any evidence of spalling, joint failure, leakage, corrosion, etc. ▪ Ensure that the filter bed is level and remove trash and debris from the filter bed. Sand or gravel covers should be raked to a depth of 3 inches.
Every 5 years	▪ Replace top sand layer. ▪ Till or aerate surface to improve infiltration/grass cover.
As needed	▪ Remove blockages and obstructions from inflows. Trash collected on the grates protecting the inlets shall be removed regularly to ensure the inflow capacity of the BMP is preserved. ▪ Stabilize CDA and side-slopes to prevent erosion. Filters with a turf cover should have 95% vegetative cover.
Upon failure	▪ Corrective maintenance is required any time the sedimentation basin and sediment trap do not draw down completely after 72 hours (i.e., no standing water is allowed).

Maintenance Inspections. Regular inspections by a qualified professional are critical to schedule sediment removal operations, replace filter media, and relieve any surface clogging. Frequent inspections are especially needed for underground and perimeter filters, since they are out of sight and can be easily forgotten. Depending on the level of traffic or the particular land use, a filter system may either become clogged within a few months of normal rainfall or could possibly last several years with only routine maintenance. Maintenance inspections should be conducted within 24 hours following a storm that exceeds 0.5 inch of rainfall, to evaluate the condition and performance of the filtering practice.

Note: Without regular maintenance, reconditioning sand filters can be very expensive.

Maintenance inspection checklists for filters and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Waste Material. Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.10.8 Filtering System Stormwater Compliance Calculations

Filtering practices are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 80% bacteria removal for the storage volume (Sv) provided by the (Table 4.46).

Table 4.46. Filter Retention and Pollutant Removal

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 30%
Bacteria Removal	= 80%

The practice must be sized using the guidance detailed in Section 4.8.4 Filtering Design Criteria.

4.10.9 References

ASTM D448-12(2017), Standard Classification for Sizes of Aggregate for Road and Bridge Construction, ASTM International, West Conshohocken, PA, 2017, www.astm.org

ASTM D4491 / D4491M-17, Standard Test Methods for Water Permeability of Geotextiles by Permittivity, ASTM International, West Conshohocken, PA, 2017, www.astm.org

Atlanta Regional Commission (ARC). 2001. Georgia Stormwater Management Manual, First Edition. Available online at: https://atlantaregional.org/natural-resources/water/georgia-stormwater-management-manual/

Claytor, R. and T. Schueler. 1996. Design of Stormwater Filtering Systems. Chesapeake Research Consortium and the Center for Watershed Protection. Ellicott City, MD. https://owl.cwp.org/

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Van Truong, Hung. 1989. The Sand Filter Water Quality Structure. D.C. Environmental Regulation Administration. Washington, DC.

Van Truong, Hung. 1993. Application of the Washington D.C. Sand Filter Water for Urban Runoff Control. Draft Report. Washington D.C. Environmental Regulations Administration. Washington, D.C. (30+ pages).

Virginia DCR Stormwater Design Specification No. 12: Filtering Practices Version 1.7. 2010.

4.11 Storage Practices

<table>
<tr><th colspan="5">Storage Practices</th></tr>
<tr><td colspan="5">Definition: Practices that are explicitly designed to provide stormwater detention (2- to 25-year, and/or flood control).</td></tr>
<tr><th colspan="2">Site Applicability</th><th colspan="3">BMP Performance Summary</th></tr>
<tr><th>Land Uses</th><th>Required Footprint</th><th colspan="3">WQ Improvement: Low</th></tr>
<tr><td rowspan="3">▪ Urban
▪ Suburban
▪ Rural</td><td rowspan="3">Medium</td><th>TSS[1]</th><th>Total N[1]</th><th>Bacteria[1]</th></tr>
<tr><td>60%</td><td>10%</td><td>60%</td></tr>
<tr><th colspan="3">Runoff Reduction</th></tr>
<tr><th>Construction Costs</th><th>Maintenance Burden</th><th colspan="3">Volume</th></tr>
<tr><td>Moderate</td><td>Low</td><td colspan="3">Low</td></tr>
<tr><th colspan="2">Maintenance Frequency:</th><th colspan="3">SWRv</th></tr>
<tr><th>Routine</th><th>Non-Routine</th><td colspan="3" rowspan="2">0%</td></tr>
<tr><td>Quarterly</td><td>Every 10–15 years</td></tr>
<tr><th colspan="2">Advantages/Benefits</th><th colspan="3">Disadvantages/Limitation</th></tr>
<tr><td colspan="2">▪ Flood control
▪ Typically less costly than stormwater (wet) ponds for equivalent flood storage
▪ Provides recreational and other open space opportunities between storm runoff events</td><td colspan="3">▪ Minimal water quality treatment
▪ Best suited to large CDAs (at least 10 acres)
▪ Tends to re-suspend sediment</td></tr>
<tr><th colspan="2">Components</th><th colspan="3">Design considerations</th></tr>
<tr><td colspan="2">▪ Conveyance
▪ Inlets/outlets
▪ Forebay
▪ Ponding area with available storage
▪ Micropool
▪ Spillway system(s)
▪ Liners, as needed</td><td colspan="3">▪ Depth to seasonal high water table must be at least 6 inches below bottom of practice
▪ Drawdown of 24 to 48 hours
▪ Shallow pond with large surface area performs better than deep pond of same volume
▪ Maintenance access</td></tr>
<tr><th colspan="5">Maintenance Activities</th></tr>
<tr><td colspan="2">▪ Remove debris (inlets/outlets/basin surface)
▪ Remove sediment buildup
▪ Repair and revegetate eroded areas.</td><td colspan="3">▪ Perform structural repairs to inlet and outlets.
▪ Mow unwanted vegetation</td></tr>
</table>

[1]*Credited pollutant load removal*

Storage practices are a common BMP used to temporarily detain runoff to reduce peak flows (Figure 4.47).

Figure 4.47. Dry Extended Detention Pond (Photo: Center for Watershed Protection, Inc.)

Definition. Storage practices are explicitly designed to provide stormwater detention (2- to 25-year, and/or flood control). Design variants include the following:

S-1 Underground detention vaults and tanks

S-2 Dry detention ponds

S-3 Rooftop storage

S-4 Stone storage under permeable pavement or other BMPs

Detention vaults are box-shaped underground stormwater storage facilities typically constructed with reinforced concrete. Detention tanks are underground storage facilities typically constructed with large diameter concrete or plastic pipe (see Figure 4.44). Both serve as an alternative to surface dry detention for stormwater quantity control, particularly for space-limited areas where there is not adequate land for a dry detention basin or multi-purpose detention area. Prefabricated concrete vaults are available from commercial vendors. In addition, several pipe manufacturers have developed packaged detention systems.

Dry detention ponds are widely applicable for most land uses and are best suited for larger SDAs. An outlet structure restricts stormwater flow, so it backs up and is stored within the basin (see Figure 4. 45). The temporary ponding reduces the maximum peak discharge to the downstream channel, thereby reducing the effective shear stress on the bed and banks of the receiving stream.

Storage practices do not receive any stormwater retention or treatment volume and should be considered only for management of larger storm events. Storage practices are not considered an acceptable practice to meet the SWRv. Storage practices must be combined with a separate facility to meet these requirements. Upland practices can be used to satisfy some, or all, of the stormwater retention requirements at many sites, which can help to reduce the footprint and volume of storage practices.

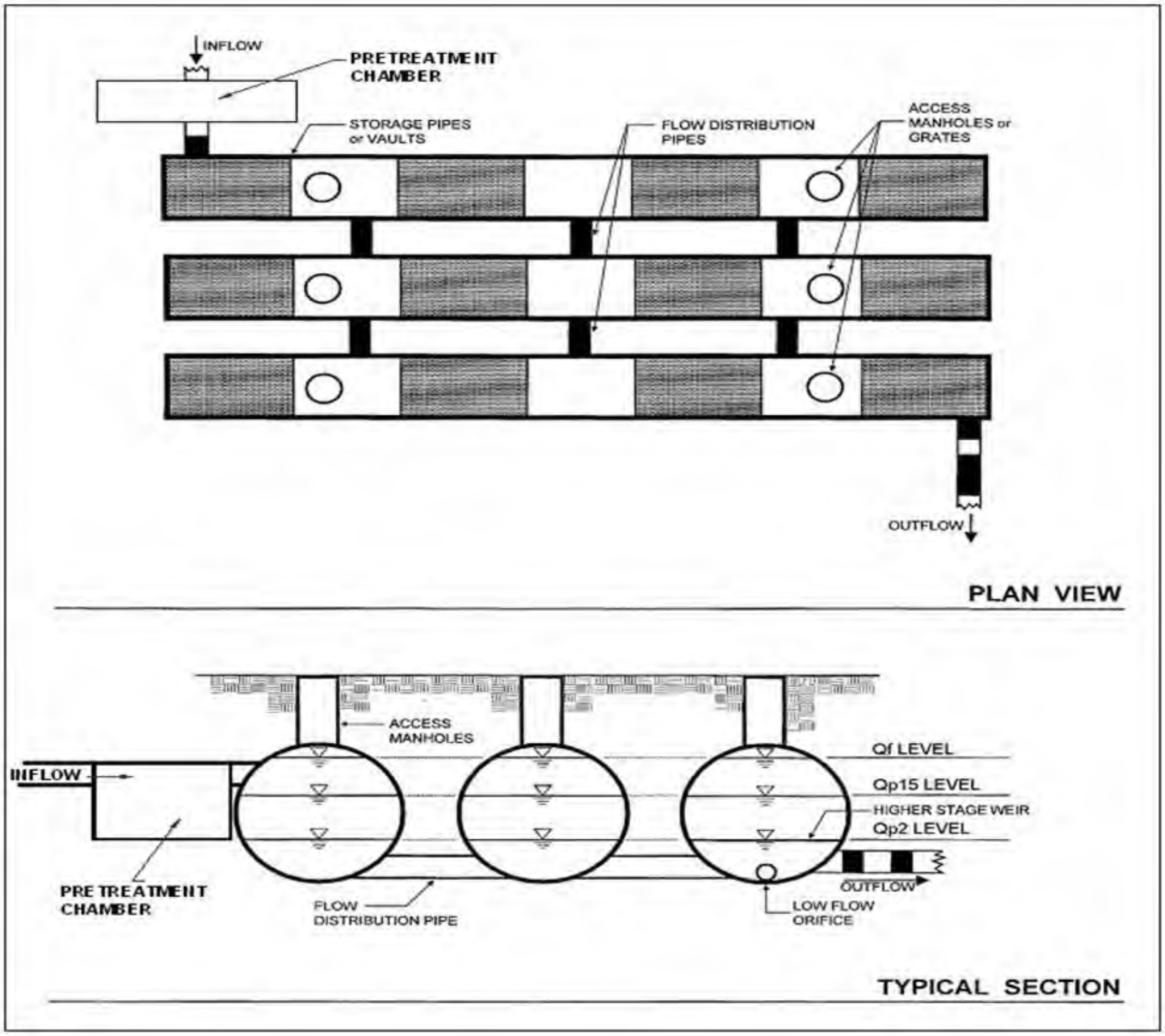


Figure 4.45 Example of an underground detention vault and/or tank (S-1).

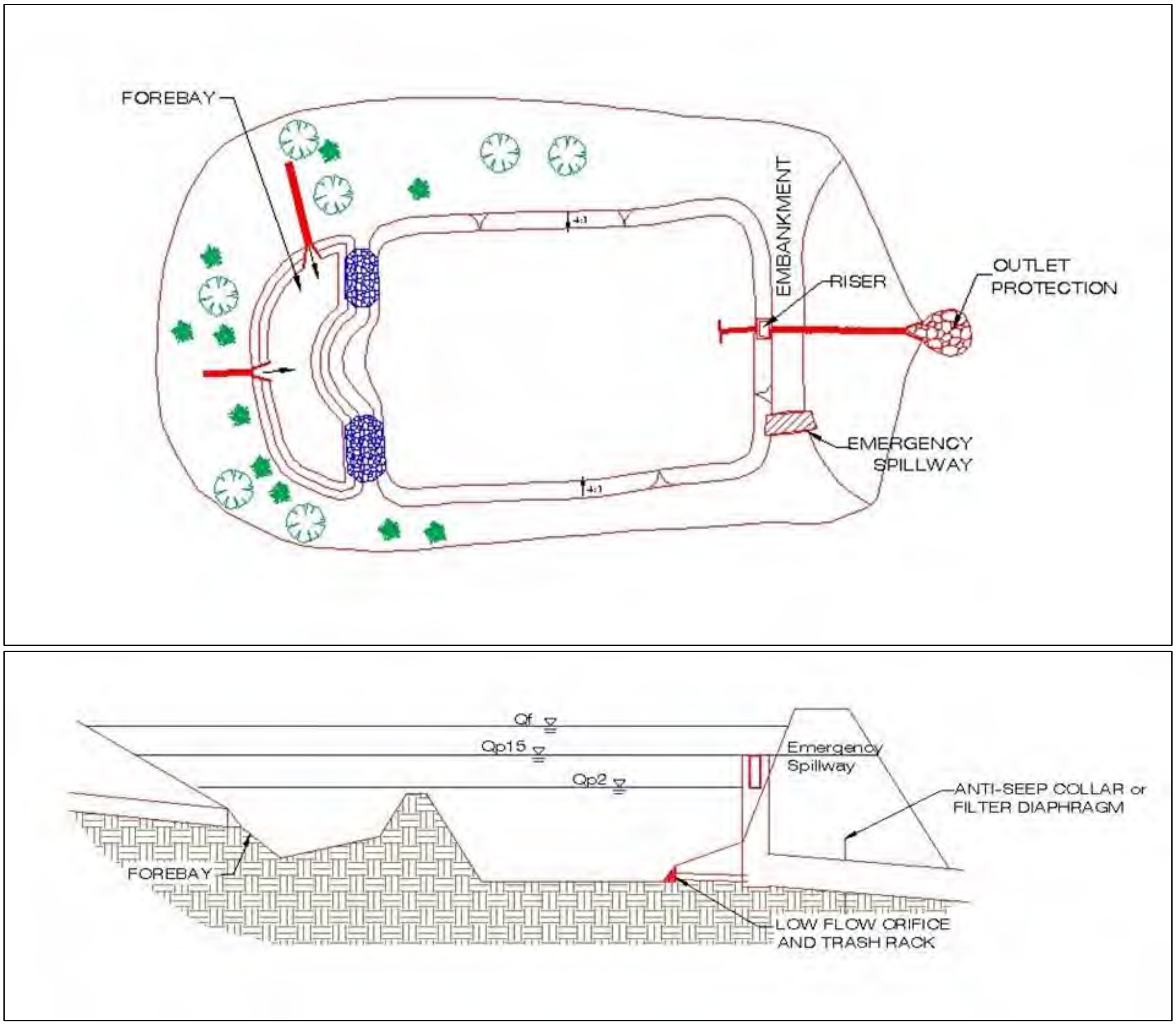


Figure 4.46 Example of a dry detention pond (S-2).

4.11.1 Storage Feasibility Criteria

The following feasibility issues need to be evaluated when storage practices are considered as the final practice in a treatment train:

Space Required. A typical storage practice requires a footprint of 1%–3% of its CDA, depending on the depth of the pond or storage vault (i.e., the deeper the practice, the smaller footprint needed).

Contributing Drainage Area. A CDA of at least 10 acres is preferred for dry ponds in order to keep the required orifice size from becoming a maintenance problem. Designers should be aware that small “pocket” ponds will typically (1) have very small orifices that will be prone to clogging, (2) experience fluctuating water levels such that proper stabilization with vegetation is very difficult, and (3) generate more significant maintenance problems.

Underground detention systems can be located downstream of other structural stormwater controls providing treatment of the design storm. For treatment train designs where upland practices are utilized for treatment of the SWRv, designers can use a site-adjusted Rv or NRCS CN that reflects the volume reduction of upland practices and likely reduce the size and cost of detention (see Storage Practice Sizing in Section 4.8.4 Storage Design Criteria).

The maximum CDA to be served by a single underground detention vault or tank is 25 acres.

Available Hydraulic Head. The depth of a storage practice is usually determined by the amount of hydraulic head available at the site (dimension between the surface drainage and the bottom elevation of the site). The bottom elevation is normally the invert of the existing downstream conveyance system to which the storage practice discharges. Depending on the size of the development and the available surface area of the basin, as much as 6 to 8 feet of hydraulic head may be needed for a dry detention practice to function properly for storage. An underground storage practice will require sufficient head room to facilitate maintenance—at least 5 feet depending on the design configuration.

Setbacks. Setbacks to structures and property lines must be at least 10 feet, and adequate waterproofing protection must be provided for foundations and basements.

Depth to Water Table. Dry ponds are not allowed if the water table will be within 0.5 feet of the floor of the pond. For underground detention vaults and tanks, an anti-flotation analysis is required to check for buoyancy problems in high water table areas.

Tidal Impacts. The outlet of a dry detention practice should be located above the tidal mean high water elevation. In tidally impacted areas, detention practices may have minimal benefit, and re- questing a variance for detention requirements may be an option.

Tailwater Conditions. The flow depth in the receiving channel should be considered when determining outlet elevations and discharge rates from the dry detention practice. Design tailwater condition elevation shall be supported by a reasonable resource and/or analysis. For direct discharges to tidal waters, a king tide evaluation shall accompany the tailwater condition evaluation.

Soils. The permeability of soils is seldom a design constraint for storage practices. Soil infiltration tests should be conducted at proposed dry pond sites to estimate infiltration rates and patterns, which can be significant in HSG A soils and some group B soils. Infiltration through the bottom of the pond is typically encouraged unless it may potentially migrate laterally thorough a soil layer and impair the integrity of the embankment or other structure.

Structural Stability. Underground detention vaults and tanks must meet structural requirements for overburden support and traffic loading if appropriate as verified by shop drawings signed by an appropriately licensed professional.

Geotechnical Tests. At least one soil boring must be taken at a low point within the footprint of any proposed storage practice to establish the water table elevations and evaluate soil suitability. A geotechnical investigation is required for all underground BMPs, including underground storage systems. Geotechnical testing requirements are outlined in Appendix B Geotechnical Information Requirements for Underground BMPs.

Utilities. For a dry pond system, no utility lines shall be permitted to cross any part of the embankment where the design water depth is greater than 2 feet. Typically, utilities require a minimum 5-foot horizontal clearance from storage facilities.

Perennial Streams. Locating dry ponds on perennial streams will require both a Section 401 and Section 404 permit from the appropriate state or federal regulatory agency.

Economic Considerations. Underground detention can be expensive, but often allows for greater use of a development site. Dry detention ponds are generally inexpensive to construct and maintain. Depending upon the type of development, dry detention practices may be required to treat a larger volume of water than other BMPs. Dry detention practices must store 1 inch of runoff from the site, whereas infiltration practices and other BMPs must capture 1 inch of runoff from only the impervious cover on a site.

4.11.2 Storage Conveyance Criteria

Designers must use accepted hydrologic and hydraulic routing calculations to determine the required storage volume and an appropriate outlet design for storage practices. See Section 3.7.2 Hydrologic and Hydraulic Analysis for a summary of acceptable hydrologic methodologies and models.

For management of the 2-year storm, a control structure with a trash rack designed to release the required predevelopment Qp_2 must be provided. Ideally, the channel protection orifice should have a minimum diameter of 3 inches in order to pass minor trash and debris. However, where smaller orifices are required, the orifice must be adequately protected from clogging by an acceptable external trash rack.

As an alternative, the orifice diameter may be reduced if internal orifice protection is used (i.e., a perforated vertical stand pipe with 0.5-inch orifices or slots that are protected by wirecloth and a stone filtering jacket). Adjustable gate valves, weir manholes, and other structures designed for simple maintenance can also be used to achieve this equivalent diameter.

For overbank flood protection, an additional outlet is sized for 2- to 25-year frequency storm event control and can consist of a weir, orifice, outlet pipe, combination outlet, or other acceptable control structure.

Riprap, plunge pools or pads, or other energy dissipators are to be placed at the end of the outlet to prevent scouring and erosion and to provide a non-erosive velocity of flow from the structure to a water course. The design must specify an outfall that will be stable for the 25-year design storm event. The channel immediately below the storage practice outfall must be modified to prevent erosion. This is typically done by calculating channel velocities and flow depths, then placing appropriately sized riprap, over geotextile fabric, which can reduce flow velocities from the principal spillway to non-erosive levels (3.5 to 5.0 feet per second depending on the channel lining material). The storage practice geometry and outfall design may need to be altered in order to yield adequate channel velocities and flow.

Flared pipe sections that discharge at or near the stream invert or into a step pool arrangement should be used at the spillway outlet. An outfall analysis shall be included in the SWMP showing discharge velocities down to the nearest downstream water course. Where indicated, the developer/contractor must secure an off-site drainage easement for any improvements to the downstream channel.

When the discharge is to a manmade pipe or channel system, the system must be adequate to convey the required design storm peak discharge.

If discharge daylights to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance. Excessive use of riprap should be avoided.

The final release rate of the facility shall be modified if any increase in flooding or stream channel erosion would result at a downstream structure, highway, or natural point of restricted streamflow.

The following **additional** conveyance criteria apply to underground detention or ponds:

- **High Flow Bypass (underground detention).** An internal or external high flow bypass or overflow must be included in underground detention designs to safely pass the extreme flood flow.
- **Primary Spillway (dry ponds).** The primary spillway shall be designed with acceptable anti-flotation, anti-vortex, and trash rack devices. The spillway must generally be accessible from dry land. When reinforced concrete pipe is used for the principal spillway to increase its longevity, "O"-ring gaskets (ASTM C361) must be used to create watertight joints, and they should be inspected during installation.
- **Avoid Outlet Clogging (dry ponds).** The risk of clogging in outlet pipes with small orifices can be reduced by the following:

  Providing a micropool at the outlet structure. For more information on micropool extended detention ponds see Section 4.12 Ponds.

  Installing a trash rack to screen the low-flow orifice.

  Using a perforated pipe under a gravel blanket with an orifice control at the end in the riser structure.
- **Emergency Spillway (dry ponds).** Dry ponds must be constructed with overflow capacity to safely pass the 100-year design storm event through either the primary spillway or a vegetated or armored emergency spillway unless waived by *<local jurisdiction>*.
- **Inlet Protection (dry ponds).** Inflow points into dry pond systems must be stabilized to ensure that non-erosive conditions exist during storm events up to the overbank flood event (i.e., the 25-year storm event).

4.11.3 Storage Pretreatment Criteria

Dry Pond Pretreatment Forebay. A forebay must be located at each major inlet to a dry pond to trap sediment and preserve the capacity of the main treatment cell. The following criteria apply to dry pond forebay design:

- A major inlet is defined as an individual storm drain inlet pipe or open channel serving at least 10% of the storage practice's CDA.
- The forebay consists of a separate cell, formed by an acceptable barrier (e.g., an earthen berm, concrete weir, gabion baskets, etc.).
- The forebay shall be sized to contain 0.1 inches per impervious acre of contributing drainage. The relative size of individual forebays should be proportional to the percentage of the total inflow to the dry pond.

- The forebay should be designed in such a manner that it acts as a level spreader to distribute runoff evenly across the entire bottom surface area of the main storage cell.
- Exit velocities from the forebay shall be non-erosive or an armored overflow shall be provided. Non-erosive velocities are 4 feet per second for the 2-year event and 6 feet per second for the 25-year event.
- The bottom of the forebay may be hardened (e.g., concrete, asphalt, or grouted riprap) in order to make sediment removal easier.
- Direct maintenance access for appropriate equipment shall be provided to the each forebay.

Underground Detention Pretreatment. A pretreatment structure to capture sediment, coarse trash, and debris must be placed upstream of any inflow points to underground detention. A separate sediment sump or vault chamber sized to capture 0.1 inches per impervious acre of contributing drainage, or a proprietary structure with demonstrated capability of removing sediment and trash, should be provided at the inlet for underground detention systems that are in a treatment train with off-line water quality treatment structural controls. Refer to Section 0 Proprietary Practices for information on approved proprietary practices.

4.11.4 Storage Design Criteria

Dry Pond Internal Design Features. The following apply to dry pond design:

- **No Pilot Channels.** Dry ponds shall not have a low-flow pilot channel, but instead must be constructed in a manner whereby flows are evenly distributed across the pond bottom, to avoid scour, promote attenuation and, where possible, infiltration.
- **Internal Slope.** The maximum longitudinal slope through the pond should be approximately 0.5%–1%.
- **Side Slopes.** Side slopes within the dry pond should generally have a gradient of 3H:1V to 4H:1V. The mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance. Ponds with side slopes steeper than 5H:1V must be fenced and include a lockable gate.
- **Long Flow Path.** Dry pond designs should have an irregular shape and a long flow path distance from inlet to outlet to increase water residence time, treatment pathways, pond performance, and to eliminate short-cutting. In terms of flow path geometry, there are two design considerations: (1) the overall flow path through the pond, and (2) the length of the shortest flow path (Hirschman et al., 2009):

  The overall flow path can be represented as the length-to-width ratio OR the flow path ratio. These ratios must be at least 2L:1W (3L:1W preferred). Internal berms, baffles, or topography can be used to extend flow paths and/or create multiple pond cells.

  The shortest flow path represents the distance from the closest inlet to the outlet. The ratio of the shortest flow to the overall length must be at least 0.4. In some cases—due to site geometry, storm sewer infrastructure, or other factors—some inlets may not be able to meet these ratios. However, the CDA served by these “closer” inlets must constitute no more than 20% of the total CDA.

Top of Bank. Dry ponds shall be provided with a 20-ft maintenance access at the top of bank with a maximum cross slope of 48:1.

Safety Features. The following safety features must be considered for storage practices:

- The underground spillway access must be designed and constructed to prevent access by small children.
- End walls above pipe outfalls greater than 48 inches in diameter must be fenced at the top of the wall to prevent a falling hazard.
- Storage practices must incorporate an additional 1 foot of freeboard above the emergency spillway, or 2 feet of freeboard if design has no emergency spillway, for the 100-year storm.
- The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges
- Underground maintenance access should be locked at all times.

Maintenance Access. All storage practices shall be designed so as to be accessible to annual maintenance. Unless waived by *<local jurisdiction>*, a 5H:1V slope and 15-foot-wide entrance ramp is required for maintenance access to dry ponds. Adequate maintenance access must also be provided for all underground detention systems. Access must be provided over the inlet pipe and outflow structure with access steps. Access openings can consist of a standard 30-inch diameter frame, grate and solid cover, a hinged door, or removable panel. Removable panels must be designed with sufficient support so they cannot fall through the opening into the vault when removed.

Outlets. Trash racks shall be provided for low-flow pipes and for risers not having anti-vortex devices.

To reduce maintenance problems for small orifices, a standpipe design can be used that includes a smaller inner standpipe with the required orifice size, surrounded by a larger standpipe with multiple openings, and a gravel jacket surrounding the larger standpipe. This design will reduce the likelihood of the orifice being clogged by sediment.

Detention Vault and Tank Materials. Underground stormwater detention structures shall be composed of materials as approved by *<local jurisdiction>*. All construction joints and pipe joints shall be soil-tight. Cast-in-place wall sections must be designed as retaining walls. The maximum depth from finished grade to the vault invert is 20 feet. The minimum pipe diameter for underground detention tanks is 24 inches unless otherwise approved by *<local jurisdiction>*. Manufacturer's specifications should be consulted for underground detention structures.

Anti-floatation Analysis for Underground Detention. Anti-flotation analysis is required to check for buoyancy problems in high water table areas. Anchors shall be designed to counter the pipe and structure buoyancy by at least a 1.2 factor of safety.

Storage Practice Sizing. Storage facilities should be sized to control peak flow rates from the 2- to 25-year frequency storm event or other design storm. Design calculations must ensure that the post-development peak discharge does not exceed the predevelopment peak discharge. See Section 3.7.2 Hydrologic and Hydraulic Analysis for a summary of acceptable hydrologic methodologies and models.

For treatment train designs where upland practices are utilized for treatment of the SWRv, designers can use a site-adjusted Rv or NRCS CN that reflects the volume reduction of upland practices to compute the 2- 50-year frequency storm event that must be treated by the storage practice.

4.11.5 Storage Landscaping Criteria

No landscaping criteria apply to underground storage practices.

For dry ponds, a landscaping plan must be provided that indicates the methods used to establish and maintain vegetative coverage within the dry pond. Minimum elements of a plan include the following:

- Delineation of pondscaping zones within the pond.
- Selection of corresponding plant species.
- The planting plan.
- The sequence for preparing the wetland bed, if one is incorporated with the dry pond (including soil amendments, if needed).
- Sources of native plant material.
- The planting plan should allow the pond to mature into a native forest in the right places, but yet keep mowable turf along the embankment and all access areas. The wooded wetland concept proposed by Cappiella et al. (2005) may be a good option for many dry ponds.
- Woody vegetation may not be planted or allowed to grow within 15 feet of the toe of the embankment nor within 25 feet from the principal spillway structure.

4.11.6 Storage Construction Sequence

Construction of underground storage systems must be in accordance with manufacturer's specifications. All runoff into the system should be blocked until the site is stabilized. The system must be inspected and cleaned of sediment after the site is stabilized.

The following is a typical construction sequence to properly install a dry pond. The steps may be modified to reflect different dry pond designs, site conditions, and the size, complexity, and configuration of the proposed facility.

1. Use of Dry Pond for Soil Erosion and Sediment Control. A dry pond may serve as a sediment basin during project construction. Installation of the permanent riser should be initiated during the construction phase, and design elevations should be set with final cleanout of the sediment basin and conversion to the post-construction dry pond in mind. The bottom elevation of the dry pond should be lower than the bottom elevation of the temporary sediment basin. Appropriate procedures must be implemented to prevent discharge of turbid waters when the basin is being converted into a dry pond.

2. Stabilize the Contributing Drainage Area. Dry ponds should only be constructed after the CDA to the pond is completely stabilized. If the propose dry pond site will be used as a sediment trap or basin during the construction phase, the construction notes must clearly indicate that the facility will be dewatered, dredged, and regraded to design dimensions after the original site construction is complete.

3. Assemble Construction Materials on Site. Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.

4. Clear and Grade. Bring the project area to the desired subgrade.

5. Soil Erosion and Sediment Controls. Install soil erosion and sediment control measures prior to construction, including temporary stormwater diversion practices. All areas surrounding the pond that are graded or denuded during construction must be planted with turf grass, native plantings, or other approved methods of soil stabilization.

6. Install the Spillway Pipe. Ensure the top invert of the spillway pipe is set to design elevation.

7. Install the Riser or Outflow Structure. Once riser and outflow structures are installed, ensure the top invert of the overflow weir is constructed level and at the design elevation.

8. Construct the Embankment and any Internal Berms. Construct the embankment and berms in 8- to 12-inch lifts and compact the lifts with appropriate equipment.

9. Excavate and Grade. Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the dry pond.

10. Construct the Emergency Spillway. The emergency spillway must be constructed in cut or structurally stabilized soils.

11. Install Outlet Pipes. The installation of outlet pipes must include a downstream riprap protection apron.

12. Stabilize Exposed Soils. All areas above the normal pool elevation should be permanently stabilized by hydroseeding or seeding over straw.

13. Dry Pond Construction Supervision. Ongoing construction supervision is recommended to ensure that stormwater ponds are properly constructed. Supervision/inspection is recommended during the following stages of construction:

- Preconstruction meeting
- Initial site preparation including the installation of soil erosion and sediment control measures
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pondscaping plan and vegetative stabilization
- Immediately seed or install vegetated ground cover upon completion of sloping and grading of each storage practice, where applicable, within a project.
- Inspect within two weeks to ensure vegetation is in fact holding banks and slopes in place.
- Prior to completion of project, mechanically remove erosion deposition from ponds that occurred during the project. Criteria should be based on erosion of designed bank slopes and loss of storage capacity.
- Final inspection (develop a punch list for facility acceptance)

Construction phase inspection checklist for storage practices and the Stormwater Facility Leak Test form can be found in Appendix E Construction Inspection Checklists.

If the dry pond has a permanent pool, then to facilitate maintenance the contractor should measure the actual constructed dry pond depth at three areas within the permanent pool (forebay, mid-pond, and at the riser), and they should mark and geo-reference them on an as-built drawing. This simple data set will enable maintenance inspectors to determine pond sediment deposition rates in order to schedule sediment cleanouts.

4.11.7 Storage Maintenance Criteria

Typical maintenance activities for storage practices are outlined in Table 4.47. Maintenance requirements for underground storage facilities will generally require quarterly visual inspections from the manhole access points by a qualified professional to verify that there is no standing water or excessive sediment buildup. Entry into the system for a full inspection of the system components (pipe or vault joints, general structural soundness, etc.) should be conducted annually. Confined space entry credentials are typically required for this inspection.

Table 4.47. Typical Maintenance Activities for Storage Practices.

Schedule	Maintenance Activity
As needed	▪ Water dry pond side slopes to promote vegetation growth and survival.
Quarterly	▪ Remove sediment and oil/grease from inlets, pretreatment devices, flow diversion structures, storage practices, and overflow structures. ▪ Ensure that the CDA, inlets, and facility surface are clear of debris. ▪ Ensure that the CDA is stabilized. Perform spot-reseeding where needed. ▪ Repair undercut and eroded areas at inflow and outflow structures.
Annual inspection	▪ Measure sediment accumulation levels in forebay. Remove sediment when 50% of the forebay capacity has been lost. ▪ Inspect the condition of stormwater inlets for material damage, erosion or undercutting. Repair as necessary. ▪ Inspect the banks of upstream and downstream channels for evidence of sloughing, animal burrows, boggy areas, woody growth, or gully erosion that may undermine pond embankment integrity. ▪ Inspect outfall channels for erosion, undercutting, riprap displacement, woody growth, etc. ▪ Inspect condition of principal spillway and riser for evidence of spalling, joint failure, leakage, corrosion, etc. ▪ Inspect condition of all trash racks, reverse sloped pipes, or flashboard risers for evidence of clogging, leakage, debris accumulation, etc. ▪ Inspect maintenance access to ensure it is free of debris or woody vegetation and check to see whether valves, manholes, and locks can be opened and operated. ▪ Inspect internal and external side slopes of dry ponds for evidence of sparse vegetative cover, erosion, or slumping, and make needed repairs immediately. ▪ Monitor the growth of wetlands, trees and shrubs planted in dry ponds. Remove invasive species and replant vegetation where necessary to ensure dense coverage.

Maintenance of storage practices is driven by annual inspections that evaluate the condition and performance of the storage practice. Based on inspection results, specific maintenance tasks will be triggered.

Maintenance inspection checklists for extended detention ponds and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Waste Material. Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.11.8 Storage Stormwater Compliance Calculations

Storage practices are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 80% bacteria removal for the SWRv (Table 4.48).

Table 4.48. Storage Retention and Pollutant Removal

Retention	= 0%
TSS Removal	= 60%
TN Removal	= 10%
Bacteria Removal	= 60%

4.11.9 References

ASTM C361-16, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe, ASTM International, West Conshohocken, PA, 2016, www.astm.org

Cappiella, K., Schueler, T., and T. Wright. 2005. Urban Watershed Forestry Manual. Part 1: Methods for Increasing Forest Cover in a Watershed. NA-TP-04-05. USDA Forest Service, Northeastern Area State and Private Forestry. Newtown Square, PA.

City of Austin. 1988. Design Guidelines for Water Quality Control Basins. City of Austin Environmental and Conservation Services Department, Environmental Resources Management Division. Austin, TX.

Hirschman, D., L. Woodworth and S. Drescher. 2009. Technical Report: Stormwater BMPs in Virginia's James River Basin: An Assessment of Field Conditions & Programs. Center for Watershed Protection. Ellicott City, MD.

Virginia DCR Stormwater Design Specification No. 15: Extended Detention (ED) Pond Version 1.8. 2010.

4.12 Ponds

Ponds				
Definition: Stormwater storage practices that consist of a combination of a permanent pool, micropool, or shallow marsh that promote a good environment for gravitational settling, biological uptake, and microbial activity.				
Site Applicability		**BMP Performance Summary**		
Land Uses	**Required Footprint**	**WQ Improvement:** Moderate to High		
▪ Urban ▪ Suburban ▪ Rural	Medium	**TSS**[1]	**Total N**[1]	**Bacteria**[1]
		80%	30%	60%
		Runoff Reductions		
Construction Costs	**Maintenance Burden**	**Volume**		
Moderate	Moderate	Low		
Maintenance Frequency:		***SWRv***		
Routine	**Non-Routine**	0%		
At least annually	Every 5–7 years			
Advantages/Benefits		**Disadvantages/Limitation**		
▪ Moderate to high pollutant removal ▪ Can be designed as a multi-functional BMP ▪ Cost effective ▪ Good for sites with high water table and/or poorly drained soils ▪ Wildlife habitat potential ▪ High community acceptance when integrated into a development		▪ Requires large amount of flat land (1-3% of CDA) ▪ Must be properly designed, installed, and maintained to avoid nuisance problems ▪ Routine sediment cleanout may be needed ▪ Potential for thermal impacts downstream		
Components		**Design considerations**		
▪ Conveyance ▪ Forebay ▪ Ponding area with available storage ▪ Micropool ▪ Spillway system(s) ▪ Liners, as needed		▪ CDA of at least 10 acres and slopes <15% ▪ Use CN adjustment factor ARC III for CDA that are irrigated with harvested rainwater ▪ Minimum length to width ratio = 3:1 ▪ Maximum depth of permanent pool = 8’ ▪ 3:1 side slopes or flatter around pond perimeter		
Maintenance Activities				
▪ Remove debris from inlet and outlet structures ▪ Maintain side slopes/remove invasive vegetation		▪ Monitor sediment accumulation and remove periodically		

[1]*Credited pollutant load removal*

Stormwater ponds are widely applicable for most land uses and are best suited for larger drainage areas (Figure 4.47); however, they should be considered for use after all other upland retention opportunities have been exhausted and there is still a remaining treatment volume or runoff from larger storms (i.e., 2- to 25-year or flood control events) to manage.

Stormwater ponds receive no retention credit and should be considered mainly for management of larger storm events. Stormwater ponds have both community and environmental concerns (see Section 4.12.1 Pond Feasibility Criteria) that should be considered before choosing stormwater ponds as the appropriate stormwater practice on site.

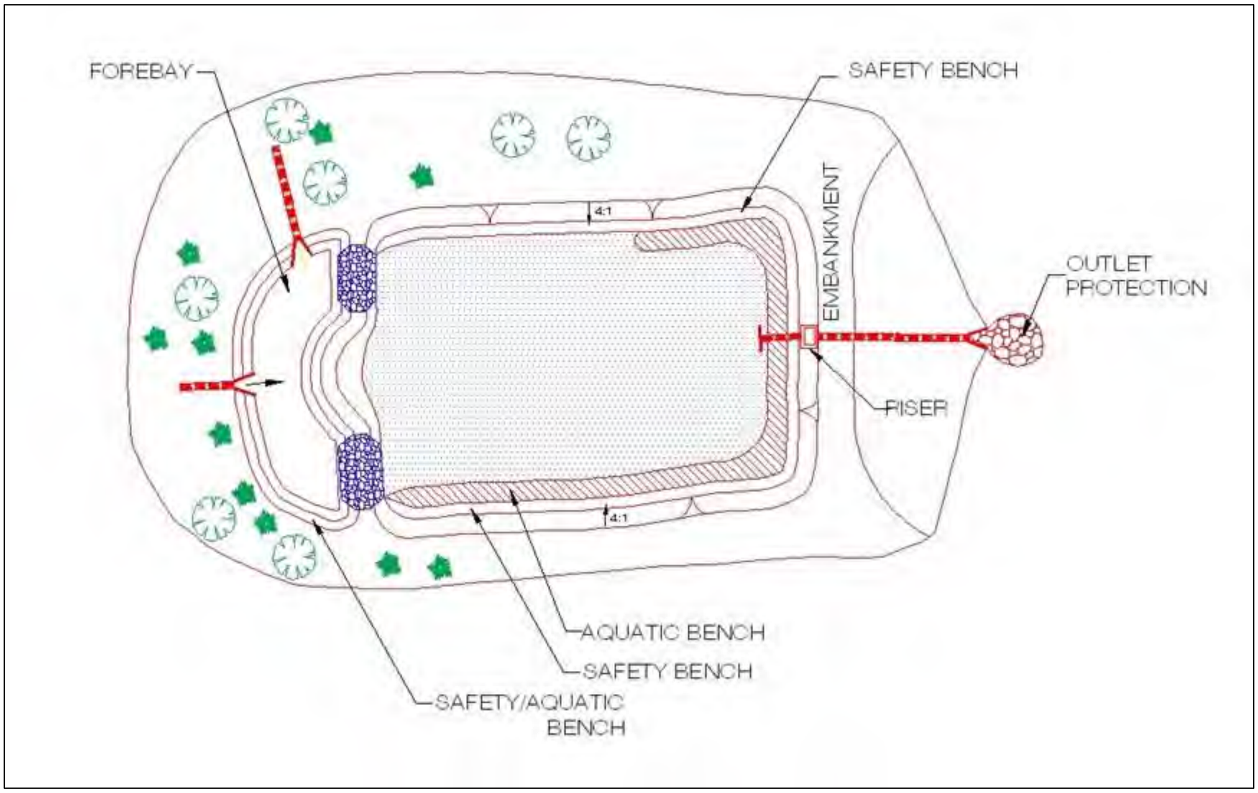
Figure 4.47 Wet Pond (photo: Denise Sanger)

Definition. Stormwater ponds are stormwater storage practices that consist of a combination of a permanent pool, micropool, or shallow marsh that promote a good environment for gravitational settling, biological uptake, and microbial activity. Ponds are best suited for larger SDAs. Runoff from each new storm enters the pond and partially displaces pool water from previous storms. The pool also acts as a barrier to resuspension of sediments and other pollutants deposited during prior storms. When sized properly, stormwater ponds have a residence time that ranges from many days to several weeks, which allows numerous pollutant removal mechanisms to operate. Stormwater ponds can also provide storage above the permanent pool to help meet stormwater management requirements for larger storms. Design variants include the following (see Figure 4. 47 and Figure 4. 48):

C-1 Micropool extended detention pond

C-2 Wet pond

C-3 Wet extended detention pond



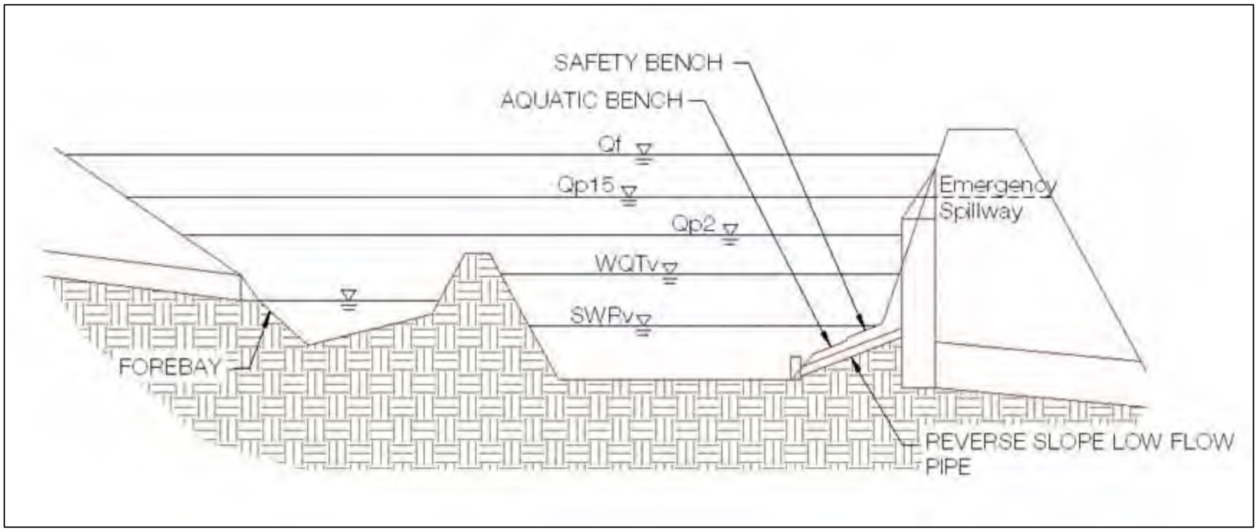
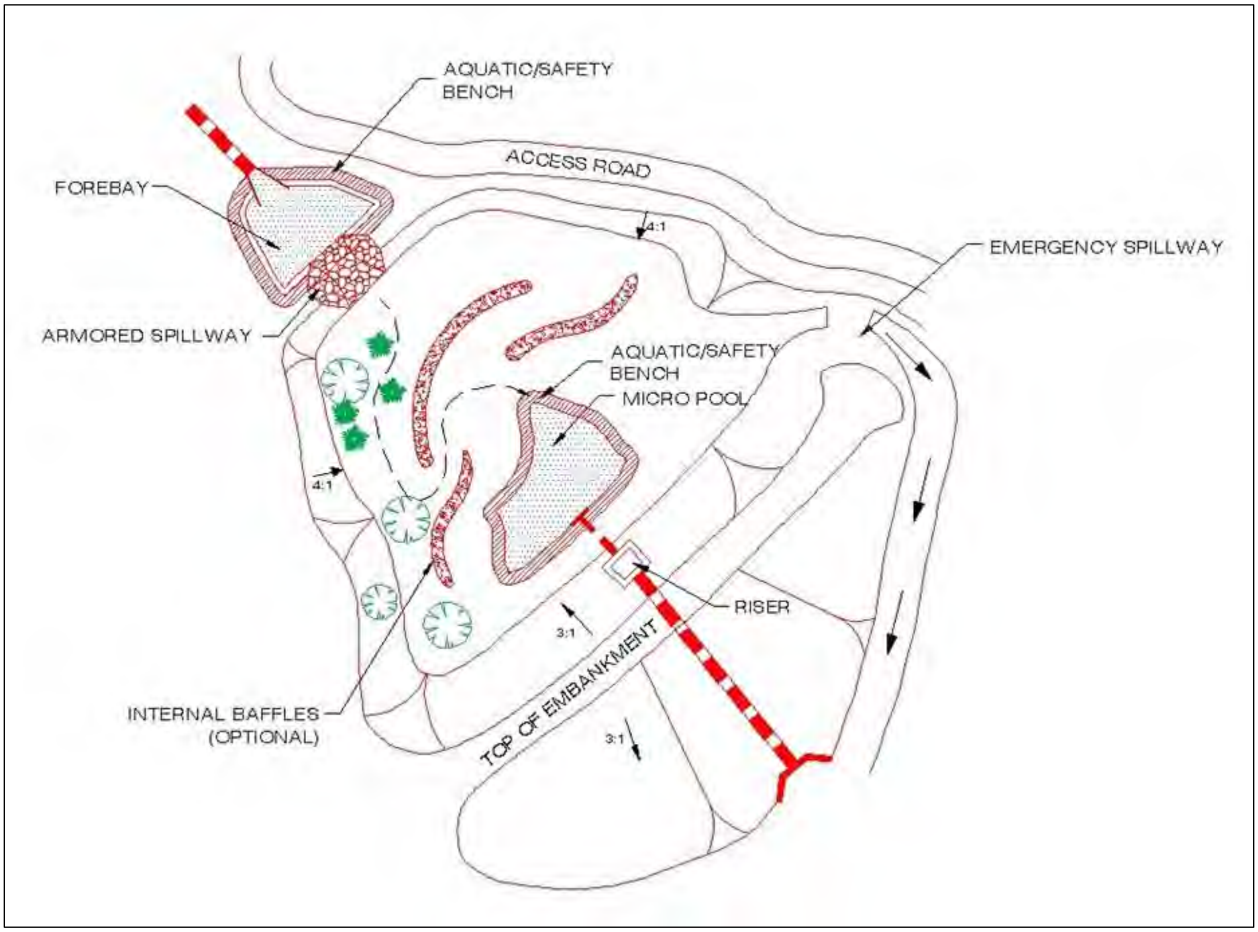


Figure 4.48 Design schematics for a wet pond (C-2).



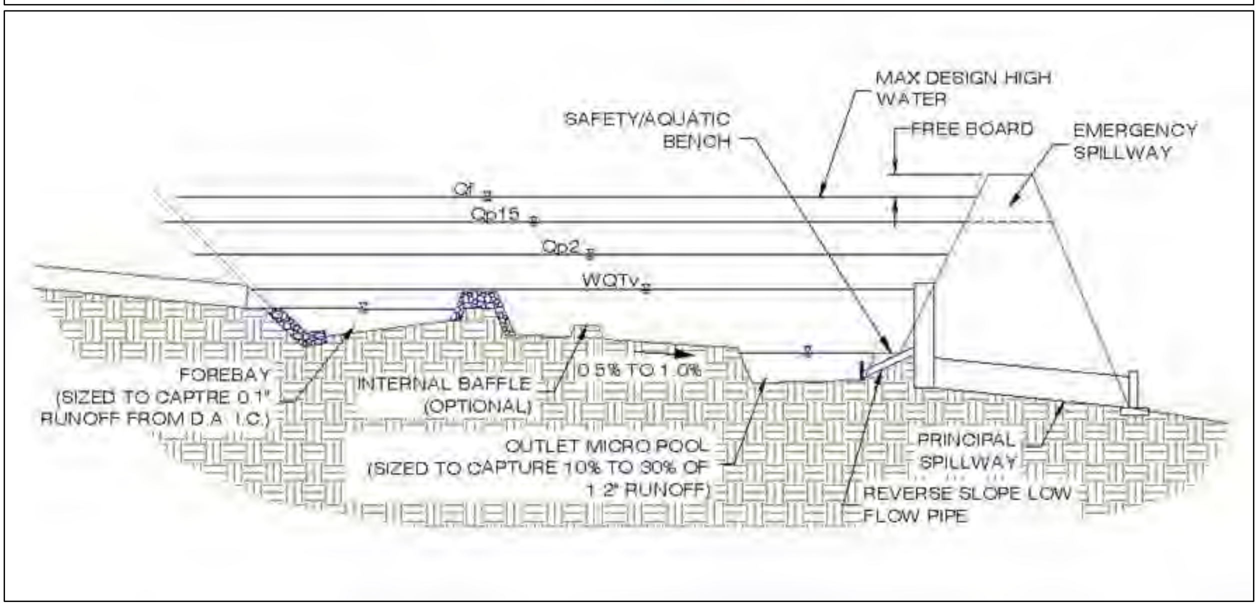


Figure 4.49 Typical extended detention pond (C-3) details.

4.12.1 Pond Feasibility Criteria

The following feasibility issues need to be considered when ponds are considered a final stormwater management practice of the treatment train.

Adequate Water Balance. Wet ponds must have enough water supplied from groundwater, runoff, or baseflow so that the wet pools will not draw down by more than 2 feet after a 30-day summer drought. A simple water balance calculation must be performed using the Equation 4.27 in Section 4.10.4 Pond Design Criteria.

Contributing Drainage Area. A CDA of 10 to 25 acres is typically recommended for ponds to maintain constant water elevations. Ponds can still function with CDAs less than 10 acres, but designers should be aware that these “pocket” ponds will be prone to clogging, experience fluctuating water levels, and generate more nuisance conditions.

Space Requirements. The surface area of a pond will normally be at least 1%–3% of its CDA, depending on the pond’s depth.

Site Topography. Ponds are best applied when the grade of contributing slopes is less than 15%.

Available Hydraulic Head. The depth of a pond is usually determined by the hydraulic head available on the site. The bottom elevation is normally the invert of the existing downstream conveyance system to which the pond discharges. Typically, a minimum of 6 to 8 feet of head are needed to hold the wet pool and any additional large storm storage or overflow capacity for a pond to function.

Setbacks. Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements.

Proximity to Utilities. For an open pond system, no utility lines shall be permitted to cross any part of the embankment of a wet pool.

Depth to Water Table. The depth to the groundwater table is not a major constraint for stormwater ponds because a high water table can help maintain wetland conditions. However, groundwater inputs can also reduce the pollutant removal rates of ponds. Further, if the water table is close to the surface, it may make excavation difficult and expensive.

Tailwater Conditions. The flow depth in the receiving channel should be considered when determining outlet elevations and discharge rates from wet pond. Design tailwater condition elevation shall be supported by a reasonable resource and/or analysis. For direct discharges to tidal waters, a king tide evaluation shall accompany the tailwater condition evaluation.

Soils. Highly permeable soils will make it difficult to maintain a healthy permanent pool. Soil infiltration tests need to be conducted at proposed pond sites to determine the need for a pond liner or other method to ensure a constant water surface elevation. Underlying soils of HSG C or D should be adequate to maintain a permanent pool. Most HSG A soils and some HSG B soils will require a liner (see Table 3.42). Geotechnical tests should be conducted to determine the saturated hydraulic conductivity and other subsurface properties of the soils beneath the proposed pond.

Use of or Discharges to Natural Wetlands. Ponds cannot be located within State waters, including wetlands, without obtaining a Section 404 permit or other permissions from the appropriate state or federal regulatory agency. In addition, the designer should investigate the wetland status of adjacent areas to determine if the discharge from the pond will change the hydroperiod of a downstream natural wetland (see Cappiella et al., 2006, for guidance on minimizing stormwater discharges to existing wetlands).

Perennial Streams. Locating ponds on perennial streams will require both US Army COE permits under Clean Water Act Section 401 and Section 404 or other permissions from the appropriate state or federal regulatory agency.

Economic Considerations. Wet detention ponds tend to have low construction costs and low space demands (in terms of the land area needed to treat a given volume of water) relative to other LID practices. In addition, the soil excavated to construct ponds can be used as fill, which is often needed for construction on low-lying coastal areas.

Community and Environmental Concerns. Ponds can generate the following community and environmental concerns that need to be addressed during design:

- Aesthetic Issues. Many residents feel that ponds are an attractive landscape feature, promote a greater sense of community and are an attractive habitat for fish and wildlife. Designers should note that these benefits are often diminished where ponds are under-sized or have small CDAs.
- Existing Forests. Construction of a pond may involve extensive clearing of existing forest cover. Designers can expect a great deal of neighborhood opposition if they do not make a concerted effort to save mature trees during pond design and construction. Consideration of Better Site Design Principles is implicit with permitting decisions related to clearing of existing forest cover.
- Safety Risk. Pond safety is an important community concern, since both young children and adults have perished by drowning in ponds through a variety of accidents, including falling through thin ice cover. Gentle side slopes and safety benches should be provided to avoid potentially dangerous drop-offs, especially where ponds are located near residential areas.
- Pollutant Concerns. Ponds collect and store water and sediment to increase residence time that will increase the likelihood for contaminated water and sediments to be neutralized. However, poorly sized, maintained, and/or functioning ponds can export contaminated sediments and/or water to receiving waterbodies (Mallin, 2000; Mallin et al., 2001; Messersmith, 2007). Further, designers are cautioned that recent research on ponds has shown that some ponds can be hotspots or incubators for algae that generate harmful algal blooms (HABs).
- Mosquito Risk. Mosquitoes are not a major problem for larger ponds (Santana et al., 1994; Ladd and Frankenburg, 2003; Hunt et al., 2005). However, fluctuating water levels in smaller or under-sized ponds could pose some risk for mosquito breeding. Mosquito problems can be minimized through simple design features and maintenance operations described in MSSC (2005).
- Geese and Waterfowl. Ponds with extensive turf and shallow shorelines can attract nuisance populations of resident geese and other waterfowl, whose droppings add to the nutrient and bacteria loads, thus reducing the removal efficiency for those pollutants. Several design and landscaping features can make ponds much less attractive to geese (see Schueler, 1992).

4.12.2 Pond Conveyance Criteria

Internal Slope. The longitudinal slope of the pond bottom should be at least 0.5% to facilitate maintenance.

Primary Spillway. The spillway shall be designed with acceptable anti-flotation, anti-vortex and trash rack devices. The spillway must generally be accessible from dry land. When reinforced concrete pipe is used for the principal spillway to increase its longevity, "O-ring" gaskets (ASTM C361) shall be used to create watertight joints.

Non-Clogging Low-Flow Orifice. A low-flow orifice must be provided that is adequately protected from clogging by either an acceptable external trash rack or by internal orifice protection that may allow for smaller diameters. Orifices less than 3 inches in diameter may require extra attention during design to minimize the potential for clogging.

- One option is a submerged reverse-slope pipe that extends downward from the riser to an inflow point 1 foot below the normal pool elevation.
- Alternative methods must employ a broad crested rectangular V-notch (or proportional) weir, protected by a half-round CMP that extends at least 12 inches below the normal pool elevation.

Emergency Spillway. Ponds must be constructed with overflow capacity to pass the 100-year design storm event through either the primary spillway or a vegetated or armored emergency spillway unless waived by *<local jurisdiction>*.

Adequate Outfall Protection. The design must specify an outfall that will be stable for the 25-year design storm event. The channel immediately below the pond outfall must be modified to prevent erosion and conform to natural dimensions in the shortest possible distance. This is typically done by placing appropriately sized riprap over geotextile fabric, which can reduce flow velocities from the principal spillway to non-erosive levels (3.5 to 5.0 feet per second) depending on the channel lining material. Flared pipe sections, which discharge at or near the stream invert or into a step pool arrangement, should be used at the spillway outlet.

When the discharge is to a manmade pipe or channel system, the system must be adequate to convey the required design storm peak discharge.

If a pond daylights to a channel with dry weather flow, care should be taken to minimize tree clearing along the downstream channel, and to reestablish a forested riparian zone in the shortest possible distance. Excessive use of riprap should be avoided.

The final release rate of the facility shall be modified if any increase in flooding or stream channel erosion would result at a downstream structure, highway, or natural point of restricted streamflow.

Inlet Protection. Inflow points into the pond must be stabilized to ensure that non-erosive conditions exist during storm events up to the overbank flood event (i.e., the 25-year storm event). Inlet pipe inverts should generally be located at or slightly below the permanent pool elevation. A forebay shall be provided at each inflow location, unless the inlet is submerged or inflow provides less than 10% of the total design storm inflow to the pond.

Dam Safety Permits. The designer must verify whether or not Dam Safety permits or approvals are required for the embankment.

4.12.3 Pond Pretreatment Criteria

Sediment forebays are considered to be an integral design feature to maintain the longevity of all ponds. A forebay must be located at each major inlet to trap sediment and preserve the capacity of the main treatment cell. The following criteria apply to forebay design:

- A major inlet is defined as an individual storm drain inlet pipe or open channel serving at least 10% of the pond's CDA.
- The forebay consists of a separate cell, formed by an acceptable barrier (e.g., an earthen berm, concrete weir, gabion baskets, etc.).
- The forebay should be between 4 and 6 feet deep and must be equipped with a variable width aquatic bench for safety purposes. The aquatic bench should be 4 to 6 feet wide at a depth of 1 to 2 feet below the water surface. Small forebays may require alternate geometry to achieve the goals of pretreatment and safety within a small area.
- The forebay shall be sized to contain 0.1 inches of runoff from the contributing drainage impervious area. The relative size of individual forebays should be proportional to the percentage of the total inflow to the pond.
- The bottom of the forebay may be hardened (e.g., with concrete, asphalt, or grouted riprap) to make sediment removal easier.
- The forebay must be equipped with a metered rod in the center of the pool (as measured lengthwise along the low-flow water travel path) for long-term monitoring of sediment accumulation.
- Exit velocities from the forebay shall be non-erosive or an armored overflow shall be provided. Non-erosive velocities are 4 feet per second for the 2-year event, and 6 feet per second for the 25-year event.
- Direct maintenance access for appropriate equipment shall be provided to each forebay.
- Designers of ponds that are used for irrigation should be mindful of pretreatment provisions that help prevent irrigation system pluggages and operational issues.

4.12.4 Pond Design Criteria

Pond Storage Design. The pond permanent pool must be sized to store a volume equivalent to the SWRv. Volume storage may be provided in multiple cells. Performance is enhanced when multiple treatment pathways are provided by using multiple cells, longer flowpaths, high surface area to volume ratios, complex microtopography, and/or redundant treatment methods (combinations of pool, ED, and marsh). Volume storage below the permanent pool is not considered in the detention calculations.

Pond Geometry. Pond designs should have an irregular shape and a long flow path from inlet to outlet to increase water residence time and pond performance. The minimum length to width ratio (i.e., length relative to width) for ponds is 1.5:1. Greater flowpaths and irregular shapes are recommended. Internal berms, baffles, or vegetated peninsulas can be used to extend flow paths and/or create multiple pond cells.

