

STUMP SOUND WATERSHED PROTECTION AND RESTORATION PLAN



November 2024

**Prepared by:
North Carolina Coastal Federation**

With Assistance From:
Greenman-Pedersen Inc. (GPI)
Town of Surf City
Town of North Topsail Beach
Onslow County
Town of Holly Ridge
Cape Fear Council of Governments

Dedication of Plan to Inspire Future Efforts to Protect Stump Sound

Lena Ritter
1936-2016

Lena Ritter was an extraordinary advocate for the North Carolina coast. She cherished Stump Sound and devoted decades to preserving its unique way of life. Her legacy includes the designation of Stump Sound as "Outstanding Resource Waters," the creation of public access and protection of 50 acres of waterfront at Morris Landing, and the establishment of the Permuda Island Estuarine Sanctuary—an area once at risk of becoming a 300-condo development with a marina. Alongside her neighbors, Bill and Bernice Rice, Lena left Stump Sound a better place for generations to come.



Table of Content

DEDICATION OF PLAN TO INSPIRE FUTURE EFFORTS TO PROTECT STUMP SOUND	1
EXECUTIVE SUMMARY	5
GUIDE TO EPA’S NINE MINIMUM ELEMENTS OF A WATERSHED PLAN	6
DEFINITIONS OF ACRONYMS USED IN THIS PLAN.....	7
SECTION 1: INTRODUCTION.....	11
SECTION 2: CHARACTERIZATION OF STUMP SOUND AND ITS WATERSHED.....	14
<i>History, Culture, Social, and Economic Importance of Stump Sound</i>	14
Figure 2-1: Stump Sound Watershed Boundaries Map.....	15
<i>Geographic Extent, Boundaries, and Existing Features</i>	16
Figure 2-2: Stump Sound Watersheds.....	16
<i>Soils Within the Stump Sound Watersheds</i>	16
Figure 2-3: Stump Sound Soils.....	17
<i>Wetlands, Creeks, and Streams in the Stump Sound Watersheds</i>	18
Table 2-1: Types and acreage of wetlands within the Stump Sound watershed	18
Figure 2-4: Freshwater Emergent and Forested/Shrub Wetlands	20
Figure 2-5: Estuarine and Marine Wetland.....	20
Figure 2-6: Blueline Streams and Coastal Waters.....	21
Figure 2-7: Stump Sound Flow Lines	21
Table 2-2: Length of Named Streams and Creeks	22
Figure 2-8: Stump Sound’s Sensitive Environmental Areas	23
<i>Existing Land Uses and Trends</i>	23
Figure 2-9: 2019 Stump Sound Land Cover.....	24
Table 2-3: Anderson Land Cover Classification	25
<i>Water Quality Conditions and Trends</i>	27
<i>Water Quality Classifications and Standards</i>	27
Figure 2-10: Bacteriological Water Quality Standards for North Carolina Quick Guide.....	28
Figure 2-11: Water Quality Designated Use	29
<i>Explanation of ORW Classification for the Sound</i>	29
<i>Trends Observed in Shellfish Sanitary Surveys</i>	30
Figure 2-12: B-9 Area Closures as Percentage of Time with Average Monthly Rainfall	31
Figure 2-13: B-9 Area Closures and Duration.....	31
<i>Changes in Shellfish Harvest Classifications</i>	31
Figure 2-14: E-3 Water Quality Monitoring Stations	32
Figure 2-15: Stump Sound Shellfish Prohibited Area 1975-1977	33
Figure 2-16: Stump Sound Shellfish Prohibited Area 2011-2016	34
<i>History of Impaired Listing on 303(d) List</i>	34
Table 2-5: Water Quality Summary of Stump Sound Watersheds (303d List).....	35
Figure 2-17: Water Quality Assessment Categories.....	38
<i>Suspected Causes of Impairments Listed in These Reports</i>	38
<i>N.C. DEQ Modeling Work</i>	38
Figure 2-18: Turkey Creek Tidal Prism Model Segments.....	39
<i>NOAA Precipitation Frequency Table</i>	39
Table 2-6: NOAA precipitation frequency table for Stump Sound	39
<i>Source Assessment</i>	40
Figure 2-19: Non-Discharge Permits within the Stump Sound Watersheds	41
Figure 2-20: Potential Nonpoint Wastewater Sources	42
Figure 2-21: NPDES and State Stormwater Permit.....	43
Table 2-6: List of State Stormwater Permits within Stump Sound Watersheds	43

Table 2-7: List of NPDES Permits within Stump Sound Watersheds	46
<i>Additional Pollution Sources</i>	46
Figure 2-22: Stormwater Areas of Concern.....	47
<i>Climate Change Risks and Resilience</i>	47
Figure 2-23 – Magnitude of sea level rise from different rates of acceleration	49
Figure 2-24: Surf City present day (2020) coastal marsh and ecosystem conditions	50
Figure 2-25: Surf City projected coastal marsh migration and ecosystem change by ~2050	51
SECTION 3: RUNOFF RATE AND VOLUME REDUCTION	52
<i>Modification of Natural Hydrology Explains How Stormwater Causes Water Quality Impairments</i>	52
Table 3-1: Identifying and linking concerns, causes, and indicators.....	53
<i>Runoff Calculation Methodology</i>	53
Table 3-2: Summary of Curve Numbers.....	54
Figure 3-1: South Morris.....	55
Figure 3-2: Everett Bay	56
Figure 3-3: Goose Bay.....	56
Figure 3-4: King Creek.....	57
Figure 3-5: Morris Landing.....	57
Figure 3-6: North Topsail.....	58
Figure 3-7: Permuda	58
Figure 3-8: Turkey Creek	59
<i>Volume Results of Runoff Calculations</i>	59
Figure 3-9: South Morris Landing.....	60
Figure 3-10: Everett Bay	60
Figure 3-11: Goose Bay.....	61
Figure 3-12: King Creek.....	61
Figure 3-13: Morris Landing.....	62
Figure 3-14: North Topsail.....	62
Figure 3-15: Permuda	63
Figure 3-16: Turkey Creek	63
<i>Runoff Volume Estimates for Stump Sound – 1980 to 2030</i>	64
Figure 3-17: Stump Sound Hydrograph (All Eight Watersheds).....	64
Table 3-3: Cubic Feet of Runoff Volume Created by the 1-Year, 24-Hour Storm Event.....	64
Table 3-4: Total Runoff Volume for all Watersheds	65
<i>Key Trends in Runoff Levels</i>	65
<i>Projected Increases in Runoff Volumes for Future Development</i>	67
<i>Implications of Runoff Findings</i>	68
SECTION 4: GOALS, OBJECTIVES, ACTIONS	70
Table 4-1: Primary Goals.....	71
<i>Objective 1: Act on Current Scientific, Technical, and Available Data</i>	71
Table 4-2: Actions and Timelines for Objective 1	72
<i>Objective 2: Restore and Perpetually Conserve Working Lands and Undeveloped Properties</i>	72
Figure 4-2: Potential Conservation Lands within Stump Sound.....	74
Table 4-3: Potential to Reduce Runoff from Conservation Lands	74
Table 4-4: Actions and Timeline for Objective 2	75
<i>Objective 3: Retrofit Stormwater Management Systems on Private Properties</i>	77
Table 4-5: Actions and Timeline for Objective 3.....	78
Table 4-6: Existing State Issued Permits on Private Properties That Are Out of Compliance	79
Table 4-7: Expired Stormwater Permits on Private Lands Not Evaluated by DEQ for Compliance	80
Table 4-8: Active Stormwater Permits on Private Properties Not Been Evaluated by DEQ for Compliance	80
Table 4-9: Active State Issued Stormwater Permits on Private Properties Deemed Compliant	81
Figure 4-3: Potential Private and Public Retrofit Sites	82
Table 4-10: Potential Retrofit Projects on Private Developed Lands	82

<i>Objective 4: Retrofit Publicly Owned Lands to Reduce Runoff</i>	87
Table 4-11: Actions and Timeline for Objective 4	87
Table 4-12: Public State Permitted Stormwater Systems with Active or Expired Permits Not Evaluated by DEQ ..	88
Figure 4-4: Existing Undeveloped Public Lands within Stump Sound Watershed	89
Table 4-13: Potential highway and town street retrofit projects identified during field visits	89
<i>Objective 5: Restore Living Shorelines</i>	90
Table 4-14: Actions and Timeline for Objective 5	91
<i>Objective 6: Monitor and Adapt Management Strategies</i>	92
Table 4-15: Actions and Timeline for Objective 6	92
<i>Objective 7: Inform and Engage</i>	92
Table 4-16: Actions and Timelines for Objective 7	92
<i>Objective 8: Update Plan Every Five Years</i>	93
Table 4-17: Actions and Timelines for Objective 8	93
SECTION 5: IMPLEMENTATION STRATEGIES	94
<i>Funding, Cost, and Technical Needs</i>	94
<i>Preventing More Runoff from New Development</i>	95
Figure 5-1: Area Required to Meet Low Impact Development Stormwater Measures.....	96
<i>Quantitative Measures of Outcomes from Plan</i>	96
Table 5-1: Runoff Reduction Goal Targets and Schedule	97
<i>Summary of Results</i>	98
SECTION 6: CONCLUSION	99
APPENDIX A: WATER QUALITY STANDARDS AND CLASSIFICATIONS	101
APPENDIX B: OBSERVATIONS RECORDED BY SHELLFISH SANITATION SECTION IN SANITARY SHORELINE SURVEYS	111
APPENDIX C: CONSERVATION EASEMENT FOR HOLLY RIDGE ASSOCIATES ACREAGE	118
APPENDIX D: POTENTIAL STORMWATER INCENTIVE STRATEGIES	132
APPENDIX E: STORMWATER MANAGEMENT DEVICES & STRATEGIES.....	152
APPENDIX F: SHORELINE SURVEY SOP	184

Executive Summary

The North Carolina Coastal Federation has chosen to proactively develop a watershed protection and restoration plan for Stump Sound which is in Onslow County behind Topsail Island. Stump Sound is one of North Carolina's premier places to grow oysters and other shellfish. It produces oysters that are renowned for their taste and size, and which have been known for decades as the "Cadillac of oysters" in the State.

This plan provides an overview of the past, present and projected water quality conditions in Stump Sound, and proposes methods and strategies intended to reduce the volume of polluted stormwater runoff to protect and improve its water quality. It outlines ways to mimic natural drainage processes to improve water quality and protect life and properties from flooding. This plan combines cost-effective, high-yield strategies such as community outreach initiatives and lot level retrofit projects aimed at reducing the impact of land uses by mimicking natural hydrology to reduce flooding and protect water quality.

The Stump Sound Watershed Restoration Plan emphasizes the application of the Environmental Protection Agency (EPA) Nine Minimum Elements, the North Carolina Department of Environmental Quality (DEQ) Section 319 office guidelines and practiced coastal watershed protection and restoration methods developed by the plan's partners. This plan is the result of a nearly two-year long process that involved input from local governments, fishers, landowners, residents, and visitors.

This restoration plan begins a multi-year process to implement and maintain, manage, and mitigate stormwater runoff issues and provide best management practices to protect the sound. There are multiple areas of concern identified in the plan that offer opportunities to drastically reduce or prevent the amount of stormwater runoff that degrades the sound, while at the same time helping reduce flooding in various areas throughout the watersheds. The plan includes all nine elements of a watershed management plan as required by the EPA to be eligible to apply for federal 319 grant funding as well as definitions of commonly used terms (see following charts). Additionally, the information provided in this plan enables the Federation and its partners to easily source the information necessary to apply for other state and national grant opportunities.

Guide to EPA’s Nine Minimum Elements of a Watershed Plan

1	Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the plan.	Section 2: Watershed Conditions Section 3: Runoff Volume Increases
2	An estimate of the load reductions expected from management measures.	Section 3: Runoff Volume Reduction Section 4: Goals Section 5: Quantitative Measures
3	A description of the nonpoint source management measures that will need to be implemented to achieve load reductions, and a description of the critical areas in which those measures will be needed to implement this plan.	Section 4: Goals, Objectives, Actions Section 5: Implementation Strategies
4	Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.	Section 5: Implementation Strategies
5	An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.	Section 4: Objective 7 Section 5: Implementation Strategies
6	Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.	Section 4: Objectives 1-8
7	A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.	Section 4: Objectives Timelines Section 5: Quantitative Measures
8	A set of criteria that can be used to determine whether load reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.	Section 4: Objectives 1, 6, 8 Section 5: Implementation Strategies
9	A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the established criteria.	Section 4: Objective 1, 6, 8 Section 5: Quantitative Measures

Definitions of Acronyms Used in this Plan

Acronyms and Definitions	
303(d) LIST	A list of waterbodies in each state that are too polluted or degraded to meet water quality standards. States are required to update their lists every two years.
319 GRANT	A grant program, named after Section 319 of the Clean Water Act, funded by EPA, and administered by NC DEQ to find solutions to impaired water.
APPROVED AREA	An area determined suitable for the harvest of shellfish for direct market purposes.
BIORETENTION AREAS	Also, known as rain gardens, these provide onsite retention of stormwater using vegetated depressions engineered to collect, store, and infiltrate runoff.
BMP	Best Management Practice of stormwater management; also, commonly referred to as Stormwater Control Measure (SCM) or Stormwater Infiltration Practice (SIP).
CAFO	Confined Animal Feeding Operation
CATCHMENT	A geographic unit within a sub watershed made up of a singular river, stream, or branch that contributes to a larger watershed.
CFU	Colony Forming Unit, used to measure fecal coliform bacteria concentrations.
CONDITIONALLY APPROVED CLOSED	This management strategy by North Carolina Shellfish Sanitation, refers to shellfish-growing waters that are closed to harvest because of high bacteria concentrations but can be opened temporarily, usually during periods of drought, when bacteria levels are low enough to make the shellfish safe to eat.
CONDITIONALLY APPROVED OPEN	This management strategy by North Carolina Shellfish Sanitation, refers to shellfish growing areas that are open to harvest but are temporarily closed after periods of moderate or heavy rain.
CWA	Clean Water Act
DCM	North Carolina Division of Coastal Management
DEGRADED WATERS	General description of surface waters that have elevated pollution levels, could include high bacteria levels, pathogens, sediment, low dissolved oxygen, and/or high nutrient levels. This is not a legal description of impairment (see impaired waters definition).
DEQ	North Carolina Department of Environmental Quality
DESIGNATED USE	A Clean Water Act term referring to the use, such as swimming, shellfish harvesting or aquatic life support, that a waterbody has been designated with

	by the state. The waterbody may not actually be able to support its designated use.
DOT	Department of Transportation
EPA	Environmental Protection Agency
EXISTING USE	A Clean Water Act term referring to all current uses and any use the waterbody has supported since November 28, 1975.
FDA	U.S. Food and Drug Administration
FECAL COLIFORM	These bacteria are found in the intestines of warm-blooded animals. They are not normally harmful to humans, but if found in a waterbody they could indicate the presence of harmful bacteria. Because they are easy to detect in the environment, these bacteria have been used for decades to determine the suitability of shellfish-growing waters.
FLOW	The volume of water moving through a channel over time, often measured in cubic feet per second (cfs).
GIS	Geographic Information Systems
GROWING WATERS	Waters that support or could support shellfish life.
HUC	Hydrologic Unit Code
HYDROGRAPH	A graph showing changes in the discharge of a surface water river, stream, or creek over a period.
HYDROLOGIC CYCLE	The cycle by which water evaporates from oceans and other bodies of water, accumulates as water vapor in clouds, and returns to the oceans and other bodies of water as precipitation or groundwater. Also, known as the water cycle.
HYDROLOGY	The science dealing with the waters of the earth, their distribution on the surface and underground, and the cycle involving evaporation, precipitation, flow to the seas, etc.
IMPAIRED WATERS	This Clean Water Act term refers to waters that no longer meet their designated uses. That would include conditionally approved and conditionally closed waters and any water where swimming advisories are being issued. These waters have been listed as impaired on the state's 303(d) list for EPA.
IMPERVIOUS COVER	A hard surface area, such as a parking lot or rooftop, that prevents or retards water from entering the soil, thus causing water to run off the surface in greater quantities and at an increased rate of flow.
INTERTIDAL	Area of land that is submerged during high tide and exposed at low tide.

LAND USE	The management and modification of natural environment or wilderness into built environment such as settlements and semi-natural habitats such as arable fields, pastures, and managed woods.
LID	Low Impact Development refers to management strategies that attempt to mimic conditions to reduce the flow of stormwater. To be successful, they should be integrated into all phases of urban planning and design from the individual residential lot level to the entire watershed.
LULC	Land use/land cover
MAXIMUM EXTENT PRACTICABLE	This term appears in many state and federal pollution regulations. It generally refers to pollution controls that are technologically available and capable of being done after taking into consideration cost and logistics.
MS4	Municipal separate storm sewer systems
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source, diffused sources of pollution, where there is no singular distinct outflow point.
NRCS	Natural Resources Conservation Service
NSSP	National Shellfish Sanitation Program
RETROFITTING	Structural stormwater management measures for preexisting development designed to help reduce the effect of impervious areas, minimize channel erosion, reduce pollutant loads, promote conditions for improve aquatic habitat, and correct past efforts that no longer represent the best science or technology.
ROW	Right of Way
RUNOFF CURVE	A runoff curve number is a numeric parameter derived from combining the effects of soil, watershed characteristics, and land use.
SA	This is a state saltwater classification intended for shellfish harvesting. These are waters that should also support aquatic life, both primary and secondary recreation (activities with frequent or prolonged skin contact), and shellfish harvest for market purposes. It is one of the highest water classifications in the state.
SB	This is a state saltwater classification intended for swimming.

SC	This is a state saltwater classification intended for fish propagation and incidental swimming. The waters are safe for swimming but have a higher risk of pollution and human illness than SB waters.
SCM	Stormwater Control Measure, also more commonly known as a Best Management Practice (BMP) of stormwater management; also, commonly referred to as Stormwater Infiltration Practice (SIP)
Shellfish	Shellfish as referenced in this document means molluscan shellfish, oysters, and clams.
SHELLFISH SANITATION	Shellfish Sanitation and Recreational Water Quality Section, N.C. Division of Marine Fisheries, N.C. DEQ.
SIP	Stormwater Infiltration Practice, also more commonly known as a Best Management Practice (BMP) of stormwater management; also, commonly referred to as Stormwater Control Measure (SCM).
STORMWATER	Water from rain that flows over the land surface, picking up pollutants that are on the ground.
SUBWATERSHED	A geographic unit within a watershed made up of individual minor rivers, streams, or branches that contribute to a larger watershed.
TMDL	Total maximum daily load, the maximum amount of a pollutant that can be found in a waterbody and still meet federal Clean Water Act standards.
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WATERSHED	All areas that drain to a waterbody, whether that be a lake, mouth of a river, or ocean.
WQS	Water quality standards

Section 1: Introduction

This watershed protection and restoration plan is a blueprint for action adopted by the North Carolina Coastal Federation as a roadmap to collaborate with four local governments, state and federal agencies, and local stakeholders (landowners, fishers, shellfish farmers, and interested citizens) to protect and restore water quality in Stump Sound. It was prepared in cooperation with these varied interests, and the Federation plans to use the plan to forge future partnerships to implement recommended actions. Since 1983, the Federation has been actively engaged in protecting Stump Sound from pollution, including work that:

- (1) Preserved Permuda Island from intense condominium and marina development plan;
- (2) Established the state's coastal stormwater management program to protect shellfish from bacteria pollution;
- (3) Designated Stump Sound as Outstanding Resource Waters in 1989;
- (4) Preserved of living shorelines and public access at Morris Landing purchasing 50 acres;
- (5) Restored illegally drained wetlands on over 1,200-acres on the Holly Ridge Associates property which resulted in a settlement that entrusted the Federation to manage over 200 acres of conservation easements on the land as well as other water quality enhancement projects conducted in the sound; and
- (6) Provided shell storage and shell dock loading facilities to the N.C. Division of Marine Fisheries that facilitate the placement of oyster shells to rebuild oyster reefs.

This plan constitutes the next chapter in the Federation's work to enhance Stump Sound and preserve its water quality for future generations.

Stump Sound in Onslow County is a tidal estuary that is situated between Topsail Island and the Onslow County mainland. It is renowned for its fabulous oysters that grow both naturally and are cultivated in privately held leases. The sound supported local fishermen for generations who traditionally caught wild and farm-cultivated oysters. In the 1980s, the sound attracted statewide attention as local fishers concerned about more frequent closures of waters for shellfish harvest sought greater safeguards for water quality to protect it from polluted stormwater runoff generated by nearby intensive land development.

Between 1985 until 1989, these concerns about water quality degradation in the sound prompted the North Carolina Environmental Management Commission to adopt coastal stormwater regulations and to designate the sound as "Outstanding Resource Waters." Despite these additional safeguards, water quality continues to decline as more nearby land is developed and the rate and volume of stormwater runoff increases. At the same time, there has been a resurgence of oyster farming in the sound, as more intensive water column leasing has expanded exponentially. These commercial operations are frequently disrupted by temporary harvest closures that now occur whenever there is 1.5 inches or more of rainfall. This watershed plan was developed to provide a roadmap for stakeholders such as the North

Carolina Coastal Federation, fishermen and shellfish farmers, local communities, and the State to take strategic and comprehensive voluntary actions to address existing and potential pollution threats to the sound.

This plan seeks to:

1. Restore and maintain the water quality of the Stump Sound watersheds;
2. Reduce instances of localized flooding to improve safety and protect property while concurrently protecting and restoring water quality;
3. Improve the resilience of the Town's infrastructure by reducing the volume of stormwater through stormwater retrofits, the use of living shorelines for shoreline stabilization, incorporating vegetative buffers, and other nature-based solutions;
4. Prioritize cost-effective nature-based stormwater retrofit techniques to address stormwater management;
5. Analyze the effects of climate change, including sea level rise, storms, and flooding, on existing stormwater infrastructure; and
6. Identify and prioritize the purchase of conservation lands, expand the use of conservation easements, and maintain existing open spaces.

Implementation of this plan should result in improvements to water quality to protect and restore Stump Sound's current designated uses for shellfish harvest and the Outstanding Resource Waters. Eight watersheds comprise the boundaries of Stump Sound, further identified by the 12-digit HUC code as Unit 30203020301. The goal of this Plan is to reduce stormwater runoff caused by a 2-year 24-hour storm to the amount that occurred during the baseline condition of the 1980's.

This document provides an overview of the past and present hydrologic conditions influencing the stormwater runoff and recommends methods and strategies for mitigating impacts. Stormwater runoff frequently has a negative impact on water quality and excessive amounts cause hazardous flooding conditions. Based on aerial imagery and the analysis within this report, a large increase in impervious surfaces resulting from development has caused a large increase in runoff. In addition, climate change effects, including sea level rise, increased storm frequency and strength and associated surges, increased flooding, saltwater intrusion, and increased shoreline erosion make existing stormwater runoff issues and water quality problems worse in Stump Sound.

This plan lays out cost effective methods to improve and protect water quality in Stump Sound. The plan identifies 22 proposed stormwater project site locations with proposed stormwater treatment methods, nine potential conservation land projects, a representation of viable living shoreline areas and suggested/existing land use plan and/or local ordinance language to implement within the Towns of Holly Ridge, North Topsail Beach, Surf City and Onslow County. This plan focuses on the importance of disconnecting impervious surfaces that currently tie directly into the existing drainage infrastructure. Doing so will allow a portion of the

stormwater to infiltrate into the many fast-draining, sandy soils to mitigate flooding while subsequently enhancing the water quality of the infiltrated stormwater. The Stump Sound Watershed Protection and Restoration Plan focuses on the application of the Environmental Protection Agency's (EPA) Nine Minimum Elements, the North Carolina Department of Environmental Quality (DEQ) Section 319 guidelines, and the practiced coastal watershed restoration methodology developed by the plan's partners.

Efforts to re-direct and infiltrate stormwater runoff will make a significant difference to reduce polluted runoff and associated flooding within the sound's watershed. However, nature-based, and targeted stormwater management solutions won't be sufficient alone to provide the long-term water quality safeguards necessary to maintain shellfish waters that can safely be harvested. These practices must be used in combination with conservation land protections and acquisition, living shorelines, and proactive land use regulation and management, to effectively maintain water quality in the sound especially as more extreme weather and intense land uses result in more intense rainfall and great potential for higher rates and volumes of stormwater runoff.

Section 2: Characterization of Stump Sound and Its Watershed

Increased rates and volumes of surface stormwater runoff related to land uses within the Stump Sound watershed are primarily responsible for both permanent and temporary closures of shellfish waters to harvest. These closures mean that the waters in the Sound that are designated for shellfish harvest (SA) and as Outstanding Resource Waters (ORW) are now legally impaired based upon U.S. EPA water quality classifications and standards. The land use changes that have occurred in the sound's watershed since 1980 include extensive residential and commercial development, as well as other land management practices, that altered the natural hydrology of the landscape creating more surface runoff that now carries bacteria (much of which is naturally occurring) from the land's surface into coastal waters thereby causing these water quality impairments. This section of plan provides an in-depth characterization of the sound and its watershed, and the land use changes experienced.

Stump Sound is between Topsail Island and the mainland of Onslow County bound by the Highway 172 high rise bridge to the north and the northern portion of the Surf City to the south. Tides flow into the sound from New River and Topsail Inlets. There are eight adjacent watersheds that drain into the sound including: Everett Bay, Goose Bay, Kings Creek, Morris Landing, North Topsail, Permuda, South Morris Landing and Turkey Creek. Portions of these watersheds are located on Topsail Island and the mainland within unincorporated areas of Onslow County, and the Towns of Holly Ridge and North Topsail Beach. (Figure 2-1). Approximately 14,754 acres (not including salt marshes) comprise these eight watersheds.

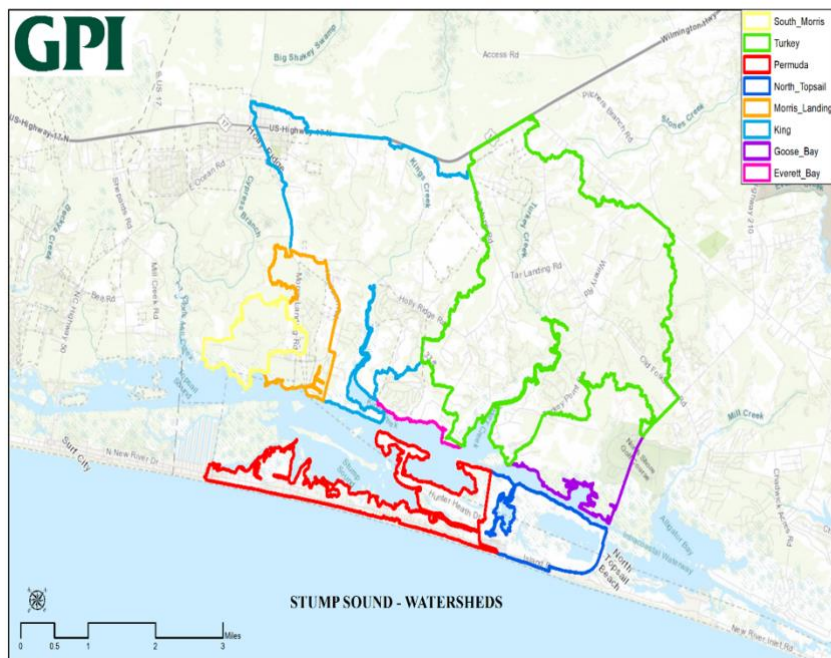
Stump Sound is designated as Outstanding Resource Waters by the North Carolina Environmental Management Commission (EMC) because in 1989 it had exceptional shellfish resources and water quality. Since then, more intense land uses primarily for residential and commercial development have reduced forest cover and modified watershed hydrology with more ditches and impervious land cover. This increased the amount and rate of runoff, which has resulted in Stump Sound now being listed by the State of North Carolina as having "impaired" water quality because of frequent restriction to shellfish harvest after rainfall events.

History, Culture, Social, and Economic Importance of Stump Sound

Stump Sound is a wonderful place to swim, fish, and cultivate shellfish.

In 1983 local shell fishers became concerned that stormwater runoff from nearby intense development projects would pollute their oyster leases. For generations, they depended on the waters for a living and became really concerned when over 300 condominiums and a marina were proposed to be built on Permuda Island right in the middle of their shellfish beds. Local fishers led by Lena Ritter and Bill Rice worked to bring these water quality concerns to the

Figure 2-1: Stump Sound Watershed Boundaries Map



attention of local, state, and federal leaders and regulators. As a result of their work, funds were found to purchase Permuda Island for preservation. In addition, the concerns they raised resulted in the adoption of the first coastal stormwater program in the 20 coastal counties in 1986. North Carolina has been a prolific producer of oysters since the 1880s. Harvests peaked in 1902 at 800,000 bushels but reached a low in 1994 with 35,000 bushels.¹ The industry has since rebounded, accounting for 158,000 bushels in 2017. Stump Sound has been an important and special growing area for producing shellfish. The sound accounts for an average of 12 percent of the total annual commercial oyster harvest value for North Carolina between 1994 and 2013.²

Stump Sound waters are important to the livelihood of the fishermen who use the sound. Maintaining clean waters is important for the economics of the area. A case study completed for the North Carolina Coastal Federation by the Research Triangle Institute, International on Morris Landing in a 2015 report revealed that projects to restore and protect Stump Sound generated \$945,520 in revenue, including \$324,765 in household income.³ Stump Sound oysters are known within the state as the “Cadillac” of oysters due to their size and texture. In recent years, it has become an important center for growth in the shellfish farming industry

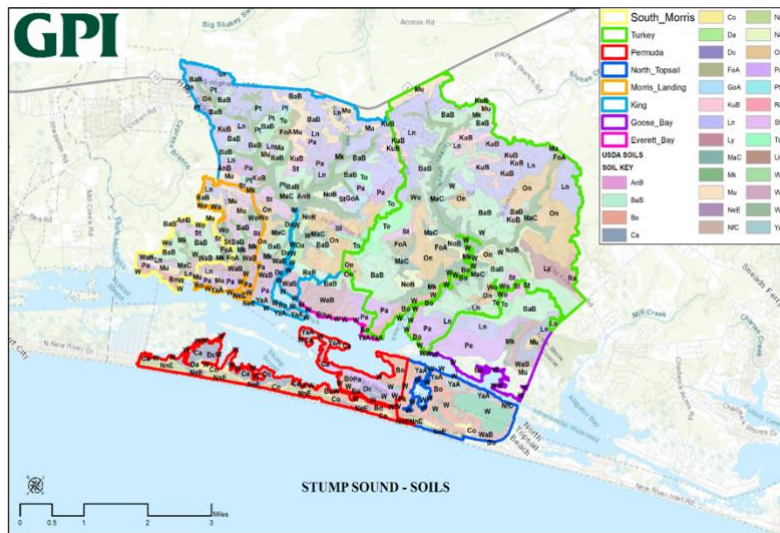
¹ <https://deq.nc.gov/media/19948/download>

² <https://files.nc.gov/ncdeq/Marine-Fisheries/fisheries-management/oyster/02-2017-Am4-OysterFMP-Final.pdf>

³ http://www.nccoast.org/wp-content/uploads/2015/03/Final_NCCF_1-19-15.pdf

because of the change of the available water capacity of the soil. Certain wet soils are placed in Group D based solely on the presence of a water table within 60 centimeters (24 inches) of the surface, even though the saturated hydraulic conductivity may be favorable for water transmission. If these soils can be adequately drained, they are assigned to dual hydrologic soil groups (A/D, B/D, and C/D) based on their saturated hydraulic conductivity and the water table depth when drained. When referring to hydrologic soil groups, adequately drained means that the seasonal high-water table is kept at least 60 centimeters (24 inches) below the surface in a soil where it would be higher in a natural state.

Figure 2-3: Stump Sound Soils⁴



Soil Group A is prominent across the Islands and areas with proximity to coastal surface water and while soil group A/D is primarily found further upland from the surface water. The following is the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) summary description for each soil group⁵:

- **Group A** soils are sands, loamy sands, or sandy loams. These soils have high infiltration rates even when thoroughly saturated. These soils consist of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
- **Group B** soils are silt loams or loams. These soils have moderate infiltration rates when thoroughly saturated and consist of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

⁴ United States Department of Agriculture Natural Resource Conservation Service Web Soil Survey. (n.d.). Retrieved from <https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx>.

⁵ Natural Resources Conservation Service. (n.d.). Updated Hydrologic Soil Group. *United States Department of Agriculture Natural Resource Conservation Service*.

- **Group C** soils are sandy clay loams. These soils have low infiltration rates when thoroughly saturated and consist of soils with a horizon that impedes downward movement of water and possesses moderately fine to fine texture.
- **Group D** soils are clay loams, silty clay loams, sandy clays, silty clays, or clay. These soils have the highest runoff potential. These soils have very low infiltration rates when thoroughly saturated and consist of clay soils with a high swelling potential, soils with a permanent high-water table, soils with a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material.

Soil survey data is useful in determining target sites for infiltration based retrofit projects. Site soil characteristics, as with any characteristic, should always be field surveyed to determine the extent of characteristics at a project site. Project consultants Greenman-Pedersen, Inc. (GPI) has determined that on coastal barrier islands with deep sand profiles, the infiltration rate is higher than reported of similar “Group A” soils in other locations where the soil type may have originally been mapped and tested. Overall, there appear to be multiple good soils within the sound’s watersheds that will allow for stormwater management systems that infiltrate into the landscape rather than runoff into nearby surface waters.

Wetlands, Creeks, and Streams in the Stump Sound Watersheds

Stump Sound includes various wetland areas, creeks, and streams. The sound area is also surrounded by forested areas, agriculture, and high density and low intensity residential areas. The Stump Sound watershed possesses qualities that make the sound ideal for growing shellfish and as a fish nursery. The sound offers an ideal mix of fresh and salt waters for producing oysters. Stump Sound waters are also ideal for nursery habitats for many local aquatic species.

The watersheds of Stump Sound contain approximately 3,001 acres of wetlands. Table 2-1 lists the types and acres of wetlands found throughout the sound’s watersheds. Figures 2-4 through 2-8 show the wetlands and hydrologic features of the watershed. Table 2-2 lists the names and the lengths of creeks that flow into the sound.

Table 2-1: Types and acreage of wetlands within the Stump Sound watershed

Wetland Type	Acreage
Estuarine and Marine Wetland	1,112
Freshwater Emergent Wetland	8
Freshwater Forested/Shrub Wetland	1,881
Total	3,001

Figure 2-4: Freshwater Emergent and Forested/Shrub Wetlands

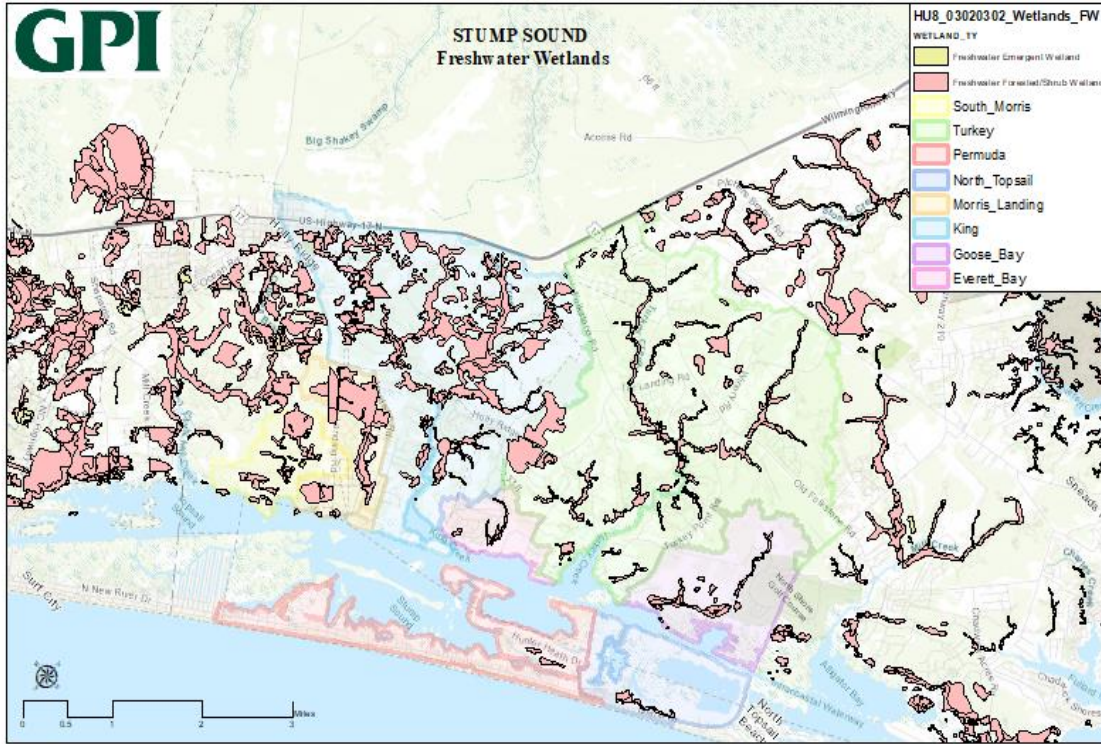


Figure 2-5: Estuarine and Marine Wetland

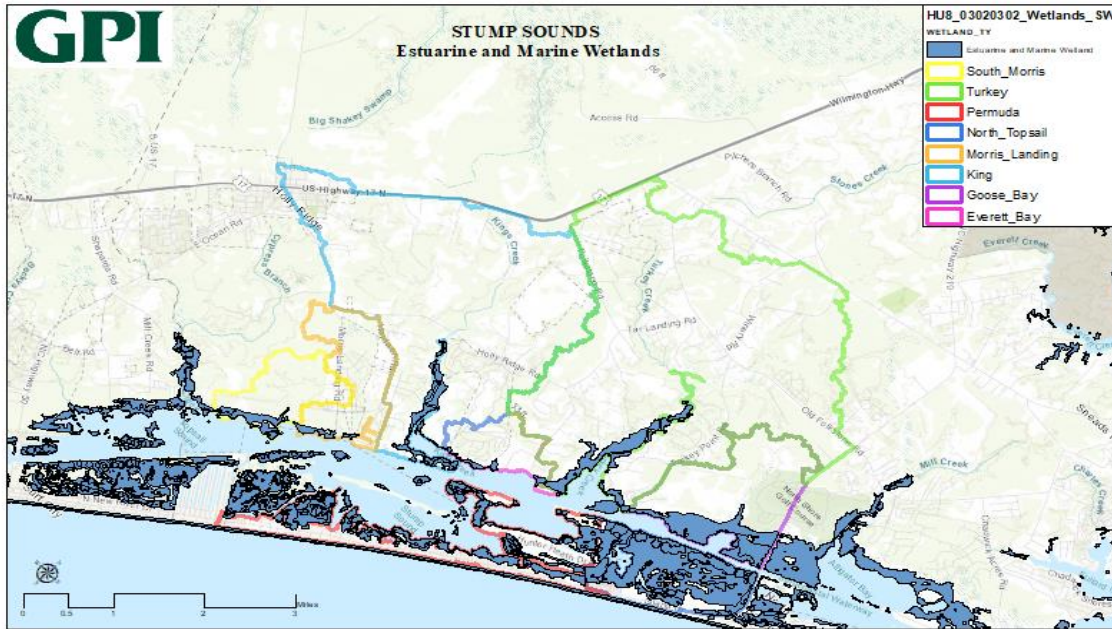


Figure 2-6: Blueline Streams and Coastal Waters

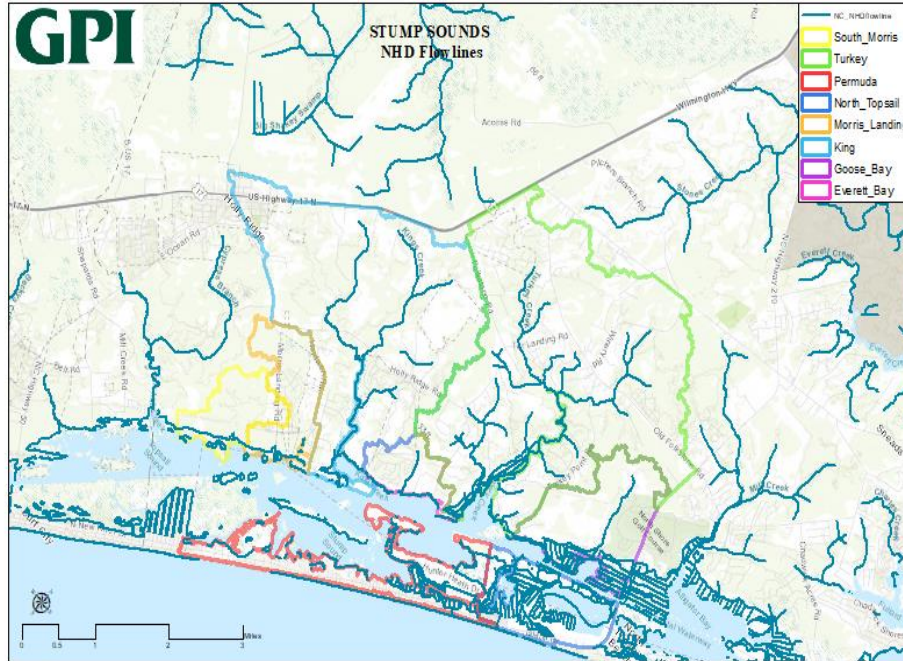


Figure 2-7: Stump Sound Flow Lines

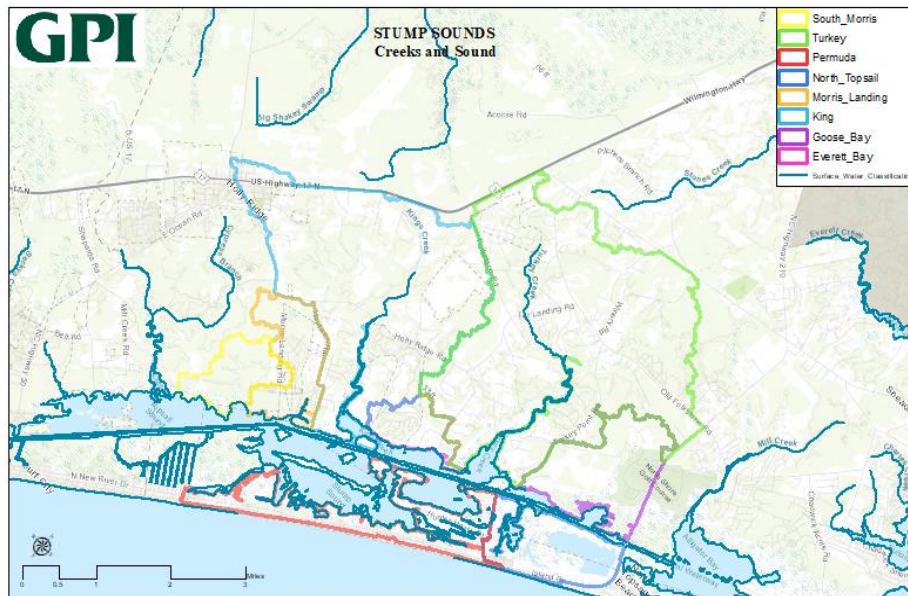


Table 2-2: Length of Named Streams and Creeks

Creek/Stream Name	Length (Ft)
Batts Mill Creek	6987.0
Beckys Creek	7129.4
Big Shakey Swamp	6006.2
Biglins Creek	2005.9
Charles Creek	4733.6
County Line Branch	1936.1
Cypress Branch	4365.0
Everett Creek	9822.9
Flat Swamp	7590.3
Fullard Creek	6978.5
Hardison Creek	2171.7
Juniper Swamp	15206.3
King Creek (Restricted Area)	12153.4
Mill Creek	7618.0
Old Mill Creek	1360.3
Stones Creek	16554.8
Turkey Creek	12673.9
TOTAL LENGTH	125293.3

Table 2-3: Anderson Land Cover Classification

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.
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 to produce annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and 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.

The land use within the watersheds falls primarily in groups 42/43 Evergreen and Mixed Forest, 22 – Low Intensity Development, as well as 90/95 Woody and Emergent Wetlands. A summary of the land use can be visualized within the watersheds using Figure 2-9. These categories represent the current designated land uses as classified by USGS and do not mean that the land has been altered or developed. Understanding the current land uses of the watershed will enhance this plan’s ability to address education and outreach, and to tailor stormwater reduction techniques to the community’s needs. For example, if a watershed is predominately residential, it may be more effective to develop strategies that focus on lot-level stormwater reduction or residential stormwater ordinances.

Water Quality Conditions and Trends

Land development and land use change has impacted the condition of the Stump Sound watersheds over the past five decades. Factors such as increased stormwater runoff, pollution, drainage infrastructure, and dockage have affected the water quality within the watersheds. Water quality classifications, watershed conditions and water quality monitoring data are presented below.

Water Quality Classifications and Standards

North Carolina has various methods to protect and measure water quality. This plan uses the state’s water quality classification system and swimming usage tier scale systems (refer to Appendix A for detailed guide of Water Quality Classification and Standards).

While Stump Sound has both SA (shellfish) and SC (waters where treated sewage can be discharged) waters, the watersheds that are the primary focus of this plan are Class SA which are classified as legally “impaired” on the 303(d) list. These waters should be able to support direct contact recreation and commercial shellfish harvest uses.

Waters in the sound are also monitored for their suitability for swimming. The tier scale assigned by the State affects the prioritization of sampling and the minimum water quality standards for swimming waters being tested. Tier I classified waters are the highest priority and are locations that are used daily, Tier II are not used as heavily for swimming and see the most use on weekends, and Tier III sites are used less frequently. These Tiers coincide with sampling requirements and maximum observation of bacteria. There are four swimming water quality monitoring stations within the boundaries of the watershed (three are Tier III, one is Tier I).

Figure 2-10: Bacteriological Water Quality Standards for North Carolina Quick Guide

Bacteriological Water Quality Standards for North Carolina Quick Guide

Shellfishing

For waters to be approved as Class SA area of harvest for direct consumption the following criteria must be met:

- (1) the shoreline survey has indicated that there are no significant sources of contamination;
- (2) the area is not so contaminated with fecal coliform that consumption of the shellfish might be hazardous;
- (3) the area is not so contaminated with radionuclides or industrial wastes that consumption of the shellfish might be hazardous; and
- (4) the median fecal coliform Most Probable Number (MPN) or the geometric mean MPN of water shall not exceed **14 per 100 milliliters**, and the 90th percentile shall not exceed 43 per 100 milliliters (per five tube decimal dilution) in those portions of areas most probably exposed to fecal contamination during most unfavorable hydrographic conditions.

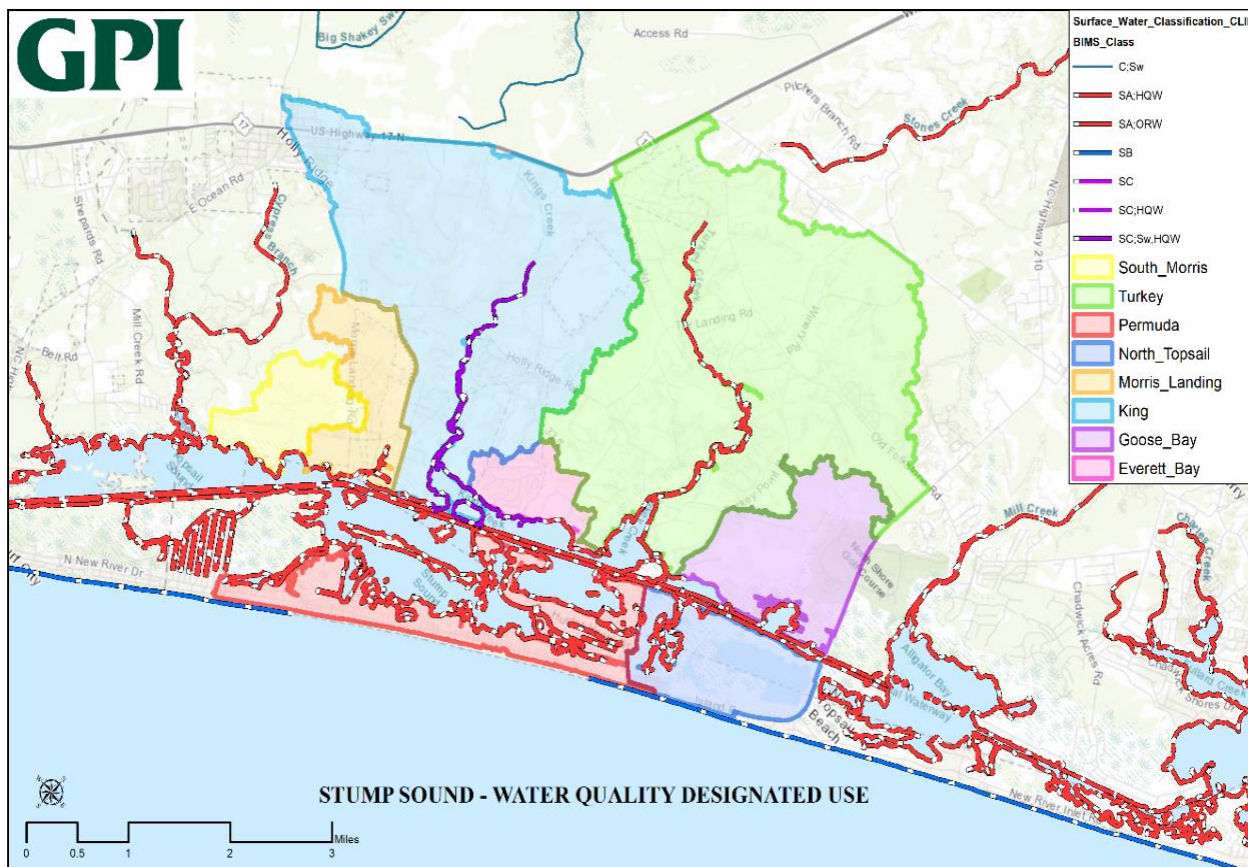
Swimming

("swimming season" April 1 – October 31)

The following standards apply to coastal North Carolina waters:

- **Tier I**
"A swimming area used daily during the swimming season, including any public access swimming area and any other swimming area where people use the water for primary contact, including all oceanfront beaches"
A geometric mean of at least five samples in 30 days that results in **35 enterococci per 100 ml of water OR a single sample of 104 enterococci in a 100-ml sample**
- **Tier II**
"A swimming area used an average of three days a week during the swimming season"
Single sample of **276 enterococci in a 100-ml sample**
- **Tier III**
"A swimming area used an average of four days a month during the swimming season"
Two consecutive samples of **500 enterococci in each 100-ml sample**

Figure 2-11: Water Quality Designated Use⁶



Explanation of ORW Classification for the Sound

Outstanding Resource Waters (ORW) is a federal Clean Water Act classification adopted into the North Carolina water quality standards that protects waters that have excellent water quality and are in exceptional state or that are ecologically or recreationally important. These waters must receive an excellent rating when classified as ORW and have significant fish habitats and fisheries, unusually high levels or potential for unusually high levels of water-based recreation and commerce, or special ecological or scientific significance.