Permanent Pool Depth. The maximum depth of the permanent pool should not generally exceed 8 feet unless the pond is designed for multiple uses.

Micropool. A micropool is a 3- to 6-foot-deep pool used to protect the low-flow pipe from clogging and to prevent sediment resuspension. For micropool extended detention ponds, the micropool shall be designed to hold at least 10%–25% of the 85th or 95th percentile storm event.

Side Slopes. Side slopes for ponds should generally have a gradient no steeper than 3H:1V. Mild slopes promote better establishment and growth of vegetation and provide for easier maintenance and a more natural appearance.

Maximum Extended Detention Levels. The total storage, including any ponding for larger flooding events (100-year storm) should not extend more than 5 feet above the pond permanent pool unless specific design enhancements to ensure side slope stability, safety, and maintenance are identified and approved.

Top of Bank. Storm ponds shall be provided with a 20-ft maintenance access at the top of bank with a maximum cross slope of 48:1.

Stormwater Pond Benches. The perimeter of all pool areas greater than 4 feet in depth must be surrounded by two benches, as follows:

- **Safety Bench.** This is a flat bench located just outside of the perimeter of the permanent pool to allow for maintenance access and reduce safety risks. Except when the stormwater pond side slopes are 5H:1V or flatter, provide a safety bench that generally extends 8 to 15 feet outward from the normal water edge to the toe of the stormwater pond side slope. The maximum slope of the safety bench is 5%.
- **Aquatic Bench.** This is a shallow area just inside the perimeter of the normal pool that promotes growth of aquatic and wetland plants. The bench also serves as a safety feature, reduces shoreline erosion, and conceals floatable trash. Incorporate an aquatic bench that generally extends up to 10 feet inward from the normal shoreline, has an irregular configuration, and extends a maximum depth of 18 inches below the normal pool water surface elevation.

Liners. When a stormwater pond is located over highly permeable soils, a liner may be needed to sustain a permanent pool of water. If geotechnical tests confirm the need for a liner, acceptable options include the following:

1. a clay liner following the specifications outlined in Table 4.49;
2. a 30-mil- poly-liner;
3. bentonite;
4. use of chemical additives; or
5. an engineering design, as approved on a case-by-case basis by *<local jurisdiction>*.

A clay liner must have a minimum thickness of 12 inches with an additional 12-inch layer of compacted soil above it, and it must meet the specifications outlined in Table 4.49. Other synthetic liners can be used if the designer can supply supporting documentation that the material will achieve the required performance.

Table 4.49. Clay Liner Specifications

Property	Test Method	Unit	Specification
Permeability	ASTM D2434	cm/s	1×10^{-6}
Plasticity Index of Clay	ASTM D4318	%	Not less than 15
Liquid Limit of Clay	ASTM D2216	%	Not less than 30
Clay Particles Passing	ASTM D422	%	Not less than 30
Clay Compaction	ASTM D2216	%	95% of standard proctor density

Source: VA DCR (1999)

Required Geotechnical Testing. Soil borings must be taken below the proposed embankment, in the vicinity of the proposed outlet area, and in at least two locations within the proposed pond treatment area. Soil boring data is needed to (1) determine the physical characteristics of the excavated material, (2) determine its adequacy for use as structural fill or spoil, (3) provide data for structural designs of the outlet works (e.g., bearing capacity and buoyancy), (4) determine compaction/composition needs for the embankment, (5) determine the depth to groundwater and (6) evaluate potential infiltration losses (and the potential need for a liner).

Non-clogging Low-Flow (Extended Detention) Orifice. The low-flow ED orifice shall be adequately protected from clogging by an acceptable external trash rack. The preferred method is a submerged reverse-slope pipe that extends downward from the riser to an inflow point 1 foot below the normal pool elevation. Alternative methods are to employ a broad crested rectangular, V-notch, or proportional weir, protected by a half-round CMP that extends at least 12 inches below the normal pool.

Riser in Embankment. The riser should be located within the embankment for maintenance access, safety, and aesthetics. Access to the riser is to be provided by lockable manhole covers and manhole steps within easy reach of valves and other controls. The principal spillway opening can be "fenced" with pipe or rebar at 8-inch intervals for safety purposes.

Trash Racks. Trash racks shall be provided for low-flow pipes and for riser openings not having anti-vortex devices.

Pond Drain. Ponds should have a drainpipe that can completely or partially drain the permanent pool. In cases where a low-level drain is not feasible (such as in an excavated pond), a pump well must be provided to accommodate a temporary pump intake when needed to drain the pond.

- The drain pipe must have an upturned elbow or protected intake within the pond to help keep it clear of sediment deposition, and a diameter capable of draining the pond within 24 hours.
- The pond drain must be equipped with an adjustable valve located within the riser, where it will not be normally inundated and can be operated in a safe manner.

Care must be exercised during pond drawdowns to prevent downstream discharge of sediments or anoxic water and rapid drawdown. The approving authority shall be notified before draining a pond.

Safety Features.

- The principal spillway opening must be designed and constructed to prevent access by small children.
- End walls above pipe outfalls greater than 48 inches in diameter must be fenced to prevent a falling hazard.
- Storage practices must incorporate an additional 1 foot of freeboard above the emergency spillway, or 2 feet of freeboard if design has no emergency spillway, for the 100-year storm.
- The emergency spillway must be located so that downstream structures will not be impacted by spillway discharges.
- Both the safety bench and the aquatic bench should be landscaped with vegetation that hinders or prevents access to the pool.
- Warning signs prohibiting swimming must be posted.
- Where permitted, fencing of the perimeter of ponds is discouraged. The preferred method to reduce risk is to manage the contours of the stormwater pond to eliminate drop-offs or other safety hazards. Fencing is required at or above the maximum water surface elevation in the rare situations when the pond slope is a vertical wall.
- Side slopes to the pond shall not be steeper than 3H:1V, and shall terminate on a 15-foot-wide safety bench. Both the safety bench and the aquatic bench may be landscaped to prevent access to the pool. The bench requirement may be waived if slopes are 4H:1V or flatter.

Maintenance Reduction Features. Many maintenance issues can be addressed through well designed access. All ponds must be designed for annual maintenance. Good access is needed so crews can remove sediments, make repairs, and preserve pond-treatment capacity. Design for the following:

  - Adequate maintenance access must extend to the forebay, safety bench, riser, and outlet structure and must have sufficient area to allow vehicles to turn around.
  - The riser should be located within the embankment for maintenance access, safety, and aesthetics. Access to the riser should be provided by lockable manhole covers and manhole steps within easy reach of valves and other controls.
  - Access roads must (1) be constructed of load-bearing materials or be built to withstand the expected frequency of use, (2) have a minimum width of 20 feet, and (3) have a profile grade that does not exceed 5H:1V.
  - A maintenance right-of-way or easement must extend to the stormwater pond from a public or private road.
  - No permanent structures (mechanical, electrical, phone, fences) or landscaping are allowed within the 20’ pond maintenance access easement.

- **Material Specifications.** ED ponds are generally constructed with materials obtained on site, except for the plant materials, inflow and outflow devices (e.g., piping and riser materials), possibly stone for inlet and outlet stabilization, and geotextile fabric for lining banks or berms.
- **Pond Sizing.** Stormwater ponds can be designed to capture and treat the remaining stormwater discharged from upstream practices from the design storm (SWRv). Additionally, stormwater ponds may be sized to control peak flow rates from the 2- to 25-year frequency storm event or other design storms as required. Design calculations must ensure that the post-development peak

discharge does not exceed the predevelopment peak discharge. See Section 3.7.2 Hydrologic and Hydraulic Analysis and Appendix I for a summary of acceptable hydrologic methodologies and models.

For treatment train designs where upland practices are utilized for treatment of the SWRv, designers can use a site-adjusted Rv or NRSC CN that reflects the volume reduction of upland practices to compute the 2- 50-year frequency storm event that must be treated by the stormwater pond.

The pond permanent pool must be sized to store a volume equivalent to the SWRv or design volume.

The storage volume (Sv) of the practice is equal to the volume provided by the pond permanent pool (Equation 4. 26). The total Sv cannot exceed the design SWRv.

Equation 4.26 Pond Storage Volume

$$Sv = Pond\ permanent\ pool\ volume$$

- **Water Balance Testing.** A water balance calculation is recommended to document that sufficient inflows to wet ponds and wet ED ponds exist to compensate for combined infiltration and evapotranspiration losses during a 30-day summer drought without creating unacceptable drawdowns (see Equation 4.27, adapted from Hunt et al., 2007). The recommended minimum pool depth to avoid nuisance conditions may vary; however, it is generally recommended that the water balance maintain a minimum 24-inch reservoir.

Equation 4.27 Water Balance Equation for Acceptable Water Depth in a Wet Pond

$$DP > ET + INF + RES - MB$$

Where:

DP	=	average design depth of the permanent pool (in.)
ET	=	summer evapotranspiration rate (in.) (assume 8 in.)
INF	=	monthly infiltration loss (assume 7.2 inches at 0.01 in./hour)
RES	=	reservoir of water for a factor of safety (assume 24 in.)
MB	=	measured baseflow rate to the pond, if any convert to pond-inches (in.)

Design factors that will alter this equation are the measurements of seasonal base flow and infiltration rate. The use of a liner could eliminate or greatly reduce the influence of infiltration. Similarly, land use changes in the upstream watershed could alter the base flow conditions over time (e.g., urbanization and increased impervious cover).

Translating the baseflow to inches refers to the depth within the pond. Therefore, Equation 4. 28 can be used to convert the baseflow, measured in cubic feet per second (cfs), to pond-inches:

Equation 4.28 Baseflow Conversion

$$Pond - inches = \frac{MB \times 2.592 \times 10^6 \times 12}{SA}$$

Where:

Pond – inches	=	depth within the pond (in,)
MB	=	measured baseflow rate to the pond (cfs)
2.592 × 106	=	conversion factor, converting cfs to ft^3/month
12	=	conversion factor, converting feet to inches
SA	=	surface area of pond (ft^2)

4.12.5 Pond Landscaping Criteria

Pond Benches. The perimeter of all deep pool areas (4 feet or greater in depth) must be surrounded by two benches:

- A safety bench that extends 8 to 15 feet outward from the normal water edge to the toe of the pond side slope. The maximum slope of the safety bench shall be 6%.
- An aquatic bench that extends up to 10 feet inward from the normal shoreline and has a maximum depth of 18 inches below the normal pool water surface elevation.

Landscaping and Planting Plan. A landscaping plan must be provided that indicates the methods used to establish and maintain vegetative coverage in the pond and its buffer (see Section 4.3.5 Bioretention Landscaping Criteria for extended landscaping and planting details). Minimum elements of a landscaping plan include the following:

- Delineation of pondscaping zones within both the pond and buffer.
- Selection of corresponding plant species.
- The planting plan.
- The sequence for preparing the wetland benches (including soil amendments, if needed).
- Sources of native plant material.
- The landscaping plan should provide elements that promote diverse wildlife and waterfowl use within the stormwater wetland and buffers.
- Woody vegetation may not be planted or allowed to grow within 15 feet of the toe of the embankment nor within 25 feet from the principal spillway structure.
- A vegetated buffer should be provided that extends at least 25 feet outward from the maximum water surface elevation of the pond. Permanent structures (e.g., buildings) should not be constructed within the buffer area. Existing trees should be preserved in the buffer area during construction.
- The soils in the stormwater buffer area are often severely compacted during the construction process, to ensure stability. The density of these compacted soils can be so great that it effectively prevents root penetration and, therefore, may lead to premature mortality or loss of vigor. As a rule of thumb, planting holes should be three times deeper and wider than the diameter of the root ball for bare root and ball-and-burlap stock, and five times deeper and wider for container-grown stock.

- Avoid species that require full shade or are prone to wind damage. Extra mulching around the base of trees and shrubs is strongly recommended as a means of conserving moisture and suppressing weeds.

For more guidance on planting trees and shrubs in pond buffers, consult Cappiella et al. (2006).

4.12.6 Pond Construction Sequence

The following is a typical construction sequence to properly install a stormwater pond. The steps may be modified to reflect different pond designs; site conditions; and the size, complexity and configuration of the proposed facility.

1. Use of Ponds for Soil Erosion and Sediment Control. A pond may serve as a sediment basin during project construction. If this is done, the volume should be based on the more stringent sizing rule (soil erosion and sediment control requirement versus storage volume requirement). Installation of the permanent riser should be initiated during the construction phase, and design elevations should be set with final cleanout of the sediment basin and conversion to the post-construction pond in mind. The bottom elevation of the pond should be lower than the bottom elevation of the temporary sediment basin. Appropriate procedures must be implemented to prevent discharge of turbid waters when the basin is being converted into a pond.

Approval from *<local jurisdiction>* must be obtained before any sediment pond can be used as for stormwater management.

2. Stabilize the Contributing Drainage Area. Ponds should only be constructed after the CDA to the pond is completely stabilized. If the proposed pond site will be used as a sediment trap or basin during the construction phase, the construction notes should clearly indicate that the facility will be de-watered, dredged, and regraded to design dimensions after the original site construction is complete.

3. Assemble Construction Materials on Site. Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.

4. Clear and Strip. Bring the project area to the desired subgrade.

5. Soil Erosion and Sediment Controls. Install soil erosion and sediment control measures prior to construction, including temporary de-watering devices and stormwater diversion practices. All areas surrounding the pond that are graded or denuded during construction must be planted with turf grass, native plantings, or other approved methods of soil stabilization.

6. Excavate the Core Trench and Install the Spillway Pipe.

7. Install the Riser or Outflow Structure. Once riser and outflow structures are installed ensure the top invert of the overflow weir is constructed level at the design elevation.

8. Construct the Embankment and any Internal Berms. These features must be installed in 8- to 12-inch lifts; compact the lifts with appropriate equipment.

9. Excavate and Grade. Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the pond.

10. Construct the Emergency Spillway. The emergency spillway must be constructed in cut or structurally stabilized soils.

11. Install Outlet Pipes. The installation of outlet pipes must include a downstream riprap protection apron.

12. Stabilize Exposed Soils. Use temporary seed mixtures appropriate for the pond buffer to stabilize the exposed soils. All areas above the normal pool elevation must be permanently stabilized by hydroseeding or seeding over straw.

13. Plant the Pond Buffer Area. Establish the planting areas according to the pondscaping plan (see Section 4.12.5 Pond Landscaping Criteria).

Construction Supervision. Supervision during construction is recommended to ensure that stormwater ponds are properly constructed, especially during the following stages of construction:

- Preconstruction meeting
- Initial site preparation including the installation of soil erosion and sediment control measures
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pondscaping plan and vegetative stabilization
- Immediately seed or install vegetated ground cover upon completion of sloping and grading of each stormwater pond within a project.
- Inspect within two weeks to insure vegetation is in fact holding banks and slopes in place.
- Prior to completion of project, mechanically remove erosion deposition from ponds that occurred during the project. Criteria should be based on erosion of designed bank slopes and loss of storage capacity.
- Final inspection (develop a punch list for facility acceptance)

Construction phase inspection checklist for ponds can be found in Appendix E Construction Inspection Checklists.

To facilitate maintenance, contractors should measure the actual constructed pond depth at three areas within the permanent pool (forebay, mid-pond and at the riser), and they should mark and geo-reference them on an as-built drawing. This simple data set will enable maintenance inspectors to determine pond sediment deposition rates in order to schedule sediment cleanouts.

4.12.7 Pond Maintenance Criteria

Maintenance is needed so stormwater ponds continue to operate as designed on a long-term basis. Ponds normally have fewer routine maintenance requirements than other stormwater control measures. Stormwater pond maintenance activities vary regarding the level of effort and expertise required to perform them. Routine stormwater pond maintenance, such as mowing and removing debris and trash, is needed several times each year (see Table 4.50). More significant maintenance (e.g., removing accumulated sediment) is needed less frequently but requires more skilled labor and special equipment. Inspection and repair of critical structural features (e.g., embankments and risers) needs to be performed by a qualified professional (e.g., a structural engineer) who has experience in the construction, inspection, and repair of these features.

Table 4.50. Pond Maintenance Tasks and Frequency.

Frequency	Maintenance Items
During establishment, as needed (first year)	▪ Inspect the site at least twice after storm events that exceed a 1/2 inch of rainfall. ▪ Plant the aquatic benches with emergent wetland species, following the planting recommendations contained in Section 4.11.6 Stormwater Wetland Landscaping Criteria. ▪ Stabilize any bare or eroding areas in the CDA or around the pond buffer. ▪ Water trees and shrubs planted in the pond buffer during the first growing season. In general, consider watering every 3 days for first month, and then weekly during the remainder of the first growing season (April through October), depending on rainfall.
Quarterly or after major storms (>1 inch of rainfall)	▪ Mowing (twice a year) ▪ Remove debris and blockages ▪ Repair undercut, eroded, and bare soil areas
Twice a year	▪ Mowing of the buffer and pond embankment
Annually	▪ Shoreline cleanup to remove trash, debris, and floatables ▪ A full maintenance inspection ▪ Open up the riser to access and test the valves ▪ Repair broken mechanical components, if needed
Once—during the second year following construction	▪ Pond buffer and aquatic bench reinforcement plantings
Every 5 to 7 years	▪ Forebay sediment removal
From 5 to 25 years	▪ Repair pipes, the riser, and spillway, as needed

Sediment removal in the pond pretreatment forebay should occur every 5 to 7 years or after 50% of total forebay capacity has been lost. The designer should also check to see whether removed sediments can be spoiled on site or must be hauled away. Sediments excavated from ponds are not usually considered toxic or hazardous. They can be safely disposed of by either land application or land filling. Sediment testing may be needed prior to sediment disposal if the pond serves a pollutant hotspot land use, as the sediment could be potentially toxic or hazardous (Weinstein et al., 2008). In lieu of local regulations for sediment testing, the parameters in Table 4.51 may be used.

Table 4.51. Ceiling Levels Governing Management of Accumulated Sediment[1]

Parameter	Ceiling Level (ppm or mg/kg)
Total Arsenic	8
Total Cadmium	10
Total Chromium	100
Total Lead	250
pH	Less than 5 or greater than 10 standard units
Electrical Conductivity	8 deciSiemens/meter (dS/m) at 25°C
[1] *Excerpt from Wisconsin Administrative Code NR 528.03, Table 2*	

Maintenance Plans. Maintenance plans must clearly outline how vegetation in the pond and its buffer will be managed or harvested in the future. Periodic mowing of the stormwater buffer is only required along maintenance rights-of-way and the embankment. The remaining buffer can be managed as a meadow (mowing every other year) or forest. The maintenance plan should schedule a shoreline cleanup at least once a year to remove trash and floatables. For information on chemical control methods for aquatic plants, consult Clemson's fact sheet entitled "Aquatic Weed Control Overview" available online at http://www.clemson.edu/extension/hgic/plants/other/landscaping/hgic1714.html.

Maintenance Inspections. Maintenance of a pond is driven by annual inspections by a qualified professional who evaluates the condition and performance of the pond. Based on inspection results, specific maintenance tasks will be triggered.

Maintenance inspection checklist for stormwater ponds and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Waste Material. Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law. However, sediment testing may be needed prior to sediment disposal because sediments excavated from ponds could be contaminated.

4.12.8 Pond Stormwater Compliance Calculations

Stormwater ponds are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 60% bacteria removal for the storage volume (Sv) provided by in the permanent pool (Table 4.52).

Table 4.52. Pond Retention and Pollutant Removal

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 30%
Bacteria Removal	= 60%

4.12.9 References

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4.13 Stormwater Wetlands

<table>
<tr><th colspan="5">Stormwater Wetlands</th></tr>
<tr><td colspan="5">Definition: Practices that create shallow marsh areas to treat urban stormwater, which often incorporate small permanent pools and/or extended detention storage. Stormwater wetlands are explicitly designed to provide stormwater detention for larger storms (2- to 25-year, or flood control events) above the design storm (SWRv) storage.</td></tr>
<tr><th colspan="2">Site Applicability</th><th colspan="3">BMP Performance Summary</th></tr>
<tr><th>Land Uses</th><th>Required Footprint</th><th colspan="3">WQ Improvement: Moderate to High</th></tr>
<tr><td rowspan="3">▪ Urban
▪ Suburban
▪ Rural</td><td rowspan="3">Medium</td><th>TSS[1]</th><th>Total N[1]</th><th>Bacteria[1]</th></tr>
<tr><td>80%</td><td>25%</td><td>60%</td></tr>
<tr><th colspan="3">Runoff Reduction</th></tr>
<tr><th>Construction Costs</th><th>Maintenance Burden</th><th colspan="3">Volume</th></tr>
<tr><td>Moderate</td><td>Moderate</td><td colspan="3">Low</td></tr>
<tr><th colspan="2">Maintenance Frequency:</th><th colspan="3">SWRv</th></tr>
<tr><th>Routine</th><th>Non-Routine</th><td colspan="3" rowspan="2">0%</td></tr>
<tr><td>At least annually</td><td>Every 2 years</td></tr>
<tr><th colspan="2">Advantages/Benefits</th><th colspan="3">Disadvantages/Limitation</th></tr>
<tr><td colspan="2">▪ High removal of typical stormwater pollutants
▪ Provides habitat for wildlife
▪ Attractive when integrated into site development
▪ Good for sites with high water table and/or poorly drained soils</td><td colspan="3">▪ Requires large amount of flat land (3% of CDA)
▪ Must be properly designed, installed, and maintained to avoid nuisance problems
▪ Needs constant source of water
▪ Routine sediment cleanout may be needed
▪ Potential for thermal impacts downstream</td></tr>
<tr><th colspan="2">Components</th><th colspan="3">Design considerations</th></tr>
<tr><td colspan="2">▪ Conveyance
▪ Forebay
▪ Deep ponding area
▪ High marsh and transition zones
▪ Micropool
▪ Spillway system(s)</td><td colspan="3">▪ CDA must be large enough to sustain permanent water level
▪ Flow path through the wetland system should be at least 2L:1W
▪ 25% of pool depth should be 18-48 inches
▪ Water balance must be maintained</td></tr>
<tr><th colspan="5">Maintenance Activities</th></tr>
<tr><td colspan="2">▪ Reinforce plantings as needed
▪ Remove accumulated sediments
▪ Remove invasive vegetation</td><td colspan="3">▪ Thin/harvest vegetation every 2 years on embankments and access areas; elsewhere every 5–10 years</td></tr>
</table>

[1]*Credited pollutant load removal*

Stormwater wetlands, sometimes called constructed wetlands, are shallow depressions that receive stormwater inputs for water quality treatment. Runoff from each new storm displaces runoff from previous storms, and the long residence time allows multiple pollutant removal processes to operate. The wetland environment provides an ideal environment for gravitational settling, biological uptake, and microbial activity. Wetlands include various design adaptations to allow them to be applied in specific settings. For example, some designs incorporate trees within the wetland area.

Stormwater wetlands should be considered for use after all other upland retention opportunities have been exhausted and there is still a remaining treatment volume or runoff from larger storms (i.e., 2- to 25-year or flood control events) to manage. Stormwater wetlands receive no stormwater retention credit and should be considered mainly for management of larger storm events. Stormwater wetlands have both community and environmental concerns (see Section 4.13.1 Stormwater Wetland Feasibility Criteria) that should be considered before choosing stormwater ponds for the appropriate stormwater practice on site.

Figure 4.50 Stormwater Wetland at Carolina Forest Recreation Center, Myrtle Beach (photo: Kathryn Ellis).

Definition. Practices that create shallow marsh areas to treat urban stormwater, which often incorporate small permanent pools and/or extended detention storage. Stormwater wetlands are explicitly designed to provide stormwater detention for larger storms (2 – 25-year, or flood control events) above the design storm (SWRv) storage. Wetlands are typically less than 1 foot deep (although they have greater depths at the forebay and in micropools) and possess variable microtopography to promote dense and diverse wetland cover. Design variants include the following:

W-1 Shallow wetland

W-2 Extended detention shallow wetland

Several stormwater wetland design features are illustrated in Figure 4. 48 through Figure 4. 52.

Note: All of the pond performance criteria presented in Section 4.10 Ponds also apply to the design of stormwater wetlands. Additional criteria that govern the geometry and establishment of created wetlands are presented in this section.

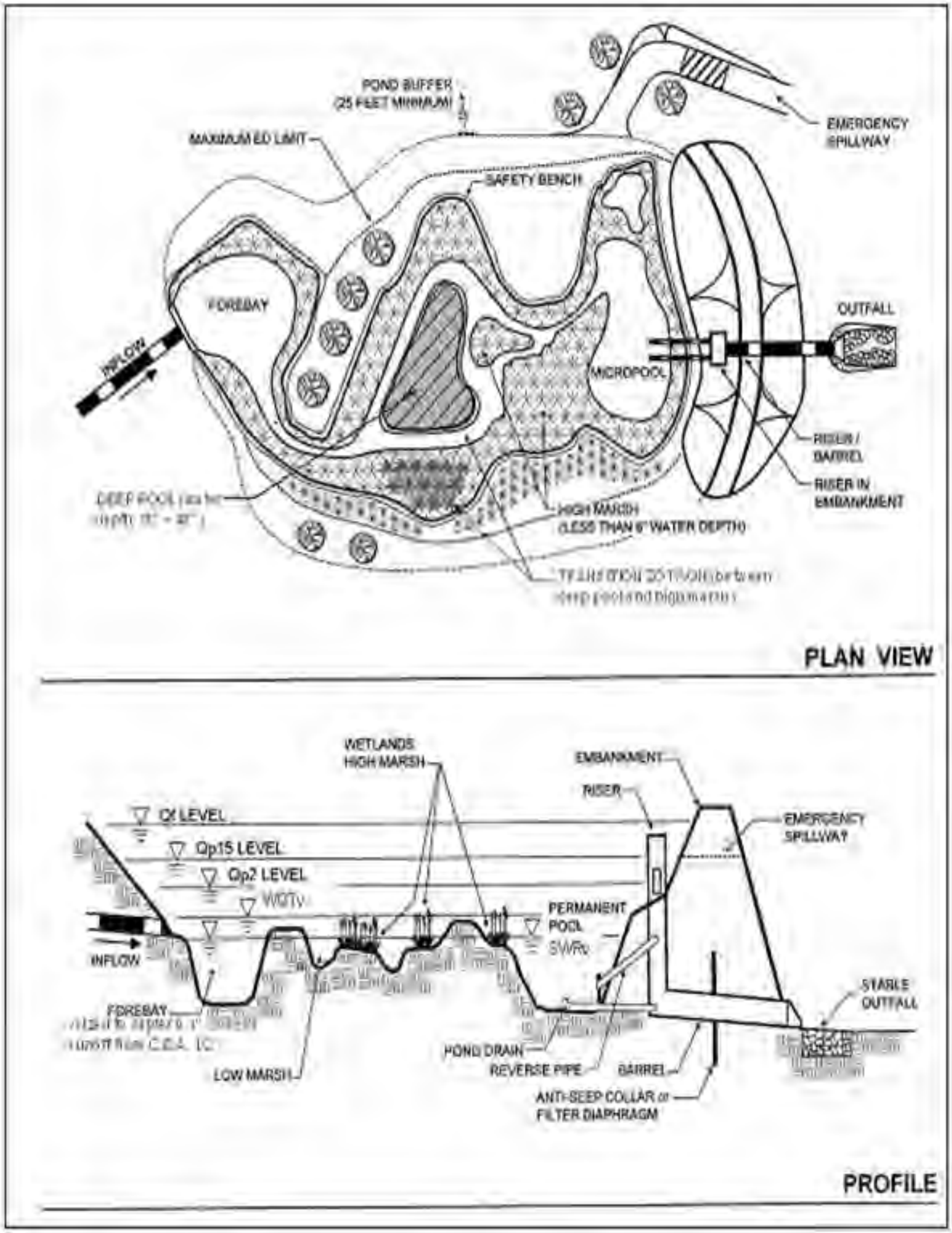

Figure 4.51 Example of extended detention shallow wetland.

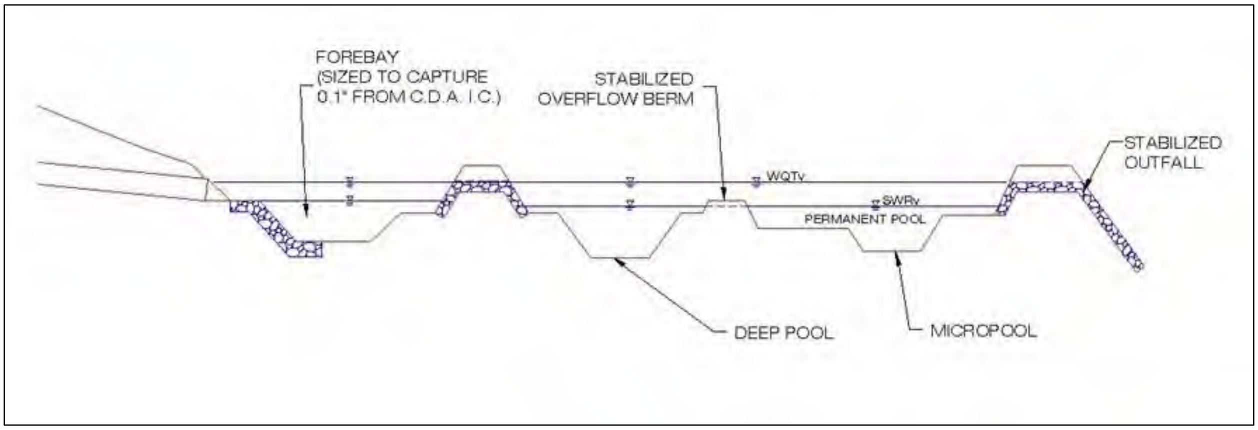

Figure 4.52 Cross section of a typical stormwater wetland.

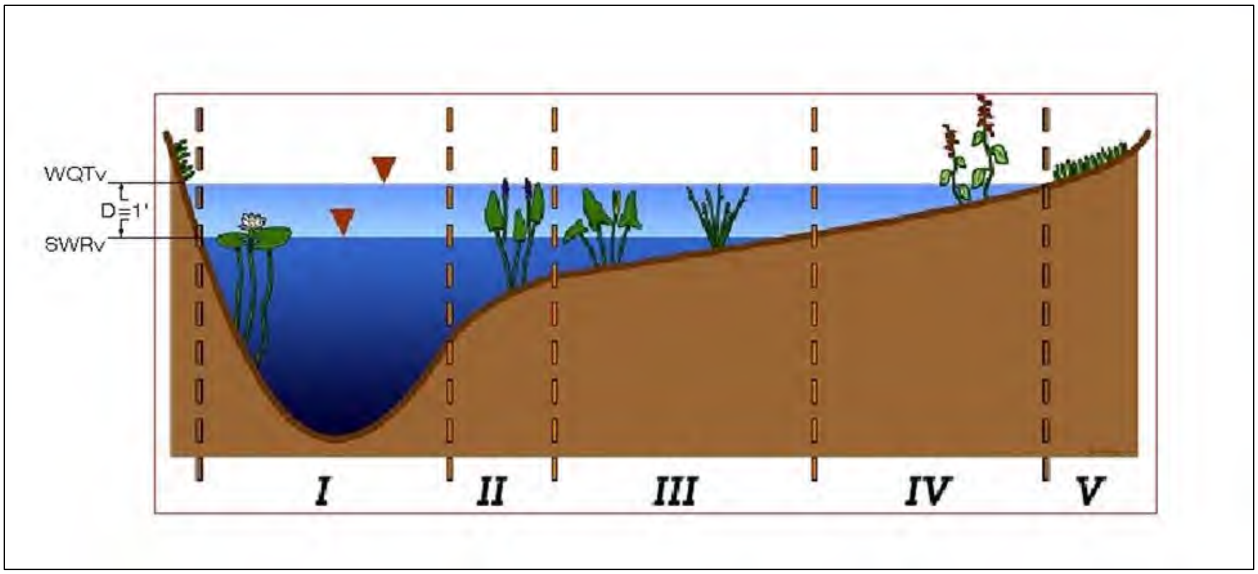

Figure 4.53 Interior wetland zones. Adapted from Hunt et al. (2007).

(I) Deep Pool (depth -48 to -18 inches),

(II) Transition Zone (depth -18 to -6 inches),

(III and IV) High Marsh Zone (depth -6 to +6 inches),

(IV) Temporary Inundation Area, and

(V) Upper Bank

4.13.1 Stormwater Wetland Feasibility Criteria

Constructed wetland designs are subject to the following site constraints:

Adequate Water Balance. Stormwater wetlands must have enough water supplied from groundwater, runoff, or baseflow so that the permanent pools will not draw down by more than 2 feet after a 30-day summer drought. A simple water balance calculation must be performed using the equation provided in Section 4.11.4 Stormwater Wetland Design Criteria.

Contributing Drainage Area. The CDA must be large enough to sustain a permanent water level within the stormwater wetland. If the only source of wetland hydrology is stormwater runoff, then several dozen acres of CDA are typically needed to maintain constant water elevations. Smaller CDAs are acceptable if the bottom of the stormwater wetland intercepts the groundwater table or if the designer or approving agency is willing to accept periodic wetland drawdown.

Space Requirements. Constructed wetlands normally require a footprint that takes up about 3% of the CDA, depending on the average depth of the wetland and the extent of its deep pool features.

Site Topography. Stormwater wetlands are best applied when the grade of contributing slopes is less than 8%.

Steep Slopes. A modification of the constructed wetland (and linear wetland or wet swale system) is the regenerative stormwater conveyance (RSC) or step pool storm conveyance channel. The RSC can be used to bring stormwater down steeper grades through a series of step pools. This can serve to bring stormwater down outfalls where steep drops on the edge of the tidal receiving system can create design challenges. A description of this practice is provided in Section 4.7 Open Channel Systems. For more detailed information on RSC systems, designers can consult Maryland's Anne Arundel County Design Specifications, available at http://www.aacounty.org/departments/public-works/wprp/watershed-assessment-and-planning/step-pool-conveyance-systems/index.html

Available Hydraulic Head. The depth of a constructed wetland is usually constrained by the hydraulic head available on the site. The bottom elevation is fixed by the elevation of the existing downstream conveyance system to which the wetland will ultimately discharge. Because constructed wetlands are typically shallow, the amount of head needed (usually a minimum of 2 to 4 feet) is typically less than for wet ponds.

Setbacks. Setbacks to structures and property lines must be at least 10 feet and adequate waterproofing protection must be provided for foundations and basements.

Depth to Water Table. The depth to the groundwater table is not a major constraint for constructed wetlands, since a high water table can help maintain wetland conditions. However, designers should keep in mind that high groundwater inputs may increase excavation costs (refer to Section 0 Ponds).

Soils. Soil tests should be conducted to determine the saturated hydraulic conductivity and other subsurface properties of the soils underlying the proposed stormwater wetland. Highly permeable soils will make it difficult to maintain a healthy permanent pool. Underlying soils of HSG C or D should be adequate to maintain a permanent pool. Most HSG A soils and some HSG B soils will require a liner (see Table 4.49 in Section 4.10 Ponds).

Use of or Discharges to Natural Wetlands. Constructed wetlands may not be located within jurisdictional waters, including wetlands, without obtaining a Section 404 permit from the appropriate federal regulatory agency. In addition, designer should investigate the status of adjacent wetlands to determine if the discharge from the constructed wetland will change the hydroperiod of a downstream natural wetland. See Cappiella et al. (2006) for guidance on minimizing stormwater discharges to existing wetlands.

Regulatory Status. Constructed wetlands built for the express purpose of stormwater treatment are generally not considered jurisdictional wetlands, but designers should check with their wetland regulatory authorities to ensure the status.

Perennial Streams. Locating a constructed wetland along or within a perennial stream will require both Section 401 and Section 404 permits from the state or federal regulatory authority.

Economic Considerations. If space is available, wetlands can be a very cost-effective stormwater practice.

Community and Environmental Concerns. In addition to the community and environmental concerns that exist for stormwater ponds, the following must be addressed during design of stormwater wetlands:

Aesthetics and Habitat. Constructed wetlands can create wildlife habitat and can also become an attractive community feature. Designers should think carefully about how the wetland plant community will evolve over time, since the future plant community seldom resembles the one initially planted.

Existing Forests. Given the large footprint of a constructed wetland, there is a strong chance that the construction process may result in extensive tree clearing. The designer should preserve mature trees during the facility layout and may consider creating a wooded wetland (see Cappiella et al., 2006).

Safety Risk. Constructed wetlands are safer than other types of ponds, although forebays and micropools must be designed with aquatic benches to reduce safety risks.

Mosquito Risk. Mosquito control can be a concern for stormwater wetlands if they are under-sized or have a small CDA. Deepwater zones serve to keep mosquito populations in check by providing habitat for fish and other pond life that prey on mosquito larvae. Few mosquito problems are reported for well-designed, properly sized, and frequently maintained constructed wetlands; however, no design can eliminate them completely. Simple precautions can be taken to minimize mosquito breeding habitat within constructed wetlands (e.g., constant inflows, benches that create habitat for natural predators, and constant pool elevations—MSSC, 2005).

4.13.2 Stormwater Wetland Conveyance Criteria

The slope profile within individual stormwater wetland cells should generally be flat from inlet to outlet (adjusting for microtopography). The recommended maximum elevation drop between wetland cells is 1 foot or less.

Since most constructed wetlands are on-line facilities, they need to be designed to safely pass the maximum design storm (e.g., the 25-year and 100-year design storms). While the ponding depths for the more frequent 2-year storm are limited in order to avoid adverse impacts to the planting pallet, the overflow for the less frequent 25-100-year storms must likewise be carefully designed to minimize the depth of ponding. A maximum depth of 4 feet over the wetland pool is recommended.

While many options are available for setting the normal pool elevation, it is strongly recommended that removable flashboard risers be used, given their greater operational flexibility to adjust water levels following construction (see Hunt et al., 2007). Also, a weir can be designed to accommodate passage of the larger storm flows at relatively low ponding depths.

4.13.3 Stormwater Wetland Pretreatment Criteria

Sediment regulation is critical to sustain stormwater wetlands. Consequently, a forebay shall be located at the inlet and a micropool shall be located at the outlet. A micropool is a 3- to 6-foot-deep pool used to protect the low-flow pipe from clogging and to prevent sediment resuspension. Forebays are designed in the same manner as stormwater ponds (see Section 4.12.3 Pond Pretreatment Criteria). The design of forebays should consider the possibility of heavy trash loads from public areas.

4.13.4 Stormwater Wetland Design Criteria

Internal Design Geometry. Research and experience have shown that the internal design geometry and depth zones are critical in maintaining the pollutant removal capability and plant diversity of stormwater wetlands. Stormwater wetland performance is enhanced when the wetland has multiple cells, longer flowpaths, and a high ratio of surface area to volume. Whenever possible, constructed wetlands should be irregularly shaped with long, sinuous flow paths. The following design elements are required for stormwater wetlands:

Multiple-Cell Wetlands. Stormwater wetlands can be divided into at least four internal sub-cells of different elevations: the forebay, a micro-pool outlet, and two additional cells. Cells can be formed by sand berms (anchored by rock at each end), back-filled coir fiber logs, or forested peninsulas (extending as wedges across 95% of the wetland width). The vegetative target is to ultimately achieve a 50-50 mix of emergent and forested wetland vegetation within all four cells.

The first cell (the forebay) is deeper and is used to receive runoff from the pond cell or the inflow from a pipe or open channel and distribute it as sheetflow into successive wetland cells. The surface elevation of the second cell is the normal pool elevation. It may contain a forested island or a sand wedge channel to promote flows into the third cell, which is 3 to 6 inches lower than the normal pool elevation. The purpose of the wetland cells is to create an alternating sequence of aerobic and anaerobic conditions to maximize pollutant removal. The fourth wetland cell is located at the discharge point and serves as a micro-pool with an outlet structure or weir.

Extended Detention Ponding Depth. When extended detention is provided for management of larger storm events, the total ED volume shall not comprise more than 50% of the total volume stored by the stormwater wetland, and its maximum water surface elevation shall not extend more than 3 feet above the normal pool.

Deep Pools. Approximately 25% of the stormwater surface area must be provided in at least three deeper pools—located at the inlet (forebay), center, and outlet (micropool) of the wetland—with each pool having a depth of from 18 to 48 inches. Refer to the sizing based on water balance below for additional guidance on the minimum depth of the deep pools.

High Marsh Zone. Approximately 70% of the stormwater wetland surface area must exist in the high marsh zone (-6 inches to +6 inches, relative to the normal pool elevation).

Transition Zone. The low marsh zone is no longer an acceptable wetland zone, and is only allowed as a short transition zone from the deeper pools to the high marsh zone (-6 to -18 inches below the normal pool elevation). In general, this transition zone should have a maximum slope of 5H:1V (or preferably flatter) from the deep pool to the high marsh zone. It is advisable to install biodegradable erosion control fabrics or similar materials during construction to prevent erosion or slumping of this transition zone.

Flow Path. In terms of the flow path, there are two design objectives:

- The overall flow path through the stormwater wetland can be represented as the length-to-width ratio OR the flow path ratio. A minimum overall flow path of 2:1 must be provided across the stormwater wetland.
- The shortest flow path represents the distance from the closest inlet to the outlet. The ratio of the shortest flow path to the overall length must be at least 0.5. In some cases—due to site geometry, storm sewer infrastructure, or other factors—some inlets may not be able to meet these ratios. However, the CDA served by these "closer" inlets must constitute no more than 20% of the total CDA.

Side Slopes. Side slopes for the stormwater wetland should generally have gradients of 4H:1V or flatter. These mild slopes promote better establishment and growth of the wetland vegetation. They also contribute to easier maintenance and a more natural appearance.

Micro-Topographic Features. Stormwater wetlands must have internal structures that create variable micro-topography, which is defined as a mix of above-pool vegetation, shallow pools, and deep pools that promote dense and diverse vegetative cover.

Stormwater Wetland Material Specifications. Stormwater wetlands are generally constructed with materials obtained on site, except for the plant materials, inflow and outflow devices (e.g., piping and riser materials), possibly stone for inlet and outlet stabilization, and geotextile fabric for lining banks or berms. Plant stock should be nursery grown, unless otherwise approved (e.g. by the local regulatory authority), and must be healthy and vigorous native species free from defects, decay, disfiguring roots, sun-scald, injuries, abrasions, diseases, insects, pests, and all forms of infestations or objectionable disfigurements, as determined during the local plan review.

Stormwater Wetland Sizing. Stormwater wetlands can be designed to capture and treat the remaining stormwater discharged from upstream practices from the design storm (SWRv). Additionally, stormwater wetlands can be sized to control peak flow rates from the 2- 50-year frequency storm event or other design storm. Design calculations must ensure that the post-development peak discharge does not exceed the predevelopment peak discharge. See Section 3.7.2 Hydrologic and Hydraulic Analysis for a summary of acceptable hydrologic methodologies and models.

For treatment train designs where upland practices are utilized for treatment of the SWRv, designers can use a site-adjusted Rv or NRCS CN that reflects the volume reduction of upland practices to compute the 2- 50-year frequency storm event that must be treated by the stormwater wetland.

The wetland permanent pools (volume stored in deep pools and pool depths) must be sized to store a volume equivalent to the SWRv or design volume.

The storage volume (Sv) of the practice is equal to the volume provided by the wetland permanent pool (Equation 4.29). The total Sv cannot exceed the SWRv.

Equation 4.29 Stormwater Wetland Storage Volume

$$Sv = Stormwater\ wetland\ permanent\ pool\ volume$$

Sizing for Minimum Pool Depth. Initially, it is recommended that there be no minimum CDA requirement for the system, although it may be necessary to calculate a water balance for the wet pond cell when its CDA is less than 10 acres (Refer to Section 4.10 Ponds).

Similarly, if the hydrology for the constructed wetland is not supplied by groundwater or dry weather flow inputs, a simple water balance calculation must be performed, using Equation 4.30 (Hunt et al., 2007), to assure the deep pools will not go completely dry during a 30-day summer drought.

Equation 4.30 Water Balance for Acceptable Water Depth in a Stormwater Wetland

$$DP = \left(RF_m \times EF \times \frac{WS}{WL}\right) - (ET - INF - RES)$$

Where:

DP	=	depth of pool (in.)
RF_m	=	monthly rainfall during drought (in.)
EF	=	fraction of rainfall that enters the stormwater wetland (in.) (CDA × Rv)
WS/WL	=	ratio of contributing drainage area to stormwater wetland surface area
ET	=	summer evapotranspiration rate (in.) (assume 8 in.)
INF	=	monthly infiltration loss (assume 7.2 inches at 0.01 in./hr)
RES	=	reservoir of water for a factor of safety (assume 6 in.)

Using Equation 4.30, setting the groundwater and (dry weather) base flow to zero and assuming a worst-case summer rainfall of 0 inches, the minimum depth of the pool calculates as follows (Equation 4.31):

Equation 4.31 Minimum Depth of the Permanent Pool

$$DP = RF_m - ET - INF - RES = 21.2$$

Where:

DP	=	depth of pool (in.)
RF_m	=	monthly rainfall during drought (in.)
ET	=	summer evapotranspiration rate (in.) (assume 8 in.)
INF	=	monthly infiltration loss (assume 7.2 inches at 0.01 in./hr)
RES	=	reservoir of water for a factor of safety (assume 6 in.)

Therefore, unless there is other input, such as base flow or groundwater, the minimum depth of the pool should be at least 22 inches (rather than the 18-inch minimum depth noted in Section 4.11.4 Stormwater Wetland Design Criteria).

4.13.5 Stormwater Wetland Construction Sequence

The construction sequence for stormwater wetlands depends on site conditions, design complexity, and the size and configuration of the proposed facility. The following two-stage construction sequence is recommended for installing an on-line stormwater wetland facility and establishing vigorous plant cover.

Stage 1 Construction Sequence: Wetland Facility Construction.

1. Stabilize Contributing Drainage Area. Stormwater wetlands should only be constructed after the CDA to the wetland is completely stabilized. If the proposed stormwater wetland site will be used as a sediment trap or basin during the construction phase, the construction notes must clearly indicate that the facility will be de-watered, dredged, and re-graded to design dimensions after the original site construction is complete.

2. Assemble Construction Materials on Site. Inspect construction materials to ensure they conform to design specifications and prepare any staging areas.

3. Clear and Strip. Bring the project area to the desired subgrade.

4. Install Soil Erosion and Sediment Control Measures prior to construction, including sediment basins and stormwater diversion practices. All areas surrounding the stormwater wetland that are graded or denuded during construction of the wetland are to be planted with turf grass, native plant materials, or other approved methods of soil stabilization. Grass sod is preferred over seed to reduce seed colonization of the stormwater wetland. During construction, the stormwater wetland must be separated from the CDA so that no sediment flows into the wetland areas. In some cases, a phased or staged soil erosion and sediment control plan may be necessary to divert flow around the stormwater wetland area until installation and stabilization are complete.

5. Excavate the Core Trench for the Embankment and Install the Spillway Pipe.

6. Install the Riser or Outflow Structure and ensure that the top invert of the overflow weir is constructed level and at the proper design elevation (flashboard risers are strongly recommended by Hunt et al., 2007).

7. Construct the Embankment and any Internal Berms in 8- to 12-inch lifts and compact them with appropriate equipment.

8. Excavate and Grade. Survey to achieve the appropriate elevation and designed contours for the bottom and side slopes of the stormwater wetland. This is normally done by "roughing up" the interim elevations with a skid loader or other similar equipment to achieve the desired topography across the wetland. Spot surveys should be made to ensure that the interim elevations are 3 to 6 inches below the final elevations for the wetland.

9. Install Micro-Topographic Features and Soil Amendments within the stormwater wetland area. Since most stormwater wetlands are excavated to deep sub-soils, they often lack the nutrients and organic matter needed to support vigorous growth of wetland plants. It is therefore essential to add sand, compost, topsoil, or wetland mulch to all depth zones in the stormwater wetland. The importance of soil amendments in excavated stormwater wetlands cannot be over-emphasized; poor survival and future wetland coverage are likely if soil amendments are not added. The planting soil should be a high organic content loam or sandy loam, placed by mechanical methods, and spread by hand. Planting soil depth should be at least 4 inches for shallow wetlands. No machinery should be allowed to traverse over the planting soil during or after construction. Planting soil should be tamped as directed in the design specifications, but it should not be overly compacted. After the planting soil is placed, it should be saturated and allowed to settle for at least one week prior to installation of plant materials.

10. Construct the Emergency Spillway in cut or structurally stabilized soils.

11. Install Outlet Pipes. The installation of outlet pipes must include a downstream riprap protection apron.

12. Stabilize Exposed Soils with temporary seed mixtures appropriate for a wetland environment. All wetland features above the normal pool elevation should be temporarily stabilized by hydro-seeding or seeding over straw.

Stage 2 Construction Sequence: Establishing the Wetland Vegetation.

1. Finalize the Stormwater Wetland Landscaping Plan. At this stage the engineer, landscape architect, and wetland expert work jointly to refine the initial wetland landscaping plan after the stormwater wetland has been constructed. Several weeks of standing time is needed so that the designer can more precisely predict the following:

- Where the inundation zones are located in and around the stormwater wetland; and
- Whether the final grade and wetland microtopography will persist over time.

This allows the designer to select appropriate species and additional soil amendments, based on field confirmation of soils properties and the actual depths and inundation frequencies occurring within the stormwater wetland.

2. Open Up the Stormwater Wetland Connection. Once the final grades are attained, the pond and/or CDA connection should be opened to allow the wetland cell to fill up to the normal pool elevation. Gradually inundate the stormwater wetland to avoid erosion of unplanted features. Inundation must occur in stages so that deep pool and high marsh plant materials can be placed effectively and safely. Wetland planting areas should be at least partially inundated during planting to promote plant survivability.

3. Measure and Stake Planting Depths at the onset of the planting season. Depths in the stormwater wetland should be measured to the nearest inch to confirm the original planting depths of the planting zone. At this time, it may be necessary to modify the plan to reflect altered depths or a change in the availability of wetland plant stock. Surveyed planting zones should be marked on the as-built or design plan, and their locations should also be identified in the field, using stakes or flags.

4. Propagate the Stormwater Wetland. Two techniques are used in combination to propagate the emergent community over the wetland bed:

5. Initial Planting of Container-Grown Wetland Plant Stock. The transplanting window extends from early March through May. Planting after these dates can decrease the chance of survival, since emergent wetland plants need a full growing season to build the root reserves needed to get through the winter. It is recommended that plants be ordered at least 6 months in advance to ensure the availability and on-time delivery of desired species.

6. Broadcasting Wetland Seed Mixes. The higher wetland elevations should be established by broadcasting wetland seed mixes to establish diverse emergent wetlands. Seeding of switchgrass or wetland seed mixes as a ground cover is recommended for all zones above 3 inches below the normal pool elevation. Hand broadcasting or hydroseeding can be used to spread seed, depending on the size of the wetland cell.

7. Install Goose Protection to Protect Newly Planted or Newly Growing Vegetation. This is particularly critical for newly established emergent and herbaceous plants, as predation by Canada geese can quickly decimate wetland vegetation. Goose protection can consist of netting, webbing, or string installed in a crisscross pattern over the surface area of the stormwater wetland, above the level of the emergent plants.

8. Plant the Stormwater Wetland Fringe and Buffer Area. This zone generally extends from 1 to 3 feet above the normal pool elevation (from the shoreline fringe to about half of the maximum water surface elevation for the 2-year storm). Consequently, plants in this zone are infrequently inundated (5 to 10 times per year) and must be able to tolerate both wet and dry periods.

Construction Supervision. Supervision during construction is recommended to ensure that stormwater wetlands are properly constructed and established. Multiple site visits and inspections by a qualified professional are recommended during the following stages of the stormwater wetland construction process:

- Preconstruction meeting
- Initial site preparation including the installation of soil erosion and sediment control measures
- Excavation/Grading (interim and final elevations)
- Installation of the embankment, the riser/primary spillway, and the outlet structure
- Implementation of the pondscaping plan and vegetative stabilization
- Immediately seed or install vegetated ground cover upon completion of sloping and grading, where applicable, of each stormwater wetland within a project.
- Inspect within two weeks to ensure vegetation is in fact holding banks and slopes in place.
- Prior to completion of project, mechanically remove erosion deposition from ponds that occurred during the project. Criteria should be based on erosion of designed bank slopes and loss of storage capacity.
- Final inspection (develop a punch list for facility acceptance)

Construction inspection checklist for Stormwater Wetlands can be found in Appendix E Construction Inspection Checklists.

4.13.6 Stormwater Wetland Landscaping Criteria

An initial stormwater wetland landscaping plan is required for any stormwater wetland and should be jointly developed by the engineer and a wetlands expert or experienced landscape architect. The plan should outline a detailed schedule for the care, maintenance, and possible reinforcement of vegetation in the wetland and its buffer for up to 10 years after the original planting.

The plan should outline a realistic, long-term planting strategy to establish and maintain desired wetland vegetation. The plan should indicate how wetland plants will be established within each inundation zone (e.g., wetland plants, seed-mixes, volunteer colonization, and tree and shrub stock) and whether soil amendments are needed to get plants started. At a minimum, the plan should contain the following:

- Plan view(s) with topography at a contour interval of no more than 1 foot and spot elevations throughout the cell showing the stormwater wetland configuration, different planting zones (e.g., high marsh, deep water, upland), microtopography, grades, site preparation, and construction sequence.
- A plant schedule and planting plan specifying emergent, perennial, shrub and tree species, quantity of each species, stock size, type of root stock to be installed, and spacing. To the degree possible, the species list for the constructed wetland should contain plants found in similar local wetlands.

The following general guidance is provided:

- **Use Native Species Where Possible.** Table 4.53 provides a list of common native shrub and tree species and Table 4.54 provides a list of common native emergent, submergent, and perimeter plant species, all of which have proven to do well in stormwater wetlands in the mid-Atlantic region and are generally available from most commercial nurseries. Other native species can be used that appear in state-wide plant lists. The use of native species is strongly encouraged, but in some cases, non-native ornamental species may be added as long as they are not invasive. Invasive species such as cattails (*Typha latifolia*), common reed (*Phragmites australis*), and purple loosestrife (*Lythrum salicaria*) must not be planted.

- **Match Plants to Inundation Zones.** The various plant species shown in Table 4.53 and Table 4.54 should be matched to the appropriate inundation zone. The first four inundation zones are particularly applicable to stormwater wetlands, as follows:

  Zone 1 -6 inches to -12 inches below the normal pool elevation

  Zone 2 -6 inches to the normal pool elevation

  Zone 3 From the normal pool elevation to +12 inches above

  Zone 4 +12 inches to +36 inches above the normal pool elevation (i.e., above ED Zone)

  Note: The Low Marsh Zone (-6 to -18 inches below the normal pool elevation) has been dropped since experience has shown that few emergent wetland plants flourish in this deeper zone.

- **Aggressive Colonizers.** To add diversity to the stormwater wetland, five to seven species of emergent wetland plants should be planted, using at least four emergent species designated as aggressive colonizers (shown in bold in Table 4.54). No more than 25% of the high marsh wetland surface area needs to be planted. If the appropriate planting depths are achieved, the entire stormwater wetland should be colonized within 3 years. Individual plants should be planted 18 inches on center within each single species "cluster."

- **Suitable Tree Species.** The major shift in stormwater wetland design is to integrate trees and shrubs into the design, in tree islands, peninsulas, and fringe buffer areas. Deeper-rooted trees and shrubs that can extend to the stormwater wetland's local water table are important for creating a mixed wetland community. Table 4. 53 above presents some recommended tree and shrub species for different inundation zones. A good planting strategy includes varying the size and age of the plant stock to promote a diverse structure. Using locally grown container or bare root stock is usually the most successful approach if planting in the spring. It is recommended that buffer planting areas be over-planted with a small stock of fast-growing successional species to achieve quick canopy closure and shade out invasive plant species. Trees may be planted in clusters to share rooting space on compacted wetland side-slopes. Planting holes should be amended with compost (a 2:1 ratio of loose soil to compost) prior to planting.

- **Pre- and Post-Nursery Care.** Plants should be kept in containers of water or moist coverings to protect their root systems and keep them moist when in transporting them to the planting location. As much as 6 to 9 months of lead time may be needed to fill orders for wetland plant stock from aquatic plant nurseries. Consult local regulatory authorities for information on area suppliers.

Table 4.53. Popular, Versatile, and Available Native Trees and Shrubs for Stormwater Wetlands

Shrubs		Trees	
Common and *Scientific* Names	Zone[1]	Common and *Scientific* Names	Zone[1]
Button Bush *(Cephalanthus occidentalis)*	2, 3	Atlantic White Cedar *(Charnaecyparis thyoides)*	2, 3
Common Winterberry *(Ilex verticillatta)*	3, 4	Bald Cypress *(Taxodium distichum)*	2, 3
Elderberry *(Sambucus canadensis)*	3	Black Willow *(Salix nigra)*	3, 4
Indigo Bush *(Amorpha fruticosa)*	3	Box Elder *(Acer Negundo)*	2, 3
Inkberry *(Ilex glabra)*	2, 3	Green Ash *(Fraxinus pennsylvanica)*	3, 4
Smooth Alder *(Alnus serrulata)*	2, 3	Grey Birch *(Betula populifolia)*	3, 4
Spicebush *(Lindera benzoin)*	3, 4	Red Maple *(Acer rubrum)*	3, 4
Swamp Azalea *(Azalea viscosum)*	2, 3	River Birch *(Betula nigra)*	3, 4
Swamp Rose *(Rosa palustris)*	2, 3	Swamp Tupelo *(Nyssa biflora)*	2, 3
Sweet Pepperbush *(Clethra ainifolia)*	2, 3	Sweetbay Magnolia *(Magnolia virginiana)*	3, 4
		Sweetgum *(Liquidambar styraciflua)*	3, 4
		Sycamore *(Platanus occidentalis)*	3, 4
		Water Oak *(Quercus nigra)*	3, 4
		Willow Oak *(Quercus phellos)*	3,4

[1] Zone 1: -6 to -12 inches below the normal pool elevation
Zone 2: -6 inches to the normal pool elevation
Zone 3: From the normal pool elevation to +12 inches
Zone 4: +12 to +36 inches; above ED zone

Source: Virginia DCR Stormwater Design Specification No. 13: Constructed Wetlands Version 1.8. 2010.