Stump Sound was classified as ORW in 1989 based on its exceptional water quality and fisheries. The saltwater to freshwater ratio in Stump Sound is optimal for producing oysters.

⁶Surface Water Classifications. (n.d.). Retrieved October 05, 2020, from <https://data-ncdenr.opendata.arcgis.com/datasets/surface-water-classifications>.

Additionally, the water quality allows for good fishing opportunities and provides crucial nursery habitats for local aquatic life.

Trends Observed in Shellfish Sanitary Surveys

Permanent Closures

Over the course of the last two decades the area’s surface waters have become increasingly more polluted by bacterial contamination. Specific areas within the Stump Sound watershed have been designated as prohibited from shellfish harvest since 1975. Persistently high bacterial counts have resulted in the designated uses of these waters not being met, which has led to waters within the multiple Stump Sound sub-watersheds being placed on the state’s 303(d) list for impairment, according to the 2020 Integrated Report. Table 2-4 is a summary of the water quality for all the watersheds.

Table 2-4: Water Quality Summary of Stump Sound Watersheds

Watershed	Designated Use	Shellfish Sanitation Closure Year	Shellfish Status
King Creek	SC	1975	All the waters of King Creek and that part of Stump Sound north of the Intercoastal Waterway channel
Rodgers Bay	SA	1986	All of Rogers Bay
Turkey Creek	SA	1992	All those waters upstream of the creek’s mouth

Temporary Closures

Temporary closures after rainfall are made by the North Carolina Division of Marine Fisheries. These closures are issued after rain events produce runoff. These closures are temporary and make it unlawful to take any oysters, clams, and mussels from the area for sale or consumption. Figure 2-12 depicts the shellfish percent closure over time with average monthly rainfall and Figure 2-13 depicts the number of temporary closures and duration of such closures.

Figure 2-12: B-9 Area Closures as Percentage of Time with Average Monthly Rainfall

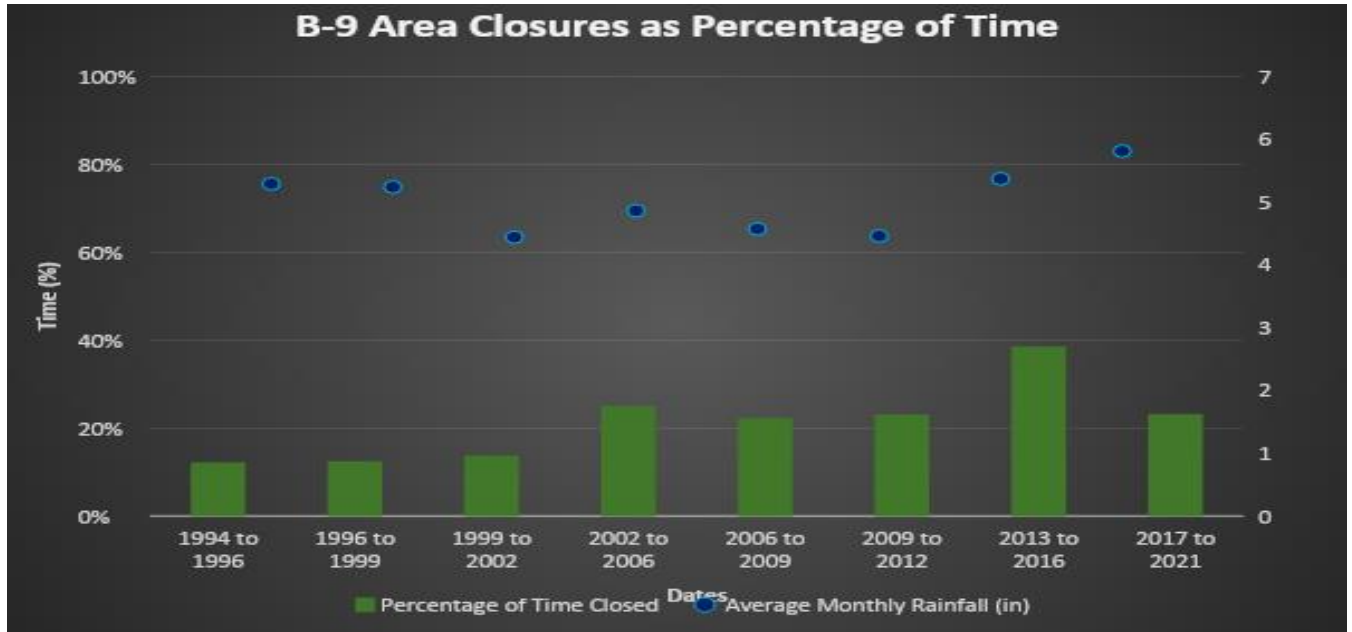
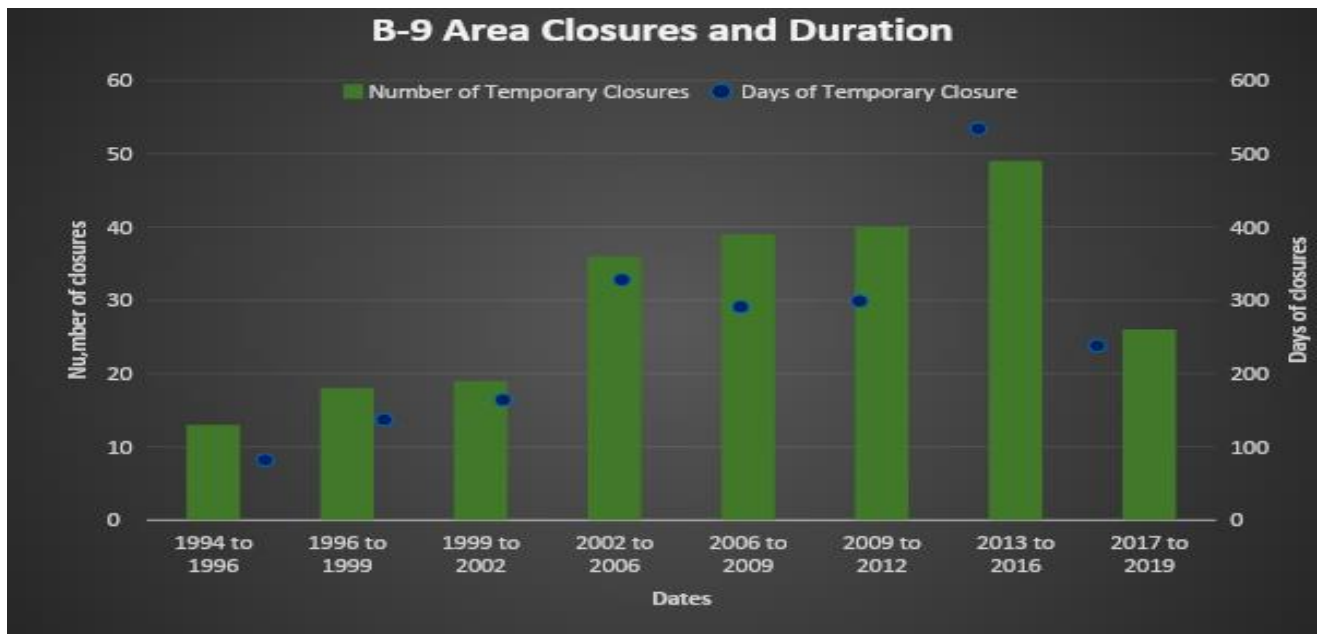


Figure 2-13: B-9 Area Closures and Duration



Changes in Shellfish Harvest Classifications

There are numerous monitoring stations utilized by the Shellfish Sanitation Section within the Division of Marine Fisheries to classify shellfish growing waters to determine which water

bodies are suitable for harvest and raw consumption. The Division of Water Resources uses this water quality data to ensure that designated uses are being met. Every three years N.C. Shellfish Sanitation staff visited the entire shoreline of shellfish growing areas to document current and potential pollution sources. The data collected by Shellfish Sanitation is publicly available and is a source of historical and present-day information regarding water quality of an area. By utilizing historic data, communities can research long term changes in water quality. Shellfish closure area information can be used by communities to determine what waterways are impaired and the source of impairment. These up-to-date surveys and monitoring station data will be the primary source of historic and current information.

Figure 2-14 shows the location of water quality sampling stations maintained by the State Division of Marine Fisheries. Over the past few decades, the procedures used by the Shellfish Sanitation Branch to measure fecal coliform contamination have evolved as it has developed water quality management plans that allow it to issue temporary closures. Without this management framework in place, the extent of permanent closures would increase significantly.

Figure 2-14: E-3 Water Quality Monitoring Stations



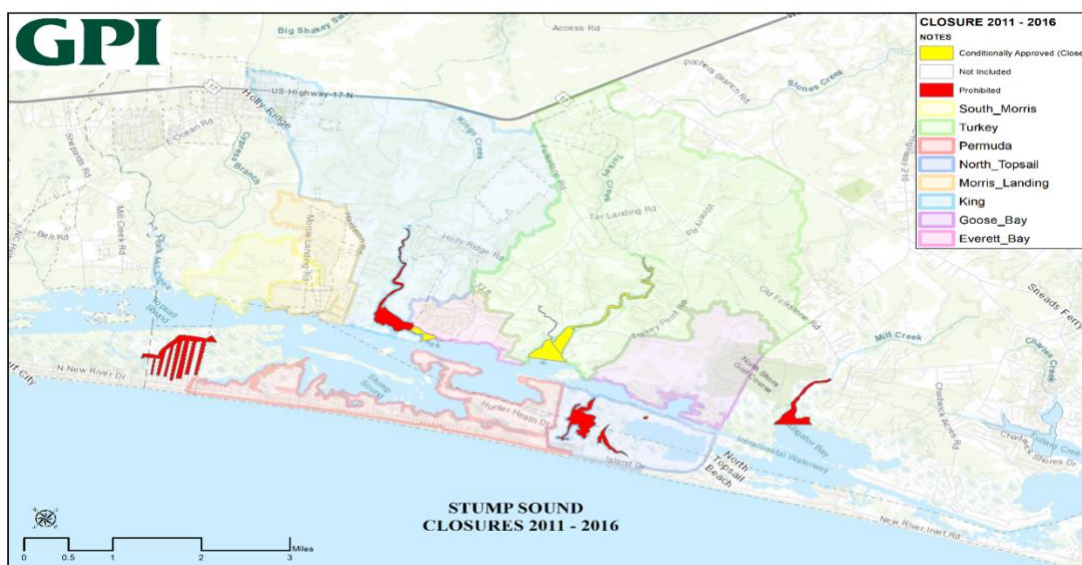
Under the federal Clean Water Act (CWA), as well as state water quality regulations, any waters that don't maintain their "existing uses" such as for shellfish harvest are legally impaired waters. This legal impairment applies to waters that have been permanently closed, or under a management plan temporarily closed to shellfish harvest since November 1975. There is an obligation to restore water quality back to its condition in this baseline year under federal and state water quality laws.

Figure 2-15 shows the extent of permanent closures that existed around 1975. No temporary closures occurred during this time. Waters were either open or prohibited. This is the ultimate baseline water quality condition for Stump Sound that this plan seeks to obtain through water quality improvement projects.

Figure 2-15: Stump Sound Shellfish Prohibited Area 1975-1977



Figure 2-16: Stump Sound Shellfish Prohibited Area 2011-2016



While the extent of permanent closures in Stump Sound has not grown dramatically since 1974, the amount of time the entire sound is closed on a temporary basis to shellfish harvest has increased significantly, nearing 40 percent of the year recently. This trend must be reversed to comply with obligations under federal and state water quality laws.

History of Impaired Listing on 303(d) List

The CWA and state water quality laws and regulations require that steps be taken to remove legal impairments from 303(d) listed waterways (refer to Appendix A for more details on water quality assessment categories). When surface waters no longer comply with federal water quality standards, CWA mandates that state's take steps to mitigate the water quality impairment and restore water quality to acceptable levels. This normally involves conducting a Total Maximum Daily Load (TMDL) study to determine to what extent a contaminant must be reduced to meet water quality standards. TMDL studies can take several years to complete and can be costly; between \$26,000 to over \$500,000 with the average being \$52,000⁷. Often, time and financial resources are not sufficient to allow for TMDL development in smaller water bodies dominated by nonpoint source pollution.

There are currently no TMDL reports completed for the impaired waters of the Stump Sound Watersheds. Partners agree that reduction of stormwater volume is the most beneficial and cost-effective way to reduce contamination and head off the necessity for developing a TMDL. Table 2-5 is a detailed list of the area's impaired water bodies and Figure 2-17 is the associated

⁷ United States Environmental Protection Agency. (2001). The National Costs of the Total Maximum Daily Load Program (EPA 841-D-01-003). Washington, DC: U.S. Government Printing Office.

map. Table 2-5 is a summary list of waterbodies in the Stump Sound region currently on the 303(d)-list published in 2018, that do not meet their designated uses.

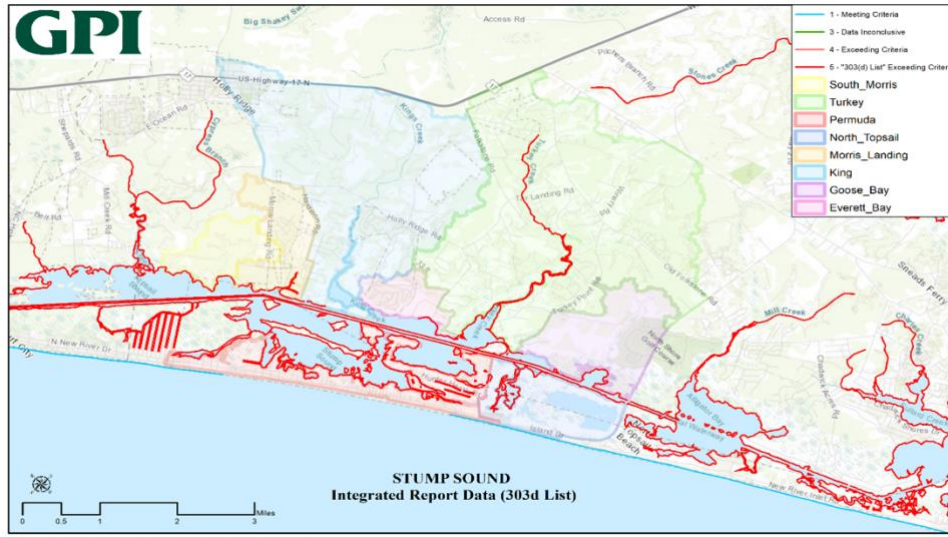
Table 2-5: Water Quality Summary of Stump Sound Watersheds (303d List)

Name	Assessment Unit	Integrated Report Category	Parameter	Class
Everett Bay	18-87-2	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Goose Bay	19-39-2	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Hardison Creek	18-87-5	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW
Hardison Creek	18-87-5	3a	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW
Intracoastal Waterway	18-87-(5.5)	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW
Intracoastal Waterway	18-87	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Intracoastal Waterway	19-39-(0.5)	3a	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Intracoastal Waterway	19-39-(0.5)	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Rogers Bay	19-39-1a	3a	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW

Rogers Bay	19-39-1a	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW
Stump Sound	18-87-3	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Stump Sound ORW Area	18-87-0.5	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA; ORW
Stump Sound ORW Area	18-87-0.5	3a	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Stump Sound ORW Area	18-87-0.5	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Topsail Sound	18-87-10c	3a	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW
Topsail Sound	18-87-10c	3a	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW
Topsail Sound	18-87-10c	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW
Topsail Sound	18-87-10a2b	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW
Turkey Creek	18-87-1b	3a	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Turkey Creek	18-87-1b	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Turkey Creek	18-87-1a	3a	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW

Turkey Creek	18-87-1a	3a	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Turkey Creek	18-87-1a	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;ORW
Rogers Bay	19-39-1b	5	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW
Rogers Bay	19-39-1b	3a	Shellfish Growing Area Status (Fecal, SH, SA)	SA;HQW
Stump Sound ORW Area	18-87-0.5	1	Enterococcus (GM 35 5 in 30, REC, SW)	SA;ORW
Stump Sound ORW Area	18-87-0.5	3a	Enterococcus (GM 35 5 in 30, REC, SW)	SA;ORW

Figure 2-17: Water Quality Assessment Categories⁸



Suspected Causes of Impairments Listed in These Reports

The parameter causing the 303(d) impairments was primarily the shellfish growing area status measured through fecal coliform criteria in waters used for shellfish harvesting. Two of the impairments listed on the 303(d) list were recreational waters with advisories based on Enterococcus criteria. Suspected causes of these impairments include polluted runoff from nearby sources. Recent growth in the Stump Sound area has created a higher probability of pollutants and contaminants entering the waters through runoff. Elements of growth that can impact runoff and water quality include impervious surface, drainage ditches, leaking sewage lines, highways, and other paved areas. The water quality trends and concerns for the sound are clearly documented in the Shoreline Shellfish Sanitary Surveys conducted by the State between 1948 and 2019. A summary of these concerns is provided in Appendix B.

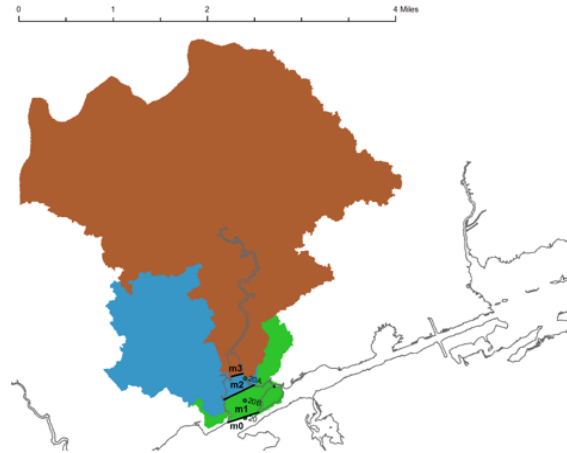
N.C. DEQ Modeling Work

The North Carolina Department of Environmental Quality Modeling and Assessment Branch has developed the Tidal Prism Model (TPM) to calculate the fecal coliform concentration in coastal waters at high tide. The model calculates the concentration as an average for segments of the waterbody. The TPM operates using a physical transport model and a water quality model. The main effects simulated in the model are tidal flushing, river input, and fecal coliform bacterial decay. The Tidal Prism Model utilizes these effects to calculate an estimated fecal coliform TMDL and determine the percent reduction needed in fecal coliform concentration based on the median and 90th percentile TMDL standards. This modeling work has included Turkey Creek.

⁸ Williams, M. M. (2019, August 1). 2018 Integrated Report Overall Category. Retrieved January 21, 2022, from <https://ncdenr.maps.arcgis.com/home/item.html?id=aa9d7582afae4fc085d84dbe1978e95c>.

The modeled segments of Turkey Creek are pictured in Figure 2-18. This work validates that stormwater runoff is the primary cause of water quality impairments in the Sound, and that the sources of that runoff are from the adjacent watersheds to the sound.

Figure 2-18: Turkey Creek Tidal Prism Model Segments



NOAA Precipitation Frequency Table

The National Oceanic and Atmospheric Administration (NOAA) precipitation models state that a 1-year, 24-hour storm event for Stump Sound, NC results in **3.71** inches (Table 2-6). This estimation was used to develop hydrographs of the watershed. The 1-year, 24-hour storm event is used because it has been established as the maximum storm parameter possible to protect shellfish harvest waters (Class SA) in North Carolina by DEQ.

Table 2-6: NOAA precipitation frequency table for Stump Sound

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
DURATION	1	2	5	10	25	50	100	200	500	1000
5-min:	0.50	0.59	0.69	0.77	0.87	0.94	1.02	1.10	1.19	1.28
10-min:	0.80	0.94	1.10	1.23	1.38	1.50	1.62	1.74	1.89	2.01
15-min:	0.99	1.19	1.39	1.55	1.75	1.90	2.05	2.19	2.38	2.52
30-min:	1.36	1.64	1.98	2.25	2.60	2.86	3.14	3.41	3.78	4.08
60-min:	1.70	2.06	2.54	2.93	3.46	3.88	4.32	4.78	5.43	5.96
2-hr:	2.08	2.53	3.21	3.78	4.59	5.27	6.00	6.79	7.93	8.91

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
3-hr:	2.24	2.73	3.48	4.13	5.07	5.89	6.78	7.77	9.24	10.50
6-hr:	2.74	3.34	4.26	5.07	6.24	7.27	8.40	9.66	11.50	13.20
12-hr:	3.23	3.94	5.05	6.04	7.50	8.78	10.20	11.80	14.30	16.40
24-hr:	3.71	4.51	5.84	6.98	8.71	10.20	11.90	13.80	16.70	19.30
2-day:	4.33	5.24	6.72	8.00	9.95	11.70	13.60	15.70	19.00	21.80
3-day:	4.57	5.53	7.06	8.36	10.30	12.00	13.90	15.90	19.10	21.90
4-day:	4.82	5.82	7.40	8.71	10.70	12.30	14.10	16.10	19.30	22.00

Source Assessment

The primary source of pollution addressed by this plan is stormwater runoff, which carries fecal coliform from the landscape into the sounder where waters are classified for shellfish harvest. State reports and TMDL studies identified bacteria transported by stormwater runoff due to hydrologic modifications as the most predominant cause of impairment in all the Stump Sound Watersheds.

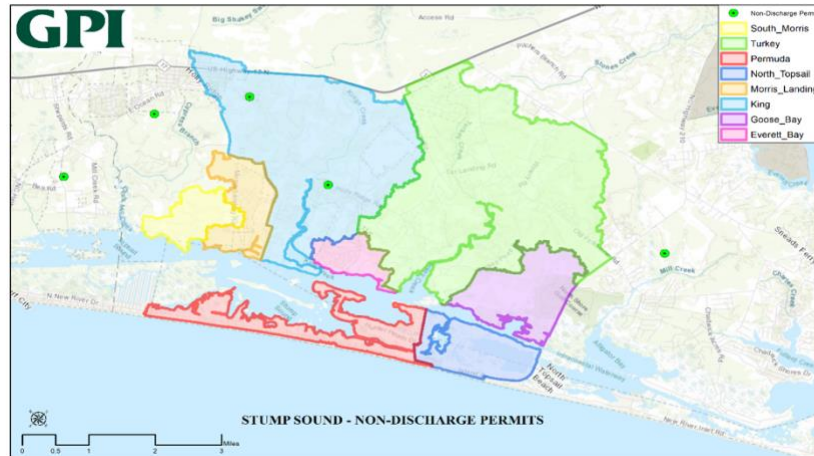
Nonpoint Source Pollution

Due to rapid urban development and alteration of natural hydrology within the watershed, bacterial contaminants have been identified as the primary issue of concern as reported in water quality assessments and Shellfish Sanitation reports. The difficulty in preventing violations of bacteria standards for coastal waters caused by stormwater runoff is compounded by the unique challenges related to coastal hydrology and bacteria pollution. These are:

1. The two bacteria used as indicators of water quality, fecal coliform, and enterococcus, naturally occur across the terrestrial landscape. These bacteria originate in the feces of warm-blooded animals, such as birds, deer, raccoons, and domestic pets. Although prudent measures should be taken to reduce the sources of bacteria, these efforts alone will not result in satisfactory improvements in coastal water quality due to unnatural levels of stormwater being discharged.
2. Treating stormwater runoff to remove bacteria pollution before it flows into shellfish and swimming waters is impractical. Although some technology exists for decreasing bacteria levels in runoff, it is not able to reduce levels to ensure pristine water quality necessary to allow shellfish harvest and swimming.
3. Treated runoff can easily be re-contaminated. Due to the ubiquitous nature of bacteria on the landscape, treated runoff, once discharged back on the landscape, will simply pick up more bacteria. The result is ineffective and costly treatment.

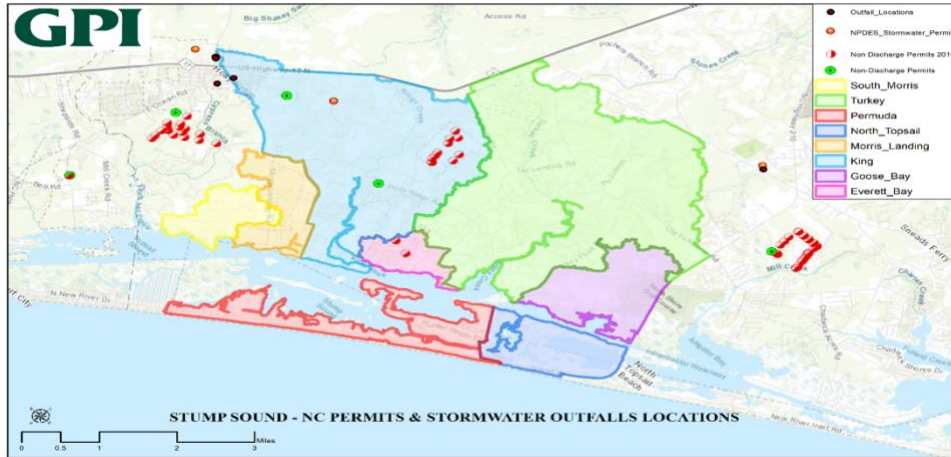
A more effective approach is to reduce the rate and amount of stormwater entering the sound by promoting infiltration within the landscape of adjacent watersheds. Stormwater runoff can convey a variety of nonpoint source contaminants from a variety of sources. Potential nonpoint sources range from wildlife and human sources. The key strategy is to keep the landscape functional for storing and infiltrating waters by disconnecting surface waters from stormwater conveyance systems.

Figure 2-19: Non-Discharge Permits within the Stump Sound Watersheds



A variety of potential nonpoint sources exist within the watersheds that can be attributed to water quality degradation. There are two potential nonpoint wastewater sources within the Stump Sound watersheds (Figure 2-20). Noted areas of concern can be both short-term and long-term concerns as noted by Shellfish Sanitation that may affect water quality. This monitoring is currently conducted by Shellfish Sanitation and the findings are released every three years within the Sanitary reports for Area B-9. For these specific sites, it is recommended that they continue to be monitored and that partnerships with property owners be formed to determine any practices that can minimize their potential risk. It is important to be aware of the locations of wastewater stations and facilities. Many of these locations represent both potential point and nonpoint sources of pollution.

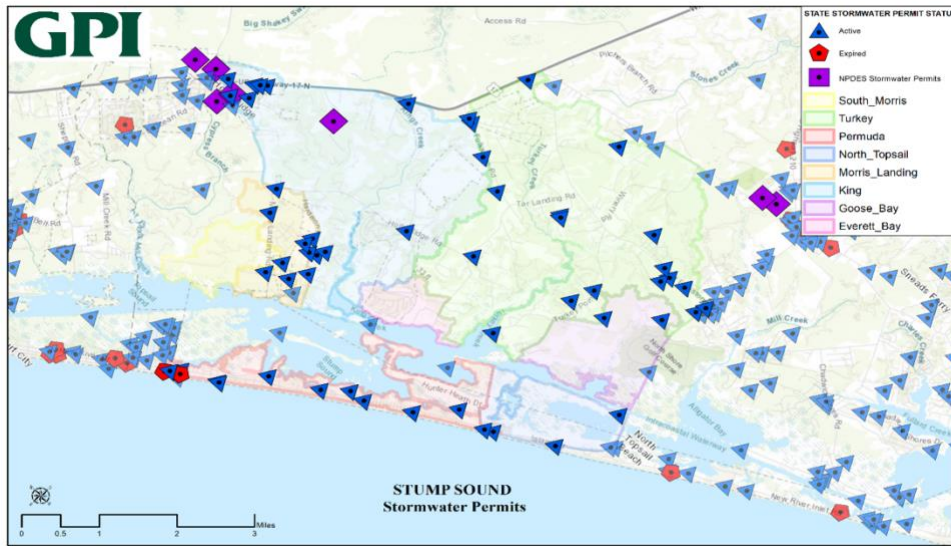
Figure 2-20: Potential Nonpoint Wastewater Sources



Stormwater Permits

Poorly maintained stormwater treatment systems can impair water quality and represent direct sources of pollution that often have the potential to be mitigated. There are numerous State Stormwater Permits along with two NPDES Stormwater Permits within the two watersheds (Figure 2-21, Table 2-6, Table 2-7).

Figure 2-21: NPDES and State Stormwater Permit



The following State Stormwater and NPDES permits exist:

Table 2-6: List of State Stormwater Permits within Stump Sound Watersheds

Permit Number	Facility Name	Address
SW8010829	Stump Sound Maintenance Dredging	169 Old Village Ln
SW8001013	Mills Mobile Home Sales Lot	Hwy 17
SW8000407	Creeks Edge Subdivision	Turkey Point Rd
SW8020705	Hampstead Pines Subdivision formerly Henderson Farms	US Hwy 17
SW8040216	Seaside Village	Is Dr Hwy 210
SW8040620	Rogers Bay Family Campground, Phase 4 Stormwater	Hwy 210
SW8020836	Scotch Bonnett Oceanside	Hwy 210 In Onslow Co
SW8060509	Summerhouse on Everett Bay	Sr 1534
SW8050212	Kings Harbor	Off NCSR 1537
SW8050926	Maple Crest Estates	Clearview Dr

SW8051224	SeaSide Inn	Hwy 50 And 210
SW8050633	Kings Harbour II	211 Tumbling Brook Ln
SW8050205	Sea Star Village	New River Dr And 9th St
SW8070653	Oyster Landing Subdivision	Oyster Landing Dr
SW8070676	Holly Tree Townhouses	652 Holly Ridge Rd
SW8070418	Kings Harbor III	Tumbling Brook Ln
SW8070420	Shopping & Office Park Holly Ridge	US Hwy 17
SW8070927	Dixon Point at Spicers Bay	NCSR 1538 Morris Landing Rd
SW8070124	The Village at Folkstone	Folkstone Rd
SW8070503	North Topsail Shores Baptist Church	Old Folkstone Rd NCSR 1518
SW8070608	Jubilation East Side	Harbor Point Rd
SW8070609	Jubilation formerly Huff Property Development	NC 210
SW8110424	Old Dock Plantation	3230 Turkey Point Rd
SW8110810	Morris Landing Oyster and Saltmarsh Habitat Restoration and Living Shoreline Project	870 Morris Landing Rd
SW8100511	Rogers Bay Campground Boat Ramp and Maintenance Dredging	4021 Island Dr
SW8090515	Bublitz Residence	4532 24th St
SW8120905	The Landing at Folkstone	Folkstone Rd
SW8121020	Lot 26 thru 35 Glenwood Subdivision	Old Folkstone Road
SW8121204	The Preserve at Morris Landing Subdivision	Hardison Rd
SW8090930	Strickland Dock Project	115 Phil Harris Ln
SW8101010	Kings Harbor Phase Four	Hardison Rd
SW8090336	Larson Dredging and Bulkhead	107 Coral Place Rd
SW8090623	Pine Ridge Townhomes	8663 US Hwy 17
SW8120314	Onslow County Environmental Education Center and Public Library	1330 Hwy 210
SW8160215	Lot Z Hark Properties	Island Dr
SW8150906	Dollar General Holly Ridge	Camp Davis Rd

SW8140516	Turkey Creek Boating Access Area	619 Turkey Point Rd
SW8160906	Sneads Ferry Retail Center	Old Folkstone Rd
SW8160609	Dollar General Sneads Ferry Hwy 210	1333 NC Hwy 210
SW8170116	North Topsail Water Main Replacement	NC Hwy 210
SW8130505	Scotch Bonnet Soundside	Island Dr
SW8130515	Morris Landing Club	Int Of Morris Landing Rd and Hardison Rd
SW8130612	Bridgeport Subdivision	Old Folkstone Rd
SW8891114	Village Of Stump Sound	Island Dr
SW8181016	Tides End Subdivision	Tar Landing Rd NCSR 1531
SW8190315	Haag Single Family Residence	6702 13th Ave
SW8190502	Landing at Stump Sound	Hardison Rd
SW8190503	Stump Sound Elementary School	Folkstone Rd
SW8890418	Mill Creek Crossing	Folkstone Rd
SW8890809	Coastal Shooting Sports	US Hwy 17 N
SW8890901	Coastal Village Section II	NC Hwy 210
SW8190608	Aaronfield at Old Folkstone	905 Old Folkstone Rd
SW8190709	Osprey Landing	NC Sr 1537
SW8190911	Dollar General - Holly Ridge Old Folkstone Road	109 Old Folkstone Rd
SW8191004	Buckhorn	US Hwy 17
SW8950815	Pelicans Nest Hotel	Island Dr
SW8930304	Ocean Ridge Summertime and Hampton Colony Developments Sewer Project	NC Hwy 210
SW8940225	Holly Ridge Town Park	Smith Street Burns St
SW8980723	Mainlander Estates Section VI	Clearview Dr
SW8970118	Yopp Brothers Marine Repair	883 NC 210
SW8990545	Holly Ridge Processing Facility	312 Sound Rd
SW8990114	Pointe Harbor Campground	224 Harbor Point Rd

Table 2-7: List of NPDES Permits within Stump Sound Watersheds

Permit Number	Facility Name	Address
NCG020929	Wellman Mine	Hines Stump Sound Church Rd
NCG060315	Holly Ridge Processing Facility	312 Sound Rd

Additional Pollution Sources

Lack of Proper Maintenance of Permitted Stormwater Control Systems

Properly functioning stormwater control systems work to protect surface waters by reducing the amount of polluted runoff flowing into waterways. Lack of proper maintenance of permitted stormwater control systems can increase the contaminants that runoff into surface waters. Improperly maintained stormwater control systems often do not treat stormwater but allow the stormwater to bypass the system, directing it straight to a stream or other waterway. Any pollutants that have been captured by stormwater runoff will also bypass the improperly maintained stormwater control system and enter the waterway.

Sewer Systems

Sewer systems can consist of storm, sanitary, or combination sewers. Storm sewers handle storm runoff and carry it to streams. Sanitary sewers handle raw sewage and carry it to wastewater treatment facilities. Combination sewers handle both stormwater runoff and raw sewage. Sewage overflows can occur because of blockages, inadequate carrying capacity, leaking pipes, and power outages at pumping stations. An overflow can allow contaminants to flow into nearby surface waters.

Septic Systems

Septic systems treat wastewater using separation and filtration. Improperly working septic systems have the potential to pollute nearby waterways with pathogens, nutrients, and chemicals. Septic systems must be maintained and periodically pumped to continue proper operation. Shellfish Sanitation noted improper septic systems to be of concern to water quality during previous surveys, but overall, these septic tanks were a minor source of pollution in the sound.

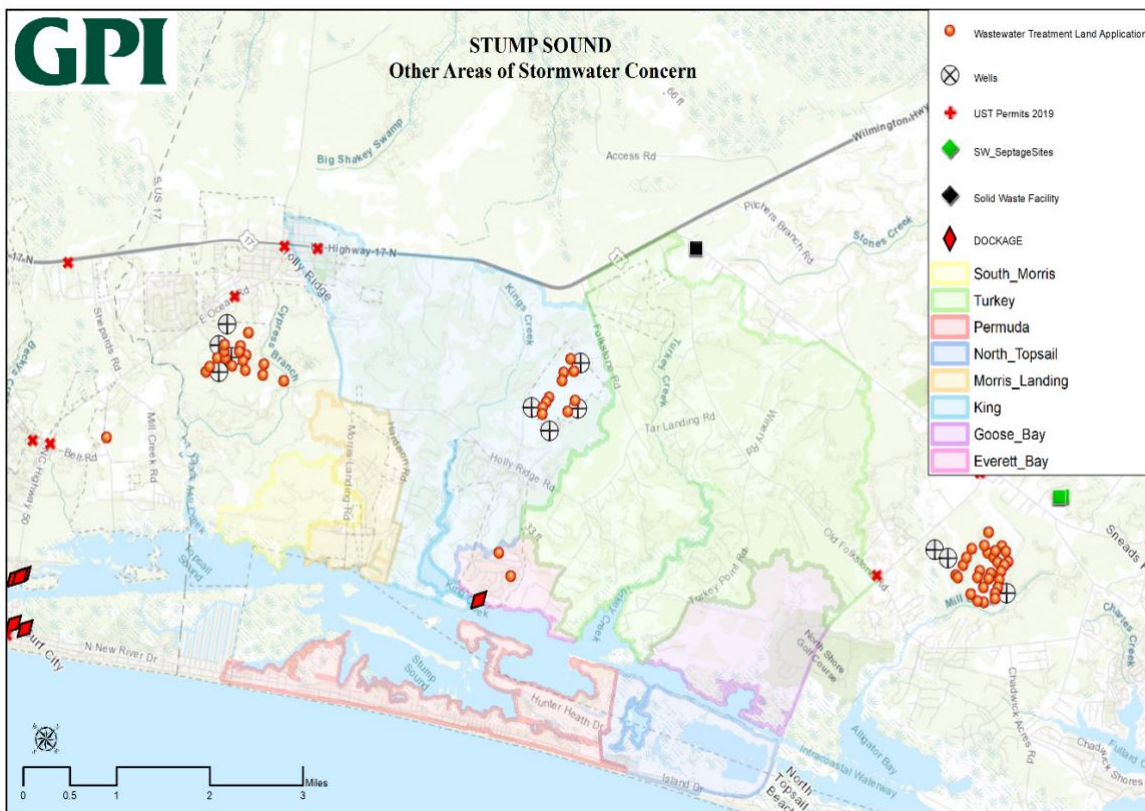
Highways

Highways result in the largest single drainage system in the watershed. Runoff from highways picks up naturally occurring bacteria within the landscape and transports it downstream into the sound. Infiltrating highway runoff will be key to addressing water quality impairments in the sound. Highways in the watershed are mostly owned by the North Carolina Department of Transportation except for city streets owned by Surf City and North Topsail Beach.

Other Notable Sources

Shellfish sanitation mapped other areas of stormwater concerns in the watershed primarily related to runoff from land application and disposal sites used for municipal wastewater treatment.

Figure 2-22: Stormwater Areas of Concern



Climate Change Risks and Resilience

Long term hazard risks/vulnerability and associated resilience strategies from flooding are key factors in planning for the protection of the waters and watersheds that drain to Stump Sound.

A variety of efforts and associated data sources are available for analyzing potential risks and vulnerability of the natural infrastructure and other assets affecting the long-term sustainability of the Stump Sound watersheds. These include the North Carolina Institute for Climate Studies' (NCICS) North Carolina Climate Science Report,⁹ the 2020 North Carolina Climate Risk Assessment and Resilience Plan¹⁰ (NCDEQ), NOAA's Sea Level Rise Viewer,¹¹ and the Southeastern North Carolina Regional Hazard Mitigation Plan¹² (ESP Associates, 2021). The recently released Topsail Island Resilience Strategy¹³ (TIRS) presents the first phases of a continued statewide resiliency planning and strategy effort, as it relates to Topsail Island and nearby areas within the Stump Sound watersheds. The TIRS planning effort has four goals:

1. Address barriers to coastal resilience in North Carolina at the local level, such as limited capacity, economic constraints, and social inequities.
2. Assist communities with risk and vulnerability assessments and develop a portfolio of well-planned and prioritized projects.
3. Advance coastal resilience projects to a "shovel-ready" status, or ready for implementation.
4. Provide funding for project implementation and link to additional funding streams

The results of this two-year planning process provide valuable analyses, risk and asset identification, and strategies to increase the resilience of these low-lying towns and the county. The findings and strategies identified in this report dovetail with many of the goals and objectives of the Stump Sound Watershed Protection and Restoration Plan, and relevant strategies and projects are incorporated into Sections 5 and 6 of this Plan.

The TIRS recognizes that the most vulnerable assets within these watersheds are natural infrastructure, including low lying coastal wetlands, intertidal lands, and adjacent riparian buffers. These important areas are critical to the protection of Stump Sound. The TIRS's risk and vulnerability assessments for this project area, as well as the Southeastern North Carolina Regional Hazard Mitigation Plan, identifies the following as priority coastal hazards, which include:

- Coastal flooding from hurricanes and winter storm events;
- Sound-side flooding from tidal and precipitation events;
- Sea level rise, storm surge, increased high tide or "sunny day" flooding and water levels associated with climate change; and
- Coastal erosion associated with each of the above hazards.

⁹ North Carolina Institute for Climate Studies' (NCICS) North Carolina Climate Science Report

¹⁰ North Carolina Climate Risk Assessment and Resilience Plan, 2020

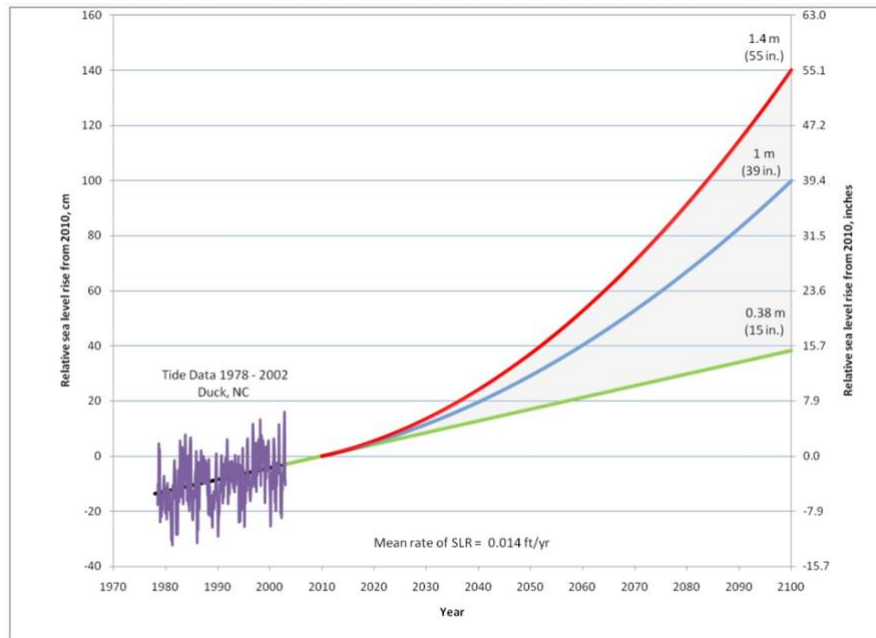
¹¹ NOAA Sea Level Rise viewer

¹² Southeastern North Carolina Regional Hazard Mitigation Plan, ESP Associates, 2021

¹³ Topsail Island Resilience Strategy (TIRS), Kleinfelder, 2022

According to the North Carolina Climate Science Report, sea level along the North Carolina coast will continue to rise due to expansion of ocean water from warming and melting of ice on land. The report also states that localized sea level rise is “virtually certain.” NOAA Intermediate Scenarios are also consistent with projections in North Carolina’s *Sea Level Rise Assessment Report*.¹⁴

Figure 2-23 – Magnitude of sea level rise from different rates of acceleration¹⁵



With rising sea levels and increasing intensity of coastal storms, stormwater runoff, coastal flooding, coastal erosion and associated water quality impairment and coastal erosion is certain to increase.

The TIRS provides relevant analyses, projections and mapping tools regarding hazards related to climate change effects and resilience of the Stump Sound watersheds. This strategy report provides an interactive web-mapping tool for assessing data related to current and future natural infrastructure resources, sea-level rise, storm surges, high tide flood exposures, etc. This tool is available via the following link from the TIRS:

<https://gis.kleinfelder.com/klfportal/apps/opsdashboard/index.html%23/29bda8afaa49430d9b7354fc6be842e6>

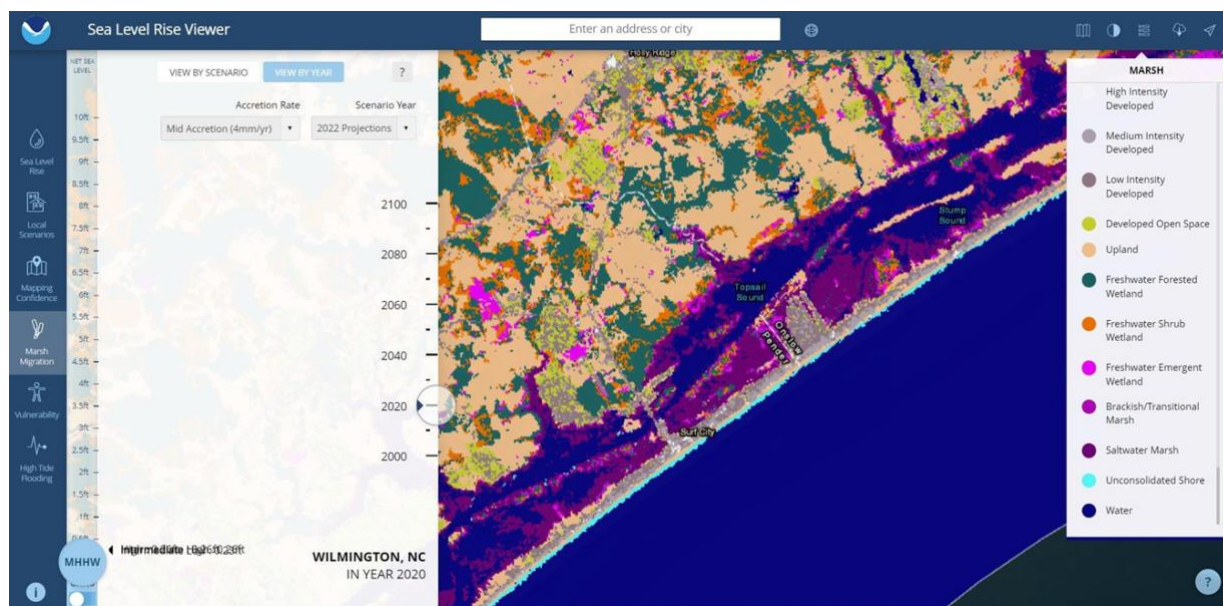
¹⁴ North Carolina’s *Sea Level Rise Assessment Report*.

¹⁵ North Carolina Department of Environment and Natural Resources, 2010.

The TIRS dashboard tool utilizes and aggregates data from publicly available mapping tools, such as NOAA's Sea Level Rise Viewer (<https://bit.ly/398EjLe>).

The NOAA Sea Level Rise Viewer is a tool to view predicted intermediate low, intermediate, intermediate high, and extreme sea level rise at certain years. It should be noted that the visual representation of sea level rise within the model only depicts one-foot intervals rather than specific predicted values of sea level rise.

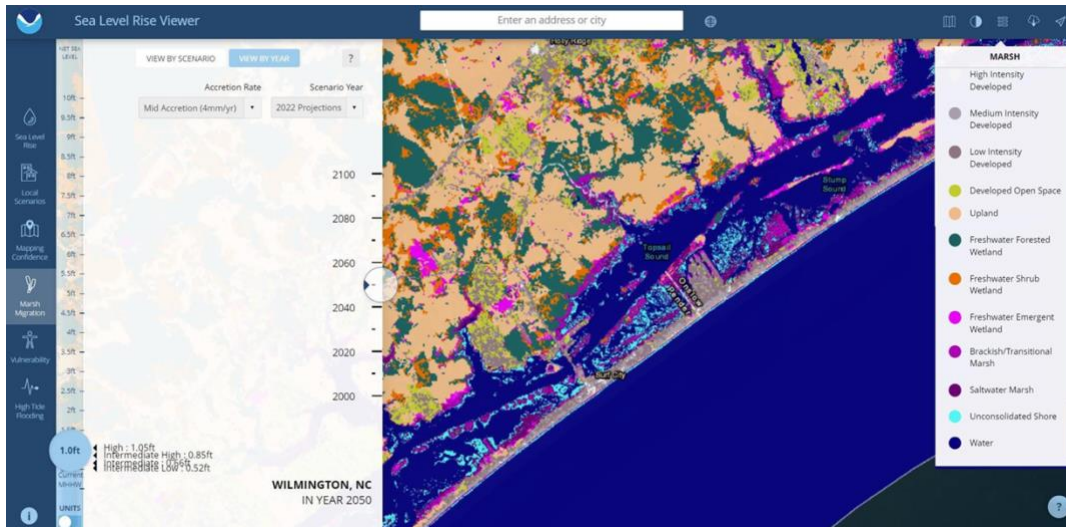
Figure 2-24: Surf City present day (2020) coastal marsh and ecosystem conditions



Note: At present, sound-side areas in Surf City have a mix of Fresh Forested Wetlands, Freshwater Emergent Wetlands with particularly large Saltwater Marsh and Brackish/Transitional Marsh areas¹⁶

¹⁶ *Topsail Island Resilience Strategy, Kleinfelder, 2022.*

Figure 2-25: Surf City projected coastal marsh migration and ecosystem change by ~2050



By 2050, areas of Freshwater Emergent Wetlands and Freshwater Shrub Wetland areas are projected to transition to Saltwater Marsh, Unconsolidated Shore, and Open Water. Around this timeframe, a transition of larger saltwater marsh area to “unconsolidated shore” and Open Water is projected to occur west of the Surf City Bridge, between the Bridge and West Onslow Beach.¹⁷

These projected changes in potential sea level rise, storm surges, flooding and erosion provide critical data which must be included in the watershed planning process, and in the prioritization of ecosystem adaptations, green infrastructure, and resilience strategies.

¹⁷ *Topsail Island Resilience Strategy, Kleinfelder, 2022*

Section 3: Runoff Rate and Volume Reduction

Modification of Natural Hydrology Explains How Stormwater Causes Water Quality Impairments

Significant changes in land uses in coastal areas result from silviculture, agriculture, and land development. Prior to these more intense land uses, rainwater mostly absorbed into the ground, evaporated, or was used by vegetation through natural hydrologic processes. This infiltration and evaporation contained or removed bacteria and other contaminants before they reached coastal surface waters. Intensive land uses that have either hardened or ditched the land's surface overwhelm the effectiveness of the natural landscape to contain this pollution, resulting in water quality impairments and increased flooding.

The rate and volume of stormwater runoff increases as that landscape is hardened, ditched and/or drained. These changes in hydrology of the land can lead to increased sedimentation and erosion, ecosystem degradation and loss, loss of aquatic biodiversity, degradation of water quality, and flooding. Instead of rainfall being infiltrated into the ground or used by vegetation, stormwater quickly flows over the land's surfaces and into water bodies with limited opportunity to naturally absorb into the ground. These altered natural land surfaces increase the rate and volume of water being transported to stormwater conveyance systems, which increases instances of flooding. As water travels more quickly across the landscape, bacteria and other contaminants are collected and transported through connected conveyance systems, such as ditches, pipes and curbs that discharge into our waterways.

By reducing the rate and volume of stormwater runoff, the rate and amount of pollution flowing into coastal waters can be significantly eliminated. This also reduces the number of instances, the impacted area, and the duration of flooding. Reducing the rate and volume of stormwater runoff reduces the transport of all the various pollutants that degrade coastal waters, including bacteria, total suspended solids, nutrients, pesticides, and heavy metals.

Rather than focusing on reducing sources of contamination or attempting the difficult and largely unsuccessful strategy of treating contaminants from stormwater runoff, ***the management techniques identified in this plan focus on reducing the overall rate and volume of stormwater runoff to limit the conveyance of pollutants from the land into coastal waters.*** Low-impact development (LID) (or nature-based) stormwater reduction practices and stormwater retrofits can achieve this goal by replicating natural hydrology and increasing infiltration in impervious areas. For already developed locations, stormwater retrofit techniques can reduce the amount of stormwater entering connected conveyance systems. The

result of implementing stormwater reduction practices is that less bacteria and contaminants are transported from the land and into water systems.

Bacteria transported via stormwater are affected by the following factors: the natural mortality of fecal coliform and enterococcus bacteria, the prevention of bacteria and contaminants from entering water bodies, and the reduction in the velocity of waters entering water bodies because of lower flows. Infiltration of rainfall into the ground can serve as an effective way to reduce the loadings of bacteria and other contaminants that reach Stump Sound. Once bacteria enter the landscape, they are subject to higher rates of mortality due to ultraviolet radiation from sunlight. The primary issue to be addressed through the stormwater runoff volume reduction methodology is the reduction of contamination and localized flooding (Table 3-1). Stormwater runoff is the primary cause of increased fecal coliform impairments and localized flooding within the Stump Sound Watersheds.

Table 3-1: Identifying and linking concerns, causes, and indicators

Issue	Source of Issue	Quantify Issue Indicators
Water quality is impaired and not meeting its designated use standard of class SA	Nonpoint source bacteria transported by stormwater runoff	Fecal coliform cannot exceed GM of 14/100 mL
Instances of localized flooding	Volume of stormwater runoff due to impervious surfaces and artificial drainage.	Volume of water

Runoff Calculation Methodology

Stormwater runoff for Stump Sound was calculated using the SCS Curve number method. To compare the watersheds over time and to set a volume reduction goal, historic land cover was used to determine the curve numbers of specific land sections. This allowed an assessment using the USGS Land Cover data and assigning those sections to specific predetermined cover conditions with corresponding curve numbers based on the soil types found within Stump Sound. (See Table 3-2.) A GIS analysis of combining land cover combined with the NRCS soil type was used for specific sections of land. After this analysis was performed a cover number was assigned for each section of land to determine a composite curve number. For example, if a portion of land was identified as Low-Intensity-Development having a soil type with an HSG rating of Type 'A' a curve number of 51 was assigned. This methodology was used for consistency across all analyses due to the development of the watersheds over the last five decades as well as the lack of historic parcel information.

Table 3-2: Summary of Curve Numbers

Level II Classes		A	A/D	B	B/D	C	D
11	Open Water	100	100	100	100	100	100
12	Perennial Ice/Snow	100	100	100	100	100	100
21	Low Intensity Residential	51	51	68	68	79	84
22	High Intensity Residential	77	77	85	85	90	92
23	Commercial/Industrial/Transportation	89	89	92	92	94	95
24	High Density	89	89	92	92	94	95
31	Bare Rock/Sand/Clay	68	68	79	79	86	89
32	Quarries/Strip Mines/Gravel Pits	68	68	79	79	86	89
33	Transitional	68	68	79	79	86	89
41	Deciduous Forest	36	36	60	60	73	79
42	Evergreen Forest	36	36	60	60	73	79
43	Mixed Forest	36	36	60	60	73	79
52	Shrubland	35	35	56	56	70	77
61	Orchards/Vineyards/Other	35	35	56	56	70	77
71	Grasslands/Herbaceous	30	30	48	48	65	73
81	Pasture/Hay	49	49	69	69	79	84
82	Row Crops	67	67	78	78	85	89
83	Small Grains	63	63	75	75	83	87
84	Fallow	74	74	83	83	88	90
85	Urban/Recreational Grasses	49	49	69	69	79	84
90	Woody Wetlands	36	36	60	60	73	79
95	Emergent Herbaceous Wetlands	36	36	60	60	73	79

Previous analyses have utilized current NOAA ATLAS 14 values for rainfall depth as well as rainfall intensity. Hydrographs were developed using Dr. Malcolm’s Small Watershed Method for each of the eight watersheds located in Stump Sound across each analysis period resulting in a total of 40 hydrographs. Dr. Malcolm’s Small Watershed Method relies on the runoff peak

flow derived from the Rational Method. Linear Interpolation was used to accurately estimate rational c values from the curve number values that had previously been determined. Utilizing both the SCS curve number method and the Rational Method allowed for comparison of the runoff values for peak flow. The Simple method was then used for comparison of the runoff volumes within the watersheds.

The information contained in Table 3-2 land cover classifications and curve numbers were used in all calculations. The runoff hydrographs for its individual watersheds are presented below with a baseline year of 1980. (See Figure 3-1 through Figure 3-9.)

Figure 3-1: South Morris

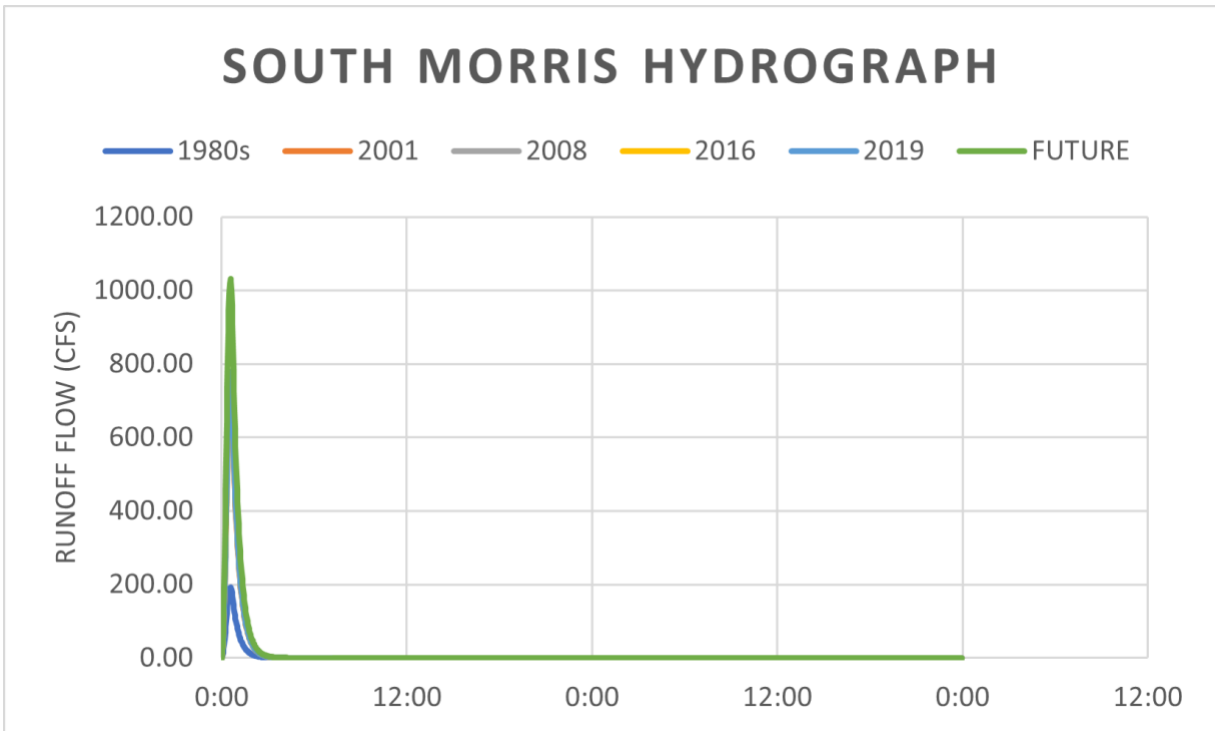


Figure 3-2: Everett Bay

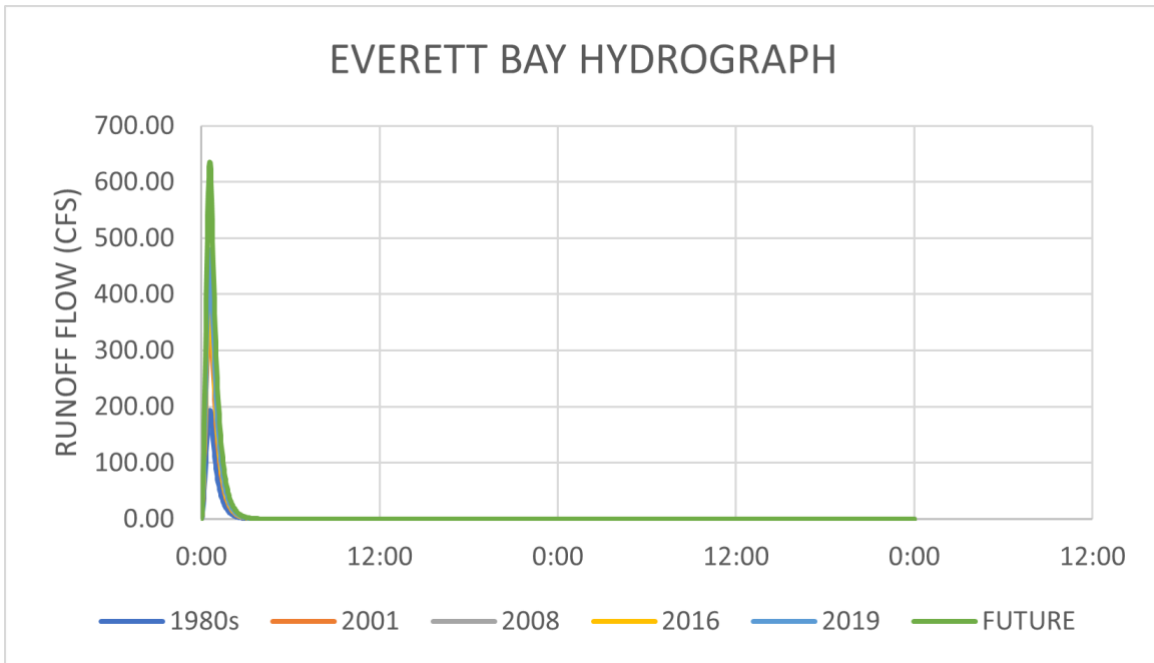


Figure 3-3: Goose Bay

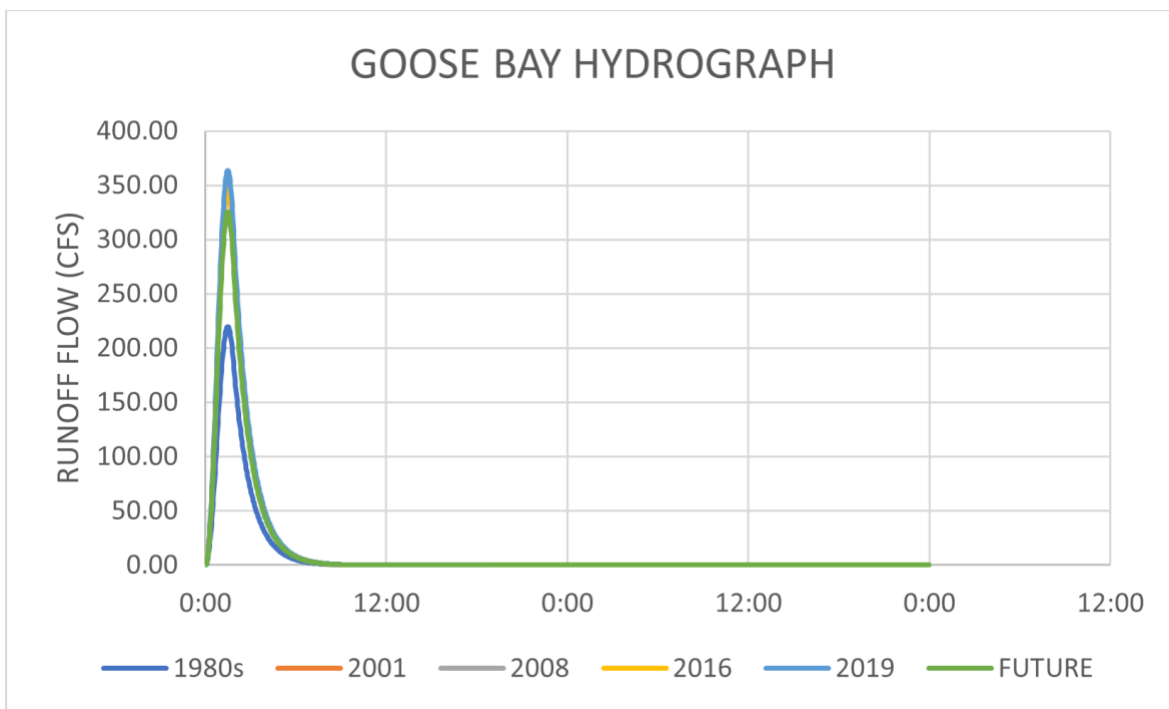


Figure 3-4: King Creek

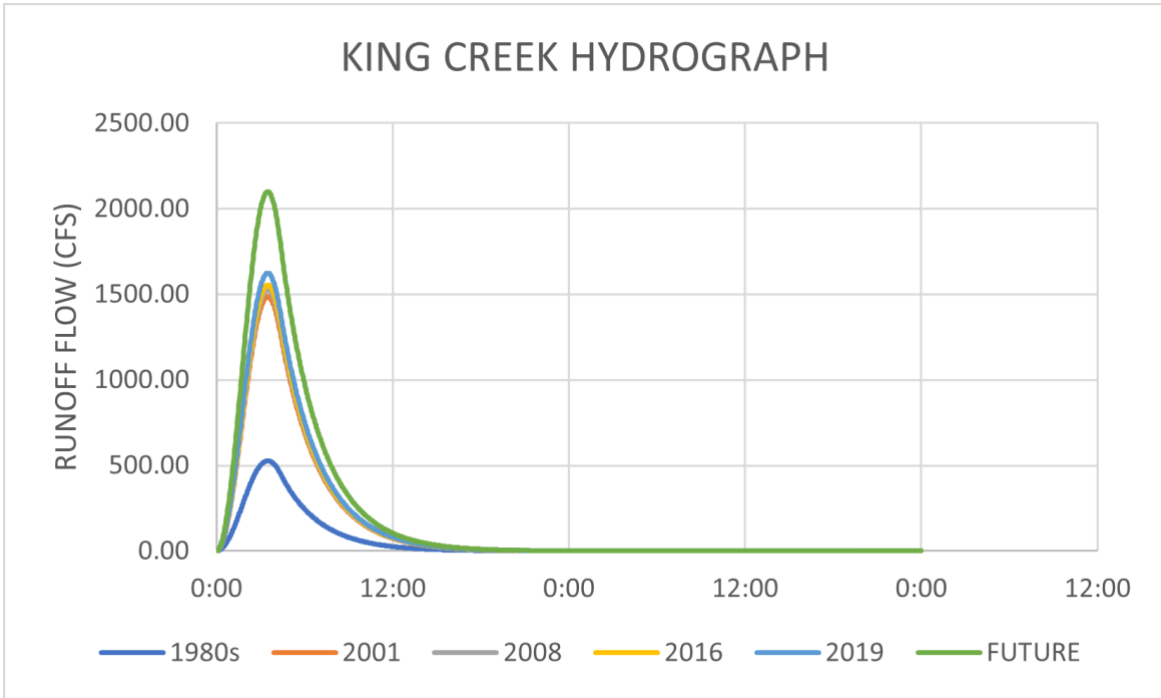


Figure 3-5: Morris Landing

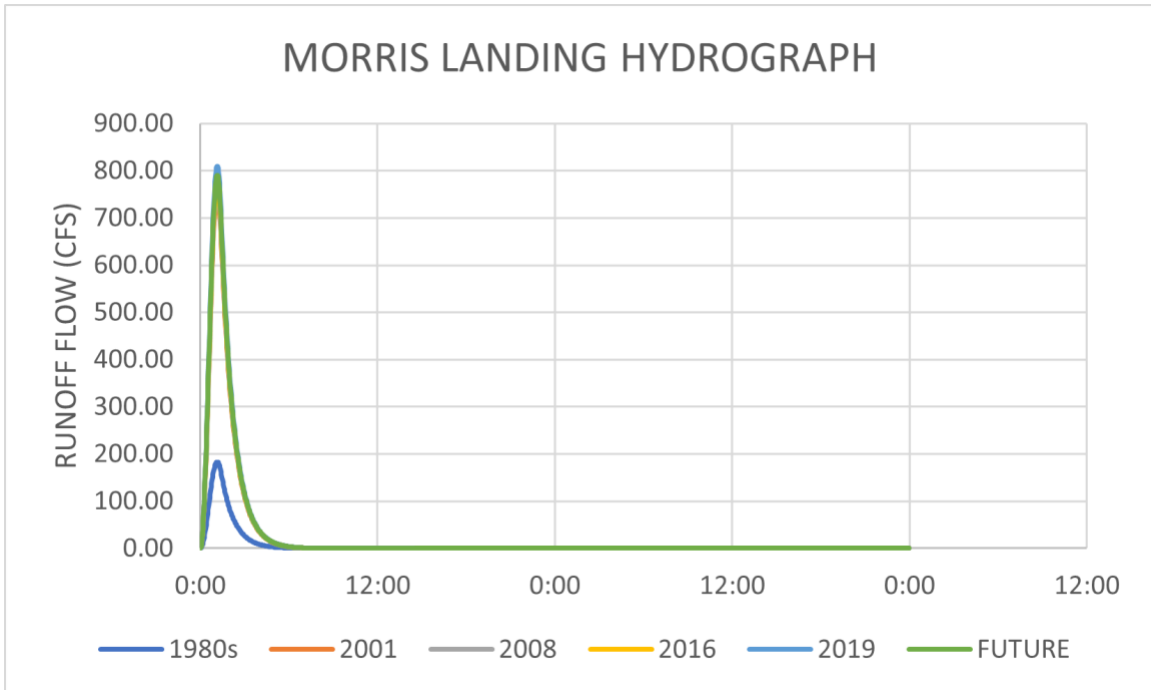


Figure 3-6: North Topsail

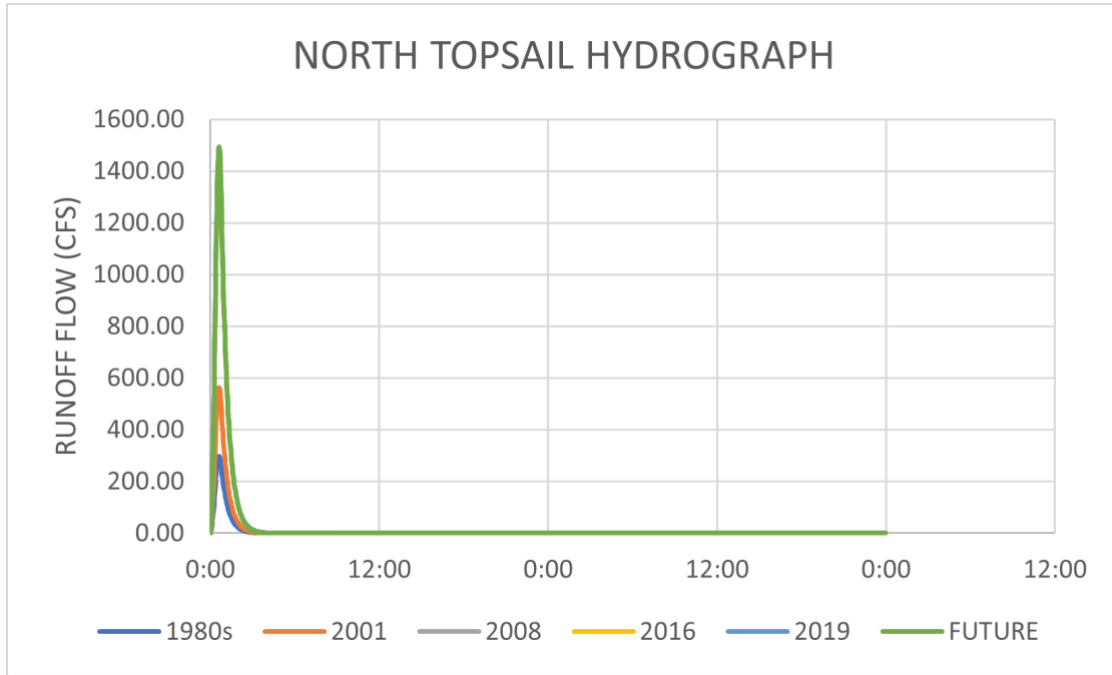


Figure 3-7: Permuda

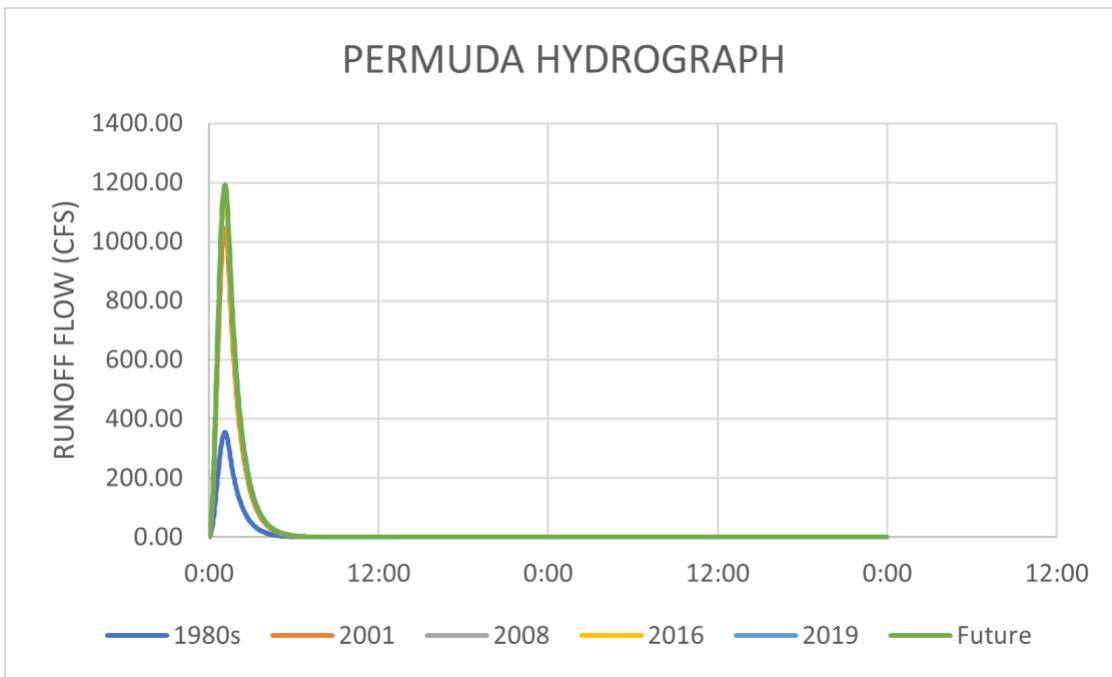
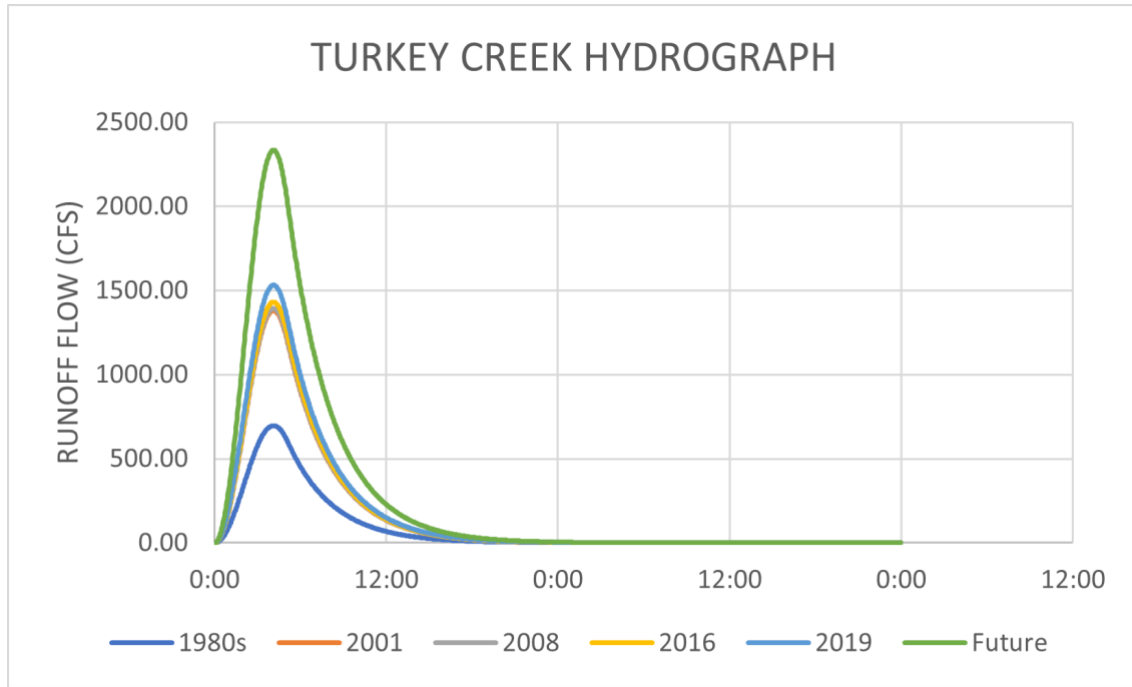


Figure 3-8: Turkey Creek



Volume Results of Runoff Calculations

The following information is a summary of the watershed analysis. There were several instances throughout the last several decades where timber rotations were harvested. These are most visible within the 1980s analysis period for South Morris, Everett Bay, Goose Bay, Morris Landing, and Turkey Creek. Since that time, it appears that the primary cause of increased rates and volumes of runoff is land development activities that have enhanced drainage and removed vegetation. (Figures 3-9 to 3-17.)

Figure 3-9: South Morris Landing

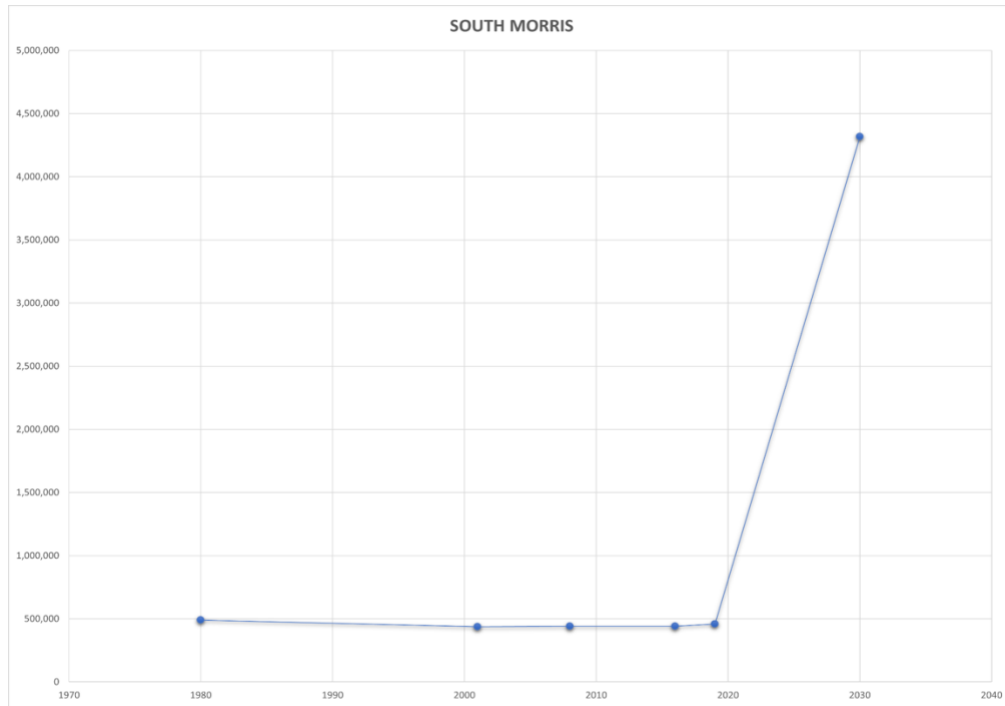


Figure 3-10: Everett Bay

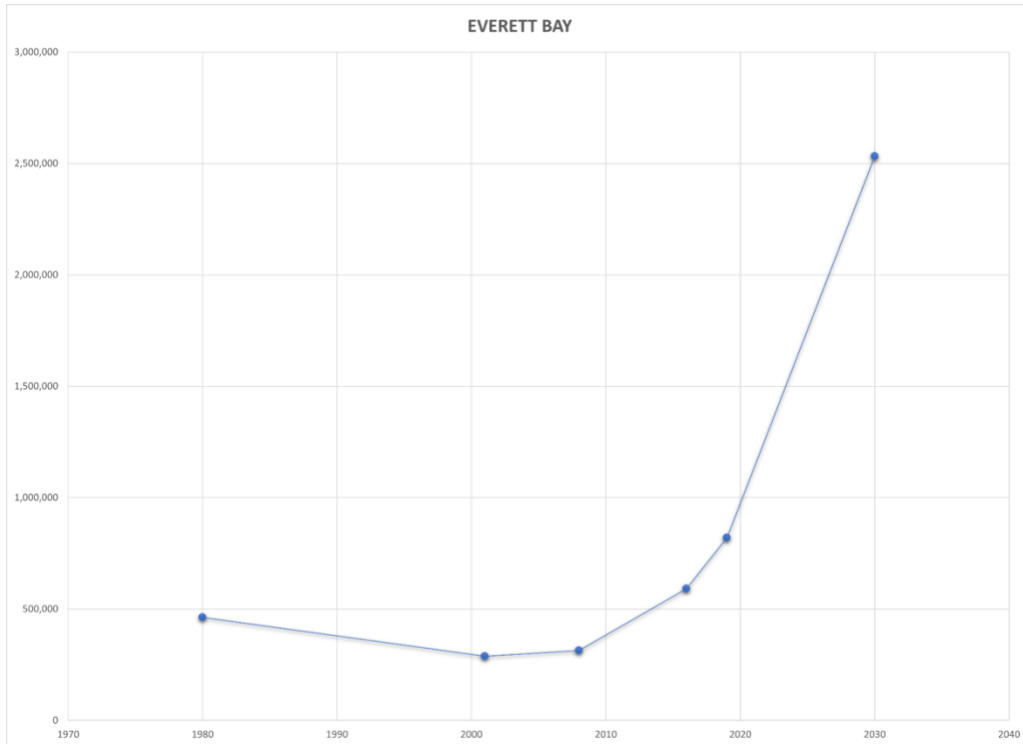


Figure 3-11: Goose Bay

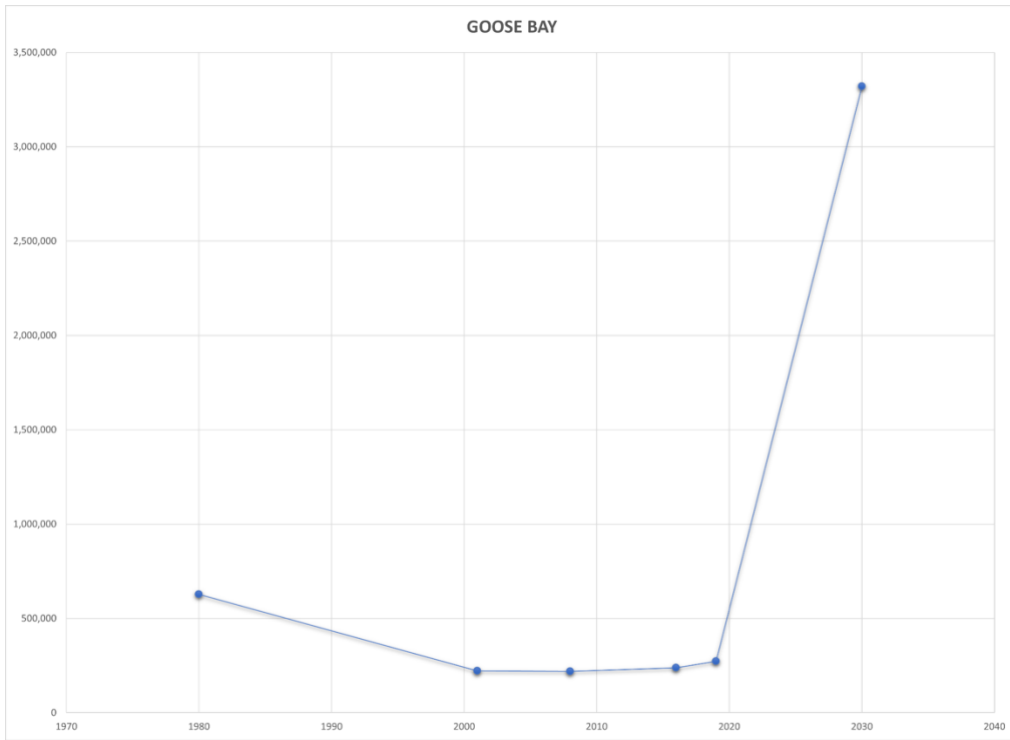


Figure 3-12: King Creek

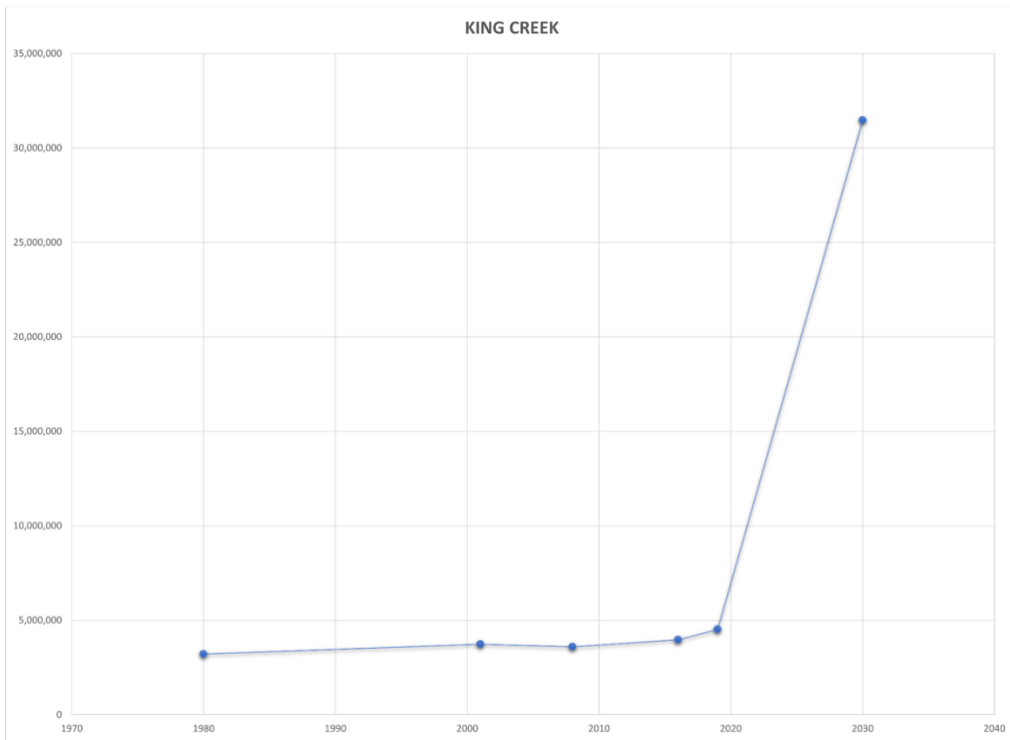


Figure 3-13: Morris Landing

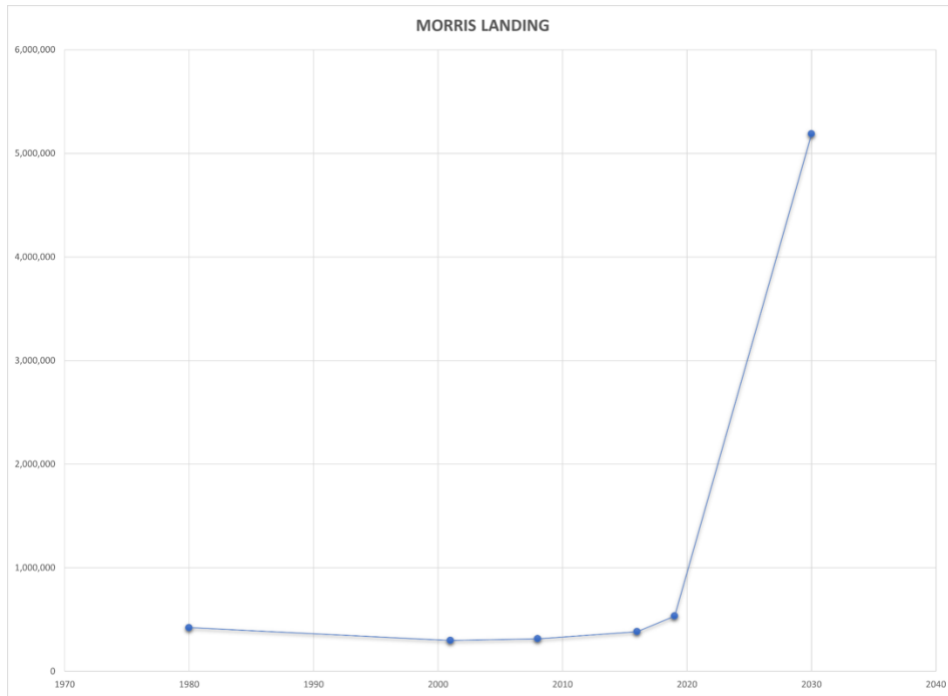


Figure 3-14: North Topsail

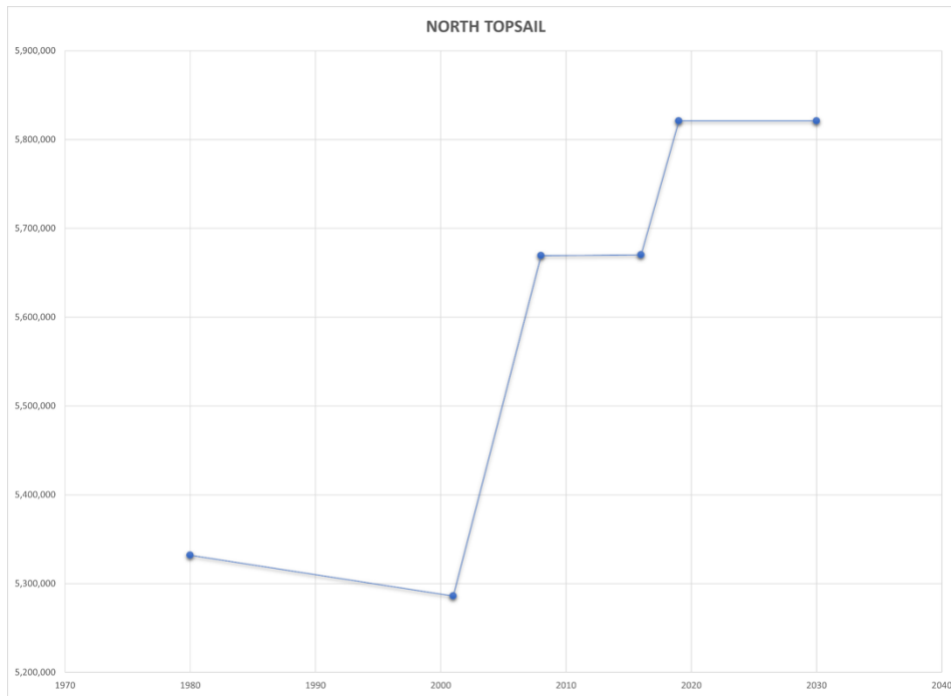


Figure 3-15: Permuda

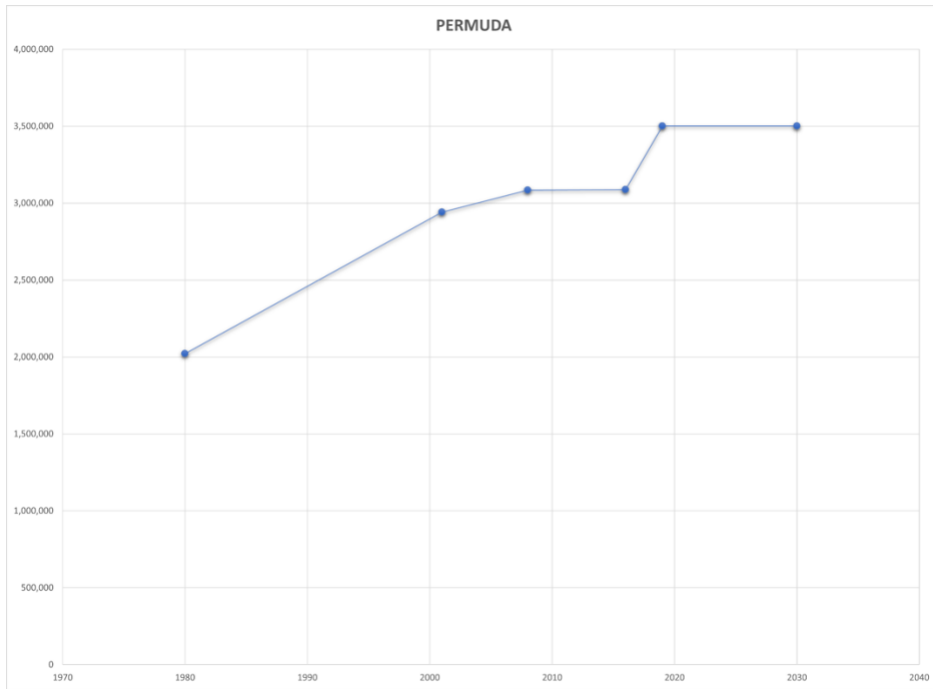
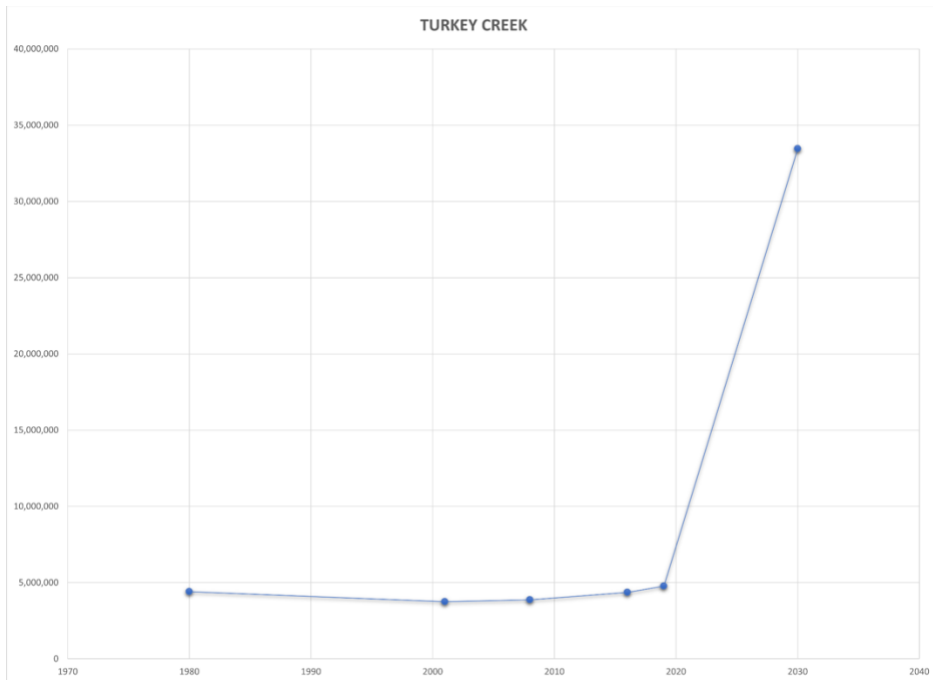


Figure 3-16: Turkey Creek



Runoff Volume Estimates for Stump Sound – 1980 to 2030

Runoff volumes and flow rates were calculated for a one-year, 24-hour storm event across the Stump Sound watershed (See Figure 3-17). These calculations consider land use changes from 1980 through 2019, with potential build out projections assuming full development of available land according to current zoning or development regulations. Notable increases in runoff volumes were observed, with the total estimated runoff volume for the entire river basin increasing from 16,976,494 cubic feet in 1980 to 20,697,999 cubic feet in 2020—an increase of almost 22%. If current land use trends continue, the future projected runoff volume could increase by almost 428% from 1980 levels.

Figure 3-17: Stump Sound Hydrograph (All Eight Watersheds)

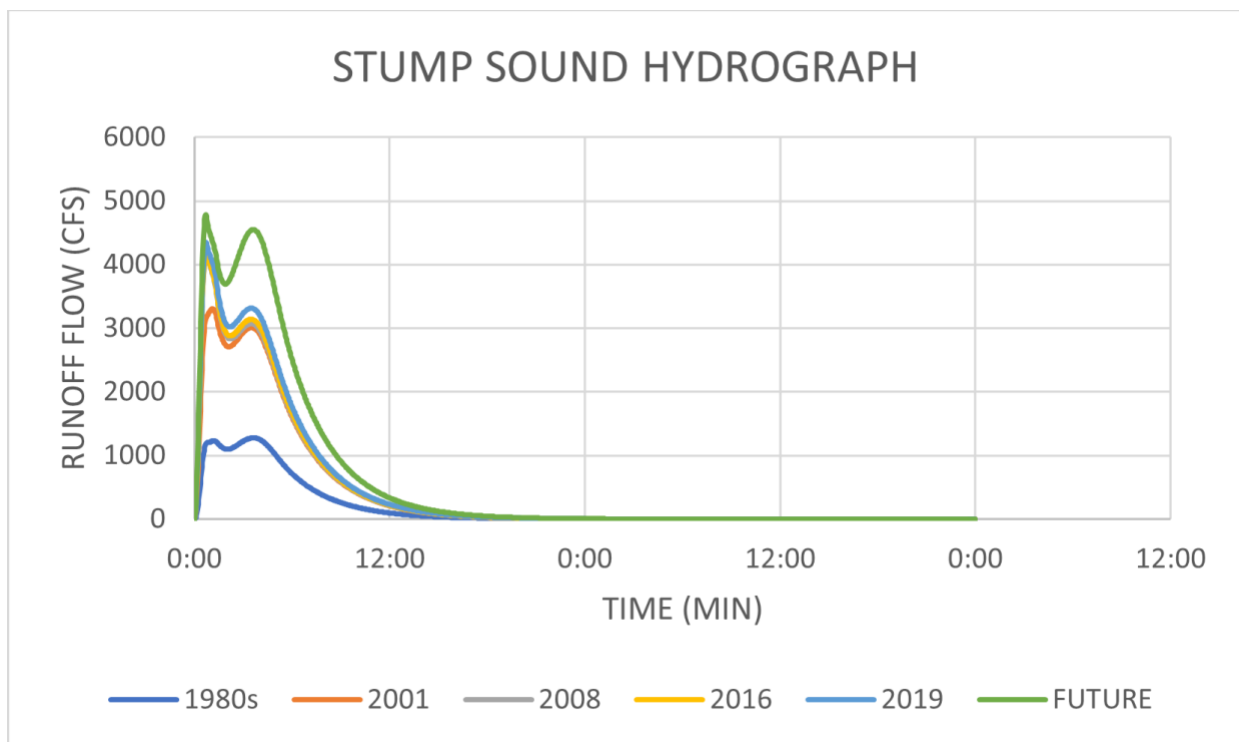


Table 3-3: Cubic Feet of Runoff Volume Created by the 1-Year, 24-Hour Storm Event

Watershed	1980 Runoff Volume	2001 Runoff Volume	2008 Runoff Volume	2016 Runoff Volume	2019 Runoff Volume
Stump Sound	16,976,494	16,953,697	17,521,147	18,753,431	20,697,999

The volume of runoff based upon changing land uses was estimated for all eight sub watersheds that make up the drainage area of Stump Sound. (See Table 3-4.) Since 1980, overall, there has been an approximate increase in the volume of runoff of about 22 percent. Looking forward, based upon zoning, development and population trends that characterize these watersheds, it is projected that based upon past increases and a 20% exponential growth rate of 20% per decade, a huge increase in the volume of runoff could occur by 2050, with a projected increase in volume of runoff of 110.2%. Given the documented impacts of water quality from almost a 22% increase from 1980 to 2019, this future level of increased runoff would have catastrophic negative impacts on water quality and would eliminate most shellfish harvest and swimming uses in the sound. Table 3-4 provides a summary of total runoff volume for all sub watersheds that comprise the overall watershed of Stump Sound.