Table 4.54. Popular, Versatile, and Available Native Emergent and Submergent Vegetation for Stormwater Wetlands

Plant	Zone[1]	Form	Inundation Tolerance	Wildlife Value	Notes
Arrow Arum *(Peltandra virginica)*	2	Emergent	Up to 1 ft	High; berries are eaten by wood ducks	Full sun to partial shade
Broad-Leaf Arrowhead (Duck Potato) *(Saggitaria latifolia)*	2	Emergent	Up to 1 ft	Moderate; tubers and seeds eaten by ducks	Aggressive colonizer
Blueflag Iris* *(Iris versicolor)*	2, 3	Emergent	Up to 6 in.	Limited	Full sun (to flower) to partial shade
Broomsedge *(Andropogon virginianus)*	2, 3	Perimeter	Up to 3 in.	High; songbirds and browsers; winter food and cover	Tolerant of fluctuating water levels and partial shade
Bulltongue Arrowhead *(Sagittaria lancifolia)*	2, 3	Emergent	0 to 24 in.	Waterfowl, small mammals	Full sun to partial shade
Burreed *(Sparganium americanum)*	2, 3	Emergent	0 to 6 in.	Waterfowl, small mammals	Full sun to partial shade
Cardinal Flower* *(Lobelia cardinalis)*	3	Perimeter	Periodic inundation	Attracts hummingbirds	Full sun to partial shade
Common Rush *(Juncus spp.)*	2, 3	Emergent	Up to 12 in.	Moderate; small mammals, waterfowl, songbirds	Full sun to partial shade
Common Three Square *(Scipus pungens)*	2	Emergent	Up to 6 in.	High; seeds, cover, waterfowl, songbirds	Fast colonizer; can tolerate periods of dryness; full sun; high metal removal
Duckweed (*Lemna sp.)*	1, 2	Submergent / Emergent	Yes	High; food for waterfowl and fish	May biomagnify metals beyond concentrations found in the water
Joe Pye Weed *(Eupatorium purpureum)*	2, 3	Emergent	Drier than other Joe-Pye Weeds; dry to moist areas; periodic inundation	Butterflies, songbirds, insects	Tolerates all light conditions
Lizard's Tail *(Saururus cernus)*	2	Emergent	Up to 1 ft	Low; except for wood ducks	Rapid growth; shade-tolerant
Marsh Hibiscus *(Hibiscus moscheutos)*	2, 3	Emergent	Up to 3 in.	Low; nectar	Full sun; can tolerate periodic dryness

Plant	Zone[1]	Form	Inundation Tolerance	Wildlife Value	Notes
Pickerelweed *(Pontederia cordata)*	2, 3	Emergent	Up to 1 ft	Moderate; ducks, nectar for butterflies	Full sun to partial shade
Pond Weed *(Potamogeton pectinatus)*	1	Submergent	Yes	Extremely high; waterfowl, marsh and shore birds	Removes heavy metals from the water
Rice Cutgrass *(Leersia oryzoides)*	2, 3	Emergent	Up to 3 in.	High; food and cover	Prefers full sun, although tolerant of shade; shoreline stabilization
Sedges *(Carex spp.)*	2, 3	Emergent	Up to 3 in.	High; waterfowl, songbirds	Wetland and upland species
Softstem Bulrush *(Scipus validus)*	2, 3	Emergent	Up to 2 ft	Moderate; good cover and food	Full sun; aggressive colonizer; high pollutant removal
Smartweed *(Polygonum spp.)*	2	Emergent	Up to 1 ft	High; waterfowl, songbirds; seeds and cover	Fast colonizer; avoid weedy aliens, such as *P. Perfoliatum*
Spatterdock *(Nuphar luteum)*	2	Emergent	Up to 1.5 ft	Moderate for food, but High for cover	Fast colonizer; tolerant of varying water levels
Switchgrass *(Panicum virgatum)*	2, 3, 4	Perimeter	Up to 3 in.	High; seeds, cover; waterfowl, songbirds	Tolerates wet/dry conditions
Sweet Flag* *(Acorus calamus)*	2, 3	Perimeter	Up to 3 in.	Low; tolerant of dry periods	Tolerates acidic conditions; not a rapid colonizer
Waterweed *(Elodea canadensis)*	1	Submergent	Yes	Low	Good water oxygenator; high nutrient, copper, manganese, and chromium removal
Wild celery *(Valisneria americana)*	1	Submergent	Yes	High; food for waterfowl; habitat for fish and invertebrates	Tolerant of murkey water and high nutrient loads
Wild Rice *(Zizania aquatica)*	2	Emergent	Up to 1 ft	High; food, birds	Prefers full sun
Woolgrass Bulrush *(Scirpus cyperinus)*	3, 4	Emergent	Yes	High: waterfowl, small mammals	Fresh tidal and non-tidal, swamps, forested wetlands, meadows, ditches

Aggressive colonizers are shown in bold type
[1] Zone 1: -6 to -12 inches below the normal pool elevation
Zone 2: -6 inches to the normal pool elevation
Zone 3: From the normal pool elevation to +12 inches
Zone 4: +12 to +36 inches; above ED zone
*Not a major colonizer, but adds color
Source: Virginia DCR Stormwater Design Specification No. 13: Constructed Wetlands Version 1.8. 2010.

4.13.7 Stormwater Wetland Maintenance Criteria

Successful establishment of constructed wetland areas requires that the following tasks be undertaken in the first 2 years:

- **Initial Inspections.** During the first 6 months following construction, the site should be inspected by a qualified professional at least twice after storm events that exceed 0.5 inch of rainfall.
- **Spot Reseeding.** Inspections should include looking for bare or eroding areas in the CDA or around the wetland buffer and make sure they are immediately stabilized with grass cover.
- **Watering.** Trees planted in the buffer and on wetland islands and peninsulas need watering during the first growing season. In general, consider watering every 3 days for first month, and then weekly during the first growing season (April through October), depending on rainfall.
- **Reinforcement Plantings.** Regardless of the care taken during the initial planting of the stormwater wetland and buffer, it is probable that some areas will remain unvegetated and some species will not survive. Poor survival can result from many unforeseen factors, such as predation, poor quality plant stock, water level changes, and drought. Thus, it is advisable to budget for an additional round of reinforcement planting after one or two growing seasons. Construction contracts should include a care and replacement warranty extending at least two growing seasons after initial planting, to selectively replant portions of the stormwater wetland that fail to fill in or survive. If a minimum coverage of 50% is not achieved in the planted wetland zones after the second growing season, a reinforcement planting will be required.

Managing vegetation is an important ongoing maintenance task at every constructed wetland and for each inundation zone. Following the design criteria above should result in a reduced need for regular mowing of the embankment and access roads. Vegetation within the stormwater wetland, however, will require some annual maintenance.

Designers should expect significant changes in wetland species composition to occur over time. Inspections should carefully track changes in wetland plant species distribution over time. Invasive plants should be dealt with as soon as they begin to colonize the stormwater wetland. As a general rule, control of undesirable invasive species (e.g., cattails and Phragmites) should commence when their coverage exceeds more than 15% of a wetland cell area. Although the application of herbicides is not recommended, some types (e.g., Glyphosate) have been used to control cattails with some success. Extended periods of dewatering may also work, since early manual removal provides only short-term relief from invasive species. While it is difficult to exclude invasive species completely from stormwater wetlands, their ability to take over the entire wetland can be reduced if the designer creates a wide range of depth zones and a complex internal structure within the wetland.

- For more information on invasive plants, consult the South Carolina Exotic Pest Plant Council. Resources are available online at http://www.se-eppc.org/southcarolina/invasivePlants.cfm.

- For more information related to chemical control methods for aquatic plants, please review the fact sheet “Aquatic Weed Control Overview” provided by Clemson’s Cooperative Extension Service and available online at http://www.clemson.edu/extension/hgic/plants/other/landscaping/hgic1714.html.

Thinning or harvesting of excess forest growth may be periodically needed to guide the forested stormwater wetland into a more mature state. Vegetation may need to be harvested periodically if the constructed wetland becomes overgrown. Thinning or harvesting operations should be scheduled to occur approximately 5 and 10 years after the initial stormwater wetland construction. Removal of woody species on or near the embankment and maintenance access areas should be conducted every 2 years.

Designers should refer to Section 4.10.7 Pond Maintenance Criteria for additional maintenance responsibilities associated with stormwater wetlands. Ideally, maintenance of constructed wetlands should be driven by annual inspections by a qualified professional that evaluates the condition and performance of the stormwater wetland. Based on inspection results, specific maintenance tasks will be triggered.

Maintenance inspection checklist for stormwater wetlands and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Waste Material. Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.13.8 Stormwater Wetland Stormwater Compliance Calculations

Stormwater wetlands are credited with 0% retention, but they do receive 80% TSS, 30% TN, and 60% bacteria removal for the storage volume (Sv) provided by in the permanent pool (Table 4.55).

Table 4.55. Stormwater Wetland Retention and Pollutant Removal

Retention	= 0%
TSS Removal	= 80%
TN Removal	= 25%
Bacteria Removal	= 60%

4.13.9 References

Atlanta Regional Commission (ARC). 2001. Georgia Stormwater Management Manual, First Edition. http://www.georgiastormwater.com

Cappiella, K., T. Schueler and T. Wright. 2006. Urban Watershed Forestry Manual: Part 2: Conserving and Planting Trees at Development Sites. USDA Forest Service. Center for Watershed Protection. Ellicott City, MD.

Hunt, W., M. Burchell, J. Wright and K. Bass. 2007. “Stormwater Wetland Design Update: Zones, Vegetation, Soil and Outlet Guidance.” Urban Waterways. North Carolina State Cooperative Extension Service. Raleigh, NC.

Minnesota Stormwater Steering Committee (MSSC). 2005. Minnesota Stormwater Manual. Emmons & Oliver Resources, Inc. Minnesota Pollution Control Agency. St. Paul, MN.

Virginia DCR Stormwater Design Specification No. 13: Constructed Wetlands Version 1.8. 2010.

4.14 Tree Planting & Preservation

Tree Planting and Preservation						
Definition: Existing trees can be preserved or new trees can be planted to reduce stormwater runoff.						
Site Applicability		**BMP Performance Summary**				
Land Uses	**Required Footprint**	**WQ Improvement:** Moderate to High				
▪ Urban ▪ Suburban ▪ Rural	Small	**TSS[1]**	**Total N[1]**	**Bacteria[1]**		
		N/A	N/A	N/A		
		Runoff Reductions				
Construction Costs	**Maintenance Burden**	**Volume**				
Low	Low	Low				
Maintenance Frequency:		***SWRv****				
Routine	**Non-Routine**	**T-1 Small**	**T-1 Large**	**T-2 Small**	**T-2 Large**	**T-2 Special**
At least annually	Every 10–15 years	5 ft^3	10 ft^3	10 ft^3	20 ft^3	30 ft^3

Advantages/Benefits	Disadvantages/Limitation
▪ High community acceptance ▪ Relatively low maintenance requirements ▪ Increases property value ▪ Easily incorporated with other practices ▪ Excellent for soils	▪ Preserved trees must be protected during construction ▪ Must be within LOD ▪ Must maintain tree health
Components	**Design considerations**
▪ Inventory of existing trees ▪ Identification of trees to preserve or plant ▪ Preference for Special trees ▪ Average tree spread	▪ Inventory of existing trees ▪ Identification of trees to preserve or plant ▪ Preference for Special trees ▪ Slope-steep slopes must be terraced/benched ▪ Maintenance access
Maintenance Activities	
▪ If staked during establishment, remove stakes within 1 year of planting	▪ Maintain appropriate mulch cover ▪ Ensure tree health

[1]*Credited pollutant load removal*

**Per planted/preserved tree*

Easily combined with other practices, tree planting and preservation provide stormwater interception, beauty, and shade, thereby increasing aesthetics and property values.

Figure 4.54 Tree Planting and Preservation in Bioretention (photo: Center for Watershed Protection, Inc.).

Definition. Existing trees can be preserved or new trees can be planted to reduce stormwater runoff. The design includes the following:

T-1 Tree planting

T-2 Tree preservation

Tree canopy can intercept a significant amount of rainfall before it becomes runoff, particularly if the tree canopy covers impervious surfaces, as in the case of street trees. Through the processes of evapotranspiration and nutrient uptake, trees—even when located on a development site—have the capacity to reduce stormwater runoff volumes and improve water quality. Further, through root growth, trees can improve the infiltration capacity of the soils in which they grow.

Both tree planting and tree preservation can contribute to stormwater management on a site. Note that retention credit is available for preserved trees only when they are within the limits of disturbance of a project. Preserved trees outside of the limits of disturbance may offer an opportunity for additional retention when they constitute an area of natural cover and stormwater is conveyed to that area.

4.14.1 Preserving Existing Trees during Construction

The preferred method for increasing tree cover at a development site is to preserve existing trees during construction, particularly where mature trees are present. Existing trees are preserved during construction through a four-step process:

1. Inventory existing trees.
2. Identify trees to preserve.
3. Protect trees and soil during construction.
4. Protect trees after construction.

Inventory Existing Trees. An inventory of existing trees and forested areas at the development site must be conducted before any site design, clearing, or construction takes place, as specified by the DDOT UFD. The inventory must be conducted by one of the following landscape professionals:

- South Carolina Licensed Forester
- South Carolina Licensed Tree Expert
- South Carolina Experienced Forester
- South Carolina Licensed Landscape Architect
- International Society of Arboriculture (ISA) Certified Arborist

The inventory must include a survey of existing trees and determine their size, species, condition, and ecological value. Locations of trees and forest stands must be recorded.

Identify Trees to Preserve. From the tree inventory, individual trees can be identified for preservation and protection during site development. Preserved trees fall into three categories of retention credit: tree species with an average mature spread less than or equal to 40 feet ("small" trees) receive 10 cubic feet of retention credit; trees species with an average mature spread greater than or equal to 40 feet ("large" trees) receive 20 cubic feet of retention credit; and trees with an existing diameter greater than 14" ("Special" trees receive 30 cubic feet of retention credit, regardless of mature spread size. Additional selection criteria may include tree species, size, condition, and location (see Table 4.56).

Table 4.56. Selecting Priority Trees and Forests for Preservation

Selection Criteria	Examples of Priority Tree and Forests to Conserve
Species	▪ Rare, threatened, or endangered species ▪ Specimen trees ▪ High quality tree species (e.g., white oaks and sycamores because they are structurally strong and live longer than trees such as silver maple and cottonwood) ▪ Species that are tolerant of specific site conditions and soils
Size	▪ Trees over a specified diameter at breast height (DBH) or other size measurement ▪ Trees designated as national, state, or local champions ▪ Contiguous forest stands
Condition	▪ Healthy trees that are structurally sound in “fair” or better condition ▪ High quality forest stands with high forest structural diversity
Location	▪ Trees located where they will provide direct benefits at the site (e.g., shading, privacy, windbreak, buffer from adjacent land use) ▪ Forest stands that are connected to off-site forests that create wildlife habitat and corridors ▪ Trees located in protected natural areas such as floodplains, stream buffers, wetlands, erodible soils, critical habitat areas, and steep slopes. ▪ Forest stands that are connected to off-site non-forested natural areas or protected land (e.g., has potential to provide wildlife habitat)

Trees selected for preservation and protection must be clearly marked both on construction drawings and at the actual site. Flagging or fencing is typically used to protect trees at the construction site. Areas of trees to preserve should be marked on the site map and walked during preconstruction meetings.

Protect Trees and Soil During Construction. Physical barriers must be properly installed around the Critical Root Zone (CRZ) of trees to be preserved. The CRZ shall be determined by a landscape professional from the above list, and in general is equal to 1.5 feet of tree protection (radius of circle) for every 1 inch in tree diameter. For example, a 10-inch diameter tree would have a CRZ radius extending 15 feet from the tree. The barriers must be maintained and enforced throughout the construction process. Tree protection barriers include highly visible, well-anchored temporary protection devices, such as 6-foot-tall chain link fencing.

All protection devices must remain in place throughout construction.

When excavation is proposed immediately adjacent to the CRZ, roots must first be pruned at the edge of the excavation with a trenching machine, vibratory knife or rock saw to a depth of 18 inches.

Protect Trees After Construction. Maintenance covenants, as described below, are required to ensure that preserved trees are protected.

4.14.2 Planting Trees

Considerations at Development Sites. New development sites provide many opportunities to plant new trees. Planting trees at development sites is done in three steps:

1. Select tree species.
2. Evaluate and improve planting sites.
3. Plant and maintain trees.

Tree Species. Planted trees fall into two categories of retention: tree species with an average mature spread less than or equal to 40 feet ("small" trees) receive 5 cubic feet of retention and trees species with an average mature spread greater than or equal to 40 feet ("large" trees) receive 10 cubic feet of retention. Trees to be planted must have a minimum caliper size of 1.5 inches.

Planting Sites. Ideal planting sites within a development are those that create interception opportunities around impervious surfaces. These include areas along pathways, roads, islands and median strips, and parking lot interiors and perimeters. Other areas of a development site may benefit from planting trees (including stream valleys and floodplains, areas adjacent to existing forest, steep slopes, and portions of the site where trees would provide buffers, screening, noise reduction, or shading).

It is important to evaluate and record the conditions, such as soil type, soil pH, soil compaction, and the hydrology of proposed planting sites to ensure they are suitable for planting. These evaluations provide a basis for species selection and determination of the need for any special site preparation techniques.

A minimum of 1,500 cubic feet of rootable soil volume must be provided per large tree. In planting arrangements that allow for shared rooting space amongst multiple trees, a minimum of 1,000 cubic feet of rootable soil volume must be provided for each large tree. Rootable soil volume must be within 3 feet of the surface.

Smaller trees with an average mature spread of less than or equal to 40 feet must have a minimum of 600 cubic feet of rootable soil volume. In planting arrangements that permit shared rooting space amongst multiple trees, a minimum of 400 cubic feet of rootable soil volume must be provided for each tree. Rootable soil volume must be within 3 feet of the surface.

Site characteristics determine what tree species will flourish there and whether any of the conditions, such as soils, can be improved through the addition of compost or other amendments. Table 4.57 presents methods for addressing common constraints to urban tree planting.

Table 4.57. Methods for Addressing Urban Planting Constraints

Potential Impact	Potential Resolution
Limited Soil Volume	▪ Provide 1,500 cubic feet of rootable soil volume per large tree (greater than or equal to 40-foot spread) and 600 cubic feet of rootable soil volume per small tree (less than or equal to 40-foot spread). This soil must be within 3 feet of the surface. • Use planting arrangements that allow shared rooting space. A minimum of 1,000 cubic feet of rootable soil volume must be provided for each tree in shared rooting space arrangements. A minimum of 400 cubic feet of rootable soil volume must be provided for each small tree in shared rooting arrangements.
Poor Soil Quality	▪ Test soil and perform appropriate restoration. ▪ Select species tolerant of soil pH, compaction, drainage, etc. ▪ Replace very poor soils if necessary.
Air Pollution	▪ Select species tolerant of air pollutants.
Damage from Lawnmowers	▪ Use mulch to protect trees.
Damage from Vandalism	▪ Use tree cages or benches to protect trees. ▪ Select species with inconspicuous bark or thorns. ▪ Install lighting nearby to discourage vandalism.
Damage from Vehicles	▪ Provide adequate setbacks between vehicle parking stalls and trees.
Damage from animals such as deer, rodents, rabbits, and other herbivores	▪ Use protective fencing or chemical retardants.
Exposure to pollutants in stormwater runoff	▪ Select species that are tolerant of specific pollutants, such as oils and metals.
Soil moisture extremes	▪ Select species that are tolerant of inundation or drought. ▪ Install underdrains if necessary. ▪ Select appropriate backfill soil and mix thoroughly with site soil. ▪ Improve soil drainage with amendments and tillage if needed.
Increased temperature	▪ Select drought tolerant species.
Increased wind	▪ Select drought tolerant species.
Abundant populations of invasive species	▪ Control invasive species prior to planting. ▪ Continually monitor for and remove invasive species.
Conflict with infrastructure	▪ Design the site to keep trees and infrastructure separate. ▪ Provide appropriate setbacks from infrastructure. ▪ Select appropriate species for planting near infrastructure. ▪ Use alternative materials to reduce conflict.
Disease or insect infestation	▪ Select resistant species

Planting trees at development sites requires prudent species selection, a maintenance plan, and careful planning to avoid impacts from nearby infrastructure, runoff, vehicles or other urban elements.

Trees Along Streets and in Parking Lots. When considering a location for planting, clear lines of sight must be provided, as well as safe travel surfaces, and overhead clearance for pedestrians and vehicles.

Also, ensure enough soil volume for healthy tree growth. Usable soil must be uncompacted and may not be covered by impervious material. Having at least a 6-foot-wide planting strip or locating sidewalks between the trees and street allows more rooting space for trees in adjacent property.

Select tree species that are drought tolerant, can grow in poor or compacted soils, and are tolerant to typical urban pollutants (oil and grease, metals, and chlorides). Additionally, select species that do not produce excessive fruits, nuts, or leaf litter, that have fall color, spring flowers or some other aesthetic benefit, and can be limbed up to 6 feet to provide pedestrian and vehicle traffic underneath.

Planting Techniques. Prepare a hole no deeper than the root ball or mass but two to three times wider than the spread of the root ball or mass. The majority of the roots on a newly planted tree will develop in the top 12 inches of soil and spread out laterally. There are some additional considerations depending on the type of plant material being used (Table 4.58).

Table 4.58. Tree Planting Techniques

Plant Material	Planting Technique	Planting Season
Bare root	Hand plant	Spring or fall when tree is dormant
Container grown	Hand plant or use mechanical planting tools (e.g., auger)	Spring or fall, summer if irrigated
Balled and burlapped	Use backhoe (or other specialized equipment) or hand plant	Spring or fall

Sources: Palone and Todd (1998), WSAHGP (2002)

One of the most important planting guidelines is too make sure the tree is not planted too deeply. The root collar, the lowest few inches of trunk just above its junction with the roots (often indicated by a flare), should be exposed. Trees planted too deeply have buried root collars, and are weakened, stressed, and predisposed to pests and disease. Trees planted too deeply can also form adventitious roots (roots that form from non-root tissue) near the soil surface in an attempt to compensate for the lack of available oxygen to buried roots. Adventitious roots are not usually large enough to provide support for a large tree and may eventually lead to collapse. ISA (2005) provides additional guidance on how to avoid planting too deeply. It is generally better to plant the tree a little high, that is, with the base of the trunk flare 2 to 3 inches above the soil, rather than at or below the original growing level.

Proper handling during planting is essential to avoid prolonged transplant shock and ensure a healthy future for new trees and shrubs. Trees should always be handled by the root ball or container, never by the trunk. Specifications for planting a tree are illustrated in Figure 4.55. Trees must be watered well after planting.

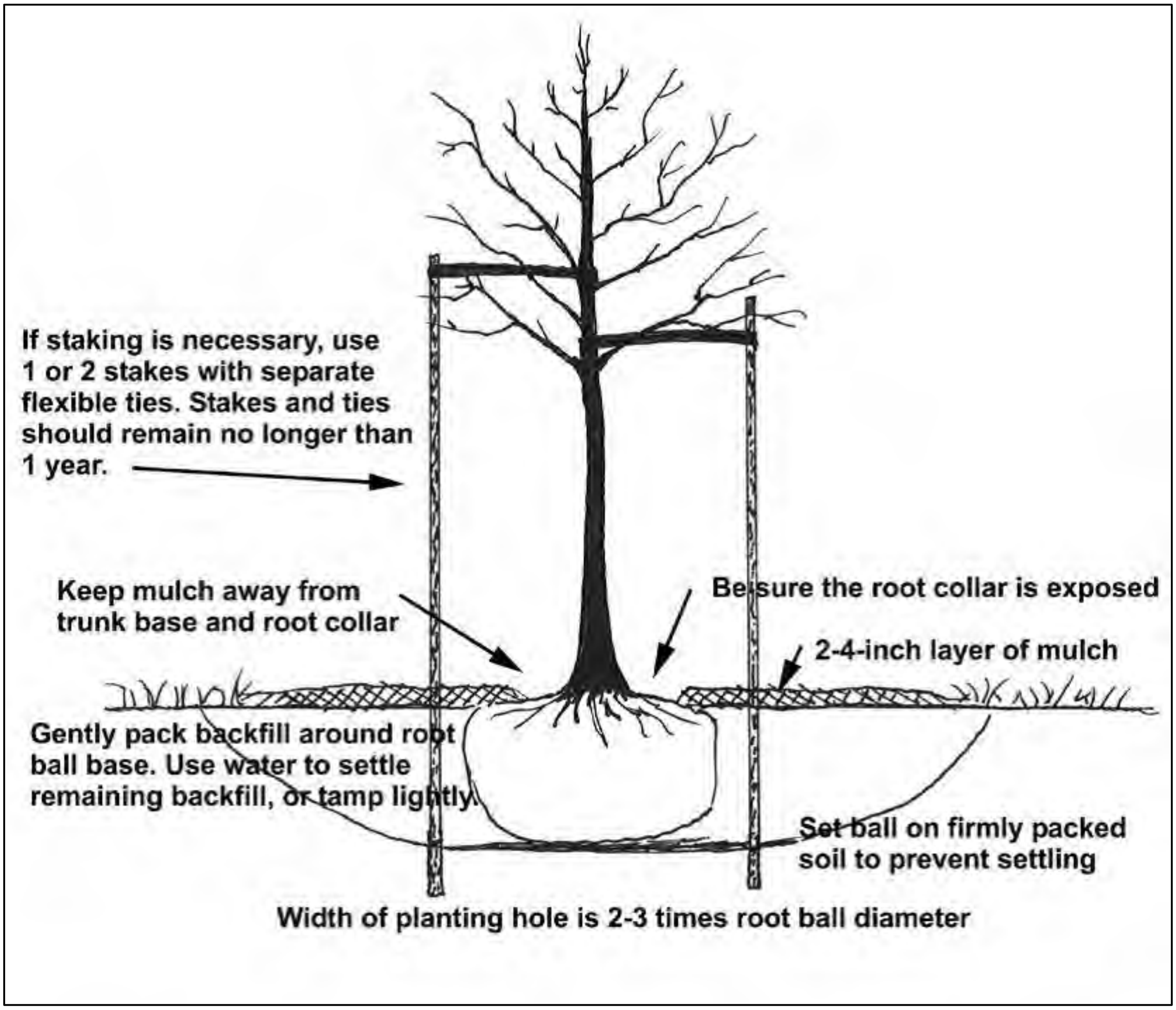

Figure 4.55. Tree planting guidelines. Adapted from Flott, 2004 and ISA, 2003b.

Steep slopes require additional measures to ensure planting success and reduce erosion, especially if the slope receives stormwater runoff from upland land uses. Depending on the steepness of the slope and the runoff volume, rill or gully erosion may occur on these slopes, requiring a twofold approach: controlling the stormwater and stabilizing the slope.

Erosion control blankets are recommended to temporarily stabilize soil on slopes until vegetation is established. Erosion control fabrics come in a variety of weights and types and should be combined with vegetation establishment such as seeding. Other options for stabilizing slopes include applying compost or bark mulch, plastic sheeting, or sodding.

Trees will add stability to slopes because of their deep roots, provided they are not planted by digging rows of pits across a slope. Required maintenance will include mowing (if slopes are not too steep) and establishing cover on bare or eroded areas.

Planting methods for slopes steeper than 3H:1V involve creating a level planting space on the slope (see Figure 4.56). A terrace can be dug into the slope in the shape of a step by cutting into the existing slope and using the excavated soil as fill to create the step area. A low soil berm (or rock berm) can be formed at the front edge of each step or terrace to slow the flow of water. Trees can also be planted in clusters on slopes (using the above method) to limit potential for desiccation. Staggering tree placement and mulching will prevent water from running straight downhill.

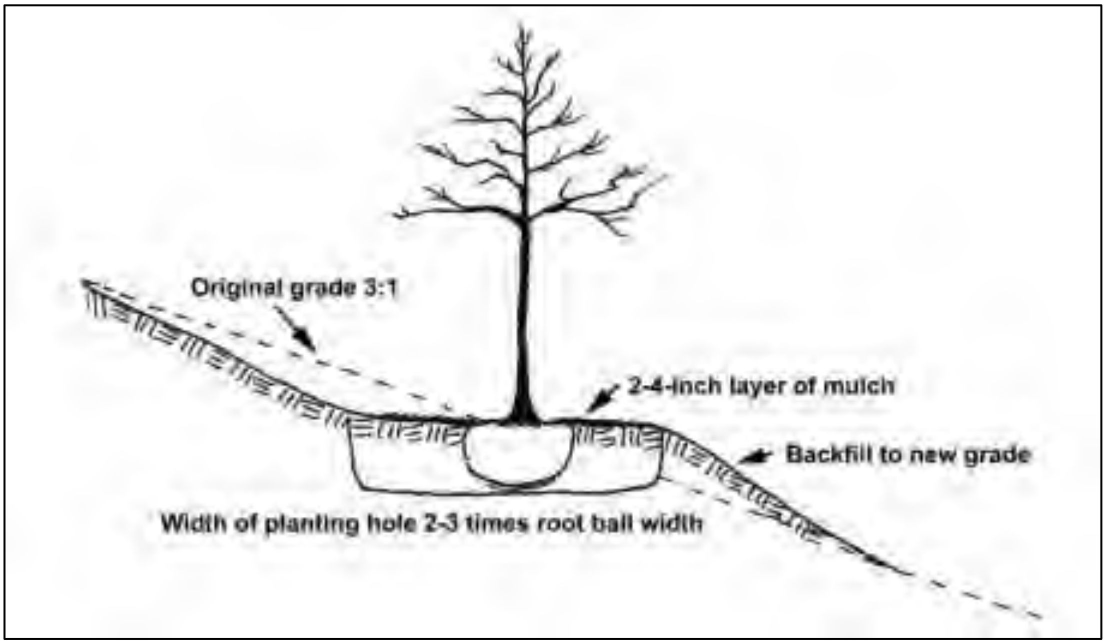

Figure 4.56 Trees planted on steep slopes require a constructed level planting surface.

Post-Planting Tree Protection

Mulching: Once the tree has been properly planted, 2 to 4 inches (maximum) of organic mulch must be spread over the soil surface out to the drip line (the outermost circumference of the tree canopy) of the tree. A mulch-free area, 2 to 3 inches wide at the base of the tree, must be provided to avoid moist bark conditions and prevent decay

If planting a cluster of trees, mulch the entire planting area, ensuring a 2- to 3-inch wide mulch free area at the base of each tree.

Slow-decomposing organic mulches, such as shredded bark, compost, leaf mulch, or wood chips provide many added benefits for trees. Mulch that contains a combination of chips, leaves, bark, and twigs is ideal for reforestation sites. Grass clippings and sawdust are not recommended as mulches because they decompose rapidly and require frequent application, resulting in reduced benefits.

For well-drained sites, up to 4 inches of mulch may be applied. For poorly drained sites, a thinner layer of mulch should be applied. Mulch should never be more than 4 inches deep or applied right next to the tree trunk; however, a common sight in many landscaped areas is the “mulch volcano.” This over-mulching technique can cause oxygen and moisture-level problems, and decay of the living bark at the base of the tree.

Staking: Studies have shown that trees will establish more quickly and develop stronger trunk and root systems if they are not staked at the time of planting. Staking for support may be necessary only for top-heavy trees or at sites where vandalism or windy exposure are a concern.

If staking is necessary for support, two stakes used in conjunction with a wide flexible tie material will hold the tree upright, provide flexibility, and minimize injury to the trunk. To prevent damage to the root ball, stakes should be placed in undisturbed soil beyond the outer edges of the root ball.

Perhaps the most important part of staking is its removal. Over time, guy wires (or other tie material) can cut into the growing trunk bark and interfere with the movement of water and nutrients within the tree. Staking material should be removed within 1 year of planting.

4.14.3 Tree Inspection Criteria

An initial inspection by a qualified professional must be done to ensure the tree has been planted, watered, and protected correctly with locations flagged if appropriate. For newly planted trees, transplant shock is common and causes stress on the tree. For this reason, newly planted trees must be inspected more frequently than established trees. The time it takes for a tree to become established varies with the size at planting, species, stock, and site conditions, but generally, trees should be inspected every few months during the first 3 years after planting, to identify problems and implement repairs or modify maintenance strategies.

After the first 3 years, annual inspections are sufficient to check for problems. Trees must also be inspected after major storm events for any damage that may have occurred. The inspection should take only a few minutes per tree, but prompt action on any problems encountered results in healthier, stronger trees. Inspections should include an assessment of overall tree health, an assessment of survival rate of the species planted, cause of mortality, if maintenance is required, insect or disease problems, tree protection adjustment, and weed control condition.

Construction inspection checklist for tree planting and preservation can be found in Appendix E Construction Inspection Checklists.

4.14.4 Tree Maintenance Criteria

Water newly planted trees regularly (at least once a week) during the first growing season. Water trees less frequently (about once a month) during the next two growing seasons. After 3 growing seasons, water trees only during drought. The exact watering frequency will vary for each tree and site.

A general horticultural rule of thumb is that trees need 1 inch of rainfall per week during the growing season. This means new trees need a minimum of 25 gallons of water a week to stay alive (http://caseytrees.org/get-involved/water/). Water trees deeply and slowly near the roots. Light, frequent watering of the entire plant can encourage roots to grow at the surface. Soaker hoses and drip irrigation work best for deep watering of trees. It is recommended that slow leak watering bags or tree buckets are installed to make watering easier and more effective. Continue watering until mid-fall, tapering off during lower temperatures.

Pruning is usually not needed for newly planted trees but may be beneficial for tree structure. If necessary, prune only dead, diseased, broken or crossing branches at planting. As the tree grows, lower branches may be pruned to provide clearance above the ground, or to remove dead or damaged limbs.

Maintenance inspection checklist for tree planting and preservation and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Waste Material. Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.14.5 Tree Stormwater Compliance Calculations

Trees receive retention credit, but are not credited with additional TSS, TN, and bacteria removal (Table 4.59). To ensure appropriate stormwater benefits associated with proposed tree preservation or planting, all trees receiving retention credit must be properly maintained until redevelopment of the area occurs. If trees die, they must be replaced with a tree of similar mature spread no longer than 6 months from time of death in an appropriate location.

Preserved trees located within a site's limits of disturbance (LOD) that meet the requirements described above receive a retention credit of 10, 20, or 30 cubic feet each, depending upon the size of the mature spread of the tree and whether the tree is designated as a Special Tree (greater than 14" diameter). Note: To receive the preserved tree retention credit, trees must be left undisturbed in their original location. Trees that are removed and replanted are not considered preserved trees.

Planted trees that meet the requirements described above receive a retention credit of 5 or 10 cubic feet each, depending upon the size of the mature spread of the tree. Note: Trees planted as part of another BMP, such as a bioretention area, also receive the 5 or 10 cubic foot retention credit. Retention credits are shown in Table 4.59 below.

Table 4.59. T-1 Preserved and Planted Tree Retention

Tree Type	Retention Credit
Planted Tree – Small	5 cf per tree
Planted Tree – Large	10 cf per tree
Preserved Tree – Small	10 cf per tree
Preserved Tree – Large	20 cf per tree
Preserved Tree – Special	30 cf per tree

Trees also contribute to peak flow reduction. This contribution can be determined in several ways. One method is to subtract the retention credit from the total runoff volume for the 2- to 25-year, and 100-year storms. The resulting reduced runoff volumes can then be used to calculate a reduced NRCS CN for the site or SDA. The reduced NRCS CN can then be used to calculate peak flow rates for the various storm events. Other hydrologic modeling tools that employ different procedures may be used as well.

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4.15 Proprietary Practices

Proprietary Practices
Definition: Manufactured stormwater treatment practices that utilize settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to manage the impacts stormwater runoff. Performance varies based on manufacturer's design.

Site Applicability		BMP Performance Summary		
Land Uses	**Required Footprint**	**WQ Improvement:** Moderate to High		
▪ Urban ▪ Suburban ▪ Rural	Small	**TSS[1]**	**Total N[1]**	**Bacteria[1]**
		Varies*	Varies*	Varies*
		Runoff Reductions		
Construction Costs	**Maintenance Burden**	**Volume**		
Moderate	Moderate	Varies*		
Maintenance Frequency:		***SWRv***		
Routine	**Non-Routine**	Refer to Device Manufacturers Specifications		
At least annually	Variable			

Advantages/Benefits	Disadvantages/Limitation
▪ On- or off-line treatment ▪ Useful in challenging stormwater site designs ▪ Water quality treatment	▪ Devices can be costly ▪ Most devices do not provide retention

Components	Design considerations
▪ Pretreatment ▪ Conveyance ▪ Bypass mechanism	▪ Must safely overflow or bypass flow from 2- to 25-year design storms. ▪ Manufacturer's specifications ▪ Adequate maintenance access required

Maintenance Activities	
▪ Based on manufacturer's specifications	▪ Routine inspection for proper function

[1]*Credited pollutant load removal*

**Varies according to proprietary practice*

Definition. Proprietary practices are manufactured stormwater treatment practices that utilize settling, filtration, absorptive/adsorptive materials, vortex separation, vegetative components, and/or other appropriate technology to manage the impacts stormwater runoff. The design includes the following:

M-1 Proprietary practices

Proprietary practices may be used to achieve treatment compliance, provided they have been approved by the State and meet the performance criteria outlined in this specification. Historically, proprietary practices do not provide retention volume. A proprietary practice will not be valued for retention volume unless the practice can demonstrate the occurrence of retention processes.

4.15.1 Proprietary Practice Feasibility Criteria

Individual proprietary practices will have different site constraints and limitations. Manufacturer's specifications should be consulted to ensure that proprietary practices are feasible for application on a site-by-site basis.

4.15.2 Proprietary Practice Conveyance Criteria

All proprietary practices must be designed to safely overflow or bypass flows from larger storm events to downstream drainage systems. The overflow associated with the 2- to 25-year design storms must be controlled so that velocities are non-erosive at the outlet point (i.e., to prevent downstream erosion).

Manufactured treatment devices may be constructed on-line or off-line. On-line systems receive upstream runoff from all storms, providing runoff treatment for the stormwater quality design storm and conveying the runoff from larger storms through an overflow. In off-line devices, most, or all, of the runoff from storms larger than the stormwater quality design storm bypass the device through an upstream diversion or other mechanism.

4.15.3 Proprietary Practice Pretreatment Criteria

Individual proprietary practices may require pretreatment or may be appropriate for use as pretreatment devices. Manufacturer's specifications should be consulted to determine the device-specific pretreatment requirements.

4.15.4 Proprietary Practice Design Criteria

The basic design parameters for a proprietary practice will depend on the techniques it employs to control stormwater runoff and remove particulate and dissolved pollutants from runoff. In general, the design of devices that treat runoff with no significant storage and flow rate attenuation must be based upon the peak design flow rate. However, devices that do provide storage and flow rate attenuation must be based, at a minimum, on the design storm runoff volume and, in some instances, on a routing of the design runoff hydrograph. Hydrologic design is discussed further in Appendix I Hydrology and Hydraulics Design Requirements.

Proprietary practices approval is contingent on adherence to the New Jersey Department of Environmental Protection Certification (NJDEP) protocols and testing. The NJDEP Certification Process includes details of the verification process and the required data submittals for determination of proprietary practice performance. The current NJDEP version should be followed and is included in the References below.

Adequate maintenance access must be provided for all proprietary practice systems. Access, with access steps, as applicable, must be provided for the inlet pipe, outflow structure, and over any other functional components.

4.15.5 Proprietary Practice Landscaping Criteria

Proprietary devices may or may not require landscaping considerations. Manufacturer's specifications should be consulted to determine any landscaping requirements for the device.

4.15.6 Proprietary Practice Construction Sequence

The construction and installation of individual proprietary practices will vary based on the specific proprietary practice. Manufacturer's specifications should be consulted to determine the device specific construction sequencing requirements.

Construction inspection checklist for generic structural BMPs can be found in Appendix E Construction Inspection Checklists.

4.15.7 Proprietary Practice Maintenance Criteria

In order to ensure effective and long-term performance of a proprietary practice, regular maintenance tasks and inspections are required.

All proprietary practices should be inspected by a qualified professional and maintained in accordance with the manufacturer's instructions and/or recommendations and any maintenance requirements associated with the device's verification by *<Local jurisdiction>*.

Maintenance inspection checklist for generic structural BMPs and the Maintenance Service Completion Inspection form can be found in Appendix F Maintenance Inspection Checklists.

Waste Material. Waste material from the repair, maintenance, or removal of a BMP or land cover shall be removed and disposed of in compliance with applicable local, state, and federal law.

4.15.8 Proprietary Practice Stormwater Compliance Calculations

Proprietary practices receive retention credit when explicitly approved by the *<local jurisdiction>*. Pollutant removal (TSS EMC reduction) may be awarded for specific practices provided they meet the performance criteria outlined in Section 4.13.4 Proprietary Practice Design Criteria.

4.15.9 References

The National Environmental Laboratory Accreditation Conference (NELAC) Institute (TNI) Available at: http://www.nelac-institute.org/

New Jersey Corporation for Advanced Technology (NJCAT) Technology Verification Program and Testing Protocols available at: http://www.njcat.org/

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4.16 Conservation Area

If a site includes a Conservation Area which is protected under a conservation easement or equivalent form of protection, a portion of the conservation area may be "removed" from the site for the purposes of calculating the stormwater retention volume (SWRv). There are four scenarios that could qualify for a conservation area credit.

4.16.1 Scenario 1: Natural Conservation Area

Scenario 1 is applicable if a portion of the post-developed area is left in its natural condition and protected, in perpetuity, by a conservation easement or equivalent form of protection. If this scenario is applicable, subtract 100% of the protected natural area from the total site area when calculating the SWRv.

4.16.2 Scenario 2: Reforestation/Revegetation

Scenario 2 is applicable if a portion of the post-developed area employs site reforestation/revegetation and is protected, in perpetuity, by a conservation easement or equivalent form of protection. If this application is used alone, subtract 50% of the reforested/revegetated area from the total site area when calculating the SWRv.

4.16.3 Scenario 3: Soil Restoration

Scenario 3 is applicable if a portion of the post-developed area employs soil restoration and is protected, in perpetuity, by a conservation easement or equivalent form of protection. If this application is used alone, subtract 50% of the soil restoration area from the total site area when calculating the SWRv.

4.16.4 Scenario 4: Reforestation/Revegetation & Soil Restoration

Scenario 4 is applicable if the same portion of the post-developed area employs site reforestation/revegetation as well as soil restoration and is protected, in perpetuity, by a conservation easement or equivalent form of protection, subtract 100% of the acres of development with restored soils in a reforested and revegetated area from the total site area when calculating the SWRv.

Chapter 5. Erosion & Sediment Control

Sedimentation involves three basic geologic processes: erosion, transportation, and deposition. These are natural geologic phenomena; however, land development activities may initiate severe, highly undesirable and damaging alterations in the natural sedimentation cycle by drastically accelerating the erosion and transportation process. Receiving waters are the final destination for sediment transport and deposition. However, natural streams and lakes are not capable of handling the excessive sediments created by this accelerated cycle. Therefore, excessive sediment loads result in turbid waters and heavy deposition over the substrate. The impact of these events directly affects the propagation of aquatic life, which relies on clear substrates and water to feed and reproduce. Sediment-laden waters affect human activities through the degradation of waters used for aquatic recreation and sport fishing and complicate water treatment processes. Consequently, minimizing the occurrence of erosion and effective control of sediment transport is imperative to all.

5.1 Sedimentation Cycle

Soil erosion is usually caused by the impact force of raindrops and by the sheer stress of runoff flowing in rills and streams. Raindrops falling on bare or sparsely vegetated soil detach soil particles; runoff, in the form of sheet flow along the ground, picks up and carries these particles to surface waters. As the runoff gains velocity and concentration, it detaches more soil particles, cuts deeper rills and gullies into the surface of the soil, and adds to its own sediment load. Coalescing rivulets produce streams which have a larger volume and usually an increased velocity. These increasing streams have a greater capacity to remove sediment and transport it downstream. The further the runoff runs uncontrolled, the greater its erosive force and the greater the resulting damage. As the distance and volume of uncontrolled flow increase, the control becomes increasingly difficult. At some point, the energy in the stream dissipates to level that can no longer support the transport of the sediment. At this time, the sediment falls out of the water column and deposits. Over time the sediment will either be incorporated into the substrate or be re-suspended for further transport.

5.2 Factors Influencing Erosion

The erosion potential of a site is principally determined by the soil type, vegetative cover, topography, climate, and season. These factors contribute to the detachment of soil particles and their transport off-site.

- **Soil Type** – Erodibility, the amount of energy needed to break down soil structure, is dependent on soil composition and texture. Soils with high erodibility require less energy to detach soil particles.
- **Vegetative Cover** – Vegetation shields soils from the impact energy of raindrops and traps suspended sediment from runoff.
- **Topography** – Steeper and longer slopes generate runoff with more velocity and energy to erode and transport more sediment.
- **Climate** – Rainfall frequency and intensity cumulatively contribute energy in the form of raindrop impact and runoff volume to detach and transport soil particles.
- **Season** – Seasonal variations in wind, temperature, humidity, and rainfall may create more ideal conditions for erosion.

5.3 Concepts of Erosion & Sediment Control

Principles of erosion and sedimentation control are based on minimizing the effects of the soil and climatologic factors just discussed. None of the following concepts provide a singular solution for controlling those factors, nor can they all be performed at every site. However, the integration of as many concepts as possible provides the most effective erosion and sedimentation control:

A. Compatible Site Planning
- Minimize development within sensitive areas (e.g. highly erosive soils).
- Limit the length and steepness of the designed slopes.
- Maintain natural vegetative cover when possible.

B. Disturbed Areas Reduction
- Minimize the extent of the disturbed area and the duration of exposure.
- Phase or stage development so that only the areas that are actively being developed are disturbed.
- Minimize large or critical area grading during the season of maximum erosion potential.

C. Disturbed Areas Protection
- Complete grading as quickly as possible.
- Establish permanent vegetation as soon as possible on disturbed areas.
- Divert runoff from disturbed areas.

D. Sediment Retention within Site Boundaries
- Filter runoff as it flows from a disturbed area.
- Impound sediment-laden runoff temporarily so that the soil particles are deposited onsite.

The NPDES Phase II storm water regulations enacted by the Clean Water Act of 1972 and promulgated by Stormwater Phase II Final Rule (1999) require that any activity disturbing an acre or greater of land, or a smaller project part of a larger common plan for development or sale, obtain NPDES construction permit coverage. This regulation differs somewhat from the South Carolina state regulations relating to areas of disturbance. Any land disturbing activity in the *<local jurisdiction>* that meets the aforementioned criteria of one acre or more of disturbance will need to will comply with the state process for permitting. Application and issuance of an approved permit under the South Carolina state regulations for erosion and sedimentation control will meet the requirements for coverage under NPDES Phase II as well (DHEC, 2012).

5.4 General Criteria

All construction site activities must adhere the SCDHEC General Permit SC0010000 for Large and Small Site Construction Activities. In addition, the *<local jurisdiction>* will require as a minimum, implementation of the following construction site BMPs:

Single Family Development, not part of a larger common plan of development:

1. Silt Fencing buried a minimum of 6 inches below disturbed grade, where applicable;
2. In areas where more than two feet of fill material has been placed or in areas adjacent to all wetlands, silt fencing meeting the requirements of SCDOT must be used;
3. Temporary gravel driveways a minimum of 15 feet by 10 feet, where applicable; and
4. Sediment barriers surrounding all catch basins or drop inlets on site and sediment socks on all catch basins or drop inlets adjoining to the site.

Single Family and Multi-Family Development, part of a larger common plan of development, and Non-residential Development:

1. Silt Fencing buried a minimum of 6 inches below disturbed grade;
2. Temporary gravel driveways a minimum of 15 feet by 10 feet;
3. Sediment barriers surrounding all catch basins or drop inlets on site and sediment socks on all catch basins or drop inlets adjoining to the site;
4. Flow dissipation devices, such as check dams, in all swales and ditches;
5. Temporary stabilization shall be placed within 7 days after construction activity is complete unless construction activity is going to resume within 21 days;
6. Floating pump suctions for all temporary or permanent ponds or pumping of excavations;
7. Discharge velocities shall be reduced to provide non-erosive flows from dewatering for all temporary or permanent ponds or pumping of excavations;
8. No more that 25 Nephelometric turbidity units (NTU) difference between upstream and downstream monitoring sites for surface water(s) receiving stormwater discharge(s). Stormwater discharge(s) not directly received by a surface water shall have a value of no more than 25 NTU's.
9. Site inspections must be performed by a <*local jurisdiction*> qualified individual. Copies of inspection reports shall be provided to the <*local jurisdiction*> within 7 days of inspection;
10. Temporary stockpile areas and appropriate BMPs to be identified on plans; and
11. Two rows of silt fence are required between land disturbing activities and adjacent wetlands.

5.5 References

South Carolina Department of Health and Environmental Control (DHEC). 2012. NPDES General Permit for Stormwater Discharges from Construction Activities SCR100000. Retrieved from: https://www.scdhec.gov/sites/default/files/docs/Environment/docs/CGP-permit.pdf

Chapter 6. Enforcement & Violations

[Section Reserved for <local jurisdiction> requirements]

Appendix A. Southern Lowcountry Post Construction Stormwater Ordinance

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Post-Construction Stormwater Management Ordinance for the Southern Lowcountry Region

Description: This ordinance addresses post-construction stormwater management in the Southern Lowcountry Region, defined as the jurisdictional boundaries of Beaufort County, Jasper County, City of Beaufort, Town of Bluffton, City of Hardeeville, and Town of Port Royal. The ordinance establishes requirements for stormwater plans that are to be submitted before land development, redevelopment or major substantial improvement commences. The plans document how post-construction stormwater runoff quality and quantity will be effectively managed according to performance criteria described in the Ordinance and Southern Lowcountry Design Manual. Guidelines for inspection, maintenance, and violations are also included and these requirements are hereby incorporated herein. The ordinance incorporates by reference the *Southern Lowcountry Stormwater Design Manual* and technical specifications for stormwater system design.

Formatting Notes*: Summary boxes precede many sections of the ordinance and provide a descriptive overview and regulatory intent of the section. Language that is italicized in brackets may be altered or removed to suit the needs of the local jurisdiction. Language italicized in sharp brackets should be changed to match the terminology used by the local jurisdiction or to include data specific to the jurisdiction.*

Section A1. General Provisions

1.1. Findings of Fact

It is hereby determined that:

1) Land development or redevelopment activities can alter the hydrologic response of local watersheds by increasing:
   a. stormwater runoff rates, volumes, and pollutant loads;
   b. flooding;
   c. channel erosion;
   d. pollutant transport and deposition in rivers and streams, wetlands, and estuaries;
   e. fluctuations in salinity concentrations and productivity in estuaries; and
   f. beach contamination and subsequent serious threats to human health.
2) Land development or redevelopment activities can alter the hydrologic response of local watersheds, increasing stormwater runoff rates and volumes, and, consequently, decreasing the amount of rainfall that is available to recharge shallow groundwater aquifers;
3) Without proper mitigation in place, some discharges which end up in stormwater management systems are not stormwater discharges and can carry with them harmful metals and other contaminants;
4) The negative impacts of land development or redevelopment activities on local aquatic resources can adversely affect the health, safety and general welfare of the general public;
5) The negative impacts of land development or redevelopment can be controlled and minimized through the regulation of stormwater runoff rates, volumes, and pollutant loads on development and redevelopment sites;

6) Communities within the *Southern Lowcountry* Region are required to comply with a number of State and Federal regulations that require the adverse impacts of stormwater runoff rates, volumes and pollutant loads to be controlled and minimized;

7) Therefore, the *<local jurisdiction>* has determined that it is in the public interest to control and minimize the adverse impacts of land development or redevelopment activities and has established this set of stormwater management provisions to regulate post-construction stormwater runoff rates, volumes and pollutant loads on development and redevelopment sites.

1.2. Purpose and Intent

The purpose of this ordinance is to protect and maintain the integrity of local aquatic resources, and, consequently, the health, safety and welfare of the general public, by establishing minimum stormwater management provisions that control and minimize the adverse impacts of land development or redevelopment activities. This ordinance seeks to meet that purpose through the following objectives:

1) Establish decision-making processes surrounding land development or redevelopment activities that protect the integrity of local aquatic resources;
2) Establish minimum post-development stormwater management standards and design criteria in the *Southern Lowcountry Stormwater Design Manual* that will reduce flooding, channel erosion, and pollutant transport and deposition in local aquatic resources;
3) Establish minimum post-development stormwater management standards and design criteria in the *Southern Lowcountry Stormwater Design Manual* that will help preserve existing hydrologic conditions on development and redevelopment sites;
4) Establish design criteria in the *Southern Lowcountry Stormwater Design Manual* for structural and nonstructural stormwater management practices that can be used to meet the minimum post-development stormwater management standards and design criteria;
5) Establish that Better Site Design (BSD) and site planning has been incorporated, documented, and presented in the development/redevelopment design process.
6) Maintain structural and nonstructural stormwater management practices to ensure that they continue to function as designed and pose no threat to public safety; and,
7) Streamline administrative procedures for the submission, review, approval and disapproval of stormwater management plans and for the inspection of approved land development projects.
8) If any of the stormwater management standards, as defined in this Ordinance and in the *Southern Lowcountry Stormwater Design Manual* cannot be attained on the site (due to impractical site characteristics or constraints), a Maximum Extent Practicable analysis shall be prepared and submitted by the applicant for review, discussion, and ultimate approval of the jurisdiction. Any uncontrolled post-development stormwater quantity or quality volume shall be intercepted and treated in one or more off-site stormwater management practices or a fee-in-lieu shall be required.
9) The stormwater management practices of approved plans shall provide volume control and at least an eighty (80) percent reduction in total suspended solids loads, thirty (30) percent reduction of total nitrogen load, and sixty (60) percent reduction in bacteria load.

1.3. Applicability and Exemptions

1) This ordinance shall be applicable to any new development or redevelopment activity that meets one or more of the following criteria, unless exempt pursuant to Section 1.3.2 below:
   a. New development that involves the creation of 5,000 square feet of impervious surface or that involves other land disturbing activities of one acre or more.
   b. Redevelopment that involves the creation, addition or replacement of 5,000 square feet or more of impervious surface or that involves other land disturbing activities of one acre or more.
   c. New development or redevelopment, regardless of size, that is part of a larger common plan of development, even though multiple, separate and distinct land disturbing activities may take place at different times and on different schedules.
   d. A major substantial improvement of an existing property.
2) The following activities are exempt from this ordinance:
   a. Any maintenance, alteration, renewal, or improvement as approved by *<local jurisdiction>* which does not alter existing drainage pattern, does not result in change or adverse impact on adjacent property, or create adverse environmental or water quality impacts, and does not increase the temperature, rate, quality, or volume or location of stormwater runoff discharge.
   b. Projects that are exclusively for agricultural or silvicultural activities within areas zoned for these agricultural and silvicultural uses;
   c. Agricultural activity not involving relocation of drainage canals;
   d. Redevelopment that constitutes the replacement of the original square footage of impervious cover and original acreage of other land development activity when the original development is wholly or partially lost due to natural disaster or other acts of God occurring after *<date of adoption>*; and,
   e. Work by agencies or property owners required to mitigate emergency flooding conditions. If possible, emergency work should be approved by the duly appointed officials in charge of emergency preparedness or emergency relief. Property owners performing emergency work will be responsible for any damage or injury to persons or property caused by their unauthorized actions. Property owners will stabilize the site of the emergency work within 60 days, or as soon as reasonable, following the end of the emergency period.

1.4. Designation of Ordinance Administrator

The *<administrator>* is hereby appointed to administer and implement the provisions of this ordinance.

1.5. Compatibility with Other Regulations

This ordinance is not intended to interfere with, modify or repeal any other ordinance, rule, regulation, or other provision of law. The requirements of this ordinance should be considered minimum requirements, and where any provision of this ordinance imposes restrictions different from those imposed by any other ordinance, rule, regulation, or other provision of law, whichever provision is more restrictive or imposes higher protective standards for human health or the environment shall control.

1.6. Severability

If the provisions of any section, subsection, paragraph, subdivision, or clause of this ordinance shall be adjudged invalid by a court of competent jurisdiction, such judgment shall not affect or invalidate the remainder of any section, subsection, paragraph, subdivision, or clause of this ordinance.

1.7. Stormwater Management Manual

The *<local jurisdiction>* will utilize the standards, criteria, and information presented in the latest edition of the *Southern Lowcountry Stormwater Design Manual or applicable addendums, appendices, technical memorandums, and/or applicable revisions that may be directly applied* for the proper implementation of this ordinance. This Manual may be updated and expanded periodically, based on improvements in science, engineering, monitoring, local experience, and state or federal water quality requirements.

The procedures and standards set forth in this Stormwater Management Ordinance, and the policies, procedures, and design data specified in the *Southern Lowcountry Stormwater Design Manual* provide the minimum standards to be adhered to by land development and redevelopment activities under the jurisdiction of *<local jurisdiction>*.

The *Southern Lowcountry Stormwater Design Manual* identifies Special Watershed Protection Areas that have standards and criteria specific to land development or redevelopment in the areas.

Section A2. Definitions

"Administrator" means the person appointed by each jurisdiction to execute the requirements of this Ordinance and Stormwater Design Manual.

"Applicant" means a property owner or other responsible person who has submitted an application for a post-development stormwater management permit.

"Best management practice" (BMP) -– Structural or non-structural practice that minimizes the impact of stormwater runoff on receiving waterbodies and other environmental resources, especially by reducing runoff volume and the pollutant loads carried in that runoff.

"Better Site Design" means site design techniques that can be used during the site design process to minimize the creation of new impervious cover and reduce a site's impact on the watershed. Better site design techniques include reduced clearing and grading limits, roadway lengths and widths, and parking lot and building footprints.

"Better Site Planning" means site planning techniques that can be used during the site planning process to protect and conserve natural areas that are critical in preserving pre-development site hydrology and reducing a site's impact on the watershed. Better site planning techniques include conserving significant stands of trees and other vegetation, natural drainage features, and riparian buffers.

"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.

"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.

"Developer" means a person who undertakes land development or redevelopment activities.

"Development" is a term that means the physical improvement of land by land disturbing activities or construction of infrastructure, buildings and structures allowed through site plan, development plan or subdivision approval.

"Drainage Easement" means an easement appurtenant or attached to a tract or parcel of land allowing the owner of adjacent tracts or other persons to discharge stormwater runoff onto the tract or parcel of 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 or treatment of stormwater runoff and access to stormwater management practices.

"Erosion and Sedimentation Control Plan" means a plan that is designed to minimize the accelerated erosion and sediment runoff at a site during land development or redevelopment activities.

"Evapotranspiration" means the loss of water to the atmosphere by both evaporation and transpiration, through the uptake of water by plants.

"Existing Conditions" means land use and land cover conditions at the time of a land development or redevelopment permit application.

"Extreme Flood Protection" means measures taken to prevent adverse impacts from large low-frequency storm events with a return frequency of 100 years or more.

"Fee-in-lieu" means a payment collected by approval of a local jurisdiction as an alternative to meeting the requirements of onsite stormwater control facilities.

"Flooding" means a volume of surface water that is too great to be confined within the banks or walls of a conveyance or stream channel and that overflows onto adjacent lands.

"Greenspace" or "**Open Space**" means permanently protected areas of the site that are preserved in a natural state.

"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 and lakes that currently do not meet their designated use classification and associated water quality standards and as identified in the Clean Water Act Section 303(d) list by the South Carolina Department of Health and Environmental Control.

"Impervious Cover" means a surface composed of any material that impedes or prevents the passive, natural infiltration of water into soil. Impervious surfaces include, but are not limited to, rooftops, buildings, streets, roads, and compacted stone or gravel, except those designed specifically to provide active, engineered infiltration.

"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 percolating stormwater runoff into the subsoil.

"Infiltration Practice" means any stormwater management practice designed to provide active, engineered infiltration of retained water to the subsurface. These stormwater management practices may be above or below grade.

"Inspection and Maintenance Agreement and Covenant" means a written agreement and covenant providing for the long-term inspection and maintenance of stormwater management facilities and practices on a site or with respect to a land development or redevelopment project, which when properly recorded in the deed records constitutes a restriction on the title to a site or other land involved in a development project.

"Land Development" means any change in land cover, including, but not limited to, clearing, digging, grubbing, stripping, removal of vegetation, dredging, grading, excavating, filling, and paving, that alters the hydrologic response of local watersheds.

"Land Development Activities" means those actions or activities that comprise, facilitate, or result in land development.

"Land Development Project" means a discrete land development undertaking.

"Larger Common Plan of Development" means a common plan for development or sale. It identifies a site where multiple separate and distinct construction activities (areas of disturbance) are occurring on contiguous areas. Such sites may have one operator or owner or several operators and owners. Construction activities may take place at different times on different schedules, in separate stages, and/or in separate phases, and/or in combination with other construction activities. Each developer, operator or owner for each site or project determined to be a part of a larger common plan of development are subject to land development approval and permitting requirements as defined herein and the Southern Lowcountry Design Manual.

"Low Impact Development" means small-scale, distributed stormwater management practices that can be used during the site design process to replicate existing hydrologic conditions, help offset the creation of new impervious cover, and reduce a site's impact on the watershed.

"Major Substantial Improvement" is a renovation or addition to a structure that meets both of the following cost and size thresholds: a) construction costs for the building renovation/addition are greater than or equal to 50% of the pre-project assessed value of the structure as developed using current Building Valuation Data of the International Code Council, and b) combined footprint of structure(s) exceeding the cost threshold and any land disturbance is greater than or equal to 5,000 square feet.

"Maximum Extent Practicable (MEP)" refers to the extent of efforts to comply with local post-construction stormwater management requirements. Elements of MEP indicate serious intent to comply and include selecting and implementing design elements to address site restrictions. Maximum extent practicable is defined as the following:

- Proponents of redevelopment projects have made all reasonable efforts to meet the applicable *Southern Lowcountry Stormwater Design Manual*;
- They have made a complete evaluation of possible stormwater management measures including environmentally sensitive site design that minimize land disturbance and impervious surfaces, low impact development techniques, and stormwater best management practices (BMPs); and,

- If not in full compliance with the applicable Standards, they are implementing the highest practicable level of stormwater management.