Table 3-4: Total Runoff Volume for all Watersheds

Total Runoff Volume (cu. ft.)											
	South Morris	Everett Bay	Goose Bay	King Creek	Morris Landing	North Topsail	Permuda	Turkey Creek	Stump Sound	Total (Acre-FT)	%Δ
1980	490,709	462,806	628,380	3,205,971	422,096	5,331,908	2,020,921	4,413,703	16,976,494	390	
2001	437,325	287,785	222,148	3,734,201	297,224	5,286,117	2,940,921	3,747,976	16,953,697	389	0%
2008	441,390	313,950	219,282	3,598,501	314,878	5,669,280	3,084,095	3,879,772	17,521,147	402	3.2%
2016	440,985	591,797	238,078	3,971,993	383,854	5,670,126	3,087,517	4,369,082	18,753,431	431	10.5%
2019	458,152	819,754	273,513	4,519,895	533,505	5,820,897	3,500,932	4,771,351	20,697,999	475	21.9%
2030	549,782	983,705	328,215	5,423,874	640,206	6,984,976	4,201,118	5,725,621	24,837,599	552	46.4%
2040	659,738	1,180,446	393,858	6,508,649	768,247	8,381,971	5,041,341	6,870,745	29,805,119	633	75.6%
2050	791,686	1,416,536	472,629	7,810,379	921,896	10,058,365	6,049,609	8,244,894	35,766,142	738	110.2%

Based on the data provided in Table 3-4 regarding "Total Runoff Volume (cu. ft.)" across different watersheds from 1980 to 2019, and incorporating the projections for 2030, 2040, and 2050, here are the key trends and implications:

Key Trends in Runoff Levels

1. Overall Increase in Runoff Volume Over Time:

- From **1980 to 2019**, there has been a clear and consistent increase in the total runoff volume across all watersheds. The total runoff volume grew from **16.97**

million cu. ft. in 1980 to **20.70 million cu. ft.** in 2019. This represents an increase of **21.9%** over the **39-year period**.

- The projections for future years show that the increase will continue. By **2030**, the total runoff volume is projected to increase by **46.4%** from 1980 levels, and by **2050**, it will have increased by **110.2%** compared to 1980.

2. Significant Increases in Specific Watersheds:

- **South Morris:** Although runoff volume decreased slightly from **490,709 cu. ft.** in 1980 to **437,325 cu. ft.** in 2001, it began rising again, reaching **458,152 cu. ft.** in 2019. This suggests a fluctuating but ultimately increasing trend. The **future build-out** projection for South Morris shows a **nearly 10-fold increase**, with runoff volumes rising to **4.31 million cu. ft.** This indicates significant future development potential.
- **Everett Bay:** There was a sharp rise in Everett Bay's runoff volume, from **462,806 cu. ft.** in 1980 to **819,754 cu. ft.** in 2019, an increase of about **77%**. The projected future runoff volume for Everett Bay at build-out is **2.53 million cu. ft.**, more than **3 times** the current volume, indicating significant growth.
- **King Creek:** This watershed experienced consistent growth, from **3.2 million cu. ft.** in 1980 to **4.52 million cu. ft.** in 2019, reflecting both a significant increase and its role as a major contributor to total runoff. The **future build-out** projection for King Creek is **31.48 million cu. ft.**, representing a more than **7-fold increase**, making it the sub-watershed with the most dramatic projected growth.
- **Goose Bay:** Although the runoff volume initially decreased between 1980 and 2001, it saw a strong rise by 2019, growing by about **23%** over the **39 years**. Goose Bay is projected to experience a dramatic increase in runoff, from **273,513 cu. ft.** in 2019 to **3.32 million cu. ft.** at future build-out, representing a **12-fold increase**.

3. Comparatively Stable Runoff in Certain Watersheds:

- **Permuda:** This watershed experienced a relatively steady increase, from **2.02 million cu. ft.** in 1980 to **3.50 million cu. ft.** by 2019. It shows moderate growth but is projected to see less dramatic increases compared to other watersheds.
- **North Topsail:** While there was some fluctuation, the overall growth in runoff volume has remained moderate compared to some of the other watersheds. Its projected future runoff volume shows moderate growth, indicating limited development potential relative to other watersheds.
- **Island Locations:** Both Permuda and North Topsail are located on Topsail Island and have limited capacity to accommodate future development, suggesting that their growth in runoff may be more constrained than mainland watersheds.

4. Major Increase Between 2008 and 2019:

- A notable spike in runoff volumes occurred between **2016** and **2019**, particularly in watersheds like **Everett Bay** and **King Creek**, which saw sharper increases. This

could indicate changes in land use, increased development, or other factors that accelerated runoff during this period.

Projected Increases in Runoff Volumes for Future Development

Based on the **future build-out projections** for 2030, 2040, and 2050, several sub-watersheds, particularly those on the mainland side of the sound, are projected to experience significant increases in runoff volume. These areas are likely to see the most future development:

Likely Sub-watersheds for Future Development:

1. **King Creek:**
 - The future build-out projection for **King Creek** is **31.48 million cu. ft.**, a dramatic increase from **4.52 million cu. ft.** in 2019. This represents a **more than 7-fold increase**, making it the sub-watershed with the most significant projected growth. King Creek extends from the Sound to the Town of **Holly Ridge**, placing it in the center of future land development activity.
2. **South Morris:**
 - **South Morris** is projected to experience an increase from **458,152 cu. ft.** in 2019 to **4.31 million cu. ft.** in the future build-out, representing nearly a **10-fold increase**. This suggests that **South Morris** is likely to undergo considerable development in the coming years, contributing to significant increases in runoff.
3. **Everett Bay:**
 - **Everett Bay** is projected to increase from **819,754 cu. ft.** in 2019 to **2.53 million cu. ft.** at future build-out, indicating a significant growth in development. The projected future runoff volume is **more than 3 times** the current volume, highlighting Everett Bay's potential for significant expansion.
4. **Goose Bay:**
 - **Goose Bay** is expected to experience a dramatic increase in runoff, from **273,513 cu. ft.** in 2019 to **3.32 million cu. ft.** at future build-out, representing a **more than 12-fold increase**. This makes **Goose Bay** one of the sub-watersheds with the most significant projected growth, signaling the potential for extensive development.

Summary of Likely High-Development Sub-watersheds:

- **King Creek** is projected to see the largest absolute increases in future runoff volumes, suggesting that it is highly likely to undergo extensive development.
- **South Morris, Everett Bay, and Goose Bay** also show significant increases in projected runoff, indicating that they are likely to experience substantial development as well.

These dramatic increases in runoff volumes for certain sub-watersheds imply that these areas will need careful planning and mitigation strategies to manage the environmental impacts of development. Particularly, **stormwater management** will be critical to prevent flooding and protect water quality as these areas undergo rapid urbanization. Proactive measures will be needed to minimize the negative environmental effects associated with such growth.

Implications of Runoff Findings

1. **Increased Water Quality Degradation and Flooding:**
 - The steady rise in runoff volume across the watersheds likely correlates with an increase in land uses that have hardened or drained the landscape, leading to higher flood risks and water quality degradation. Increased runoff results in more pollutants including bacteria entering Sound, closing shellfish beds to harvest and resulting in swimming advisories.
2. **Potential for Infrastructure Problems:**
 - The substantial increases in runoff, particularly in **King Creek** and **Everett Bay**, may strain existing stormwater management infrastructure especially systems that have been permitted by the state's coastal stormwater permit program. These areas may require more significant investments in stormwater retention systems or updated management practices to prevent pollution and localized flooding.
3. **Need for Adaptive Management Strategies:**
 - The uneven rate of runoff increase across different watersheds suggests that certain areas will require more focused attention. For example, **Everett Bay** and **South Morris** may need tailored strategies to mitigate future increases, such as conserving undeveloped properties, enhancing natural buffers, and increasing nature-based stormwater infiltration facilities.
4. **Impact of Development and Land Use Changes:**
 - The sharp rises in runoff in some watersheds is linked to increased urbanization, land development, or land clearing and ditching activities in those sub-watersheds. Financial and policy interventions to moderate further land development in vulnerable areas or to provide for more effective stormwater controls is needed.

5. Environmental and Ecological Effects:

- The increased runoff volumes have likely contributed to bacteria, sedimentation and nutrient loadings in Stump Sound, which degrade and violate water quality standards for these designated Outstanding Resource Waters. Unless this pollution is controlled, there will be long-term impacts on water quality and fisheries, further emphasizing the need for integrated land-use planning and conservation efforts.

In summary, the data indicates a growing challenge of managing runoff, especially in certain high-risk watersheds. The increase in runoff volumes not only poses environmental risks but also highlights the need for stronger stormwater management policies and investments to safeguard these coastal and riparian areas.

Section 4: Goals, Objectives, Actions

The overarching goal of the Stump Sound Watershed Protection and Restoration Plan is to protect and restore water quality so that shellfish harvest and swimming can be maintained and enhanced, and the natural infrastructure can sustain and adapt to changes such as sea level rise, increased flooding, storm surges and coastal erosion. This comprehensive goal requires several strategies and efforts from many partners, including municipal, town and county leaders, residents, Stump Sound businesses, users such as fishermen and shellfish growers, NGO's and other stakeholders from Onslow County, the Town of North Topsail Beach, the Town of Holly Ridge, and the Town of Surf City.

The primary goals of this plan are to prevent further degradation of water quality and to restore impaired water quality consistent with the water quality classifications and standards that are assigned to the Sound. A secondary goal is to achieve these benefits by pursuing projects that increase community resilience to extreme weather conditions, especially flooding and erosion to mitigate the effects of climate change, such as rising sea levels and more severe storms. The plan seeks to protect existing uses of the Sound such as for shellfish harvest and swimming. Additional goals of this plan include reduced nuisance flooding and maintaining the varied recreational uses of the Sound.

The North Carolina Coastal Federation will be the lead entity that will seek to achieve these goals, objectives, and actions. The Federation will focus staff time on carrying out a variety of strategies to implement recommendations in the plan. Some of these actions are low-cost and others that will require substantial investments. The Federation will pursue state appropriations and federal and state grant funding to acquire key properties and to retrofit land uses to reduce existing sources of pollution. As a fundamental strategy, the recommended actions in this plan aim to protect, restore, or replicate through passive nature-based strategies as well as engineering practices the natural hydrology of the Sound's watersheds to reduce the volume and rate of stormwater runoff. **These goals will be accomplished over the coming 20 years by achieving objectives and management actions identified below.**

This plan uses innovative approaches to reduce stormwater runoff rates and volumes within the Stump Sound watersheds to improve and protect water quality. As with other watershed plans adopted by other coastal communities that incorporate this volume reduction philosophy, this plan emphasizes six restoration objectives to accomplish its goals (Table 4-1).

To implement the plan, the Federation will collaborate with the four local governments (Onslow County, Holly Ridge, North Topsail Beach, and Surf City) that have jurisdiction within the Stump Sound watershed, as well as with private landowners, oyster farm operators, and state and federal agencies that own and manage properties that drain to the sound. The Federation has worked to safeguard Stump Sound since 1983 and has made a long-term commitment to its protection and restoration. It is also a landowner on the Sound, and it holds conservation easements covering several hundred acres within the watershed.

Table 4-1: Primary Goals

Primary Goal	
<i>Restore impaired water quality, reduce flooding, preserve natural resources and traditional existing uses, and enhance community and ecological resilience within the Stump Sound watershed</i>	
Objectives	
1	Design and implement actions plan based upon the most current and accepted scientific and technical knowledge.
2	Restore and perpetually conserve working lands and undeveloped properties that either already contribute increased rates and volumes of polluted runoff, or which are anticipated to be developed in ways that will result in further degradation of water quality and increased flooding.
3	Retrofit private residential, commercial and industrial land uses to reduce the rate and volume of stormwater runoff.
4	Retrofit public land uses to reduce the rate and volume of stormwater runoff.
5	Install living shorelines and restore degraded salt marshes to enhance and restore riparian water quality buffers and reduce impacts from flooding and storm surges.
6	Monitor and adapt management strategies in this five-year plan to ensure the goal and objectives of the plan are being met.
7	Inform and engage the residents, visitors and other stakeholders to enlist their help and support to accomplish plan objectives.
8	Update plan every five years.

Objective 1: Act on Current Scientific, Technical, and Available Data

This objective seeks to use monitoring and promote research to inform the design and implementation of actions recommended by this plan.

Table 4-2: Actions and Timelines for Objective 1

Actions and Timeline for Objective 1		Timeline
A1.1	Continue to work closely with the N.C. Division of Marine Fisheries, Shellfish Sanitation and Recreational Water Quality Section, to use its water quality monitoring and Sanitary Shoreline Survey results to identify acute and chronic water quality issues and problems to guide the location of management actions, and to determine if the implementation of plan actions is having a measurable result on the frequency and geographic extent of shellfish closures and swimming advisories.	Years 1-5
A1.2	Pursue joint project with UNC-Wilmington to acquire and conserve a 1,200+ waterfront property in Morris and South Morris sub-watersheds to establish a research forest to study watershed interactions and restoration methods.	Years 1-3
A1.3	Organize an advisory committee to include shellfish lease holders to foster citizen-based water quality monitoring on leases to better document status and trends in water quality in Stump Sound.	Years 2-5
A1.4	Produce an annual list of research priorities that will aid in the implementation and adaptation of plan actions. To prepare this list, convene all researchers and other stakeholders that are engaged in the use, research and management of the Sound and/or surrounding waters.	Years 1-5

Objective 2: Restore and Perpetually Conserve Working Lands and Undeveloped Properties

This objective involves prioritization of working and undeveloped lands to preserve and/or restore natural hydrology within the watershed that either already contribute increased rates and volumes of polluted runoff due to past hydrologic modifications, and/or which are anticipated to be developed in ways that will result in further degradation of water quality and increased flooding. Due to rapidly increasing populations and associated intense development pressures within the watersheds, protection of Stump Sound depends heavily on preservation and/or restoration of working and natural lands where natural hydrology can be maintained or restored. This can only occur by the acquisition of properties either by fee-simple conservation purchases or through conservation easements that protect natural hydrology and vegetated riparian buffers.

This objective focuses on identifying, prioritizing, acquiring (in fee-simple or through conservation easements) working and natural properties that can be managed to provide for enhancements and protection of water quality and reductions in flooding. Preservation and hydrologic restoration of various properties will be explored by the North Carolina Coastal Federation through partnerships with private landowners, other non-profits, and government agencies, especially the Department of Defense. Acquiring these properties in fee-simple or placing them under conservation easements will be pursued. Figure 4-1, Figure 4-2, and Table 4-3 present a variety of potential conservation lands opportunities that are being evaluated. The list represents potential ideas for acquisition projects.

Figure 4-1: Large Parcels of Privately Owned Land

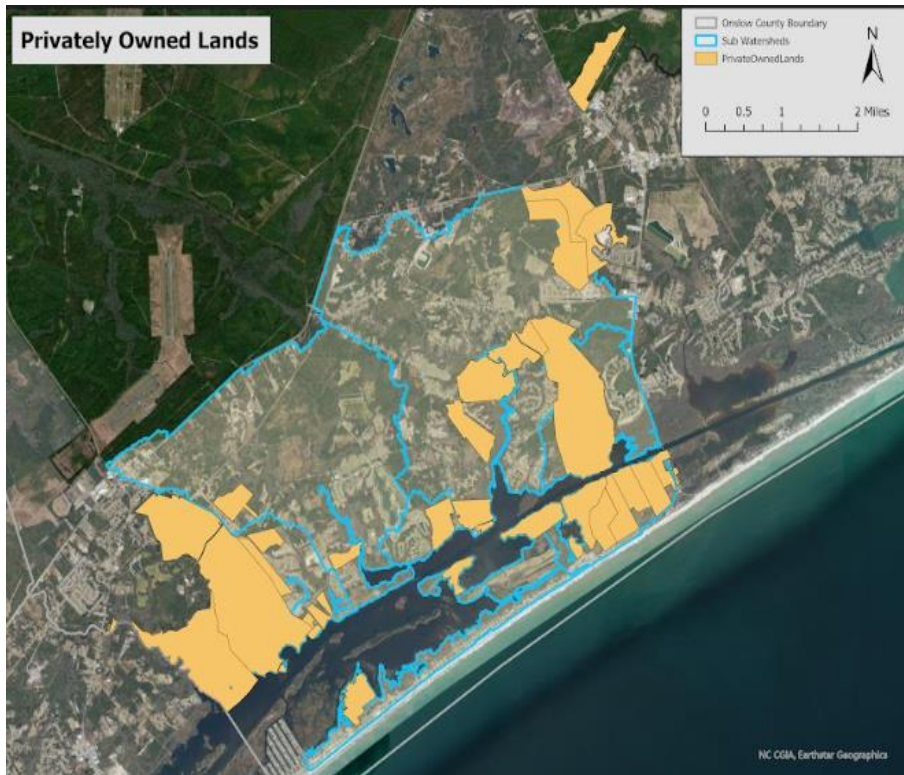


Figure 4-2: Potential Conservation Lands within Stump Sound

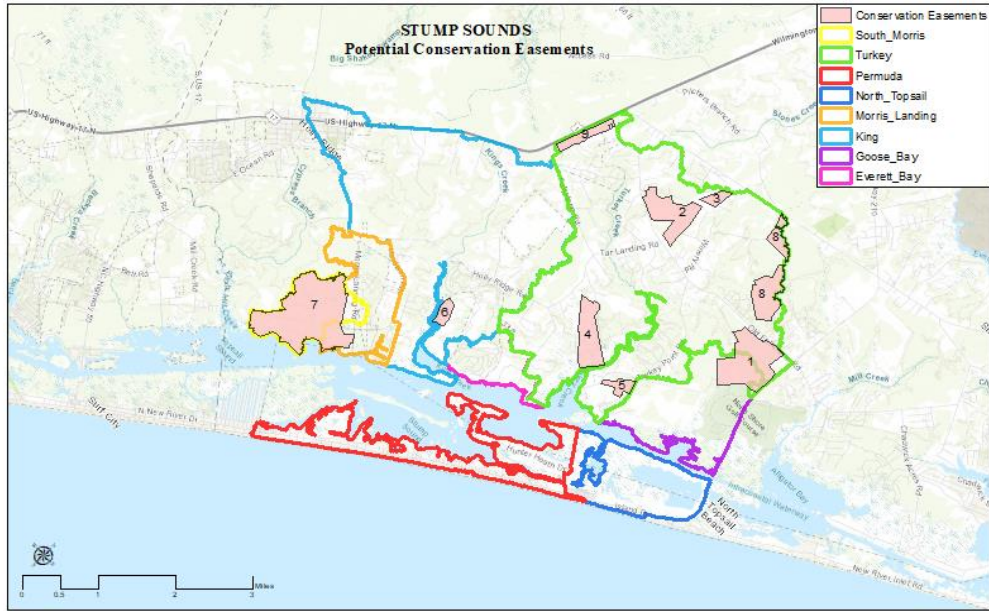


Table 4-3: Potential to Reduce Runoff from Conservation Lands

Location	Watershed	Project Type	Acreage	Estimated Storage (Acre-feet)
HWY 210, North Topsail Beach	Everett Bay and North Topsail	Conservation Land	75.40	24
HWY 210, Old Folkstone Road	Turkey Creek	Conservation Land	170	53
Area adjacent to Oyster Catcher Landing extending to Old Folkstone Drive	Turkey Creek	Conservation Land	160	49
Oyster Landing between Oyster Landing Drive and Virginia Lane	Turkey Creek	Conservation Land	25	8
Area adjacent to Gus Home Road (LoggerHead Subdivision)	Turkey Creek	Conservation Land	150	46

Area west of Harbor Point Road enclosed by Turkey Point Road	Turkey Creek	Conservation Land	40	12
West of King Crossing Road	King Creek	Conservation Land	25	8
West of Morris Landing Road	Morris Landing and South Morris Landing	Conservation Land	1213.25	380
North of Bridgeport Community off Old Folkstone Road	Turkey Creek	Conservation Land	390	121
The Village at Folkstone, Currituck Drive and Winfall Drive	Turkey Creek	Conservation Land	55	17
TOTAL ACRE-FEET OF STORAGE				718
TOTAL CUBIC FEET OF STORAGE				31,268,080

Table 4-4: Actions and Timeline for Objective 2

Actions and Timeline for Objective 2		Timeline
A2.1	Acquire through donation a 77.5-acre undeveloped parcel is situated on either side of Highway 210 at the southern end of the high-rise bridge at North Topsail Beach. It contains about 60 acres of wetlands and 15.5 acres of high ground that could be intensely developed. This land was donated to the North Carolina Coastal Federation in September 2024 and is now preserved in perpetuity under the terms of the gift. The property will not be developed in the future thus helping to prevent future increases in polluted runoff. The estimated storage volume of the property during a 1-year, 24-hour storm event is approximately 24 acre-feet.	Completed in September 2024
A2.2	<u>Area 7 on the map:</u> The large property west of Morris Landing Road consists of approximately 1,213 acres of forest, wetland areas, including a large drainage feature of Cypress creek that adjoins Batts Mill Creek. This parcel is currently undeveloped and is a substantial portion of the Morris and South Morris sub-watersheds. The North Carolina Coastal Federation currently holds a couple of conservation easements on portions of this land. The Federation is currently working with the property owners, the Department of Defense, UNC-W, state and local	Year 1-4

	stakeholders to acquire and protect the entire property. The estimated reduction in runoff during a 1-year, 24-hour storm event is approximately 380 acre-feet.	
A2.3	<u>Area 2 on the map</u> : The parcel extends south of Oyster Catcher Landing to Old Folkstone Drive. It has potential for a large continuous tract (approximately 160 acres) of conservation easement. This area contains areas of wetlands and bottom land hardwoods. This area makes up a substantial portion of the watershed draining to Turkey Creek and includes much of the head waters of the watershed. The North Carolina Coastal Federation is negotiating with the owner of the property and has initiated an appraisal to agree upon its fair market value. This would reduce any future increases in runoff from a 1-year, 24-hour storm by 49 acre-feet.	Years 1-4
A2.4	<u>Area 1 on the map</u> : The large track of forested land on the south side of Old Folkstone Road is a viable option for a conservation easement. The area is approximately 170 acres and represents a large portion of the watershed draining to Goose Bay. This would reduce any future increases in runoff from a 1-year, 24-hour storm by 53 acre-feet.	Year 2-4
A2.5	<u>Area 3 on the map</u> : The parcels extending east of Oyster Catcher Landing extending down to Virginia Lane has potential for a conservation easement consisting of approximately 25 acres. Satellite imagery appears to indicate this area is made up of predominantly pine forest This area makes up a portion of the watershed draining to Turkey Creek and includes much of the headwaters of the watershed. This would reduce any future increases in runoff from a 1-year, 24-hour storm by 8 acre-feet.	Years 2-4
A2.6	<u>Area 4 on the map</u> : The parcels extending south of Gus Home Road extending down to Simon Lane has potential for a large continuous tract (approximately 150 acres) of conservation easement. This area appears to contain areas mostly pine forest and is part of the riparian zone of Turkey Creek. This area makes up a substantial portion of the watershed draining to Turkey Creek and conserves land adjoining the water which offers potential for other enhancements such as living shorelines. This would reduce any future increases in runoff from a 1-year, 24-hour storm by 46 acre-feet.	Years 5-10

A2.7	<p><u>Area 5 on the map:</u> The area to the west of Harbor Point Road enclosed by Turkey Point Road and Firelight Ln is a good candidate for a conservation easement. This area consists of approximately 40 acres that appears to be forest land with a drainage feature that runs down the center to Turkey Creek. This would reduce any future increases in runoff from a 1-year, 24-hour storm by 12 acre-feet.</p>	Year 5-10
A2.8	<p><u>Area 6 on the map:</u> The parcel to the west of the last 0.5 mile of King Crossing Road is currently undeveloped riparian forest and marsh. The approximately 25 acre is a good candidate for a conservation easement as it offers critical habitat and makes up a substantial area draining to Turkey Creek. The property owner to the of this parcel was met on site during field investigations and seem agreeable to also having a conservation practice integrated into their farm/property. This would reduce any future increases in runoff from a 1-year, 24-hour storm by 8 acre-feet.</p>	Year 5-15
A2.9	<p><u>Area 8 on the map:</u> The parcels north of the Bridgeport Community off Old Folkstone Road includes approximately 390 acres of land. Of the 390 acres, almost 180 acres are within the watershed boundaries and drain to Turkey Creek. While currently appearing cleared with some vegetation, replanting and growth of vegetation post easement can help restore natural land and mitigate potential flooding impact. This would reduce any future increases in runoff from a 1-year, 24-hour storm by 121 acre-feet.</p>	Years 5-20
A2.10	<p><u>Area 9 on the map:</u> The area enclosed by Folkstone Road, Currituck Drive, HWY 17, and Old Folkstone Road is approximately 55 acres of forested land. The forest land also borders The Village at Folkstone. This parcel is a good candidate for conservation easement within the Turkey Creek watershed. This would reduce any future increases in runoff from a 1-year, 24-hour storm by 17 acre-feet.</p>	Years 5-20

Objective 3: Retrofit Stormwater Management Systems on Private Properties

Stormwater system retrofits for existing development on private lands will reduce the overall rate and volume of polluted stormwater runoff into coastal waters. There are a wide variety of

nature-based solutions to reduce the rate and volume of runoff that can be designed and installed to achieve this objective. The primary strategy is to maximize the ability of the natural landscape to hold, infiltrate and slow the runoff of surface runoff. These retrofits are needed on properties that were built prior to the adoption of coastal stormwater runoff regulations, and on those with state issued coastal stormwater permits that no longer have state-of-the-art designs, or which have not been properly built, operated and maintained.

Potential project opportunities were identified based upon a compliance evaluation conducted by the state, as well as based upon discussions and meetings with project partners from the towns of Holly Ridge, Surf City and North Topsail Beach, as well as Onslow County. The project locations were determined based upon the “hot spots” of water quality and quantity concerns identified during these meetings as well as data collection. A high-level feasibility analysis was conducted at the locations of highest concern to determine the most appropriate project for each location.

Table 4-5: Actions and Timeline for Objective 3

Actions and Timeline for Objective 3		Timeline
A3.1	Continuously investigate the availability of stormwater grants and potentially state appropriations and other funding sources to install lot-level, lower-cost retrofits that disconnect impervious surfaces and enhance stormwater infiltration.	Years 1-5
A3.2	Continuously explore opportunities to secure funds from the Community Conservation Assistance Program (CCAP) to help pay for private landowner stormwater retrofits.	Years 1-5
A3.3	Use a portion of the existing \$5 million appropriation from the N.C. General Assembly to develop and begin to implement a cost-share program that will help landowners within the watershed that have state issued coastal stormwater permits comply with regulations and upgrade their stormwater systems. Focus evaluation on the 51 permits issued in the watershed, with priority given to the 14 permits that DEQ has found to be out of compliance, 2 permits that are expired, and 27 permits that DEQ has not evaluated for compliance. See next three tables for list of these permits. Estimated volume reduction from 25 retrofits in the first 5 years would be 350,000 cubic feet. This work would accelerate once the retrofit program is up and running.	Years 1-5
A3.4	Further evaluate and rank for funding the retrofits sites that were visited in the field or identified by local government officials (see list). Prioritize any sites that have DEQ stormwater permits that are out of compliance.	Years 1-2

Table 4-6: Existing State Issued Permits on Private Properties That Are Out of Compliance

Permit Number	Facility Name	Facility Address	City	DEQ Compliant?	Density	Status	Regulated Activity
SW8070418	Holly Tree Townhouses	Tumbling Brook Ln	Holly Ridge	Not Compliant	Low Density	Active	State Stormwater - Low Density
SW8070420	Jubilation East Side	US Hwy 17	Holly Ridge	Not Compliant	High Density	Active	State Stormwater - HD - Detention Pond
SW8070503	Kings Harbor III	Old Folkstone Rd NCSR 1518	Sneads Ferry	Not Compliant	Low Density	Active	State Stormwater - Low Density
SW8070608	Kings Harbor Phase Four	Harbor Point Rd	Topsail Beach	Not Compliant	Low Density	Active	State Stormwater - Low Density
SW8070609	Kings Harbour II	NC 210	Topsail Beach	Not Compliant	Low Density	Active	State Stormwater - Low Density
SW8070676	Holly Ridge Processing Facility	652 Holly Ridge Rd	Holly Ridge	Not Compliant	Low Density	Active	State Stormwater - Low Density
SW8070927	Jubilation formerly Huff Property Development	NCSR 1538 Morris Landing Rd	Holly Ridge	Not Compliant	Low Density	Active	State Stormwater - Low Density
SW8090515	Mainlander Estates Section VI	4532 24th St	N Topsail Beach	Not Compliant	Low Density	Active	State Stormwater - Low Density
SW8100511	Lot Z Hark Properties	4021 Island Dr	N Topsail Beach	Not Compliant	N/A	Active	State Stormwater - Exclusion
SW8101010	Morris Landing Club	Hardison Rd	Holly Ridge	Not Compliant	Low Density	Active	State Stormwater - Low Density
SW8110424	Landing at Stump Sound	3230 Turkey Point Rd	Sneads Ferry	Not Compliant	Low Density	Active	State Stormwater - Low Density
SW8120314	North Topsail Shores Baptist Church	1330 Hwy 210	Sneads Ferry	Not Compliant	Low Density	Active	State Stormwater - Low Density
SW8070653	Hampstead Pines Subdivision formerly Henderson Farms	Oyster Landing Dr	Sneads Ferry	Not Compliant	High Density	Expired	State Stormwater - HD - Detention Pond
SW8970118	Tides End Subdivision	883 NC 210	Sneads Ferry	Not Compliant	Low Density	Active	State Stormwater - Low Density

Table 4-7: Expired Stormwater Permits on Private Lands Not Evaluated by DEQ for Compliance

Permit Number	Facility Name	Facility Address	City	DEQ Compliant?	Density	Status	Regulated Activity
SW8190315	SeaSide Inn	6702 13th Ave	Wilmington	Not Evaluated	Low Density	Expired	State Stormwater - Low Density
SW8190502	Sea Star Village	Hardison Rd	Topsail Beach	Not Evaluated	High Density	Expired	State Stormwater - HD - Detention Pond

Table 4-8: Active Stormwater Permits on Private Properties Not Been Evaluated by DEQ for Compliance

Permit Number	Facility Name	Facility Address	City	DEQ Compliant?	Density	Status	Regulated Activity
SW8050926	Dollar General Holly Ridge	Clearview Dr	Sneads Ferry	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8060509	Dixon Point at Spicers Bay	Sr 1534	Holly Ridge	Not Evaluated	High Density	Active	State Stormwater - HD - Detention Pond
SW8070124	Kings Harbor	Folkstone Rd	Holly Ridge	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8051224	Dollar General Sneads Ferry Hwy 210	Hwy 50 And 210	N Topsail Beach	Not Evaluated	High Density	Expired	State Stormwater - HD - Infiltration
SW8090623	Pine Ridge Townhomes	8663 US Hwy 17	Holly Ridge	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8120905	Maple Crest Estates	Folkstone Rd	Holly Ridge	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8121020	Mill Creek Crossing	Old Folkstone Road	Sneads Ferry	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8121204	Mills Mobile Home Sales Lot	Hardison Rd	Holly Ridge	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8130505	Pointe Harbor Campground	Island Dr	Topsail Beach	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8130515	Rogers Bay Campground Boat Ramp and Maintenance Dredging	Int Of Morris Landing Rd and Hardison Rd	Holly Ridge	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8130612	Rogers Bay Family Campground, Phase 4 Stormwater	Old Folkstone Rd	Sneads Ferry	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8140516	Osprey Landing	619 Turkey Point Rd	Sneads Ferry	Not Evaluated	N/A	Active	State Stormwater - Exclusion
SW8160215	Old Dock Plantation	Island Dr	N Topsail Beach	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8160609	Pine Ridge Townhomes	1333 NC Hwy 210	Sneads Ferry	Not Evaluated	High Density	Active	State Stormwater - HD - Sand filters

SW8160906	Oyster Landing Subdivision	Old Folkstone Rd	Sneads Ferry	Not Evaluated	High Density	Active	State Stormwater - HD - Wetlands
SW8181016	Scotch Bonnett Oceanside	Tar Landing Rd NCSR 1531	Sneads Ferry	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8190503	Seaside Village	Folkstone Rd	Holly Ridge	Not Evaluated	High Density	Active	State Stormwater - HD - Wetlands
SW8190608	Stump Sound Elementary School	905 Old Folkstone Rd	Sneads Ferry	Not Evaluated	High Density	Active	State Stormwater - HD - Detention Pond
SW8190709	Summerhouse on Everett Bay	NC Sr 1537	Richlands	Not Evaluated	High Density	Active	State Stormwater - HD - Hybrid Infiltration
SW8190911	The Landing at Folkstone	109 Old Folkstone Rd	Holly Ridge	Not Evaluated	High Density	Active	State Stormwater - HD - Infiltration
SW8191004	The Preserve at Morris Landing Subdivision	US Hwy 17	Holly Ridge	Not Evaluated	High Density	Active	State Stormwater - HD - Detention Pond
SW8200704	Yopp Brothers Marine Repair	Folkstone Rd	Holly Ridge	Not Evaluated	High Density	Active	State Stormwater - HD - Detention Pond
SW8890418	Shopping & Office Park Holly Ridge	Folkstone Rd	Holly Ridge	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8890809	Sneads Ferry Retail Center	US Hwy 17 N	Holly Ridge	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8891114	Scotch Bonnet Soundside	Island Dr	N Topsail Beach	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8980723	The Village at Folkstone	Clearview Dr	Holly Ridge	Not Evaluated	Low Density	Active	State Stormwater - Low Density
SW8990114	Village Of Stump Sound	224 Harbor Point Rd	Sneads Ferry	Not Evaluated	Low Density	Active	State Stormwater - Low Density

Table 4-9: Active State Issued Stormwater Permits on Private Properties Deemed Compliant

Permit Number	Facility Name	Facility Address	City	DEQ Compliant?	Density	Status	Regulated Activity
SW8000407	Bridgeport Subdivision	Turkey Point Rd	Jacksonville	Compliant	Low Density	Active	State Stormwater - Low Density
SW8001013	Aaronfield at Old Folkstone	Hwy 17	Topsail Beach	Compliant	Low Density	Active	State Stormwater - Low Density
SW8020705	Bublitz Residence	US Hwy 17	Holly Ridge	Compliant	Low Density	Active	State Stormwater - LD - Curb and Gutter
SW8020836	Creeks Edge Subdivision	Hwy 210 In Onslow Co	Holly Ridge	Compliant	Low Density	Active	State Stormwater - Low Density
SW8040216	Buckhorn	Is Dr Hwy 210	N Topsail Beach	Compliant	Low Density	Active	State Stormwater - Low Density

SW8040620	Coastal Shooting Sports	Hwy 210	Topsail Beach	Compliant	N/A	Active	State Stormwater - Exempted
SW8050212	Dollar General - Holly Ridge Old Folkstone Road	Off NCSR 1537	Jacksonville	Compliant	Low Density	Active	State Stormwater - Low Density
SW8050633	Folkstone Heights	211 Tumbling Brook Ln	Holly Ridge	Compliant	Low Density	Active	State Stormwater - Low Density

Figure 4-3: Potential Private and Public Retrofit Sites

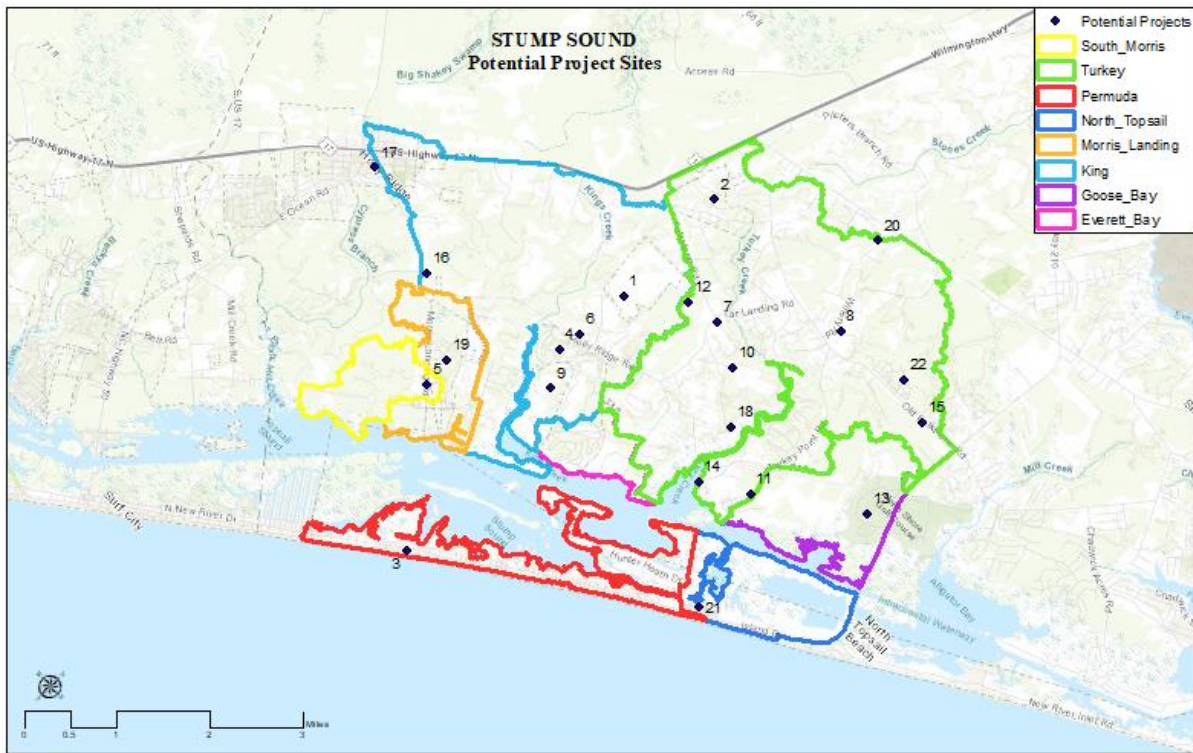


Table 4-10: Potential Retrofit Projects on Private Developed Lands

Site on Map	Location	Watershed	Project Type	Approximate Treatment Volume (CUFT)	Opinion of Probable Cost (\$)	Cost per CUFT Reduction	Water Quality	Water Quantity	Bacteria Removal / Prevention
2	The Village at Folkstone, Currituck Drive and Winfall Drive	Turkey Creek	Bioswale	15,000	389,000	\$26	High	High	High
3	Island Drive and	Permuda	Underground retention cell	76,000	\$750,000	\$10	High	High	High

	Carver Street								
4	Summer House	King Creek	BMP retrofit/enhancement	16,000	485,000	\$30	High	Med	High
5	734 Morris Landing Road, Holly Ridge, NC 28445	Turkey Creek	Regional Bioretention Cell/Bioswale	2,500	\$90,000	\$36	High	High	High
6	Dolph Everett Road	King Creek	Drainage water management plan	12,000	\$180,000	\$15	High	Med	High
7	Creek Landing Road at Tar Landing Road	Turkey Creek	Drainage water management plan	155,000	\$170,000	\$1.10	High	High	High
8	East Side of Winery Road	Turkey Creek	Drainage water management plan	125,000	\$140,000	\$1.12	High	Med	High
9	End of King Creek Crossing	King Creek	Drainage water management plan	52,000	\$60,000	\$1.15	High	High	High
10	South Parker Rd	Turkey Creek	Drainage water management plan	247,000	\$270,000	\$1.09	High	High	High
11	End of Harbor Point Road	Turkey Creek	Regional Bioretention Cell	8,000	\$250,000	\$31.25	High	High	High
13	Seascape Dr	Turkey Creek	Bioswales	9,500	\$110,000	\$12	High	High	High
15	Unknown Name Street off Old Folkstone Road	Turkey Creek	Bioswales	4,000	\$430,000	\$107	High	Med	High
16	451 Morris Landing Rd, Holly Ridge, NC 28445	King Creek	Bioswales	12,000	\$350,000	\$29	High	Med	High
17	212 N Dyson St, Holly Ridge NC 28445	King Creek	Regional Bioretention Cell	8,500	\$250,000	\$29	High	High	High

18	Gus Home Road (Logger Head Subdivision)	Turkey Creek	Regional BMP	59,000	\$410,000	\$7	High	Med	High
19	The Preserves Morris Landing	Morris Landing	Regional Bioretention Cell	4,000	120,000	\$30	High	Med	High
20	Oyster Landing between Oyster Landing Drive and Virginia lane	Turkey Creek	BMP retrofit	7,000	\$200,000	\$29	High	High	High
21	4021 Island Drive	King Creek	Regional Bioretention Cell	12,500	200,000	\$16	High	Med	High
22	Bridgeport Community of Old Folkstone Road	Turkey Creek	Bioswales	44,000	480,000	\$11	High	Med	High

Figure 4-3 provides a map of locations possible stormwater retrofit projects on private and public properties that were identified in developing the plan. These possible projects on private properties include:

Project Site 2: The Village at Folkstone consists of a mix of duplexes and half acre homes with roadside swales conveying most of the stormwater to a small creek that cuts through the neighborhood. It was observed on Windfall Drive that the stream has experienced increased rates of erosion leading to bank failures. This site is a suitable candidate for a stream restoration project paired with a constructed wetland to the northeast of the stream crossing on Windfall Drive. This development has an out-of-compliance coastal stormwater permit (SW8070124). The North Carolina Coastal Federation will approach the permit holder in year one of the plan’s implementation to determine if the subdivision would like to participate in the

Located on the corner of Island Drive and Carver Street is a larger undeveloped parcel that **cost-share program funded by the N.C. General Assembly in 2023 to retrofit such systems.**

Project Site 3: currently hosts the Ocean City Jazz Festival. This lot is unique in that it offers a larger area for stormwater reduction practices on the barrier island which are typically highly developed and partitioned. This location could offer a multitude of stormwater reduction options that would maintain the existing use or enhance it by adding vegetation to the

landscape. One commonly used BMP that would be a good fit for this location is underground stormwater retention tanks. These tanks offer storage of stormwater runoff to reduce nuisance flooding in the area and then once in the chambers they infiltrate the stormwater into the ground over time, helping minimize the amount of direct discharge of runoff into the surface water. The North Carolina Coastal Federation is working with the owner of this property and has recently submitted a funding request to the Attorney General's Environmental Enhancement Program to design and permit this project.

Project Site 4: The Summer House subdivision is a large subdivision off Holly Ridge Road. Upon site visits it was deduced that current stormwater practices for the subdivision including bioretention ponds and roadside swales were not adequately mitigating the stormwater within the community. Discussion with the HOA or representative of the community should be pursued to enhance the current practices. This development has a compliant coastal stormwater permit (SW8060509). The North Carolina Coastal Federation will approach the permit holder in year one of the plan's implementation to determine if the HOA would like to participate in the cost-share program funded by the N.C. General Assembly in 2023 to retrofit such systems.

Project Site 5: The area north of the Topsail Sound RV Park is currently an undeveloped, cleared lot. This area would be a suitable candidate for a regional BMP such as an infiltration area or constructed wetland to treat the incoming runoff from the ditch along Morris Landing Road prior to entering the receiving water body near Dixon Point. The North Carolina Coastal Federation will explore how to advance this project in year one of the plan's implementation.

Project Sites 6-10: Multiple sections of farmland within the watershed area have been identified as good candidates for Drainage Water Management Plans (DWMP). Implementation of a DWMP can help mitigate stormwater runoff into the respective water body for each farm. Farms identified for a DWMP include farmland at the end of South Parker Road, south of Creek Landing Road, the east side of Winery Road, the end of King Creek Crossing, and along Dolph Everett Road. In addition to DWMPs, the farmland on S Parker Road and Creek Landing Road appear to be ditched. The North Carolina Coastal Federation is already in discussions with the landowners of the farmland at the end of South Parker Road regarding acquisition of this property. It will reach out to other landowners during years 2 and 5 of the plan's implementation.

Project Site 11: The RV community at the end of Harbor Point Road was deemed a good candidate for regional stormwater reduction practices within the community. No stormwater management practices were observed in the field or with aerial imagery within the approximately 30-acre community. It was issued a high-density stormwater permit (SW8210915) on October 27, 2021. The possible proposed locations identified were north of the clubhouse\pool area, in the northwest corner of the community in the open grass field or at the southern board of the community adjoining Turkey Creek. The North Carolina Coastal Federation will approach the permit holder in year one of the plan's implementation to

determine if the RV park would like to participate in the \$5 million cost-share program funded by the N.C. General Assembly in 2023 to retrofit these systems.

Project Site 13: The North Shore Country Club of SeaScape Drive has a series of ponds within the golf course. These ponds then drain directly into the creek that enters Goose Bay. Integrating bioretention cells at the downstream end of the pond/drainage ditch network could offer a substantial level of treatment and handle small storms and initial plumes of stormwater runoff for the neighborhood and golf course. The club was issued a coastal stormwater permit (SW8990808) on September 17, 1999. The North Carolina Coastal Federation will approach the permit holder in year one of the plan's implementation to determine if the Club would like to participate in the \$5 million cost-share program funded by the N.C. General Assembly in 2023 to upgrade these older systems to current standards.

Project Site 15: On the south side of Old Folkstone Road a gravel/dirt road leads to a radio tower off Unknown Name Road. The drainage ditch beside this road could be converted to a vegetated bioswale to offer a greater level of stormwater attenuation. The North Carolina Coastal Federation will reach to the landowner in year 3 of the plan's implementation to determine if they would participate in such a water quality enhancement project.

Project Site 16: There is the potential for the paving and development around the private air strip along Morris Landing Road. Considering the possible changes, this area is a good candidate for a preemptive stormwater pond or vegetated swale to account for any future paving of the airstrip or development in the surrounding area. The North Carolina Coastal Federation will explore this opportunity in year 2 of the plan's implementation.

Project Site 17: The lot adjacent to the Holly Ridge Town Hall on N Dyson Street consists approximately 0.5 acres of undeveloped grass land. This area is in a prime location for a showcase BMP such as a retention pond or constructed wetland. Due to its prominent location, it could be utilized as a tool for educating the public on stormwater practices and how they benefit the community.

Project Site 18: The new subdivision of Loggerhead Landing was cited during site visits as a potential site to discuss with developers about stormwater management methods and integration of better stormwater practices into the subdivision design such as regional BMPs, roof leaders, and other methods to improve the water quality of the runoff entering Turkey Creek.

Project Site 19: The Preserves at Morris Landing subdivision currently has no stormwater practices integrated into the subdivision making it a suitable candidate for enhancement. Installing one or more practices in the area along the eastern side of the subdivision could help reduce the subdivision's impacts to the small drainage feather that also runs along the east side of the subdivision. The subdivision received a low-density coastal stormwater permit (SW8121204) on January 31, 2013, and is therefore to be considered for upgrades under the \$5

million stormwater retrofit program funded by the N.C. General Assembly. The North Carolina Coastal Federation will reach out to the subdivision HOA during year one of the plan’s implementation.

Project Site 20: Site investigation of the BMP to the south of Oyster Catchers Landing found that the potential for a retrofit or redesign could offer a higher level of treatment before discharging stormwater. Enlarging the size of the current stormwater practice could allow for higher water quality and reduced water quantity following rain events. According to DEQ, this development has an out-of-compliance coastal stormwater permit (SW8070653) that was first issued on October 2, 2007. The North Carolina Coastal Federation will approach the permit holder in year one of the plan’s implementation to determine if the subdivision would like to participate in the \$5 million cost-share program funded by the N.C. General Assembly in 2023 to retrofit such non-compliant systems.

Project Site 21: Adjacent to the Rogers Bay Property Owners Association and Hunters, Heather Drive there is an undeveloped low area. This area is unique in that it offers an adequate area for a Stormwater BMP on the island, which is mostly developed. This could offer a large stormwater impact as it is near the RV that holds a large impervious area. The campground was issued a low-density coastal stormwater permit (SW8100511) on August 30, 2010.

Project Site 22: The North Bridgeport Community of Old Folkstone Road is adjacent to a small unnamed stream to the north of the subdivision running northwest. Implementation of a stream buffer in this area could offer enhanced water quality and habitat enhancement. The subdivision was issued a low-density coastal stormwater permit (SW8130612) on July 16, 2013. The North Carolina Coastal Federation will approach the permit holder in year one of the plan’s implementation to determine if the subdivision would like to participate in the \$5 million cost-share program funded by the N.C. General Assembly in 2023 to retrofit such non-compliant systems.

Objective 4: Retrofit Publicly Owned Lands to Reduce Runoff

The rate and volume of stormwater runoff being transported over land to waterways needs to be reduced to restore water quality. This objective focuses on opportunities on publicly owned land that is owned by the federal, state and local governments, including N.C. Department of Transportation. By focusing the objective on public lands and conveyance systems; governmental agencies managing property and infrastructure within the watershed can lead by example and demonstrate commitment to improving watershed health to the community.

Table 4-11: Actions and Timeline for Objective 4

Actions and Timeline for Objective 4		Timeline
A4.1	Utilize the plan as framework to obtain public funds for stormwater management to help pay for expenditures on retrofits on infrastructure that is publicly owned.	Years 1-5

A4.2	Review list of state issued stormwater permits that are held by governmental agencies and prioritize retrofits for permits that are not in compliance with requirements, or which have not been evaluated for compliance. Examine three permits that have not been evaluated for compliance, one of which is expired (Table 5-4.1). Pick priority projects to provide cost-share support to bring them into compliance using the \$5 million appropriation by the N.C. General Assembly, and other funds that will be secured.	Years 1-2
A4.3	Work with N.C. Department of Transportation, Holly Ridge and North Topsail Beach to install stormwater retrofits along highway and street drainage systems that will reduce the rate and volume of runoff into coastal waters. Specific projects identified are listed in Table 5-4-2 below for other potential retrofit locations.	Years 2-4
A4.4	Where applicable and practical, work with government agencies to seek to use pervious paving surfaces for public development or redevelopment projects.	Years 1-5

Table 4-12: Public State Permitted Stormwater Systems with Active or Expired Permits Not Evaluated by DEQ

Permit Number	Facility Name	Facility Address	City	DEQ Compliant?	Density	Status	Regulated Activity
SW8190608	Stump Sound Elementary School	905 Old Folkstone Rd	Sneads Ferry	Not Evaluated	High Density	Active	State Stormwater - HD - Detention Pond
SW8970325	Onslow County Beach Access 2	Hwy 210	N Topsail Beach	Not Evaluated	High Density	Expired	State Stormwater - HD - Infiltration
SW8990545	Turkey Creek Boating Access Area	312 Sound Rd	Holly Ridge	Not Evaluated	High Density	Active	State Stormwater - HD - Detention Pond

Within the Stump Sound watershed, several significant undeveloped properties are held in local, state, and federal ownership (Figure 3-3). These lands exist as state-maintained game lands (Stones Creek), as military buffer areas (Camp Lejeune), as municipal open space (Town of

Holly Ridge, Onslow County, North Topsail Beach), as a publicly owned coastal research reserve (Permuda Island), as legally mandated conservation easements (Holly Ridge Associates, LLC- Appendix C), or as conservation lands (Morris Landing Clean Water Preserve). These lands provide critical roles in offsetting the effects of rapid development patterns and protecting the water quality and natural resources of Stump Sound and should be protected as conservation lands in perpetuity.

Figure 4-4: Existing Undeveloped Public Lands within Stump Sound Watershed

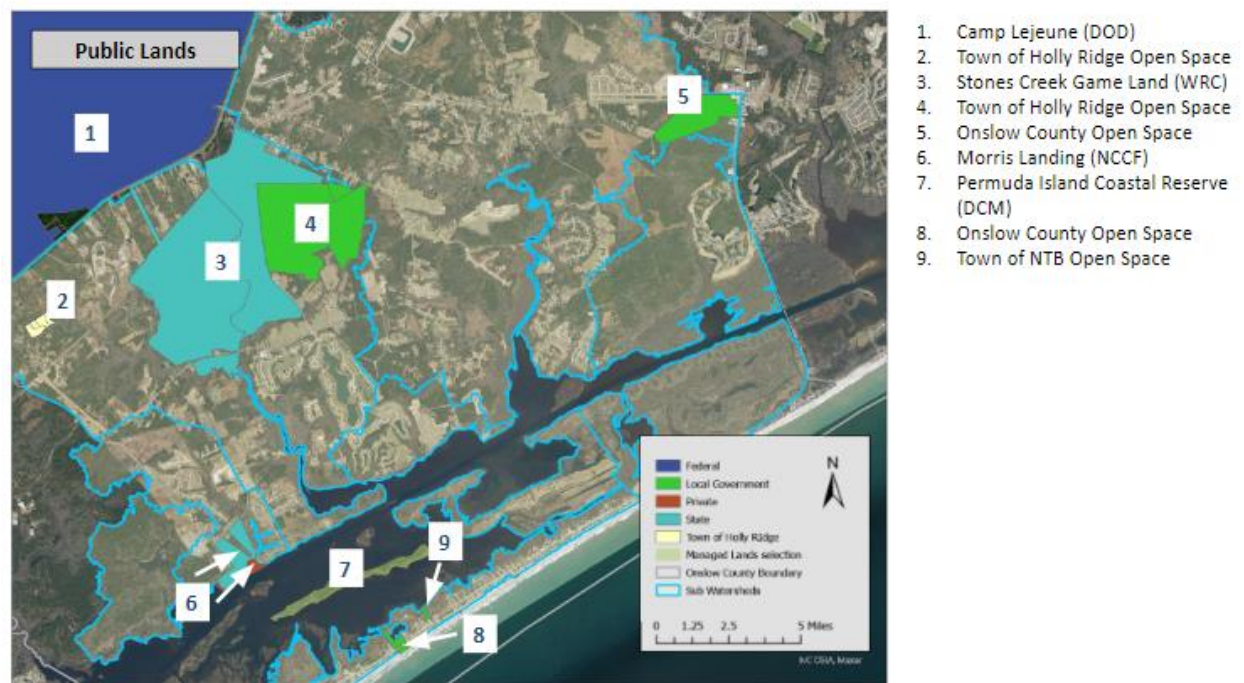


Table 4-13 below illustrates the potential runoff reductions that can be achieved on three public properties that were evaluated in preparing this Plan. Additional purchases of public land in future years will result in more opportunities to restore or replicate natural hydrology within more of the watershed.

Table 4-13: Potential highway and town street retrofit projects identified during field visits

Site on Map (4-3)	Location	Watershed	Project Type	Approximate Treatment Volume (CUFT)	Opinion of Probable Cost (\$)	Cost per CUFT Reduction	Water Quality	Water Quantity	Bacteria Removal / Prevention
1	WRC - Stones Dolph Everett Road	King Creek	Wetland Restoration	8,148,000	\$3,630,000	\$0.45	High	Med	High

12	370 Folkstone Rd, Holly Ridge, NC 28445	Turkey Creek	BMP retrofit	6,000	\$185,000	\$31	High	Med	High
14	Turkey Creek Boat Access Area at Turkey Point Road	Turkey Creek	Pervious Pavement	50,000	820,000	\$16.40	High	Med	High

Project Site 1: The North Carolina Wildlife Resources Commission’s Stones Creek Game Lands – Folkstone Tract is a large tract of and northeast of Dolph Everett Road. The drainage network within the game lands could be modified to hold/store/infiltrate stormwater within an already conserved tract of land. Currently large drainage ditches discharge to both Turkey and King Creek. Utilizing drainage water management techniques on this tract of land would increase the potential of wetland restoration, fire control, and minimize the runoff to the estuaries. The North Carolina Coastal Federation has a close working relationship with the Commission and will be approaching it during the first year of implementation of the plan to pursue this project.

Project Site 12: Stump Sound Elementary School located at 370 Folkstone Road has three existing stormwater practices in place to manage the stormwater runoff from the building and parking area. Retrofit and redesign of these practices to increase treatment and storage capacity can help align the school with growing requirements and recommendations from the state and local governments and related organizations. This will be especially critical as development continues around the school, such as the construction of the new middle school across the street.

Project Site 14: The Turkey Creek boat ramp configuration is currently completely impervious asphalt. This site therefore is a suitable candidate for the installation of permeable pavement. The design could either be limited to the 12 parking stall areas or be expanded to the entire paved ramp area. The ramp is permitted under the Coastal Stormwater Program (SW8140516) and would be eligible for funding for design upgrades that exceed state standards from the Section 319 program. The North Carolina Coastal Federation is currently working with the NC Wildlife Resources Commission to pursue this upgrade.

Objective 5: Restore Living Shorelines

Long-term resilience is enhanced through the protection and restoration of living shorelines. Within the Stump Sound watershed, living shorelines provide increasingly valuable functions as fisheries/animal habitats, water quality vegetated buffers, storm surge mitigation, sea level rise adaptation, and shoreline stabilization. While many shorelines have been stabilized with traditional hardened approaches (bulkheads, rip-rap revetments), there remain many shorelines surrounding Stump Sound that are nature vegetated shorelines. Where existing naturally vegetated shorelines are unable to be sustained over time, living shorelines provide

excellent opportunities to provide erosion control and maintain the environmental benefits that these shorelines provide.

A field survey of Stump Sound shorelines resulted in the identification of potential living shoreline project sites, which can be found in Section 5.2 of this plan. The identification of these sites is preliminary, intended to provide examples of viable opportunities for successful establishment of living shorelines within the Stump Sound waters.

Table 4-14: Actions and Timeline for Objective 5

Actions and Timeline for Objective 5		Timeline
A5.1	Target as a priority the promotion of living shoreline projects along Stump Sound by securing cost-share funding to provide incentives to private property owners and local governments.	Years 1-5
A5.2	Secure grants for cost-share assistance for private shorelines as well as individual funding for larger-scale projects on public lands.	Years 2-4
A5.3	Seek local government policies that encourage the retention and management of natural vegetation in buffer areas along creeks, sounds and islands.	Years 3-5
A5.4	Promote educational opportunities at the completed living shoreline demonstration project at Soundside Park, Surf City Boat Basin to encourage more living shoreline projects.	Years 1-5
A5.5	Promote educational opportunities at the completed living shoreline project at North Topsail Beach’s Peter’s Park to encourage more living shoreline projects.	Years 1-5

Objective 6: Monitor and Adapt Management Strategies

Accomplishing the actions in this plan requires monitoring the performance of the plan and projects that are implemented. Records should be maintained on the progress of the plan. Progress made in achieving water quality improvements should be tracked and recorded. This plan will be adapted as necessary based upon the results of this monitoring.

Table 4-15: Actions and Timeline for Objective 6

Actions and Timeline for Objective 6		Timeline
A6.1	Document the rate and volume of stormwater reduced by actions taken because of this plan by utilizing the Runoff Reduction Calculator Tool or other appropriate volume calculation methodologies, which will be maintained by the Federation.	Years 1-5
A6.2	Maintain a dashboard and monitor the performance of stormwater reduction retrofits that have been installed within the watersheds. This will be carried out as part of the tools and data collected for the ongoing \$5 million project to develop a cost-share program for stormwater retrofits.	Years 1-3
A6.3	Conduct yearly, scheduled assessments with partners of the progress made to date implementing plan actions.	Years 1-5
A6.4	Based upon yearly assessments, revise and update actions as needed that can still be accomplished within the 5-year timeframe of the plan.	Yearly

Objective 7: Inform and Engage

Community awareness and engagement is a critical component to achieving the primary goal of this plan. Stakeholders including residents, property owners, fishers, business owners, developers and others can help advance actions in the plan.

Table 4-16: Actions and Timelines for Objective 7

Actions and Timelines for Objective 7		Timeline
A7.1	Develop regular articles to appear in Coastal Review as well as to be televised on “Stories from the Coast” (on WRAL, WITN, WECT) that provide updates and analysis on plan implementation.	Years 1-5
A7.2	Use financial support for outreach and education provided by funding from U.S. EPA for the CPRG grant to raise awareness and understanding of the value of the coastal habitats in and around Stump Sound to mitigate climate change as well as to protect water quality.	Years 1-5

A7.3	Distribute copies of Smart Yards to residents and landowners within the watershed.	Years 1-5
A7.4	Include education signage at select retrofit sites to educate the public about the techniques and widespread applicability.	Years 1-5
A7.5	Place educational signage at Morris Landing Water Quality Preserve owned by the Coastal Federation.	Years 1-2
A7.6	Continue to convene working group of partners that devised the plan to maintain engagement to implement actions and to provide continuity and liaisons with local governments.	Yearly

Objective 8: Update Plan Every Five Years

Starting in year 4 of this plan, it should be comprehensively reviewed and updated to reflect actions achieved, in progress, or not started. The update should include any Community awareness and engagement is a critical component to achieving the primary goal of this plan. Stakeholders including residents, property owners, fishers, business owners, developers and others can help advance actions in the plan.

Table 4-17: Actions and Timelines for Objective 8

Actions and Timelines for Objective 8		Timeline
A8.1	Convene planning team to review and update plan actions.	Years 4-5
A8.2	Distribute drafts of update to local governments for review and suggestions.	Year 5
A8.3	Incorporate new actions that provide additional opportunities for reducing the existing rates and volumes of stormwater runoff.	Year 5
A8.4	At the end of year 5, release updated plan and begin anew on implementation.	Year 5

Section 5: Implementation Strategies

The rate and volume of stormwater runoff being transported over land to waterways needs to be reduced to restore water quality. The ultimate federal Clean Water Act mandate is to restore existing uses of Stump Sound such as shellfish harvest to the level that was occurring as of November 28, 1975. However, based upon available data on land use trends, the feasible baseline year is 1980 upon which it is possible to measure the success of efforts to reduce the rate and volume of runoff to levels that occurred at that time, which is generally reflective of conditions that existing in 1975 based upon a review of the Sanitary Surveys prepared by DMF in that time period. By focusing the objective on public lands and conveyance systems, the state, county, and towns within the watershed can lead by example and demonstrate commitment to improving watershed health to the community.

The management actions described in Section 4 above are potential opportunities to reduce the rate and volume of stormwater runoff into Stump Sound. The potential projects listed provide opportunities that the North Carolina Coastal Federation and its partners will explore as the plan is implemented. Site assessments and work with property owners and local governments will take place as part of developing and implementing any of these potential projects.

The immediate runoff volume reduction goal for the watershed area is a decrease of approximately 20.7 million cubic feet of water, or the difference in runoff volume generated from a one-year, 24-hour in 1980 and 2019. The total amount of reduction of volume of stormwater that will need to be achieved by 2050 is approximately 35.8 million cubic feet of water accounting for more intense land uses. This storage and reduction goal is possible using a combination of potential stormwater BMP retrofit and land conservation projects suggested Section 4. This calculation assumes that the retrofit projects listed for private and public properties will achieve a 12 million cubic feet reduction in its volume of runoff and the conservation lands restored and retrofitted will reduce runoff by more than 31 million cubic feet of runoff during a one-year, 24-hour storm. The reduction number for conservation lands includes reducing current volumes of runoff as well as avoiding an increase in the volume of runoff by maintaining the natural hydrology of these properties.

Funding, Cost, and Technical Needs

The total cost to implement actions identified in this plan varies greatly due to parameters such as location of the project, size of project, design complexity, labor and materials, land values, and market changes. Annual maintenance should always be considered and budgeted for accordingly by the parties responsible for any stormwater management system or retrofit. Project partners will explore various funding sources on a project-by-project basis. The information compiled within this plan will serve as a source when developing funding proposals.

Potential funding sources include:

Stormwater Retrofits: N.C. Land and Water Fund, up to \$2 million per project; Section 319 Grant Program, up to \$250,000 per project; N.C. General Assembly direct appropriations, already funded \$5 million retrofit program; NC Division of Coastal Management, Resilient Coastal Communities Program, up to \$500K; NOAA Coastal Resiliency Program, up to \$25 million.

Land Conservation: N.C. Land and Water Fund, up to \$2 million per project; N.C. Environmental Enhancement Program, up to \$500,000 per project; N.C. General Assembly, direct appropriations of varying amounts; Department of Defense, up to \$6 million for protecting base training functions; USFWS, up to \$1 million per project; NOAA resiliency, up to \$10 million for various projects, National Fish and Wildlife Foundation, up to \$3 million per project.

Living Shorelines: NOAA habitat funding, up to \$3 million; USFWS, up to \$1 million, N.C. Land and Water Fund, up to \$500K per project; N.C. General Assembly, direct appropriations up to \$1.5 million.

Preventing More Runoff from New Development

Figure 5-1 shows the land areas within the sound's watershed that are within a half mile of SA waters. Any future development in these areas is required to meet the more stringent SA requirements within the 2017 Stormwater Rules to Use Low Impact Development Stormwater Measures. These rules require the use of low impact development measures to achieve hydrologic matching if such stormwater controls are feasible. It will be vital to make it a priority to follow these design rules for new systems so that new development does not add to the rate and volume of stormwater runoff entering Stump Sound.

Figure 5-1: Area Required to Meet Low Impact Development Stormwater Measures



Quantitative Measures of Outcomes from Plan

To achieve the measurable outcome of reductions in permanent and temporary closures of shellfish waters within the Stump Sound estuary, the volume of runoff will be reduced by the following quantities listed in Table 5-1 over the next 5 years, and then in 10-year increments. The overall volume reduction goal increases over this time as land uses intensify in the watershed.

Table 5-1: Runoff Reduction Goal Targets and Schedule

Time Frame	Overall Volume Reduction Goals (CFT) From 1980 Baseline Year	Objective 2: Restore and Conserve Working and Undeveloped Properties (CFT Reduced)	Objective 3: Retrofit Private Stormwater Management Systems (CFT Reduced)	Objective 4: Retrofit Publicly Owned Stormwater Management Systems (CFT Reduced)	Percent of Total Runoff Volume Reduction Goal Achieved (Objectives 2, 3 and 4 combined)
Short-Term (2030)	24,837,599	19,719,180	1,000,000	1,000,000	87.2%
Long-Term (2040)	29,805,119	25,000,000	3,000,000	3,000,000	94.6%
Long-Term (2050)	35,766,142	31,268,080	6,000,000	6,000,000	112.1%

The table above is divided into three key periods: **Short-Term (2030)**, **Mid-Term (2040)**, and **Long-Term (2050)**. The **Overall Volume Reduction Goals (CFT)** presented are cumulative, reflecting both the increased runoff observed since 1980 and the projected increases in runoff volume from 2025 to 2050. The total runoff reduction goal for **2050** is **35,766,142 CFT**, which accounts for a **20% increase in runoff volume every 10 years**, reflecting the expected exponential growth in population and development within the watershed.

Runoff volume estimates associated with objective Objectives represent the cumulative amount of reductions that will be achieved by carrying out actions in the plan. Objective 2 focuses on restoring and conserving working lands and undeveloped properties to help reduce runoff. Objective 3 involves retrofitting existing private stormwater systems to reduce runoff while Objective 4 involves retrofitting public properties to reduce runoff volumes. All these values represent the overall runoff volume reduction goals, measured in cubic feet (CFT), from a baseline year (1985) to account for the increased runoff due to land use changes.

Summary of Results

- For **2030**, approximately **87.2%** of the runoff volume reduction goal is achieved.
- By **2040**, about **94.6%** of the goal will be achieved.
- By **2050**, the goal would be exceeded, with **112.1%** of the total runoff volume reduction goal achieved, reflecting a potential overachievement or further efforts to expand stormwater management practices.

This suggests a substantial reduction in runoff volumes by 2050, with the objectives making significant progress in meeting and exceeding the set goals.

Section 6: Conclusion

The ***Stump Sound Watershed Protection and Restoration Plan*** sets forth goals, objectives, management actions, and timelines designed to enhance water quality by reducing runoff rates and volumes. These efforts will also mitigate flooding and elevate community awareness regarding watershed management. The successful implementation of this plan hinges on the collaborative efforts of the Federation and its partners, who will work together to execute the proposed actions. Achieving these goals will require the voluntary participation and support of diverse public and private stakeholders, providing mutual benefits such as safeguarding the military training mission of the U.S. Department of Defense (which will help fund land acquisition), preserving open space and recreational areas for residents and visitors, and ensuring clean water for the thriving shellfish and seafood industries.

Protecting and restoring water quality in Stump Sound is an ongoing commitment that will extend beyond the initial five-year scope of this plan. To remain effective, the plan will be updated every five years, reflecting progress, challenges, and new opportunities. Continuous evaluations will ensure that this Plan meets the evolving needs of both the watershed and the community. The Federation will maintain active engagement with all stakeholders, including the military, state and federal environmental agencies, towns and the county, to monitor progress in implementing educational initiatives, project developments, cumulative runoff reduction, and ongoing water quality monitoring.

The most direct measure of the plan's success will be the frequency and duration of shellfish harvest closures in Stump Sound. The primary goal is to prevent the expansion of these closures, ultimately reducing both their occurrence and the acreage affected. Key strategies to achieve these objectives include reducing runoff rates and volumes from land uses within the various Stump Sound sub-watersheds.

Water quality data from the Shellfish Sanitation and Recreational Water Quality Section of the N.C. Division of Marine Fisheries will be used to monitor the Sound's watersheds. These agencies regularly test and report on coastal water quality, allowing the plan's effectiveness to be assessed without the need for additional data collection efforts.

The Federation is already engaged in efforts to acquire and protect two of the key conservation lands identified in this proposal that if successful would involve more than 1,400 acres. These properties are strategically located near shellfish growing waters and have the potential to significantly reduce both existing and future runoff rates and volumes that impair water quality. Restoring hydrology on this land, which currently contributes to water quality issues, is a critical action that will ensure it remains undeveloped and unurbanized. However, to meet stormwater reduction targets, it is also essential to secure runoff reductions from private and public lands and to ensure that new land uses comply with existing state coastal stormwater standards.

The total cost to implement the actions identified in this plan will vary significantly depending on factors such as project location, size, design complexity, labor and materials, land values, and market fluctuations. Annual maintenance costs should be considered and budgeted accordingly by those responsible for any stormwater management system or retrofit. Project partners will explore a variety of funding sources on a project-by-project basis and pursue projects that deliver multiple benefits to local governments, residents, and visitors within the river's watershed.

Appendix A: Water Quality Standards and Classifications

Further information regarding 303(d) List and its reporting categories¹⁹:

“The term "303(d) list" is short for a state’s list of impaired and threatened waters (e.g., stream/river segments, lakes). States are required to submit their list for EPA approval every two years. For each water on the list, the state identifies the pollutant causing the impairment, when known. In addition, the state assigns a priority for development of Total Maximum Daily Loads (TMDL) based on the severity of the pollution and the sensitivity of the uses to be made of the waters, among other factors (40 C.F.R. §130.7(b)(4)). In general, once a water body has been added to a state’s list of impaired waters it stays there until the state develops a TMDL and EPA approves it. EPA reporting guidance provides a way to keep track of a state’s water bodies, from listing as impaired to meeting water quality standards. This tracking system contains a running account of all the state’s water bodies and categorizes each based on the attainment status. For example, once a TMDL is developed, a water body is no longer on the 303(d) list, but it is still tracked until the water is fully restored.”

Category/Subcategory	Description
Category 1	Meets tested standards for clean waters. All designated uses are supported, no use is threatened.
Category 2	Waters of concern. Available data and/or information indicate that some, but not all, designated uses are supported.
Category 3	Insufficient data. There is insufficient available data and/or information to make a use support determination.
Category 4	Polluted waters that do not require a TMDL. Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed.
Category 4a	Has a TMDL. A State developed TMDL has been approved by EPA or a TMDL has been established by EPA for any segment-pollutant combination.
Category 4b	Has a pollution control program. Other required control measures are expected to result in the attainment of an applicable water quality standard in a reasonable period.
Category 4c	Is impaired by a non-pollutant. The non-attainment of any applicable water quality standard for the segment is the result of pollution and is not caused by a pollutant.

¹⁹ Environmental Protection Agency. Retrieved from <https://www.epa.gov/tmdl/program-overview-303d-listing>

Category 5**Polluted waters that require a TMDL or other WQI project.**

Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

DWR PRIMARY SURFACE WATER CLASSIFICATIONS

All surface waters in North Carolina are assigned a primary classification by the N.C. Division of Water Resources (DWR). All waters must at least meet the standards for Class C (fishable / swimmable) waters. The other primary classifications provide additional levels of protection for primary water contact recreation (Class B) and drinking water (Water Supply Classes I through V). To find the classification of a water body you can either use the BIMS database or contact Adriene Weaver of the Classifications & Standards/Rules Review Branch. To view the regulatory differences between the currently implemented classifications for freshwaters, click here for the freshwater classifications table.

North Carolina Surface Water Classifications. Full Descriptions Available on DEQ Website.

Primary Use Classifications	
SA	Commercial Shellfish Harvest
SB	Primary Recreation in tidal salt water
SC	Aquatic Life, Secondary Recreation, and Fishing in tidal salt water
SWL	Coastal wetlands
Supplemental Use Classifications	
HQW	High Quality Waters
ORW	Outstanding Resource Waters
NSW	Nutrient Sensitive Waters
CA	Critical Area
UWL	Unique Wetland
	Special Designations (variable based on river basin)

Class SC

All tidal salt waters are protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; aquatic life propagation and survival; and wildlife.

Class SB

Tidal salt waters are protected for all SC uses in addition to primary recreation. Primary recreational activities include swimming, skin diving, water skiing, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis.

Class SA

Tidal salt waters that are used for commercial shellfish harvest or marketing purposes and are also protected for all Class SC and Class SB uses. All SA waters are also HQW by supplemental classification.

High Quality Waters (HQW)

Supplemental classification intended to protect waters which are rated excellent based on biological and physical/chemical characteristics through Division monitoring or special studies, primary nursery areas designated by the Marine Fisheries Commission, and other functional nursery areas designated by the Marine Fisheries Commission.

The following waters are HQW by definition:

- WS-I,
- WS-II,
- SA (commercial shellfish harvest),
- ORW,

Primary nursery areas (PNA) or other functional nursery areas designated by the Marine Fisheries Commission, or

Waters for which DWR has received a petition for reclassification to either WS-I or WS-II.

Outstanding Resource Waters (ORW)

All outstanding resource waters are a subset of High-Quality Waters. This supplemental classification is intended to protect unique and special waters having excellent water quality and being of exceptional state or national ecological or recreational significance. To qualify, waters must be rated Excellent by DWR and have one of the following outstanding resource values:

- Outstanding fish habitat and fisheries,
- Unusually high level of water-based recreation or potential for such kind of recreation,
- Some special designation such as North Carolina Natural and Scenic River or National Wildlife Refuge,
- Important component of state or national park or forest, or
- Special ecological or scientific significance (rare or endangered species habitat, research, or educational areas).

For more details, refer to the Biological Assessment Branch homepage.

Nutrient Sensitive Waters (NSW)

Supplemental classification intended for waters needing additional nutrient management due to being subject to excessive growth of microscopic or macroscopic vegetation.

North Carolina Water Quality Classification and Standards.

Classification	Description
<p>Class SA</p>	<p>Tidal salt waters that are used for commercial shellfish harvest or marketing purposes and are also protected for all Class SC and Class SB uses. All SA waters are also HQW by supplemental classification.</p> <p>The following water quality standards apply to surface waters that are used for shellfish harvest for market purposes and are classified SA. Water quality standards applicable to Class SC waters as described in Rule .0220 of this Section also apply to Class SA waters.</p> <ol style="list-style-type: none"> (1) Best Usage of Waters. Shellfish harvest for market purposes and any other usage specified by the "SB" or "SC" classification; (2) Conditions Related to Best Usage. Waters shall meet the current sanitary and bacteriological standards as adopted by the Commission for Health Services and shall be suitable for shellfish culture; any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be considered to be violating a water quality standard; (3) Quality Standards applicable to Class SA Waters: <ol style="list-style-type: none"> a. Floating solids; settleable solids; sludge deposits: none attributable to sewage, industrial wastes, or other wastes; b. Sewage: none; c. Industrial wastes, or other wastes: none which are not effectively treated to the satisfaction of the Commission in accordance with the requirements of the Division of Health Services; d. Organisms of coliform group: fecal coliform group not to exceed a median MF of 14/100 ml and not more than 10 percent of the samples shall exceed an MF count of 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.
<p>Class SB</p>	<p>Tidal salt waters are protected for all SC uses in addition to primary recreation. Primary recreational activities include swimming, skin diving, water skiing, and similar uses involving human body contact with water where such activities take place in an organized manner or on a frequent basis.</p> <p>The following water quality standards apply to surface waters that are used for primary recreation, including frequent or organized swimming, and are classified SB.</p>

Water quality standards applicable to Class SC waters are described in Rule .0220 of this Section also apply to SB waters.

1. Best Usage of Waters. Primary recreation and any other usage specified by the "SC" classification;
2. Conditions Related to Best Usage. The waters shall meet accepted sanitary standards of water quality for outdoor bathing places as specified in Item of this Rule and will be of sufficient size and depth for primary recreation purposes; any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be considered to be violating a water quality standard;
3. Quality Standards applicable to Class SB waters:
 - a. Floating solids; settleable solids; sludge deposits: none attributable to sewage, industrial wastes, or other wastes;
 - b. Sewage: none;
 - c. industrial wastes; or other wastes: none which are not effectively treated to the satisfaction of the Commission; in determining the degree of treatment required for such waters discharged into waters which are to be used for bathing, the Commission shall take into consideration quantity and quality of the sewage and other wastes involved and the proximity of such discharges to the waters in this class; discharges in the immediate vicinity of bathing areas may not be allowed if the Director determines that the waste cannot be treated to ensure the protection of primary recreation;
 - d. **Organisms of coliform group: fecal coliforms not to exceed a geometric mean of 200/100 ml (MF count) based on at least five consecutive samples examined during any 30-day period and not to exceed 400/100 ml in more than 20 percent of the samples examined during such period.**

Class SC

All tidal salt waters are protected for secondary recreation such as fishing, boating, and other activities involving minimal skin contact; aquatic life propagation and survival; and wildlife.

The water quality standards for all tidal salt waters are the basic standards applicable to Class SC waters. Additional and more stringent standards applicable to other specific tidal saltwater classifications are specified in Rules .0221 and .0222 of this Section.

1. Best Usage of Waters. Aquatic life propagation and maintenance of biological integrity (including fishing, fish and functioning PNAs), wildlife, secondary

- recreation, and any other usage except primary recreation or shellfish harvest for market purposes.
2. Conditions Related to Best Usage. The waters shall be suitable for aquatic life propagation and maintenance of biological integrity, wildlife, and secondary recreation; Any source of water pollution which precludes any of these uses, including their functioning as PNAs, on either a short-term or a long-term basis shall be violating a water quality standard.
 3. Quality Standards applicable to Class SB waters:
 - a. Chlorophyll a (corrected): not greater than 40 ug/l in sounds, estuaries, and other waters subject to growths of macroscopic or microscopic vegetation; the Commission or its designee may prohibit or limit any discharge of waste into surface waters if, in the opinion of the Director, the surface waters experience or the discharge would result in growths of microscopic or macroscopic vegetation such that the standards established pursuant to this Rule would be violated or the intended best usage of the waters would be impaired;
 - b. Dissolved oxygen: not less than 5.0 mg/l, except that swamp waters, poorly flushed tidally influenced streams or embayment, or estuarine bottom waters may have lower values if caused by natural conditions;
 - c. Floating solids; settleable solids; sludge deposits: only such amounts attributable to sewage, industrial wastes, or other wastes, as shall not make the waters unsafe or unsuitable for aquatic life and wildlife, or impair the waters for any designated uses;
 - d. Gases, total dissolved: not greater than 110 percent of saturation;
 - e. **Organisms of coliform group: fecal coliforms not to exceed a geometric mean of 200/100 mL (MF) count) based on at least five consecutive samples examined during any 30-day period and not to exceed 400/100 mL in more than 20 percent of the samples examined during the search period;** violations of the fecal coliform standard are expected during rainfall events, and in some cases, this violation is expected to be caused by uncontrollable nonpoint source pollution; all coliform concentrations are to be analyzed using the MF technique unless high turbidity or other adverse conditions necessitate the tube dilution method; in the case of controversy over results the MPN 5-tube dilution method shall be used as the reference method;
 - f. Oils; deleterious substances; colored or other wastes: only such amounts as shall not render the waters injurious to public health, secondary recreation or to aquatic life and wildlife or adversely affect the palatability of fish, aesthetic quality or impair the waters for any designated uses; for the purpose of implementing this Rule, oils, deleterious substances, colored or other wastes shall include but not be limited to substances that cause a film or sheen upon or discoloration of

the surface of the water or adjoining shorelines pursuant to 40 CFR 110.4(a)-(b);

- g. pH: shall be normal for the waters in the area, which generally shall range between 6.8 and 8.5 except that swamp waters may have a pH as low as 4.3 if it is the result of natural conditions;
- h. Phenolic compounds: only such levels as shall not result in fish-flesh tainting or impairment of other best usage;
- i. Radioactive substances: (i) Combined radium-226 and radium-228: The maximum average annual activity level (based on at least four samples, collected quarterly) for combined radium-226, and radium-228 shall not exceed five picoCuries per liter; (ii) Alpha Emitters. The average annual gross alpha particle activity (including radium-226 but excluding radon and uranium) shall not exceed 15 picoCuries per liter; (iii) Beta Emitters. The maximum average annual activity level (based on at least four samples, collected quarterly) for strontium-90 shall not exceed eight picoCuries per liter; nor shall the average annual gross beta particle activity (excluding potassium-40 and other naturally occurring radionuclides) exceed 50 picoCuries per liter; nor shall the maximum average annual activity level for tritium exceed 20,000 picoCuries per liter;
- j. Salinity: changes in salinity due to hydrological modifications shall not result in removal of the functions of a PNA; projects that are determined by the Director to result in modifications of salinity such that functions of a PNA are impaired will be required to employ water management practices to mitigate salinity impacts;
- k. Temperature: shall not be increased above the natural water temperature by more than 0.8 degrees C (1.44 degrees F) during the months of June, July, and August nor more than 2.2 degrees C (3.96 degrees F) during other months and in no cases to exceed 32 degrees C (89.6 degrees F) due to the discharge of heated liquids;
- l. Turbidity: the turbidity in the receiving water shall not exceed 25 NTU; if turbidity exceeds this level due to natural background conditions, the existing turbidity level shall not be increased. Compliance with this turbidity standard can be met when land management activities employ Best Management Practices (BMPs) [as defined by Rule .0202(6) of this Section] recommended by the Designated Nonpoint Source Agency (as defined by Rule .0202 of this Section). BMPs must be in full compliance with all specifications governing the proper design, installation, operation, and maintenance of such BMPs;
- m. Toxic substances: numerical water quality standards (maximum permissible levels) to protect aquatic life applicable to all tidal saltwater: (i) Arsenic, total recoverable: 50 ug/l; (ii) Cadmium: 5.0 ug/l; attainment of these water quality standards in surface waters shall be based on

measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit from a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators. (iii) Chromium, total: 20 ug/l; (iv) Cyanide: 1.0 ug/l; (v) Mercury: 0.025 ug/l; (vi) Lead, total recoverable: 25 ug/l; collection of data on sources, transport and fate of lead shall be required as part of the toxicity reduction evaluation for dischargers that are out of compliance with whole effluent toxicity testing requirements and the concentration of lead in the effluent is concomitantly determined to exceed an instream level of 3.1 ug/l from the discharge; (vii) Nickel: 8.3 ug/l; attainment of these water quality standards in surface waters shall be based on measurement of total recoverable metals concentrations unless appropriate studies have been conducted to translate total recoverable metals to a toxic form. Studies used to determine the toxic form or translators must be designed according to the "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit from a Dissolved Criterion" published by the Environmental Protection Agency (EPA 823-B-96-007) which are hereby incorporated by reference including any subsequent amendments. The Director shall consider conformance to EPA guidance as well as the presence of environmental conditions that limit the applicability of translators in approving the use of metal translators. (viii) Pesticides: (A) Aldrin: 0.003 ug/l; (B) Chlordane: 0.004 ug/l; (C) DDT: 0.001 ug/l; (D) Demeton: 0.1 ug/l; (E) Dieldrin: 0.002 ug/l; (F) Endosulfan: 0.009 ug/l; (G) Endrin: 0.002 ug/l; (H) Guthion: 0.01 ug/l; (I) Heptachlor: 0.004 ug/l; (J) Lindane: 0.004 ug/l; (K) Methoxychlor: 0.03 ug/l; (L) Mirex: 0.001 ug/l; (M) Parathion: 0.178 ug/l; (N) Toxaphene: 0.0002 ug/l. (ix) Polychlorinated biphenyls: 0.001 ug/l; (x) Selenium: 71 ug/l; (xi) Trialkyltin compounds: 0.002 ug/l expressed as tributyltin.

4. Action Levels for Toxic Substances: if the Action Levels for any of the substances listed in this Subparagraph (which are generally not bioaccumulate and have variable toxicity to aquatic life because of chemical

form, solubility, stream characteristics or associated waste characteristics) are determined by the waste load allocation to be exceeded in a receiving water by a discharge under the specified low flow criterion for toxic substances (Rule .0206 in this Section), the discharger shall be required to monitor the chemical or biological effects of the discharge; efforts shall be made by all dischargers to reduce or eliminate these substances from their effluents. Those substances for which Action Levels are listed in this Subparagraph may be limited as appropriate in the NPDES permit if sufficient information (to be determined for metals by measurements of that portion of the dissolved instream concentration of the Action Level parameter attributable to a specific NPDES permitted discharge) exists to indicate that any of those substances may be a causative factor resulting in toxicity of the effluent. NPDES permit limits may be based on translation of the toxic form to total recoverable metals. Studies used to determine the toxic form or translators must be designed according to: "Water Quality Standards Handbook Second Edition" published by the Environmental Protection Agency (EPA 823-B-94-005a) or "The Metals Translator: Guidance for Calculating a Total Recoverable Permit Limit From a

Shellfish Sanitation Classifications

North Carolina Shellfish Sanitation Growing Area Classifications	
Approved	These areas are always open to shellfish harvesting and close only after rare heavy rainfall events such as hurricanes. The median fecal coliform Most Probable Number (MPN) or geometric mean MPN of water shall not exceed 14 per 100 milliliters, and the estimated 90th percentile shall not exceed an MPN of 43 per 100 mL for a five-tube decimal dilution test.
Conditionally Approved-Open Shellfish Areas	Sanitary Survey indicates an area can meet approved area criteria for a reasonable period, and the pollutant event is known and predictable and can be managed with a plan. These areas are open to harvest much of the year but are immediately closed after certain sized rainfall events.
Conditionally Approved-Closed Shellfish Areas	Sanitary Survey indicates an area can meet approved area criteria during dry periods of time, and the pollutant event is known and predictable and can be managed with a plan. This growing area classification allows harvest when fecal coliform bacteria levels are lower than the state standard in areas that otherwise might be closed to harvesting. These areas are regularly monitored to determine if temporary openings are possible.

Prohibited Shellfish Harvest Areas

Sanitary Survey is not routinely conducted because previous sampling data did not meet criteria for Approval or Conditional Approved. Area may also be closed as a matter of regulation due to the presence of point source discharges or high concentrations of boats with heads.

Recreational Water Quality Standards

Tier	Description
Tier I	<p>"Tier I swimming area" means a swimming area used daily during the swimming season, including any public access swimming area and any other swimming area where people use the water for primary contact, including all oceanfront beaches.</p> <ol style="list-style-type: none"> 1. The enterococcus level in a Tier I swimming area shall not exceed either: <ol style="list-style-type: none"> a. A geometric mean of 35 enterococci per 100 milliliters of water, that includes a minimum of at least five samples collected within 30 days; or b. A single sample of 104 enterococci per 100 milliliters of water. <p>Tier I Swimming areas:</p> <ol style="list-style-type: none"> (1) A swimming advisory shall be issued by the Division when samples of water from a swimming area exceeds a geometric mean of 35 enterococci per 100 milliliters during the swimming season. (2) A swimming alert shall be issued by the Division when a single sample of water from a swimming area exceeds 104 enterococci per 100 milliliters and does not exceed 500 enterococci per 100 milliliters during the swimming season. (3) A swimming advisory shall be issued by the Division when a sample of water from a swimming area exceeds a single sample of 500 enterococci per 100 milliliters during the swimming season. (4) A swimming advisory shall be issued by the Division when at least two of three concurrent water samples collected at a swimming area exceeds 104 enterococci per 100 milliliters during the swimming season. <p>A Tier I swimming area advisory shall be rescinded when two consecutive weekly water samples and the geometric mean meet the bacteriological limits in Rule 18A .3402(a) of this Section. A swimming alert shall be rescinded within 24 hours of compliance with Rule 18A .3402(a)(2) of this Section.</p>
Tier II	<p>"Tier II swimming area" means a swimming area used an average of three days a week during the swimming season.</p>

	<p>The enterococcus level in a Tier II swimming area shall not exceed a single sample of 276 enterococci per 100 milliliters of water.</p> <p>Tier II swimming areas:</p> <p>(1) A swimming alert shall be issued by the Division when a single sample of water from a swimming area exceeds 276 enterococci per 100 milliliters and does not exceed 500 enterococci per 100 milliliters during the swimming season.</p> <p>(2) A swimming advisory shall be issued by the Division when a single sample of water from a swimming area exceeds 500 enterococci per 100 milliliters during the swimming season.</p> <p>A Tier II or Tier III swimming area advisory or alert shall be rescinded after water samples meet the bacteriological standard in Rule 18A .3402(b) or (c) of this Section.</p>
Tier III	<p>"Tier III swimming area" means a swimming area used an average of four days a month during the swimming season.</p> <p>Tier III swimming area with a water sample result of 500 enterococci per 100 milliliters or higher on the first sample shall be resampled the following day. If the laboratory results of the second sample exceed 500 enterococci per 100 milliliters a swimming advisory shall be issued by the Division.</p> <p>A Tier II or Tier III swimming area advisory or alert shall be rescinded after water samples meet the bacteriological standard in Rule 18A .3402(b) or (c) of this Section.</p>
Swimming Season	<p>April 1 through October 31 of each year.</p> <p>The enterococcus level in a Tier III swimming area shall not exceed two consecutive samples of 500 enterococci per 100 milliliters of water.</p>
Winter Season	<p>November 1 through March 31 of each year.</p>

Appendix B: Observations Recorded by Shellfish Sanitation Section in Sanitary Shoreline Surveys

1948 – 1949

The abandonment of Camp Davis and dismantling of STP since the 1944 survey may have effects on Barlow Creek. The USPHS standard has a median less than 70/100 mL. It can be concluded that Barlow Creek is well within limits for shellfish consumption.

August 1973 – September 1974

Multiple concerns arise during this time. Some private sewage systems were not functioning properly. Filter beds for Holly Ridge STP were sealed with sludge and not properly working for an unknown amount of time. Additionally, concerns over intensive growth in Surf City, campgrounds, and mobile home parks led to a recommended closure near Surf City Bridge.

August 1975 – July 1977

The land west of Stump Sound on the mainland was rural, primarily consisted of woodland and agricultural areas, and was sparsely populated. Two new notable sources of pollution were noted since the 1974 survey: a new sanitary landfill site just west of 50/210 that does not appear to discharge directly into shellfish waters and a new development of approximately 300 mobile homes on septic on SR 1538 (Laniers Campground). There was noted direct discharge from storm sewers into Stump Sound and a drain field close to the water's edge was also potentially contributing. The Holly Ridge STP, a large septic system with an old filter bed, was determined to drain directly into Kings Creek. Industrial and sewage discharge entered ICWW(?) via Barlow Creek. There was heavy rainfall that affected bacteria levels, but overall improvement in water quality since the previous survey.

March 1978 – June 1979

The population was noted to be approximately 2,400 permanent residents with an increase to 4,800 people during the tourist season. There were 84 out of approximately 1600 sewage drainage systems that malfunctioned, with most being corrected. The Holly Ridge STP was very poor and discharges into Kings Creek. This was noted to be the only major source of pollution. Additional notes were made concerning pollution from industrial and agricultural sources. One small marina, Thompson, existed in Stump Sound, but no boats were reported during the survey. The water quality was improved due to lower rainfall. All waters east and north of Station 9 were open to shellfish harvest.

October 1979 – June 1981

The population remained at the same level as the previous survey (2,400 permanent, 4,800 with tourists). The Thompson marina increase from 6 to 8 slips and held 5 boats with heads and no pump out. The 96 residents served by Holly Ridge septic tank were replaced with 46 apartments, but the system was still too poor and discharging to Kings Creek. There was little change in conditions, except high fecal counts at Old Settlers Beach. No new closures occurred.

August 1984 – July 1986

The population increased to approximately 4,000 permanent residents, with 15,000 during tourist season. The land west of the Stump Sound on the mainland continued to be rural, primarily woodland, and agricultural, and sparsely populated. Notable changes since the previous survey include a NC WRC ramp in Surf City, Island Villas, a 51-unit complex to be

treated by the North Topsail Beach STP, was approved, Ocean Ridge was approved for 50 units and marina, and Scotch Bonnet mobile homes would be replaced with condos. Upgrades to the Holly Ridge STP were underway, including aerated lagoon and stabilization cells and chlorination chambers, but discharge to continue into Kings Creek. It is uncertain if changes will improve water quality. Industrial expansion increases areas of discharge; however, increased discharge may not directly affect shellfish waters. The North Topsail Beach and Sewer Treatment Plant located at 210/1568 was updated with secondary treatment, lagoons, and spray irrigation. Growth is expected as a result. Overall, little changes were observed in water quality. There was some improvement and no recommended changes to closures were made.

July 1986 – July 1988

Permanent population remains at approximately 4,000 residents, but a larger increase is expected during the tourist season for 22,000 people. The land west of the Stump Sound on the mainland continued to be rural, primarily woodland, and agricultural, and sparsely populated. There were 295 prohibited acres, but oyster and clam production were fair. It was noted that NTSTP online would allow expanded development and future water quality may be affected. Surf City was planning for a new STP off Highway 50 near Holly Ridge. One package plan for Surf Condos in Stump Sound existed. Stump Sound and unincorporated areas were using septic tanks with probable impacts to B9 waters. The new Holly Ridge STP was operating but with numerous problems with operation and exceeding capacity. Increased development and agriculture raised future concerns. Future septic violations from housing development rose concerns but did not cause any new closure recommendations. 65 acres were closed in Rogers Bay, possibly due to waterfowl impoundment.

February 1989 – March 1992

The population increased to approximately 4,500 permanent residents, with 25,000 during tourist season. The land west of the Stump Sound on the mainland continued to be rural, primarily woodland, and agricultural, and sparsely populated. There were 310 prohibited acres, but oyster and clam productions were fair. It was recommended that 180 acres of Stump Sound be opened and 25 acres of Turkey Creek close. At the time of this survey, 4 STPs were operating. 2 such STPs were operating in compliance but concerns were raised over exceeding capacity. 1 STP was operating under capacity. The final STP mostly operated in the C1 area and increasing water quality but allowed for high density developments in previous unsuitable areas. Concerns continued over campgrounds and mobile home parks discharge. There was an overall improvement in water quality due to the new STP, but increased potential for increased development and runoff in the future.

May 1992 – May 1995

The permanent population increased to approximately 6,000 residents and population during the tourist season remained at 25,000. The land west of the Stump Sound on the mainland continued to be rural, primarily woodland, and agricultural, and sparsely populated. There were 220 prohibited acres, but oyster and clam productions were fair. It was recommended that 180 acres of Stump Sound and 20 acres of Rogers Bay be opened and 50 acres of Spicers Bay close. Five out of the 8 mobile home parks were connected to STP. Two were reported to have

numerous sewage violations or malfunctions, with both being in low areas with probable water quality impacts. Rogers Bay was much improved. A moratorium on NTP sewage expansion and associated new development was created. Stormwater runoff responsible for SS reclassifications was to be conditionally approved in Stump Sound to 1.5-inches in 24-hours. The water quality improved in outer Rogers Bay in ICWW and Surf City area and can be reopened and reclassified to conditionally opened. Additional closures were made in Spicers and Kings Creek. New sampling stations were recommended in Rogers and Batts Mill Creek.

November 1996 – February 1999

The population increased to approximately 6,400 permanent residents, with 27,500 during tourist season. The land west of the Stump Sound on the mainland continued to be rural, primarily woodland, and agricultural, and sparsely populated. The tourism population on the island continued to increase. There were 220 prohibited acres, but oyster and clam production were fair. A change was made to close the conditionally approved section of Area B-9 after 1.5 inches of rain within 24 hours. The temporary closed areas included All those waters bordered on the northeast by a straight line from Swan Point through ICWW Channel Marker #4 to the eastern tip of West Onslow Beach (south shore of New River Inlet) and bordered on the southwest by the Surf City Bridge. This closure line includes all waters in the B-9 and C-I areas. These areas were to remain closed until the rainfall has ended, sampling indicates quarter quality meets approved area criteria, and shellfish have had sufficient time to cleanse. The Turkey Creek and Spicer Bay sections of Area B-9 were classified as conditionally approved. No temporary openings of the conditionally approved closed waters of the B-9 Area were opened. Hurricanes Bertha and Frain caused major damages in 1996. One of the three remaining non-STP mobile home parks was connected to the municipal sewage system. The other 2 are on individual septic systems and continue to adversely impact water quality. No changes were noted in existing STPs. Holly Ridge was working on new floating aerators.