"New Development" means a land development activity on a previously undeveloped site.

"Nonpoint Source Pollution" means a form of water pollution that does not originate from a discrete point, such as a sewage treatment plant or industrial discharge, but involves the transport of pollutants, such as sediment, fertilizers, pesticides, heavy metals, oil, grease, bacteria, nutrients, organic materials, and other contaminants from land to surface water and groundwater via mechanisms such as precipitation, stormwater runoff and leaching. Nonpoint source pollution is a by-product of land use practices, such as agriculture, silviculture, mining, construction, subsurface disposal, suburban and urban runoff.

"Nonstructural Stormwater Management Practice" or **"Nonstructural Practice"** means any natural or planted vegetation or other nonstructural component of the stormwater management plan that provides for or enhances stormwater quantity and/or quality control or other stormwater management benefits and includes, but is not limited to, riparian buffers, open and greenspace areas, overland flow filtration areas, natural depressions, and vegetated channels.

"Off-Site Facility" means a stormwater management facility located outside the boundaries of the site.

"On-Site Facility" means a stormwater management facility located within the boundaries of the site.

"Overbank Flood Protection" means measures taken to prevent an increase in the frequency and magnitude of out-of-bank flooding (i.e. flow events that exceed the capacity of the channel and enter the floodplain) and that are intended to protect downstream properties from flooding for the 2-year through 25-year frequency storm events.

"Owner" means the legal or beneficial owner of a site, 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.

"Permit" means the permit issued by the *<local jurisdiction>* to the applicant, which is required for undertaking any land development or redevelopment activity.

"Person" means, except to the extent exempted from this ordinance, 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 of the State, any interstate body, or any other legal entity.

"Post-development" refers to the time period or the conditions that may reasonably be expected or anticipated to exist, after completion of the land development or redevelopment activity on a site.

"Pre-development" refers to the time period or the conditions that exist, on a site prior to land development. For the purpose of determining pre-development surface runoff conditions, it is assumed that predevelopment is meadow conditions.

"Project" means a land development or redevelopment project.

"Recharge" means the replenishment of groundwater aquifers.

"Redevelopment" means a change to previously existing, improved property, including but not limited to the 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 Facility" or **"Regional Facility"** means stormwater management facilities designed to control stormwater runoff from multiple properties, where the owners or developers of the individual properties may assist in the financing of the facility and the requirement for on-site controls in the contributing drainage area is either eliminated or reduced.

"Riparian Buffer" means an area of land at or near a streambank, wetland, or waterbody that has intrinsic water quality value due to the ecological and biological processes it performs or is otherwise sensitive to changes which may result in significant degradation of water quality.

"Runoff" means stormwater runoff.

"Runoff Reduction" means the total annual runoff volume reduced through canopy interception, soil infiltration, evaporation, transpiration, rainwater harvesting, engineered filtration, or extended filtration.

"Site" means the parcel of land being developed, or the portion thereof on which the land development or redevelopment project is located.

"Special Watershed Protection Area" means a watershed or drainage catchment designated by the *<local jurisdiction>* to provide specific stormwater management requirements beyond those established in the *Southern Lowcountry Stormwater Design Manual* for the general three watershed protection areas of the Southern Lowcountry.

"Stop Work Order" means an administrative order that requires development activity on a site to be stopped. The extent of the stop work order is determined by the *<local jurisdiction>* and is identified in accompanying details of each Order.

"Stormwater Hotspot" means an area where land use or activities generate highly contaminated runoff with concentrations of pollutants in excess of those typically found in stormwater runoff. The following operations are examples of, but not limited to, stormwater hot spots in this ordinance: car washes, industrial sites, auto repair shops, parking garages, vehicle fueling and storage areas, golf courses, marinas, and transportation equipment repair facilities.

"**Stormwater Management Practice**" means structural and nonstructural practices that control stormwater runoff and provide for or enhance stormwater quantity and/or quality control or other stormwater management benefits.

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

"Stormwater Management Facility" means any infrastructure that controls or conveys stormwater runoff.

"Stormwater Management Plan" means a document describing how existing runoff characteristics will be affected by a land development or redevelopment project and containing measures for complying with the provisions of this ordinance.

“Stormwater Management System” means the entire set of structural and nonstructural stormwater management practices that are used to capture, convey, and control the quantity and quality of the stormwater runoff.

“Stormwater Retrofit” means a stormwater management practice designed for an existing development site that previously had either no stormwater management practice in place or a practice inadequate to meet the requirements of the *Southern Lowcountry Stormwater Design Manual*.

"Stormwater Runoff" means the flow of surface water resulting from precipitation.

“Structural Stormwater Management Practice” means a structural stormwater management facility or device that controls stormwater runoff and changes the characteristics of that runoff including, but not limited to, the quantity and quality, the period of release, or the velocity of flow of such runoff.

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

“Violation” means to transgress conditions of a permit, development plan, maintenance agreement, or local or state statutes.

“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” means a document, usually developed cooperatively by government agencies and other stakeholders, to protect, restore, and/or otherwise manage the water resources within a particular watershed or subwatershed. The plan commonly identifies threats, sources of impairment, institutional issues, and technical and programmatic solutions or projects to protect and/or restore water resources.

“Watershed Protection Area” means a watershed or drainage catchment designated in the *Southern Lowcountry Stormwater Design Manual* with specific stormwater management requirements that are intended to enhance the quality of development, protect and enhance stormwater quality and management, protect aquatic resources from the negative impacts of land development process, address water quality impairments or a total maximum daily load, as identified by the South Carolina Department of Health and Environmental Control (DHEC), or address localized flooding issues.

Section A3. Permit Procedures and Requirements

3.1 Permit Application Requirements

No owner or developer shall perform any land development or redevelopment activity without first meeting the requirements of this ordinance and the *Southern Lowcountry Stormwater Design Manual* and having been issued a permit from the *<local jurisdiction>*. Unless specifically exempted by this ordinance, any owner or developer proposing a land development or redevelopment activity shall submit to the *<local jurisdiction>* a permit application and accompanying items as dictated in the *Southern Lowcountry Stormwater Design Manual* and *<local jurisdiction>* for that purpose.

The *<Administrators>* shall use the criteria, and information, including technical specifications and standards, in the *Southern Lowcountry Stormwater Design Manual* as the basis for decisions about stormwater plans and about the design, implementation and performance of structural and non-structural stormwater systems. The *Southern Lowcountry Stormwater Design Manual* standards shall describe in detail how post-development stormwater runoff will be controlled and managed, the design of all stormwater facilities and practices, the components of a project plan necessary to meet the requirements of this Ordinance and post-construction maintenance and inspection requirements.

3.2 Maximum Extent Practical Guidelines and Process

Maximum extent practicable, or "MEP," is the language of the Clean Water Act that sets the standards to evaluate efforts pursued to achieve pollution reduction to the waters of the United States. It is the determination of this Ordinance that all proposed development and redevelopment sites meet the requirements of the Southern Lowcountry Stormwater Design Manual to achieve reduction of pollution to the waters of the Southern Lowcountry. If it is technically infeasible to do so, the applicant shall document and provide such information to <*local authority*> for review. Information provided shall demonstrate how a combination of several iterations of Better Site Design and post development stormwater management design scenarios fail to meet the minimum requirements of the Southern Lowcountry Stormwater Design Manual and justification of their determination of infeasibility. Cost is not a viable justification.

The MEP process defined by the Southern Lowcountry Stormwater Design Manual shall be the basis of submittals for plan approval under this Ordinance. The MEP submittal must provide documentable evidence of the process the applicant has performed that demonstrates the restrictions to the use and implementation of BMPs to meet the requirements of this Manual in whole or in part. The consideration for a waiver of this Ordinance’s requirements will rely on the MEP submittal and <*Administrator*> review.

3.3 Performance Bonds

Bonding for the cost of stormwater facilities approved for the proposed development shall be provided in accordance with the <*local jurisdiction*> performance bond and permit issuance process. The <*local jurisdiction*> shall require from the developer a surety or cash bond, irrevocable letter of credit, or other means of security acceptable to the <*local jurisdiction*> prior to the issuance of any building, grading and/or stormwater permit for any land development, redevelopment or major substantial improvement activity requiring a permanent stormwater management system. The bond required in this Section shall include provisions relative to forfeiture for failure to complete work specified in the approved stormwater management design plan, compliance with all of the provisions of this ordinance, other applicable laws and regulations, and any time limitations.

3.4 Waivers

Individuals seeking a waiver from the requirements of this Ordinance may submit to the *(administrator)* a request for a waiver in accordance with the Southern Lowcountry Stormwater Design Manual.

3.5 Fee-in-Lieu

A fee-in-lieu process shall be established by <*local jurisdiction*> for development projects when none or only partial stormwater requirements can be met. The intent of the fee-in-lieu is to perform or construct future stormwater management BMP projects to mitigate impacts resulting from the development project. The fee-in-lieu may apply in both a waiver and non-waiver development and redevelopment review process.

Section A4. Post-Construction Stormwater Management Criteria

All development and redevelopment sites shall utilize structural and nonstructural stormwater management practices to control and minimize the increased stormwater runoff rates, volumes, and pollutant loads caused by land development in accordance with the criteria presented in the *Southern Lowcountry Stormwater Design Manual*.

For structural and nonstructural stormwater management practices not included in the *Southern Lowcountry Stormwater Design Manual*, or for which pollutant removal and runoff reduction rates have not been provided, the effectiveness of the structural or nonstructural stormwater management practice must be documented through prior studies, literature reviews, or other means and receive approval from the *<local jurisdiction>* before being included in the design of a stormwater management system. In addition, if the site is located in a Watershed Protection Area or a Special Watershed Protection Area the *<local jurisdiction>* may impose additional requirements as deemed necessary, which are located in the *Southern Lowcountry Stormwater Design Manual*.

4.1 Stormwater Volume Control

Some portion of the stormwater runoff generated on a development or redevelopment site shall be captured and retained, reused, or otherwise reduced in order to preserve and/or replicate pre-development site hydrology, recharge shallow groundwater aquifers, promote baseflow to on-site and downstream aquatic resources, and minimize the water quality impacts of land development. Applicants shall follow the runoff reduction, peak flow and extreme flood requirements in the *Southern Lowcountry Stormwater Design Manual*.

4.2 Stormwater Conveyance Systems

Stormwater conveyance systems, which may include but are not limited to culverts, stormwater drainage pipes, catch basins, drop inlets, junction boxes, headwalls, gutters, swales, channels, ditches, and energy dissipaters, shall be provided when necessary for the protection of public right-of-way and private properties adjoining development and redevelopment sites and/or public right-of-ways. Applicants shall consult the latest edition of the *Southern Lowcountry Stormwater Design Manual* for guidance on the design and specification of stormwater conveyance systems.

4.3 Structural Stormwater Management Practices

All structural stormwater management practices shall be selected, designed, constructed, and maintained in accordance with the standards, criteria, and information presented in the latest edition of the *Southern Lowcountry Stormwater Design Manual* and any relevant addenda.

Section A5. Construction of Stormwater Management Systems

The <*local jurisdiction*> is authorized under this Ordinance to require performance bonds for construction of stormwater management systems, as detailed in the *Southern Lowcountry Stormwater Design Manual*.

The <*local jurisdiction*> is authorized under this Ordinance to perform construction inspections including, but not limited to, preconstruction, preclearing, and construction sequence inspections as detailed in the *Southern Lowcountry Stormwater Design Manual*.

The <*local jurisdiction*> is authorized under this Ordinance to perform final construction inspections and require “as built” plans for all permanent stormwater management practices as detailed in the *Southern Lowcountry Stormwater Design Manual*.

Section A6. Ongoing Inspection and Maintenance of Stormwater Management Systems

The <local jurisdiction> is authorized under this Ordinance to perform and require ongoing inspections and maintenance of stormwater management systems as detailed in the *Southern Lowcountry Stormwater Design Manual*.

Section A7. Violations, Enforcement, and Penalties

The <*local jurisdiction*> is authorized under this Ordinance to enforce the provisions of this ordinance as described in <*local jurisdiction*> violations, enforcement and penalties process. Any action or inaction that violates the provisions of this ordinance or the requirements of an approved stormwater management design plan, stormwater management inspection and maintenance agreement and plan, or permit may be subject to the enforcement actions. Any such action or inaction that is continuous with respect to time is deemed to be a public nuisance and may be abated by injunctive or other equitable relief.

Appendix B: Infiltration Testing and Geotechnical Requirements

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B.1 General Notes Pertinent to All Geotechnical Testing

A geotechnical report is required for all underground stormwater best management practices (BMPs), including infiltration-based practices, filtering systems, and storage practices, as well as stormwater ponds and wetlands. The following must be taken into account when producing this report.

- Testing is to be conducted at the direction of a qualified professional. This professional shall either be a registered professional engineer, soils scientist, or geologist and must be licensed in the State.
- Soil boring or test pit information is to be obtained from at least one location on the site. Additional borings or test pits are required within the proposed BMP facility under three conditions: (1) when the soils or slopes vary appreciably from the findings in the initial boring or test pit, (2) when the groundwater level is found to be significantly higher than the initial boring or test pit indicated, and (3) when the groundwater level may adversely affect the performance of the proposed BMP facilities. However, the location, number, and depth of borings or test pits shall be determined by a qualified professional, and be sufficient to accurately characterize the site soil conditions.
- Log any indications of water saturation to include both perched and groundwater table levels; include descriptions of soils that are mottled or gleyed. Depth to the groundwater table (with 24-hour readings) must be included in the boring logs/geotechnical report.
- Laboratory testing must include grain size analysis. Additional tests such as liquid limit and plastic limit tests, consolidation tests, shear tests and permeability tests may be necessary where foundation soils or slopes are potentially unstable based on the discretion of the qualified professional.
- The geotechnical report must include soil descriptions from each boring or test pit, and the laboratory test results for grain size. Based upon the proposed development, the geotechnical report may also include evaluation of settlement, bearing capacity and slope stability of soils supporting the proposed structures.
- All soil profile descriptions should provide enough detail to identify the boundary and elevations of any problem (boundary/restrictions) conditions such as fills and seepage zones, type and depth of rock, etc.

In addition to the testing requirements described above, infiltration tests must be performed for all BMPs in which infiltration will be relied upon, including permeable pavement systems, bioretention, infiltration, and dry swales. Specific requirements for infiltration testing are discussed below.

B.2 Initial Feasibility Assessment

The feasibility assessment is conducted to determine whether full-scale infiltration testing is necessary, screen unsuitable sites, and reduce testing costs. However, a designer or landowner may opt to skip the initial feasibility assessment at his or her discretion and begin with soil borings.

The initial feasibility assessment typically involves existing data, such as the following:

- On-site septic percolation testing, which can establish historic percolation rates, water table, and/or depth to bedrock. Percolation tests are different than tests for coefficient of permeability or infiltration rate;
- Previous geotechnical reports prepared for the site or adjacent properties; or
- Natural Resources Conservation Service (NRCS) Soil Mapping.

If the results of initial feasibility assessment show that a suitable infiltration rate (typically greater than 0.5 inches per hour) is possible or probable, then test pits must be dug or soil borings drilled to determine the saturated hydraulic conductivity (K_{sat}).

B.3 Test Pit/Boring Requirements for Infiltration Tests

- Excavate a test pit or drill a standard soil boring to a depth of 2 feet below the proposed BMP bottom.
- Do not construct, maintain or abandon a well in a manner that may create a point source or non-point source of pollutants to waters of the State, impair the beneficial uses of waters of the State, or pose a hazard to public health and safety or the environment.
- Determine depth to groundwater table if within 2 feet of proposed bottom.
- Determine Unified Soil Classification System (USCS) and/or United Sates Department of Agriculture (USDA) textures at the proposed bottom to 2 feet below the bottom of the BMP.
- Determine depth to bedrock (if within 2 feet of proposed bottom).
- Include the soil description in all soil horizons. Perform the infiltration test at the proposed bottom of the practice. If any of the soil horizons below the proposed bottom of the infiltration practice (within 2 feet) appear to be a confining layer, additional infiltration tests must be performed on this layer (or layers), following the procedure described below.
- The location of the test pits or borings shall correspond to the BMP locations; a map or plan that clearly and accurately indicates the locations(s) of the test pits or soil borings must be provided with the geotechnical report.

Table 1 indicates the number of test pits or soil borings and subsequent infiltration tests that must be performed per BMP. In cases where multiple BMPs are proposed in 1 area with generally uniform conditions, a circular shape that fully encompasses all of the BMPs may be substituted for the “area of practice” that determines the number of required infiltration tests.

Table 1. Number of Infiltration Tests Required per BMP.

Area of Practice (ft^2)	Minimum Number of Test Pits/Soil Borings
< 1,000	1
1,000–1,999	2
2,000–9,999	3
≥ 10,000	Add 1 test pit/soil boring for each additional 10,000 ft^2 of BMP.

When one test pit or boring is required, it must be located as near to the testing area as possible. When more than one test pit or boring is necessary for a single BMP or area, the pit or boring locations must be equally spaced throughout the proposed area, as directed by the qualified professional. The reported saturated hydraulic conductivity for a BMP shall be the median or geometric mean (area-weighted average) of the observed results from the soil boring/test pit locations.

B.4 Infiltration Testing Requirements

The following tests are acceptable for use in determining soil infiltration rates. The geotechnical report shall include a detailed description of the test method and published source references:

1) Constant Head Bore-Hole Infiltration Tests (also referred to as bore-hole permeameter tests and constant-head well permeameter tests). These types of tests determine saturated hydraulic conductivity (coefficient of permeability) by measuring the rate of water flow to a borehole. Analytical solutions utilize principles of Darcy's Law, borehole geometry, and head (or multiple heads) of water in determining saturated hydraulic characteristics. Where the soil characteristics meet all of the above described requirements for infiltration BMPs, the hydraulic gradient element of Darcy's Law is often estimated as 1 for determining infiltration rate.

   One published standard developed by the United States Bureau of Reclamation for this method is USBR 7300-89. Some of the commercially available equipment is listed below:

   - Aardvark Permeameter
   - Amoozemeter
   - Guelph Permeameter
   - Johnson Permeameter

2) Testing Requirements for Infiltration, Bioretention, and Sand Filer Subsoils, as modified below. The data obtained from this infiltration testing procedure shall be used to calculate the saturated hydraulic conductivity (see Section B.5 Saturated Hydraulic Conductivity Calculations).
   a. Install solid casing in the boring or test pit to the proposed BMP bottom or other required test depth (i.e. confining layer encountered within 2 feet below the BMP bottom). When installing casing, drive the casing between 3 to 5 inches below the test surface to promote a good casing-to-soil seal.
   b. Remove any smeared, soiled surfaces, and provide a natural soil interface into which water may infiltrate. Remove all loose material from the casing. At the tester's/registered professional's discretion, a 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scouring and sediment. Fill the casing with clean, potable water 24 inches above the test surface (24 inches of head), and allow to presoak for 24 hours.

c. Protect the open borehole with suitable cover such as a sanitary well cap and steel plate with surrounding sandbags to prevent the introduction of surface water runoff, trash, debris, and other pollutants.

d. Twenty-four hours later, refill the casing with approximately 24 inches of clean water (24 inches of head), and monitor the water level for 1 hour, recording the depth of water at the beginning and end of the test.

e. Repeat step 4 (filling the casing each time) three additional times, for a total of four observations. At the registered professional's discretion, the saturated hydraulic conductivity calculations may be performed based on the values recorded during the average of the four readings or the last observation. The testing interval can be increased at the discretion of the registered professional.

All soil borings and test pits shall be properly backfilled after conclusion of the tests. A person shall not construct, maintain or abandon a well in a manner that may create a point source or non-point source of pollutants to waters of the State, impair the beneficial uses of waters of the State, or pose a hazard to public health and safety or the environment. To prevent a soil boring from becoming a conduit for stormwater or other contaminants to enter groundwater and create a low-permeability seal against vertical fluid migration, follow these steps:

1) Use a positive displacement technique, inject a sodium-based bentonite slurry through a tremie pipe at least 1 inch in diameter starting at the bottom of the borehole. The slurry shall be composed of 2 pounds of sodium-based bentonite powder to 1 gallon of water.
2) If the borehole is too narrow to accommodate a tremie pipe or the borehole is less than 10 feet deep, slowly place uncoated, medium-sized, sodium-based bentonite chips in the borehole to create a 2-foot lift of chips measured from the bottom of the borehole.
3) Tamp down the bentonite chips to prevent bridging.
4) Using a ratio of 1 gallon of water to 12.5 pounds of bentonite chips, add potable water to the borehole and allow 15 to 30 minutes to elapse to ensure proper hydration of the bentonite chips.
5) Adjust these instructions as necessary in accordance with the manufacturer's instructions, providing that the resulting seal will have an effective hydraulic conductivity of no more than 1 × 10-7 cm/s.
6) The process should be repeated until the boring is filled 1 to 2 feet from the ground surface.
7) The remainder of the borehole should be backfilled with material to match the surrounding cover and must not include the use of a coal-tar product.

Further details are provided in SCDHEC Regulations R.61-71, Well Standards.

Note: If the infiltration testing procedure reveals smells or visual indications of soil or groundwater contamination then the boring or test hole must be filled in accordance with wellhead protection best practices, unless laboratory analysis determines groundwater or soil is not contaminated.

B.5 Saturated Hydraulic Conductivity Calculations

To convert the field infiltration measurements to a saturated hydraulic conductivity value (K_{sat}), the following calculations must be performed.

$$K_{sat} = \frac{\pi D}{11(t_2 - t_1)} \times \ln(H_1/H_2)$$

where:

- K_{sat} = saturated hydraulic conductivity (in/hr)
- D = casing diameter (in) (minimum 4 inches)
- t_2 = recorded end time of test (hr)
- t_1 = recorded beginning time of test (hr)
- H_1 = head in casing measured at time t_1 (ft)
- H_2 = head in casing measured at time t_2 (ft)

This equation was adapted by the U.S. Bureau of Reclamation in 1975 from Lambe and Whitman, 1969.

B.6 Infiltration Restrictions

If a Phase I Environmental Site Assessment identifies a Recognized Environmental Concern at a site indicating that site contamination is likely or present; or if DHEC is aware of upgradient or downgradient contaminant plumes, the presence of a brownfield or historic hotspot use, such as any of the following current or previous uses, then an impermeable liner must be used for BMPs, and infiltration is prohibited.

- Leaking underground storage tank (LUST),
- Above ground storage tanks (AST),
- Gas stations,
- Vehicle maintenance or repair facility,
- Dry cleaner,
- Transformer sub-station,
- Waste transfer or holding facility,
- Print shop,
- Chemical storage warehouse,
- Illicit hazardous wastes generator,
- Greenhouse with unlined floor,
- Septic system,
- Cement or asphalt plant, or
- Dump or landfill.

If an ASTM Phase II Environmental Site Assessment is performed based on a DHEC-approved workplan and DHEC reviews the results and determines that stormwater infiltration BMPs may impact on-site contamination by the following means, then an impermeable liner must be used for BMPs, and infiltration is prohibited.

- Spreading of contamination vertically or horizontally at the site,
- Increasing on-site groundwater contamination by leaching contaminants from the soil,

- Causing or enhancing contaminant migration to go offsite,
- Interfering with contaminant remedial activities,
- Decreasing or reversing the natural degradation of contaminants, or
- Causing a pollutant discharge to a surface water body.

If DHEC concludes there is no evidence of a Recognized Environmental Concern based on ASTM Phase I and II Environmental Site, and there is no current site use that could result in the foreseeable creation of a Recognized Environmental Concern, then impermeable liners are not required, and infiltration is not restricted.

Appendix C: Soil Compost Amendment Requirements

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C.1 Introduction

Soil amendment (also called soil restoration) is a technique applied after construction to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can be used to enhance the performance of impervious cover disconnections and grass channels.

C.2 Physical Feasibility and Design Applications

Amended soils are suitable for any pervious area where soils have been or will be compacted by the grading and construction process. They are particularly well suited when existing soils have low infiltration rates (HSG C and D) and when the pervious area will be used to filter runoff (downspout disconnections and grass channels). The area or strip of amended soils should be hydraulically connected to the stormwater conveyance system. Soil restoration is recommended for sites that will experience mass grading of more than a foot of cut and fill across the site.

Compost amendments are not recommended where any of the following exists:

- Existing soils have high infiltration rates (e.g., HSG A and B), although compost amendments may be needed at mass-graded B soils in order to maintain infiltration rates.
- The water table or bedrock is located within 1.5 feet of the soil surface.
- Slopes exceed 10% (compost can be used on slopes exceeding 10% as long as proper soil erosion and sediment control measures are included in the plan).
- Existing soils are saturated or seasonally wet.
- They would harm roots of existing trees (keep amendments outside the tree drip line).
- The downhill slope runs toward an existing or proposed building foundation.

- Areas that will be used for snow storage.

C.3 Design Criteria

C.3.1 Performance

When Used in Conjunction with Other Practices. As referenced in several of the Chapter 4 Stormwater Best Management Practices (BMPs) specifications, soil compost amendments can be used to enhance the performance of allied practices by improving runoff infiltration. The specifications for each of these practices contain design criteria for how compost amendments can be incorporated into those designs:

- Impermeable Surface Disconnection – See Section 4.6 Impervious Surface Disconnection.
- Grass Channels – See Section 4.7 Open Channel Systems.

C.3.2 Soil Testing

Soil tests are required during two stages of the compost amendment process. The first testing is done to ascertain preconstruction soil properties at proposed amendment areas. The initial testing is used to determine soil properties to a depth 1 foot below the proposed amendment area, with respect to bulk density, pH, salts, and soil nutrients. These tests should be conducted every 5,000 square feet and are used to characterize potential drainage problems and determine what, if any, further soil amendments are needed.

The second soil test is taken at least 1 week after the compost has been incorporated into the soils. This soil analysis should be conducted by a reputable laboratory to determine whether any further nutritional requirements, pH adjustment, and organic matter adjustments are necessary for plant growth. This soil analysis must be done in conjunction with the final construction inspection to ensure tilling or subsoiling has achieved design depths.

C.3.3 Determining Depth of Compost Incorporation

The depth of compost amendment is based on the relationship of the surface area of the soil amendment to the contributing area of impervious cover that it receives. Table C.1 presents some general guidance derived from soil modeling by Holman-Dodds (2004) that evaluates the required depth to which compost must be incorporated. Some adjustments to the recommended incorporation depth were made to reflect alternative recommendations of Roa Espinosa (2006), Balousek (2003), Chollak and Rosenfeld (1998), and others.

Table 1 indicates the number of test pits or soil borings and subsequent infiltration tests that must be performed per BMP. In cases where multiple BMPs are proposed in 1 area with generally uniform conditions, a circular shape that fully encompasses all of the BMPs may be substituted for the “area of practice” that determines the number of required infiltration tests.

Table 1. Method to Determine Compost and Incorporation Depths.

Ratio of Area of Contributing Impervious Cover to Soil Amendment[a] (IC/SA)	Compost Depth[b] (in.)	Incorporation Depth (in.)	Incorporation Method
0.5	3[c]	12[c]	Tiller
0.75	4[c]	18[c]	Subsoiler
1.0[d]	6[c]	24[c]	Subsoiler

[a] IC = contrib. impervious cover (ft^2) and SA = surface area of compost amendment (ft^2)

[b] Average depth of compost added
[c] Lower end for B soils, higher end for C/D soils
[d] In general, IC/SA ratios greater than 1 should be avoided

Once the area and depth of the compost amendments are known, the designer can estimate the total amount of compost needed, using an estimator developed by TCC, (1997):

$$C = A \times D \times 0.0031$$

where:

C = compost needed (yd^3)
A = area of soil amended (ft^2)
D = depth of compost added (in)

C.3.4 Compost Specifications

The basic material specifications for compost amendments are outlined below:

- Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program. See https://compostingcouncil.org/ for a list of local providers.
- Alternative specifications and/or certifications, such as Clemson University or the US Department of Agriculture, may be substituted, as authorized by *<local jurisdiction>*. In all cases, compost material must meet standards for chemical contamination and pathogen limits pertaining to source materials, as well as reasonable limits on phosphorus and nitrogen content to avoid excessive leaching of nutrients.
- The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have a moisture content that has no visible free water or dust produced when handling the material. It shall meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:
    a. 100% of the material must pass through a half-inch screen
    b. The pH of the material shall be between 6 and 8
    c. Manufactured inlet material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight
    d. The organic matter shall be between 35%–65%
    e. Soluble salt content shall be less than 6.0 mmhos/cm
    f. Maturity must be greater than 80%
    g. Stability shall be 7 or less
    h. Carbon/nitrogen ratio shall be less than 25:1
    i. Trace metal test result must equal “pass”
    j. The compost must have a dry bulk density ranging from 40–50 lb/ft^3

C.4 Construction Sequence

The construction sequence for compost amendments differs depending whether the practice will be applied to a large area or a narrow filter strip, such as in a rooftop disconnection or grass channel. For larger areas, a typical construction sequence is as follows:

1) **Soil Erosion and Sediment Control.** When areas of compost amendments exceed 2,500 square feet install soil erosion and sediment control measures, such as silt fences, are required to secure the area until the surface is stabilized by vegetation.
2) **Deep Till.** Deep till to a depth of 12 to 18 inches after the final building lots have been graded prior to the addition of compost.
3) **Dry Conditions.** Wait for dry conditions at the site prior to incorporating compost.
4) **Compost.** Incorporate the required compost depth (as indicated in Table 1) into the tilled soil using the appropriate equipment. Level the site. Seeds or sod are required to establish a vigorous grass cover. To help the grass grow quickly, lime or irrigation is recommended.
5) **Vegetation.** Ensure surface area is stabilized with vegetation.
6) **Construction Inspection.** Construction inspection by a qualified professional involves digging a test pit to verify the depth of amended soil and scarification. A rod penetrometer should be used to establish the depth of uncompacted soil at a minimum of 1 location per 10,000 square feet.

C.5 Maintenance

C.5.1 First-Year Maintenance Operations

In order to ensure the success of soil compost amendments, the following tasks must be undertaken in the first year following soil restoration:

- **Initial inspections.** For the first 6 months following the incorporation of soil amendments, the site should be inspected by a qualified professional at least once after each storm event that exceeds 1/2-inch of rainfall.
- **Spot Reseeding.** Inspectors should look for bare or eroding areas in the contributing drainage area (CDA) or around the soil restoration area and make sure they are immediately stabilized with grass cover.
- **Fertilization.** Depending on the amended soils test, a one-time, spot fertilization may be needed in the fall after the first growing season to increase plant vigor.
- **Watering.** Water once every 3 days for the first month, and then weekly during the first year (April through October), depending on rainfall.

C.5.2 Ongoing Maintenance

There are no major ongoing maintenance needs associated with soil compost amendments, although the owners may want to de-thatch the turf every few years to increase permeability. The owner should also be aware that there are maintenance tasks needed for filter strips, grass channels, and reforestation areas. The maintenance inspection checklist for an area of Soil Compost Amendments can be accessed in Appendix F Maintenance Inspection Forms.

C.5.3 Maintenance Agreement

A Maintenance Agreement that includes all maintenance responsibilities to ensure the continued stormwater performance for the BMP is required. The Maintenance Agreement specifies the property owner's primary maintenance responsibilities and authorizes the *<local jurisdiction>* staff to access the property for inspection or corrective action in the event the proper maintenance is not performed. The Maintenance Agreement is attached to the deed of the property as attached to the land. It is to be recorded in the Register of Deeds in the County office. Maintenance responsibilities on government properties must be defined through a partnership agreement or a memorandum of understanding.

C.6 References

Balusek. 2003. Quantifying decreases in stormwater runoff from deep-tilling, chisel-planting and compost amendments. Dane County, WA, Land Conservation Department. Madison, Wisconsin.

Chollak, T. & P. Rosenfeld. 1998. Guidelines for Landscaping with Compost-Amended Soils. City of Redmond Public Works. Redmond, WA. Available online at: http://www.redmond.gov/common/pages/UserFile.aspx?fileId=14766

The Composting Council (TCC). 1997. Development of a Landscape Architect Specification for Compost Utilization. Alexandria, VA. Retrieved from: http://infohouse.p2ric.org/ref/13/12551.pdf

Holman-Dodds, L. 2004. Chapter 6. Assessing Infiltration-Based Stormwater Practices. PhD Dissertation. Department of Hydroscience and Engineering. University of Iowa. Iowa City, IA.

Low Impact Development Center. 2003. Guideline for Soil Amendments.

Roa-Espinosa. 2006. An Introduction to Soil Compaction and the Subsoiling Practice. Technical Note. Dane County, WA, Land Conservation Department. Madison, Wisconsin

Appendix D: Design Checklist

D.1 Design Checklist

This checklist serves as a guide for the consultant in the preparation and for the reviewer in the evaluation of a Stormwater Management Plan (SWMP). Any questions regarding items contained herein should be referred to the *<local jurisdiction>*. Applicable page number or section in the Southern Lowcountry Stormwater Design Manual is included for reference.

NOTE: PLANS SUBMITTED WITHOUT A COMPLTED CHECKLIST MAY BE RETURNED WITHOUT REVIEW

Site/Project Name:		Date:	
Consultant:		Applicant:	
Phone Number:		Phone Number:	
Email Address:		Email Address:	

☐**Conceptual Plan** or ☐**Final Plan**

Consultant: Please complete the checklist below by indicating one of the following symbols in each box in the Consultant column:

C = Completed; X = Not Applicable; O = outstanding, needs to address

	Consultant	Reviewer
A. Narrative Information		
1. Cover Sheet with a blank space measuring 7 inches wide by 9.5 inches high. The blank space must be located 1 inch below the top edge and 1 inch from the left edge of the page		
2. Site development plan and stormwater management narrative		
3. 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. The following site information and practices shall be considered: a. Soil type (from Soil Study); b. Depth of ground water on site; c. Whether the type of development proposed is a hotspot as defined by the Ordinance and Design Manual and address how this influences the concept proposal; d. Protection of primary and secondary conservation areas; e. Reduced clearing and grading limits; f. Reduced roadway lengths and widths; g. Reduced parking lot and building footprints to minimize impervious surface; h. Soil restoration; i. Site reforestation/revegetation; j. Impervious area disconnection;		

k. Green roof; and l. Permeable pavement		
4. Stormwater Pollution Prevention Plan (SWPPP) or Erosion and Sediment Control narrative (for projects disturbing over an acre)		
5. Information regarding the mitigation of any off-site impacts anticipated as a result of the proposed development		
6. Construction specifications		
B. Site Plan		
1. Standard drawing size (24 x 36 inches)		
2. A plan showing property boundaries and the complete address of the property		
3. Lot number or property identification number designation (if applicable)		
4. Property lines (include longitude and latitude)		
5. Location of easements (if applicable)		
6. A legend identifying all symbols used on the plan		
7. Location and size of existing and proposed utilities (including gas lines, sanitary lines, telephone lines or poles, electric utilities and water mains), structures, roads, and other paved areas		
8. Existing and proposed topographic contours		
9. Show drainage patterns, property ridge line(s) and building finish elevation on the grading plan.		
10. Material and equipment staging areas and parking areas		
11. Clearly note on plans: - A right-of-way permit shall be obtained prior to performing construction activity in the *<local jurisdiction>* right-of-way - Chlorinated disinfected water shall not be discharged into the stormwater system - Call before you dig note and number		
12. Soil information for design purposes		
13. Area(s) of soil disturbance		
14. Site drainage area(s) (SDAs) within the limits of disturbance (LOD) and contributing to the LOD		
15. Contributing drainage area (CDA) to each BMP		
16. Location(s) of BMPs, marked with the BMP ID Numbers to agree with the BMP design summary list		
17. Delineation of existing and proposed land covers corresponding to the hydrology calculations supporting the plans.		
18. Site fingerprint map of the location of existing stream(s), wetlands, or other natural features within the project area; tree and vegetation survey; and preservation area(s)		
19. All plans and profiles must be drawn at a scale of 1 in. = 10 ft, 1 in. = 20 ft, 1 in. = 30 ft, 1 in. = 40 ft, 1 in. = 50 ft, or 1 in. = 100 ft. Although, 1 in. = 10 ft, 1 in = 20 ft, and 1 in. = 30 ft, are the most commonly used scales. Vertical scale for profiles must be 1 in. = 2 ft, 1 in. = 4 ft, 1 in. = 5 ft, or 1 in. = 10 ft		

20. Drafting media that yield first- or second-generation, reproducible drawings with a minimum letter size of No. 4 (1/8 inch)		
21. Applicable flood boundaries and FEMA map identification number for sites lying wholly or partially within the 100-year floodplain		
C. Design and As-Built Certification		
1. Statement and seal by a registered professional engineer licensed in the State of South Carolina that the site design, land covers, and design of the BMPs conform to engineering principles applicable to the treatment and disposal of stormwater pollutants		
2. Submission one set of the As-Built drawings sealed by a registered professional engineer licensed in the State of South Carolina within 21 days after completion of construction of the site, all BMPs, land covers, and stormwater conveyances.		
3. For a project consisting entirely of work in the public right-of-way (PROW), the submission of a Record Drawing certified by an officer of the project contracting company is acceptable if it details the as-built construction of the BMP and related stormwater infrastructure.		
D. Maintenance of Stormwater BMPs		
1. BMP maintenance access easements shall not be located on pipe easements.		
2. A minimum 20’ wide maintenance access easement is provided around stormwater detention ponds and from publicly accessible road has been provided.		
3. A maintenance plan that identifies routine and long-term maintenance needs and a maintenance schedule		
4. For major regulated projects, a declaration of covenants stating the owner’s specific maintenance responsibilities identified in the maintenance plan and maintenance schedule. These must be exhibits recorded with the property deed at the Recorder of Deeds.		
5. For applicants using Rainwater Harvesting, submission of third-party testing of end-use water quality may be required at equipment commissioning.		
E. Stormwater Retention Volume Computations		
1. Calculation(s) of the required SWRv for the entire site within the LOD and each SDA within the LOD		
2. Calculation(s) for each proposed BMP demonstrating retention value towards SWRv in accordance with Chapters 2 and 4 Stormwater Best Management Practices (BMPs)		
3. For Rainwater Harvesting BMP, calculations demonstrating the annual water balance as determined using the Rainwater Harvesting Retention Calculator		
4. For proprietary and non-proprietary BMPs outside Chapter 4, complete documentation defined in Chapter 4.15		
F. Pre/Post-Development Hydrologic Computations		
1. A summary of soil conditions and field data		

2. Pre- and post-project curve number summary table		
3. Pre and post construction peak flow summary table for the 2, 10, 25, 50 and the 100-year 24-hour storm events for each SDA within the project's LOD		
4. Flow control structure elevations		
G. Hydraulic Computations		
1. Existing and proposed SDA must be delineated on separate plans with the flow paths used for calculation of the times of concentration		
2. Hydraulic capacity and flow velocity for drainage conveyances, including ditches, swales, pipes, inlets, and gutters.		
3. Plan profiles for all open conveyances and pipelines, with energy and hydraulic gradients for the 25-year and 100-year, 24-hour storms		
4. The proposed development layout including the following:		
a) Location and design of BMP(s) on site, marked with the BMP ID Numbers		
b) A list of design assumptions (e.g., design basis, 2 through 25-year return periods)		
c) The boundary of the CDA to the BMP		
d) Schedule of structures (a listing of the structures, details, or elevations including inverts)		
e) Manhole to manhole listing of pipe size, pipe type, slope, computed velocity, and computed flow rate (i.e., a storm drain pipe schedule		
5. Demonstrate downstream conveyance system capacity for the development.		
H. Erosion and Sediment Control Plans		
1. Provide erosion and sediment control drawings and detail sheets required by the CSWPPP		
2. Show dewatering setup to ensure no negative off-site impacts result from the discharge		
3. Provide erosion and sediment control inspection forms required by the CSWPPP		
I. Supporting Documentation (written report)		
1. Pre- and Post-development curve number selection		
2. Time of concentration calculation		
3. Travel time calculation		
4. Hydrologic computations supporting peak discharges assumed for each SDA within the project's LOD for the 2-, 10-, 25-, and 50-year, 24-hour storm events		
5. Provide downstream and surrounding neighborhood area analysis to identify any existing capacity shortfalls or flooding based on the 10% rule.		
6. Document off-site stormwater volume where required.		
7. Document the 8-steps of the MEP process in Chapter 3.8.		

8. SCDHEC's Construction Stormwater Pollution Prevention Plan (C-SWPPP)		

The engineering features of all stormwater best management practices (BMPs), stormwater infrastructure, and land covers (collectively the "Facility") have been designed/examined by me and found to be in conformity with the standard of care applicable to the treatment and disposal of stormwater pollutants. The Facility has been designed in accordance with the specification required under Town of Bluffton Unified Development Ordinance and Southern Lowcountry Design Manual.			
Seal	Signed		Date
License Number:		Expiration Date:	

Appendix E: Construction Stormwater Inspection Form

Table of Contents

E.1 Post Construction Inspection Report 1

E.1 Post Construction Inspection Report

<Local Jurisdiction> Stormwater Department
Inspection Report

Inspection Type: ***POST CONSTRUCTION*** **Inspection ID:** **Inspection Results:**		**Inspection Date:** **Inspector:** **Inspector Comments:**	
Owner:		**Property Information:**	
PASS/FAIL Checklist Items			
Control is active	Pass	Built within specifications	Pass
Notes:		*Notes:*	
Sediment depth acceptable	Pass	Maintenance Required	Pass
Notes:		*Notes:*	
Requires Repairs	Pass	Structural Damage	Pass
Notes:		*Notes:*	
Standing Water	Pass	Erosion Problem	Pass
Notes:		*Notes:*	
Operator attending Inspection	Pass	Days / Months since last routine maintenance cleaning	Pass
Notes:		*Notes:*	
BMP O&M plan on file with party responsible for maintenance	Pass	Where is the BMP O&M plan stored	Pass
Notes:		*Notes:*	
Are maintenance records available for audit	Pass	Where are maintenance records stored	Pass
Notes:		*Notes:*	
Standing water	Pass	Water depth (in inches) in BMP	Pass
Notes:		*Notes:*	
Is water depth low	Pass	Is water depth normal / typical for the BMP	Pass
Notes:		*Notes:*	

Is water depth above the outlet pipe	Pass	Standing water causing problems	Pass
Notes:		*Notes:*	
If answer to question PC20 is Yes, explain	Pass	List types of pollutants captured in BMP	Pass
Notes:		*Notes:*	
Is Trash Collection minimal	Pass	Is Trash Collection typical	Pass
Notes:		*Notes:*	
Is Trash Collection Unacceptably High	Pass	Comments on Trash Collection	Pass
Notes:		*Notes:*	
Sediment depth (in inches) on inlet side of BMP	Pass	Sediment depth (in inches) on outlet side of BMP	Pass
Notes:		*Notes:*	
Sediment level low / little accumulation	Pass	Sediment level typical for the BMP	Pass
Notes:		*Notes:*	
Sediment level excessive	Pass	Comments on Sediment	Pass
Notes:		*Notes:*	
Filter media	Pass	If answer to question PC33 is Fail, explain	Pass
Notes:		*Notes:*	
Repairs needed to Structures/pipes/basin slopes/headwalls/inlets/pavers/etc	Pass	Lid/Grate need repair	Pass
Notes:		*Notes:*	
Trash Racks need repair	Pass	Baffle Plates need repair	Pass
Notes:		*Notes:*	
Vegetation needed	Pass	Mowing / pruning of vegetation needed	Pass
Notes:		*Notes:*	
If answer to any of questionsPC35 to PC40 is Fail, explain	Pass	Pollutants/erosion in downstream conveyance	Pass
Notes:		*Notes:*	
If answer to question PC42 is Fail, explain	Pass	Signs of vandalism	Pass
Notes:		*Notes:*	
If answer to question PC44 is FAIL, explain in comments	Pass	BMP needs NO maintenance on a shorter schedule	Pass
Notes:		*Notes:*	
BMP needs NO maintenance on a longer schedule	Pass	If answer to either question PC46 or PC47 is FAIL, explain in comments	Pass
Notes:		*Notes:*	
Additional inspection report specific to BMP attached with this inspection	Pass	The monitoring equipment needs NO repair	Pass
Notes:		*Notes:*	

If answer to either question PC49 or PC50 is FAIL, explain in comments	Pass	Closed all lids, grates, etc. and secure the site at the end of inspection	Pass
Notes:		*Notes:*	

Inspectors Signature ______________________________________

Infiltration/Filtration/Bioretention/Dry Swale Practice
Maintenance Inspection Checklist

Party Responsible for Maintenance: ______________________

Contact: ______________________

Phone Number: ______________________

E-mail: ______________________

Mailing Address: ______________________

____

Practice ID: ______________________

Location: ______________________

GPS Coordinates:

____

Inspector(s): ______________________

____

Date: __________ **Time:** ______________

Key Questions		
Item	**X**	**Comments**
1. Type of practice (check all that apply)		
a. Bioretention		
b. Dry Swale		
d. Residential Rain Garden		
e. Infiltration Practice		
f. Filtration Practice		
2. For Bioretention		
a. Standard Design		
b. Enhanced Design		
3. Practice Location		
a. Open to Surface		
b. Underground		
4. Filtration Media		
a. No filtration media (e.g., stone reservoir only)		
b. Sand		
c. Bioretention Soil Mix		
d. Peat		
e. Other		
5. Hydraulic configuration		
a. On-line		
b. Off-line		
6. Type of pretreatment		
a. Separate pretreatment cell		
b. Sedimentation chamber/manhole		
c. Grass channel		
d. Grass filter strip		
e. Gravel or stone flow spreader		
f. Gravel diaphragm		
g. Other		Type of pretreatment:
7. If designed for infiltration (i.e., no underdrain OR infiltration sump below underdrain):		
a. Soil boring logs and infiltration testing report provided		
b. Field-measured infiltration rate of at least 0.5 in/hr (preferred 1-4 in/hr)		Field-measured rate:

Infiltration/Filtration/Bioretention/Dry Swale Practice
Maintenance Inspection Checklist

A. Contributing Drainage Area

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item		Comments
1.	Excessive trash/debris	0 1 2 3 N/A	
2.	Bare/exposed soil	0 1 2 3 N/A	
3.	Evidence of erosion	0 1 2 3 N/A	
4.	Excessive landscape waste/yard clippings	0 1 2 3 N/A	

B. Pretreatment

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item		Comments
1.	Maintenance access to pretreatment facility	0 1 2 3 N/A	
2.	Excessive trash/debris/sediment	0 1 2 3 N/A	
3.	Evidence of standing water	0 1 2 3 N/A	
	a. Ponding	☐	
	b. Noticeable odors	☐	
	c. Water stains	☐	
	d. Presence of algae or floating aquatic vegetation	☐	
4.	Evidence of clogging	0 1 2 3 N/A	
5.	Dead vegetation/exposed soil	0 1 2 3 N/A	
6.	Evidence of erosion	0 1 2 3 N/A	

C. Inlets

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item		Comments
1.	Inlets provide stable conveyance into practice	0 1 2 3 N/A	
2.	Excessive trash/debris/sediment accumulation at inlet	0 1 2 3 N/A	
3.	Evidence of erosion at/around inlet	0 1 2 3 N/A	

Infiltration/Filtration/Bioretention/Dry Swale Practice
Maintenance Inspection Checklist

D.	***Practice*** 0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.						
☐	Inspected						
☐	Not Inspected						
	Item						**Comments**
1.	Maintenance access	0	1	2	3	N/A	
2.	Condition of structural components	0	1	2	3	N/A	
3.	Condition of hydraulic control components	0	1	2	3	N/A	
4.	Excessive trash/debris/sediment	0	1	2	3	N/A	
5.	Evidence of erosion	0	1	2	3	N/A	
6.	Evidence of oil/chemical accumulation	0	1	2	3	N/A	
7.	Evidence of standing water:	0	1	2	3	N/A	
	a. Ponding	☐					
	b. Noticeable odors	☐					
	c. Water stains	☐					
	d. Presence of algae or floating aquatic vegetation	☐					
8.	Underdrain system (if equipped)	0	1	2	3	N/A	
	a. Broken	☐					
	b. Clogged	☐					
9.	Vegetation	0	1	2	3	N/A	
	a. Plant composition consistent with approved plans	☐					
	b. Presence of invasive species/weeds	☐					
	c. Dead vegetation/exposed soil	☐					

E.	***Outlets*** 0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.						
☐	Inspected						
☐	Not Inspected						
	Item						**Comments**
1.	Outlets provide stable conveyance out of practice	0	1	2	3	N/A	
2.	Excessive trash/debris/sediment accumulation at outlet	0	1	2	3	N/A	
3.	Evidence of erosion at/around outlet	0	1	2	3	N/A	

☐	Inspected
☐	Not Inspected

Infiltration/Filtration/Bioretention/Dry Swale Practice
Maintenance Inspection Checklist

F. Miscellaneous							
0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.							
Item							**Comments**
1. Complaints from local residents	0	1	2	3	N/A		
2. Mosquito proliferation	0	1	2	3	N/A		
3. Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A		

Inspector's Summary:

Photographs

Photo ID	Description
1.	
2.	
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5.	
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Infiltration/Filtration/Bioretention/Dry Swale Practice
Maintenance Inspection Checklist

Sketch of Practice
(note problem areas)

Permeable Pavement
Maintenance Inspection Checklist

Party Responsible for Maintenance: ____________________

Contact: ____________________

Phone Number: ____________________

E-mail: ____________________

Mailing Address: ____________________

____

Practice ID: ____________________

Location: ____________________

GPS Coordinates:

____

Inspector(s): ____________________

____

Date: __________ **Time:** ____________

Key Questions		
Item	**X**	**Comments**
1. Type of practice (check all that apply)		
a. Standard design		
b. Infiltration design		
c. Infiltration sump design		
2. Pavement Type		
a. Pervious concrete		
b. Porous asphalt		
c. Concrete grid pavers		
d. Permeable interlocking concrete pavers		
e. Other:		
3. External drainage area?		
a. Yes		Ratio:
b. No		
4. Pretreatment (if landscaped/turf areas in drainage area)		
a. Yes		Type:
b. No		
5. If designed for infiltration (e.g., no underdrain OR infiltration sump below underdrain):		
b. Soil boring logs and infiltration testing report provided		
c. Field-measured infiltration rate indicated		Field-measured rate:

A. Contributing Drainage Area						
0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.						
☐ Inspected						
☐ Not Inspected						
Item						**Comments**
1. Excessive trash/debris	0	1	2	3	N/A	
2. Bare/exposed soil	0	1	2	3	N/A	
3. Evidence of erosion	0	1	2	3	N/A	
4. Excessive landscape waste/yard clippings	0	1	2	3	N/A	
5 Excessive grit, sand, or other clogging agents on upgradient pavement that drains onto permeable pavement	0	1	2	3	N/A	

B. Pretreatment (if applicable to landscaped/turf drainage area)

Permeable Pavement
Maintenance Inspection Checklist

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

Item						Comments
1. Maintenance access to pretreatment facility	0	1	2	3	N/A	
2. Excessive trash/debris/sediment	0	1	2	3	N/A	
3. Evidence of standing water						
a. Ponding	0	1	2	3	N/A	
b. Noticeable odors	0	1	2	3	N/A	
c. Water stains	0	1	2	3	N/A	
d. Presence of algae or floating aquatic vegetation	0	1	2	3	N/A	
4. Evidence of clogging	0	1	2	3	N/A	
5. Dead vegetation/exposed soil	0	1	2	3	N/A	
6. Evidence of erosion	0	1	2	3	N/A	

C. Evidence of Materials Storage or Resurfacing of Permeable Pavement

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

Item						Comments
1. Evidence of storage of sand, mulch, soil, construction staging, power washing, or other activities that can clog pavement	0	1	2	3	N/A	
2. Evidence of resealing or resurfacing of permeable pavement surface	0	1	2	3	N/A	

Permeable Pavement
Maintenance Inspection Checklist

D. Practice

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item						Comments
1.	Maintenance access to practice	0	1	2	3	N/A	
2.	Condition of structural components	0	1	2	3	N/A	
3.	Condition of hydraulic control components	0	1	2	3	N/A	
4.	Excessive trash/debris/sediment on pavement surface	0	1	2	3	N/A	
5.	Evidence of damaged pavers and/or cracked/broken surface	0	1	2	3	N/A	
6.	Evidence of oil/chemical accumulation	0	1	2	3	N/A	
7.	Evidence of clogging:	☐					
	a. Ponding/water standing in observation wells	0	1	2	3	N/A	
	b. Noticeable odors	0	1	2	3	N/A	
	c. Water stains	0	1	2	3	N/A	
8.	Underdrain system (if equipped)	0	1	2	3	N/A	
	a. Broken	0	1	2	3	N/A	
	b. Clogged	0	1	2	3	N/A	
9.	Vegetation (e.g., grass in grid pavers) if present	0	1	2	3	N/A	
	a. Grass or vegetation needs mowing or maintenance	0	1	2	3	N/A	
	b. Excessive growth of weeds	0	1	2	3	N/A	
	c. Dead vegetation	0	1	2	3	N/A	

E. Miscellaneous

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item						Comments
1.	Complaints from local residents	0	1	2	3	N/A	
2.	Spring clean-up conducted?	0	1	2	3	N/A	
3.	Vacuum sweeping without water spray (2 -- 4 time annually)	0	1	2	3	N/A	
4.	Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A	

Permeable Pavement
Maintenance Inspection Checklist

Inspector's Summary:

Photographs

Photo ID	Description
1.	
2.	
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Sketch of Practice

(note problem areas)

Green Roof
Maintenance Inspection Checklist

Party Responsible for Maintenance: ____________________

Contact: ____________________

Phone Number: ____________________

E-mail: ____________________

Mailing Address: ____________________

____

Practice ID: ____________________

Location: ____________________

GPS Coordinates:

____

Inspector(s): ____________________

____

Date: __________ **Time:** __________

Key Questions		
Item	**X**	**Comments**
1. Type of vegetated roof (check all that apply)		
a. Extensive - shallow soil		
b. Intensive - deep soil		
c. Other		Type:
2. Type of plant cover (check all that apply)		
a. Sedums		
b. Shrubs		
c. Trees		
d. Other		Type:

A. Practice

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

Item		**Comments**
1. Maintenance access to practice	0 1 2 3 N/A	
2. Condition of structural components	0 1 2 3 N/A	
3. Condition of hydraulic control components	0 1 2 3 N/A	
4. Excessive trash/debris/sediment	0 1 2 3 N/A	
5. Evidence of leaking in waterproof membrane	0 1 2 3 N/A	
6. Evidence of perforated root barrier	0 1 2 3 N/A	
7. Evidence of standing water:	0 1 2 3 N/A	
a. Ponding	☐	
b. Noticeable odors	☐	
c. Water stains	☐	
d. Presence of algae	☐	
8. Roof drain system	0 1 2 3 N/A	
a. Broken	☐	
b. Clogged	☐	
9. Vegetation	0 1 2 3 N/A	
a. Plant composition consistent with approved plans	☐	
b. Presence of invasive species/weeds	☐	
c. Plants appear nutrient deficient	☐	
d. Evidence of birds/pests removing plants	☐	
e. Dead/sparse vegetation soil	☐	

Green Roof
Maintenance Inspection Checklist

B. Outlets						
0 = Good condition. Well maintained, no action required.						
1 = Moderate condition. Adequately maintained, routine maintenance needed.						
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.						
3 = Serious condition. Immediate need for repair or replacement.						
☐ Inspected						
☐ Not Inspected						
Item						**Comments**
1. Roof drain conveyance is clogged	0	1	2	3	N/A	
2. Excessive trash/debris/sediment accumulation at roof drain outlets	0	1	2	3	N/A	
3. Evidence of erosion at/around outlet	0	1	2	3	N/A	

C. Miscellaneous						
0 = Good condition. Well maintained, no action required.						
1 = Moderate condition. Adequately maintained, routine maintenance needed.						
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.						
3 = Serious condition. Immediate need for repair or replacement.						
☐ Inspected						
☐ Not Inspected						
Item						**Comments**
1. Complaints from local residents	0	1	2	3	N/A	
2. Mosquito proliferation	0	1	2	3	N/A	

Inspector's Summary:

Photographs

Photo ID	**Description**
1.	
2.	
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Green Roof
Maintenance Inspection Checklist

Sketch of Practice
(note problem areas)

Rainwater Harvesting
Maintenance Inspection Checklist

Party Responsible for Maintenance: ____________________

Contact: ____________________

Phone Number: ____________________

E-mail: ____________________

Mailing Address: ____________________

____

Practice ID: ____________________

Location: ____________________

GPS Coordinates:

____

Inspector(s): ____________________

____

Date: __________ **Time:** ______________

A. *Contributing Drainage Area (Roof Area)*

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item		Comments
1.	Excessive leaves and debris in gutters/downspouts	0 1 2 3 N/A	
2.	Other materials/debris on roof surface (e.g., excessive bird droppings)	0 1 2 3 N/A	
3.	Clear overhanging trees/vegetation over roof surface	0 1 2 3 N/A	

B. *Pretreatment*

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item		Comments
1.	Maintenance access to pretreatment facility	0 1 2 3 N/A	
2.	Check first flush diverters/filters for proper functioning (e.g., not bypassing too much water). Clean debris from filter screens	0 1 2 3 N/A	Sediment marker reading:

C. *Inlets*

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item		Comments
1.	Check all conveyances into tank; remove debris; check for clogging	0 1 2 3 N/A	
2.	Patch any holes or gaps.	0 1 2 3 N/A	

Rainwater Harvesting
Maintenance Inspection Checklist

D. Tank or Cistern							
0 = Good condition. Well maintained, no action required.							
1 = Moderate condition. Adequately maintained, routine maintenance needed.							
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.							
3 = Serious condition. Immediate need for repair or replacement.							
☐ Inspected							
☐ Not Inspected							
Item							**Comments**
1. Maintenance access to practice	0	1	2	3	N/A		
2. Check storage tank lids	0	1	2	3	N/A		
a. Vents and screens on inflow/outflow spigots	0	1	2	3	N/A		
b. Lids in place, properly secured	0	1	2	3	N/A		
3. Overflow pipes & downstream flow path	0	1	2	3	N/A	Cause:	
a. Debris/clogging in overflow pipes	0	1	2	3	N/A	Cause:	
b. Erosion, excessive debris, clogging of flow path	0	1	2	3	N/A	Cause:	
c. Condition of downstream secondary runoff reduction practice (see applicable checklist)	0	1	2	3	N/A	Cause:	
4. Sediment build-up in tank	0	1	2	3	N/A		
5. Backflow preventer	0	1	2	3	N/A		
6. Structural integrity	0	1	2	3	N/A		
a. Tank and foundation	0	1	2	3	N/A		
b. Pump and pump housing	0	1	2	3	N/A		
c. Pipes	0	1	2	3	N/A		
d. Electrical system and housing	0	1	2	3	N/A		
7. Water Quality Devices	0	1	2	3	N/A		
8. Mosquitos	0	1	2	3	N/A		
a. Mosquito screens; check gaps and holes	0	1	2	3	N/A		
b. Evidence of mosquito larvae in tank or manholes	0	1	2	3	N/A		

E. Miscellaneous						
0 = Good condition. Well maintained, no action required.						
1 = Moderate condition. Adequately maintained, routine maintenance needed.						
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.						
3 = Serious condition. Immediate need for repair or replacement.						
☐ Inspected						
☐ Not Inspected						
Item						**Comments**
1. Complaints from local residents	0	1	2	3	N/A	
2. Mosquito proliferation	0	1	2	3	N/A	
3. Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A	
4. Adequate safety signage	0	1	2	3	N/A	

Rainwater Harvesting
Maintenance Inspection Checklist

Inspector's Summary:

Photographs

Photo ID	Description
1.	
2.	
3.	
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Sketch of Practice

(note problem areas)

Impervious Surface Disconnection
Maintenance Inspection Checklist

Party Responsible for Maintenance: ______________________

Contact: ______________________

Phone Number: ______________________

E-mail: ______________________

Mailing Address: ______________________

____

Practice ID: ______________________

Location: ______________________

GPS Coordinates:

____

Inspector(s): ______________________

____

Date: __________ **Time:** __________

Key Questions		
Item	**X**	**Comments**
1. Type of impervious area disconnected		
a. Rooftop		
b. Parking		
c. Other		
2. Type of disconnection surface		
a. Managed turf areas		
b. Forest cover or preserved open space		
c. Soil compost amended filter path		
3. Type of forest cover or open space (if applicable)		
a. Forest		
b. Meadow/Brush		
c. Other		
4. Vegetative Cover Condition		
a. Good		
b. Average		
c. Poor		
5. Meets width/length requirement		

A. Contributing Drainage Area

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

Item		**Comments**
1. Excessive trash/debris	0 1 2 3 N/A	
2. Excessive landscape waste/yard clippings	0 1 2 3 N/A	

Impervious Surface Disconnection
Maintenance Inspection Checklist

B. Inflow Points

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

Item		Comments
1. Inflow points (e.g. downspouts, curb cuts, edge of pavement, level spreader) provide stable conveyance into practice	0 1 2 3 N/A	
2. Runoff enters pervious area as sheet flow	0 1 2 3 N/A	
3. Excessive trash/debris/sediment	0 1 2 3 N/A	
4. Evidence of erosion at/around inflow points	0 1 2 3 N/A	
5. Level spreader functional, if applicable	0 1 2 3 N/A	

C. Practice (Pervious Area Receiving Runoff)

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

Item		Comments
1. Maintenance access to area	0 1 2 3 N/A	
2. Downspouts or surface impervious area drains to the receiving pervious area (doesn't bypass)	0 1 2 3 N/A	
3. Receiving pervious areas retain dimensions as shown on plans and are in good	0 1 2 3 N/A	
4. Excessive trash/debris/sediment	0 1 2 3 N/A	
5. Evidence of standing water:	0 1 2 3 N/A	
a. Ponding	☐	
b. Noticeable odors	☐	
c. Water stains	☐	
d. Presence of algae or floating aquatic vegetation	☐	
6. Evidence of erosion	0 1 2 3 N/A	
7 Evidence of oil/chemical accumulation	0 1 2 3 N/A	
8. Vegetation	0 1 2 3 N/A	
a. Plant composition consistent with approved plans	0 1 2 3 N/A	
b. Presence of invasive species/weeds	0 1 2 3 N/A	
c. Dead vegetation/exposed soil	0 1 2 3 N/A	
d. Disturbance to natural vegetation or excessive maintenance (e.g. mowing, tree cutting)	0 1 2 3 N/A	
e. Restoration planting survival, if	0 1 2 3 N/A	
9. Conservation area signs (if applicable)	0 1 2 3 N/A	
10. Level spreader (if applicable)	0 1 2 3 N/A	

D. Miscellaneous

Impervious Surface Disconnection
Maintenance Inspection Checklist

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item						Comments
1.	Complaints from local residents	0	1	2	3	N/A	
2.	Mosquito proliferation	0	1	2	3	N/A	
3.	Encroachment on pervious area or easement by buildings or other structures	0	1	2	3	N/A	

Inspector's Summary:

Photographs	
Photo ID	**Description**
1.	
2.	
3.	
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Impervious Surface Disconnection
Maintenance Inspection Checklist

Sketch of Practice
(note problem areas)

Dry Detention Practices
Maintenance Inspection Checklist

Party Responsible for Maintenance: ______________________

Contact: ______________________

Phone Number: ______________________

E-mail: ______________________

Mailing Address: ______________________

____

Practice ID: ______________________

Location: ______________________

GPS Coordinates: ______________________

Inspector(s): ______________________

____

Date: __________ **Time:** __________

Key Questions		
Item	**X**	**Comments**
1. Type of detention practice		
a. Dry Pond		
b. Underground Detetention Vault and/or Tank		
c. Other		Type:

A. *Contributing Drainage Area*

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

Item		**Comments**
1. Excessive trash/debris	0 1 2 3 N/A	
2. Bare/exposed soil	0 1 2 3 N/A	
3. Evidence of erosion	0 1 2 3 N/A	
4. Excessive landscape waste/yard clippings	0 1 2 3 N/A	
5. Oils, greases, paints and other harmful substances disposed of in drainage area.	0 1 2 3 N/A	

B. *Forebay/Pretreatment*

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

Item		**Comments**
1. Maintenance access to pretreatment facility	0 1 2 3 N/A	
2. Excessive trash/debris accumulation	0 1 2 3 N/A	
3. Excessive sediment accumulation	0 1 2 3 N/A	Sediment marker reading:
4. Evidence of clogging	0 1 2 3 N/A	
5. Dead vegetation/exposed soil	0 1 2 3 N/A	
6. Evidence of erosion	0 1 2 3 N/A	

Dry Detention Practices
Maintenance Inspection Checklist

C.	***Inlets***							
	0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.							
	Inspected							
	Not Inspected							
	Item							**Comments**
1.	Inlets provide stable conveyance into	0	1	2	3	N/A		
2.	Excessive trash/debris/sediment accumulation at inlet	0	1	2	3	N/A		
3.	Evidence of erosion at/around inlet	0	1	2	3	N/A		
4.	Damaged pipes or components	0	1	2	3	N/A		
5.	Inflow hindered by soil height, build up of sediment and/or grass	0	1	2	3	N/A		

D.	***Practice***							
	0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.							
	Inspected							
	Not Inspected							
	Item							**Comments**
1.	Maintenance access to practice	0	1	2	3	N/A		
2.	Sediment accumulation	0	1	2	3	N/A		
3.	Abnormally high or low water levels	0	1	2	3	N/A	Cause:	
4.	Evidence of pollution/hotspot runoff	0	1	2	3	N/A	Cause:	
5.	Berm(s)/embankment(s)	0	1	2	3	N/A		
	a. Cracking, bulging, or sloughing	0	1	2	3	N/A		
	b. Soft spots or sinkholes	0	1	2	3	N/A		
	c. Evidence of erosion/bare spots	0	1	2	3	N/A		
	d. Evidence of animal burrows	0	1	2	3	N/A		
	e. Presence of woody vegetation	0	1	2	3	N/A		
6.	Riser/outlet	0	1	2	3	N/A	Type of riser:	
	a. Maintenance access to riser	0	1	2	3	N/A		
	b. Structural condition of riser	0	1	2	3	N/A		
	c. Condition of joints	0	1	2	3	N/A		
	d. Trash/debris accumulation	0	1	2	3	N/A		
	e. Woody growth within 5 ft. of outlet	0	1	2	3	N/A		
	f. Emergency spillway eroding or failing	0	1	2	3	N/A		
7.	Low flow orifice	0	1	2	3	N/A		
	a. Trash/debris accumulation	0	1	2	3	N/A		
	b. Adjustable control valve accessible and operational	0	1	2	3	N/A		
9.	Vegetation	0	1	2	3	N/A		
	a. Plant composition consistent with approved plans	0	1	2	3	N/A		
	b. Presence of invasive species/weeds	0	1	2	3	N/A		
	c. Dead vegetation/exposed soil	0	1	2	3	N/A		
	d. Reinforcement planting recommended							

Dry Detention Practices
Maintenance Inspection Checklist

E. Outlets						
0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.						
☐ Inspected						
☐ Not Inspected						
Item						**Comments**
1. Outlets provide stable conveyance out of practice	0	1	2	3	N/A	
2. Excessive trash/debris/sediment accumulation at outlet	0	1	2	3	N/A	
3. Evidence of erosion at/around outlet/outfall	0	1	2	3	N/A	
4. Evidence of leaking/clogging of trash racks or reversed slope pipes	0	1	2	3	N/A	

F. Miscellaneous						
0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.						
☐ Inspected						
☐ Not Inspected						
Item						**Comments**
1. Complaints from local residents	0	1	2	3	N/A	
2. Mosquito proliferation	0	1	2	3	N/A	
3. Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A	
4. Adequate safety signage	0	1	2	3	N/A	

Inspector's Summary:

Dry Detention Practices
Maintenance Inspection Checklist

Photographs	
Photo ID	**Description**
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

Sketch of practice

(note problem areas)

Stormwater Wet Pond/Wetland
Maintenance Inspection Checklist

Party Responsible for Maintenance: ______________________

Contact: ______________________

Phone Number: ______________________

E-mail: ______________________

Mailing Address: ______________________

____

Practice ID: ______________________

Location: ______________________

GPS Coordinates: ______________________

Inspector(s): ______________________

____

Date: __________ **Time:** ______________

Key Questions			
	Item	**X**	**Comments**
1.	Type of stormwater practice (check all that apply)		
	a. Stormwater wetland basin		
	b. Stormwater multi-cell wetland or pond/wetland combination		
	c. Subsurface gravel wetland		
	d. Wet pond		
	d. Other		Type:
2.	Type of pretreatment facility (check all that apply)		*Pretreatment must be provided*
	a. Sediment forebay		
	b. Other		Type:

A. Contributing Drainage Area

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item						**Comments**
1.	Excessive trash/debris	0	1	2	3	N/A	
2.	Bare/exposed soil	0	1	2	3	N/A	
3.	Evidence of erosion	0	1	2	3	N/A	
4.	Excessive landscape waste/yard clippings	0	1	2	3	N/A	
5.	Oils, greases, paints and other harmful substances disposed of in drainage area.	0	1	2	3	N/A	

Stormwater Wet Pond/Wetland
Maintenance Inspection Checklist

B.	***Pretreatment***						
	0 = Good condition. Well maintained, no action required.						
	1 = Moderate condition. Adequately maintained, routine maintenance needed.						
	2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.						
	3 = Serious condition. Immediate need for repair or replacement.						
	Inspected						
	Not Inspected						
	Item						**Comments**
1.	Maintenance access to pretreatment facility	0	1	2	3	N/A	
2.	Excessive trash/debris accumulation	0	1	2	3	N/A	
3.	Excessive sediment accumulation	0	1	2	3	N/A	Sediment marker reading:
4.	Evidence of clogging	0	1	2	3	N/A	
5.	Dead vegetation/exposed soil	0	1	2	3	N/A	
6.	Evidence of erosion	0	1	2	3	N/A	

C.	***Inlets***						
	0 = Good condition. Well maintained, no action required.						
	1 = Moderate condition. Adequately maintained, routine maintenance needed.						
	2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.						
	3 = Serious condition. Immediate need for repair or replacement.						
	Inspected						
	Not Inspected						
	Item						**Comments**
1.	Inlets provide stable conveyance into	0	1	2	3	N/A	
2.	Excessive trash/debris/sediment accumulation at inlet	0	1	2	3	N/A	
3.	Evidence of erosion at/around inlet	0	1	2	3	N/A	
4.	Damaged pipes or components	0	1	2	3	N/A	
5.	Inflow hindered by soil height, build up of sediment and/or grass	0	1	2	3	N/A	
6.	Asphalt/concrete crumbling at inlets	0	1	2	3	N/A	

Stormwater Wet Pond/Wetland
Maintenance Inspection Checklist

D. Practice 0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.							
☐ Inspected							
☐ Not Inspected							
Item							**Comments**
1. Maintenance access to practice	0	1	2	3	N/A		
2. Sediment accumulation	0	1	2	3	N/A		
Bathymetric study recommended	☐						
3. Abnormally high or low water levels	0	1	2	3	N/A	Cause:	
4. Evidence of pollution/hotspot runoff	0	1	2	3	N/A	Cause:	
5. Berm(s)/embankment(s)	0	1	2	3	N/A		
a. Cracking, bulging, or sloughing	0	1	2	3	N/A		
b. Soft spots or sinkholes	0	1	2	3	N/A		
c. Evidence of erosion/bare spots	0	1	2	3	N/A		
d. Evidence of animal burrows	0	1	2	3	N/A		
e. Presence of woody vegetation	0	1	2	3	N/A		
6. Riser/outlet	0	1	2	3	N/A	Type of riser:	
a. Maintenance access to riser	0	1	2	3	N/A		
b. Structural condition of riser	0	1	2	3	N/A		
c. Condition of joints	0	1	2	3	N/A		
d. Trash/debris accumulation	0	1	2	3	N/A		
e. Woody growth within 5 ft. of outlet	0	1	2	3	N/A		
f. Emergency spillway eroding, or failing	0	1	2	3	N/A		
7. Low flow orifice	0	1	2	3	N/A		
a. Trash/debris accumulation	0	1	2	3	N/A		
b. Adjustable control valve accessible and operational	0	1	2	3	N/A		
8. Pond drain (underdrain) system (if applicable)	0	1	2	3	N/A		
a. Broken	0	1	2	3	N/A		
b. Clogged	0	1	2	3	N/A		
c. Adjustable control valve accessible and operational	0	1	2	3	N/A		
9. Vegetation	0	1	2	3	N/A		
a. Plant composition consistent with approved plans	0	1	2	3	N/A		
b. Presence of invasive species/weeds	0	1	2	3	N/A		
c. Dead vegetation/exposed soil	0	1	2	3	N/A		
d. Reinforcement planting recommended	☐						

Stormwater Wet Pond/Wetland
Maintenance Inspection Checklist

E. *Outlets*

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
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3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item						Comments
1.	Outlets provide stable conveyance out of practice	0	1	2	3	N/A	
2.	Excessive trash/debris/sediment accumulation at outlet	0	1	2	3	N/A	
3.	Evidence of erosion at/around outlet/outfall	0	1	2	3	N/A	
4.	Evidence of polluted water being released – discoloration, odor, staining, etc.	0	1	2	3	N/A	

F. *Miscellaneous*

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item						Comments
1.	Complaints from local residents	0	1	2	3	N/A	
2.	Mosquito proliferation	0	1	2	3	N/A	
3.	Encroachment on practice or easement by buildings or other structures	0	1	2	3	N/A	
4.	Adequate safety signage	0	1	2	3	N/A	

Inspector's Summary:

Stormwater Wet Pond/Wetland
Maintenance Inspection Checklist

Photographs

Photo ID	Description
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	

Sketch of practice

(note problem areas)

Grass Swale
Maintenance Inspection Checklist

Party Responsible for Maintenance: ______________________

Contact: ______________________

Phone Number: ______________________

E-mail: ______________________

Mailing Address: ______________________

____

Practice ID: ______________________

Location: ______________________

GPS Coordinates: ______________________

Inspector(s): ______________________

____

Date: __________ **Time:** ______________

A. Contributing Drainage Area

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item		Comments
1.	Excessive trash/debris	0 1 2 3 N/A	
2.	Bare/exposed soil	0 1 2 3 N/A	
3.	Evidence of erosion	0 1 2 3 N/A	
4.	Excessive landscape waste/yard clippings	0 1 2 3 N/A	
5.	Impervious area added	0 1 2 3 N/A	

B. Inflow Points

0 = Good condition. Well maintained, no action required.
1 = Moderate condition. Adequately maintained, routine maintenance needed.
2 = Degraded condition. Poorly maintained, routine maintenance and repair needed.
3 = Serious condition. Immediate need for repair or replacement.

☐ Inspected
☐ Not Inspected

	Item		Comments
1.	Inflow points (e.g. curb cuts, edge of pavement, pipes) provide stable conveyance into the channel	0 1 2 3 N/A	
2.	Excessive trash/debris/sediment accumulation at inflow points	0 1 2 3 N/A	
3.	Evidence of erosion at/around inflow points	0 1 2 3 N/A	

Grass Swale
Maintenance Inspection Checklist

C. *Practice (Grass Swale)*		
	0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.	
☐	Inspected	
☐	Not Inspected	

	Item		**Comments**
1.	Swale remains vegetated; no concrete, rip-rap, or other lining has been added	0 1 2 3 N/A	
2.	Grade ensures positive flow	0 1 2 3 N/A	
3.	Evidence of erosion	0 1 2 3 N/A	
4.	Sediment accumulation	0 1 2 3 N/A	
5.	Excessive trash/debris accumulation	0 1 2 3 N/A	
6.	Evidence of oil/chemical accumulation	0 1 2 3 N/A	
7.	Vegetation condition	0 1 2 3 N/A	
	a. Mowing as needed to maintain 4"-6" grass height.	0 1 2 3 N/A	
	b. 90% turf cover in practice.	0 1 2 3 N/A	
8.	Check dams in place	0 1 2 3 N/A	
9.	Signs of erosion around or under check dams	0 1 2 3 N/A	

D. *Miscellaneous*		
	0 = Good condition. Well maintained, no action required. 1 = Moderate condition. Adequately maintained, routine maintenance needed. 2 = Degraded condition. Poorly maintained, routine maintenance and repair needed. 3 = Serious condition. Immediate need for repair or replacement.	
☐	Inspected	
☐	Not Inspected	

	Item		**Comments**
1.	Complaints from local residents	0 1 2 3 N/A	
2.	Mosquito breeding	0 1 2 3 N/A	
3.	Encroachments (e.g. filling, fences, obstructions, etc.)	0 1 2 3 N/A	

Inspector's Summary:

Grass Swale
Maintenance Inspection Checklist

Photographs	
Photo ID	**Description**
1.	
2.	
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Sketch of Practice

(note problem areas)

Grass Swale
Maintenance Inspection Checklist

Appendix G: Compliance Calculator Spreadsheet Instructions

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G.1 Introduction 1

G.2 Compliance Calculator Spreadsheet Guidance 1

G.1 Introduction

The compliance calculator spreadsheet (Appendix H) was created to allow a designer to quickly analyze multiple LID options and check them against the watershed area's water quality design requirements. As is clear from the specifications, each LID BMP has different design requirements, equations, and standards that determine its effectiveness. Depending upon the site, it can become difficult to determine which BMP(s) best meets the requirements. With the compliance calculator, it is easier to examine different combinations of BMPs in order to find the best option or set of options. The compliance calculator is also to be used by the plan reviewer to quickly verify the compliance status of a plan.

It is important to note that the compliance calculator is not a model, and while it can be used as a design tool, it does not replace the needed efforts of a competent designer. The numbers in the spreadsheet don't guarantee that a BMP meets the specifications, is appropriate for its location, or is generally well-designed.

G.2 Compliance Calculator Spreadsheet Guidance

The following guidance explains how to use each of the worksheets in the compliance calculator spreadsheet (Appendix H).

Note: All cells highlighted in blue are user input cells. Cells highlighted in gray are calculation cells, and cells highlighted in yellow are constant values that generally should not be changed.

Site Data Sheet

1. Enter the name of the proposed project on **line 9**.
2. Enter the pre-development land cover areas (in acres) of forest/open space cover, turf cover, impervious cover and BMP cover for the site for Natural Resource Conservation Service (NRCS) soil types A, B, C, and D in cells C24-C27, E24-E27, G24-G27, and I24-I27, respectively.
3. Verify/enter the NRCS runoff curve numbers for each land use/soil type combination in cells D24-D27, F24-F27, H24-H27, and J24-J27. Default values have already been included in these cells, but they can be changed if necessary.
4. Enter the post-development land cover areas (in acres) of forest cover/open space, turf cover, impervious cover and BMP cover on the site for Natural Resource Conservation Service (NRCS) soil types A, B, C, and D in cells C34-C37, E34-E37, G34-G37, and I34-I37, respectively.
5. Verify/enter the NRCS runoff curve numbers for each land use/soil type combination in cells D34-D37, F34-F37, H34-H37, and J34-J37. As with the pre-development entries, default values have already been included in these cells, but they can be changed if necessary.

BMP Sheet

1. Apply BMPs to the drainage area to address the required water quality volume by indicating the area in square feet (sf) of forest cover, turf cover, and impervious cover to be treated by a given BMP in **Columns B, C, and D**. This will likely be an iterative process. The available BMPs include the following:
    - Bioretention – No Underdrain
    - Bioretention - IWS
    - Bioretention - Standard
    - Permeable Pavement - Enhanced
    - Permeable Pavement - Standard
    - Infiltration
    - Green Roof
    - Green Roof – Irrigated
    - Rainwater Harvesting
    - Impervious Surface Disconnection
    - Grass Channel
    - Grass Channel – Amended Soils
    - Dry Swale
    - Wet Swale
    - Regenerative Stormwater Conveyance (RSC)
    - Filtering Systems
    - Storage Practices
    - Stormwater Ponds
    - Stormwater Wetlands
    - Proprietary Practice
    - Planted Tree
    - Preserved Tree
2. Enter the BMP’s surface area (sf) in Column E and storage volume (cf) in Column F.
3. If a Stormwater Pond is used for irrigation the contributing drainage area and storage volume (determined from the Rainwater Harvesting Calculator) are entered in the Rainwater Harvesting cells B24, C24, D24, E24 and F24, respectively. The Stormwater Pond row remains empty unless there are other ponds used that are not used for irrigation.
4. If other Rainwater Harvesting BMPs are used, the Rainwater Harvesting Calculator is used to determine the contributing drainage area and storage volume inputs to the BMP worksheet.
5. The volume from direct drainage to the BMP is calculated and reported in **Column E**. Note that the total disturbed area is reflected as the sum of impervious cover (**Column D**), turf cover (**Column C**) and forest/open space cover (**Column B**) draining to the practice.
6. If more than one BMP will be employed in series, any overflow from upstream BMPs will be accounted for in **Column M**.

7. The total volume captured by the practice (V_{CAP}) is reported in **Column N** and is equal to the following:

$$V_{CAP} = Minimum(Sv, V_{US} + V_{DD})$$

Where:

WQv_{CAP} = Water Quality Volume captured by the practice (cf) (**Column N)**
Sv = Storage Volume (cf) (**Column F)**
V_{US} = Volume of runoff from upstream practice (cf) (**Column M)**
V_{DD} = Volume of runoff from direct discharge (cf) (**Column L)**

8. The Runoff Reduction or Pollutant Removal Efficiency (%) for each BMP (from Table 2.3) is reported in **Columns H-K**.
9. The Water Quality Volume Credited is calculated in **Column O**, and is equal to the following:

$$WQv_{CR} = Minimum\ of\ (Sv \times CR, V_{CAP})$$

Where:

WQv_{CR} = Water Quality Volume Credited (cf)
Sv = Storage Volume (cf) **(Column F)**
CR = Credit (fraction)
V_{CAP}= Volume Captured by the Practice (cf) **(Column N)**

10. The Remaining Water Quality Volume **(Column P)** is calculated as:

$$WQv_R = V_{US} + V_{DD} - WQv_{CR}$$

Where:

WQv_R = Water Quality Volume Remaining (cf) **(Column O)**
V_{US} = Volume from Upstream Practices (cf) **(Column M)**
V_{DD} = Volume from Direct Drainage (cf) **(Column L)**

11. Any runoff volume remaining can be directed to a downstream BMP by selecting a practice from the pull-down menu in **Column G**. Selecting a BMP from the menu will automatically direct the runoff volume remaining to **Column M (volume from upstream practices)** for the appropriate BMP.
12. Planted Trees. Input the number of planted and preserved trees of each size class in cells F38-F42 (retention values correspond to Table 4.62 and 4.63 in design manual).
13. The Target Retention Volume (WQv_T) is reported in **Cell B49**, from corresponding **Cell C42** on the **Site Data Tab**.
14. The Water Quality Volume Provided (WQv_P), is calculated in **Cell C49** as a combination of the retention values for all BMPs and trees (Cells O17-O42)
15. The fraction of target achieved (either by practice or by the entire site as appropriate) is calculated in **Cells F31-F35).** The % of target achieved is calculated as follows:

$$T = Minimum\ of\ \left(\frac{WQv_P}{WQv_T}, 1\right)$$

Where:

T = Treatment (fraction)

WQv_P = Water Quality Volume Provided (cf)
WQv_T = Water Quality Volume Target (cf)

16. **Cells D49, 52, 54, 58, and 61** determine if the site target has been reached as follows:
    - Overall Retention Goal
        - Target Retention Volume
    - General Stormwater Management Watershed Area Minimum Requirements
        - Target Retention Volume (1.16 in storm)
        - Target TSS Removal
        - Target Nitrogen Removal
        - Target Bacteria Removal
    - Savannah River Special Watershed Protection Area Minimum Requirements
        - Target Retention Volume (1.16 in storm)
        - Target TSS Removal
        - Target Nitrogen Removal
        - Target Bacteria Removal

Channel and Flood Protection

This sheet assists with calculation of Adjusted Curve Numbers that can be used to calculate peak flows associated with the 2- to 100-year storm events.

17. Enter the appropriate depths for the 2-year, 10-year, 25-year and 100-year 24-hour storms (as provided in Table 2.4) on **Line 5**.
18. The Total Site Area (from the **Site Data** Tab), is reported in **Cell C7**.
19. Detention Storage Volume (cf) is calculated in **Cell C8**, and refers to the total storage provided in all LID practices using the following equation:

$$V_{DS} = \sum_{LID\ BMPs} Sv_{BMP} \cdot IRD_{BMP}$$

Where:
V_{DS} = Volume in Site Detention Storage (cf)
Sv_{BMP} = Storage Volume Provided in Each BMP (cf) (from **Column F** of the **BMPs** Tab)
IRD_{BMP} = Infiltration, Retention or Detention Credit for Each BMP (from **Column J** of the **BMPs** Tab)

Note that, while other practices such as ponds provide detention, it is assumed that design engineers will explicitly account for this detention in a Pond Routing program.

20. As indicated in the Site Data sheet, each cover type is associated with a NRCS curve number. **Cells D15–G22** show the pre-development land cover areas and curve numbers that were indicated on the Site Data Sheet. Using these curve numbers, a weighted curve number is calculated in **cell G24**.

21. **Cells D29–G36** show the post-development land cover areas and curve numbers that were indicated on the Site Data Sheet. Using these curve numbers, a weighted curve number is calculated in **cell G38**.

22. Using NRCS methodology, **Line 42** calculates the pre-development runoff volume (inches) for the various storm events.

    Potential Abstraction

    $$S = \frac{1000}{(CN - 10)}$$

    Where:
    S = potential abstraction (in.)
    CN = weighted curve number

    Runoff Volume

    $$Q = \frac{(P - 0.2 \cdot S)^2}{(P + 0.8 \cdot S)}$$

    Where:
    Q = runoff volume (in.)
    P = precipitation depth for a given 24-hour storm (in.)
    S = potential abstraction (in.)

23. **Line 43** calculates the post-development runoff volume based solely on land cover (without regard to the BMPs selected on the BMP sheet). **Line 44** then subtracts the runoff reduction volume provided by BMPs, from **Cell C8**.

24. Based upon the reduced runoff volumes calculated in line 44, the spreadsheet then calculates corresponding reduced curve numbers for each storm event. This Adjusted Curve Number is reported on **Line 45**.

25. **Line 46** compares the pre-development runoff volume in line 42 with the post-development (with BMPs) runoff volume in line 44. If the post-development volume (with BMPs) is less than or equal to the pre-development volume for a given storm event, then it is assumed that detention will not be required. If the post-development volume (with BMPs) is greater than the pre-development volume for a given storm event, then detention will be necessary, and the Adjusted Curve Numbers form line 45 should be used to calculate the post-development peak runoff rates.

Southern Low Country Stormwater Compliance Calculator

(cyan)	data input cells
(gray)	calculation cells
(yellow)	constant values

Site Data

Site Name:	Trial
Watershed Protection Area	Bacteria and Shellfish Special Watershed Protect

Design Storm (in.)	1.95

	Runoff Coefficients		
	Soil Type A	Soil Type B	Soil Type C
Forest/Open Space	0.02	0.03	0.04
Managed Turf	0.15	0.20	0.22
Impervious Cover	0.95	0.95	0.95
BMP	0.95	0.95	0.95

Indicate Pre-Development Land Cover and Runoff Curve Numbers in the Site's Disturbed Are

	Area (square feet)					
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN
Forest Cover/Open Space		30		55		70
Turf Cover		39		61		74
Impervious Cover	43,560	98		98		98
BMP		98		98		98
Total	43,560		0		0	

Indicate Post-Development Land Cover and Runoff Curve Numbers in the Site's Disturbed A

	Area (square feet)					
Cover Type	Soil Type A	CN	Soil Type B	CN	Soil Type C	CN
Forest Cover/Open Space		30		55		70
Turf Cover		39		61		74
Impervious Cover	43,560	98		98		98
BMP		98		98		98
Total	43,560		0		0	

Stormwater Retention Volume (cf)	**6,725**

ion Area

Soil Type D
0.05
0.25
0.95
0.95

a

Soil Type D	CN	Total	**% Cover**	Rv
	77	0	0%	0
	80	0	0%	0
	98	43,560	100%	0.95
	98	0	0%	0
0		43,560	100%	0.95

rea

Soil Type D	CN	Total	**% Cover**	Rv
	77	0	0%	0
	80	0	0%	0
	98	43,560	100%	0.95
	98	0	0%	0
0		43,560	100%	0.95

Southern Low Country Stormwater Compliance Calculator

Site Drainage Area 1

Indicate Post-Development Land Cover and Runoff Curve Numbers in the Site's Disturbe

	Area (square f		
Cover Type	Soil Type A	Soil Type B	Soil Type C
Forest Cover/Open Space			
Turf Cover			
Impervious Cover			
BMP			
Total	0	0	0

BMPs

	Contributing Drainage Are		
	Forest Cover Draining to BMP	**Turf Cover Draining to BMP**	**Impervious Cover Draining to BMP**
	Area (square feet)	**Area (square feet)**	**Area (square feet)**
Bioretention - No Underdrain			
Bioretention - IWS			
Bioretention - Standard			
Permeable Pavement - Enhanced			
Permeable Pavement - Standard			
Infiltration			
Green Roof			
Rainwater Harvesting			
Impervious Surface Disconnection			
Grass Channel			
Grass Channel - Amended Soils			
Dry Swale			
Wet Swale			
RSC			
Filtering Systems			
Storage Practices			
Stormwater Ponds			

Stormwater Wetlands			
Proprietary Practice			
Planted Tree - Small			
Planted Tree - Large			
Preserved Tree - Small			
Preserved Tree - Large			
Preserved Tree - Special			
Totals	**0.00**	**0.00**	**0.00**

d Area						
eet)						
Soil Type D	Total	**% Cover**	Rv			
	0	0%	0			
	0	0%	0			
	0	0%	0.95			
	0	0%	0.95			
0	0	0%	0			

a			**Water Quality Credits**			
BMP Surface Area						
Area (square feet)	**Storage Volume Provided by BMP (cubic feet)**	**Downstream BMP**	**Runoff Reduction**	**TSS % Removal**	**Total N % Removal**	**Bacteria % Removal**
			100%	100%	100%	100%
			75%	85%	85%	80%
			60%	85%	75%	80%
			100%	100%	100%	100%
			30%	80%	45%	30%
			100%	100%	100%	100%
			100%	100%	100%	100%
			100%	100%	100%	100%
			40%	80%	40%	40%
			10%	50%	25%	30%
			20%	50%	35%	30%
			60%	85%	70%	80%
			0%	80%	25%	60%
			0%	80%	40%	80%
			0%	80%	30%	80%
			0%	60%	10%	60%
			0%	80%	30%	60%

			0%	80%	25%	60%
Input Number of Trees						
			5 cf/tree	N/A	N/A	N/A
			10 cf/tree	N/A	N/A	N/A
			10 cf/tree	N/A	N/A	N/A
			20 cf/tree	N/A	N/A	N/A
			30 cf/tree	N/A	N/A	N/A
	0.00					

Retention (cf)			
Volume from Direct Drainage	**Volume from Upstream Practices**	**Total Volume Captured by BMP**	**Volume Credited**
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0

0	0	0	0
0	0	0	0
N/A	N/A	N/A	0
N/A	N/A	N/A	0
N/A	N/A	N/A	0
N/A	N/A	N/A	0
N/A	N/A	N/A	0

Southern Low Country Stormwater Compliance Calculator

Detention Calculations

	2-year storm	10-year storm	25-year storm	100-year storm
Target Rainfall Event (in)	4.19	6.39	7.79	10.10

Site Area (square feet)	43,560.00
Storage Volume Provided by BMPs	0

Based on the use of stormwater BMPs, the spreadsheet calculates an adjusted Runoff Volume and Adjusted Curve Number.

Pre-Development Conditions

Land Area		A Soils	B Soils	C Soils	D Soils
Forest Cover	Area (sf)	0	0	0	0
	CN	30	55	70	77
Turf Cover	Area (sf)	0	0	0	0
	CN	39	61	74	80
Impervious Cover	Area (sf)	43560	0	0	0
	CN	98	98	98	98
BMP	Area (sf)	0	0	0	0
	CN	98	98	98	98

Weighted CN	S
98	0.20

Post-Development Conditions

Land Area		A Soils	B Soils	C Soils	D Soils
Forest Cover	Area (ac)	0	0	0	0
	CN	30	55	70	77
Turf Cover	Area (ac)	0	0	0	0
	CN	39	61	74	80
Impervious Cover	Area (ac)	43560	0	0	0
	CN	98	98	98	98
BMP	Area (sf)	0	0	0	0
	CN	98	98	98	98

Weighted CN	S
98	0.20

	2-year storm	10-year storm	25-year storm	100-year storm
Pre-Development Runoff Volume (in)	3.95	6.15	7.55	9.86
Post Development Runoff Volume (in) with no BMPs	3.95	6.15	7.55	9.86
Post-Development Runoff Volume (in) with BMPs	3.95	6.15	7.55	9.86
Adjusted CN	**98**	**98**	**98**	**98**
Additional Detention Required?	No	No	No	N/A

2-year storm	10-year storm	25-year storm	100-year storm		
v (in)	v (in)	v (in)	v (in)	CN	S
0.00	0.01	0.10	0.49	25	30.00
0.00	0.01	0.10	0.50	25.1	29.84
0.00	0.01	0.11	0.51	25.2	29.68
0.00	0.01	0.11	0.52	25.3	29.53
0.00	0.01	0.12	0.53	25.4	29.37
0.00	0.01	0.12	0.54	25.5	29.22
0.00	0.01	0.13	0.55	25.6	29.06
0.00	0.01	0.13	0.56	25.7	28.91
0.00	0.01	0.13	0.57	25.8	28.76
0.00	0.02	0.14	0.58	25.9	28.61
0.00	0.02	0.14	0.59	26	28.46
0.00	0.02	0.15	0.60	26.1	28.31
0.00	0.02	0.15	0.61	26.2	28.17
0.00	0.02	0.16	0.62	26.3	28.02
0.00	0.02	0.16	0.63	26.4	27.88
0.00	0.02	0.17	0.64	26.5	27.74
0.00	0.03	0.17	0.65	26.6	27.59
0.00	0.03	0.18	0.66	26.7	27.45
0.00	0.03	0.18	0.67	26.8	27.31
0.00	0.03	0.19	0.68	26.9	27.17
0.00	0.03	0.19	0.69	27	27.04
0.00	0.04	0.20	0.70	27.1	26.90
0.00	0.04	0.20	0.72	27.2	26.76
0.00	0.04	0.21	0.73	27.3	26.63
0.00	0.04	0.21	0.74	27.4	26.50
0.00	0.05	0.22	0.75	27.5	26.36
0.00	0.05	0.22	0.76	27.6	26.23
0.00	0.05	0.23	0.77	27.7	26.10
0.00	0.05	0.24	0.78	27.8	25.97
0.00	0.06	0.24	0.79	27.9	25.84
0.00	0.06	0.25	0.80	28	25.71
0.00	0.06	0.25	0.81	28.1	25.59
0.00	0.06	0.26	0.82	28.2	25.46
0.00	0.07	0.26	0.83	28.3	25.34
0.00	0.07	0.27	0.85	28.4	25.21
0.00	0.07	0.28	0.86	28.5	25.09
0.00	0.07	0.28	0.87	28.6	24.97
0.00	0.08	0.29	0.88	28.7	24.84
0.00	0.08	0.29	0.89	28.8	24.72
0.00	0.08	0.30	0.90	28.9	24.60
0.00	0.09	0.31	0.91	29	24.48
0.00	0.09	0.31	0.92	29.1	24.36
0.00	0.09	0.32	0.93	29.2	24.25
0.00	0.10	0.32	0.95	29.3	24.13
0.00	0.10	0.33	0.96	29.4	24.01
0.00	0.10	0.34	0.97	29.5	23.90
0.00	0.10	0.34	0.98	29.6	23.78
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

1.03	2.47	3.53	5.41	63.2	5.82
1.04	2.48	3.54	5.42	63.3	5.80
1.05	2.49	3.55	5.44	63.4	5.77
1.05	2.50	3.56	5.45	63.5	5.75
1.06	2.51	3.57	5.46	63.6	5.72
1.06	2.52	3.58	5.48	63.7	5.70
1.07	2.53	3.59	5.49	63.8	5.67
1.08	2.54	3.60	5.50	63.9	5.65
1.08	2.55	3.61	5.52	64	5.62
1.09	2.55	3.63	5.53	64.1	5.60
1.09	2.56	3.64	5.54	64.2	5.58
1.10	2.57	3.65	5.56	64.3	5.55
1.10	2.58	3.66	5.57	64.4	5.53
1.11	2.59	3.67	5.58	64.5	5.50
1.12	2.60	3.68	5.60	64.6	5.48
1.12	2.61	3.69	5.61	64.7	5.46
1.13	2.62	3.70	5.62	64.8	5.43
1.13	2.63	3.71	5.64	64.9	5.41
1.14	2.64	3.73	5.65	65	5.38
1.15	2.65	3.74	5.66	65.1	5.36
1.15	2.66	3.75	5.68	65.2	5.34
1.16	2.67	3.76	5.69	65.3	5.31
1.16	2.68	3.77	5.70	65.4	5.29
1.17	2.69	3.78	5.72	65.5	5.27
1.18	2.70	3.79	5.73	65.6	5.24
1.18	2.70	3.80	5.74	65.7	5.22
1.19	2.71	3.81	5.76	65.8	5.20
1.20	2.72	3.83	5.77	65.9	5.17
1.20	2.73	3.84	5.78	66	5.15
1.21	2.74	3.85	5.80	66.1	5.13
1.21	2.75	3.86	5.81	66.2	5.11
1.22	2.76	3.87	5.82	66.3	5.08
1.23	2.77	3.88	5.84	66.4	5.06
1.23	2.78	3.89	5.85	66.5	5.04
1.24	2.79	3.90	5.86	66.6	5.02
1.24	2.80	3.91	5.88	66.7	4.99
1.25	2.81	3.93	5.89	66.8	4.97
1.26	2.82	3.94	5.90	66.9	4.95
1.26	2.83	3.95	5.92	67	4.93
1.27	2.84	3.96	5.93	67.1	4.90
1.28	2.85	3.97	5.94	67.2	4.88
1.28	2.86	3.98	5.96	67.3	4.86
1.29	2.87	3.99	5.97	67.4	4.84
1.29	2.88	4.00	5.98	67.5	4.81
1.30	2.89	4.01	6.00	67.6	4.79
1.31	2.89	4.03	6.01	67.7	4.77
1.31	2.90	4.04	6.02	67.8	4.75
1.32	2.91	4.05	6.04	67.9	4.73
1.33	2.92	4.06	6.05	68	4.71
1.33	2.93	4.07	6.06	68.1	4.68
1.34	2.94	4.08	6.08	68.2	4.66
1.35	2.95	4.09	6.09	68.3	4.64
1.35	2.96	4.10	6.10	68.4	4.62
1.36	2.97	4.12	6.12	68.5	4.60
1.37	2.98	4.13	6.13	68.6	4.58
1.37	2.99	4.14	6.14	68.7	4.56
1.38	3.00	4.15	6.16	68.8	4.53
1.39	3.01	4.16	6.17	68.9	4.51
1.39	3.02	4.17	6.18	69	4.49
1.40	3.03	4.18	6.20	69.1	4.47
1.40	3.04	4.19	6.21	69.2	4.45
1.41	3.05	4.21	6.22	69.3	4.43
1.42	3.06	4.22	6.24	69.4	4.41
1.42	3.07	4.23	6.25	69.5	4.39
1.43	3.08	4.24	6.26	69.6	4.37
1.44	3.09	4.25	6.28	69.7	4.35
1.44	3.10	4.26	6.29	69.8	4.33
1.45	3.11	4.27	6.30	69.9	4.31
1.46	3.12	4.28	6.31	70	4.29
1.46	3.13	4.30	6.33	70.1	4.27
1.47	3.14	4.31	6.34	70.2	4.25
1.48	3.15	4.32	6.35	70.3	4.22
1.48	3.16	4.33	6.37	70.4	4.20
1.49	3.17	4.34	6.38	70.5	4.18
1.50	3.18	4.35	6.39	70.6	4.16
1.51	3.19	4.36	6.41	70.7	4.14
1.51	3.20	4.37	6.42	70.8	4.12
1.52	3.21	4.39	6.43	70.9	4.10
1.53	3.22	4.40	6.45	71	4.08
1.53	3.23	4.41	6.46	71.1	4.06
1.54	3.24	4.42	6.47	71.2	4.04
1.55	3.25	4.43	6.49	71.3	4.03
1.55	3.26	4.44	6.50	71.4	4.01
1.56	3.27	4.45	6.51	71.5	3.99
1.57	3.28	4.47	6.53	71.6	3.97
1.57	3.29	4.48	6.54	71.7	3.95
1.58	3.30	4.49	6.55	71.8	3.93
1.59	3.31	4.50	6.56	71.9	3.91
1.59	3.32	4.51	6.58	72	3.89
1.60	3.33	4.52	6.59	72.1	3.87
1.61	3.33	4.53	6.60	72.2	3.85
1.62	3.34	4.54	6.62	72.3	3.83
1.62	3.35	4.56	6.63	72.4	3.81
1.63	3.36	4.57	6.64	72.5	3.79
1.64	3.37	4.58	6.66	72.6	3.77
1.64	3.38	4.59	6.67	72.7	3.76
1.65	3.39	4.60	6.68	72.8	3.74
1.66	3.40	4.61	6.70	72.9	3.72
1.67	3.41	4.62	6.71	73	3.70
1.67	3.42	4.64	6.72	73.1	3.68
1.68	3.43	4.65	6.74	73.2	3.66
1.69	3.44	4.66	6.75	73.3	3.64
1.69	3.46	4.67	6.76	73.4	3.62
1.70	3.47	4.68	6.77	73.5	3.61
1.71	3.48	4.69	6.79	73.6	3.59
1.72	3.49	4.70	6.80	73.7	3.57
1.72	3.50	4.72	6.81	73.8	3.55
1.73	3.51	4.73	6.83	73.9	3.53
1.74	3.52	4.74	6.84	74	3.51
1.74	3.53	4.75	6.85	74.1	3.50
1.75	3.54	4.76	6.87	74.2	3.48
1.76	3.55	4.77	6.88	74.3	3.46
1.77	3.56	4.78	6.89	74.4	3.44
1.77	3.57	4.80	6.91	74.5	3.42
1.78	3.58	4.81	6.92	74.6	3.40
1.79	3.59	4.82	6.93	74.7	3.39
1.80	3.60	4.83	6.94	74.8	3.37
1.80	3.61	4.84	6.96	74.9	3.35
1.81	3.62	4.85	6.97	75	3.33
1.82	3.63	4.86	6.98	75.1	3.32
1.83	3.64	4.88	7.00	75.2	3.30
1.83	3.65	4.89	7.01	75.3	3.28
1.84	3.66	4.90	7.02	75.4	3.26
1.85	3.67	4.91	7.04	75.5	3.25
1.86	3.68	4.92	7.05	75.6	3.23
1.86	3.69	4.93	7.06	75.7	3.21
1.87	3.70	4.94	7.07	75.8	3.19
1.88	3.71	4.96	7.09	75.9	3.18
1.89	3.72	4.97	7.10	76	3.16
1.89	3.73	4.98	7.11	76.1	3.14
1.90	3.74	4.99	7.13	76.2	3.12
1.91	3.75	5.00	7.14	76.3	3.11
1.92	3.76	5.01	7.15	76.4	3.09
1.92	3.77	5.02	7.17	76.5	3.07
1.93	3.78	5.04	7.18	76.6	3.05
1.94	3.79	5.05	7.19	76.7	3.04
1.95	3.80	5.06	7.20	76.8	3.02
1.95	3.81	5.07	7.22	76.9	3.00
1.96	3.82	5.08	7.23	77	2.99
1.97	3.83	5.09	7.24	77.1	2.97
1.98	3.84	5.11	7.26	77.2	2.95
1.98	3.85	5.12	7.27	77.3	2.94
1.99	3.86	5.13	7.28	77.4	2.92
2.00	3.87	5.14	7.29	77.5	2.90
2.01	3.88	5.15	7.31	77.6	2.89
2.02	3.89	5.16	7.32	77.7	2.87
2.02	3.90	5.17	7.33	77.8	2.85
2.03	3.92	5.19	7.35	77.9	2.84
2.04	3.93	5.20	7.36	78	2.82
2.05	3.94	5.21	7.37	78.1	2.80
2.06	3.95	5.22	7.39	78.2	2.79
2.06	3.96	5.23	7.40	78.3	2.77
2.07	3.97	5.24	7.41	78.4	2.76
2.08	3.98	5.25	7.42	78.5	2.74
2.09	3.99	5.27	7.44	78.6	2.72
2.09	4.00	5.28	7.45	78.7	2.71
2.10	4.01	5.29	7.46	78.8	2.69
2.11	4.02	5.30	7.48	78.9	2.67
2.12	4.03	5.31	7.49	79	2.66
2.13	4.04	5.32	7.50	79.1	2.64
2.13	4.05	5.34	7.51	79.2	2.63
2.14	4.06	5.35	7.53	79.3	2.61
2.15	4.07	5.36	7.54	79.4	2.59
2.16	4.08	5.37	7.55	79.5	2.58
2.17	4.09	5.38	7.57	79.6	2.56
2.18	4.10	5.39	7.58	79.7	2.55
2.18	4.11	5.41	7.59	79.8	2.53
2.19	4.12	5.42	7.60	79.9	2.52
2.20	4.13	5.43	7.62	80	2.50
2.21	4.15	5.44	7.63	80.1	2.48
2.22	4.16	5.45	7.64	80.2	2.47
2.22	4.17	5.46	7.65	80.3	2.45
2.23	4.18	5.47	7.67	80.4	2.44
2.24	4.19	5.49	7.68	80.5	2.42
2.25	4.20	5.50	7.69	80.6	2.41
2.26	4.21	5.51	7.71	80.7	2.39
2.27	4.22	5.52	7.72	80.8	2.38
2.27	4.23	5.53	7.73	80.9	2.36
2.28	4.24	5.54	7.74	81	2.35
2.29	4.25	5.56	7.76	81.1	2.33
2.30	4.26	5.57	7.77	81.2	2.32
2.31	4.27	5.58	7.78	81.3	2.30
2.32	4.28	5.59	7.80	81.4	2.29
2.32	4.29	5.60	7.81	81.5	2.27
2.33	4.30	5.61	7.82	81.6	2.25
2.34	4.32	5.63	7.83	81.7	2.24
2.35	4.33	5.64	7.85	81.8	2.22
2.36	4.34	5.65	7.86	81.9	2.21
2.37	4.35	5.66	7.87	82	2.20
2.37	4.36	5.67	7.89	82.1	2.18
2.38	4.37	5.68	7.90	82.2	2.17
2.39	4.38	5.70	7.91	82.3	2.15
2.40	4.39	5.71	7.92	82.4	2.14
2.41	4.40	5.72	7.94	82.5	2.12
2.42	4.41	5.73	7.95	82.6	2.11
2.43	4.42	5.74	7.96	82.7	2.09
2.43	4.43	5.75	7.97	82.8	2.08
2.44	4.44	5.77	7.99	82.9	2.06
2.45	4.45	5.78	8.00	83	2.05
2.46	4.47	5.79	8.01	83.1	2.03
2.47	4.48	5.80	8.02	83.2	2.02
2.48	4.49	5.81	8.04	83.3	2.00
2.49	4.50	5.82	8.05	83.4	1.99
2.50	4.51	5.84	8.06	83.5	1.98
2.50	4.52	5.85	8.08	83.6	1.96
2.51	4.53	5.86	8.09	83.7	1.95
2.52	4.54	5.87	8.10	83.8	1.93
2.53	4.55	5.88	8.11	83.9	1.92
2.54	4.56	5.89	8.13	84	1.90
2.55	4.57	5.91	8.14	84.1	1.89
2.56	4.58	5.92	8.15	84.2	1.88
2.57	4.60	5.93	8.16	84.3	1.86
2.57	4.61	5.94	8.18	84.4	1.85
2.58	4.62	5.95	8.19	84.5	1.83
2.59	4.63	5.96	8.20	84.6	1.82
2.60	4.64	5.98	8.21	84.7	1.81
2.61	4.65	5.99	8.23	84.8	1.79
2.62	4.66	6.00	8.24	84.9	1.78
2.63	4.67	6.01	8.25	85	1.76
2.64	4.68	6.02	8.27	85.1	1.75
2.65	4.69	6.03	8.28	85.2	1.74
2.66	4.70	6.05	8.29	85.3	1.72
2.66	4.72	6.06	8.30	85.4	1.71
2.67	4.73	6.07	8.32	85.5	1.70
2.68	4.74	6.08	8.33	85.6	1.68
2.69	4.75	6.09	8.34	85.7	1.67
2.70	4.76	6.10	8.35	85.8	1.66
2.71	4.77	6.12	8.37	85.9	1.64
2.72	4.78	6.13	8.38	86	1.63
2.73	4.79	6.14	8.39	86.1	1.61
2.74	4.80	6.15	8.40	86.2	1.60
2.75	4.81	6.16	8.42	86.3	1.59
2.76	4.83	6.17	8.43	86.4	1.57
2.77	4.84	6.19	8.44	86.5	1.56
2.77	4.85	6.20	8.45	86.6	1.55
2.78	4.86	6.21	8.47	86.7	1.53
2.79	4.87	6.22	8.48	86.8	1.52
2.80	4.88	6.23	8.49	86.9	1.51
2.81	4.89	6.25	8.50	87	1.49
2.82	4.90	6.26	8.52	87.1	1.48
2.83	4.91	6.27	8.53	87.2	1.47
2.84	4.92	6.28	8.54	87.3	1.45
2.85	4.94	6.29	8.55	87.4	1.44
2.86	4.95	6.30	8.57	87.5	1.43
2.87	4.96	6.32	8.58	87.6	1.42
2.88	4.97	6.33	8.59	87.7	1.40
2.89	4.98	6.34	8.60	87.8	1.39
2.90	4.99	6.35	8.62	87.9	1.38
2.91	5.00	6.36	8.63	88	1.36
2.92	5.01	6.37	8.64	88.1	1.35
2.92	5.02	6.39	8.65	88.2	1.34
2.93	5.04	6.40	8.67	88.3	1.33
2.94	5.05	6.41	8.68	88.4	1.31
2.95	5.06	6.42	8.69	88.5	1.30
2.96	5.07	6.43	8.70	88.6	1.29
2.97	5.08	6.45	8.72	88.7	1.27
2.98	5.09	6.46	8.73	88.8	1.26
2.99	5.10	6.47	8.74	88.9	1.25
3.00	5.11	6.48	8.75	89	1.24
3.01	5.13	6.49	8.77	89.1	1.22
3.02	5.14	6.50	8.78	89.2	1.21
3.03	5.15	6.52	8.79	89.3	1.20
3.04	5.16	6.53	8.80	89.4	1.19
3.05	5.17	6.54	8.82	89.5	1.17
3.06	5.18	6.55	8.83	89.6	1.16
3.07	5.19	6.56	8.84	89.7	1.15
3.08	5.20	6.58	8.85	89.8	1.14
3.09	5.22	6.59	8.87	89.9	1.12
3.10	5.23	6.60	8.88	90	1.11
3.11	5.24	6.61	8.89	90.1	1.10
3.12	5.25	6.62	8.90	90.2	1.09
3.13	5.26	6.63	8.92	90.3	1.07
3.14	5.27	6.65	8.93	90.4	1.06
3.15	5.28	6.66	8.94	90.5	1.05
3.16	5.29	6.67	8.95	90.6	1.04
3.17	5.31	6.68	8.97	90.7	1.03
3.18	5.32	6.69	8.98	90.8	1.01
3.19	5.33	6.71	8.99	90.9	1.00
3.20	5.34	6.72	9.00	91	0.99
3.21	5.35	6.73	9.02	91.1	0.98
3.22	5.36	6.74	9.03	91.2	0.96
3.23	5.37	6.75	9.04	91.3	0.95
3.24	5.38	6.76	9.05	91.4	0.94
3.25	5.40	6.78	9.06	91.5	0.93
3.26	5.41	6.79	9.08	91.6	0.92
3.27	5.42	6.80	9.09	91.7	0.91
3.28	5.43	6.81	9.10	91.8	0.89
3.29	5.44	6.82	9.11	91.9	0.88
3.30	5.45	6.84	9.13	92	0.87
3.31	5.46	6.85	9.14	92.1	0.86
3.32	5.48	6.86	9.15	92.2	0.85
3.33	5.49	6.87	9.16	92.3	0.83
3.34	5.50	6.88	9.18	92.4	0.82
3.35	5.51	6.89	9.19	92.5	0.81
3.36	5.52	6.91	9.20	92.6	0.80
3.37	5.53	6.92	9.21	92.7	0.79
3.38	5.54	6.93	9.23	92.8	0.78
3.39	5.56	6.94	9.24	92.9	0.76
3.40	5.57	6.95	9.25	93	0.75
3.42	5.58	6.97	9.26	93.1	0.74
3.43	5.59	6.98	9.27	93.2	0.73
3.44	5.60	6.99	9.29	93.3	0.72
3.45	5.61	7.00	9.30	93.4	0.71
3.46	5.63	7.01	9.31	93.5	0.70
3.47	5.64	7.03	9.32	93.6	0.68
3.48	5.65	7.04	9.34	93.7	0.67
3.49	5.66	7.05	9.35	93.8	0.66
3.50	5.67	7.06	9.36	93.9	0.65
3.51	5.68	7.07	9.37	94	0.64
3.52	5.69	7.09	9.38	94.1	0.63
3.53	5.71	7.10	9.40	94.2	0.62
3.54	5.72	7.11	9.41	94.3	0.60
3.55	5.73	7.12	9.42	94.4	0.59
3.56	5.74	7.13	9.43	94.5	0.58
3.58	5.75	7.14	9.45	94.6	0.57
3.59	5.76	7.16	9.46	94.7	0.56
3.60	5.78	7.17	9.47	94.8	0.55
3.61	5.79	7.18	9.48	94.9	0.54
3.62	5.80	7.19	9.49	95	0.53
3.63	5.81	7.20	9.51	95.1	0.52
3.64	5.82	7.22	9.52	95.2	0.50
3.65	5.83	7.23	9.53	95.3	0.49
3.66	5.85	7.24	9.54	95.4	0.48
3.67	5.86	7.25	9.56	95.5	0.47
3.68	5.87	7.26	9.57	95.6	0.46
3.70	5.88	7.28	9.58	95.7	0.45
3.71	5.89	7.29	9.59	95.8	0.44
3.72	5.90	7.30	9.60	95.9	0.43
3.73	5.92	7.31	9.62	96	0.42
3.74	5.93	7.32	9.63	96.1	0.41
3.75	5.94	7.34	9.64	96.2	0.40
3.76	5.95	7.35	9.65	96.3	0.38
3.77	5.96	7.36	9.67	96.4	0.37
3.78	5.97	7.37	9.68	96.5	0.36
3.80	5.99	7.38	9.69	96.6	0.35
3.81	6.00	7.39	9.70	96.7	0.34
3.82	6.01	7.41	9.71	96.8	0.33
3.83	6.02	7.42	9.73	96.9	0.32
3.84	6.03	7.43	9.74	97	0.31
3.85	6.05	7.44	9.75	97.1	0.30
3.86	6.06	7.45	9.76	97.2	0.29
3.87	6.07	7.47	9.77	97.3	0.28
3.89	6.08	7.48	9.79	97.4	0.27
3.90	6.09	7.49	9.80	97.5	0.26
3.91	6.10	7.50	9.81	97.6	0.25
3.92	6.12	7.51	9.82	97.7	0.24
3.93	6.13	7.53	9.83	97.8	0.22
3.94	6.14	7.54	9.85	97.9	0.21
3.95	6.15	7.55	9.86	98	0.20
3.97	6.16	7.56	9.87	98.1	0.19
3.98	6.18	7.57	9.88	98.2	0.18
3.99	6.19	7.59	9.90	98.3	0.17
4.00	6.20	7.60	9.91	98.4	0.16
4.01	6.21	7.61	9.92	98.5	0.15
4.02	6.22	7.62	9.93	98.6	0.14
4.04	6.23	7.63	9.94	98.7	0.13
4.05	6.25	7.65	9.96	98.8	0.12
4.06	6.26	7.66	9.97	98.9	0.11
4.07	6.27	7.67	9.98	99	0.10
4.08	6.28	7.68	9.99	99.1	0.09
4.09	6.29	7.69	10.00	99.2	0.08
4.11	6.31	7.71	10.02	99.3	0.07
4.12	6.32	7.72	10.03	99.4	0.06
4.13	6.33	7.73	10.04	99.5	0.05
4.14	6.34	7.74	10.05	99.6	0.04
4.15	6.35	7.75	10.06	99.7	0.03
4.17	6.37	7.77	10.08	99.8	0.02
4.18	6.38	7.78	10.09	99.9	0.01
4.19	6.39	7.79	10.10	100	0.00

Watershed Protection Area	Design Storm
General Stormwater Management Watershed Area	1.16
Savannah River Special Watershed Protection Area	1.16
Bacteria and Shellfish Special Watershed Protection Area	1.95

0%
100%

0%
80%

Appendix I: General Design Criteria and Guidelines

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I.1 Hydrology and Runoff Determination

I.1.1 Acceptable Hydrologic Methods and Models

The following are the acceptable methodologies and computer models for estimating runoff hydrographs before and after development. These methods are used to predict the runoff response from given rainfall information and site surface characteristic conditions. The design storm frequencies used in all of the hydrologic engineering calculations will be based on design storms required in this guidebook unless circumstances make consideration of another storm intensity criterion appropriate:

- Rational Method (limited to sites under 10 acres)
- Urban Hydrology for Small Watersheds TR-55 (TR-55)
- Storage-Indication Routing
- HEC-1, WinTR-55, TR-20, and SWMM Computer Models

These methods are given as valid in principle and are applicable to most stormwater management design situations in the Southern Lowcountry. Other methods may be used when the Southern Lowcountry reviewing authority approves their application.

Note: Of the above methods, TR-55 and SWMM allow for the easiest correlation of the benefits of retention BMPs used to meet the stormwater retention volume (SWRv) with peak flow detention requirements and are therefore strongly recommended.

The following conditions shall be assumed when developing predevelopment, pre-project, and post-development hydrology, as applicable:

- For new development sites the runoff conditions shall be computed independent of existing developed land uses and conditions and shall be based on "Meadow in good condition" or better, assuming good hydrologic conditions and land with grass cover (NEH, 2004).
- For infill and redevelopment sites the predeveloped condition is the condition at the time of project submittal.
- Post-development conditions shall be computed for future land use assuming good hydrologic and appropriate land use conditions. If an NRCS CN Method-based approach, such as TR-55, is used, this curve number (CN) may be reduced based upon the application of retention BMPs, as indicated in the General Retention Compliance Calculator (Appendix H). This CN reduction will reduce the required detention volume for a site, but it should not be used to reduce the size of conveyance infrastructure.
- The rainfall intensity - duration - frequency curve should be determined from the most recent version of the Hydrometeorological Design Studies Center's Precipitation Frequency Data Server (NOAA Atlas 14, Volume 2).
- Predevelopment Time of Concentration (Tc) shall be based on the sum total of computed or estimated overland flow time and travel in natural swales, streams, creeks and rivers, but never less than 6 minutes.
- Post-development Time of Concentration shall be based on the sum total of the inlet time and travel time in improved channels or storm drains but shall not be less than 6 minutes.
- Site drainage areas exceeding 10 acres that are heterogeneous with respect to land use, soils, RCN or Time of Concentration (Tc) shall require a separate hydrologic analysis for each sub-area.
- Hydrologic soil groups (HSGs) approved for use in the <local jurisdiction> are contained in the US Department of Agriculture Web Soil Survey. Where the HSG is not available through the Soil Survey due to the listed soil type being "Urban Soils" or similar, an HSG of C shall be used.

I.1.1.1 Urban Hydrology for Small Watersheds TR-55

Chapter 6 of Urban Hydrology for Small Watersheds TR-55, Storage Volume for Detention Basins, or TR-55 shortcut procedure, is based on average storage and routing effects for many structures and can be used for multistage outflow devices. Refer to TR-55 for more detailed discussions and limitations.