September 2001 – May 2006

Population was estimated to be 2,420 permanent residents and 20,000 during the tourist season. There were 220 acres of prohibited areas during this period, but oyster and clam production remained fair. Little overall change was noted in the bacteriological water quality in most areas of B-9. Kings Creek and Spicer Bay have shown some change in bacteriological water quality but continues to be classified properly. No classification changes were made due to this data. Surf City and North Topsail Beach saw a lot of new construction, in both single family and vacation homes. Surf City is determined to be a major source of storm water pollution, with all storm water discharged into the ICWW and Stump Sound. North Topsail Beach is also determined to be a major contributor to storm water pollution. All storm water discharges into the waters of Stump Sound. The campground was a possibility of concern over indirect fecal coliform bacteria contamination due to portable sewage holding tanks. At the time of this survey, all surrounding areas of Rogers Bay were closed to the harvest of shellfish. The wastewater treatment plant consists of three lagoons, a chlorinator, and 180 acres of spray fields and was operating under capacity. The mainland side of Area B-9 is composed mostly of year around residents, small farms, and forestland. The only large subdivision that is in this area is called North Shore subdivision and Golf Course. The Turkey Creek area has two subdivisions.

One has no homes built at the time of this survey and the second has 18 homes built, with one waterfront. The second subdivision has 135 plots, each with an individual septic system. A mobile home subdivision is located next to Kings Creek with 87 homes that are served by on-site septic systems that were not observed to be malfunctioning. Holly Ridge is approximately 4 miles inland and operates a small wastewater treatment plant that was upgraded in 2004. It was converted to a non-discharge plant. The treatment plant now discharges to a 13-million-gallon storage pond and the effluent is sprayed onto spray fields. The removal of discharge to Kings Creek should help water quality.

The 2002 Triennial Sanitary Survey resulted in two closures. The first closure was located on the west side of the ICWW in a channel. This closure was added due to increases in fecal coliform counts in the water in the channel of the closure. This increase may be due to new boat slips and additional storm water runoff from impervious surfaces of new structures. The second closure located near the Surf City NC 50 and Highway 210 Swing Bridge, adjacent to the only marina in the B-9 area. This closure is an expansion of the previous 100 feet of the marina due to increases in levels of fecal coliform bacteria. The cause may be additional storm water runoff and larger marina that includes a dry stack for boats. Portions of conditionally improved waters of B-5 were closed 36 times for a total of 328 following the 2002 triennial survey, including for Hurricane Isabel (2003), Hurricane Charley (2004), and Hurricane Ophelia (2005). Additionally, bacteriological water quality appeared to be improving since the end of 2004, perhaps due to the removal of the Holly Creek wastewater discharge into Kings Creek. Changes were made to sampling stations to monitor the area more effectively.

November 2004 – December 2009

Population was estimated to be approximately 3,702 permanent residents with 20,000 during tourist season. The shellfish water classification acreages were: 7.04 acres Approved, 4,650.37 acres Conditionally Approved – Open, 716.84 acres Conditionally Approved – Closed, and 395.68 acres Prohibited. This is a total of 4,657.41 acres open and 1,112.52 acres closed. Point sources were determined to be the wastewater treatment plants. The Surf City wastewater treatment plant has two large, aerated lagoons with approximately 19 million gallons of capacity. The city also has 16 lift stations near estuarine waters. The Holly Ridge wastewater treatment plant was given over to county operation following 2004 upgrades, including converting to a non-discharge plant. Bacteriological data showed overall improvement following the 2006 Sanitary Survey. This may be attributed to reduced rainfall. Three stations exceeded NSSP standards for approval at the time of the survey, all located in areas closed for shellfish harvest. Station #24A in Kings Creek was added after the last Sanitary Survey but did not have enough sampling data to be opened until the next Sanitary Survey.

March 2008 – October 2012

Population was estimated to be approximately 5,650 permanent residents with 20,000 during the tourist season. Land use on the Topsail Island side was largely residential and mainly agricultural on the mainland side, though residential and commercial uses also exist on the mainland. The shellfish water classification acreages were: 7.04 acres Approved, 4,650.37 acres Conditionally Approved – Open, 716.84 acres Conditionally Approved – Closed, and 395.68

acres Prohibited. This is a total of 4,657.41 acres open and 1,112.52 acres closed. Large areas of the mainland remained undeveloped but had a potential for future residential growth. One such area of future expansion had only 7 homes, but 1,036 home sites. Wastewater services were seen as an influential driver in such future expansion. During the period of this survey, the Conditionally Approved areas that are normally open were closed 40 times for a total of 299 days due to rainfall and runoff, with 5 times being due to tropical storms and hurricanes. Additionally, 2 separate wastewater discharges into B-9 waters caused 50 of the 299 days of closures. No Conditionally Approved and normally closed sites were temporarily opened during this period. Bacteriological data indicated a decline in water quality after the 2010 survey, maybe due to increased average monthly rainfall.

December 2011 – November 2016

Population was estimated to be approximately 6,352 permanent residents with 20,000 during the tourist season. Land use on the Topsail Island side was largely residential and mainly agricultural on the mainland side, though residential and commercial uses also exist on the mainland. The shellfish water classification acreages were: 5.01 acres Approved, 4,289.26 acres Conditionally Approved – Open, 730.77 acres Conditionally Approved – Closed, and 745.74 acres Prohibited. This is a total of 4,294.27 acres open and 1,476.51 acres closed. Subdivisions were noted as an indicator of population growth, as well as for their tendency to concentrate potential sources of pollution such as septic systems, pet wastes, and stormwater. There was moderate growth in the area during this period. Additional residential areas include 4 new subdivisions and an RV park served by onsite wastewater systems. Large portions of the mainland remain undeveloped, but potential for growth remains high. Stormwater remains a major source of contamination within the area. Portions of B-9 were closed 49 times for a total of 534 days during this period, including 6 closures and 90 days for hurricanes and tropical storms. Only two sampling stations exceeded the standard for approved status for this time, both in waters classified as prohibited or conditionally approved closed. Approximately 50 acres were reclassified from conditionally approved closed to conditionally approved open due to this report. Otherwise, there was little change in bacteriological water quality and not additional reclassification changes were made.

December 2014 – October 2019

Population was estimated to be approximately 6,352 permanent residents with 20,000 during the tourist season. The shellfish water classification acreages were: 5.09 acres Approved, 4,276.54 acres Conditionally Approved – Open, 712.68 acres Conditionally Approved – Closed, 41.46 acres Restricted, and 745.30 acres Prohibited. This is a total of 4,281.63 acres open and 1,489.44 acres closed. Residential growth continued, particularly around Morris Landing, Kings Creek, and Turkey Creek. However, there is still undeveloped land, and growth is likely to continue. Two new subdivisions were noted during this survey. It is likely that at least one of these developments will have an impact on water quality. Due to Hurricane Florence in September 2018, a treatment lagoon overflowed into a tributary of King's Creek. Additionally, excessive rainfall and power outages due to the hurricane likely resulted in localized issues within the watershed. The whole Growing Area was closed for 27 days following the hurricane. No other treatment plant or collection system problems were noted during this period. There

was little widespread change in water quality during this period. One exception is a Conditionally Approved Open area meeting the standards for Approved classification while in the open status. A few new sampling stations were added to the sampling regime to monitor bacteriological water quality more effectively.

Appendix C: Conservation Easement for Holly Ridge Associates Acreage

BK2540 PG923-933 – Onslow County Register of Deeds

CONSERVATION EASEMENT

THIS CONSERVATION EASEMENT ("**Conservation Easement**") is made on this day of October 2005, by and between **HOLLY RIDGE ASSOCIATES, LLC** a North Carolina Limited Liability Company, and **JOHN A. ELMORE, II**, hereinafter GRANTOR and **NORTH CAROLINA COASTAL FEDERATION**, a NC non-profit Corporation, whose address is 3609 Highway 24 (Ocean, Newport, NC 28570, herein after GRANTEE.

RECITALS & CONSERVATION PURPOSES

Grantor is the record owner in fee simple of the property located in the Holly Ridge area of Onslow County and described in the attached Exhibit A and by this reference incorporated herein ("Property"); and

A. Grantor and Grantee were parties to a Consent Decree entered in the United States District Court for the Eastern District of North Carolina-Southern Division in case file No. 7:01-CV-36-BO (3), hereinafter (Consent Decree). The terms of the Consent Decree are hereby incorporated into this Conservation Easement by reference. Under Appendix 2, Section V under the Consent Decree entitled "Conservation Easement", and as part of the consent decree Grantor agreed to execute a document in the nature of a conservation easement on the above-described properties, Grantor recognizes the conservation and water quality values of the Property in its present state as a riparian shoreline and intend that said conservation values of the Property be preserved and maintained under the terms of this agreement; and,

NOW, THEREFORE, in consideration of the premises and the mutual benefits recited herein, together with the payment of a one-time stewardship fee of ten thousand dollars

(\$10,000.00) payable to Grantee upon execution of this agreement and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged by the parties hereto, and in order to comply with the Consent Decree described above, the Grantor hereby unconditionally and irrevocably gives, grants and conveys forever and in perpetuity to the Grantee, its successors and assigns, and the Grantee hereby accepts, a Deed of Conservation Easement of the nature and character and to the extent hereinafter set forth in, over, through and across the Property, together with the right to preserve and protect the conservation values thereof as described in the Recitals herein.

The purposes of this Conservation Easement are to provide environmental protection for surface waters, and it shall be so held, maintained, and used, therefore. It is the further purpose of this Easement to prevent any use of the Property for drainage that will significantly impair or interfere with the preservation of said conservation values. Grantor intends that this easement will restrict use of the Property to such activities as are consistent with the purposes of conservation.

ARTICLE I. DURATION OF EASEMENT

This Conservation Easement shall be perpetual. It is an easement in gross, runs with the land, and is enforceable by Grantee against Grantor, its representatives, successors, assigns, lessees, agents, and licensees.

ARTICLE II. RIGHTS RESERVED TO GRANTOR

Grantor reserves certain rights accruing from ownership of the Property, including the right to engage in or permit others to engage in uses of the Property that are not inconsistent with the purpose(s) of this Easement. All rights reserved by Grantors are reserved for Grantors, their representatives, successors, and assigns, and are consistent with the conservation purposes of this Conservation Easement. The following rights are expressly reserved:

- A. To construct pedestrian-only walkways across the area described as "Conservation Easement Area 3" on the attached Exhibit A. The allowable walkways shall be for access to docks that may be constructed along the shoreline adjacent to the Atlantic Intercoastal Waterway. The Grantor shall also be allowed to construct and install such reasonable utilities as may be necessary to provide for the safe use of the walkways and adjacent docks. Any walkways or docks contemplated by this section shall be subject to any permit requirements of the North Carolina Department of Environment and Natural Resources and the U.S. Army Corps of Engineers. Nothing in this Easement shall allow the right of Grantor

to construct a marina, as defined by the appropriate state and local land use regulations.

- B. To construct minimal utility crossings across all easement areas as may be reasonably necessary to connect and provide utility service to

upland areas owned by Grantor separated by the easement areas described on the attached exhibit A.

- C. To engage in the hunting and trapping of wildlife consistent with State and Federation regulations.

ARTICLE III. PROHIBITED AND RESTRICTED ACTIVITIES

Any activity on, or use of, the Property inconsistent with the purposes of this Conservation Easement is prohibited. The Property shall be maintained in its natural, scenic, wooded, and open condition and restricted from any development or use that would impair or interfere with the conservation purposes of this Conservation Easement set forth herein. No residential or commercial development of any kind shall be allowed within the easement area.

The following activities and uses are expressly prohibited or restricted.

A. **Ditch Prohibitions.** The Grantor is prohibited from the construction of ditches or other forms of conveyance to discharge stormwater or other pollutants in or across the property described as Conservation Easement Areas 2 and 3 in the Exhibit A into the waters of the United States, except for the stormwater permitted to be discharged as sheet flow into the Property from the termini of ditches 6, 9 and 12 as described under the Consent Decree, Appendix 2, Paragraph I entitled "Ditch Restoration", Section E, and the discharge of stormwater from the existing pond north of James Johnson Road into the existing ditch that runs to the marshes along the Atlantic Intracoastal Waterway. Grantor is also prohibited from, diverting, or causing or permitting the diversion of surface or underground water into, within or out of the easement area by any means, except sheet flow across the easement that does not alter the natural topography, and removing of wetlands, polluting, or discharging into waters, springs, seeps, or wetlands, is prohibited.

B. **Agricultural, Timber Harvesting, Grazing and Horticultural Use.** Agricultural, commercial timber harvesting, grazing, horticultural and animal husbandry operations are prohibited on the Property.

C. **Disturbance of Natural Features.** No trees may be cut or removed, and the natural features of the Property may not be disturbed, except for: (i) as may be incidental to boundary marking, fencing, and signage allowed or required hereunder; and (ii) selective cutting and prescribed burning or clearing of vegetation and the application of mutually approved pesticides and fire containment and protection, disease control, restoration of hydrology, wetlands enhancement and/or control of non-native plants, all subject however, to prior approval of the Grantee.

ARTICLE IV. ENFORCEMENT AND REMEDIES

A. Enforcement To accomplish the purposes of this Easement, Grantee is allowed to prevent any activity on or use of the Property that is inconsistent with the purposes of this Easement and to require the restoration of such areas or features of the Property that may have been damaged by such activity or use. Upon any breach of the terms of this Conservation Easement by Grantor that comes to the attention of the Grantee, the Grantee shall, except as provided below, notify the Grantor in writing of such breach. The Grantor shall have sixty (60) days after receipt of such notice to commence correction of the conditions constituting such breach and one hundred twenty (120) days to complete such corrections unless the parties otherwise agree. If action has not been commenced to correct the breach after sixty (60) days, the Grantee may enforce this Conservation Easement by appropriate legal proceedings including damages, injunctive and other relief. The Grantee shall also have the power and authority, consistent with its statutory authority: (a) to prevent any impairment of the Property by acts which may be unlawful or in violation of this Conservation Easement; (b) to otherwise preserve or protect its interest in the Property; or (c) to seek damages from any appropriate person or entity. Notwithstanding the foregoing, the Grantee reserves the immediate right, without notice, to obtain a temporary restraining order, injunctive or other appropriate relief if the breach of the term of this Conservation Easement is or would irreversibly or otherwise materially impair the benefits to be derived from this Conservation Easement. The Grantor and Grantee acknowledge that under such circumstances damage to the Grantee would be irreparable and remedies at law will be inadequate. The rights and remedies of the Grantee provided hereunder shall be in addition to, and not in lieu of, all other rights and remedies available to Grantee in connection with this Conservation Easement, including, without limitation, those set forth in the Grant Agreement under which this Conservation Easement was obtained.

B. Inspection. Grantee, its employees and agents and its successors and assigns, have the right, with reasonable notice, to enter the Property at reasonable times for the purpose of inspecting the Property to determine whether the Grantor, Grantor's representatives, or assigns are complying with the terms, conditions, and restrictions of this Conservation Easement

C. Acts Beyond Grantor's Control. Nothing contained in this Conservation Easement shall be construed to entitle Grantee to bring any action against Grantor for any injury or change in the Property caused by third parties, resulting from causes beyond the Grantor's control, including, without limitation, trespass by third parties, fire, flood, storm, and earth movement, or from any prudent action taken in good faith by the Grantor under emergency conditions to prevent, abate, or mitigate significant injury to life, damage to property or harm to the Property resulting from such causes.

D. Costs of Enforcement Any costs incurred by Grantee in enforcing the terms of this Conservation Easement against Grantor, including, without limitation, any costs of restoration

necessitated by Grantor's acts or omissions in violation of the terms of this Conservation Easement, shall be borne by Grantor.

E. No Waiver. Enforcement of this Easement shall be at the discretion of the Grantee and any forbearance by Grantee to exercise its rights hereunder in the event of any breach of any term set forth herein shall not be deemed or construed to be a waiver by Grantee of such term or of any subsequent breach of the same or of any other term of this easement or of Grantee's rights. No delay or omission by Grantee in exercise of any right or remedy shall impair such right or remedy or be construed as a waiver.

ARTICLE V. DOCUMENTATION AND TITLE

A. Title. The Grantor covenants and represents that the Grantor is the sole owner and is seized of the Property in fee simple and has good right to grant and convey the aforesaid Conservation Easement; that there is legal access to the Property, which access may be limited as shown on Exhibit A; that the Property is free and clear of any and all encumbrances, except easements of record, none of which would nullify, impair or limit in any way the terms or effect of this Conservation Easement; Grantor shall defend its title against the claims of all persons whomsoever, and Grantor covenants that the Grantee shall have the use of and enjoy all of the benefits derived from and arising out of the aforesaid Conservation Easement.

ARTICLE VI. MISCELLANEOUS

A. Subsequent Transfers. The Grantor agrees to the terms of this Conservation Easement in any deed or other legal instrument that transfers any interest in all or a portion of the Property. The Grantor agrees to provide written notice of such transfer at least thirty (30) days prior to the date of the transfer. The Grantor and Grantee agree that the terms of this Conservation Easement shall survive any merger.

B. Conservation Purpose.

(1) Grantee, for itself, its successors and assigns, agrees that this Conservation Easement shall be held exclusively for conservation purposes.

(2) The parties hereto recognize and agree that the benefits of this Conservation Easement are in gross and assignable, provided, however that the Grantee hereby covenants and agrees, that in the event it transfers or assigns this Conservation Easement, the organization receiving the interest will be a qualified organization as that term is defined in Section 170(h)(3) of the Internal Revenue Code, which is organized or operated primarily for one of the conservation purposes specified in Section 170(h)(4)(A) of the Internal Revenue Code, and Grantee further covenants and agrees that the terms of the transfer or assignment will be such that the transferee or assignee will be required to continue to carry out in perpetuity the conservation purpose that the contribution was originally intended to advance, set forth in the Recitals herein.

(3) Unless otherwise specifically set forth in this Conservation Easement, nothing herein shall convey to or establish for the public a right of access over the Property.

C. Construction of Tenna. This Conservation Easement shall be construed to promote the purposes of the North Carolina enabling statute set forth in N.C.G.S. 121-34 which authorizes the creation of Conservation Easements for purposes including those set forth in the Recitals herein, and the conservation purposes of this Conservation Easement, including such purposes as are defined in Section I 70(h)(4)(A) of the Internal Revenue Code.

D. Recording. The Grantee shall record this instrument and any amendment hereto in timely fashion in the official records of Onslow County, North Carolina, and may re-record it at any time as may be required to preserve its rights.

E. Notices. All notices, requests or other communications permitted or required by this Agreement shall be sent by registered or certified mail, return receipt requested, addressed to the parties as set forth above, or to such other addresses such party may establish in writing to the other. All such items shall be deemed given or made three (3) days after being placed in the United States mail as herein provided. In any case where the terms of this Conservation Easement require the consent of any party, such consent shall be requested by written notice. Such consent shall be deemed denied unless, within ninety (90) days after receipt of notice, a written notice of approval and the reason therefore has been mailed to the party requesting consent.

F. Amendments. Grantor and Grantee are free to jointly amend this Conservation Easement to meet changing conditions, provided that no amendment will be allowed that is inconsistent with the purposes of this Conservation Easement or the Consent Decree or affects the perpetual duration of this Conservation Easement. Such amendment(s) require the written consent of both Grantor and Grantee and shall be effective upon recording in the public records of Onslow County, North Carolina

G. Environmental Condition of Property. The Grantor warrants, represents and covenants to the Grantee that to the best of its knowledge after appropriate inquiry and investigation that: (a) the Property described herein is and at all times hereafter will continue to be in full compliance with all federal, state and local environmental laws and regulations, and (b) as of the date hereof there are no hazardous materials, substances, wastes, or environmentally regulated substances (including, without limitation, any materials containing asbestos) located on, in or under the Property or used in connection therewith, and that there is no environmental condition existing on the Property that may prohibit or impede use of the Property for the purposes set forth in the Recitals and the Grantor will not allow such uses or conditions.

H. Entire Agreement. This instrument sets forth the entire agreement of the parties with respect to the Conservation Easement and supersedes all prior discussions, negotiations, understandings, or agreements relating to the Conservation Easement. If any provision is

found to be invalid, the remainder of the provisions of this Conservation Easement, and the application of such provision to persons or circumstances other than those as to which it is found to be invalid, shall not be affected thereby. The party(ies) hereto intend

this document to be an instrument executed under seal. If any party is an individual, partnership or limited liability company, such party hereby adopts the word "SEAL" following his/her signature and the name of the partnership or limited liability company as his/her/its legal seal. The Recitals set forth above and the Exhibits attached hereto are incorporated herein by reference.

I. Indemnity. The Grantors agree to the fullest extent permitted by law, to defend, protect, indemnify and hold harmless the Grantee from and against all claims, actions, liabilities, damages, fines, penalties, costs and expenses suffered as a direct or indirect result of any violation of any federal, state, or local environmental or land use law or regulation or of the use or presence of any hazardous substance, waste or other regulated material in, on or under the property caused by actions or omissions of the Grantors or Grantors' invitees. In the event such claims, actions, liabilities, damages, fines, penalties, costs and expenses suffered as a direct or indirect result of any violation of any federal, state, or local environmental or land use law or regulation or of the use or presence of any hazardous substance, waste or other regulated material in, on or under the property are caused by Grantee or Grantee's invitees, Grantee agrees to the fullest extent permitted by law, to defend, protect, indemnify and hold harmless the Grantors.

J. Interpretation. This Conservation Easement shall be construed and interpreted under the laws of the State of North Carolina, **and** any ambiguities herein shall be resolved to give maximum effect to the conservation purposes sought to be protected herein.

K. Parties. Every provision of this Conservation easement that applies to the Grantors or to the Grantee shall likewise apply to their respective heirs, executors, administrators, assigns, and grantees, and all other successors in interest herein.

L. Merger. The parties agree that the terms of this Conservation Easement shall survive any merger of the fee and easement interest in the Property.

M. Subsequent Liens. No provisions of this Conservation Easement shall be construed as impairing the ability of Grantors to use this Property for collateral for borrowing purposes, provided that any mortgage or lien arising therefrom shall be subordinated to this Easement.

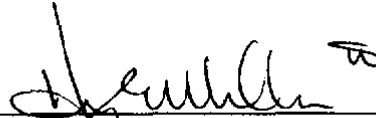
TO HAVE AND TO HOLD unto NORTH CAROLINA COASTAL FEDERATION,

its successors and assigns, forever. The covenants agreed to, and the terms, conditions, restrictions, and purposes imposed as aforesaid shall be binding upon Grantor, Grantor's representatives, successors and assigns, and shall continue as a servitude running in perpetuity with the Property.

IN WITNESS WHEREOF, Grantor, by authority duly given, has herewith caused this Conservation Easement to be executed by the appropriate party and to be effective the day and

year first above written.

GRANTOR: **HOLLY RIDGE ASSOCIATES, LLC**

By:  _____ seal
Manager

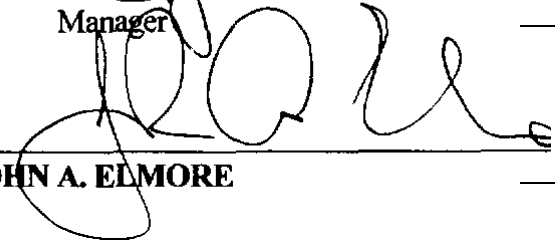
 _____ seal
JOHN A. ELMORE

EXHIBIT A

AREA 1

Beginning at the northwestern most corner of the tract of land claimed in DB. 1065, PG. 844; said point being further located where said boundary line intersects the southern right of way of Smith Street (60' R/W)Runs thence with the western boundary line of said tract as in meanders approximately 3,054 feet to a point where it intersects with Cypress Creek Canal a common corner now or formerly with Darel G. Lockamy (DB. 737, PG. 581); thence in a easterly direction approximately 50 feet to a point; thence parallel with the western boundary line of said tract in a north westerly direction to its intersection with the southern right of way of Smith Street; thence with said right of way to the beginning. Said easement being 50 feet in width and containing approximately 5.27 Acres more or less.

AREA 2

Parcel I

Beginning at a point where the western boundary line of the tract of land claimed in DB. 1065, PG. 844 intersects with Cypress Creek Canal a common corner now or formerly with Darel G. Lockamy (DB. 737, PG. 581); thence with said *western* boundary line to its intersection with the northern right of way of SR 1540 (60' R/W); thence with said right of way in a north easterly direction approximately 200 feet; thence parallel with the western boundary line in a northerly direction to a point 200 feet perpendicular to the beginning; thence in southerly direction approximately 200 feet to the beginning containing approximately 10.47 Acres more or less.

Parcel II

Beginning at a point where the *western* boundary line of the tract of land claimed in DB.1065, PG. 844 intersects the southern right of way of SR 1540; thence with the western boundary line in a southerly direction as it runs with Cypress Creek Canal, Double Gulley Branch and Barlow's Ditch to its intersection with a paved road{ not *state* maintained}; said point being located approximately 3,870 feet from where the boundary line intersects the right of way of the Atlantic Intra Coastal Waterway right of way; thence along said paved road in a northeasterly direction approximately 200 feet; thence in a northwesterly direction and parallel to the *western* boundary line to a point in the southern right of way of SR 1540; thence with

said right of way approximately 200 feet to the beginning containing approximately 32.17 Acres more or less.

AREA 3

Beginning at a point in the western boundary line of the tract of land claimed in DB. 1065, PG. 844; said point being located approximately 2,770 feet north of intersection of said boundary line and the right of way of the Atlantic Intra Coastal Waterway right of way; thence from said beginning in a northeasterly direction and perpendicular to the western boundary line approximately 1,150 feet to a point; thence in a southeasterly direction and perpendicular to the last call and parallel to the western boundary line approximately 630 feet to a point; thence in a northeasterly direction and perpendicular to the last call approximately 1,650 feet to a point; thence in a southeasterly direction approximately 500 feet to a point; thence in a northeasterly direction approximately 2,000 feet to the eastern boundary line of the tract of land claimed in DB. 1065, PG. 844; said point also being located approximately 1,150 feet south of the intersection of a paved road (not state maintained) and the eastern boundary line; thence from said point in the eastern boundary line and running with said boundary line southwardly to its intersection with the shoreline; thence in a southwest direction with the shore line as it meanders to its intersection with the western boundary line of said tract; thence with said boundary line northwesterly approximately 600 feet to the beginning containing approximately 93.62 Acres more or less.

Reference is made to a Sediment and Erosion Control Plan by Cape Fear Engineering, Inc., and a map by McKim and Creed Engineers, P.A.

Appendix D: Potential Stormwater Incentive Strategies

Incentive Categories

The EPA has identified five basic incentive categories that can be utilized to encourage the reduction of stormwater¹⁹:

Incentive Type	Description
Stormwater Fee Discount	Require a stormwater fee that is based on impervious surface area. If property owners reduce need for service by reducing impervious area and the volume of runoff discharged from the property, the municipality reduces the fee.
Development Incentives	Offered to developers during the process of applying for development permits. Examples include zoning upgrades, expedited permitting, reduced stormwater requirements, and increases in floor area ratios.
Grants	Provide direct funding to property owners and/or community groups for implementing a range of green infrastructure projects and practices.
Rebates & Installation Financing	Provide funding, tax credits or reimbursements to property owners who install specific practices. Often focused on practices needed in certain areas or neighborhoods
Awards & Recognition Incentive	Provide marketing opportunities and public outreach for exemplary projects. May include monetary awards. Emphasize LID projects on website, at Council meetings and in utility mailers.

Basic Strategies

¹⁹ Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanism. 2009. US Environmental Protection Agency, EPA-833-F-09-001. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_incentives_0.pdf

The following is a compiled list of basic strategies and descriptions (summarized or quotes directly from Slo County²⁰ and EPA²¹; see references):

Strategy	Description
Adjustments to the Required Parking	Reducing parking is both an LID technique for reducing impervious surfaces as well to encourage more projects.
Dedicated Review Team	Create an LID review team that is familiar with and dedicated to LID projects.
Density bonuses	Allow greater residential densities with the implementation of LID techniques.
Disconnect of rooftop runoff credit	A credit is given when rooftop runoff is disconnected and then direction to a vegetated area where it can either infiltrate into the soil or filter over it. The credit is typically obtained by grading the site to promote overland filtering or by providing bioretention areas on single family residential lots.
Disconnection of Non-Rooftop Runoff Credit (aka Impervious Area Disconnection Credit)	This credit may be granted when impervious areas are disconnected from the stormwater control system via overland flow filtration/ infiltration (i.e., pervious) zones. These pervious areas are incorporated into the site design to receive runoff small impervious areas (e.g., driveways, small parking lots, etc.). This can be achieved by grading the site to promote overland vegetative filtering or by providing infiltration or “rain garden” areas.

²⁰ Slo County. n.d. *List of Potential Municipal LID Incentive Programs*. Retrieved from <http://www.slocounty.ca.gov/Assets/PW/stormwater/Potential+LID+Incentives.pdf>

²¹ *Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanism*. 2009. US Environmental Protection Agency, EPA-833-F-09-001. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_incentives_0.pdf

Environmentally Sensitive Large Lot Neighborhood Credit (aka Environmentally Sensitive Development Credit)	<p>This credit is targeted toward large lot residential developments that implement several Better Site Design practices to reduce stormwater discharges from the development. This credit may be granted when a group of environmental site design techniques are applied to low and very low-density residential development (e.g., 1 dwelling unit per 2 acres [du/ac] or lower). The credit can eliminate the need for structural stormwater controls to treat water quality volume requirements. The project must have a total impervious cover (including streets) of less than 15% of the total area. utilize grass channels to convey runoff versus curb and gutter, etc.</p>
Exemptions from local stormwater permitting	<p>Allow redevelopment projects from being exempt from local stormwater permitting requirements if they can:</p> <ul style="list-style-type: none"> • reduce the total impervious cover by 40% from existing conditions where site conditions prevent reduction in stormwater practices, implement controls for at least 40% of the site's impervious area, or where a combination of impervious area reduction and implementation of stormwater practices is used for redevelopment projects, the combination of impervious area reduction and area controlled by stormwater management practices is equal to or exceeds 40%.
Fast track of review process	<p>Provide priority status to LID projects with decreased time between receipt and review.</p>
Green Roof Bonus	<p>Add one square foot of additional floor area for each square foot of green roof, if green roof covers at least 50% of roof area and at least 30% of the garden contains plants.</p>
LID Point system	<p>Require a certain number of LID points and provide points when using approved LID IMP practices.</p>
Managed Conservation Area Credit	<p>A credit may be granted when areas of managed open space, typically reserved for passive recreation or agricultural practices, are conserved on a site. Under this credit, a designer would be able to subtract conservation areas from total site area when computing water quality volume requirements.</p>

Modify building and inspection codes to include LID	<p>Municipal entities that enforce building and inspection standards can also modify these standards in ways that acknowledge LID. In this subsection, we list sources of information on modifying building and inspection codes to make them more LID friendly. The list includes sources specific to Oregon and the Pacific Northwest, as well as from outside the region.</p> <p>http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf</p>
Natural Area Conservation Credit	<p>Credit may be granted when undisturbed, natural areas are conserved on a site, thereby retaining their pre-development hydrologic and water quality characteristics. Under this credit, a designer would be able to subtract conservation areas from total site area when computing water quality volume requirements.</p>
Property tax reduction	<p>Reduce or waive property taxes on an LID project for a given number of years.</p>
Reduction of municipal submittal fees	<p>Projects that infiltrate 100 percent of stormwater receive up to 50% reduction in the stormwater utility fee.</p>
Stream and Vegetated Buffer Credit (aka Stream Buffer Credit or Sheet flow to Buffer Credit)	<p>This credit may be granted when stormwater runoff is effectively treated by a stream buffer or other vegetated buffer. Effective treatment constitutes treating runoff as overland sheet flow through an appropriately vegetated and forested buffer. Under the proposed credit, a designer would be able to subtract areas draining via overland flow to the buffer from total site area when computing water quality volume requirements.</p>
Tree canopy credit	<p>Reduce stormwater treatment volume requirements as a ratio of the number of acceptably sized trees planted on the project.</p>
Vegetated Channel Credit (aka Grass Channel Credit (in lieu of Curb and Gutter))	<p>This credit may be granted when vegetated (grass) channels are used for water quality treatment. Site designers will be able to subtract the areas draining to a grass channel and the channel area itself from total site area when computing water quality volume requirements.</p>
Education Strategy	<ul style="list-style-type: none"> • Municipal sponsored public workshops on how to build rain gardens and emphasizing the increase in property value and curb appeal of LID landscaping. • Municipal sponsored public workshops on how to make your own rain barrels.

	<ul style="list-style-type: none"> • Municipal public education and outreach on how to conserve water and save money using rain barrels, rainwater harvesting water tanks, cisterns, and rain chains. • Municipal sponsored contests with giveaways using rain barrels, rain harvesting water tanks, cisterns, and rain chains. • Municipal sponsored gardening workshops promoting the value of rainwater harvesting, rain gardens, etc.
Business Outreach	<p>Communication about grant opportunities, partnerships, awards, competitions, and regulations via email, newsletter, website, etc. directed directly at business owners and commercial landowners to encourage participation and encourage a vested interest in the community</p>

Examples of LID-friendly Regulatory Language

Several cities and counties list LID-friendly stormwater ordinances on their websites. A recent Google search of “LID regulation” found the following ordinances:

- City of Sammamish, Washington: Ordinance 02008-236 Low Impact Development Regulations. An ordinance of the City of Sammamish, Washington, amending the City of Sammamish Municipal Code to create a Low Impact Development Chapter, and amending certain other Chapters of the City of Sammamish Municipal code to ensure consistency with the Low Impact Development Chapter. <http://www.ci.sammamish.wa.us/Ordinances.aspx?ID=107> (accessed January 5, 2009).
- Fauquier County, Virginia: A zoning ordinance text amendment to Sections 5-006.5, 12-610 and 15-300 related to utilization of Low Impact Development techniques with site development. http://www.fauquiercounty.gov/government/departments/BOS/past_agendas/02-14-08/lid_ord.htm (accessed January 5, 2009).
- Township of Lower Makefield, Pennsylvania: Ordinance No. 364. An ordinance of the Township of Lower Makefield, Bucks County, Pennsylvania, amending the Lower Makefield Township Codified Zoning Ordinance of 1996, as amended, to provide for Low Impact Development Standards. http://www.lmt.org/LID%20-%20ZONING%20v%206%20_4_.pdf (accessed January 5, 2009).²²
- Vermont utilizes a suite of stormwater regulations http://acrpc.org/files/2012/04/LID_For_VT_Towns.pdf

Discussion of challenges faced by developers and how municipalities can maximize the effectiveness of stormwater programs:

²² ECONorthwest. 2009. Low Impact Development at the local level: Developer’s experiences and city and county support. Retrieved from http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf

- http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf

List of Cost savings from installed LID stormwater controls:

- http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf
- <http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/guidance/factsheets/Documents/Incorporating%20ESD%20into%20Municipal%20SW%20Programs.pdf>
- <https://www3.epa.gov/region1/npdes/stormwater/assets/pdfs/IncorporatingLID.pdf>

Examples of Specific Stormwater Incentive Strategies

The following is a compiled list of specific incentive strategies and descriptions that are summarized or directly quoted from the EPA²³:

Stormwater Fee Discount Programs	
Program Name	Description
Stormwater fee equitability	Fees are based on actual impervious area at each site as determined by aerial photography, so the less impervious surface, the lower the fee charged. All properties.
Stormwater Management Utility Exemption	Gainesville's Stormwater Management Utility reduces monthly fees for nonresidential properties with privately maintained, onsite stormwater management retention systems. The utility's base fee is established per the property's impervious area and one-half its pervious parking areas. Credits of up to 100% are available based on the volume of onsite retention provided. Detention volume is not considered because that stormwater is discharged. Most credits range from 15% to 35%. Non-residential.
Stormwater Utility Discount	<p>Orlando's stormwater utility provides a lower rate for commercial and multifamily residential properties with onsite stormwater management facilities. Properties with approved onsite retention or detention get a 42% credit on the rate charged per equivalent residential unit. Beneficiary: Commercial and multi-family residential.</p> <p>Flow Chart for Rate Determination:</p> <p>http://www.cityoforlando.net/public_works/Stormwater/Utility%20Fee/FLOWCART%20FOR%202008%20BILLING%20YEAR.pdf</p> <p>FAQs:</p> <p>http://www.cityoforlando.net/public_works/Stormwater/faq.htm#04.3</p>

²³ *Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanism*. 2009. US Environmental Protection Agency, EPA-833-F-09-001. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_incentives_0.pdf

<p>Stormwater Credits Program</p>	<p>The County provides stormwater credit to landowners who install four types of practices: watershed stewardship, water quality, peak flow, and channel protection. The total maximum credit for any property is 40%. Watershed stewardship practices include: public participation, low impact parcels, farmland deep tillage, stream restoration / streambank stabilization, watershed improvement project participation, conservation easements, conservation use valuation, assessment (CUVA) properties, county approved training programs, stream buffers that exceed 75' standards, fencing livestock out of streams, rain barrels, automatic sprinkler sensors, direct discharges, septic tank maintenance, and connection to sanitary sewers. Water quality credits of up to 10% are earned by property owners who install facilities that capture pollutants, thereby providing treatment of stormwater before it enters streams. There are several practices to accomplish this available to all property owners. Porous pavement, roof gardens and green roofs are acceptable practices to receive this credit. Residential property owners can install rain gardens to earn this credit. Channel protection credit (maximum 10%) is earned by property owners who provide protection of stream channels from bank and stream bed erosion by detaining and reducing the volume of stormwater from their properties. Peak flow credit (maximum 10%) is earned by property owners who install basins that delay the system, thereby protecting downstream of the highest flows from reaching the drainage properties.</p> <p>Beneficiary: Property owner in Gwinnett County.</p>
<p>Utility Fee Credit</p>	<p>Credits are available for eligible properties that install, alter, or conduct activities that reduce the costs of services provided by the County. A 10% reduction of the stormwater fee is allowed for property owners; a 1% reduction is allowed for each percent of stormwater directed to rain garden. If all stormwater is treated on site, no fee is charged. Beneficiary: All properties</p>
<p>Stormwater Fee Discount</p>	<p>Wichita's stormwater utility offers two types of credits only for properties with 50 or more equivalent residential units. Up to a 40% credit is available for detention that equals or exceeds the city's new development standards, which are based on a 100-year storm. An 80% credit is available for retention of all runoff from the site. Wichita has not issued any credits, because the standards are difficult to achieve.</p> <p>Beneficiary: Residential</p>

<p>Drainage Charge Credit</p>	<p>The Louisville and Jefferson County Metropolitan Sewer District (MSD) provides credits primarily for commercial properties with onsite detention for controlling peak flows. The credit amount depends on how the detention basin functions. Basins must be sized for 2-, 10-, or 100-year storms, and limit discharges to predevelopment runoff rates. Credits are available for each type of storm, with an 82% maximum credit if all criteria are met. Currently, MSD is evaluating ways to incorporate stormwater quality measures into its credit approach. Stormwater Fee Discount Beneficiary: Commercial</p>
<p>Stormwater Surcharge Credit</p>	<p>Any non-residential property owner who has either installed an approved on-site post-construction storm water control facility, implemented an approved best management practice (BMP), or developed and implemented an approved education program, may apply for a reduction of the Surcharge applied to that specific parcel. The district will evaluate each case individually in determining the appropriate level of credit. A total maximum of an 80% credit against the Surcharge may be granted:</p> <ul style="list-style-type: none"> • The credit is applied by reducing the number of billable equivalent residential units. • The property parcel can qualify for both water quantity and water quality credits. • The maximum allowable water quantity credit percentage = 35%. • The maximum allowable water quality credit percentage = 50%. <p>Beneficiary: Commercial</p>
<p>Stormwater Enterprise Fund Fee Abatement</p>	<p>The City allows single and two-family residential properties to abate up to 50% of the total fee if they install and maintain infiltration systems or other means to reduce runoff. Commercial/industrial/multi-family properties are allowed this abatement if they install and maintain “state-of-the-art” stormwater treatment and infiltration systems. Typical devices that qualify are drywells, infiltration chambers, detention ponds. Drinking water filtration systems and rain barrels do not qualify. The stormwater abatement continues if the impervious surface does not change. Beneficiary: Property owner in Reading, Massachusetts.</p>
<p>Stormwater Quality Credit</p>	<p>Residential storm water fee credit determined by the percent of a property’s impervious area that drains to a stormwater management tool/practice (BMP). The maximum credit allowed is equal to 50% of the total percentage of impervious area draining to a BMP. Beneficiary: Residential</p>

<p>NC CHARLOTTE Stormwater Services Credit</p>	<p>A credit toward reducing a ratepayer’s storm water user fee. The storm water fee is proportional to the amount of impervious area on a given property. The credit is also developed to be proportional to the effective reduction in impervious area. The credit is allowed for all properties except single-family residential properties, except in extraordinary situations. Credit will only be allowed for properties that maintain their structural controls in fully functional condition and per maintenance criteria and BMP standards. Credit will be allowed for previously constructed controls. A maximum of 100 percent of the user fee can be granted in credit with a maximum of 40% for peak reduction and 60% for volume reduction. Beneficiary: Commercial and Some Residential</p>
<p>NC CHARLOTTE Stormwater Credit Fee</p>	<p>Charlotte provides one or more credits to commercial, industrial, institutional, and multifamily residential properties and homeowner associations that provide stormwater management measures. Eligibility for credits is proportional to the extent that the measures address the impacts of peak discharge, total runoff 12 volume, and annual pollutant loading from the site.</p> <ul style="list-style-type: none"> • Up to 100% credit is available as follows: • Up to 50% credit for reducing peak discharge from a 10-year, 6-hour storm. • Up to 25% credit for reducing total runoff volume from a 2-year, 6-hour storm. • Up to 25% credit for reducing annual pollutant loading. <p>Each credit is conditional on continued compliance with the Charlotte/Mecklenburg Land Development Standards Manual and may be rescinded for noncompliance with those standards. Beneficiary: Commercial, industrial, institutional, multifamily residential</p>
<p>NC DURHAM Stormwater Credit</p>	<p>Durham provides up to a 25% pollution credit for selected structural stormwater controls on nonresidential properties. The city first offered credits for onsite retention basins based on the pool volume for retention. Later, the city offered credits for onsite extended detention and extended detention-retention basins based on drawdown time. Currently, the maximum pollution credit goes to standard basin designs that achieve maximum pollutant removal efficiency under North Carolina’s performance standards. For other structural controls listed in the state’s standards, the city’s pollution credit is linearly variable, with a maximum 25% credit for a removal efficiency of 85% of total suspended solids. The city recently approved the use of sand filters in addition to approved onsite basin designs, but no pollution credits have been established yet for their use. Durham receives few applications for credits. Beneficiary: Nonresidential properties</p>

<p>NC RALEIGH Stormwater Facility Credit</p>	<p>A maximum 50% credit against stormwater fees for installing Stormwater Facilities exceeding City requirements specified in the Stormwater Ordinance. To qualify, customers must demonstrate that their existing Stormwater or New Stormwater Facility manages stormwater generated from their immediate property and/or upstream tributary areas.</p>
<p>Clean River Rewards Incentive and Discount Program</p>	<p>Portland, OR. Provides financial incentives to property owners who manage stormwater on their site through a discount on their monthly stormwater utility charge. The Portland City Council instituted a two-part rate—35% of the charge for providing drainage services to the property and 65% of the charge to provide drainage services to the public right of way that served the property. Not only did the charge breakdown reinforce that street drainage is an issue the City must deal with, but it also allowed a portion of the rate to be discounted for properties providing onsite stormwater management. So, with 35% of the stormwater rate up for a potential discount, some properties could be encouraged to make retrofit changes. The CRID has a simplified discount program for residential properties based on volume control, and a more complex commercial property program that requires water quality and flow control for the full discount. Beneficiary: Residential and Commercial</p>
<p>Sixty-Five-Ten Discount</p>	<p>Discount on fee assessment if your property is at least 65% forested, has no more than 10% effective impervious area and BMP for dispersing and infiltrating runoff are being met. Other conditions may apply and at least one site visit will be required for approval, but qualification for this discount would lower your assessment by one-rate category. Residential parcels meeting this condition will receive a discount equal to half the residential fee, or \$51.00. Both residential and commercial properties are eligible. This discount may not be combined with other runoff mitigation discounts Beneficiary: Residential / Commercial</p>
<p>Surface Water Utility Reductions</p>	<p>The surface water utility rate can be reduced by a minimum of 10 percent for any new or remodeled commercial building that uses a permissive rainwater harvesting system properly sized to use the available roof surface of the building. Rate reductions more than 10 percent will be considered dependent upon the amount of rainwater harvested divided by the mean annual runoff volume generated by the total impervious surface area at the parcel. Additionally, properties using low impact development techniques as recommended in the Marysville Municipal Code may be eligible for a reduction in their surface water utility rate. Commercial properties</p>

Development Incentive	
Incentive Name	Description
Green Building and Green development Program	<p>Green buildings or green developments shall qualify for expedited permitting and priority inspections. Green buildings and developments shall be defined and certified as appropriate by the U.S. Green Building Council (i.e., Leadership in Energy and Environmental Design (LEED) certification) or the Florida Green Building Coalition. The County discontinued the permit fee rebate previously offered to these projects as well on December 28, 2007.</p> <p>Beneficiary: Qualified developer in Sarasota County.</p>
Green Permit Program	<p>Chicago's Department of Construction and Permits (DCAP) has created an incentive that encourages inclusion of environmentally conscious design elements by promising developer's savings of both time and money. Architects, developers and building owners can be part of an expedited permit process by adding elements of green building strategies and technologies from a menu of items created by DCAP. Projects admitted into the Green Permit Program can receive permits in less than 30 business days as opposed to the 60 to 90 that are normally allotted for permit issuance. Participants that display a particularly high level of green strategy can possibly have consultant code review fees waived as well. A team of green building design experts compiled by the city help applicants navigate the permit process to ensure timely implementation of these technologies.</p> <p>Beneficiary: Architects, developers, and building owners</p>
Floor Area Ration Bonus	<p>Projects that install Eco roofs in the Central City Plan District are eligible for a floor area ratio bonus, which increases the building's allowable area, and can use Eco roofs to conform to the Central City Design Guidelines. Buildings can receive bonus FAR based on three ranges of Eco roof coverage in relation to the building's footprint: 10-30%, 30-60% and 60% or greater earns one, two- and three-square feet of additional floor area per square foot of Eco roof respectively. Beneficiary: Commercial buildings in the Central City area of Portland.</p>

	<p>http://www.portlandonline.com/shared/cfm/image.cfm?id=53363, see 510-28</p>
<p>Stream and Vegetated Buffers Credit</p>	<p>Credit may be granted when stormwater runoff is effectively treated by a stream buffer or other vegetated buffer. Effective treatment constitutes treating runoff as overland sheet flow through an appropriately vegetated and forested buffer.</p> <p>Beneficiary: Developer</p>
<p>Use of Vegetated Channels</p>	<p>This credit may be granted when vegetated (grass) channels are used for water quality treatment. Site designers will be able to subtract the areas draining to a grass channel and the channel area itself from the total site area when computing water quality volume requirements.</p> <p>Beneficiary: Developer</p>
<p>Impervious Area Disconnection</p>	<p>This credit may be granted when impervious areas are disconnected from the stormwater control system via overland flow filtration/infiltration (i.e., pervious) zones. These pervious areas are incorporated into the site design to receive runoff from rooftops or other small impervious areas. If impervious areas are adequately disconnected in accordance with the criteria listed below, they can be deducted from the total site area when computing the water quality volume requirements.</p> <p>Beneficiary: Developer</p>

**Water Quality
Volume Credits**

Allows for a reduction in the water quality treatment volume (WQV). The credit system directly translates into cost savings to the developer by reducing the size of structural stormwater control and conveyance facilities. If a developer incorporates one or more of the credited practices in the design of the site, the requirement for capture and treatment of the WQV will be reduced. Site designers are encouraged to utilize as many credits as they can on a site. Greater reductions in stormwater storage volumes can be achieved when many credits are combined (e.g., disconnecting rooftops and protecting natural conservation areas).

Beneficiary: Developer

Grant Incentive	
Incentive Name	Description
Sustainable Landscape Grant Program	Grants are awarded for up to 50% of the cost of the project, not to exceed \$5,000, including a maximum of \$3,500 for qualified irrigation equipment and a maximum of \$1,500 for climate-appropriate plants defined as very low, low, and medium water use plants. No turf or high-water using plants or invasive plants will be funded. In addition to the \$5,000, applicants may also apply for rebates for specific irrigation equipment including weather-based irrigation controllers, rotary nozzles for sprinklers and synthetic turf. The grant is a reimbursement grant, paid upon completion of the approved project. Invoices to substantiate costs will be required for all reimbursements. This grant is a first come, first served program available until funds run out. Projects in the parkway will receive priority funding. Projects must be completed within 180 days of grant award to receive funding. Partial funding for incomplete projects will not be permitted. Beneficiary: Individuals, property owners, businesses, non-governmental organizations, and public agencies who are water customers in Santa Monica; new construction and major remodel projects are not eligible.