Information Needed
To calculate the required storage volume using TR-55, the predevelopment hydrology, along with the post-development hydrology for the 2, 10 and 25-year, 24-hour storm events are needed. The predevelopment hydrology is based on natural conditions (meadow) and will determine the site's predevelopment peak rate of discharge, or allowable release rate, *qo*.

The post-development hydrology may be determined using the reduced CNs calculated in the General Retention Compliance Calculator or more detailed routing calculations. This will determine the site's post-development peak rate of discharge, or inflow for the 2, 10 and 25-year, 24-hour storm events, and the site's post-developed runoff in inches. Note that this method does not require a hydrograph. Once the above parameters are known, the TR-55 Manual can be used to approximate the storage volume required for each design storm.

Procedure
1) Determine the peak development inflows, q_i, and the allowable release rates, q_O, from the hydrology for the appropriate design storm.

Using the ratio of the allowable release rate (q_O) to the peak developed inflow (q_i)—or q_O/q_i—for the design storms, use Figure 1 to obtain the ratio of storage volume (V_S) to runoff volume (V_R)—for Type III storms.

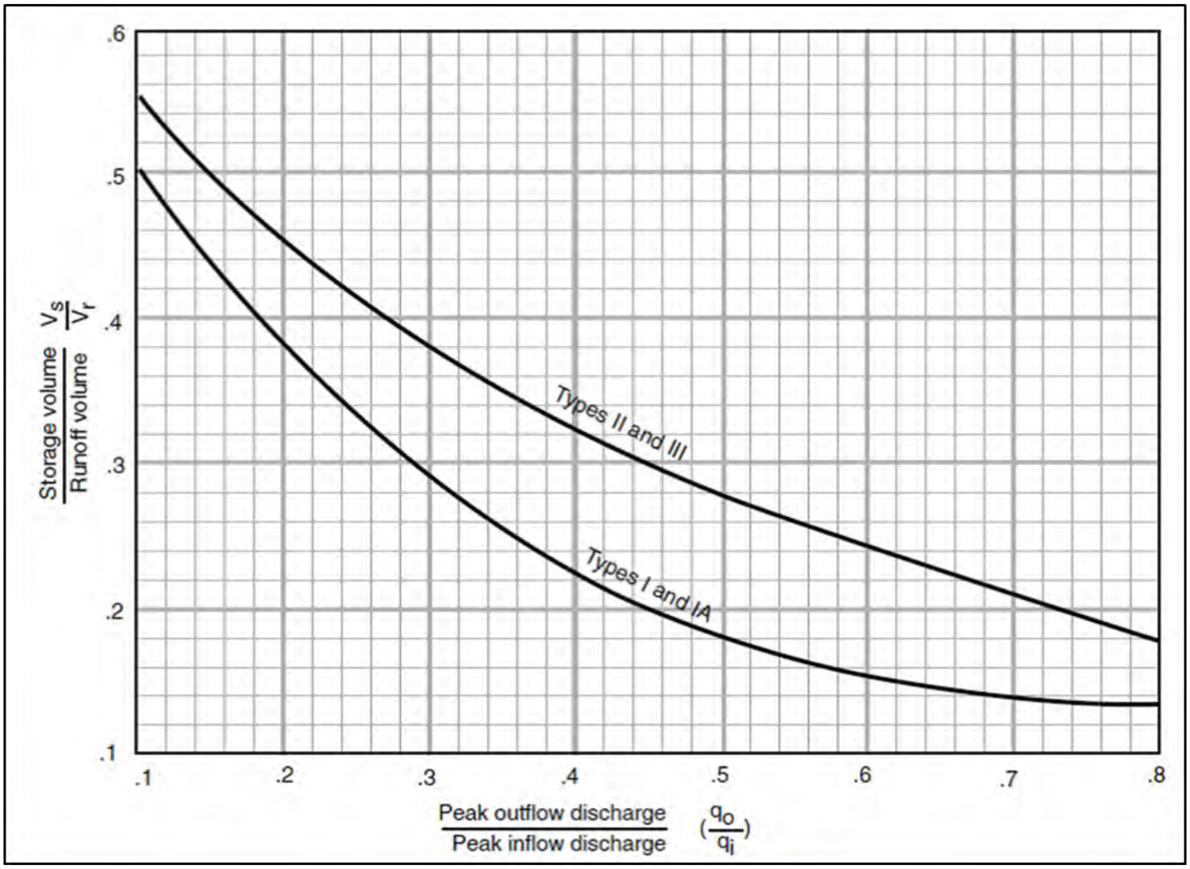

Figure 1. Approximate detention basin routing for rainfall Types I, IA, II, and III.

2) Determine the runoff volume V_R.

$$V_R = \frac{Q}{12} \times SDA$$

where:

V_R = post-development runoff for the design storm (ft^3)

Q = post-development runoff for the design storm (in)

12 = conversion factor (inches to feet)

SDA = site drainage area (ft^2)

3) Multiply the V_S/V_R ratios from Step 1 by the runoff volume (V_R) from Step 2 to determine the required storage volumes (V_S) in acre-feet.

$$\left(\frac{V_S}{V_R}\right) V_R = V_S$$

The design procedure presented above may be used with Urban Hydrology for Small Watersheds TR-55 Worksheet 6a. The worksheet includes an area to plot the stage-storage curve, from which actual elevations corresponding to the required storage volumes can be derived. The characteristics of the stage-storage curve are dependent upon the topography of the proposed storage practice and the outlet structure, and it may be best developed using a spreadsheet or appropriate hydraulics software.

Limitations
This routing method is less accurate as the q_O/q_i ratio approaches the limits shown in Figure 1. The curves in Figure 1 depend on the relationship between available storage, outflow device, inflow volume, and shape of the inflow hydrograph. When storage volume (V_S) required is small, the shape of the outflow hydrograph is sensitive to the rate of the inflow hydrograph. Conversely, when V_S is large, the inflow hydrograph shape has little effect on the outflow hydrograph. In such instances, the outflow hydrograph is controlled by the hydraulics of the outflow device and the procedure therefore yields consistent results. When the peak outflow discharge (q_O) approaches the peak inflow discharge (q_i) parameters that affect the rate of rise of a hydrograph, such as rainfall volume, CN, and Time of Concentration, become especially significant.

The procedure should not be used to perform final design if an error in storage of 25% cannot be tolerated. Figure 1 is biased to prevent under-sizing of outflow devices, but it may significantly overestimate the required storage capacity. More detailed hydrograph development and storage indication routing will often pay for itself through reduced construction costs.

I.1.1.2 Storage-Indication Routing

Storage-Indication Routing may be used to analyze storage detention practices. This approach requires that the inflow hydrograph be developed through one of the methods listed in this appendix (TR-55, WinTR-55, SWMM, etc.), as well as the required maximum outflow, q_o. Using the stage-discharge relationship for a given combination outlet devices, the detention volume necessary to achieve the maximum outflows can be determined.

I.1.1.3 HEC-1, WinTR-55, TR-20, ICPR and SWMM Computer Models

If the application of the above computer models is needed, the complete input data file and print-out will be submitted with the Stormwater Management Plans (SWMPs). Submission of SWMPs shall include the following computer model documentation:

- For all computer models, supporting computations prepared for the data input file shall be submitted with the SWMPs.
- Inflow-outflow hydrographs shall be computed for each design storm presented graphically and submitted for all plans.
- Schematic (node) diagrams must be provided for all routings.

I.1.2 Stormwater Volume Peak Discharge

The peak rate of discharge for individual design storms may be required for several different components of water quality BMP design. While the primary design and sizing factor for most stormwater retention BMPs is the design Stormwater Retention Volume (SWRv), several design elements will require a peak rate of discharge for specified design storms. The design and sizing of pretreatment cells, level spreaders, by-pass diversion structures, overflow riser structures, grass swales and water quality swale geometry, etc. all require a peak rate of discharge in order to ensure non-erosive conditions and flow capacity.

The peak rate of discharge from an SDA can be calculated from any one of several calculation methods discussed in this appendix. The two most commonly used methods of computing peak discharges for peak runoff calculations and drainage system design are NRCS TR-55 CN methods (NRCS TR-55, 1986) and the Rational Formula. The Rational Formula is limited to 10 acre drainage areas. It is highly sensitive to the Time of Concentration and rainfall intensity, and therefore should only be used with reliable Intensity-Duration-Frequency (IDF) curves or tables for the rainfall depth and region of interest (Claytor & Schueler, 1996).

The NRCS CN methods are very useful for characterizing complex sub-watersheds and SDAs and estimating the peak discharge from large storms (greater than 2 inches), but it can significantly underestimate the discharge from small storm events (Claytor and Schueler, 1996). Since the SWRv is based on smaller storm events, this underestimation of peak discharge can lead to undersized diversion and overflow structures, potentially bypassing a significant volume of the design SWRv around the retention practice. Undersized overflow structures and outlet channels can cause erosion of the BMP conveyance features that can lead to costly and frequent maintenance.

In order to maintain consistency and accuracy, the following Modified CN Method is recommended to calculate the peak discharge for the SWRv rain event. The method utilizes the Small Storm Hydrology Method (Pitt, 1994) and NRCS Graphical Peak Discharge Method (USDA, 1986) to provide an adjusted CN that is more reflective of the runoff volume from impervious areas within the SDA. The design rainfall is a NRCS Type III distribution, so the method incorporates the peak rainfall intensities common in the eastern United States, and the time of concentration is computed using the method outlined in TR-55.

The following steps describe how to calculate the SWRv peak rate of discharge (q_{pSWRv}) for the 85th percentile rain (1.16-inch) event.

1) **Calculate the adjusted CN for the site or contributing drainage area (CDA).**
The following equation is derived from the NRCS CN Method and is described in detail in the National Engineering Handbook Part 630 Chapter 10: Estimation of Direct Runoff from Storm Rainfall and NRCS TR-55 Chapter 2: Estimating Runoff:

$$CN = \frac{1{,}000}{10 + 5P + 10Q_a - 10(Q_a^2 + 1.25Q_aP)^{0.5}}$$

where:

CN = adjusted curve number

P = rainfall (in, 1.16 or 1.95 in)

Q_a = runoff volume (watershed inches), equal to SWRv/SDA

Note: When using hydraulic/hydrologic model for sizing a retention BMP or calculating the SWRv peak discharge, designers must use this modified CN for the CDA to generate runoff equal to the SWRv for the design rainfall event.

2) **Compute the site drainage area's time of concentration (*Tc*).**
TR-55 Chapter 3: Time of Concentration and Travel Time provides a detailed procedure for computing the Tc.

3) Calculate the stormwater retention volume peak discharge (q_{pSWRv}).
The q_{pSWRv} is computed using the following equation and the procedures outlined in TR-55, Chapter 4: Graphical Peak Discharge Method. Designers can also use WinTR-55 or an equivalent TR-55 spreadsheet to compute q_{pSWRv}:

- Read initial abstraction (I_a) from TR-55 Table 4.1 or calculate using I_a = 200/CN – 2
- Compute I_a/P (P = 1.16)
- Read the Unit Peak Discharge (q_u) from Exhibit 4-II using Tc and I_a/P
- Compute the q_{pSWRv} peak discharge:

$$qp_{SWRv} = q_u \times A \times Q_a$$

where:

q_{pSWRv} = stormwater retention volume peak discharge (ft^3/sec)
q_u = unit peak discharge (ft^3/sec/mi^2/in)
A = site drainage area (mi^2)
Q_a = runoff volume (watershed inches), equal to SWRv/SDA

This procedure is for computing the peak flow rate for the 85th and 95th percentile rainfall events. Calculations of peak discharge from larger storm events for the design of drainage systems, culverts, etc., should use published CNs and computational procedures.

I.2 Storm Sewer Collection System

I.2.1 Introduction

The focus of *the Southern Lowcountry Stormwater Design Manual* is to define standards and specifications for design, construction and maintenance of BMPs required to meet post construction stormwater performance objectives. Design of the conveyance of stormwater runoff within the public right-of-way (PROW) must follow the current requirements in SCDOT's Requirements for Hydraulic Studies, Part 2 Requirements for Roadway Drainage (SCDOT, 2009). These are incorporated by reference with the following notes pertinent to the *<local jurisdiction>*.

I.2.2 Clearance with Other Utilities

- All proposed and existing utilities crossing or parallel to designed storm sewer systems must be shown on the plan and profile.
- Storm drain and utility crossings must not have less than a 45-degree angle between them.
- Minimum vertical and horizontal clearances, wall to wall, must be provided between storm drainage lines and other utilities as defined by the Beaufort-Jasper Water & Sewer Authority.

I.2.3 Pipe Systems

- The pipe sizes used for any part of the storm drainage system within the PROW must be designed in accordance with the current requirements in SCDOT's Requirements for Hydraulic Studies, Part 2 Requirements for Roadway Drainage. (SCDOT, 2009)

- The material and installation of the storm drain for any part of public storm sewer must be designed in accordance with the current requirements in SCDOT's Requirements for Hydraulic Studies, Part 2 Requirements for Roadway Drainage (SCDOT, 2009). An exception to the SCDOT list is spiral ribbed aluminum pipe (SRAP), which is not an acceptable pipe material for brackish waters. Materials shall be RCP, CAAP, HDPE or HP Storm per AASHTO standards for H20/H25 loading and installation per ASTM/AASHTO standards. Durability must be 100 years or greater per SCDOT standards.
- An alternative overflow path for the 100-year storm is to be shown on the plan view if the path is not directly over the pipe. Where applicable, proposed grading must ensure that overflow will be into attenuation facilities designed to control the 100-year storm.
- A pipe schedule tabulating pipe length by diameter and class is to be included on the drawings. Public and private systems must be shown separately.
- Profiles of the proposed storm drains must be shown on the drawings and indicate size, type, and class of pipe, percent grade, existing ground and proposed ground over the proposed system, and invert elevations at both ends of each pipe run. Pipe elevations and grades must be set to avoid hydrostatic surcharge during design conditions. Where hydrostatic surcharge greater than 1-foot of head cannot be avoided, a rubber gasket pipe is to be specified.

I.2.4 Hydraulic Grade Line

The existing grade line and proposed 25- and 100-year hydraulic grade lines (HGL) must be clearly indicated on the system profiles and identified with the initials HGL on the line and identified in the legend key. This grade line must take into consideration pipe and channel friction losses, computing structures losses, tailwater conditions and entrance losses. All pipe systems must be designed so that they will operate without building up a surcharged hydrostatic head under design flow conditions. It is recommended that the HGL be no more than 1 foot above the pipe crown. If pipes have a HGL more than 1 foot above the pipe crown, rubber gaskets are required. The 100-year HGL must not overtop the 6" curb of ingress/egress routes that would isolate interior parcels in the extreme flood event.

If the structural stormwater BMP discharges into a storm sewer, a detailed HGL analysis of the system including the receiving system must be submitted with the final Stormwater Management Plans (SWMPs) for 100-year storm event. Provide documentation supporting safe passage of the 100-yr post-development flow downstream and an analysis of the surrounding neighborhood area to identify any existing capacity shortfalls or drainage blockages based on the 10% rule in Section 3.8.

I.3 Open Channels

- Calculations must be provided for all channels, streams, ditches, swales, etc., including a typical section of each reach and a plan view with reach locations. In the case of existing natural streams/swales, a field survey of the stream (swale) cross sections may be required prior to the final approval.
- The final designed channel must safely pass the 100-yr storm event.
- If the base flow exists for a long period of time or velocities are more than 5 feet per second in earth and sodded channel linings, gabion or riprap protection must be provided at the intersection of the inverts and side slopes of the channels unless it can be demonstrated that the final bank and vegetation are sufficiently erosion-resistant to withstand the designed flows, and the channel will stay within the floodplain easement throughout the project life.

- Channel inverts and tops of bank are to be shown in plan and profile views.
- For a designed channel, a cross section view of each configuration must be shown.
- For proposed channels, a final grading plan must be provided.
- The limits of a recorded 100-year floodplain easement or surface water easement sufficient to convey the 100-year flow must be shown.
- The minimum 25-foot horizontal clearance between a residential structure and 100-year floodplain must be indicated in the plan.
- For designed channels, transition at the entrance and outfall is to be clearly shown on the site plan and profile views.

I.4 References

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Virginia Department of Conservation and Recreation DRAFT 2009 Virginia Stormwater Management Handbook. September 2009.

Appendix J: Rainwater Harvesting Treatment and Management Requirements

This Appendix is provided as an example of requirements necessary for approval of use of reclaimed rainwater in non-potable water systems. It is not intended to regulate water retained by another BMP for use in irrigation and to meet stormwater retention volume requirements.

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J.1 Rainwater Harvesting Treatment and Management Requirements

J.1.1 Introduction

The majority of the information and requirements provided herein are excerpted from the 2017 Water Environment and Reuse Foundation Report: Risk-Based Framework for the Development of Public Health Guidance for Decentralized Non-Potable Water Systems (DNWS Report), and much of the text is directly quoted. In some cases, text from this report has been modified to conform to the Stormwater Design Manual and <*local jurisdiction*> review and inspection procedures.

The purpose of this appendix is to provide information and guidance through a risk-based framework to help designers and <*local jurisdiction*> ensure that all rainwater harvesting systems are adequately protective of public health. This appendix identifies pathogen reduction targets that must be met and various treatment systems that can be used to meet the targets, as well as volatile organic compound (VOC) limits that must be achieved storage and distribution management considerations, operation and maintenance as well as long-term monitoring and reporting requirements are also discussed.

J.1.2 Pathogen Reduction Targets

Risk-based pathogen reduction targets have been developed based on analysis of potential human health risks associated with exposure to microbial hazards, and are based on a "10^{-4} Per Person per Year Benchmark." This means that the agreed-upon "tolerable" risk level is a probability of infection of 1 in 10,000 people per year. Pathogen reduction targets are expressed in terms of the 95th percentile Log_{10} Reduction Target (LRT). LRTs were developed for each source water and end use addressed in this appendix based on attaining the "tolerable" infection risk. If a system can maintain this level of treatment performance at all times, then the predicted probability of infection across the population will be less than the 1 in 10,000 benchmark for each pathogen 95% of the time.

The LRT for each non-potable use scenario is presented in Table 1 for healthy adults (values are based on the DNWS Report, although additional uses have been added). A rainwater harvesting system must maintain this level of treatment performance at all times for all three pathogen types: viruses, protozoa, and bacteria. When both general runoff and roof runoff (as defined below in Table 1) are combined, the reduction targets for general runoff shall apply. Similarly, when multiple uses are proposed, the highest reduction targets shall apply.

Table 1. Ninety-fifth percentile log10 pathogen reduction targets (LRT) to meet infection ppy benchmarks for healthy adults.

Water Source and Use	Log_{10} Reduction Targets for 10^{-4} Per Person Per Year Benchmarks		
	Enteric Viruses	Parasitic Protozoa	Enteric Bacteria
General Runoff[a]			
Cooling Towers[b]	–	–	–
Irrigation	5.0	4.5	4.0
Indoor Use	5.5	5.5	5.0
Roof Runoff[c]			
Cooling Towers[b]	–	–	–
Irrigation	N/A	Limited data available	3.5
Indoor Use	N/A	Limited data available	3.5

a. For the purposes of this appendix, general runoff means precipitation runoff from rain or snowmelt events that flows over land and/or impervious surfaces (e.g., streets, sidewalks, and parking lots). It also includes runoff from roofs or parking garages with frequent public access.

b. The pathogen risks associated with cooling towers and other uses in which there is no public exposure can be controlled by post-treatment management practices rather than initial treatment. The reason is that greater microbial risks from this use is likely to result from not controlling the growth of water-based pathogens (e.g., Legionella pneumophila, Pseudomonas aeruginosa, and non-tuberculous mycobacteria) that may proliferate in stagnant piped water. Management practices are discussed in Section J.1.7 Storage and Distribution Management Practices.

c. Roof runoff means precipitation from a rain event that is collected directly from a roof surface not subject to frequent public access.

The non-potable uses and LRTs included in Table 1 assume that human contact with the harvested water will be infrequent, and ingestion unintentional. Uses where frequent human contact with the harvested water is intended, like fountains or splash pads, will be considered similar to swimming pools, and must meet the standards defined by the *<local jurisdiction>*. The remaining sections in this appendix only cover non-potable uses with infrequent human contact. Treatment and monitoring procedures for frequent contact uses will be reviewed on a case-by-case basis.

Treatment Process

A well-established and accepted concept in modern drinking water and water reuse practices is to attribute the log10 reduction of pathogen groups to specific technologies that are operated within defined limits, coupled with appropriate control points to demonstrate the proper performance of the technology. This is referred to as the log10 reduction value (LRV) and can be compared directly to the LRTs described in Section J.1.2 above. Various treatment processes and treatment trains can be used to obtain the LRT for each pathogen for a given combination of source water and end use. Sections J.1.5 and J.1.6 discuss a range of treatment processes and provide LRVs for each process.

J.1.3 Filtration

The removal of particulate matter, including pathogens, by size exclusion is of interest because filters can serve as a barrier to pathogens in water. Filtration is especially important because pathogens can be shielded by or embedded in particulate matter, reducing the effectiveness of subsequent disinfection processes. Typical values for pathogen group log10 reduction by filtration processes are summarized in Table 2.

Table 2. Typical values for pathogen reduction using filtration processes.

Barrier	Typical Log_{10} Reduction Values		
	Virus	**Protozoa**	**Bacteria**
Slow sand filter	2	4	2
Dual media filter with coagulant	1	2	1
Cartridge/bag filter (5-10 microns)	0	0	0
Cartridge/bag filter (3 microns or less)	0	3	0
Cartridge/bag filter (1 micron)	0	4	0
Diatomaceous earth	1	4	2
Microfilter	1	6	6
Ultrafilter or Nanofilter	6	6	6
Reverse osmosis	6	6	6

J.1.4 Disinfection

Processes for pathogen inactivation include disinfection by chlorine, peracetic acid, ozone, ultraviolet (UV) radiation, advanced oxidation, and pasteurization. Particles in water can inhibit effective disinfection through shading (in the case of UV) and shielding embedded pathogens. Larger particles may require more time for a disinfecting agent to penetrate the particle and reach an embedded pathogen; therefore, for any disinfectant to be effective, particles larger than 10 microns must be removed.

Typical values for the inactivation of pathogens for disinfection processes in filtered water are given in Table *3*, Table 4, and

Table 5. These values serve as a guide to the relative effectiveness of different disinfection technologies and are not for a specific microorganism.

Table 3. Typical values for various levels of the inactivation of enteric virus in filtered secondary effluent with selected disinfection processes.

Disinfectant	**Unit**[b]	**Dose for Corresponding Log_{10} Reduction Value**			
		1 Log_{10}	**2 Log_{10}**	**3 Log_{10}**	**4 Log_{10}**
Free chlorine	mg•min/L	–	1.5–1.8	2.2–2.6	3.0–3.5
Chloramine[a]	mg•min/L	–	370–400	550–600	750–800
Peracetic acid	mg•min/L	NA	NA	NA	NA
Ozone	mg•min/L	–	0.25–0.30	0.35–0.45	0.50–0.60
Ultraviolet radiation	mJ/cm^2	50–60	90–110	140–150	180–200
Advanced oxidation	mJ/cm^2	10–20	50–60	70–80	110–130
Pasteurization (60°C)	Second	140	280	420	560
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log10 reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter					
c. mJ/cm2 = Millijoules per square centimeter.					

Table 4. Typical values for various levels of the inactivation of parasitic protozoa in filtered secondary effluent with selected disinfection processes.

Disinfectant	**Unit**[b]	**Dose for Corresponding Log_{10} Reduction Value**			
		1 Log_{10}	**2 Log_{10}**	**3 Log_{10}**	**4 Log_{10}**
Free chlorine	mg•min/L	2,000–2,600	NA	NA	NA
Chloramine[a]	mg•min/L	NA	NA	NA	NA
Peracetic acid	mg•min/L	NA	NA	NA	NA
Ozone	mg•min/L	4.0–4.5	8.0–8.5	12–13	NA
Ultraviolet radiation	mJ/cm^2	2–3	5–6	11–12	20–25
Advanced oxidation	mJ/cm^2	2–3	5–6	10–12	20–25
Pasteurization (60°C)	Second	30	60	90	120
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log10 reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter.					
c. mJ/cm2 = Millijoules per square centimeter.					

Table 5. Typical values for various levels of the inactivation of enteric bacteria in filtered secondary effluent with selected disinfection processes.

Disinfectant	Unit[b]	Dose for Corresponding Log_{10} Reduction Value			
		1 Log_{10}	2 Log_{10}	3 Log_{10}	4 Log_{10}
Free chlorine	mg•min/L	0.4–0.6	0.8–1.2	1.2–1.8	1.6–2.4
Chloramine[a]	mg•min/L	50–70	95–150	140–220	200–300
Peracetic acid	mg•min/L	10–25	40–60	75–125	150–200
Ozone	mg•min/L	0.005–0.01	0.01–0.02	0.02–0.03	0.03–0.04
Ultraviolet radiation	mJ/cm^2	10–15	20–30	30–45	40–60
Advanced oxidation	mJ/cm^2	4–6	6–8	8–10	10–12
Pasteurization (60°C)	Second	50	100	150	200
a. Due to interferences with chloro-organic compounds, when chloramine is used as a disinfectant, log10 reductions can only be used if the actual dosage of monochloramine is known, not just the amount of combined chlorine.					
b. mg•min/L = Milligram-minutes per liter.					
c. mJ/cm2 = Millijoules per square centimeter.					

J.1.5 Treatment Trains

Most non-potable water systems use a number of unit processes in series to accomplish treatment, known commonly as the “multiple barrier” approach. Multiple barriers are used to improve the reliability of a treatment approach through process redundancy, robustness, and resiliency. When multiple treatment barriers are used to achieve the pathogen LRT, the contribution from each barrier is cumulative; therefore, a reduction in performance by one process is mitigated by other processes in the treatment train.

In addition to these treatment barriers, operational and management barriers are used to ensure that systems are in place to respond to non-routine operation. Treatment barriers can be monitored using sensors and instrumentation for continuous process monitoring. An important ability is to take the treatment train offline automatically in the event of process malfunction.

If each barrier in a treatment train is independent, the LRVs for each process in the treatment train can be added together to obtain the overall treatment train LRV.

J.1.6 Volatile Organic Compounds

For rainwater harvesting systems that use general runoff from vehicular access areas as a source and will have some level of public exposure risk, the treated water must be tested for the presence of volatile organic compounds (VOCs); however, this does not apply when the water will be used for cooling towers or other “no public exposure” uses. The test must be performed by the system operator prior to commissioning of the system (see Commissioning) and prior to subsequent *<local jurisdiction>* maintenance inspections (see Operational Monitoring and Reporting). VOC levels must be below the maximums indicated in Table 6. If any VOC levels exceed these limits, the rainwater harvesting system must not be utilized until the problem is satisfactorily addressed, and a successful test has been performed. VOC limit exceedances may be addressed through source controls or through provision of additional treatment devices.

Table 6. Volatile organic compound maximum concentrations.

VOC	Maximum Concentration (mg/L)[a]
Benzene	0.1
Carbon Tetrachloride	0.5
1,2-Dichlorobenzene	5.4
1,4-Dichlorobenzene	5.4
1,1 Dichloroethane	14.4
1,2 Dichloroethane	0.1
1,1-Dichloroethylene	0.1
cis-1,2-Dichloroethylene	28.4
trans-1,2-Dichloroethylene	28.4
Dichloromethane	3.1
1,2-Dichloropropane	12.6
1,3-Dichloropropene	0.2
Ethylbenzene	15.6
Methyl-tert-butyl ether	5.2
Monochlorobenzene	1.7
Styrene	7.7
1,1,2,2-Tetrachloroethane	0.3
Tetrachloroethylene	6.1
Toluene	6.8
1,2,4-Trichlorobenzene	1.4
1,1,1-Trichloroethane	68.2
1,1,2-Trichloroethane	1.6
Trichloroethylene	4.8
Trichlorofluoromethane	201.1
1,1,2-Trichloro-1,2,2-Trifluoroethane	272.9
Vinyl Chloride	0.1
Xylenes	15.6

a. Values determined by the San Francisco Department of Public Health based on U.S. Occupational Safety and Health Administration Permissible Exposure Limits for 8-hour inhalation exposures to selected VOCs.

J.1.7 Storage and Distribution Management Practices

To achieve the desired objectives of public health protection, treated water must be properly stored and distributed to prevent compromising the quality of water after treatment. For example, opportunistic pathogens like Legionella could grow in the distribution system, sewage could contaminate treated water, or lead and copper (which cause toxicity) could leach from piping. Producing adequate quality non-potable water that meets all the pathogen control criteria set forth in this appendix is the first step in ensuring proper public health protection. The final step in quality control is to manage properly 1) storage and distribution systems and 2) the uses of non-potable water.

In rainwater harvesting systems, neither significant/routine ingestion nor direct contact with the treated water product is typically anticipated due to limited exposures to non-potable water. Nevertheless, the occurrence of aerosol inhalation and indirect contact requires the careful management of DNW system storage and distribution systems to control exposures to non-tuberculous mycobacterial and Legionella pathogens. For example, even clean drinking water may allow biofilm growth of Legionella (aerosol pathogen risk) if the water temperature is between 25°C and 45°C and stagnates, resulting in the presence of minimal residual chlorine.

A number of approaches are available to control microbial regrowth in distribution systems, each with varying benefits and drawbacks that depend on the characteristics and use of the system. Below are some recommended approaches for controlling microbial growth in distribution systems:

- **Producing non-potable water low in carbonaceous material and nutrient content**
  The primary energy source for pathogen regrowth is organic carbon measured as assimilable organic carbon, biodegradable dissolved organic carbon, total organic carbon, and other essential nutrients, including nitrogen (N), phosphorous (P), and iron (Fe); therefore, the primary means to reduce the regrowth potential of pathogens is to provide highly treated water. Reducing the potential for regrowth is more important in large-scale buildings or neighborhood/district-scale projects where there will be more residence time (creating more opportunities for regrowth) in distribution systems that supply non-potable water.

- **Producing highly disinfected non-potable water**
  Low concentrations of microbes resulting from filtration and advanced means of disinfection have a reduced potential for regrowth if organic carbon levels are low. Otherwise, there may be a need for a residual disinfectant to manage growth in larger community systems that produce aerosols. Post-treatment disinfection with UV radiation is a recommended means of disinfection that does not increase levels of assimilable organic carbon or biodegradable dissolved organic carbon.

- **Using non-reactive, biologically stable materials of construction**
  Avoid the use of corrosive materials or organic materials that tend to protect microorganisms from disinfection and enhance the regrowth environment by the adsorption of organic compounds.

- **Maintaining a residual disinfectant**
  Different disinfectants offer advantages and disadvantages to overall water quality and system management. In general, a higher disinfectant residual provides lower regrowth. Many design and operation considerations are available for each specific system. It is recommended that a free chlorine residual of 0.2 milligrams per liter (mg/L) or monochloramine residual of 2 to 3 mg/L be maintained at or near the point of use to control microbial growth. Chloramine provides a better residual duration as compared to chlorine. Various combinations of UV,

chlorine, chloramine, ozone, and hydrogen peroxide are beneficial for specific disinfection goals. Periodic shock treatments with disinfectants and continuous disinfection looping of reservoirs help reduce the potential for regrowth and manage issues with biofilms. Stagnation resulting from dead zones or prolonged periods of zero-flow or low flow that create long residence times and allow disinfectants to dissipate and sediments to deposit result in improved conditions for regrowth and should be avoided.

- **Cleaning storage tanks**
  The required frequency of storage tank cleaning varies depending upon the quality of water stored, detention time in storage, temperature of the water, and nature of the tank. Tanks that are open to the atmosphere require more frequent cleaning.
- **Flushing the distribution system**
  The required frequency of distribution system flushing varies depending upon the quality of water transmitted, detention time in the distribution system, temperature of the water, and nature of the distribution system components. Periodic flushing is a good means of both removing sediments and scouring pipe walls. System design must include means for easily flushing pipes as part of routine maintenance.
- **Controlling temperature**
  Avoid the storage and distribution of non-potable water within 20°C to 45°C to reduce the potential for pathogen regrowth. Otherwise, consider a disinfection residual or point-of-use system, particularly if aerosols are generated.

The rainwater harvesting system designer and Person Responsible for Maintenance each should review published guidelines for the management of Legionella in distribution systems and implement as appropriate for each specific system. In particular, ANSI/ASHRAE Standard 188-2015 Legionellosis: Risk Management for Building Water Systems (2015) provides guidance on stormwater best management practices (BMPs) for both potable and non-potable water systems. It addresses management program responsibilities, system design, risk analysis, control mechanisms, monitoring, confirmation, and documentation. Although the ASHRAE Standard targets legionellosis, its rationales and approaches are applicable to all pathogens and health risks identified in this appendix.

J.1.8 Commissioning

In the process of initializing a rainwater harvesting system, the system must be evaluated for leaks in the storage unit and the performance of the components of the treatment and distribution system. A commissioning report of the evaluation is required at the initial startup of the system and anytime the system is brought back online after cleaning, flushing, and/or a hiatus of use (e.g., winter shutdown).

J.1.9 Operational Monitoring and Reporting

The Person Responsible for Maintenance, as identified in the Stormwater Management Plan (SWMP), must maintain the rainwater harvesting system in good working condition and assure adequate treatment of the harvested rainwater. All systems, with the exception of those installed in single-family homes, shall include continuous monitoring systems that are capable of determining if the rainwater harvesting system is operating within the design specification, and if all system components of the rainwater harvesting system are functional.

Data logs from continuous monitoring systems must be kept on file and produced upon request from *<local jurisdiction>*. In addition, annual reports must be generated that identify the following:

- Significant maintenance activities;
- Treatment modifications;
- Outages and malfunctions (including reasons and durations); and
- Steps taken to mitigate or eliminate recurrence of outages and malfunctions.

If there is a change of personnel—Person Responsible for Maintenance—it is the responsibility, within 15 business days, of the owner of the rainwater harvesting system or her/his agent to update the *<local jurisdiction>* with the name and contact information of the new personnel.

An operation and maintenance manual that includes a schematic drawing of the system, standard operating procedures for the system, and maintenance schedule(s), as well as commissioning reports, field verification reports, and annual reports must be on site and produced upon request from *<local jurisdiction>*.

J.1.10 Field Verification

Field verification is a performance confirmation of a rainwater harvesting system. It can be accomplished by physically observing the collection, storage, and distribution system, and the treatment process components. It can also be conducted using challenge testing, including surrogate microorganisms and/or other non-biological surrogates and typically involves manual collection of water samples for microbial analysis to check system performance in achieving LRTs. While not specifically required, *<local jurisdiction>* construction or maintenance inspections may include field verification testing to ensure that the rainwater harvesting system is achieving its LRTs, and that operational monitoring and control systems are functional.

J.1.11 Design Report

A design report must be submitted with each rainwater harvesting system that includes, at a minimum, the following:

- Pathogen $\log_{10}$ reduction target
- Proposed treatment process and associated $\log_{10}$ reduction value
- Proposed storage and distribution management practices
- Identification of the Person Responsible for Maintenance
    - Operation and Maintenance Manual
- Reliability analysis that identifies the following:
    - How the equipment used to monitor treatment, operations, and water quality enables determination of whether the system is working as planned.
    - How the monitoring and controls of the system will enable the operator or automatic controls to intervene in the event of the production of off-specification water.
    - Remedies and provisions for operation disruption (e.g., power failures, vandalism, and excessive source contamination)
    - Unauthorized access limitations for the rainwater harvesting and distribution system.

J.1.12 Treatment Design Examples

Example 1: Rooftop Runoff for Landscape Irrigation

1) **Identify the $\log_{10}$ reduction targets for the reference pathogen groups.**
Since the roof will not allow frequent public access, the water source qualifies as roof runoff rather than general runoff. No LRT is provided for enteric bacteria or parasitic protozoa, but an LRT of 3.5 is defined for enteric bacteria.

2) **Select a treatment process to achieve the $\log_{10}$ reduction target.**
An ozone system with a CT value (the product of concentration and contact time) of 0.04 mg • min/L can achieve 4-$\log_{10}$ reduction of enteric bacteria. However, as all disinfection processes require removal of particles 10 microns or larger, a 10-micron cartridge filter or similar device will also be necessary (see Figure 1).

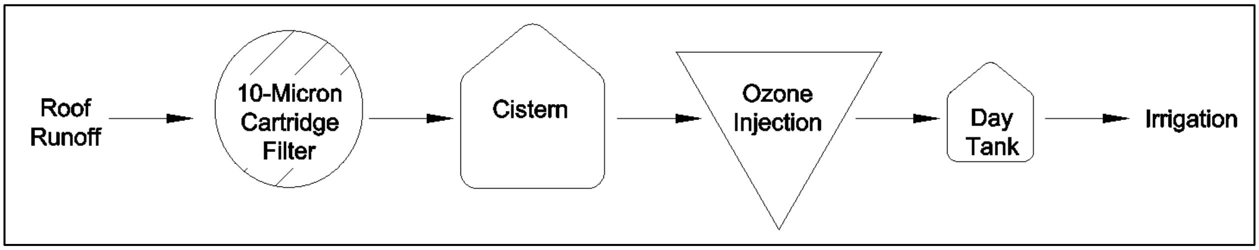

Figure 1. Example 1 treatment schematic.

Alternative treatment trains that also could meet the required LRT include the following:

- Microfiltration (i.e., 6-$\log_{10}$ reduction of bacteria).
- Sand filter with an equivalent effluent particle size distribution of 10 microns, followed by UV radiation with a dose of 40 to 60 mJ/cm2 (i.e., 4-$\log_{10}$ inactivation of bacteria).
- Cartridge filtration (10 microns), followed by chlorination with free chlorine with a CT value of 1.6 to 2.4 mg•min/L (i.e., 4-$\log_{10}$ inactivation of bacteria).

3) **Determine storage and distribution management practices.**
For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

- Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
- If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.

4) **Identify maintenance and monitoring requirements and schedule of activities.**
These will vary based on the specific equipment and devices included in each design.

5) **Submit design report and SWMP.**

Example 2: General Runoff for Indoor Use

1) **Identify the log_{10} reduction targets for the reference pathogen groups.**
The proposed rainwater harvesting system will capture runoff from two different areas on a rooftop. The first area will have no public access, but the second area includes a patio area that is designed for public access. The combined water from the two areas is therefore considered "general runoff," and will need to be treated accordingly. The LRT for both enteric viruses and protozoa is 5.5, and the LRT for enteric bacteria is 5.0.

2) **Select a treatment process to achieve the log_{10} reduction target.**
An ultrafiltration system can achieve 6-log_{10} reduction of viruses, protozoa, and bacteria (see Figure 2).

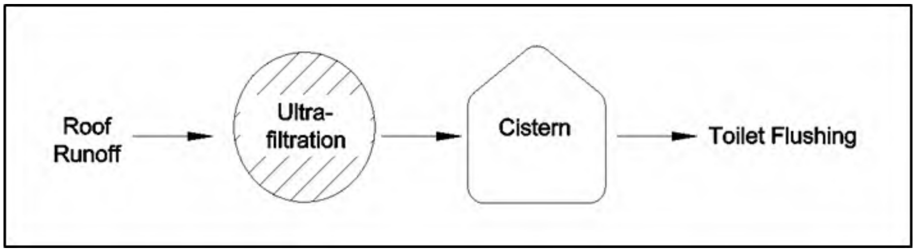

Figure 2. Example 2 treatment schematic.

The only alternative processes that can also meet the required LRTs are nanofiltration and reverse osmosis.

3) **Determine storage and distribution management practices.**
For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:

- Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
- If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.

4) **Identify maintenance and monitoring requirements and schedule of activities.**
These will vary based on the specific equipment and devices included in each design.

5) **Submit design report and SWMP.**

Example 3: Roof Runoff for Cooling Towers

1) **Identify the $\log_{10}$ reduction targets for the reference pathogen groups.**
   As there is not public exposure to the harvested rainwater, there are not initial treatment requirements. Chlorination may still be required to control the growth of opportunistic pathogens however (see Step 2).
2) **Determine storage and distribution management practices.**
   For non-potable water systems, consider the chemical characteristics of roof runoff and storage conditions, as follows:
   - Due to its high purity, roof runoff may result in the corrosion of components and fixtures of the metallic distribution system. If any metallic pipe, fittings, solder, or fixtures are used that may be subject to corrosion from contact with aggressive water, then modify the water system or add a corrosion inhibitor to the non-potable water supply.
   - If the temperature of water in the non-potable water distribution system exceeds 25°C (which is a condition that could promote the growth of opportunistic pathogens like Legionella), then maintain a free chlorine residual of 0.2 milligrams per liter (mg/L) or chloramine residual of 0.5 mg/L at or near the point of use.
3) **Identify maintenance and monitoring requirements and schedule of activities.**
   These will vary based on the specific equipment and devices included in each design.
4) **Submit design report and SWMP.**

J.2 Rainwater Harvesting Storage Volume Calculator Instructions

Input Sheet

The cells of the spreadsheet are color coded as follows:

Color Code

(light orange)	Title/New Category
(light green)	Required Entry value
(bright green)	Alternate Category Entry (if selected, do not enter value into "Required Entry value")
(yellow)	Final Category Value

Design Storm (inches)	
Cell L4	Choose either 1.16 inches or 1.95 inches depending on the Watershed Protection Area in which the project is located.
CONTRIBUTING DRAINAGE AREA (CDA)	
Cell L7, L9, L11	Indicate the impervious CDA, the turf cover CDA, and the runoff coefficient (Rv) for the turf cover. The turf cover Rv should range between 0.15 and 0.25. The CDA is assumed to convey 95 percent of the rainfall that lands on its impervious surface and 15 - 25 percent of the rainfall that lands on its turf cover area.

CONTRIBUTING BMPS	
Cell L17	Enter the retention volume as well as the overflow from the Design Storm for any BMPs that drain to the cistern. Both of these values can be found in the SoLoCo Compliance Calculator. The retention volume is in the "Volume Credited" column, and the overflow volume is in the "Remaining Volume" column.
The following instructions identify how the collected rainwater will be used. Only fill in the sections that are applicable to the site.	
IRRIGATION	
Cells L23, L25	Indicate the area to be irrigated in square feet and if the irrigation system as smart controls.
Row A31-L31	The spreadsheet allows for irrigation to be used in certain months. Indicate, for each month, the average weekly irrigation application rate in either inches per week or gallons per month.
	The EPA WaterSense Water Budget Tool can be used to calculate Monthly Landscape Water Requirement (based on the site's peak watering month). The output for this calculation is found on the Part 2-LWA sheet, which can be found at the following link: https://www.epa.gov/watersense/water-budget-tool
INDOOR DEMAND - FLUSHING TOILETS/URINALS	
Cell L35	Indicate the number of people using the building.
Cells L35, L37	The values in **lines 35 and 37** can be altered depending on how much water is used when flushing urinals or toilets. The default values are 0.80 gallons/flush and 1.60 gallons/flush for urinals and toilets, respectively.
Cell L39	If the user knows the daily toilet and urinal demand, that value can be input into **line 39** and the information in the rows above will not be used.
Cells L44, L46, L48	Indicate the first and last day of the week that the building will be in use and the number of hours each day the building will be occupied.
INDOOR DEMAND - LAUNDRY	
Cell L54	Indicate the number of loads of laundry done each day.
Cell L54	The value in **line 54** can be altered depending on how much water is used for each load of laundry. The default value is 42 gallons per load.
Cell L56	If the user knows the daily laundry demand, the value can be input into **line 56** and the information in the rows above will not be used.
Cells L60, L62	Indicate the first and last day of the week when the water will be used.
ADDITIONAL DAILY USE	
Row A71-L71	If there is any other additional daily use not covered in the spreadsheet, **line 69** can accommodate additional demand. Indicate, for each month, the average daily demand in gallons per day.
Cells L73, L75	Indicate the first and last day of the week when the water will be used.

COOLING TOWERS	
Row A79-L79	If the rainwater collected is to be used for cooling towers, indicate in **line 79** the average daily demand in gallons per day for each month the cooling towers use the collected rainwater.
The following section allows for additional contribution to the cistern from sources other than rainwater.	
CONTRIBUTION FROM OTHER SOURCES	
Row A88-L88	If there are other sources of water that contribute to the cistern, indicate the average daily contribution in gallons per day for each month
Cells L90, L92	Indicate the first and last day of the week when the water will be input.
FIRST FLUSH FILTER DIVERSION AND EFFICIENCY	
This section accounts for the filter efficiency of the cistern. It is assumed that, after the first flush diversion and loss of water due to filter inefficiencies, the remainder of the SWRv storm will be successfully captured. These minimum values can be altered if appropriate.	
Cell L98	**Line 98** indicates that for the 1.16-inch storm, a minimum of 95 percent of the runoff should be conveyed into the cistern.
Cell L100	**Line 100** indicates that for the 4.19-inch storm, a minimum of 90 percent of the runoff should be conveyed.

Storage Volume Results Sheets

These sheets give a range of possible cistern sizes and the corresponding storage volume available. Once a cistern size is chosen, the corresponding storage volume may be used in the Stormwater Database.

The table on this sheet has the following information.

- **Cistern Volume** (gallons) – This row gives a range of cistern sizes in gallons based on the CDA size.

- **Daily Average Available Storage Volume** (gallons or cubic feet) – This row shows the average available storage capacity of a given cistern (Sv). Use the Sv that corresponds to the cistern size selected for the site for the General Retention Calculator.

- **Overflow Volume (Sv)** (gallons or cubic feet) – This row shows the average overflow created by a 1.7" storm for various cistern sizes, based on average available storage volumes.

The graph shows a trade-off curve, which allows for a comparison of the retention achieved versus cistern size. While larger cisterns yield more retention, they are more costly. The curve helps the user to choose the appropriate cistern size, based on the design objectives and site needs. The overflow volume is also plotted to illustrate the effects of cistern size on overflow volume.

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Southern Low Country -- RAINWATER HARVESTING S

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of the spreadsheet are color coded as follows:

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Title/New Category

Required Entry value

Alternate Category Entry (if selected, do not enter value into "Required Entry value")

Final Category Value

torm (inches)

Choose either 1.16 inches or 1.95 inches depending on the Watershed Protection Area in which the project is located.

IBUTING DRAINAGE AREA (CDA)

Indicate the impervious CDA, the turf cover CDA, and the runoff coefficient (Rv) for the turf cover. The turf cover Rv should range between 0.15 and 0.25. The CDA is assumed to convey 95 percent of the rainfall that lands on its impervious surface and 15 - 25 percent of the rainfall that lands on its turf cover

IBUTING BMPS

Enter the retention volume as well as the overflow from the Design Storm for any BMPs that drain to the cistern. Both of these values can be found in the SoLoCo Compliance Calculator. The retention volume is in the "Volume Credited" column, and the overflow volume is in the "Remaining Volume" column.

owing instructions identify how the collected rainwater will be used. Only fill in the sections that are

TION

Indicate the area to be irrigated in square feet and if the irrigation system as smart controls.

The spreadsheet allows for irrigation to be used in certain months. Indicate, for each month, the average weekely irrigation application rate in either inches per week or gallons per month.
The EPA WaterSense Water Budget Tool can be used to calculate Monthly Landscape Water Requirement (based on the site's peak watering month). The output for this calculation is found on the
https://www.epa.gov/watersense/water-budget-tool

R DEMAND - FLUSHING TOILETS/URINALS

Indicate the number of people using the building.
The values in **lines 35 and 37** can be altered depending on how much water is used when flushing urinals or toilets. The default values are 0.80 gallons/flush and 1.60 gallons/flush for urinals and toilets,
If the user knows the daily toilet and urinal demand, that value can be input into **line 39** and the information in the rows above will not be used.
Indicate the first and last day of the week that the building will be in use and the number of hours each

R DEMAND - LAUNDRY

Indicate the number of loads of laundry done each day.
The value in **line 54** can be altered depending on how much water is used for each load of laundry. The default value is 42 gallons per load.
If the user knows the daily laundry demand, the value can be input into **line 56** and the information in the
Indicate the first and last day of the week when the water will be used.

ONAL DAILY USE

If there is any other additional daily use not covered in the spreadsheet, **line 69** can accommodate additional demand. Indicate, for each month, the average daily demand in gallons per day.
Indicate the first and last day of the week when the water will be used.

NG TOWERS

If the rainwater collected is to be used for cooling towers, indicate in **line 79** the average daily demand in gallons per day for each month the cooling towers use the collected rainwater.

wing section allows for additional contribution to the cistern from sources other than rainwater.

IBUTION FROM OTHER SOURCES

If there are other sources of water that contribute to the cistern, indicate the average daily contribution in
Indicate the first and last day of the week when the water will be input.

LUSH FILTER DIVERSION AND EFFICIENCY

ion accounts for the filter efficiency of the cistern. It is assumed that, after the first flush diversion of water due to filter inefficiencies, the remainder of the SWRv storm will be successfully captured. inimum values can be altered if appropriate.

Line 96 indicates that for the 1.16-inch storm, a minimum of 95 percent of the runoff should be conveyed
Line 98 indicates that for the 4.19-inch storm, a minimum of 90 percent of the runoff should be conveyed.

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AGE VOLUME CALCULATOR v1, March 17, 2020

Volume Results Sheets

ets give a range of possible cistern sizes and the corresponding storage volume available. Once a cistern ›sen, the corresponding storage volume may be used in the Stormwater Database.

on this sheet has the following information.

- **Cistern Volume** (gallons) – This row gives a range of cistern sizes in gallons based on the CDA size.
- **Daily Average Available Storage Volume** (gallons or cubic feet) – This row shows the average available storage capacity of a given cistern (Sv). Use the Sv that corresponds to the cistern size selected for the site for the General Retention Calculator.
- **Overflow Volume (Sv)** (gallons or cubic feet) – This row shows the average overflow created by a 1.7" storm for various cistern sizes, based on average available storage volumes.

ι shows a trade-off curve, which allows for a comparison of the retention achieved versus cistern size. ger cisterns yield more retention, they are more costly. The curve helps the user to choose the appropriate ιe, based on the design objectives and site needs. The overflow volume is also plotted to illustrate the cistern size on overflow volume.

e to the site.

Southern Low Country -- RAINWATER HARVI

Input

Design Storm

Design Storm (inches)

CONTRIBUTING DRAINAGE AREA (CDA)

What is the area of impervious cover in the CDA (SF)?

What is the area of compacted cover in the CDA (SF)?

What is the Runoff Coefficient (Rv) of the compacted cover?

CONTRIBUTING BMPS

Retention Volume for the Up

Overflow volume from Design Storm

IRRIGATION

How big is the area to irrigate? (SF)

Does the irrigation system have smart controls (e.g. soil moisture sensor shutoff)?

Enter monthly irrigation needs for site. Select units (Inches

If using EPA WaterSense Water Budget Tool (link below), select Gall

https://www.epa.gov/watersense/water-budget-tool

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug

0.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00

INDOOR DEMAND - FLUSHING TOILETS/URINALS

Toilet and urinal use (if only toilets are used, set urinals = 0)

How many people will use the building? (# people)

How much water will each urinal use? (gallons/flush) Set to 0, if no urinal.

How much water will each toilet use? (gallons/flush)

Calculated daily toilet and urinal demand. (gallons/day)

Use this cell if value has already been calculated, instead of the rows above.

Select the first day of the week this water will typically be used (e.g. Monday).

Select the last day of the week this water will typically be used (e.g. Friday).

Hours per day the building is used (e.g. 8 for a 9-5 office building; 24 for a shift-

Total daily toilet and urinal demand (gallons/day).

INDOOR DEMAND - LAUNDRY

Laundry use (use either loads per day, pounds per day or calculated demand

How many loads of laundry are done each day? (# loads/day)

How much water does each load of laundry use in gallons? (gallons/load)

Calculated daily laundry demand. (gallons/day)

Select the first day of the week this water will typically be used (e.g. Monday).

Select the last day of the week this water will typically be used (e.g. Friday).

Total daily laundry demand. (gallons/day)

ADDITIONAL DAILY USE

Additional daily use (bus wash, street sweepers, etc)

This value is user defined and is provided to allow for any other demand value.

Enter the average daily demand for each month throughout the year. (gallons/day

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
0	0	0	0	0	0	0	0

Select the first day of the week this water will typically be used (e.g. Monday).

Select the last day of the week this water will typically be used (e.g. Friday).

COOLING TOWERS

If water is to be used for cooling towers (for large scale projects)

Enter the average daily demand for each month throughout the year. (gallons/day

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
0	0	0	0	0	0	0	0

CONTRIBUTION FROM OTHER SOURCES

If any other sources will contribute water to the cistern, add them here (e.g.

This value is user defined and will be treated as a negative daily demand.

Enter the average daily demand for each month throughout the year. (gallons/day

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
0	0	0	0	0	0	0	0

Select the first day of the week this water will typically be input (e.g. Monday).

Select the last day of the week this water will typically be input (e.g. Friday).

FIRST FLUSH FILTER DIVERSION AND EFFICIENCY

Enter Approximate Filter Efficiencies associated with the 1.16" and 4.19" storms

Minimum values are 95% and 90%, respectively. See Specification for additiona

Filter Efficiency Associated with the 1.16" storm (%)

Filter Efficiency Associated with the 4.19" storm (%)

Disclaimer: By using this spreadsheet, the User understands and accepts that the accuracy of results pr
the responsibility of the User to verify results and to use professional judgement in its application.

ESTING STORAGE VOLUME CALCULATO

Color Code

1.16

Total CDA (SF) 0

ıstream BMP(s) (cubic feet)

from BMP(s) (cubic feet)

? If no, leave unchecked. ☐ Yes

s/Week or Gallons/Month) Inches/Week
.ons/Month.

Sept	Oct	Nov	Dec

1.00	0.00	0.00	0.00

0.80

1.60

0

work factory).

0.0

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42

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Sept	Oct	Nov	Dec
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R v1, March 17, 2020

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ntry value")

Do Not Delete

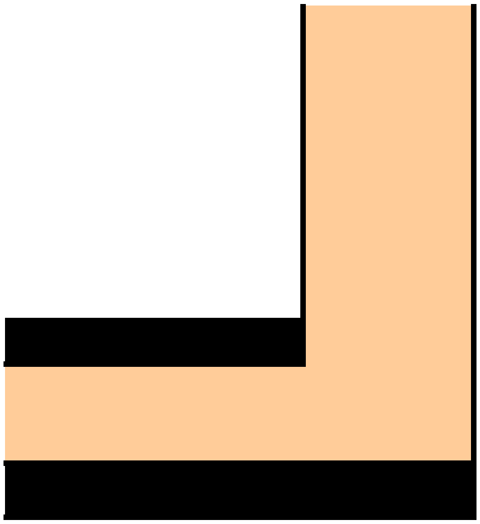
Yes

No

Do Not delete

Inches/Week

Gallons/Month



Assigning Numeric Code for Day of Week

Category	Read from inut	
Indoor Flushing Toilets		
Start Day Numeric Code	0	
Final Day Numberic Code		0

Indoor Laundry

Start Day Numeric Code	0
Final Day Numberic Code	0

Additional Daily Use

Start Day Numeric Code	0
Final Day Numberic Code	0

Contribution from other sources

Start Day Numeric Code	0
Final Day Numberic Code	0

Smart Irrigation?	FALSE
Inches/Week	0

Numeric Code					0
			Monday	1	1
9	9		Tuesday	2	2
9	9		Wednesday	3	3
			Thursday	4	4

		Friday	5	5
		Saturday	6	6
9	**9**	Sunday	7	7
9	**9**			8
				9
				10
				11
9	**9**			12
9	**9**			13
				14
				15
9	**9**			16
9	**9**			17
				18
				19
				20
				21
				22
				23
				24

1.2 inch rain	1.2
1.7 inch rain	1.7
3.2 inch rain	3.2

Storage Volume Summary

Average Daily Available Storage Volume by Month and Cistern Volume

Month\ Cistern Volume (gallons)	500	1,000	1,500	2,000	2,500
January	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
February	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
March	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
April	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
May	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
June	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
July	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
August	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
September	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
October	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
November	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
December	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Daily Average Available Storage Volume, *Sv* (cubic feet)	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**

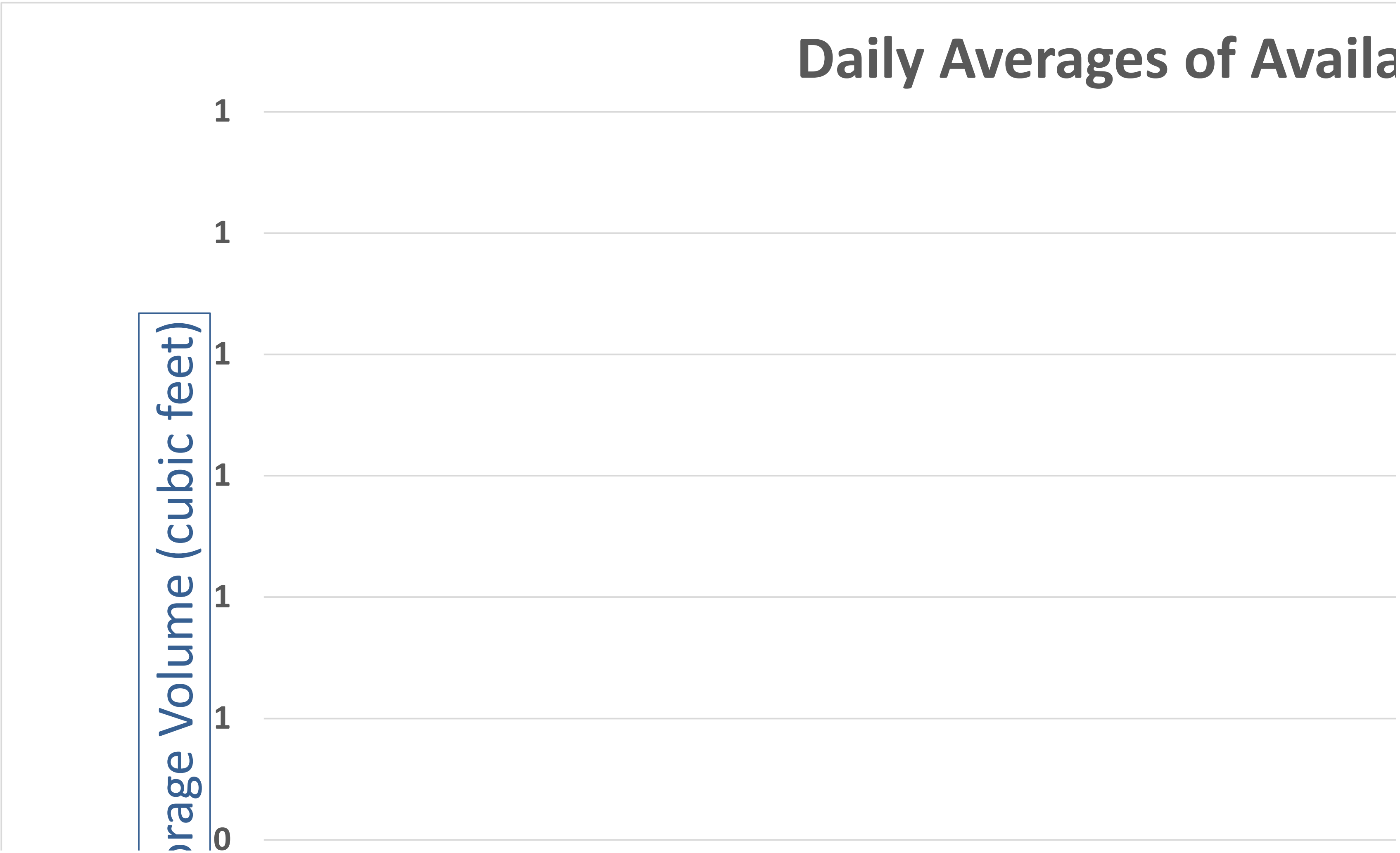
Note: Cistern Volume does not include detention for large

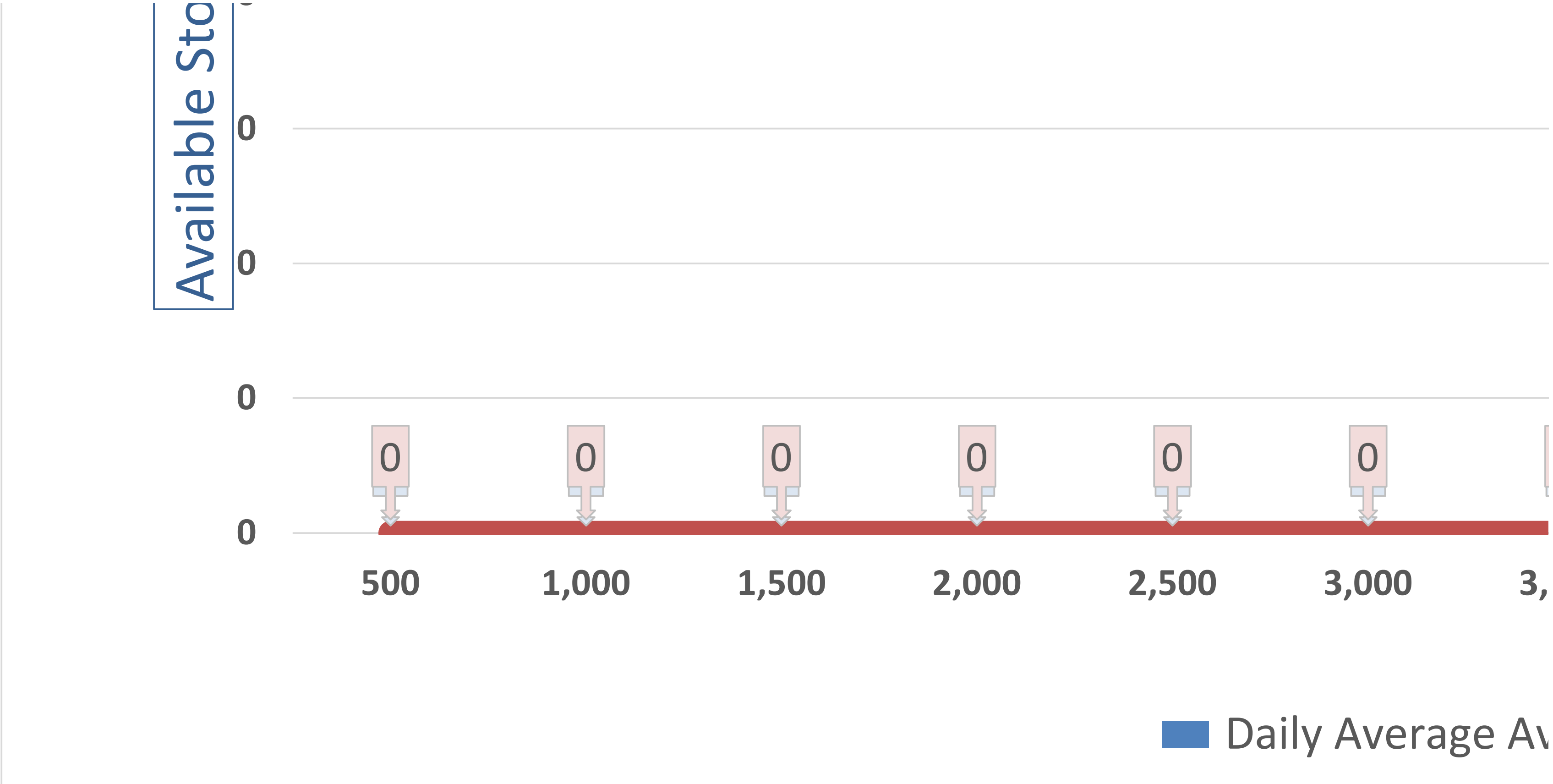
Detention volume that will be drawn down after each storm

Overflow Volume from a 1.16-Inch Rain Event by Cistern Volume

Cistern Volume (Gallons)	500	1,000	1,500	2,000	2,500

Overflow Volume (cubic feet)	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

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r storm events.

n event should be modeled separately.

3,000	3,500	4,000	4,500	5,000	5,500	6,000	6,500	7,000

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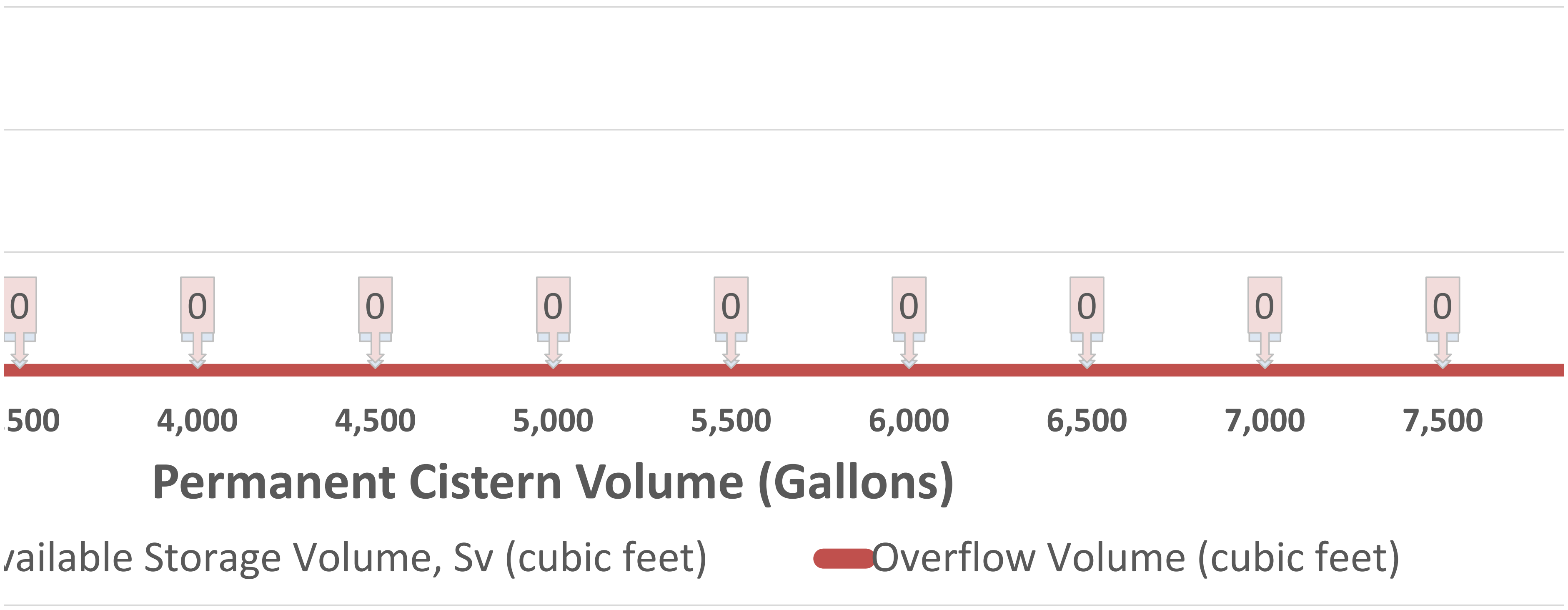
ıble Storage (Sv) and Overflow Volumes for Various Cistern Si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6,500
7,000
7,500
Permanent Cistern Volume (Gallons)
vailable Storage Volume, Sv (cubic feet)
Overflow Volume (cubic feet)

7,500	8,000	8,500	9,000	9,500
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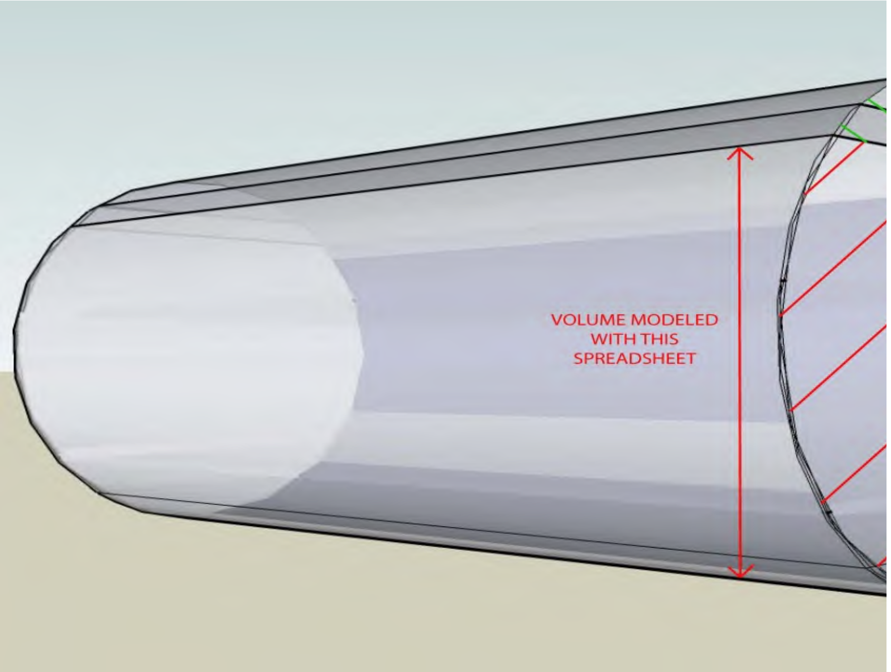

7,500	8,000	8,500	9,000	9,500

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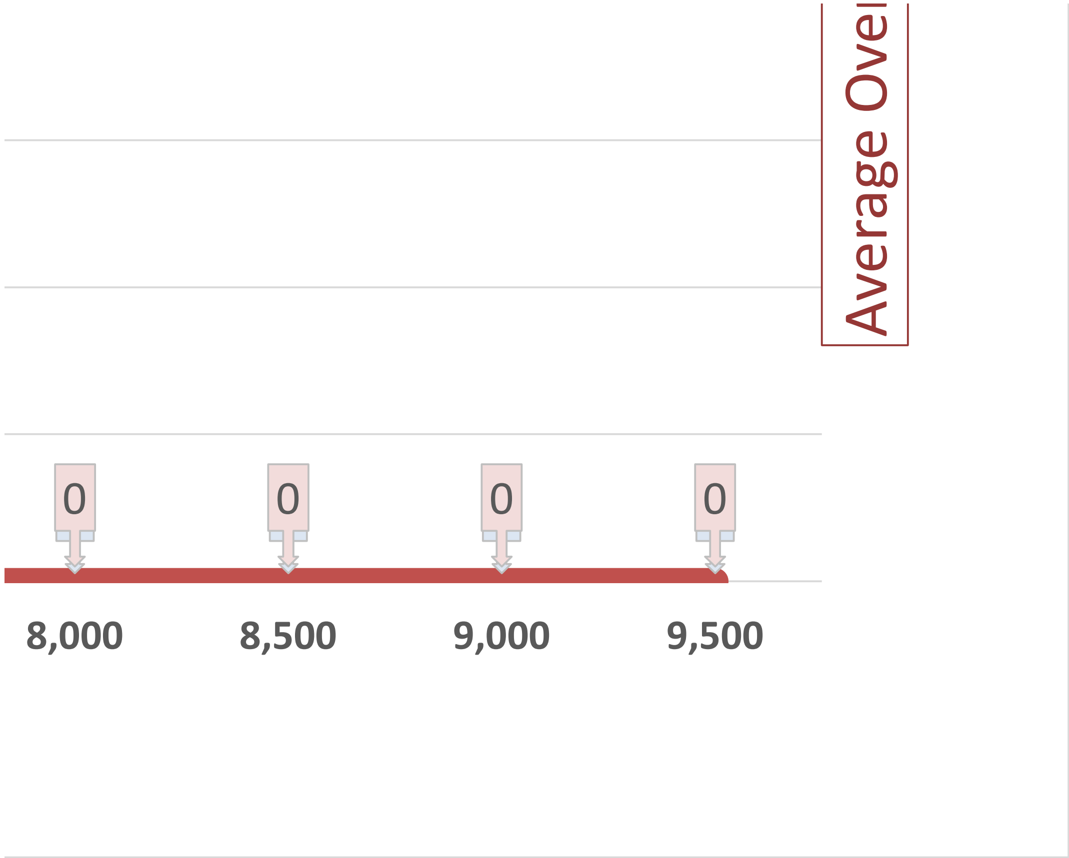
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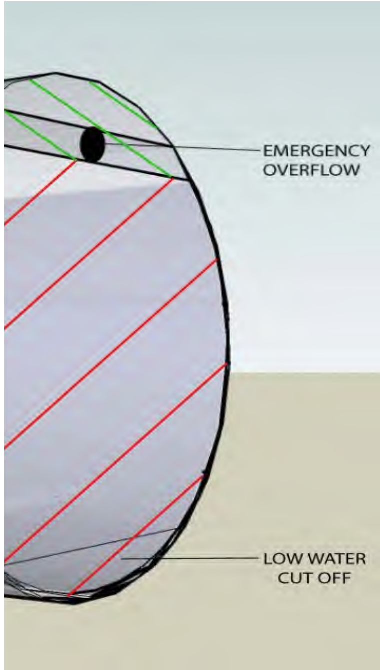
EMERGENCY
OVERFLOW
LOW WATER
CUT OFF

a

Appendix L: Glossary

A	
Advanced Design (AD)	Detailed design for an area of a project described explicitly in the following: • Stage II planned unit development (PUD) application to the District of Columbia Zoning Commission; • Application for design review under the Capitol Gateway Overlay District to the District Zoning Commission; and • Final design submission to the National Capital Planning Commission (NCPC)
Affordable housing	A single-family or two-family house that is built to be offered for rent or for sale for residential occupancy below market value and is made available to, and affordable to, a household whose income is equal to, or less than, eighty percent (80%) of the Area Median Income calculation provided by the United States Department of Housing and Urban Development
Animal confinement area	An area, including a structure, used to stable, kennel, enclose, or otherwise confine animals, not including confinement of a domestic animal on a residential property
Applicant	A person or their agent who applies for approval pursuant to this chapter
As-built plan	A set of architectural, engineering, or site drawings, sometimes including specifications that certify, describe, delineate, or present details of a completed construction project
Athletic playing fields	Compacted land cover and synthetic surfaces that are constructed primarily for use for athletic activities at public parks and schools. Compacted land cover and synthetic surfaces for which athletic activities are not the primary use are not considered athletic playing fields, unless these areas are necessary to support use of an adjacent area that is primarily used for athletic activities. Synthetic surfaces must have a minimum surface permeability of at least 10 inches per hour, in accordance with ASTM F2898 Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method
B	
Best management practice (BMP)	Structural or nonstructural practice that minimizes the impact of stormwater runoff on receiving waterbodies and other environmental resources, especially by reducing runoff volume and the pollutant loads carried in that runoff
Buffer	An area along a stream, river, or other natural feature that provides protection for that feature
Building permit	Authorization for construction activity issued by the <*local jurisdiction*>
C	

Clearing	The removal of trees and brush from the land excluding the ordinary mowing of grass, pruning of trees or other forms of long-term landscape maintenance
Combined sewer overflow (CSO)	The discharge of untreated effluent into a water body as a result of the combined volume of stormwater and sanitary water exceeding the capacity of the combined sewer system and wastewater treatment plant
Combined sewer system (CSS)	Sewer system in which stormwater runoff is conveyed together with sanitary wastewater through sewer lines to a wastewater treatment plant
Common plan of development	Multiple, separate, and distinct land-disturbing, substantial improvement, or other construction activities taking place under, or to further, a single, larger plan, although they may be taking place at different times on different schedules
Compacted cover	An area of land that is functionally permeable, but where permeability is impeded by increased soil bulk density as compared to natural cover, such as through grading, construction, or other activity and will require regular human inputs such as periodic planting, irrigation, mowing, or fertilization. Examples include landscaped planting beds, lawns, or managed turf
Conservation area	An area with a natural cover designation set aside to receive stormwater runoff as part of an impervious surface disconnection practice
Construction	Activity conducted for the following: • Building, renovating, modifying, or razing a structure; or • Moving or shaping of earth, sediment, or a natural or built feature
Contributing drainage area (CDA)	Area contributing runoff to a BMP
Control measure	Technique, method, device, or material used to prevent, reduce, or limit discharge
Critical area stabilization	Stabilization of areas highly susceptible to erosion, including down-slopes and side-slopes, through the use of brick bats, straw, erosion control blanket mats, gabions, vegetation, and other control measures
Cut	An act by which soil or rock is dug into, quarried, uncovered, removed, displaced, or relocated and the conditions resulting from those actions
D	
Demolition	The removal of part or all of a building, structure, or built land cover
Detention	Controlling the peak discharge rate of stormwater from a site
Dewatering	Removing water from an area or the environment using an approved technology or method, such as pumping
Director	The local administrator of the stormwater construction permits.
E	

Easement	A right acquired by a person to use another person's land for a special purpose
Electronic media	Means of communication via electronic equipment, including the internet
Energy Grade Line	The energy grade line represents the total energy at any point along the culvert (pipe) barrel.
Erosion	The process by which the ground surface, including soil and deposited material, is worn away by the action of wind, water, ice, or gravity
Excavation	An act by which soil or rock is cut into, dug, quarried, uncovered, removed, displaced or relocated and the conditions resulting from those actions
Exposed area	Land that has been disturbed or land over which unstabilized soil or other erodible material is placed
F	
G	
Grading	Causing disturbance of the earth, including excavating, filling, stockpiling of earth materials, grubbing, root mat or topsoil disturbance, or any combination of them
H	
Hydraulic Grade Line	The hydraulic grade line is the depth to which water would rise in vertical tubes connected to the side of the culvert (pipe) barrel.
I	
Impervious cover	A surface area that has been compacted or covered with a layer of material that impedes or prevents the infiltration of water into the ground, examples include conventional streets, parking lots, rooftops, sidewalks, pathways with compacted sub-base, and any concrete, asphalt, or compacted gravel surface and other similar surface
Infiltration	The passage or movement of surface water through the soil profile
J	
K	
L	
Land cover	Surface of land that is impervious, compacted, or natural
Land cover change	Conversion of land cover from one type to another, typically in order to comply with a requirement of this chapter.
Land-disturbing activity	Movement of earth, land, or sediment that disturbs the land surface and the related use of pervious land to support that movement. Land-disturbing activity includes stripping, grading, grubbing, trenching, excavating, transporting, and filling of land, as well as the use of pervious adjacent land for movement and storage of construction vehicles and materials. Land-disturbing activity does not include repaving or re-milling that does not expose the underlying soil

Low impact development (LID)	A land-planning and engineering-design approach to manage stormwater runoff within a development footprint. It emphasizes conservation, the use of on-site natural features, and structural stormwater BMPs to store, infiltrate, evapotranspire, retain, and detain rainfall as close to its source as possible with the goal of mimicking the runoff characteristics of natural cover
M	
Maintenance agreement	See Section 5.5.2 Maintenance Agreement
Maintenance contract	See "maintenance agreement"
Maintenance responsibility	See Section 5.5.1 Maintenance Responsibility
Maintenance plan	Planned scheduled maintenance for the life of the BMP
Maintenance schedule	See "maintenance plan"
Maintenance standards	Detailed maintenance plan laid out in Exhibit C within declaration of covenants
Major land-disturbing activity	A distinct project or a part of a larger common plan of development that involves the creation, addition or replacement of 5000 square feet of impervious surface, or that involves one acre or greater of land disturbing activities. New development regardless of size, that is part of a larger common plan of development, even though multiple, separate and distinct land disturbing activities, may take place at different times and on different schedules. Multiple distinct areas that each disturb one acre of land, that are in separate, non-adjacent sites, and that are not part of a larger common plan of development do not constitute a major land-disturbing activity.
Major Substantial Improvement	a renovation or addition to a structure or existing property that meets both of the following cost and size thresholds: a) construction costs for the building renovation/addition are greater than or equal to 50% of the pre-project assessed value of the structure as developed using current Building Valuation Data of the International Code Council, and b) combined footprint of structure(s) exceeding the cost threshold and any land disturbance are greater than or equal to 5,000 square feet.
N	
Natural cover	Land area that is dominated by vegetation and does not require regular human inputs such as irrigation, mowing, or fertilization to persist in a healthy condition. Examples include forest, meadow, or pasture
Non-structural BMP	A land use, development, or management strategy to minimize the impact of stormwater runoff, including conservation of natural cover or disconnection of impervious surface
O	
Off-site retention	Use of property not within the limits of disturbance of the project to comply with the stormwater retention volumes required by this Manual

Off-site retention volume (Off_V)	A portion of a required stormwater retention volume or required water quality treatment volume that is not retained on site
On-site retention	Retention of a site's stormwater on that site or via conveyance to a shared stormwater BMP on another site
On-site stormwater management	Retention, detention, or treatment of stormwater on site or via conveyance to a shared stormwater BMP
Owner	The person who owns real estate or other property, or that person's agent
P	
Peak discharge	The maximum rate of flow of water at a given point and time resulting from a storm event
Permeable athletic track	A surface, including a surface made of synthetic material, located at a school or public park that is used for athletic purposes including biking, running, and walking, and that allows the infiltration of water into the ground. The track must have a minimum surface permeability of at least 10 inches per hour, in accordance with the ASTM F2898 Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method
Permeable playground surface	A surface, including a surface made of synthetic material, located under a playground area at a school or public park, that allows the infiltration of water into the ground. The playground surface must have a minimum surface permeability of at least 10 inches per hour, in accordance with ASTM F2898 Standard Test Method for Permeability of Synthetic Turf Sports Field Base Stone and Surface System by Non-confined Area Flood Test Method
Person	A legal entity, including an individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, cooperative, the *<local authority>* and its agencies, the State of South Carolina and its agencies, and the federal government and its agencies
Pervious area	Area with a compacted cover designation set aside to receive stormwater runoff as part of an impervious surface disconnection practice
Post-development	Describing conditions that may be reasonably expected to exist after completion of land development activity on a site
Practice	A system, device, material, technique, process, or procedure that is used to control, reduce, or eliminate an impact from stormwater; except where the context indicates its more typical use as a term describing a custom, application, or usual way of doing something
Preconstruction meeting	The mandatory meeting occurring prior to any construction, including the owner, the designer, the installer, and the DHEC inspector. This meeting must contain an on-site component to evaluate the SWMP against existing site conditions. This should include, at a minimum, a visual examination of land cover types, the tree preservation plan, boundaries of the CDA(s), the existing inlet elevation(s) to ensure they conform to original design

Predevelopment	Describing conditions of meadow land and its relationship to stormwater before human disturbance of the land
Pre-project	Describing conditions, including land covers, on a site that exist before the construction described in a Stormwater Management Plan has begun
Publicly-owned or publicly-financed project	A project: a. That is municipally-owned or municipality-instrumentality-owned; b. Where at least 15% of the project's total cost is municipally-financed or municipality-instrumentality-financed; or c. That includes a gift, lease, or sale from municipally-owned or municipality-instrumentality-owned property to a private entity
Public right-of-way (PROW)	The surface, the air space above the surface (including air space immediately adjacent to a private structure located on public space or in a public right-of-way), and the area below the surface of any public street, bridge, tunnel, highway, railway track, lane, path, alley, sidewalk, or boulevard
Public space	All the publicly owned property between the property lines on a street, park, or other public property as such property lines are shown on the records of the State. This includes any roadway, tree space, sidewalk, or parking between such property lines, but it excludes adjacent parks and other public property that is not associated with the public right-of-way
Q	
R	
Raze	The complete removal of a building or other structure down to the ground or to its foundation
Responsible person	Construction personnel knowledgeable in the principles and practices of erosion and sediment control and certified by a Department-approved soil erosion and sedimentation control training program to assess conditions at the construction site that would impact the effectiveness of a soil-erosion or sediment-control measure on the site
Retention	Keeping a volume of stormwater runoff on site through infiltration, evapotranspiration, storage for non-potable use, or some combination of these
Retention capacity	The volume of stormwater that can be retained by a stormwater BMP or land cover
Retrofit	A stormwater BMP or land cover installed in a previously developed area to improve stormwater quality or reduce stormwater quantity relative to current conditions
Runoff	The portion of precipitation (including snow-melt) that travels over the land surface, and also from rooftops, either as sheetflow or as channel flow, in small trickles and streams, into the main water courses

S	
Savannah River Watershed Protection Area	
Sediment	Soil, including soil transported or deposited by human activity or the action of wind, water, ice, or gravity
Sedimentation	The deposition or transportation of soil or other surface materials from one place to another as a result of an erosion process
Shared BMP (S-BMP)	A stormwater BMP, or combination of BMPs, providing stormwater management for stormwater conveyed from another site or sites
Single- or two-family house	An individual house, townhouse, or rowhouse designed and used for occupancy by one or two families. An individual house, townhouse, or rowhouse that has been physically altered for use by more than one or two families is not considered a single- or two-family house
Site	A tract, lot or parcel of land, or a combination of tracts, lots, or parcels of land for which development is undertaken as part of a unit, sub-division, or project. The mere divestiture of ownership or control does not remove a property from inclusion in a site
Site drainage area (SDA)	The area that drains stormwater from the site to a single discharge point or sheet flows from a single area off the site
Soil	All earth material of whatever origin that overlies bedrock and may include the decomposed zone of bedrock that can be readily excavated by mechanical equipment
Soil erosion and sediment control plan	A set of drawings, calculations, specifications, details, and supporting documents related to minimizing or eliminating erosion and off-site sedimentation caused by stormwater on a construction site. It includes information on construction, installation, operation, and maintenance
Soils report	A geotechnical report addressing all soil erosion and sediment control-related soil attributes, including but not limited to site soil drainage and stability
Special watershed protection areas	Areas identified by US Geological Survey 12-digit Hydrologic Unit Code (HUC 12) in the Southern Low Country Stormwater Design Manual that require area-specific stormwater standards
Storm sewer	A system of pipes or other conduits that carries or stores intercepted surface runoff, street water, and other wash waters, or drainage, but excludes domestic sewage and industrial wastes
Stormwater	Flow of water that results from runoff, snow melt runoff, and surface runoff and drainage
Stormwater management	A system to control stormwater runoff with structural and non-structural stormwater BMPs, including the following: (a) quantitative control of volume and rate of surface runoff and (b) qualitative control to reduce or eliminate pollutants in runoff
Stormwater Management Plan (SWMP)	A set of drawings, calculations, specifications, details, and supporting documents related to the management of stormwater for a site. A SWMP includes information on construction, installation, operation, and maintenance

Stormwater Pollution Prevention Plan (SWPPP)	A document that identifies potential sources of stormwater pollution at a construction site, describes practices to reduce pollutants in stormwater discharge from the site, and may identify procedures to achieve compliance
Stormwater retention volume (SWRv)	Volume of stormwater from a site for which the site is required to achieve retention
Stripping	An activity that removes or significantly disturbs the vegetative surface cover including clearing, grubbing of stumps and rock mat, and top soil removal
Substantial improvement	A repair, alteration, addition, or improvement of a building or structure, the cost of which equals or exceeds 50% of the market value of the structure before the improvement or repair is started
Structural stormwater BMP	A practice engineered to minimize the impact of stormwater runoff, including a bioretention, green roof, permeable pavement, system to capture stormwater for non-potable uses, etc.
Supplemental review	A review that *<local jurisdiction>* conducts after the review it conducts for a first resubmission of a plan
Swale	A narrow low-lying stretch of land that gathers or carries surface water runoff
T	
Total suspended solids (TSS)	The entire amount of organic and inorganic particles dispersed in water. TSS is measured by several methods, which entail measuring the dry weight of sediment from a known volume of a subsample of the original
U	
V	
W	
Waste material	Construction debris, dredged spoils, solid waste, sewage, garbage, sludge, chemical wastes, biological materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt, and industrial or municipal waste
X	
Y	
Z	

Appendix M: References and Resources

M.1 References

The following documents provide more detailed information on many aspects of BMP design than is found in this Manual. These resources may be useful for those looking to develop greater understanding of individual BMPs or stormwater design in general. Recommendations in these resources may be used to inform BMP designs; however, where conflicts occur between these resources and the Manual, the requirements of the Manual prevail.

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M.2 Resources for Natural Resources Survey

Resource Group	Resource Type	Sources for Information
General Resources	•Topography •Natural Drainage Divides •Natural Drainage Patterns •Natural Drainage Features (e.g., Swales, Basins, Depressional Areas) •Soils •Erodible Soils Comes with soil survey •Steep Slopes (e.g., Areas with Slopes Greater	LiDAR: https://coast.noaa.gov/dataviewer/index.html#/lidar/search/ Major basin boundaries: https://apps.dhec.sc.gov/GIS/ClearingHouse/ Soils: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx Land Cover (NLCD): https://www.mrlc.gov/data Land Cover (NOAA C-CAP): https://coast.noaa.gov/digitalcoast/data/ccapregional.html

	Than 15%) Can determine from DEM or query soil types with steep slopes. Recommend the former for accuracy. • Trees and Other Existing Vegetation – Can use NLCD data to get forest land cover • Impervious surfaces • Protected Lands	County Level LIDAR http://www.dnr.sc.gov/GIS/lidarstatus.html NLCD impervious surface - https://www.mrlc.gov/data/type/urban-imperviousness Protected Lands (PAD-US) - LINK TNC
Freshwater Resources	• Rivers – NHD or state level data should be available • Perennial and Intermittent Streams – This distinction might not be available. • Freshwater Wetlands – National Wetland Inventory	NHD: https://www.usgs.gov/core-science-systems/ngp/national-hydrography Water classifications (view only): https://gis.dhec.sc.gov/watersheds/ NWI: https://www.fws.gov/wetlands/index.html
Estuarine Resources	• Tidal Rivers and Streams I think we can get all of this from NWI. Tidal influence might not be denoted. • Tidal Creeks • Coastal Marshlands • Tidal Flats • Scrub-Shrub Wetlands	NOAA C-CAP classification scheme includes palustrine forested wetland, palustrine scrub/shrub wetland, palustrine emergent wetland, estuarine forested wetland, estuarine scrub/shrub wetland, estuarine emergent wetland, palustrine aquatic bed, and estuarine aquatic bed County Level LIDAR Breaklines (with terrain dataset) http://www.dnr.sc.gov/GIS/lidarstatus.html
Marine Resources	• Near Coastal Waters • Beaches • Shoreline	NOAA C-CAP classification scheme includes unconsolidated shore DHEC OCRM - https://apps.dhec.sc.gov/GIS/ClearingHouse/ ←look under OCRM from drop down “List GIS Layers by DHEC…”

Groundwater Resources	•Groundwater Recharge Areas •Wellhead Protection Areas	https://scdhec.gov/environment/bureau-water/groundwater-use-reporting/groundwater-management-planning/groundwater-2 http://hydrology.dnr.sc.gov/well-database.html DHEC Watershed atlas - https://gis.dhec.sc.gov/watersheds/ Check under Public Water supply tab in layer contents for protection areas

Resource Group	Resource Type	Sources for Information
Terrestrial Resources	•Dunes •Maritime Forests •Marsh Hammocks •Evergreen Hammocks •Canebrakes •Bottomland Hardwood Forests •Beech-Magnolia Forests •Pine Flatwoods •Longleaf Pine-Wiregrass Savannas •Longleaf Pine-Scrub Oak Woodlands	• Forest inventory analysis (FIA). The SC Forestry Commission would have that data •Natural Communities of SC https://dc.statelibrary.sc.gov/handle/10827/30179
Other Resources	• Shellfish Harvesting Areas •Floodplains – FEMA data available nationally •Aquatic Buffers •Other High Priority Habitat Areas as described by South Carolina Department of Natural Resources	•FEMA: https://msc.fema.gov/portal/home •SCDHEC: https://apps.dhec.sc.gov/GIS/ClearingHouse/ •GAP/species richness/habitat/etc. data http://www.dnr.sc.gov/GIS/gap/mapping.html •Intertidal Oyster Reefs - http://www.dnr.sc.gov/GIS/descoysterbed.html •Shellfish harvesting areas - Link

Appendix N: Summary of Federal and State Stormwater Regulations

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N.1 Summary of Federal Regulations

In general, Federal regulations and legislation have been applied at the State level to regulate stormwater runoff quality, whereas for many years local stormwater ordinances and regulations focused on regulating drainage, streets, peak stormwater runoff flow and flooding concerns.

Federal regulations that directly affect stormwater runoff control include the Coastal Zone Management Act and the National Pollutant Discharge Elimination System (NPDES) stormwater regulations of the Clean Water Act, administered by the U.S. Environmental Protection Agency (EPA). The Coastal Zone Management Act was designed to encourage and assist coastal states to develop and implement management programs. The State of South Carolina developed its own Coastal Zone Management Act in 1977, to protect coastal resources and promote responsible development in Beaufort County and seven other coastal counties. This will be discussed further in the following section on State regulations. The EPA NPDES requirements are presented below.

The 1987 amendments to the Federal Clean Water Act define specific stormwater discharges as point source discharges subject to NPDES regulations. These amendments required EPA to promulgate regulations pertaining to stormwater discharges via a phased approach.

The initial phase, promulgated by EPA on November 16, 1990, became known as the Phase I Stormwater NPDES regulations. These final regulations created two broad classes of stormwater discharges under the NPDES program:

1) Municipal Separate Storm Sewer System (MS4) discharges; and
2) Stormwater Discharges Associated with Industrial Activity.

The MS4 Program was divided into three categories (large, medium, and small populations) based on U.S. Census Bureau population estimates, with Phase I regulations including only large and medium MS4 stormwater discharges.

The Stormwater Discharges Associated with Industrial Activity program was divided into 11 categories of industrial activity. These included industrial manufacturing facilities, landfills, transportation facilities, construction (land clearing on 5 or more acres), etc., without consideration given to the type of facility owner or operator such that a publicly owned or operated facility could be included in one of the 11 categories.

On December 8, 1999, EPA adopted the Phase II stormwater regulations, which included small MS4 discharges located in an "Urbanized Area" per U.S. Census Bureau definitions and delineations. In addition, the land disturbance activity regulation with the threshold of 5 or more acres (as per the construction activity regulation) was reduced to 1 or more acres, with a provision that construction sites that disturb less than 1 acre could also be regulated if water quality concerns or problems related to the activity warrant permit coverage under the NPDES Program.

The State of South Carolina has been an EPA NPDES Program delegated authority for a number of years. The State agency that administers the Federal NPDES Program in South Carolina is the Department of Health and Environmental Control (DHEC). As such, DHEC oversees all NPDES Program related permitting, monitoring, and enforcement issues in the State of South Carolina. However, EPA does have authority over DHEC on NPDES Program issues and may, at its discretion, conduct independent audits of a DHEC-issued NPDES permit.

N.1.1 MS4 Program

Phase I of the NPDES Stormwater Program required large MS4s (with populations of 250,000 people or greater) and medium MS4s (with populations of 100,000 people or greater but less than 250,000) to apply for permit coverage in two parts. All permits issued under this phase were individual permits and required the development and implementation of a stormwater management program. At a minimum, this program had to address the following key elements:

1) Structural control maintenance
2) Areas of significant development and redevelopment
3) Roadway runoff management
4) Flood control related to water quality issues
5) Municipally owned operations, including landfills, wastewater treatment facilities, etc.
6) Hazardous waste treatment, storage or disposal sites, etc.
7) Application of pesticides, herbicides, and fertilizers
8) Illicit discharge detection and elimination
9) Regulation of sites classified as associated with industrial activity
10) Construction site and post-construction site runoff control
11) Public education and outreach

As of July 2007, the State of South Carolina has one large MS4 (South Carolina Department of Transportation) and four medium MS4s – the City of Columbia, Greenville County, Lexington County, and Richland County.

As of July 2007, there is a list of 70 regulated small MS4s, which did not specifically include Beaufort County. In 2014 this list was increased, and additional communities were added, including Beaufort County. These small MS4s are required to begin running programs to address stormwater runoff from construction sites and post- construction activities. These activities are two of the six components of a stormwater management program as defined by the NPDES Phase II Final Rule, as listed below:

1) Public education and outreach.

2) Public participation/involvement.
3) Illicit discharge detection and elimination.
4) Construction site runoff control.
5) Post-construction runoff control.
6) Pollution prevention/good housekeeping.

Several of these items are addressed by this document and will fulfill part of the NPDES Phase II requirements.

N.1.2 Industrial Activity Program

The NPDES Phase I stormwater regulations created 11 categories of Stormwater Discharges Associated with Industrial Activity. Categories "i "through "ix" and category "xi" became part of the Industrial Program, while category "x" became part of the Construction Program. Thus, the NPDES stormwater program is made up of three distinct program components: the MS4 Program, the Industrial Program, and the Construction Program. Although the Phase I included a provision for a no-exposure permit exemption to category "xi" (light industry) only, the Phase II regulations extended this no-exposure exemption to categories "i" through "ix."

The no-exposure exemption applied to facilities that had no stormwater runoff exposed to raw materials, byproducts, waste products, intermediate products, final products, etc. Activities within the Industrial Program and the Construction Program can have NPDES stormwater permits issued as either individual permits or general permits; however, due to the nature and number of facilities that must be issued NPDES stormwater permits, general permits are typically utilized. On rare occasions, when water quality concerns become a permit issue, DHEC may require an individual permit in lieu of granting general permit coverage. The general permit under the Industrial Program requires the preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP) for each covered facility and requires monitoring and/or inspections. Although only certain facilities require both, inspections are required of all facilities.

Under the Construction Program, the construction activity category is divided into two phases, Phase I (for large construction sites) and Phase II (for small construction sites). On a case-by-case basis, a permit may also be required when a construction activity involves the disturbance of less than 1 acre of land. Stormwater discharges from construction activities that disturb less than 5 acres of land are called "small construction activities." A Construction Activity permit can either be issued in the form of a general permit or an individual permit. Typically, the general permit is utilized unless specific water quality issues warrant the use of an individual permit. The general permit requires that a SWPPP be prepared and implemented for each construction site, but sampling of stormwater runoff from the site is not required.

Inspections must be conducted at all construction sites covered under the general permit. In addition, a provision in the MS4 program regulations requires that all regulated MS4s implement a program for controlling construction site runoff. This provision essentially requires that the construction site must receive a permit from the regulated MS4 in addition to having to be covered under an NPDES Stormwater Construction Activity permit.

It is important to note that with the March 10, 2003 initiation of the NPDES Phase II Stormwater Program implementation, considerable overlap exists between the Federal NPDES Stormwater Program and the State of South Carolina's Sediment, Erosion, and Stormwater Management Program as discussed below.

N.2 Summary of State Regulations

In addition to being an EPA NPDES Program delegated authority, the State of South Carolina also has its own relevant regulations. The South Carolina's Sediment, Erosion, and Stormwater Management Program was initiated in 1983, and required construction activities on State-owned and State-managed lands to control sediment and erosion. In 1991, via the South Carolina Stormwater Management and Sediment Reduction Act, the program was expanded to include all construction activities that disturbed more than 2 acres of land. Regulation 72-300, entitled "Standards for Stormwater Management and Sediment Reduction," describes the requirements for preparing a stormwater management and sediment and erosion control plan from land disturbance activities. Exemptions, Waivers, and Variances from the Law are explained in Section 72-302. The Bureau of Water of the Office of Environmental Quality Control (EQC) of DHEC is responsible for administering the Sediment, Erosion, and Stormwater Management Program, and by regulation the Office of Ocean and Coastal Resource management (OCRM) implements the program in the eight coastal county areas. A local government may become a State-delegated authority after submitting a request and receiving approval by the State. However, Federal, State, local government, and public school projects must be submitted to DHEC even if they are located within the jurisdiction of a State-delegated entity.

As indicated previously, the Federal NPDES Stormwater Construction Activity Program requires permit coverage for construction sites that disturb more than 1 acre of land and, on a case-by-case basis, even less than 1 acre of land. Consequently, an overlap exists currently between the State's Sediment, Erosion, and Stormwater Management Program and the NPDES Stormwater Construction Activity Program (that is, when more than 2 acres of land are disturbed due to a construction activity, permits must be secured under both programs). The State coordinates the various aspects of the two programs (i.e., permitting, compliance, monitoring, and enforcement) to minimize the overlapping responsibilities. The two programs are integrated into a comprehensive Stormwater Regulatory Program for the State of South Carolina.

The *South Carolina Stormwater Management and Sediment Control Handbook for Land Disturbance Activities* (DHEC, 2003) includes all existing South Carolina stormwater management regulations required for individuals to submit a stormwater management and sediment reduction permit application to DHEC. Elements of the Federal NPDES Stormwater Program, Coastal Zone Management Program, and the State's Stormwater Management and Sediment Reduction regulations are included in the handbook.

Table 1 summarizes the State regulatory requirements that are applicable to Southern Lowcountry, including jurisdictions in the State of South Carolina's Coastal Zone Management Program. For land disturbance of 0.5 acre or less that is within 0.5 mile of a receiving waterbody in the coastal zone, Section R.72- 307H of the State Stormwater Management and Sediment Reduction Act of 1991 is applicable. Section R.72-307H is also applicable for land disturbance of less than 1 acre, at locations that are not within 0.5 mile of a coastal zone receiving water If the land disturbance is at least 1 acre, but less than 2 acres, the NPDES General Permit and Section R.72-307H apply. Development is highly impervious or is located directly adjacent to a critical area, the more stringent R.72-307I regulations are applicable; otherwise, the less stringent R.72-307H regulations are appropriate.

Table 1. South Carolina Requirements for Land Development in Southern Lowcountry.

Extent of Land Disturbance (acres)	Applicable Regulatory Requirements
Less than 0.5 acre and within 0.5 acre of receiving waters	R.72-307H
Less than 1 acre and not within 0.5 acre of receiving waters	R.72-307H
At least 1 but less than 2 acres	R.72-307H, SCR100000
More than 2 and less than 5 acres	R.72-307I, SCR100000
5 acres or more	R.72-305, R.72-307, SCR100000

Section R.72-307I regulations are also applicable for developments of more than 2 and less than 5 acres. For developments of 5 acres or more, the applicable regulations include Sections R.72-305 and R.72-307 of the Stormwater Management and Sediment Reduction Act of 1991, plus the NPDES General Permit.

Features of the regulations highlighted in Table 1 are presented in

Table *2*. The regulations under Section R.72-307H provide for a simplified stormwater management and sediment control plan that does not require approval by DHEC and does not require preparation or certification by a registered engineer, landscape architect or Tier B land surveyor (SCDHEC, 1997). However, DHEC staff does have the authority to conduct site inspections to ensure compliance with the submitted plan. Under Section R.72-307I, the stormwater management and sediment control plan must be approved by DHEC, and requires preparation and certification by a registered engineer, landscape architect or Tier B land surveyor. The plan must also include BMPs to control erosion and sediment, and measures to control peak discharge rates and peak velocities of stormwater runoff from the site.

Table 2. South Carolina Sediment, Erosion, and Stormwater Management Program Land Development Regulatory Requirement Details Applicable to Non-Coastal Counties.

Plan Feature	Applicable Regulation(s)		
	R.72-307H	R.72-307I	R.72-305, R.72-307, SCR100000
Plan Approval by Implementing Agency	Not required	Required	Required
Plan Preparation / Certification by Registered Professional Engineers / Landscape Architects / Land Surveyors	Not required	Required	Required
BMPs to Control Erosion and Sediment	Not required	Required	Required
Measures to Control Stormwater Quantity	Not required	Required[1]	Required[1]
Measures to Control Stormwater Quality	Not required	Not required	Required[2]

1. Stormwater quantity control requirements include:
   a. Post-development peak discharge rates shall not exceed pre-development discharge rates for the 2- and 10- year frequency, 24-hour duration storm events. Implementing agencies may utilize a less frequent storm event (e.g., 25-year, 24-hour storm) to address existing or future stormwater quantity or quality problems.
   b. Discharge velocities shall be reduced to provide a non-erosive velocity flow from a structure, channel, or other control measure or the velocity of the 10-year, 24-hour storm runoff in the receiving waterway prior to the land disturbance activity, whichever is greater.
   c. Watersheds other than "designated watersheds" that have well documented water quantity problems may have more stringent, or modified, design criteria determined by the local government that is responsive to the needs of that watershed.
2. See Table A-3 for a summary of stormwater quality requirements.

The State regulation requires that post-development peak flows shall not exceed the pre- development peak flow rate for the 2-year/24-hour and 10-year/24-hour design storms. Developments of 5 acres or more must meet all of the requirements listed above and must provide measures for stormwater quality control.

The current NPDES general permit SCR100000 (effective September 1, 2006) includes requirements for inspections on construction sites. Once construction begins, these inspections must be conducted at least once every 7 calendar days, or at least once every 14 calendar days and within 24 hours of the end of a storm event of 0.5 inches or greater. The inspections must be conducted by qualified personnel (as defined in the permit) and an inspection report must be completed for each inspection. The report must be retained for at least 3 years from the date that permit coverage expires or is terminated. For construction activities disturbing 10 acres or more, a monthly report must also be submitted to DHEC. Monthly reports may also be required on a case-by- case basis.

Stormwater runoff quality control measures required for developments of 5 acres or more are presented in Table 3. In general, the water quality storage requirements depend upon the type of BMP and, in some cases, the location of the development site.

Table 3. South Carolina Coastal Zone Management Program Stormwater Quality Bmp Requirements Beaufort County.

BMP Facility Type	Water Quality Volume Requirements		
	General	Within 0.5 Miles of a Receiving Waterbody in the Coastal Zone	Within 1,000 Ft of Shellfish Beds
Water quality facility with permanent pool of water (e.g., wet detention pond)	Permanent pool volume of 0.5 inches of runoff per acre of drainage; storage above permanent pool of 0.5 inches of runoff per acre of drainage, required to bleed down over a 24-hour period	Permanent pool volume of 0.5 inches of runoff per acre of drainage or 1.0 inches of runoff per impervious acre of drainage, whichever is greater; same general storage requirement above permanent pool	Permanent pool volume of 0.5 inches of runoff per acre of drainage or 1.5 inches of runoff per impervious acre of drainage, whichever is greater; same general storage requirement above permanent pool
Water quality facility without permanent pool of water (e.g., extended dry detention pond)	Storage of 1.0 inches of runoff from the entire drainage area, required to bleed down over a 24-hour period	General requirements apply	Not applicable
Infiltration practices	Storage of 1.0 inches of runoff per impervious acre of drainage, required to drain completely in 72 hours	General requirements apply	Storage of 1.5 inches of runoff per impervious acre of drainage, required to drain completely in 72 hours

The basic water quality volume requirements vary based on the type of BMP. A water quality facility with a permanent pool of water (e.g., a wet detention pond) has a required permanent pool volume equivalent to 0.5 inch of runoff per acre of drainage, as well as another 0.5 inch of storage above the permanent pool. The storage above the permanent pool is required to bleed down over a 24-hour period. In contrast, a water quality facility without a permanent pool of water (e.g., an extended dry detention pond) has a required water quality storage volume equivalent to 1.0 inch of runoff per acre of drainage, and this volume is required to bleed down over a 24-hour period. Infiltration facilities, which capture runoff and then release the captured runoff through evapotranspiration and infiltration into the underlying soil, are required to provide water quality storage equivalent to 1.0 inches of runoff per impervious acre of drainage.

Under existing State regulations, water quality control facilities with a permanent pool of water may have more stringent requirements if the development is within 0.5 mile of a receiving waterbody in the coastal zone. In this case, the required permanent pool volume is the greater of: (a) 0.5 inch of runoff from the entire drainage area, or (b) 1.0 inch of runoff per impervious acre of drainage. The latter condition will apply for commercial, industrial and high-density residential land uses with an imperviousness of more than 50 percent. There are no special requirements for infiltration facilities and facilities without a permanent pool of water.

Special considerations also apply when the development is within 1,000 ft of shellfish beds (determined from State mapping or by site inspection). In this case, the regulations require that 1.5 inches of runoff per impervious acre of drainage must be retained. Of the three BMP types discussed above, only infiltration facilities are designed to retain runoff (i.e., captured runoff is depleted by storage through evapotranspiration and infiltration into the underlying soil, rather than released to a drainage channel or waterbody). In contrast, facilities such as ponds are designed to detain runoff (i.e., captured runoff is detained for treatment and is then released to a drainage channel or waterbody).

Table 3 shows how the shellfish bed regulation has been interpreted for this report. The requirement for infiltration facilities is 1.5 inches per impervious acre of drainage, which is 50 percent greater than the general requirements. For facilities with a permanent pool, it was presumed that the requirement would be met by providing a permanent pool volume equivalent to 1.5 inches of runoff per impervious acre. For storms producing runoff of 1.5 inches or less, the runoff will be stored in the permanent pool and an equal volume of water will be displaced from the pool and discharged to a drainage channel or waterbody. The table provides no interpretation of the shellfish bed requirements for other facilities without a permanent pool. Such a facility would actually be operating as an infiltration facility.

As mentioned previously, DHEC administers the Federal NPDES Program on behalf of EPA; therefore, along with having jurisdiction over the NPDES Construction Program, DHEC also has jurisdiction over the NPDES Industrial Program. Under the latter program, the general permit (SCR000000) covers all categories of stormwater discharges associated with industrial activity, except the construction activity, which is covered under the Construction Program. SCR00000 requires the development of a SWPPP, which identifies potential sources of stormwater pollution and describes practices to be implemented for reducing stormwater pollutant discharges. These practices may include structural BMPs (e.g., wet detention ponds), good housekeeping practices, spill prevention procedures, and employee training. Annual or semi-annual monitoring of stormwater discharge from the site is required for certain industrial facilities. The monitoring would include measurement of specific pollutants such as nutrients and metals, and acute whole effluent toxicity tests.

Information on the South Carolina Sediment, Erosion, and Stormwater Management Program can be found at: http://www.scdhec.net/water/html/erfmain.html

Information on NPDES Stormwater Program Implementation in South Carolina can be found at: http://www.scdhec.net/eqc/water/html/swnhistory.html

Appendix O: Maintenance Agreement Template

O.1 Maintenance Agreement Template

E.3 Sample Maintenance Agreement

State of South Carolina	)	**Permanent Stormwater Facility Maintenance**
	)	**and Responsibility Agreement**
County of Beaufort	)	**Tax Map No.** ____________________

This Agreement is entered into this _____ day of ____________________, 20____, by and between ____________________________, (hereinafter referred to as "Landowner") and the County of Beaufort, political subdivision of the State of South Carolina (hereinafter referred to as "County").

It is agreed as follows:

<u>Landowner Responsible for Stormwater Facility:</u>

The South Carolina Stormwater Management and Sediment Reduction Act of 1991 (§48-14-10, et. seq.) and Regulation 72-308 provide that a Landowner shall adequately establish and maintain stormwater management/Best Management Practices (BMP) facilities upon making certain improvements to the Landowner's property. This law applies to any individual, partnership, corporation or other entity, constructing a stormwater facility. It also applies to all subsequent owners of the property. The obligation applies to the maintenance of all pipes, equipment, and channels built to convey stormwater to a retention facility, as well as all structures, improvements, and vegetation provided to control the quantity and quality of the stormwater on the property. (All fixtures and graded or excavated improvements for controlling stormwater are herein the "Facility"). Adequate maintenance is herein defined as keeping the Facility in good working condition so that the Facility is performing all of its design functions in accordance with the purposes for which it is designed.

<u>Maintenance Required:</u>

The Landowner, its successors and assigns, will perform the maintenance, repair, and replacement necessary to keep the Facility in good working order. In the event a maintenance schedule for the Facility (including sediment removal) is outlined on the approved plans, the schedule must be followed.

<u>Inspection Required:</u>

The Landowner, its successors and assigns, shall regularly and periodically inspect the Facility in its entirety. Records shall be kept to identify the dates and maintenance performed and shall be made available to the County at the County's request. The purpose of the inspection is to assure safe and proper functioning of the Facility. The inspection shall cover all parts of the Facility including, but not limited to, berms, outlet structures, pond areas, and access roads. The Landowner's failure to inspect shall be treated as a breach of this Agreement just as much as a failure to repair if repair is needed after inspection.

<u>Access Permitted:</u>

The Landowner grants permission to the County, its authorized employees and agents, to enter upon the Property and to inspect the Facility whenever the County deems necessary. The purpose of inspection is to follow-up on reported or observed deficiencies, to respond to citizen complaints, or to make an inspection if a significant time has passed after the last inspection. The County shall provide the Landowner a copy of the inspection findings and a directive to commence with the repairs if necessary. In the case of multiple Landowners of a single property, notice to one shall suffice as notice to all.

No Duty on the County:

This Agreement creates no affirmative duty on the County to inspect, and it imposes no liability of any kind whatsoever on the County for omissions in inspecting. The Landowner agrees to hold the County harmless from any liability in the event the Facility fails to operate properly due to the Landowner's failure to abide by the terms of this Agreement.

Landowner Covenants:

The Landowner accepts responsibility for ownership and proper maintenance of the stormwater system, the Facility (pond, swales, etc.) on parcel # (R________________________) located at______________________________________, (see attached Site Map) Beaufort, South Carolina, per the approved maintenance plan. The specific BMPs on the property are listed below:

1) ____
2) ____
3) ____
4) ____
5) ____

Landowner will complete any necessary repairs and/or preventive maintenance procedures in a timely manner to ensure proper functioning as a stormwater management device(s).

Landowner understands that the maintenance plan may be amended or revised at any time by the County in order to address changed conditions or to address conditions not being effectively met by the Facility. Following the County's sending notice; Landowner will abide by any prescribed changes.

This covenant to maintain the Facility shall run with the land. Landowner will continue to own and maintain the Facility until the County is notified in writing of a transfer in ownership and maintenance responsibility. The notification will include a date for the transfer of responsibility which will become effective upon the County's receipt of a letter of acceptance from the new owner. Notwithstanding the provision for a letter of acceptance, any new Landowner shall be responsible for all duties and obligations created by this Permanent Stormwater Facility and Maintenance Responsibility Agreement upon it being executed and filed in the Register of Deeds Office for Beaufort County.

Landowner understands that failure to adhere to the signed Maintenance Agreement may result in fines of up to $1,000.00 per day, per violation and /or the institution of a court action, or such other and additional penalties, fines, or assessments as shall be enacted and provided for by the general law of the state or by local regulation lawfully enacted.

(Signatures contained on the next page)

IN WITNESS our hand and seal this_____day of______________, 20___.

_________________________________ WITNESS 1

Land Owner Name:______________________ (Print)

_________________________________ WITNESS 2

Land Owner Signature:___________________

Mailing Address:_______________________

____

Phone Number: _______________________

_________________________________ WITNESS 1

County of Beaufort

_________________________________ WITNESS 2

BY: _____________________________

ITS: County Administrator

____

STATE OF SOUTH CAROLINA)
) ACKNOWLEDGEMENT
COUNTY OF BEAUFORT)

The foregoing instrument was acknowledged before me this______day of____________, 20___ by____, (Landowner's name).

____
Notary Public for South Carolina
My Commission Expires: __________

STATE OF SOUTH CAROLINA)
) ACKNOWLEDGEMENT
COUNTY OF BEAUFORT)

The foregoing instrument was acknowledged before me this______day of____________, 20___ by ________________, County Administrator for Beaufort County.

____
Notary Public for South Carolina
My Commission Expires: __________

Appendix P: Reserved for future Special Watershed Area designation and criteria by <local jurisdiction>

Appendix Q: Reserved for future use by <local jurisdiction>

Appendix R: Land Cover Designation and Maintenance

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R.1 General Notes

The retention standard approach taken in this guidance manual for on-site stormwater management and the run-off reduction methodology recognizes the ability of pervious land covers to manage some, or most, of the rainwater that falls on it. This is termed "land abstraction" in this appendix and is assumed to be based on SCS Hydrologic Soil Group (HSG) or soil type and whether the land cover is best represented as Forest/Open Space (RvN), Managed Turf (RvC) or Impervious Cover (RvI). As noted in Section 3.7, Equation 3.2 Stormwater Retention Volume, the designation of Forest/Open Space with these lands will generate between 2-5% stormwater runoff for a design rain event. The designation of compacted cover assumes these lands will generate 15-25% stormwater runoff for a design rain event. Impervious cover will generate 95% stormwater runoff for the design rain event. The minimum area threshold for the natural cover designation is 1,500 square feet, with a minimum length of 30 feet. Areas not meeting the natural cover threshold will be considered compacted cover RvC. To ensure no loss of land abstraction, all land cover designations must be recorded in the maintenance agreement.

R.1.1 Existing Natural Cover Requirements

A site claiming natural cover based on the preservation of existing conditions must ensure conditions remain undisturbed to preserve hydrologic properties equal to or better than meadow in good condition. No credit will be given for areas that are cut and then replaced with planting. The intention of preserving areas is to allow for natural succession with saplings reaching maturity after a period of time.

Preservation areas for natural cover may include the following:

- Portions of residential yards in forest cover that will not be disturbed during construction;
- Community open space areas that will not be mowed routinely, but left in a natural vegetated state, as defined below (can include areas that will be rotary mowed no more than two times per year);
- Utility rights-of-way that will be left in a natural vegetated state (can include areas that will be rotary mowed no more than two times per year); or

- Other areas of existing forest and/or open space that will be protected during construction and that will remain undisturbed.

R.1.2 Planting Requirements for the Creation of Natural Cover

Every 1,500 square feet of created natural area shall be vegetated according to the following options of plant material quantity:

- 1 native understory tree: 1.5-inch caliper (minimum), and 2 native canopy trees: 2.5 inch caliper (minimum), or
- 6 native shrubs: 5 to 7-gallon container size (minimum), or
- 50 native perennial herbaceous or woody plants or clump-forming grasses: 1-gallon container size (minimum), or
- 1 native canopy tree: 2.5-inch caliper (minimum), and 25 native perennial herbaceous plants: 1-gallon container size (minimum), or
- 3 native shrubs: 5 to 7-gallon container size (minimum), and 25 native perennial herbaceous plants 1-gallon container size (minimum)

Plantings shall be indigenous to the immediate area and shall be arranged in a natural random pattern (e.g. not a formal composition). To ensure a resilient planting composition, diversity must be provided in the planting plan: at least 2 different species of trees, 3 different species of shrubs, and/or 5 different types of perennials/grasses shall be used in each planting.

If planting near marshes, vegetation should be elevated as much as possible to ease establishment from the saline environment and lessen the impacts of inundation from King Tide events.

Steep slopes greater than 6% grade will require additional plantings, soil stabilization, or a terracing system.

Whip and seedling stock may be used (when approved by *<local jurisdiction>*) as a site's natural cover creation if a stream bank stabilization opportunity falls within the site's footprint. In this instance, whips or seedlings must be planted at a minimum density of 700 plants per acre, and at least 55% of these plants must remain at the end of the 2-year management period.

Natural regeneration (i.e., allowing volunteer plants to propagate from surrounding natural cover as a cover creation technique) may be allowed by *<local jurisdiction>*, when 75% of the proposed planting area is located within 25 feet of adjoining forest, and the adjoining forest contains less than 20% cover of invasive exotic species (as documented by the South Carolina Exotic Pest Plant Council 2014 list here: https://www.se-eppc.org/southcarolina/SCEPPC_LIST2014finalOct.pdf). In this case, supplemental planting must ensure a density of 400 seedlings per acre.

All plant materials used must be native to the southeastern region and must be installed in areas suitable for their growth. There are several websites that may be consulted to select the most appropriate plantings for the Southern Lowcountry:

- Low Impact Development in Coastal South Carolina: A Planning and Design Guide; see suggested plant lists for bioretention (4.2), open channels (4.8) and stormwater wetlands (4.12) http://www.northinlet.sc.edu/wp-content/uploads/2019/12/LID-in-Coastal-SC.pdf

- South Carolina Wildlife Federation: http://www.scwf.org/native-plant-list
- South Carolina Native Plant Society: https://scnps.org/wp-content/uploads/2012/04/CoastalNativePlantList.pdf
- Carolina Yards Plant Database: https://www.clemson.edu/extension/carolinayards/plant-database/index.html
- Clemson University Cooperative Extension Services Home & Garden Information Center factsheet for freshwater shoreline landscaping: https://hgic.clemson.edu/factsheet/shorescaping-freshwater-shorelines/

Plant irrigation is recommended until established.

R.2 Stormwater Management Plans and Natural Cover

Sites using preservation of existing areas for the natural cover designation shall include on their Stormwater Management Plan (SWMP) their natural resources inventory, a tree and vegetation survey, identification of location, and extent of preservation areas. Depending on the extent of the preservation area, *<local jurisdiction>* may require the SWMP to include a more detailed schedule for retained trees, noting the tree species, size, canopy, condition, and location.

The SWMP will include the identification of material and equipment staging areas and parking areas. Material and equipment staging areas and parking areas must be sufficiently offset for preservation areas to ensure no adverse impacts.