<p>Green Roof Improvement Fund</p>	<p>A one-year pilot redevelopment program to provide financial assistance for the installation of Green Roofs on certain eligible commercial facilities. Eligible Applicants can receive a grant for up to 50% of Eligible Costs, with a maximum assistance of \$100,000 per project and per applicant. All grants shall be in the form of reimbursement funding to be awarded only after the Green Roof is installed and all other requirements for funding are met.</p> <p>Beneficiary: Commercial</p>
<p>Community Watershed Stewardship Grant</p>	<p>Watershed stewardship grants provide up to \$10,000 to schools, churches, businesses, and other community organizations for projects that protect and enhance watershed health at the local level. Groups can use grant money for supplies, materials, equipment, room rentals, feasibility studies or technical assistance. Past projects include education and monitoring, Eco roofs, stormwater features, restoration, and nature scaping. Community organizations</p>
<p>Impervious Surface Cost Share and Credit Program</p>	<p>As an incentive to reduce impervious surface, the county is making funds available for sharing the costs of converting impervious surface to (1) native vegetated landscape, (2) compost-amended lawn or (3) grassed, modular-grid pavement. To qualify, a plot plan, technical information and description must be submitted to county engineers who will work with the customer to develop the plan. 50% of costs up to \$20K will be reimbursed after the job is complete and inspected. Reducing impervious surface could potentially place the property into a lower rate category, reducing the surface water fee.</p> <p>Beneficiary: Commercial</p>
<p>Aquatic Habitat Matching Grant</p>	<p>Seattle Public Utilities provides matching grants for individuals or groups to help improve Seattle's aquatic habitat along creeks and shorelines. Award amounts begin at \$2,000 per project, with \$300,000 in total awards available. Projects require a one-to-one match. Projects considered are those that improve, preserve, and/or restore aquatic habitat and/or ecological diversity and enhancement; address water flow and/or quality; or improve/prevent impacts from the City's drainage system.</p> <p>Beneficiary: Individuals or groups</p>

Rebates Installation Financing Incentive	
Incentive Name	Description
Rain Gutter Downspout Redirect Rebate, Rain Barrel Rebate, Cistern Rebate	<ol style="list-style-type: none"> 1) Rain Gutter Downspout Redirect Rebate (rainwater percolation): Up to \$40 per qualified rain gutter downspout (up to and including all downspouts on one's property), includes labor and materials. Rebates are available for the cost of redirecting rain gutter downspouts to permeable surfaces, such as landscaped areas. 2) Rain Barrel Rebate (rainwater storage): Rebates up to \$100 per barrel (limited to 125-gallon maximum capacity), includes design, labor, and materials. 3) Cistern Rebate (rainwater storage): Up to \$500 per cistern (limited to cisterns over 500 gallons each), includes design, labor, and materials. Beneficiary: Any property owner (resident, institution, or business) in the City of Santa Monica and any tenant of said property with the permission of the owner.
City of Palo Alto Innovative Stormwater Measures Rebate Program	<ol style="list-style-type: none"> 1) Rain Barrel Rebate: \$50 rebate for purchase and installation of a rain barrel to collect and harvest rainwater runoff from rooftops. 2) Permeable Pavement Rebate: Rebate of \$1.50 per square foot for installation of permeable pavement (porous asphalt concrete, pervious Portland cement concrete, or permeable interlocking concrete pavers) to reduce storm water runoff from driveways, walkways, patios, and parking lots. 3) Cistern Rebate: Rebate of 15 cents per gallon for purchase and installation of a cistern to collect and harvest rainwater runoff from rooftops and site runoff. 4) Green Roof Rebate: Rebate of \$1.50 per square foot for the installation of a green (vegetated) roof to minimize storm runoff from rooftops. Rebates are limited to a maximum of \$1,000 per single-family residential property and \$10,000 for commercial/industrial and multi-family residential properties. <p>Beneficiary: Residential, commercial, or governmental property owner in the City of Palo Alto, California.</p>

<p>River Smart Homes</p>	<p>This program offers incentives to homeowners interested in reducing stormwater pollution from their properties. Homeowners receive up to \$1,200 to adopt one or more landscape enhancements, including shade trees, above-ground cisterns/rain barrels, permeable/porous pavers, rain gardens, and Bay Scaping. Beneficiary: Residential properties</p>
<p>City of Maitland Incentive Programs</p>	<p>The city has three stormwater/water quality incentive programs. Through the Shoreline Revegetation Program, the City will reimburse qualified residents up to 50% of the cost to purchase and install aquatic plants along their property shoreline. A maximum one-time reimbursement of \$200 is being offered. The Wetland Tree Planting Program provides lakefront homeowners up to three, 8- 10-foot-tall, bald cypress trees at a cost of only \$25 per tree. A City representative works with the homeowner to establish the ideal location for the trees to ensure that the trees will benefit the lake and the shoreline. Finally, the City has an Environmental Swale Program which pays for 20% of the cost to grade and sod a swale, or \$500 per property whichever is less. A City representative helps establish the best location for the swale to ensure that the lakes/canals have maximum water quality benefit.</p> <p>Beneficiary: Property owner in Maitland, Florida</p>
<p>Roll Out the Barrel Events</p>	<p>Events held where rain barrels sold at discounted prices (\$15 - \$20) to residents. Barrels were built by the City's ex-offender job training program by retrofitting recycled 55-gallon plastic barrels. City provided information on installing and maintaining rain barrels, as well as information on stormwater management and water conservation. Pilot program cost ~\$40K excluding city labor.</p> <p>Beneficiary: Residential</p>
<p>Rain Gardens for Rock Island</p>	<p>City reimburses residents \$4/square foot of rain garden space and if a rain is incorporated into the design the city will supply one for free. The City must approve the design prior to installation and inspect the rain garden upon completion prior to paying the incentive payment.</p> <p>Beneficiary: Residential property owner in Rock Island, Illinois.</p>
<p>Raincapes Regards</p>	<p>Up to \$1,200 is offered per single-family lot or up to \$5,000 per multi-family or commercial lot for installation of rain gardens, cisterns green roofs, native plants, shade trees and permeable pavement.</p>

	Beneficiary: Residential and commercial properties
Rain Garden Retrofit Projects	<p>\$150K project to target homeowners in a specific neighborhood near Crystal Lake to compel residents to build rain gardens in their yards to reduce stormwater runoff. An architect met w/ residents free of charge to design the gardens and residents helped to build them. The city installed 6-ft. curb cuts w/ 2- ft. tapering sections on either side to direct stormwater off the streets and into the gardens. The project reduced runoff by 90% compared to neighboring control area. Homeowners maintain gardens w/ city assistance if needed.</p> <p>Beneficiary: Residential</p>
Street Redesign and Reconstruction	<p>As part of large-scale redesign of existing streets and utilities, the city offered to construct standard-size rain gardens in the public boulevard right-of-way on the front edge of residential properties. These gardens handle drainage from yards, rooftops, driveways, and some runoff from the street. Residents volunteer to have the garden built by the city and are responsible for planting the provided plants and maintaining the gardens with free technical assistance from the city.</p> <p>Beneficiary: Residential</p> <p>RESOLVE. 2007. Public Funding Incentives for Private Residential and Commercial Watershed Protection Projects: Report on Key Case Studies and Community Workshop. http://www.resolve.org/rainscapesworkshop/Report.pdf.</p>
Rain Barrel Discount Program	<p>2,000 rain barrels made available to Minneapolis households at a reduced cost (\$45). Barrels made available thanks to a \$100,000 grant from the EPA's Region 5 Great Cities Program and in partnership w/ Minnesota/Metro Blooms and the Green Institute.</p> <p>Beneficiary: Residential</p>

Reverse Bidding Auction	<p>Reverse auction to encourage the installation of rain barrels and rain gardens. Bids were received from qualified residents which outlined what rain catcher projects they agreed to have installed and the incentive payment they requested to do so. The bids were selected based upon the project(s) they agreed to install, their scoring within an Environment Benefit Index and the amount of the incentive payment requested. The selected project(s) were installed for free, and the residents were paid the bid amount as a one-time incentive payment. The first round of the reverse auction in 2007 resulted in 50 rain gardens and 100 rain barrels installed at 67 of the approximately 350 residential properties in the watershed. In 2008, the auction was repeated, and an additional 35 rain gardens and 74 rain barrels were installed.</p> <p>Beneficiary: Residential property owner in the Shepherd Creek watershed.</p>
Downspout Disconnection Program	<p>Targets property owners to disconnect roof downspouts onto lawns and flowerbeds or use onsite stormwater mgmt. facilities such as drywells and soakage trenches. The City's Plumbing division works directly with homeowners to disconnect downspouts without the homeowner having to get a plumbing permit. A target area of CSO basins is selected and Disconnection Program staff go to work, door-to-door canvassing to get voluntary agreement from property owners to complete the disconnection. Owners then complete the disconnection themselves and receive a \$53 per downspout incentive, or have the city complete the disconnection for them free of charge. The program is funded primarily by a mixture of capital and operating funds due to this ability to remove enough stormwater from the CSO system, that collection pipes may be able to be downsized providing significant pipe construction cost savings.</p> <p>Beneficiary: Residential</p>

Awards and Recognition Incentive	
Incentive Name	Description

<p>Mayor Daley's GreenWorks Award</p>	<p>Mayor Daley's GreenWorks Awards promote a green city by recognizing businesses, non-profits, schools, and government agencies whose buildings, practices, and products or services are environmentally responsible. The GreenWorks Awards are presented annually. Beneficiary: Projects/buildings must be in the city of Chicago. The award program is open to businesses, non-profits, schools, and government agencies.</p>
<p>Business for an Environmentally Sustainable Tomorrow (BEST)</p>	<p>Since 1993, the BEST Awards have been presented annually to Portland area companies demonstrating excellence in business practices that promote economic growth and environmental benefits. The BEST Awards recognize businesses with significant and unique achievements in the following categories: (1) BEST Practices for Sustainability for Small, Medium, and large companies, (2) Sustainable Products or Services, (3) Innovations in Resource Conservation, (4) Green Building, and (4) Sustainable Food Systems. Beneficiary: Local businesses</p>
<p>Eco-logical Business Program</p>	<p>A certification and recognition program to highlight environmentally friendly businesses. After a certification visit, participating shops receive a shop display package, press coverage, listing on the program web site, and promotion on the radio and at public events. Beneficiary: Commercial</p>
<p>Stormwater BMP Recognition Program</p>	<p>The BMP Recognition Program recognizes innovative stormwater Best Management Practices (BMPs) in the southeastern region of Pennsylvania. The program is looking for projects such as rain gardens, green roofs, infiltration swales, and treatment wetlands. Those who are recognized will receive a certificate and/or award from top officials of the Department of Environmental Protection (DEP) and the City of Philadelphia; recognition at an awards ceremony; and region-wide media exposure, such as in partner newsletters and the PWD newsletter, which reaches over half a million households and businesses in the region, in addition to acknowledgment on the PWD website. Beneficiary: Landscape architects, engineers, developers, university students, neighborhood residents and others</p>

Appendix E: Stormwater Management Devices & Strategies

The purpose of this appendix is to provide example concepts and designs of typical stormwater runoff reduction practices that can be used throughout the watershed and within the public right of way. The measures shown are examples of the techniques and processes encouraged with the watershed restoration & stormwater resilience plan.

These figures and details are intended to serve as the starting point for stormwater retrofits alongside active roadways. These details outline the major design elements of curbside stormwater management facilities. Roadside safety, pedestrian safety, maintenance, gutter spread, and other factors must still be evaluated prior to implementation. Additionally, existing utilities or environmental conditions may make it necessary to modify or revise the standard designs to fit each individual BMP location. Curbside stormwater management may not be feasible in all locations.

Disconnected Impervious Surfaces

Figure 1: Example Disconnected Rooftop: Plan View

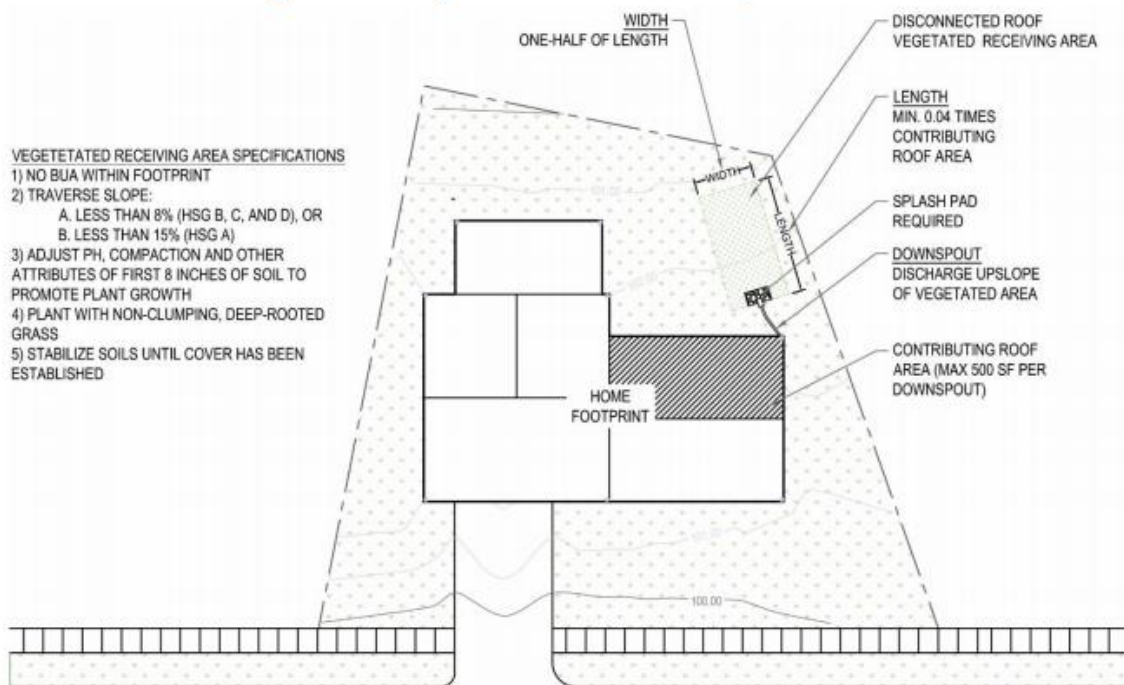


Figure 2: Example Disconnected Pavement: Plan View

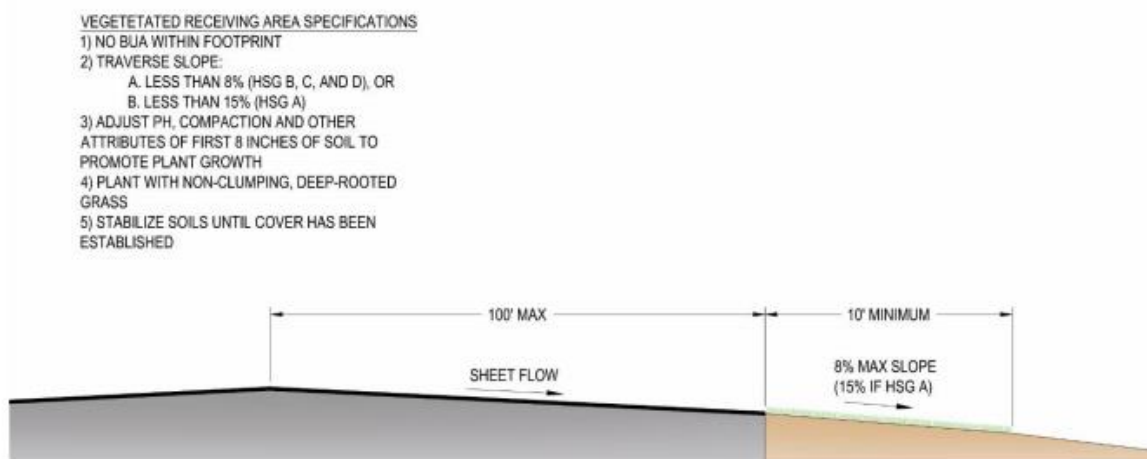


Figure 3. Outlet configuration with a foundation planting (Carmen, NCSU)

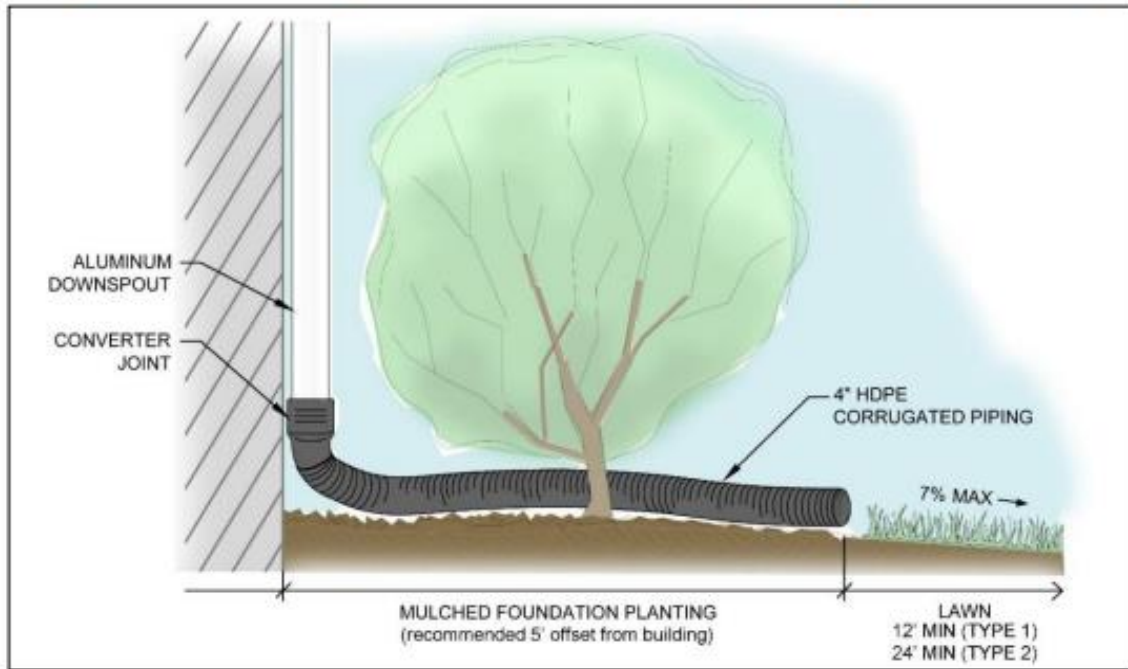


Figure 4. Hinged outlet configuration (Carmen, NCSU)

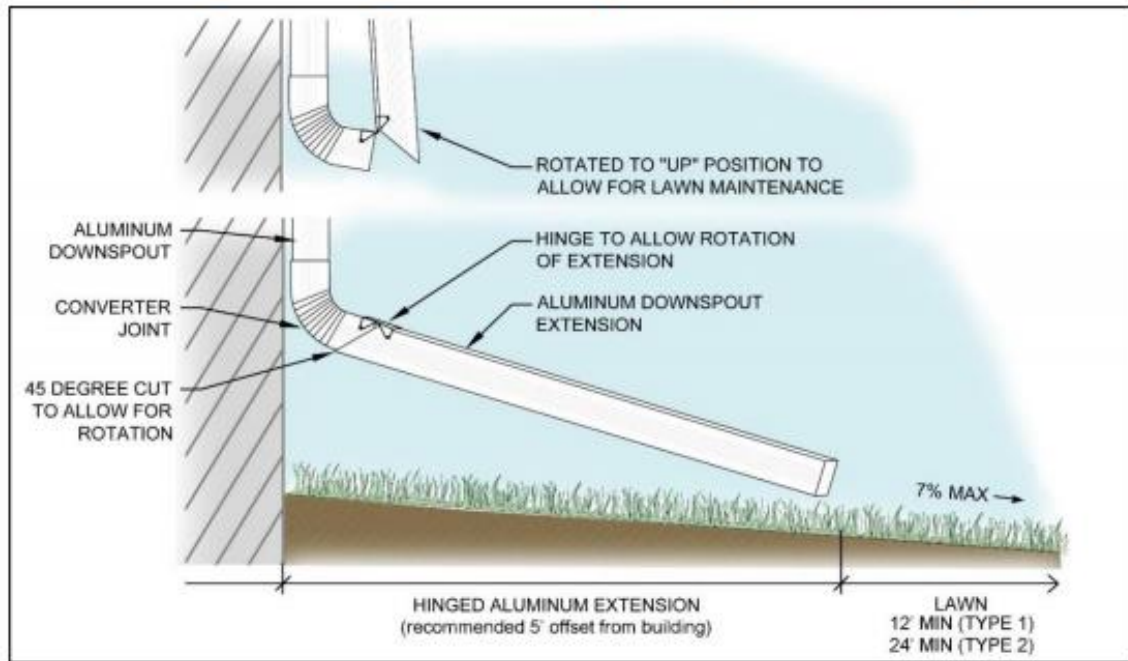
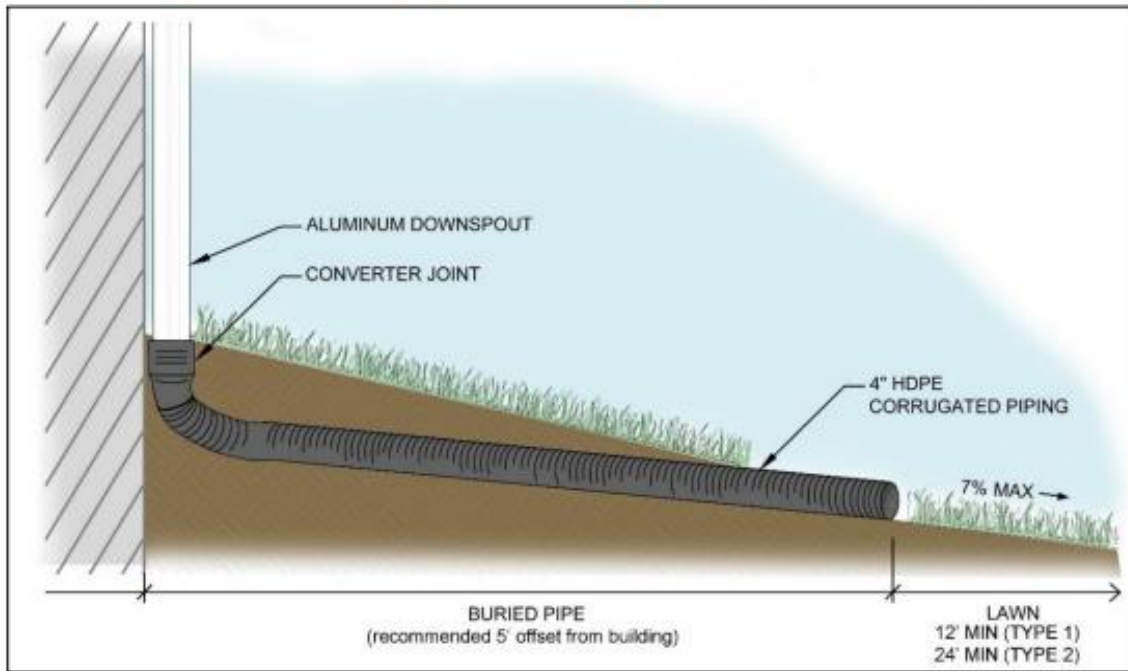


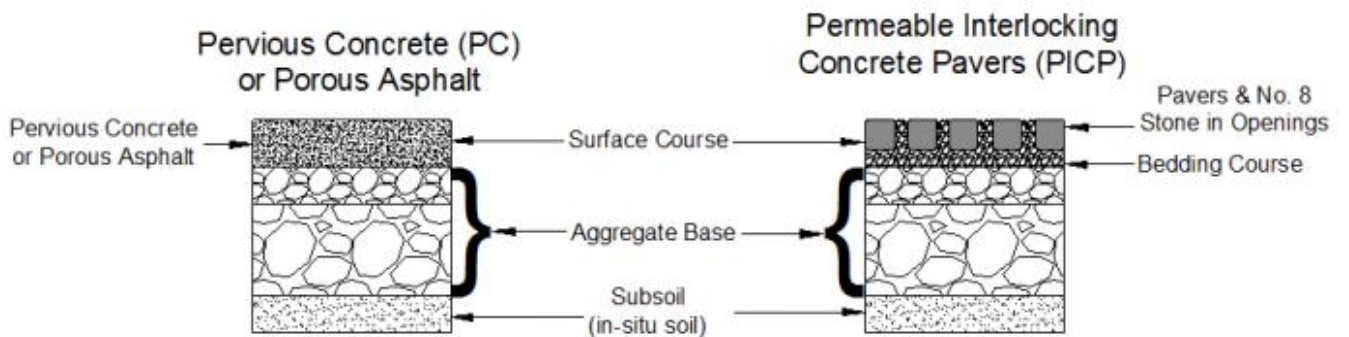
Figure 5. Buried pipe outlet configuration (Carmen, NCSU)



24

Permeable Pavement

Figure 1. Permeable Pavement Example: Cross-Section (NCSU-BAE)



²⁴ <https://stormwater.bae.ncsu.edu/resources/>

Figure 2. Permeable Pavement Example: Outlet for Infiltration System (NCSU-BAE)

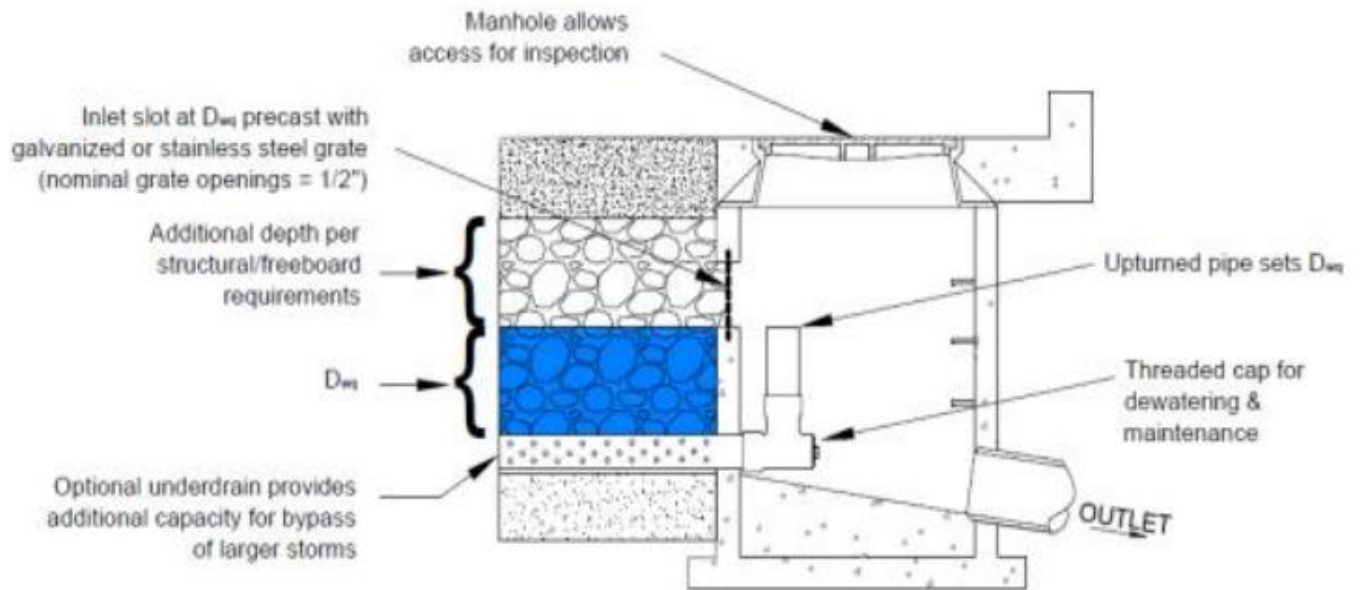
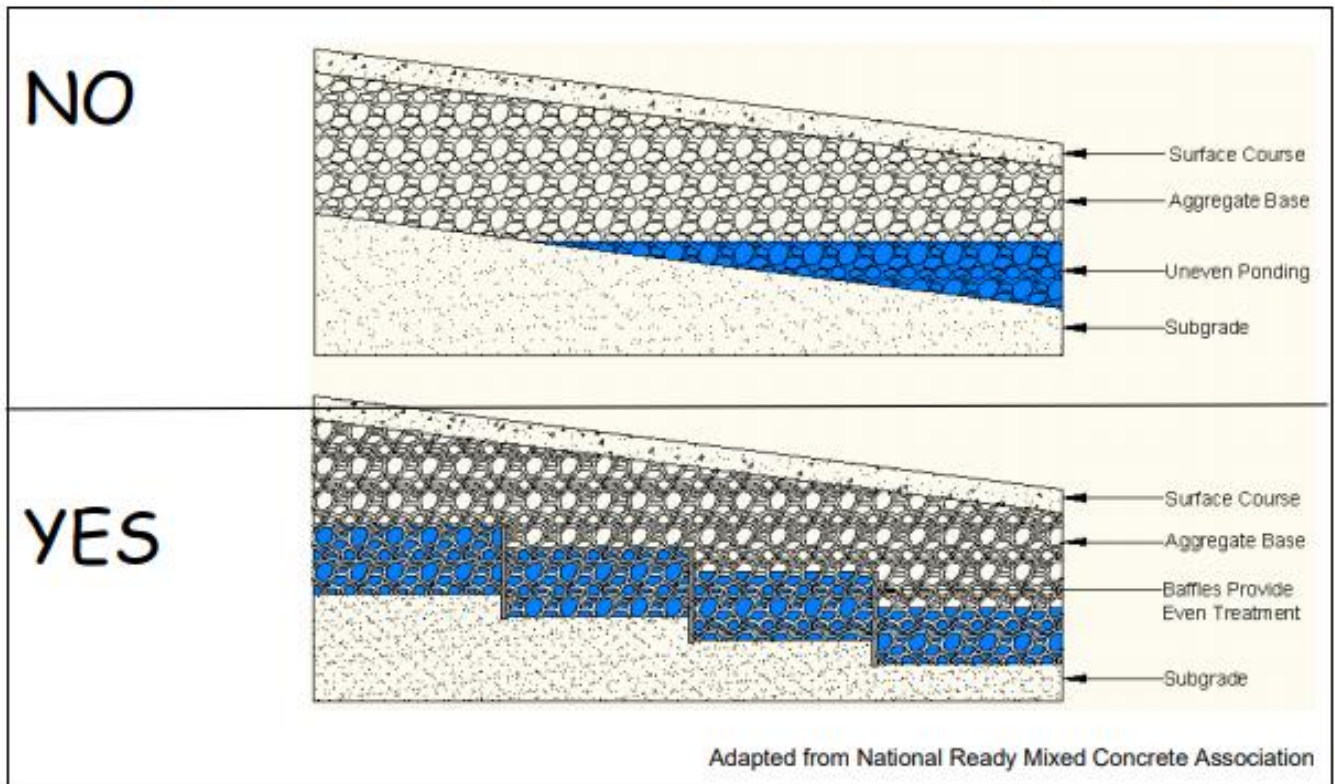


Figure 3. Terraces and Baffles under Permeable Pavement. (NCSU-BAE)

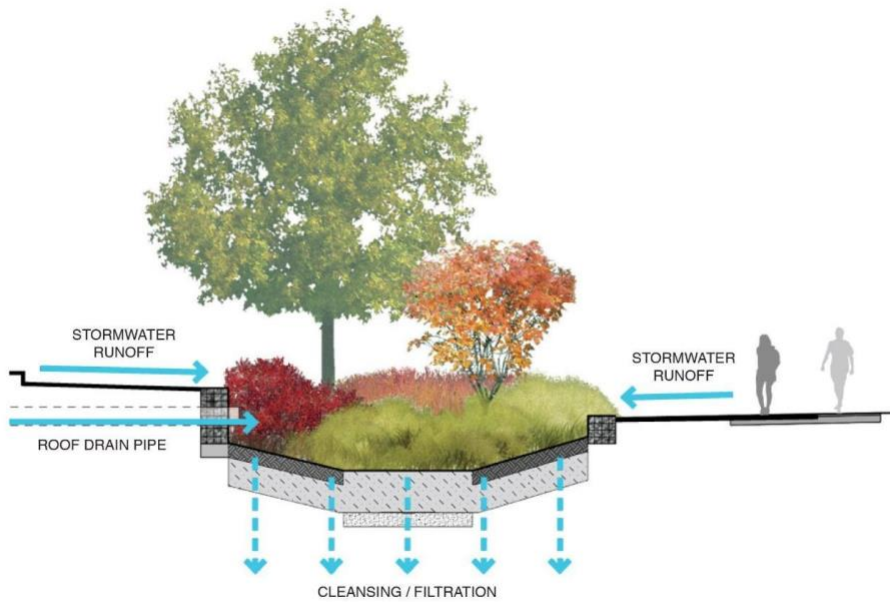


Adapted from National Ready Mixed Concrete Association



25

Bioswales



Bioswale cross-section

26

²⁵ <https://www.ecorastergrid.com/about/>

²⁶ <https://www.lwa-architects.com/sustainable-design/>



27

²⁷ <https://www.watershedcouncil.org/bioswale.html>

Bioretention

Figure 1: Bioretention Example: Plan View

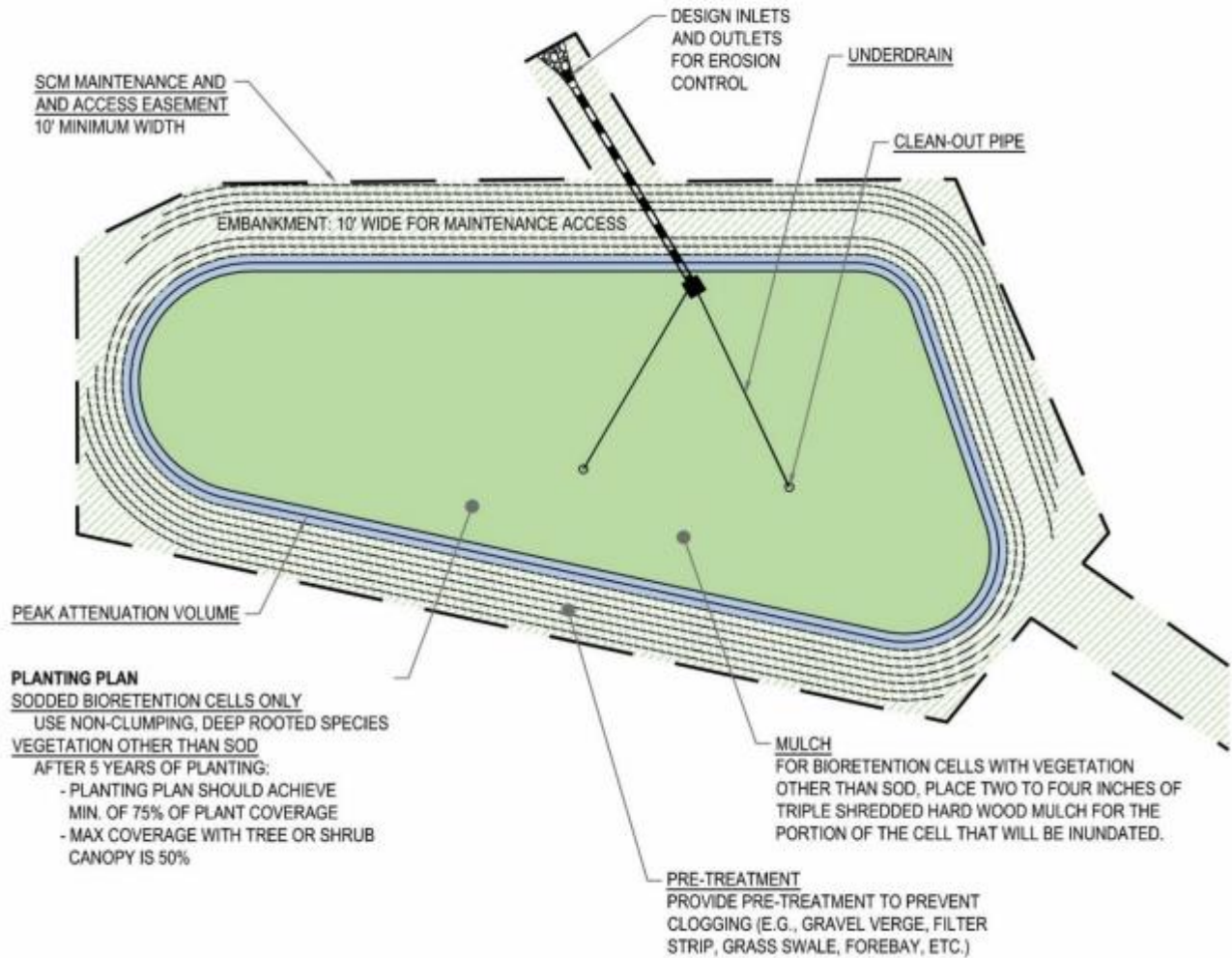
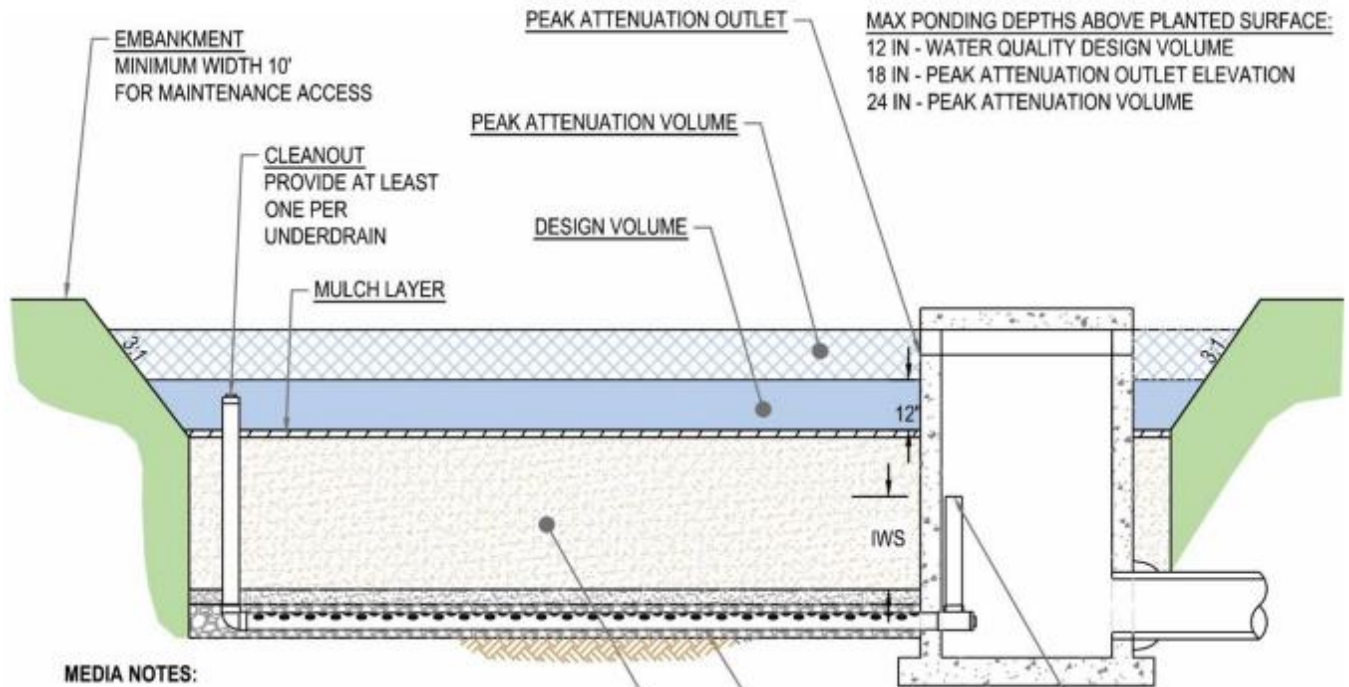


Figure 2: Bioretention Example: Cross-Section



MEDIA NOTES:

MEDIA MIX

THE MEDIA SHOULD BE COMPOSED OF A HOMOGENOUS MIX OF THE FOLLOWING:

- a. 75 - 85% MEDIUM TO COARSE WASHED SAND
- b. 8 - 10% FINES (SILT AND CLAY); AND
- c. 5 - 10% ORGANIC MATTER (SUCH AS PINE BARK FINES)

MINIMUM MEDIA DEPTH

ALL CELLS WITH TREES AND SHRUBS: 36 INCHES
 CELLS WITHOUT TREES AND SHRUBS:
 WITH NO IWS: 24 INCHES
 WITH IWS: 30 INCHES

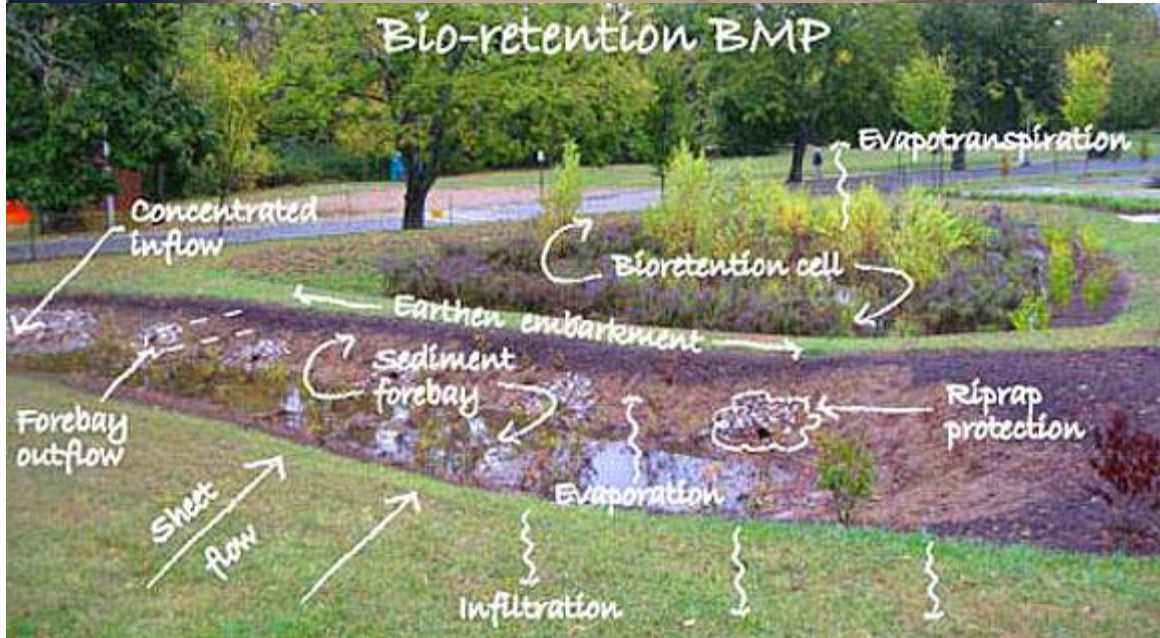
MEDIA P-INDEX

LESS THAN 30 IN NSW WATERS
 LESS THAN 50 ELSEWHERE

MEDIA MAINTENANCE

MAINTAIN MEDIA SUCH THAT INFILTRATION RATE IS AT LEAST 1 IN/R

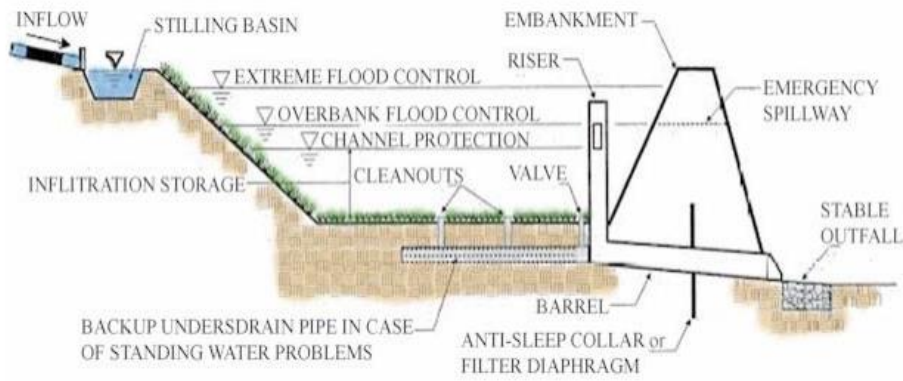
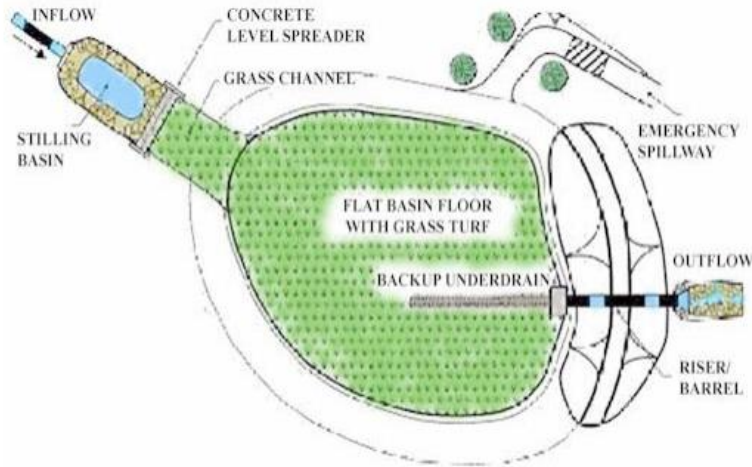
SHWT MUST BE > 2 FT BELOW THE LOWEST POINT OF THE BIORETENTION CELL