For areas maintained as meadow in good condition, the SWMP shall document either the preservation of existing conditions or the creation of meadow conditions. A plan submission claiming meadow preservation will note the existing meadow boundaries and include a field survey of the richness and diversity of existing plant species and the existing soil conditions by a qualified individual (see Section 2.1.3). A plan submission claiming meadow creation will note the proposed meadow boundaries, the planting and/or seeding species methods, and provide a soil amendment plan as specified in Appendix C Soil Compost Amendment Requirements.

R.3 Construction Requirements for Natural Cover Designation

The preservation of lands designated as natural cover—such as undisturbed portions of yards, community open space, and any other areas designated on a site's SWMP as preserved natural cover—must be shown outside the limits of disturbance on the site's Soil Erosion and Sediment Control Plan. These areas must be clearly demarcated with signage prior to commencement of construction on the site on the site and with fencing during construction.

The creation of lands designated as natural cover as part of a public right-of-way (PROW) project and on sites where soils were not protected from compaction during construction the soils must be conditioned prior to planting with soil compost amendments as prescribed in Appendix C Soil Compost Amendment Requirements.

For maximum survivability, planting of trees, shrubs, and herbaceous vegetation for the creation of natural cover should occur only during the fall and early spring (i.e., September through November and March through May). The work should be done only under the supervision of someone qualified and skilled in landscape installation (see Section 4.14 Tree Planting and Preservation for details on qualifications). Proper maintenance of the materials after installation will be key in ensuring plants survival. Prior to inspection, all trees and shrubs planted must be alive and in good health, and native grass and wildflower seeds must have been sown at adequate densities and at the right time of year for each species.

Once a natural cover designation has been assigned to a portion of regulated development site, that area will need to be recorded in the declaration of covenants, documented at the site prior to construction activities, protected during construction activities, and permanently protected/maintained for the life of the regulated site.

Root pruning and fertilizing are examples of preconstruction activities. These measures aim to increase the wellbeing of trees and prepare them for higher stress. Prior to beginning construction, temporary devices such as fences or sediment controls are installed and remain throughout the construction phase. Some devices, like retaining walls and root aeration systems may remain permanently. For example, if part of a root system is collapsed by a built road, permanent aeration may be necessary for the tree to remain healthy.

R.4 Maintenance Requirements for Natural Cover Designation

All areas that will be considered natural cover for stormwater purposes must have documentation that prescribes that the area will remain in a natural, vegetated state. Appropriate documentation includes subdivision covenants and restrictions; deeded operation and maintenance agreements and plans; parcels of common ownership with maintenance plans; third-party protective easements within the PROW; or other documentation approved by *<local jurisdiction>*.

While the goal is to have natural cover areas remain undisturbed, some activities may be prescribed in the appropriate documentation, as approved by *<local jurisdiction>*, such as forest management, control of invasive species, replanting and revegetation, passive recreation (e.g., trails), limited bush hogging to maintain desired vegetative community, etc.

R.5 Compacted Cover Designation

The compacted cover designation can apply to all site areas that are disturbed and/or graded for eventual use as managed turf or landscaping. Examples of compacted cover include lawns, portions of residential yards that are graded or disturbed and maintained as turf (including yard areas), residential utility connections, and PROW. Landscaping areas intended to be maintained as vegetation other than turf within residential, commercial, industrial, and institutional settings are also considered compacted cover if regular maintenance practices are employed.

Appendix S: Reserved for future use by <local jurisdiction>

Appendix T: Single Family On-Lot Volume Control

Step 2 On-Lot Volume Control

Beaufort County passed the On-Lot Volume Controls on June 13, 2011. This requires On-Lot Volume Control when constructing new homes in communities that do not meet current community-wide runoff volume control requirements. This section is applicable only for home lots of record platted but not yet developed. Worksheets are available in an online calculator format at http://stormwaterworksheet.createandsolve.com/.

Purpose

The purpose of this worksheet and web-based program is to help a homeowner or builder determine the amount of excess stormwater runoff that will come off the property after construction of the home.

It will also assist in selecting the controls necessary to control this excess runoff so that the County's water resources are not impacted. Scientists have determined that excess freshwater runoff into saltwater tidal waters can impact the area's fishery resources.

The worksheet and program will allow the user to print out a sheet that can be used to document satisfactory controls so a zoning permit can be obtained. This zoning permit is necessary for issuance of a building permit.

Step 1 – Lot Information

This information is used to compute the excess runoff after construction. If a homeowner is planning an irrigation system, (entered in Section 1), storage and reuse of stormwater from rooftop should be considered for a portion of the irrigation needs. Use of drinking water for irrigation is an expensive alternative for homeowners, and reduction of this can save money as well as reducing amount of water running off the parcel after construction. While this is recommended, storage and reuse is optional because of its initial cost.

Step 2 – Post Construction Stormwater Runoff Calculations

The amount of excess runoff in gallons can be computed using this web-based program. It will depend on whether the soil is sandy or clay (entered in Section 1). The rainfall event that is used to determine the amount of runoff to be controlled is a 1.95-inch rainfall (95^{th} percentile of average events in a year) in a 24-hour period. Before construction, on sandy soils, generally no runoff will occur with the 1.95-inch rainfall event. For clay soils, more than 0.5 inch of a 1.95 rainfall will runoff before construction. Taking this into account, the program will determine the runoff to be controlled, in gallons, after construction.

Step 3 – Application of Best Management Practices

This section takes the gallons determined in the Step above and guides the user through three steps that will reduce these gallons until they are all being controlled. The first step is an optional

storage and reuse/infiltration practice. This practice will utilize a holding facility of some size and then the water can be utilized for reuse or infiltrated at a slow rate from the storage facility.

When storage is utilized, it will control a certain amount of rooftop impervious surface. The maximum storage allowed for credit is limited to the rooftop impervious surface (in square feet) times 1.15. Additional storage can be added but credit is limited to 1.15 gallon per square foot of rooftop surface. When storage is used, it decreases the amount of impervious surface that needs to be handled by the other practices. This is called unaddressed impervious surface.

The second practice is **disconnected impervious surface**. It can utilize the natural infiltration capacity of the lot to control water running off unaddressed impervious surfaces. It will require a determination of which way the water sheet flows across the lot. The program allows up to two directions to be selected. The user starts with an estimate of the impervious surfaces and pervious portion of the lot. If the lot flows in one direction, the estimate is easy. It would be the unaddressed impervious surface and the previous surface it flows over to the end of the lot. If the ratio of unaddressed impervious surface to pervious area is greater than 5, there will be no credit, and runoff is better controlled by the next step. Figures 5-1 and 5-2 provide examples of one- and two-direction calculations to help in determining input figures for this practice.

If after the employing the first two practices there is still excess runoff to be handled, **rain gardens and other practices** will be used to control the remaining runoff. This will be computed for the user, who will be given a square foot size of a standard rain garden.

This standard size rain garden is 3 ft deep and can have special soil or sand and rock mixture that will store runoff and allow it to infiltrate. There is some flexibility between storage and reuse and rain gardens. If less rain garden is desired, storage can be increased, and vice-versa.

There is an attached sheet at the end of this help sheet that provides examples of alternative practices under this step.

It should be remembered that impervious surface on the property causes the excess volume that needs to be controlled. The amount of controls can be reduced by decreasing the impervious surface on the property by considering pervious driveways and walks, reducing rooftop size (two story versus one story), and other practices.

Step 4 – Summary of Volume Reduction Practices

This section is computed for the user to show a summary. This program allows the user to print a one-page sheet that summarizes entry and practices being used. This sheet would be attached to zoning and building permits and will be checked at completion of the project.

Definitions:
Impervious surface – hard surface that allows rainfall to run off and not infiltrate the soil.

Rooftop impervious surface – horizontal surface area of rooftops including overhangs and other detached buildings/sheds.
Other impervious – generally hard surfaces on the ground like paved driveways, patios, walkways and sidewalks.
Pervious surface – surface that is not hard, such as grass, garden or forest area. This also includes gravel and dirt driveways.
Irrigated area is area that would be served by an installed irrigation system. **Unaddressed impervious surface** – term used to determine amount of impervious surface or runoff gallons that had not been controlled by a previous practice.
Standard rain garden – rain garden that has 3 ft of fill material and a 6-inch maximum ponding depth. Different sizes can be constructed but then credits must be computed from Beaufort County BMP manual.

Conversions
Rainfall to gallons of runoff
Design storm is 1.95 inches, of which 1.85 inches is available to run off impervious surface. 1.85 inch on 1 sq ft of impervious surface is equivalent to 1.15 gallons of runoff
Preconstruction runoff
Clayey soils – 0.53 inches run off for a 1.95-inch storm. 0.53 inch on 1 sq ft is equivalent to 0.33 gallon of runoff.
Sandy soils – No runoff for a 1.95-inch storm
Storage and reuse – if irrigation is used on parcel then storage must be between 0.3 gallon/sq ft of rooftop impervious surface to maximum credit of 1.15 gallon/ sq ft of rooftop impervious surface. Storage can be larger but maximum credit is 1.15g/sq ft.

Rain garden
Square foot of impervious surface per square foot of standard rain garden
Clayey soils 4 sq ft of impervious surface to 1 sq ft of standard rain garden
Sandy soils 7 sq ft of impervious surface to 1 sq ft of standard rain garden
Disconnected imperviousness – is the practice of running uncontrolled stormwater flow from impervious surfaces over pervious surfaces to take advantage of natural infiltration of the soil. Credit is given in Table 5-8 based on ratio of impervious surface over pervious surface to compute a ratio.

Table 5-8 Credit Table for Disconnected Impervious Area

Disconnected Impervious Ratio	**Runoff reduction (Gal/sq. ft-impervious area)**	**Runoff reduction (Gal/sq. ft-impervious area)**
	Clayey	Sandy
0.1	.40	1.15
0.2	.40	1.12
0.4	.38	1.08
0.8	.33	1.01
1.0	.31	.98
2.0	.24	.84
3.0	.19	.74
4.0	.16	.67
5.0	.14	.60

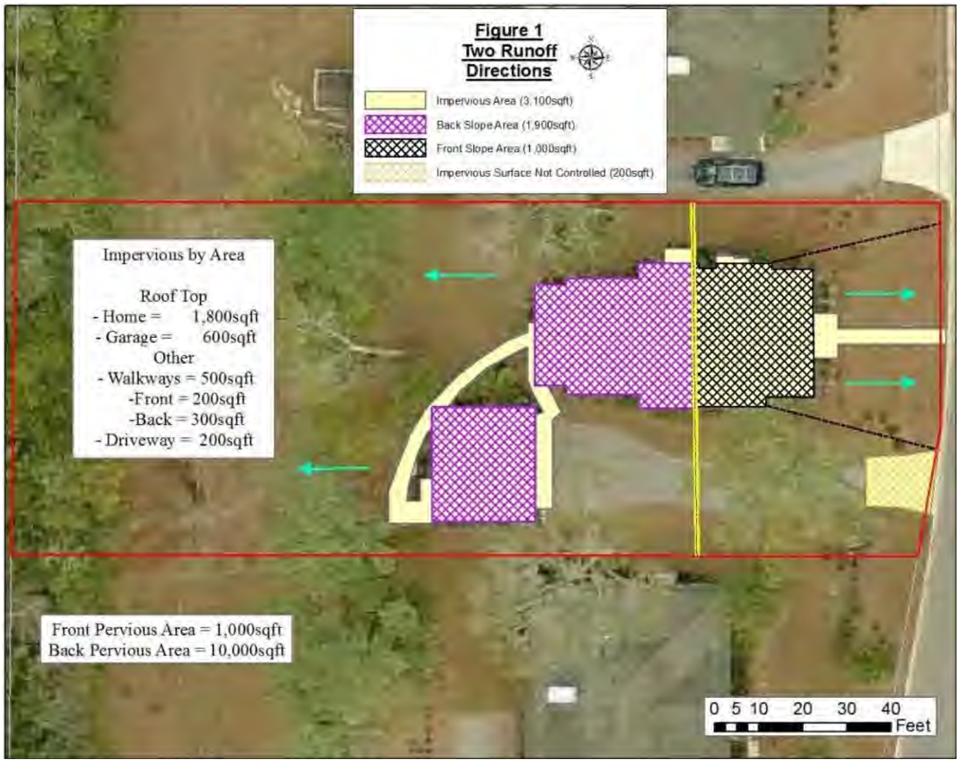


Figure 5-1
Example of a One-Direction Calculation for Disconnected Impervious Surface

This is a home on a 16,000 sq ft lot with about 2,500 sq ft of living space.

In this example, runoff from 1,000 sq ft of impervious surface flows towards the front of the house. It can be made to sheet flow over 1,000 sq ft of lawn (pervious surface). Therefore, on the worksheet or web program, enter 1,000 in impervious area and 1,000 in pervious area of the first direction.

The second direction is to the back of the home, and this 1,900 sq ft of rooftop and other impervious surface flow over 10,000 sq ft of lawn and forest area.

Therefore, enter in the second direction 1,900 sq ft in impervious area and 10,000 in pervious area.

In this example, there is 200 sq ft (paved portion of driveway) that cannot sheet flow over enough pervious area to receive a credit and would not be included in calculations

If storage and reuse/infiltration was used in the first step (say two 500 cisterns/tanks in front of house) then the unaddressed impervious surface would be computed by reducing the first direction impervious surface.

Therefore, the in first direction, enter 130 in impervious surface (reduced by 870 sq ft = 1000 gal/1.15 gal/sq ft) and still 1,000 in pervious surface. See program printout for this example (with storage) in Appendix E.3

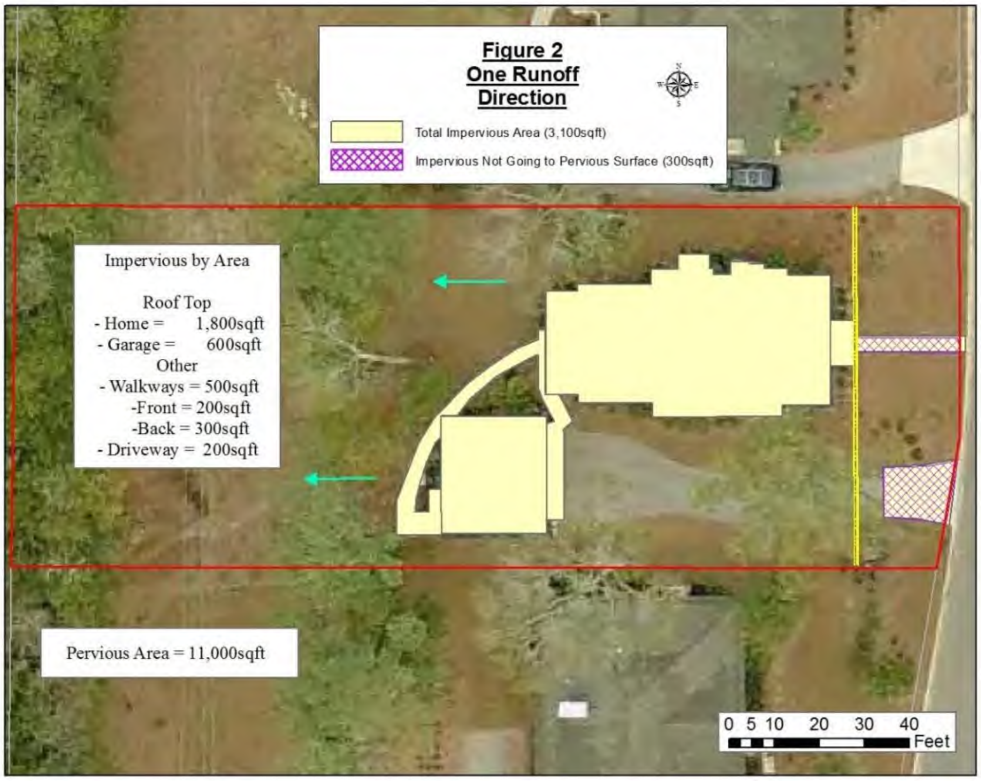


Figure 5-2
Example of a Two-Direction Calculation for Disconnected Impervious Surface

In this example, there would be 2,800 (3,100 to 300) sq ft of impervious surface sheet flowing over 11,000 sq ft of pervious surface out the back yard.

Therefore, enter 2,800 in the first impervious area and 11,000 in the pervious area. The second direction would have zero entered in both categories.

Again, if storage and reuse/infiltration was used, the impervious surface that included in the worksheet or web program would need to be reduced.

If, for example, two 500-gallon storage devices were used, the impervious surface needs to be reduced by 870 sq ft (1000 gal/1.15 gal/sq ft).

Therefore, enter 1,930 in first impervious area and 11,000 in pervious area. The second direction would have zero in both categories.

BEAUFORT COUNTY

-STORMWATER PERMIT APPLICATION-

DATE ACCEPTED	RECEIVED BY	FILING FEE	RECEIPT#	PERMIT#	PIN#

PROJECT NAME:	PROJECT TYPE:
PROJECT LOCATION:	
APPLICANT/DEVELOPER NAME, ADDRESS, PHONE#	PROPERTY OWNER NAME, ADDRESS, PHONE#
EMAIL	EMAIL
SWPPP PREPARER NAME, ADDRESS, PHONE#	CONTRACTOR NAME, ADDRESS, PHONE#
EMAIL	EMAIL
QUALIFIED INSPECTOR NAME, ADDRESS, PHONE#	ADDITIONAL INFORMATION:
EMAIL	

SW01 (Single Family Home)

- ☐ COPY OF TIER I STORMWATER POLLUTION PREVENTION PLAN (SWPPP) – (See Appendix D)
- ☐ PLOT PLAN SHOWING, VICINITY MAP, NORTH ARROW, GRAPHIC SCALE, PROPOSED IMPROVEMENTS
- ☐ SITE PLAN SHOWING EXISTING GRADES/CONTOURS/ELEVATIONS AND PROPOSED GRADES/CONTOURS/ELEVATIONS, WITH OFFSITE DISCHARGE POINTS IDENTIFIED
- ☐ NATURAL RESOURCE INVENTORY SHOWING TREES, WETLANDS, DRAINAGE COURSES, AND BUFFERS
- ☐ GRADING AND DRAINAGE CERTIFICATION
- ☐ STEP II VOLUME CONTROL (See Section 5.3) (http://stormwaterworksheet.createandsolve.com)
- ☐ APPLICATION FEE

SW02 (Non Residential and Attached Residential)

- ☐ COPY OF TIER II STORMWATER POLLUTION PREVENTION PLAN (SWPPP)
- ☐ POST CONSTRUCTION STORMWATER PLAN CHECKLIST WITH LOCATION OF ALL ITEMS INDICATED.
- ☐ SITE PLAN: VICINITY MAP, PROJECT LOCATION, NORTH ARROW, GRAPHIC SCALE, PROPOSED IMPROVEMENTS
- ☐ CONSTRUCTION PLANS
- ☐ DRAINAGE CALCULATIONS (See Section 5.3)
- ☐ APPLICATION FEE

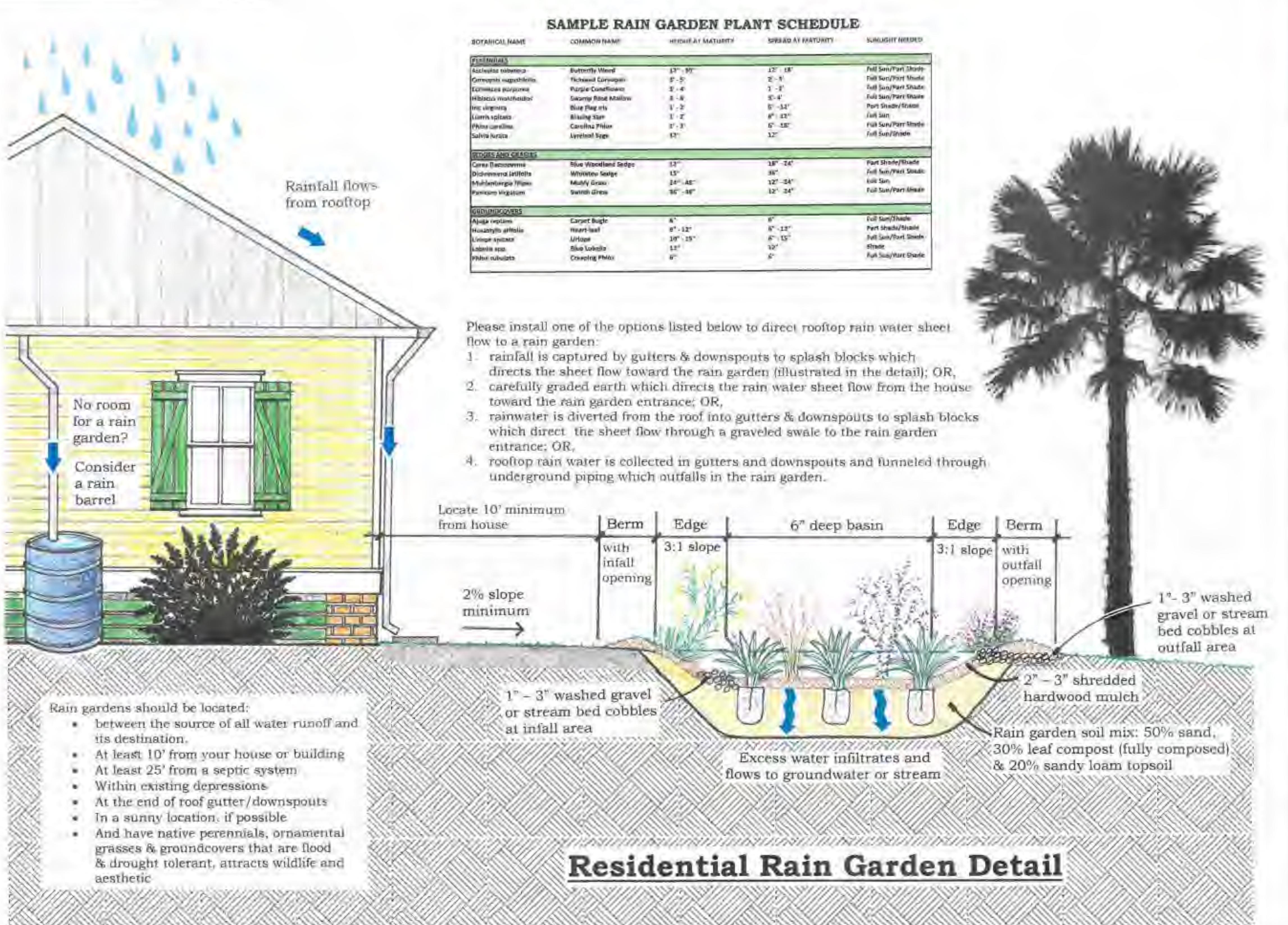
Application Affidavit
The applicant acknowledges that application and issuance of the local Beaufort County Stormwater Permit does not preclude the need to obtain a NPDES permit from SC-DHEC per the South Carolina Erosion and Sediment Reduction act of 1983 as promulgated via 72-300, Standards for Stormwater Management and Sediment Reduction. Any change to the SWPPP associated with this permit as a result of permitting by DHEC renders this permit void until revised by the applicant to match the DHEC approved plan. The applicant further acknowledges the County may refuse to conduct inspections and may issue Notices of Violation, Stop Work Orders, and/or Civil Penalties for failure to comply with DHEC requirements.
Signature__________________________________ Date___________________

SAMPLE RAIN GARDEN PLANT SCHEDULE

BOTANICAL NAME	COMMON NAME	HEIGHT AT MATURITY	SPREAD AT MATURITY	SUNLIGHT NEEDED
PERENNIALS				
Asclepias tuberosa	Butterfly Weed	12" - 30"	12" - 18"	Full Sun/Part Shade
Coreopsis augustifolia	Tickseed Coreopsis	3' - 5'	2' - 5'	Full Sun/Part Shade
Echinacea purpurea	Purple Coneflower	3' - 4'	1' - 3'	Full Sun/Part Shade
Hibiscus moscheutos	Swamp Rose Mallow	3' - 6'	3' - 4'	Full Sun/Part Shade
Iris virginica	Blue Flag Iris	1' - 3'	6" - 12"	Part Shade/Shade
Liatris spicata	Blazing Star	1' - 2'	6" - 12"	Full Sun
Phlox carolina	Carolina Phlox	1' - 3'	6" - 18"	Full Sun/Part Shade
Salvia lyrata	Lyreleaf Sage	12"	12"	Full Sun/Shade
SEDGES AND GRASSES				
Carex flaccosperma	Blue Woodland Sedge	12"	18" - 24"	Part Shade/Shade
Dichromena latifolia	Whitetop Sedge	15"	36"	Full Sun/Part Shade
Muhlenbergia filipes	Muhly Grass	24" - 48"	12" - 24"	Full Sun
Panicum virgatum	Switch Grass	36" - 48"	12" - 24"	Full Sun/Part Shade
GROUNDCOVERS				
Ajuga reptans	Carpet Bugle	6"	6"	Full Sun/Shade
Hexastylis arifolia	Heart-leaf	8" - 12"	6" - 12"	Part Shade/Shade
Liriope spicata	Liriope	10" - 15"	6" - 15"	Full Sun/Part Shade
Lobelia spp.	Blue Lobelia	12"	12"	Shade
Phlox subulata	Creeping Phlox	6"	6"	Full Sun/Part Shade

Please install one of the options listed below to direct rooftop rain water sheet flow to a rain garden:

1. rainfall is captured by gutters & downspouts to splash blocks which directs the sheet flow toward the rain garden (illustrated in the detail); OR,
2. carefully graded earth which directs the rain water sheet flow from the house toward the rain garden entrance; OR,
3. rainwater is diverted from the roof into gutters & downspouts to splash blocks which direct the sheet flow through a graveled swale to the rain garden entrance; OR,
4. rooftop rain water is collected in gutters and downspouts and funneled through underground piping which outfalls in the rain garden.



Rain gardens should be located:

- between the source of all water runoff and its destination.
- At least 10' from your house or building
- At least 25' from a septic system
- Within existing depressions
- At the end of roof gutter/downspouts
- In a sunny location, if possible
- And have native perennials, ornamental grasses & groundcovers that are flood & drought tolerant, attracts wildlife and aesthetic

Residential Rain Garden Detail

BEAUFORT COUNTY SOUTH CAROLINA 1769

Residential Rain Garden Detail

DATE: 10/01/18
SCALE: Not to Scale
DRAWN BY: NRM
REVISIONS: 10/10/18
11/08/18
11/26/18

RAIN GARDEN DETAIL

ATTACH
Recommended Motion

RECOMMENDED MOTION LANGUAGE

"I move to approve a Resolution to adopt the *Southern Lowcountry Stormwater Design Manual* as a supporting document to Unified Development Ordinance Article 5 – Design Standards, Sec. 5.10 Stormwater Management."

TOWN COUNCIL

STAFF REPORT
Engineering Department

MEETING DATE:	February 9, 2021
PROJECT:	Consideration of a Proposed Lighting Agreement with Palmetto Electric for the Law Enforcement Center – Bryan McIlwee, Director of Engineering
PROJECT MANAGER:	Bryan McIlwee, Director of Engineering

RECOMMENDATION:

Staff recommends that Town Council authorize the Town Manager to execute an Agreement (Attachment 1) with Palmetto Electric "Palmetto" to provide and install 11 LED light fixtures for the Law Enforcement Parking and Services Yard Expansion Project. The Agreement includes the following up-front cost and lease terms:

FUND (Project Cost)

1) Purchase and Installation of 11 light poles	$ 0.00
2) Light Buyout/Labor and Materials	$ 450.00
	$ 450.00
GENERAL FUND (Operating Cost)	
3) 15-Year Lease ($427.41/month x 12 months/yr. x 15yrs)	$76,933.80
Total Agreement	**$76,933.80**

BACKGROUND/DISCUSSION:

The budget for the expansion of the Law Enforcement Center was adopted with the FY2020-2021 Strategic Plan and is consistent with the Comprehensive Plan. In addition to enhancing public safety within the Town of Bluffton, the implementation of the proposed lighting will improve the functionality and security of the parking and service yard areas to meet or exceed national standards for Police Department Facilities. The new lighting will increase visibility and safety for pedestrians and staff utilizing the facility.

The LEC parking and service yard expansion project was bid according to the Town of Bluffton procurement requirements and construction began in December 2020. The LEC project is within the Palmetto Electric service area and the attached Lighting Agreement was requested for Town Council review and approval.

NEXT STEPS:

1. Execution of Palmetto Agreement
2. Install conduits
3. Install lighting in FY2021

SUMMARY:

The approval of this Lighting Agreement is consistent with the Comprehensive Plan and Infrastructure and Community Quality of Life Strategic Focus Areas within the FY 2020-2021 Strategic Action Plan. As a result, Town Staff recommends that Town Council authorize the Town Manager execute the Lighting Agreement and Staff take such actions as are necessary to complete this lighting project.

ATTACHMENTS:

1. Lighting Agreement
2. Lighting Plan
3. Recommended Motion

Agreement Nu
Expiration Date: **November 3, 2035**

AGREEMENT
FOR
OUTDOOR LIGHTING SERVICE

1. This Agreement is entered into this 3rd day of November , 2020 by and between Palmetto Electric Cooperative, Inc., hereinafter referred to as **"PALMETTO"**, and **Town of Bluffton** , hereinafter referred to as "**MEMBER**". This Agreement constitutes the entire agreement between the parties with respect to the subject matter thereof and shall be binding upon the heirs, successors and assigns of both parties.

2. NOW, THEREFORE, for and in consideration of the sum of One and 00/100th ($1.00) Dollar, each to the other paid, the sufficiency and receipt of which are hereby acknowledged, and the other rights, duties and obligations as imposed upon the parties and set out below, the parties agree as follows:

3. The **MEMBER** desires that **PALMETTO** install dusk to dawn outdoor lighting for a certain tract or tracts of land described below:

Bluffton Police Station - Buckwalter Place

4. The **MEMBER** agrees to pay **PALMETTO** for service hereunder and for the following number, type, size and present monthly charges as shown (see attachment for exact fixture and pole specifications); and in accordance with the terms and conditions of **PALMETTO's** Outdoor Lighting Schedule and standard electric service payment requirements.

QUANTITY	TYPE & SIZE	RATE PER UNIT	LIGHT ID NUMBER	MONTHLY CHARGE
9	Autobahn Large 250EQ LED1U	$36.43	ALDE14	$327.87
	25'LAMWD			
2	Autobahn Large 250EQ LED2U	$49.77	ALDF14	$99.54
	25'LAMWD			
MEMBER AGREES TO PAY MONTHLY CHARGE OF				**$427.41**

(Plus applicable sales, use, franchise or utility taxes and/or fees.)

THE PROMISES OF MEMBER

5. **MEMBER** agrees that from time to time **PALMETTO** may adjust the rates charged hereunder to account for actual changes (increases or decreases) in costs incurred by **PALMETTO** for supplying electrical power and/or service under this Agreement.

6. The **MEMBER** shall provide free of charge to **PALMETTO** any and all written easements necessary to construct and maintain its facilities and equipment, including but not limited to any necessary access easements, free and clear of liens and other encumbrances. Outdoor Lighting service shall be provided only at locations which are readily accessible to **PALMETTO's** equipment for installation and maintenance purposes.

7. The equipment and facilities installed by **PALMETTO** shall remain the property of **PALMETTO** except for as provided in Paragraph "20-b", and the **MEMBER** hereby grants to **PALMETTO** the right to enter upon the **MEMBER's** premises without prior notice for the installation, maintenance and removal of such equipment or facilities.

8. The **MEMBER** understands that the Agreement is contingent upon a coordinated installation sequence with respect to other site work including installation of water lines, sewer lines, storm drains, paving, irrigation, landscaping, etc. In the event that impeding site work precedes the electrical distribution and outdoor lighting system and necessary electrical conduits have not been installed, or have not been installed properly, an additional charge, based upon the cost of the additional work may be charged to the **MEMBER**. Any contribution-in-aid of construction required by **PALMETTO** for such unusual conditions (road bores, parking lot bores, hand digging, remove and replace existing landscaping, etc.) will be determined by a **PALMETTO** representative and shall be paid in full by **MEMBER** in advance of actual installation.

9. If the **MEMBER** desires relocation of a light, a relocation charge will be billed to the **MEMBER** for the amount of actual cost, both labor and materials. This charge is to be paid before commencement of the relocation.

10. If any portion of the lighting system is disconnected due to non-payment, **MEMBER** shall be required to pay actual labor cost of disconnecting and reconnecting, in addition to any delinquent payments and possibly a deposit, prior to reconnection of lighting system.

11. It is the responsibility of the **MEMBER** to notify **PALMETTO** of any failed or malfunctioning light(s) in need of repair or replacement.

12. The **MEMBER** shall be required to reimburse **PALMETTO** for the costs of any maintenance work which is required due to negligence or vandalism. If vandalism persists, **PALMETTO** reserves the right to terminate the agreement and permanently remove the lighting system.

13. The **MEMBER** agrees to allow **PALMETTO** and its authorized representatives t and shrubs as necessary for the installation, maintenance or removal of the lighting equipment, however, **PALMETTO** is not responsible for the trimming of trees which block or impede the light source.

14. The **MEMBER** may, when approved in writing in advance by **PALMETTO** and attached to this Agreement and made a part thereof, make attachments or modifications to the pole. If the **MEMBER** makes attachments or modifications to the pole, the **MEMBER** will be responsible for actual costs of labor and materials for said attachments or modifications. If these attachments or modifications cause the pole or any part of the lighting system to fail prematurely, **PALMETTO** may require the **MEMBER** to reimburse **PALMETTO** for the cost of the work which is required to replace or repair the affected parts. **PALMETTO** will not be responsible for maintenance or replacement of any attachments or modifications to the pole. Unapproved attachments may be removed by **PALMETTO** without penalty and discarded without notice.

15. The **MEMBER** shall defend, indemnify, and hold harmless **PALMETTO** from all claims, losses, liabilities, and expenses for personal loss, injury or death to persons and loss, damage to or destruction of **PALMETTO** or any other persons or entities' property arising out of any work or modifications by the **MEMBER** to **PALMETTO's** lighting system and from all Acts of God.

16. Due to changes over time in available product offerings, **PALMETTO** may, from time to time, change, alter, or adjust the appearance of any portion of the lighting system including its lumen output and color temperature, so long as the light continues to provide the same or similar function.

17. **MEMBER** agrees to disclose this Agreement and all requirements herein to any and all successors, heirs and assigns, including the monthly payment obligations and remaining term. All successors, heirs and assigns of **MEMBER** shall be required to fulfill any remaining term of Agreement.

THE PROMISES OF PALMETTO

18. Subject to the above stipulations, **PALMETTO** will furnish, install, operate and maintain the lighting system, including lamp, luminaire, bracket attachment, control device, poles and necessary wiring, electrically connected so that the power for operation of the light does not pass through the **MEMBER's** electric meter.

19. **PALMETTO** will repair or replace a failed light at no additional cost to the **MEMBER** as soon as practical after notification to **PALMETTO** by the **MEMBER** of the failed light with specific location or unique light ID number. Light repairs will take place during **PALMETTO's** normal business hours.

20. The lighting system shall remain the property of **PALMETTO**, regardless of **MEMBER** has made a contribution-in-aid of construction, unless otherwise provided as in Paragraph "21-b".

GENERAL

21. This Agreement shall be for a minimum initial term of Fifteen (15) years from the commencement of service of each individual light and shall be automatically extended for successive one year terms, unless the **MEMBER** should give a minimum of one year's written notice to **PALMETTO** that the **MEMBER** elects not to renew. **PALMETTO** may terminate this Agreement should **PALMETTO** cease to do business as a provider of outdoor lighting services and given 1 year's written notice to **MEMBER**. Additionally, **PALMETTO** may terminate this contract should **MEMBER** fail to pay the monthly charges as required per this Agreement or upon any other breach of this Agreement by the **MEMBER**. If the **MEMBER** terminates or defaults on payment during the initial Term or any extension thereof, the **MEMBER** shall agree to one of the following provisions:

    a) The **MEMBER** pays **PALMETTO** the total amount of charges which would be payable to **PALMETTO** during the remaining term of this Agreement in one lump sum payment. Under this provision, all wiring, poles, lighting system, fixtures, and other miscellaneous equipment installed by **PALMETTO** will remain the property of **PALMETTO** and **PALMETTO** may remove the lighting system. **PALMETTO** may also abandon some of the underground facilities (cable, conduit, etc.) in place.

    OR

    b) The **MEMBER** pays to **PALMETTO** the depreciated in-place value of the entire lighting system as determined by **PALMETTO**. Under this provision, the entirety of the lighting system in its existing as-is condition to including all wiring, poles, and fixtures shall become the property of the **MEMBER**; however, the **MEMBER** will have to make provisions to purchase energy from **PALMETTO** at metering locations designated by **PALMETTO** and which pass inspection by the local inspecting Authority Having Jurisdiction. The **MEMBER** shall pay all costs associated and bear full responsibility for establishing these new metered services in accordance with **PALMETTO's** commercial service policies as well as all applicable Federal, State and Local electrical codes.

22. This Agreement shall be governed by the laws of the State of South Carolina.

IN WITNESS WHEREOF, the parties hereto have executed this Agre of the date and year first above written, and by their signatures they warrant that the individual whose signature appears below has the authority to enter into this Agreement and to bind their respective parties.

"PALMETTO"

______________________	**By:**	______________________
(Witness)		
		Tim Hutchinson
		(Print Signatory Name)
______________________	**Title:**	**Manager, Engineering Services**
(Witness)		

"MEMBER"

______________________	**By:**	______________________
(Witness)		
		______________________
		(Print Signatory Name)
______________________	**Title:**	______________________
(Witness)		

ATTACHMENT

Agreement Number: **1351**

Expiration Date: **November 3, 2035**

This attachment to the Agreement covers the following account and their specific locations.
Account Name: Town of Bluffton
Billing Address: PO Box 386, Bluffton, SC 29910
Member Separator: 176600-001

#	LOCATION NUMBER	TRANSFORMER STATION	POLE NUMBER	SERVICE TYPE	LIGHT ID NUMBER
1	663-24-018-001			UG	ALDE14
2				UG	ALDE14
3				UG	ALDE14
4				UG	ALDE14
5				UG	ALDE14
6				UG	ALDE14
7				UG	ALDE14
8				UG	ALDE14
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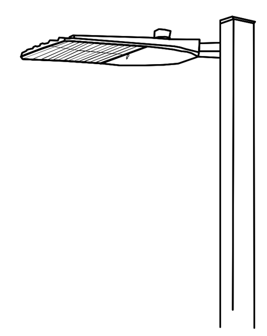
Attachment 2
Lighting Plan



LED LARGE AUTOBAHN

APPLICATIONS
Walkways, driveways, malls,
shopping centers, commercial and industrial
complexes, and residential areas.

SPECIFICATIONS
UL1572 Listed Suitable for Wet Locations
Heavy-duty die-cast aluminum housing and door
Polyester powder finish standard in dark bronze

Luminaire Schedule

Symbol	Qty	Label	Arrangement	Total Lamp Lumens	LLF	Description
→	9	LARGE AUTOBAHN	SINGLE	N.A.	0.720	250EQ LED ON 25' POLE, 20' MOUNTING HEIGHT
←→	2	DOUBLE LARGE AUTOBAHN	BACK-BACK	N.A.	0.720	250EQ LED ON 25' POLE, 20' MOUNTING HEIGHT
⊙	2	EXISTING HAGERSTOWN	SINGLE	11700	0.720	175W MH ON 14' POLE

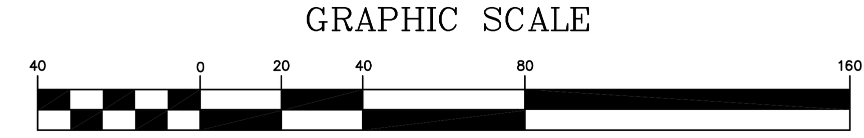
Calculation Summary

Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
CalcPts	Illuminance	Fc	1.91	7.4	0.6	3.18	12.33

Luminaire Location Summary

LumNo	Label	X	Y	Z	Orient	Tilt
1	DOUBLE LARGE AUTOBAHN	2024954.	160220.7	20	267.902	0
2	DOUBLE LARGE AUTOBAHN	2024755.	160101.3	20	86.054	0
3	EXISTING HAGERSTOWN	2024990.	160050.7	14	266.962	0
4	EXISTING HAGERSTOWN	2024909.	160055.2	14	266.349	0
5	LARGE AUTOBAHN	2024998.	160138.4	20	355.077	0
6	LARGE AUTOBAHN	2024843.	160312.3	20	266.818	0
7	LARGE AUTOBAHN	2024940.	160304.6	20	265.855	0
8	LARGE AUTOBAHN	2024745.	160320.3	20	266.733	0
9	LARGE AUTOBAHN	2025013.	160243.3	20	356.239	0
10	LARGE AUTOBAHN	2024684.	160150.2	20	357.798	0
11	LARGE AUTOBAHN	2024690.	160238.6	20	358.729	0
12	LARGE AUTOBAHN	2024751.	160169.4	20	355.192	0
13	LARGE AUTOBAHN	2024754.	160237.9	20	358.348	0

GRAPHIC SCALE



(IN FEET)
1 inch = 40 ft.

NOTES

1. P.E.C.I. ONLY PROVIDES LIGHTING DESIGNS AS REQUESTED BY THE CUSTOMER OR AS REQUESTED BY LOCAL GOVERNING AGENCIES.

2. IT IS THE RESPONSIBILITY OF THE CUSTOMER TO ENSURE THAT THE LIGHT VALUES, LOCATIONS, LIGHT TYPE, POLE TYPE AND MOUNTING HEIGHT ARE IN COMPLIANCE WITH ALL GOVERNING AGENCY REQUIREMENTS AND/OR RECOMMENDATIONS.

3. ANY OBSTRUCTIONS, OR THE INTRODUCTION OF, WITHIN THE LIGHTED SPACE MAY PRODUCE RESULTS THAT ARE DIFFERENT FROM THE PREDICTED VALUES.

4. THE EXACT LOCATION OF THE LIGHT POLES WILL BE VERIFIED IN THE FIELD FOR PROXIMITY TO TREE CANOPY BY TOWN OF HILTON HEAD REPRESENTATIVE AND PALMETTO ELECTRIC REPRESENTATIVE PRIOR TO CONSTRUCTION.

THESE PLANS ARE FOR THE APPROVAL AND CONSTRUCTION OF PALMETTO ELECTRIC COOPERATIVE, INC. OUTDOOR LIGHTS ONLY.

NAME: X:\MAP20\2004004L-4.DWG

PALMETTO ELECTRIC COOPERATIVE, INC.
1 COOPERATIVE WAY • HARDEEVILLE, SOUTH CAROLINA 29927 •
(843) 208-5551 / FAX (843) 208-5532

PALMETTO ELECTRIC COOPERATIVE INC.
A Touchstone Energy Partner

REMARKS:

DESIGNED BY: ML
CHECKED BY: ML
DRAWN BY: RBT
DATE: 6/9/20
SCALE: 1" = 40'
PROJECT NO.: 2004004L-4
MAP NO: 00000000
SHEET NO. 1 OF 1

LIGHTING PROPOSAL FOR
BLUFFTON POLICE STATION
BUCKWALTER PLACE
TOWN OF BLUFFTON
BEAUFORT COUNTY, SOUTH CAROLINA

RECOMMENDED MOTION LANGUAGE

"I make a motion to authorize the Town Manager to enter into the Agreement with Palmetto Electric covering the area lighting Law Enforcement Expansion project. The Agreement includes a commitment from the Town of Bluffton for $450.00 for materials and labor and buyout of two existing lights, and $76,933.80 for the cost of a 15-year lighting lease."

TOWN COUNCIL

STAFF REPORT
Finance Department

MEETING DATE:	February 9, 2020
PROJECT:	Consideration of an Extension for the Memorandum of Understanding between the Town of Bluffton and Beaufort Jasper Water and Sewer Authority Regarding Collaboration on Projects and Capacity Fee Credits
PROJECT MANAGER:	Chris Forster, MPA, CPFO, CGFM, Director of Finance & Administration

RECOMMENDATION: Staff requests that the Town Council consider approving a ninety-day extension of Memorandum of Agreement ("MOA") 2011-38 with Beaufort-Jasper Water and Sewer Authority ("BJWSA") to continue their franchise agreement and updated calculation of Capacity Fee Credits within the Town.

BACKGROUND/DISCUSSION: The Town and BJWSA first entered into a franchise agreement on November 14, 2001 to establish the terms and conditions upon which BJWSA would provide water and sewer to residences and businesses within the Town. Prior to expiration, that agreement was extended via MOA 2011-38 and expanded to include project collaboration and capacity fee credits with a term of ten (10) years. MOA 2011-38 was set to expire November 21, 2020. It was approved for a 90-day extension on November 10, 2020.

The Town has engaged BJWSA in negotiations to renew for another ten (10) year period. BJWSA has requested an additional 90-day extension while they coordinate all their intergovernmental agreements with surrounding municipalities.

NEXT STEPS: Attached hereto is a draft of the MOA extension for Town Council's review and approval. Upon approval by Town Council, the Town Manager will execute this MOA extension.

ATTACHMENTS:

1. MOA 2011-38, ninety-day extension
2. Recommended Motion

STATE OF SOUTH CAROLINA)
)
COUNTY OF BEAUFORT)

AMENDMENT # 2
TO
MOU 2011-38

WITNESSETH:

WHEREAS, Memorandum of Understanding ("MOU") # 2011-38 was made and entered into the 22nd day of November, 2010 between the Town of Bluffton (hereinafter the "Town") and Beaufort-Jasper Water and Sewer Authority (hereinafter "BJWSA"); and

WHEREAS, Section III (B) of MOU # 2011-38 provided for a ten (10) year validity period which could be extended by mutual agreement of both parties; and

WHEREAS, prior to the end of the validity period, the Town and BJWSA agreed to extend the agreement for a period of ninety (90) days from November 22, 2020 through February 20, 2021; and

WHEREAS, the Town and BJWSA agree to amend MOU # 2011-38 as described herein.

NOW, THEREFORE, in exchange for the mutual promises written herein and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, and intending to be legally bound, the Town and the BJWSA agree as follows:

1. Town and BJWSA agree to extend MOU # 2011-38 for an additional period of ninety (90) days from February 21, 2021 to May 22, 2021.

2. All other terms and conditions of MOU # 2011-38 shall remain in full force and effect and remain unchanged except as stated herein.

IN WITNESS WHEREOF, the parties hereto have caused the within Amendment # 2 to MOU # 2011-38 to be executed this _______ day of ______________, 2021.

BEUAFORT-JASPER WATER
AND SEWER AUTHORITY

Date: ________________________________

By: __________________________________

Print Name: ___________________________

Position: ______________________________

Witness: ___________________________

TOWN OF BLUFFTON

Date: ________________________________

By: __________________________________

Print Name: ___________________________

Position: ______________________________

Witness: ___________________________

Attachments:
1. none

Attachment 2

Recommended Motion

Consideration of an Extension for the Memorandum of Understanding between the Town of Bluffton and Beaufort Jasper Water and Sewer Authority Regarding Collaboration on Projects and Capacity Fee Credits

"I make a motion to approve the extension of the Memorandum of Agreement 2011-38 between the Beaufort Jasper Water Sewer Authority and the Town of Bluffton for a period of ninety days."

INTEROFFICE MEMORANDUM

TO: MEMBERS OF TOWN COUNCIL

FROM: SCOTT M. MARSHALL, INTERIM TOWN MANAGER

SUBJECT: COVID-19 INFECTION RATE UPDATE

DATE: JANUARY 31, 2021

CC: LEE LEVESQUE, EMERGENCY MANAGER

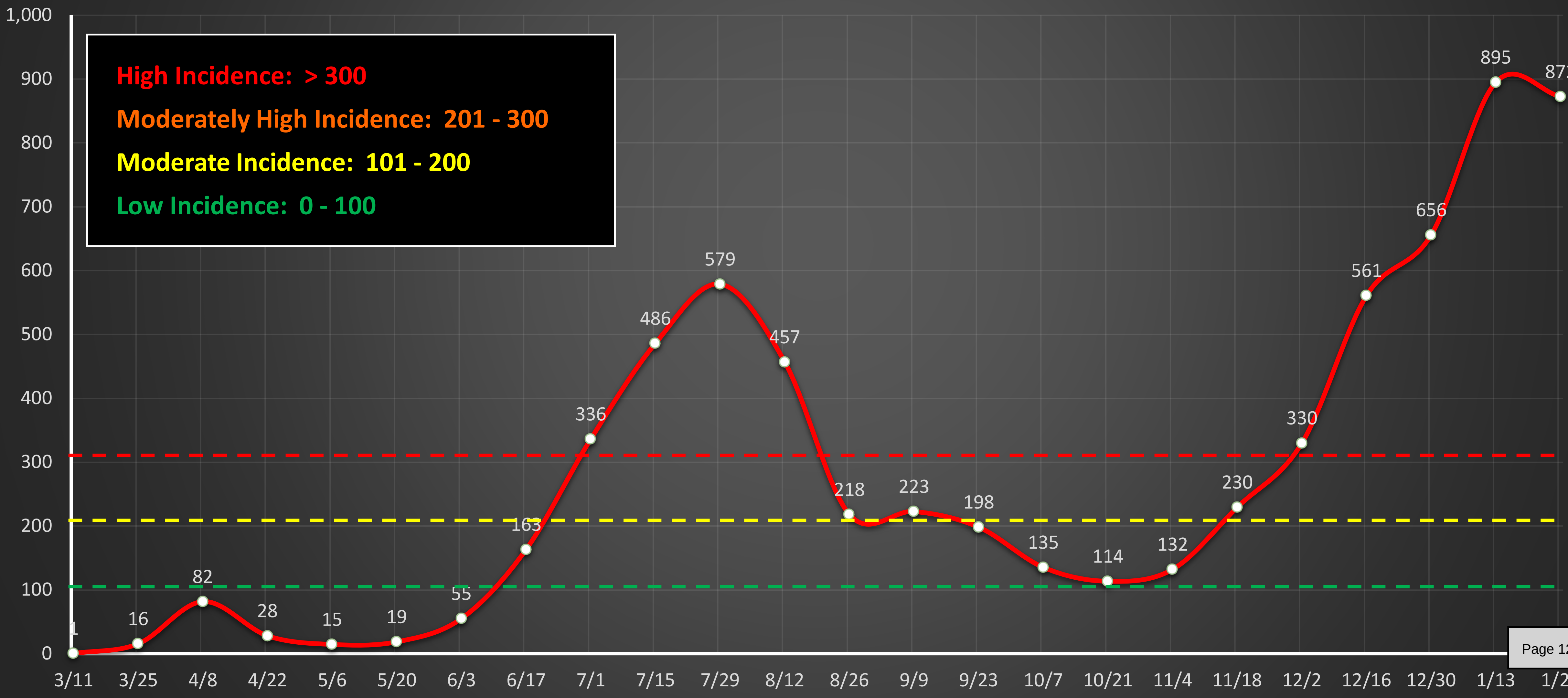
This memo is provided to fulfill the request of Town Council to receive monthly updates regarding local COVID-19 infection rates.

Attached are the charts with which you are already familiar from previous presentations.

The latest two-week reporting period available as of the drafting of this memo was for **the reporting period ending January 27, 2021**. On these charts, the following is depicted:

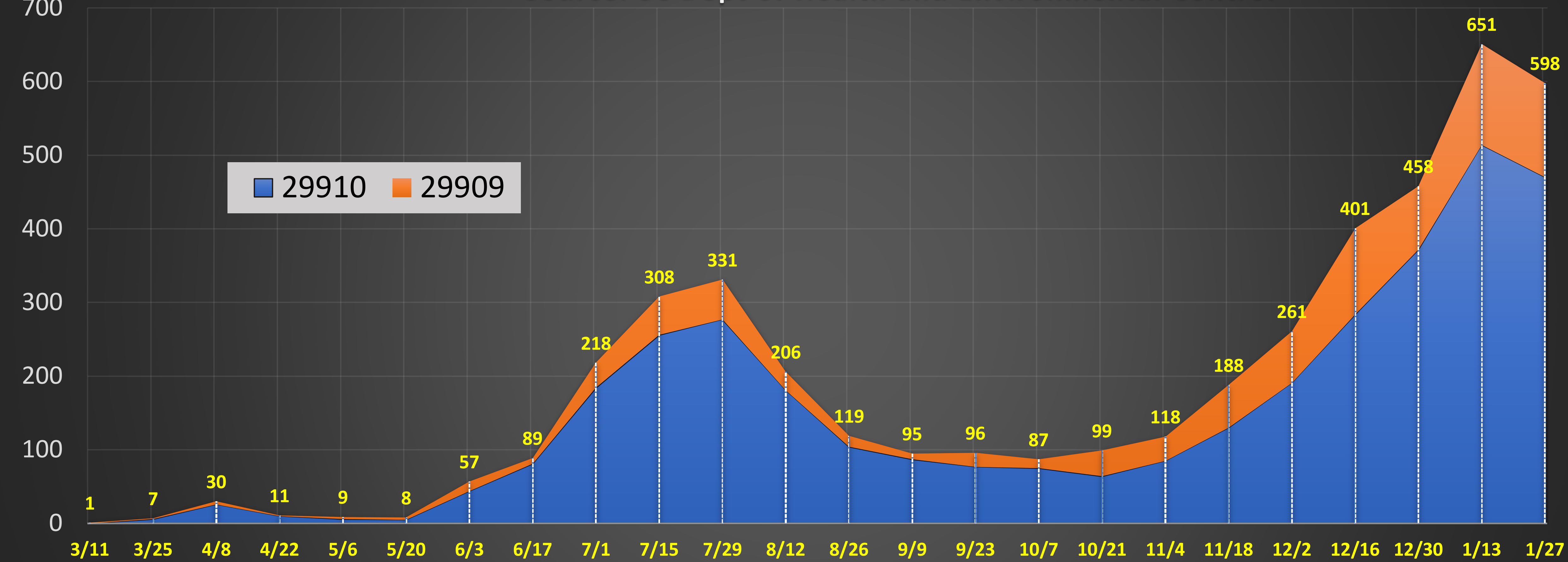
- Beaufort County Two-Week Incidence Rate
  - Cases Reported: 872 cases per 100,000 in population
  - Incidence Rate: High
  - Change from Previous Reporting Period: 2.5% Decrease
- 29909 / 29910 Combined Cases Reported
  - Number of Cases Reported: 598
  - Change from Previous Reporting Period: 8.1% Decrease

Two-Week Incidence Rate – Beaufort County, SC
COVID-19 Cases Reported per 100,000 population
Source: SC Dept of Health and Environmental Control

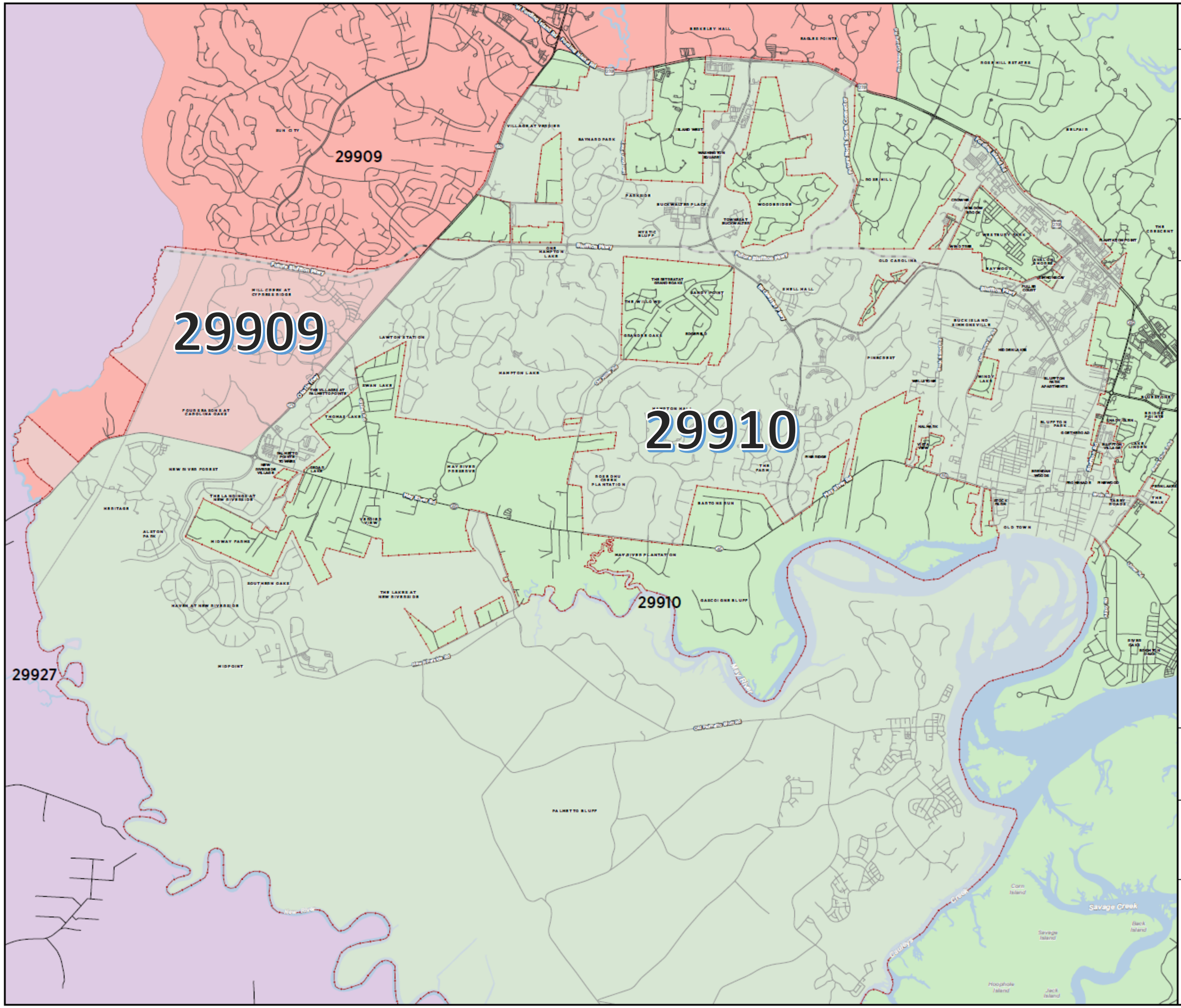


Number of COVID-19 Reported Cases per 2-Week Period
Bluffton Zip Codes 29909 and 29910

Source: SC Dept of Health and Environmental Control



	3/11	3/25	4/8	4/22	5/6	5/20	6/3	6/17	7/1	7/15	7/29	8/12	8/26	9/9	9/23	10/7	10/21	11/4	11/18	12/2	12/16	12/30	1/13	1/27
29909	1	1	4	1	3	3	13	8	34	52	54	25	15	8	19	12	35	33	58	70	117	86	137	128
29910	0	6	26	10	6	5	44	81	184	256	277	181	104	87	77	75	64	85	130	191	284	372	514	470
Total	1	7	30	11	9	8	57	89	218	308	331	206	119	95	96	87	99	118	188	261	401	458	651	598



Town of Bluffton
Beaufort County, SC

INFORMATION TECHNOLOGY DEPARTMENT

ZIP CODES

Updated: 10/28/2020

Legend

- 29909
- 29910
- 29927

JURISDICTIONAL

- Town of Bluffton
- Bluffton Town Limits

TRANSPORTATION

- Roads
- Future Road
- Future Parkway

HYDROLOGY

- Water

0 0.25 0.5 1
Miles

Map Prepared By:
Ryan J. Coleman, GISP

NORTH

DISCLAIMER:
This map was created by the Town of Bluffton and is solely intended to be used as a graphical representation for the Town of Bluffton. The GIS maps and data distributed by the Town of Bluffton are derived from a variety of public and private sector sources considered to be dependable, but the accuracy, completeness and currency thereof are not guaranteed. The Town of Bluffton makes no warranties, expressed or implied, as to the accuracy, completeness, currency, reliability, or suitability for any particular purpose of information or data contained in or generated from the town's Geographic Information Systems database. Additionally, the Town of Bluffton or any agent, servant, or employee thereof assume no liability associated with the use of this data, and assume no responsibility to maintain it in any matter or form.