28

Infiltration Basins

²⁸ <https://nandscape.com/retention.html>



Dune Infiltration & Subsurface Dune Infiltration

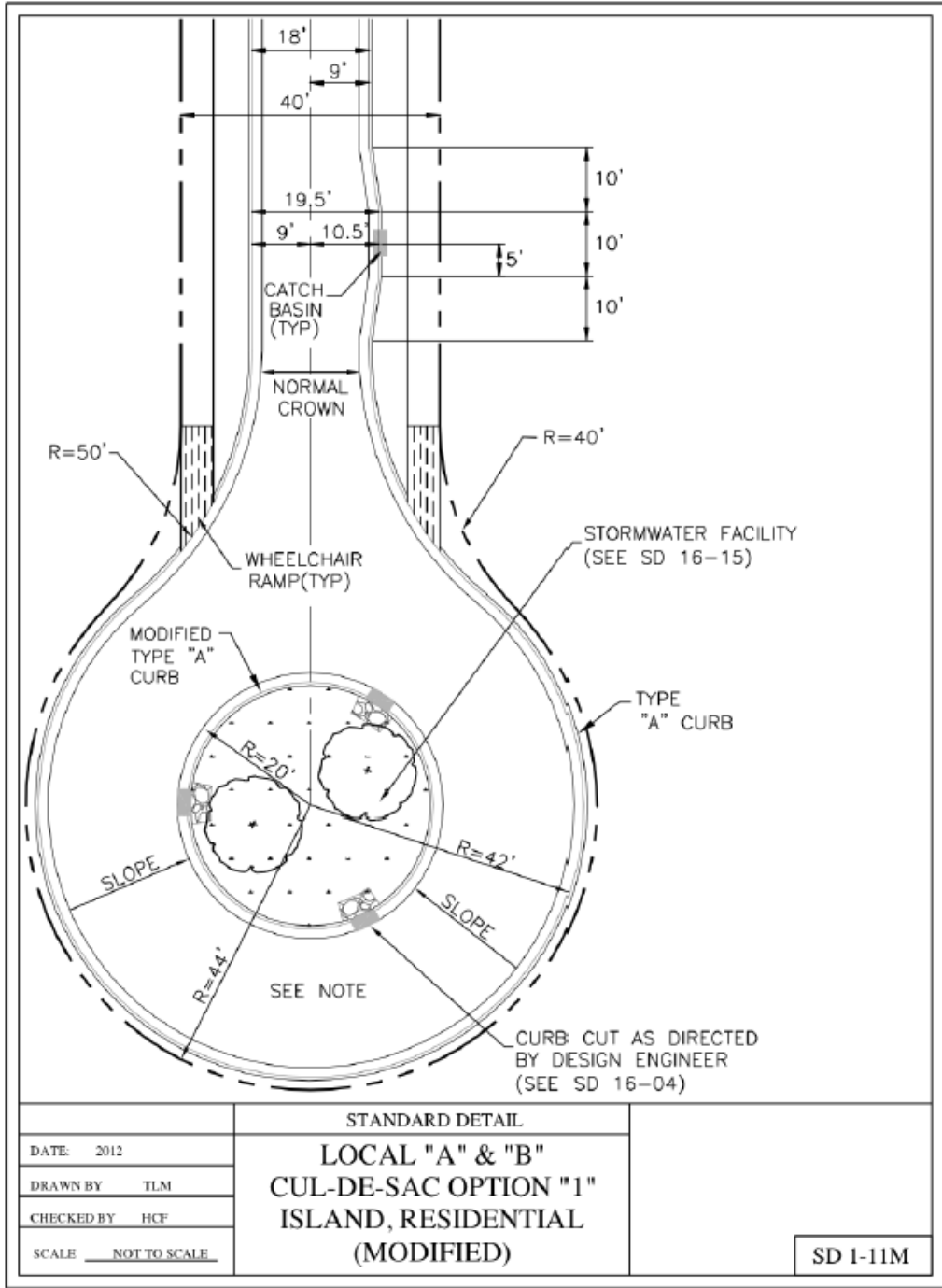


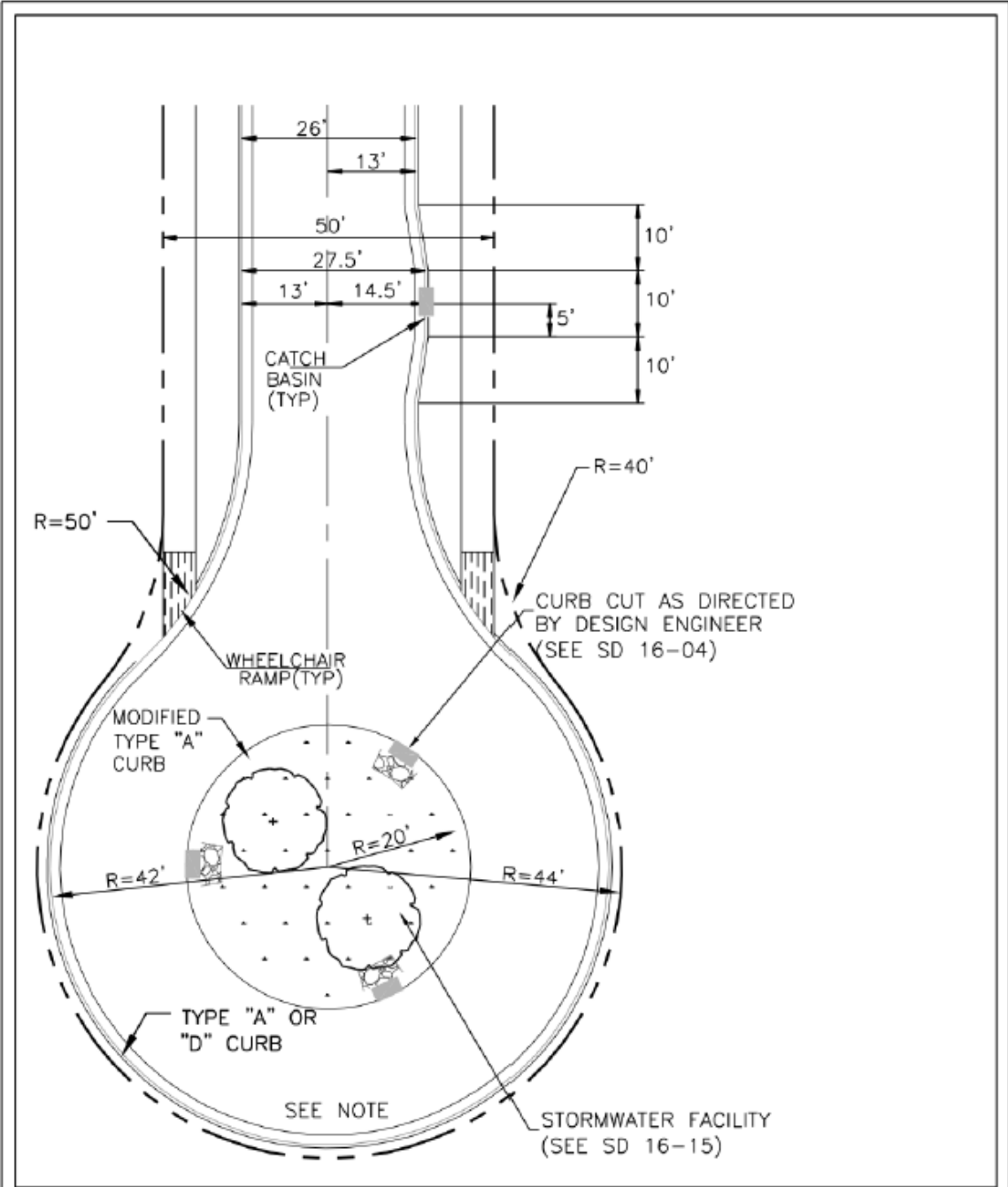


29

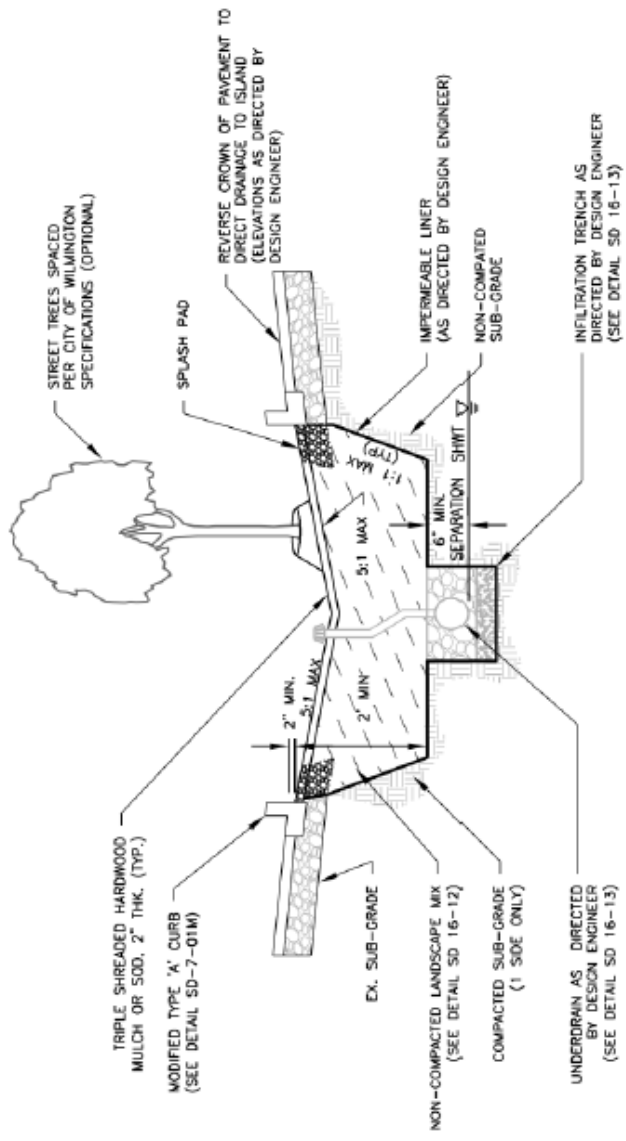
Standard Details

²⁹ <https://content.ces.ncsu.edu/dune-infiltration-systems-for-reducing-stormwater-discharge-to-coastal-recreational-beaches>



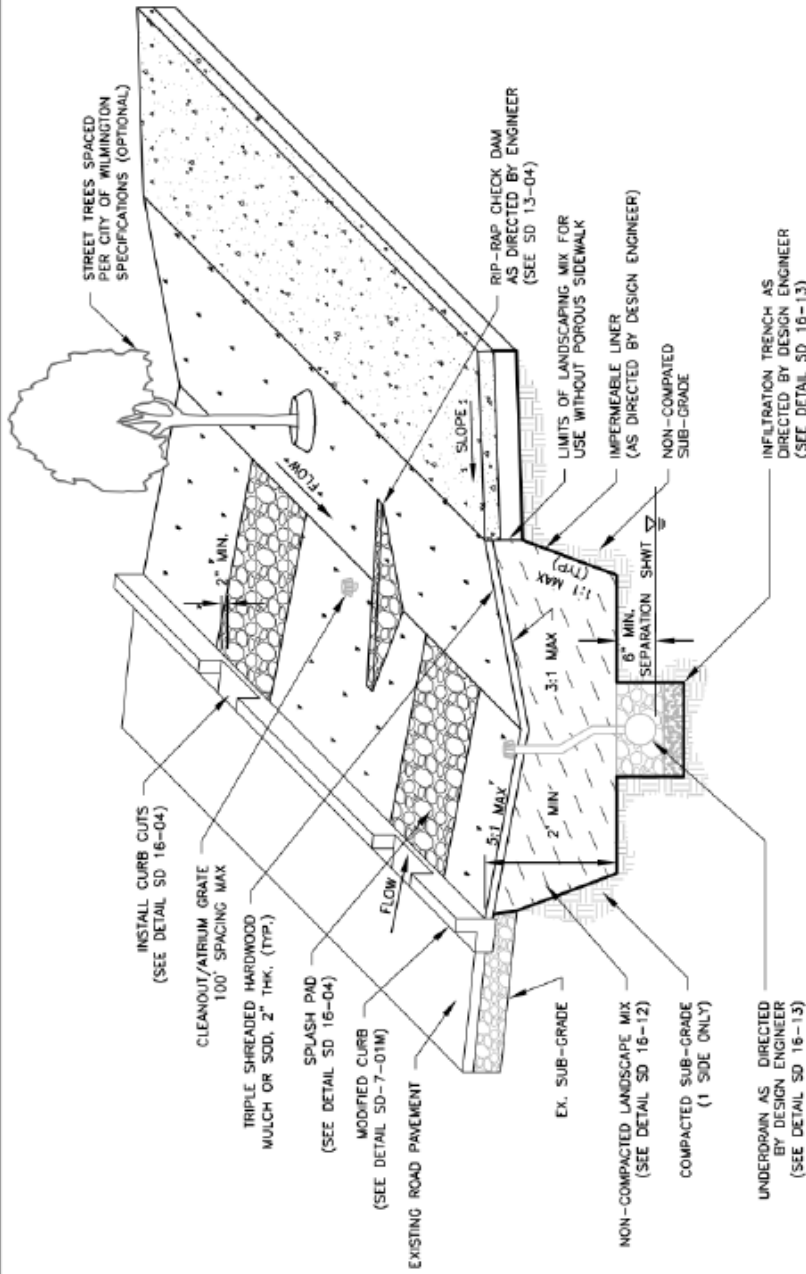


STANDARD DETAIL		SD 1-13M
LOCAL "A" & "B"		
CUL-DE-SAC OPTION "2"		
ISLAND, RESIDENTIAL		
(MODIFIED)		
DATE: 2012		
DRAWN BY: TLM		
CHECKED BY: HCF		
SCALE: NOT TO SCALE		



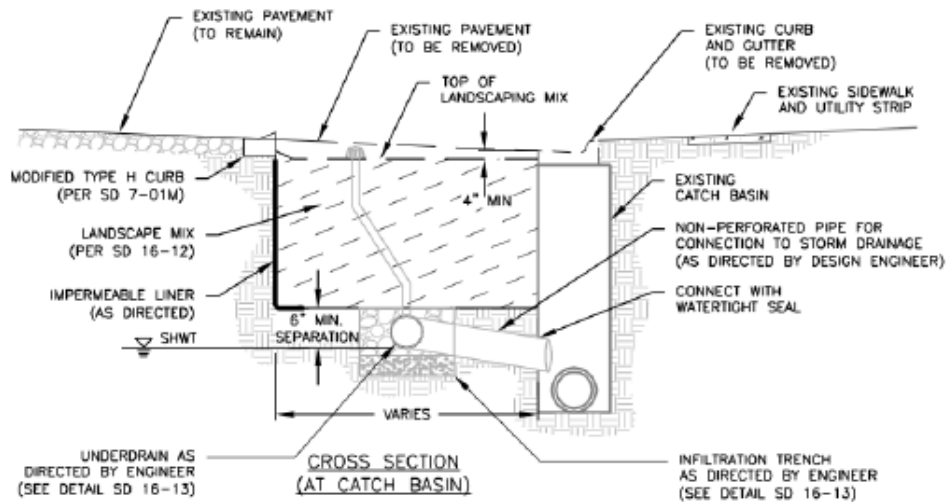
- NOTES:**
1. 10-YR STORM VELOCITY NOT TO EXCEED 2 FT/S.
 2. UTILITY LINES MAY NEED TO BE SLEEVED OR RELOCATED.
 3. SOD OR TRIPLE SHREDED MULCH SHALL BE A MINIMUM OF 2" BELOW THE GUTTER LINE TO ALLOW FOR UNIMPEDED FLOW INTO ISLAND.
 4. UNDERDRAIN AND IMPERMEABLE LINER TO BE USED ON CASE BY CASE BASIS, AT DESIGN ENGINEER'S DISCRETION.
 5. SOIL TESTING REQUIRED WHEN UNDERDRAIN IS NOT USED.
 6. DRAINAGE STRUCTURE MAY BE REQUIRED TO PREVENT FLOODING DURING LARGE STORMS.

STANDARD DETAIL		<h2 style="margin: 0;">STORMWATER ISLAND CROSS SECTION</h2>	SD 16-15
DATE:	2012		
DRAWN BY	TLM		
CHECKED BY	HCF		
SCALE	NOT TO SCALE		



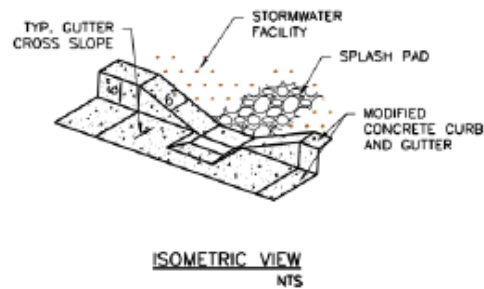
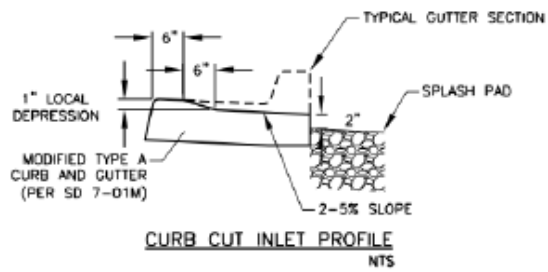
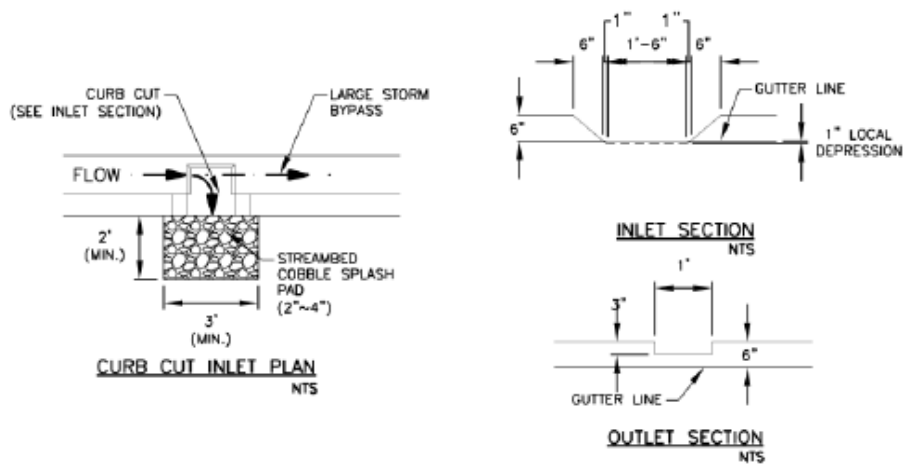
- NOTES:**
1. SWALE DEPTH SHALL BE DEEP ENOUGH TO PASS 10-YR STORM FLOW WITHOUT SURCHARGING GUTTER OR FLOODING PAVEMENT.
 2. 10-YR STORM VELOCITY NOT TO EXCEED 2 FT/S.
 3. UTILITY LINES MAY NEED TO BE SLEEVED OR RELOCATED.
 4. TREES AND SHRUBS SHALL BE PLANTED AT LEAST 2' FROM CENTERLINE OF SWALE.
 5. USE THE RAISED AREAS OF NEAR TREE PLANTINGS AS A BARRIER TO ENCOURAGE SHALLOW PONDING.
 6. SOD OR TRIPLE SHREDDED MULCH SHALL BE A MINIMUM OF 2" BELOW THE GUTTER LINE TO ALLOW FOR UNIMPEDED FLOW INTO SWALE.
 7. TOP OF LANDSCAPING MIX SHALL BE A MINIMUM OF 4" BELOW THE GUTTER LINE.
 8. UNDERDRAIN AND IMPERMEABLE LINER TO BE USED ON CASE BY CASE BASIS, AT DESIGN ENGINEER'S DISCRETION.
 9. SOIL TESTING REQUIRED WHEN UNDERDRAIN IS NOT USED.

STANDARD DETAIL		<h2 style="margin: 0;">SIDEWALK SWALE WITH CURB & GUTTER</h2>	SD 16-01
DATE	2012		
DRAWN BY	TLM		
CHECKED BY	HCF		
SCALE	NOT TO SCALE		

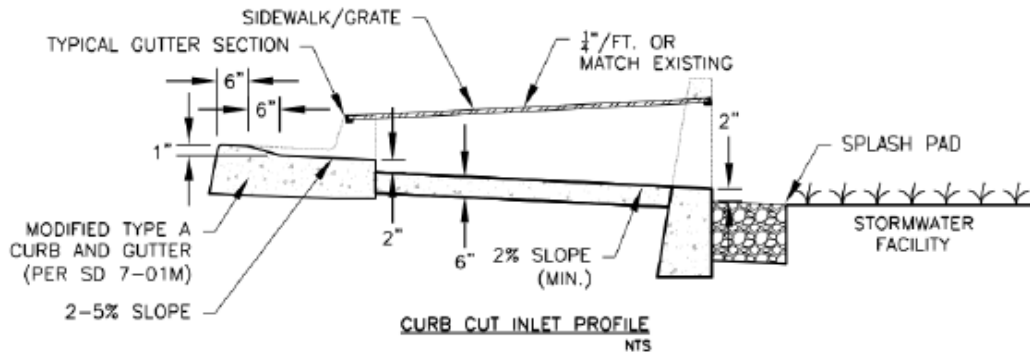
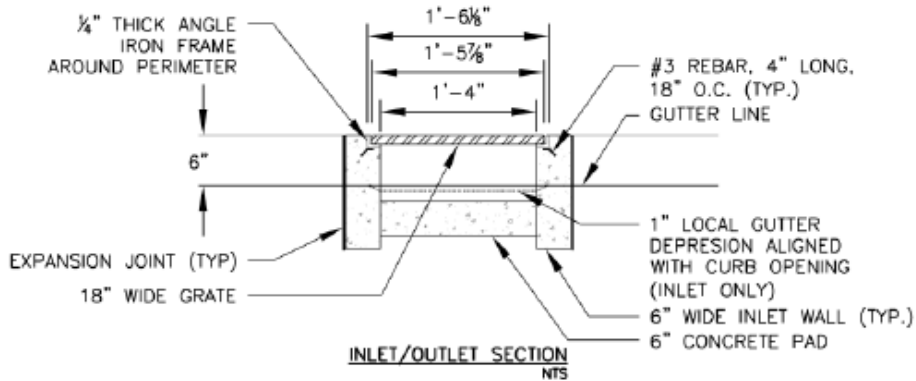
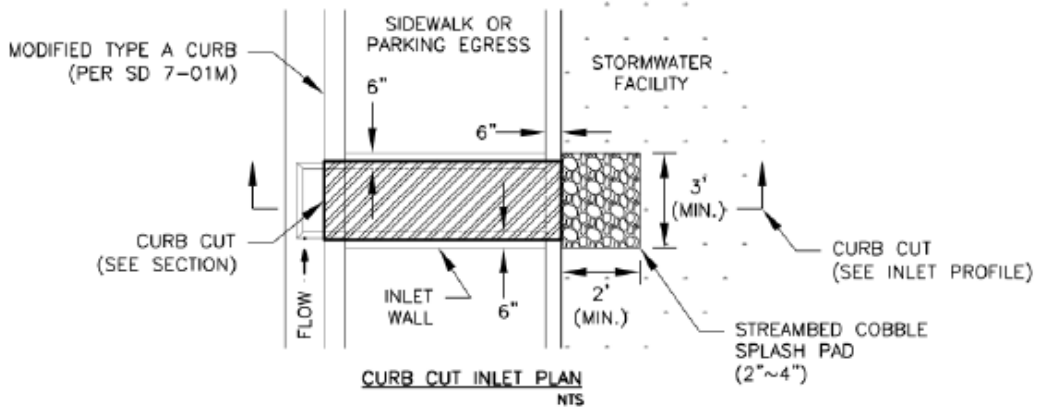


NOTES:
 SOIL TESTING REQUIRED WHEN NOT USING UNDERDRAIN

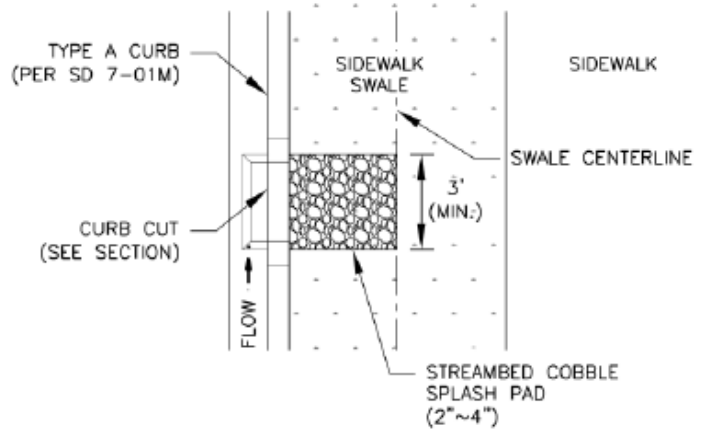
STANDARD DETAIL		CURB EXTENSION (2 OF 3)	SD 16-03b
DATE:	2012		
DRAWN BY:	TLM		
CHECKED BY:	HCF		
SCALE:	NOT TO SCALE		



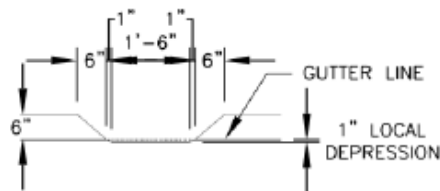
STANDARD DETAIL		CURB CUTS (GENERAL)	SD 16-04
DATE	2012		
DRAWN BY	TLM		
CHECKED BY	HCF		
SCALE	NOT TO SCALE		



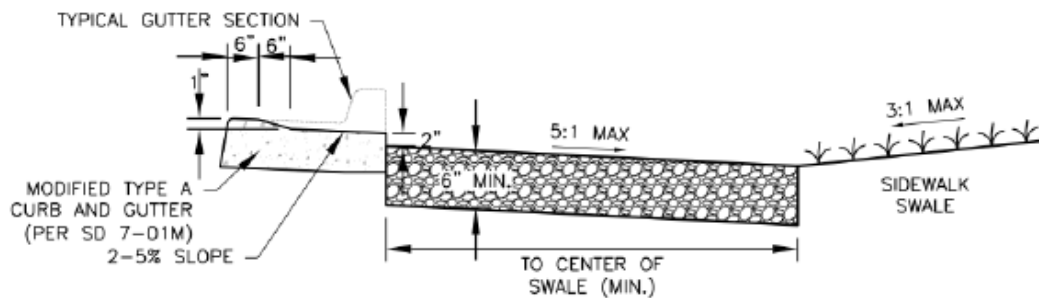
STANDARD DETAIL		
DATE: 2012	CURB CUTS (CHANNEL AND GRATE)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-05



CURB CUT INLET PLAN
NTS

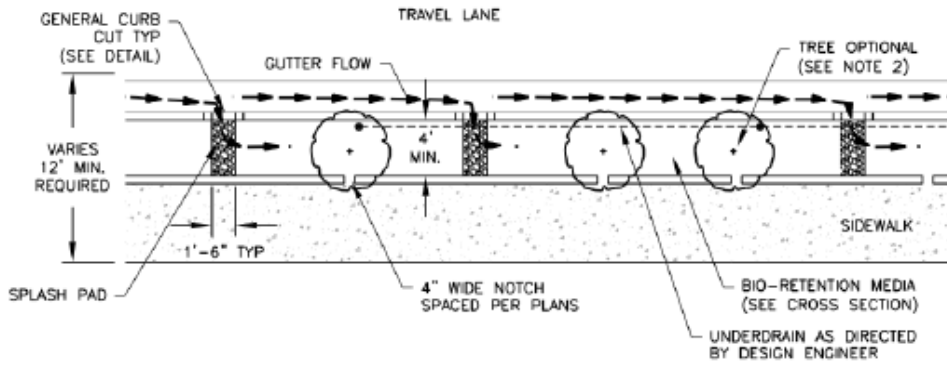


INLET SECTION
NTS

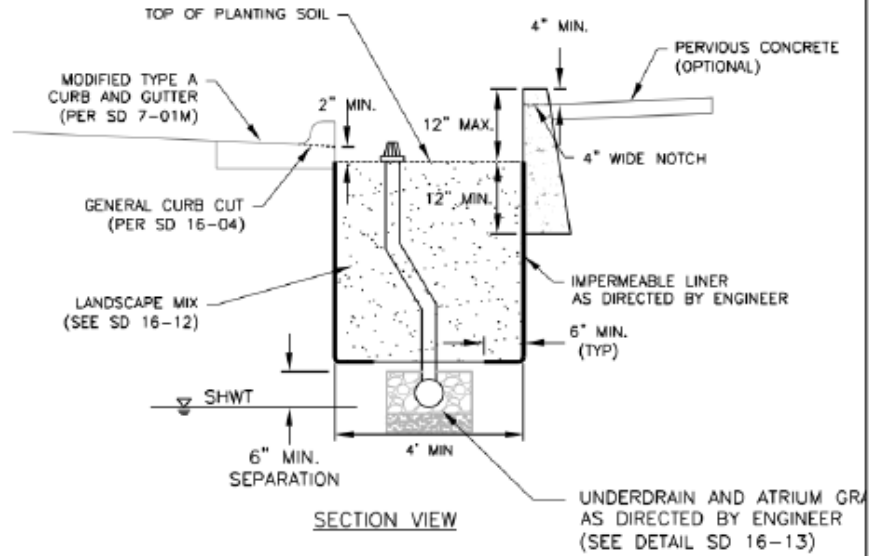


CURB CUT INLET PROFILE
NTS

STANDARD DETAIL		<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;">SD 16-06</div>
DATE: 2012	<div style="border: 1px solid black; padding: 10px;"> <p style="margin: 0;">CURB CUTS</p> <p style="margin: 0;">(CHANNEL AND GRATE)</p> </div>	
DRAWN BY: TLM		
CHECKED BY: HCF		
SCALE: NOT TO SCALE		



PLAN VIEW

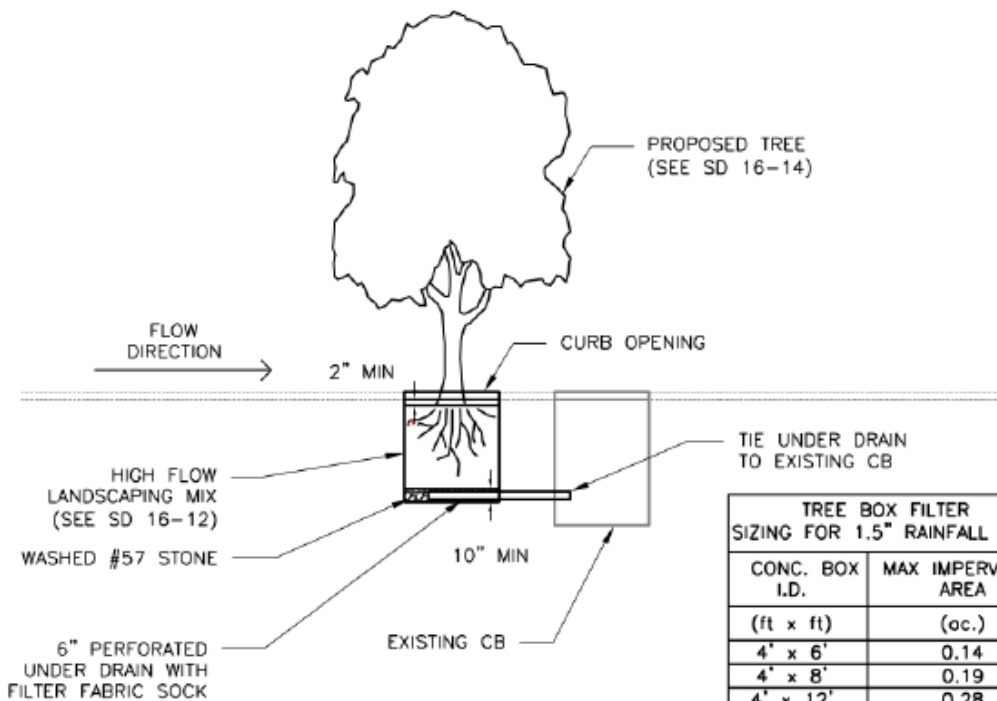
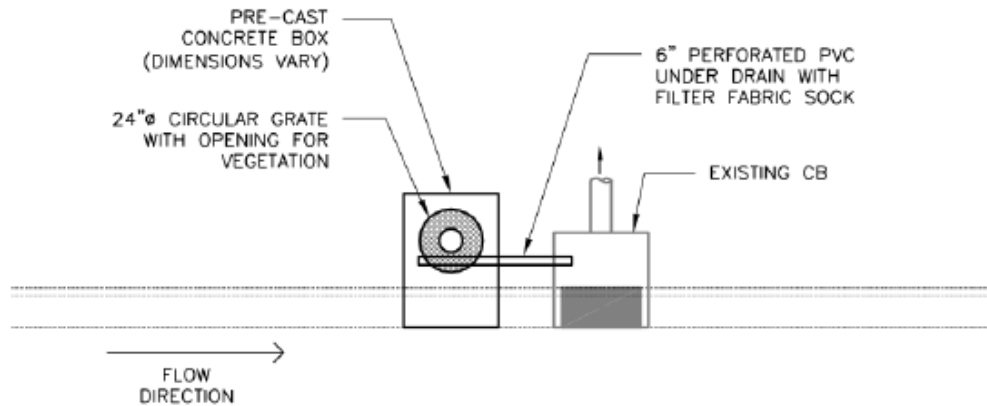


SECTION VIEW

NOTES:

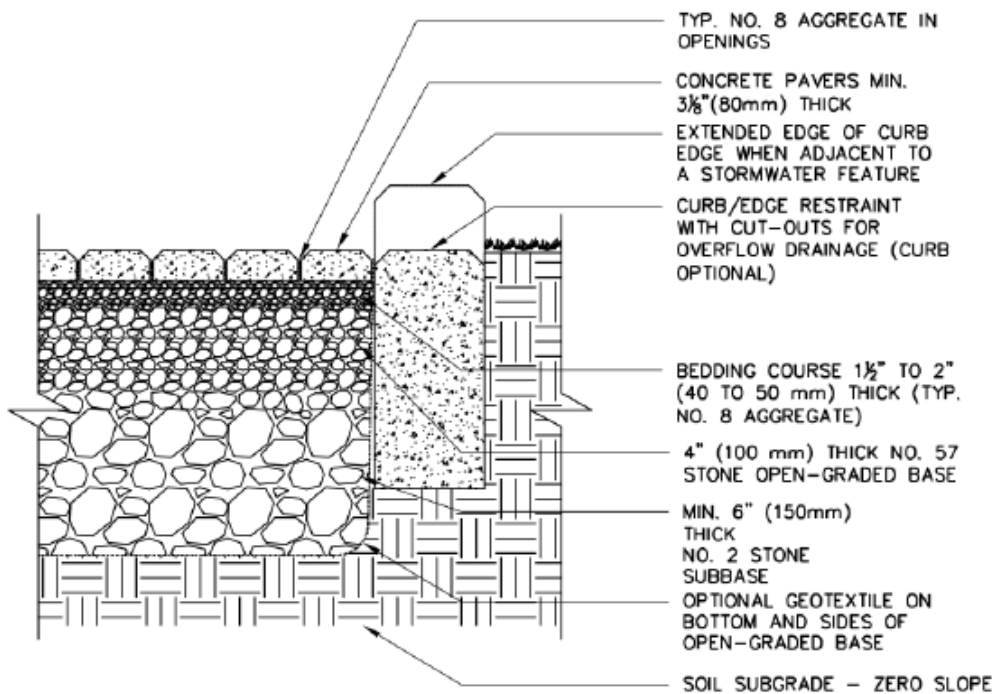
1. 10' PER TREE MINIMUM, MAXIMUM LENGTH SHALL BE 30'
2. WIDTH AND DEPTH DIMENSIONS MAY BE REDUCED IF NO TREES PLANTED, AS APPROVED BY CITY OF WILMINGTON.

STANDARD DETAIL		
DATE: 2012	SIDEWALK RETENTION (WITHOUT PARKING)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE <u>NOT TO SCALE</u>		SD 16-08



TREE BOX FILTER SIZING FOR 1.5" RAINFALL	
CONC. BOX I.D.	MAX IMPERVIOUS AREA
(ft x ft)	(oc.)
4' x 6'	0.14
4' x 8'	0.19
4' x 12'	0.28
6' x 6'	0.21
6' x 8'	0.28
6' x 10'	0.35
6' x 12'	0.42
7' x 13'	0.54

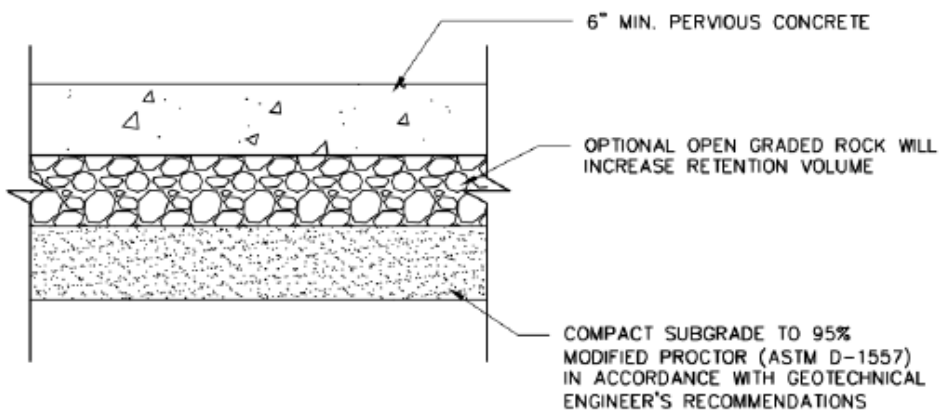
STANDARD DETAIL		SD 16-09
DATE: 2012	STANDARD URBAN TREE PLANTER BOX	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		



NOTES:

1. 2 3/8" (60mm) THICK PAVERS MAY BE USED IN PEDESTRIAN APPLICATIONS.
2. NO. 2 STONE SUBBASE THICKNESS VARIES WITH DESIGN. CONSULT ICPI PERMEABLE INTERLOCKING CONCRETE PAVEMENT MANUAL.
3. CURB EDGE MAY EXTEND 6" ABOVE GRADE WHEN ADJACENT TO STORMWATER FEATURE.

STANDARD DETAIL		
DATE: 2012	STANDARD POROUS PAVERS	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-10



	STANDARD DETAIL	
DATE: 2012	STANDARD POROUS CONCRETE	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE <u>NOT TO SCALE</u>		SD 16-11

NATURAL SOIL INFILTRATION

IN-SITU INFILTRATION MEDIA SHALL MEET THE REQUIREMENTS FOR INFILTRATION SYSTEMS AS DEFINED BY NCDWQ IN THE CURRENT VERSION OF THE BMP MANUAL. SOIL TESTS SHALL BE COMPLETED AND SUBMITTED WITH THE DESIGNS TO CONFIRM COMPLIANCE WITH THE SPECIFICATIONS.

IN SITU SOIL SHALL MEET THE FOLLOWING SPECIFICATIONS

1. INFILTRATION RATE SHALL EXCEED 0.52 IN/HR, >3 IN/HR PREFERRED
2. P INDEX SHALL BE BETWEEN 10 AND 30
3. PARTICLE SIZE DISTRIBUTION
 - a. COARSE / VERY COARSE SAND 70% TO 80%
 - b. GRAVEL 10% TO 20%
 - c. CLAY / SILTS < 10%
4. SOIL SHALL BE FREE OF CONTAMINATION FROM HEAVY METALS
5. SEASONAL HIGH WATER ELEVATION SHALL BE AT LEAST 2' BELOW FINISHED SURFACE
6. AREAS USED FOR EROSION CONTROL SHALL BE CLEANED OF ALL ACCUMULATED SILTS, FINES, SEDIMENTS, AND DEBRIS PRIOR TO CONVERSION

LOW FLOW MEDIA MIXES

FOR INSTALLATIONS REQUIRING ENGINEERED MEDIA WITH INFILTRATION RATES BETWEEN 0.52 IN/HR AND 10 IN/HR, THE GENERAL STANDARDS OF "BIORETENTION MIX" AS DEFINED IN THE CURRENT VERSION OF THE NCDWQ BMP MANUAL SHALL APPLY.

THE ENGINEER SHALL PROVIDE SOILS SAMPLES, AND RESULTS OF LABORATORY SOIL TESTS DOCUMENTING COMPLIANCE WITH THE SOIL SPECIFICATIONS PRIOR TO FINAL PROJECT APPROVAL.

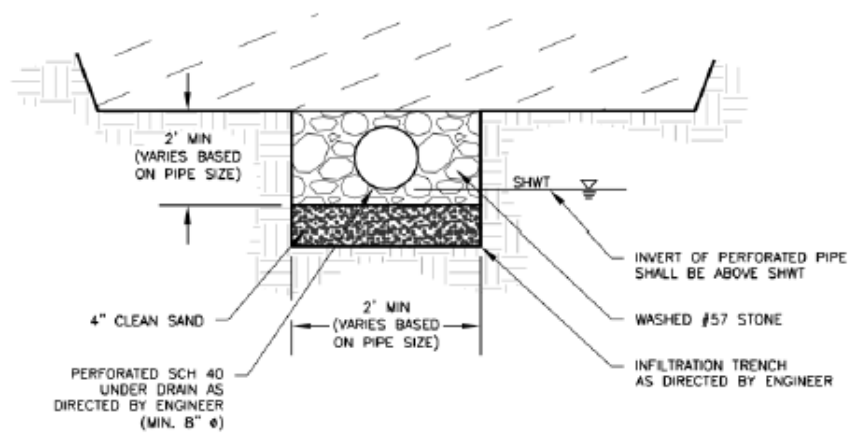
HIGH FLOW MEDIA MIXES

FOR URBAN INSTALLATIONS OR OTHER INSTALLATIONS WHERE HIGHER INFILTRATION RATES ARE NECESSARY, ENGINEERED HIGH FLOW MEDIA MIXES MAY BE REQUIRED. HIGH FLOW FILTER MEDIA IS SPECIALLY DESIGNED TO OPTIMIZE THE CAPTURE AND REMOVAL OF NUTRIENTS FROM URBAN RUNOFF THROUGH THE USE OF A HIGH PERFORMANCE PEAT / SAND FILTER MEDIA. THE MEDIA SUPPORTS MICROBIOLOGICAL ACTIVITY THAT CAPTURES NUTRIENTS FROM STORMWATER RUNOFF TO SUPPORT PLANT LIFE WHILE ALLOWING RUNOFF TO FLOW THROUGH THE MEDIA LAYERS AT A HIGH RATE.

ENGINEERED HIGH FLOW MEDIA SHALL MEET THE FOLLOWING SPECIFICATIONS

1. PEAT MOSS 15% BY VOLUME
 - a. LISTED BY ORGANIC MATERIALS REVIEW INSTITUTE
 - b. 100% NATURAL PEAT (NO COMPOSTED, SLUDGE, YARD OR LEAF WASTE)
 - c. TOTAL CARBON >85%
 - d. CARBON TO NITROGEN RATIO 15:1 TO 23:1
 - e. LIGNIN CONTENT 49% TO 52%
 - f. HUMIC ACID >18%
 - g. PH 6.0 TO 7.0
 - h. MOISTURE CONTENT 30% TO 50%
 - i. 95% TO 100% PASSING 2.0MM SIEVE
 - j. > 80% PASSING 1.0MM SIEVE
2. POLLUTANT REMOVAL MINIMAL PERFORMANCE
 - a. TSS 80%
 - b. TOTAL NITROGEN 43%
 - c. HEAVY METALS 58-82%
 - d. PHOSPHORUS 50 %
 - e. BACTERIA > 95%
3. GENERAL SAND PARTICLE SIZE DISTRIBUTION NECESSARY TO SUPPORT FLOW RATES OF > 50 INCHES / HOUR AT THE TIME OF INITIAL INSTALLATION.
 - a. SAND - FINE <5%
 - b. SAND - MEDIUM 10%- 15%
 - c. SAND - COARSE 15% TO 25%
 - d. SAND - VERY COARSE 40 % TO 45%
 - e. GRAVEL 10% TO 20%
 - f. CLAY / SILTS < 2%

	STANDARD DETAIL	
DATE: 2012	LANDSCAPE MIX SPECIFICATIONS	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		
		SD 16-12



STANDARD DETAIL		<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;">SD 16-13</div>
DATE: 2012	STANDARD UNDERDRAIN AND TRENCH	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE <u>NOT TO SCALE</u>		

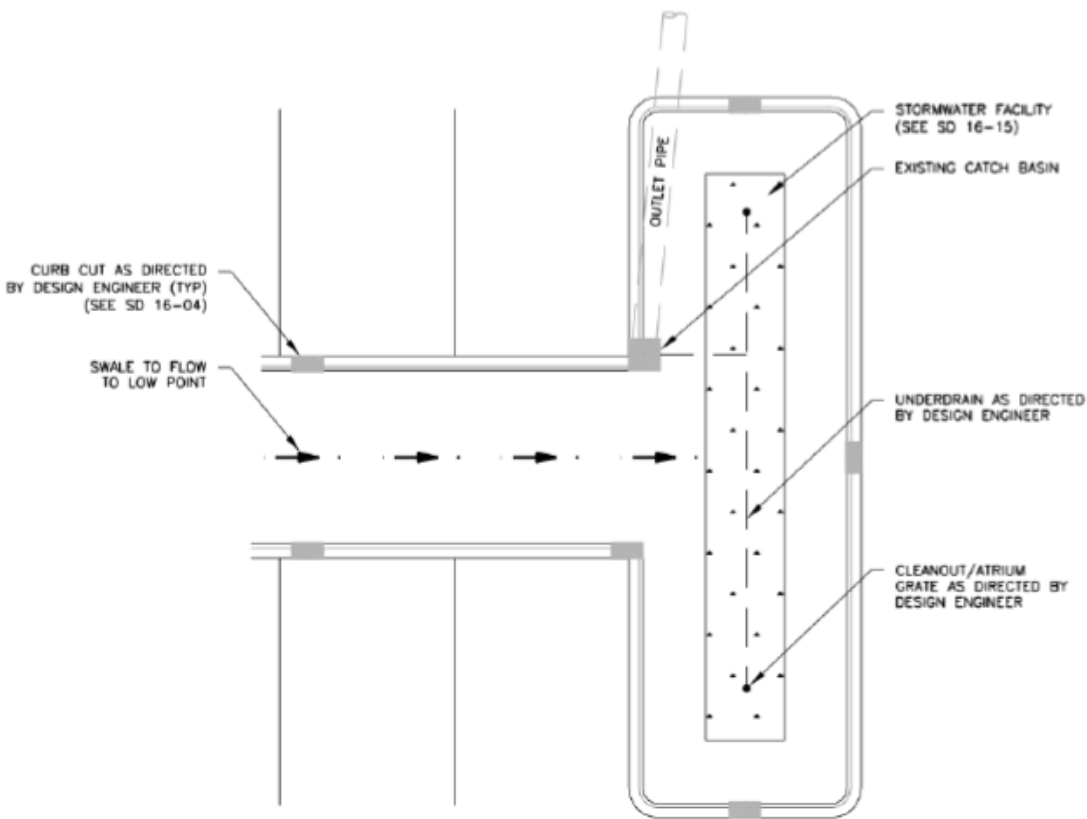
RECOMMENDED PLANTS LIST FOR ALL STORMWATER DETAILS:

<u>SCIENTIFIC NAME</u>	<u>COMMON NAME</u>
CERCIS CANADENSIS	RED BUD
CORNUS FLORIDA	DOGWOOD
ILEX ATTENUATA	FOSTER'S HOLLY
ILEX VOMITORIA	YAUPON HOLLY
LAGERSTROEMIA INDICA	CRAPE MYRTLE
MAGNOLIA SOULANGIANA	SAUCER MAGNOLIA
MAGNOLIA STELLATA	STAR MAGNOLIA
NYSSA SYLVATICA	BLACK GUM
TAXODIUM DISTICHUM	BALD CYPRESS

NOTE:

OTHER PLANTS, INCLUDING TREES, SHRUBS, AND GROUND COVERS, MAY BE PERMITTED ON A CASE BY CASE BASIS AS APPROVED BY CITY STAFF.

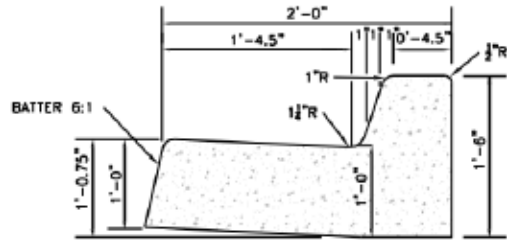
	STANDARD DETAIL	
DATE: 2012	RECOMMENDED STORMWATER PLANTING LIST	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE <u>NOT TO SCALE</u>		SD 16-14



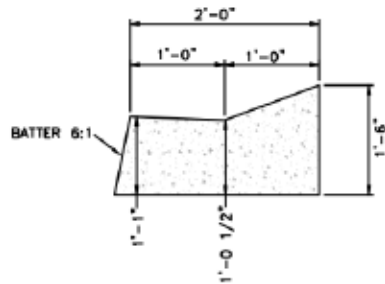
NOTES:

1. DESIGN ENGINEER TO PROVIDE DIMENSIONS OF ISLANDS.
2. SWALE DEPTH SHALL BE DEEP ENOUGH TO PASS 10-YR STORM FLOW WITHOUT SURCHARGING GUTTER OR FLOODING PAVEMENT.
3. 10-YR STORM VELOCITY NOT TO EXCEED 2 FT/S.
4. MAXIMUM PONDING DEPTH SHALL BE 6".
5. UTILITY LINES MAY NEED TO BE SLEEVED OR RELOCATED.
6. TREES AND SHRUBS SHALL BE PLANTED AT LEAST 2' FROM CENTERLINE OF SWALE.
7. SOD OR TRIPLE SHREDDED MULCH SHALL BE A MINIMUM OF 2" BELOW THE GUTTER LINE TO ALLOW FOR UNIMPEDED FLOW INTO SWALE.
8. TOP OF LANDSCAPING MIX SHALL BE A MINIMUM OF 4" BELOW THE GUTTER LINE.
9. UNDERDRAIN AND IMPERMEABLE LINER TO BE USED ON CASE BY CASE BASIS, AT DESIGN ENGINEER'S DISCRETION.
10. SOIL TESTING REQUIRED WHEN UNDERDRAIN IS NOT USED.

STANDARD DETAIL		<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;">SD 16-16</div>
DATE	2012	
DRAWN BY	TLM	
CHECKED BY	HCF	
SCALE	NOT TO SCALE	
<p>STORMWATER PARKING ISLAND</p>		



MODIFIED TYPE "A" CURB AND GUTTER



MODIFIED TYPE "H" CURB AND GUTTER

NOTES:

1. MODIFIED CURB AND GUTTER TO BE USED WHEN ADJACENT TO SURFACE STORMWATER FACILITIES.
2. CURB EXPOSURE IS 6". VARY ONLY AS SHOWN ON PLANS OR AS APPROVED.

STANDARD DETAIL		SD 7-01M
DATE: 2012	MODIFIED CURB AND GUTTER TYPES "A" AND "H"	
DRAWN BY: TLM		
CHECKED BY: HCF		
SCALE: <u>NOT TO SCALE</u>		

References

North Carolina Institute for Climate Studies' (NCICS) North Carolina Climate Science Report 2020 North Carolina Climate Risk Assessment and Resilience Plan (NCDEQ-2020)

NOAA's Sea Level Rise Viewer

Southeastern North Carolina Regional Hazard Mitigation Plan (ESP Associates, 2021)

Slo County. n.d. List of Potential Municipal LID Incentive Programs. Retrieved from <http://www.slocounty.ca.gov/Assets/PW/stormwater/Potential+LID+Incentives.pdf>

Managing Wet Weather with Green Infrastructure Municipal Handbook: Incentive Mechanism. 2009. US Environmental Protection Agency, EPA-833-F-09-001. Retrieved from https://www.epa.gov/sites/production/files/2015-10/documents/gi_munichandbook_incentives_0.pdf

Doll, A., and G. Lindsey. 1999. Credits Bring Economic Incentives for Onsite Stormwater Management. Watershed and Wet Weather Technical Bulletin, January 1999, <http://www.watershed.org> Water Environment Federation.

<http://stormwaterfinance.urbancenter.iupui.edu/PDFs/LindseyDoll.pdf>

ECONorthwest. 2009. Low Impact Development at the local level: Developer's experiences and city and county support. Retrieved from:

http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf

Appendix F: Shoreline Survey SOP

The following are direct excerpts from *Shoreline Survey Program Standard Operating Procedure* created by Shellfish Sanitation and Recreational Water Quality Section on June 2011. These are the standardized definitions used to designate nonpoint sources³⁰.

Dockage

In accordance with North Carolina Division of Environmental Health rules, and with guidance from the United States Food and Drug Administration and the National Shellfish Sanitation Program that marinas be considered as potential sources for contamination of shellfish, the North Carolina Shellfish Sanitation and Recreational Water Quality Section adopts the following policy to be used in the classification of shellfish harvesting waters with respect to marinas, docking facilities, and other mooring areas.

Definitions

- **Marina** - A marina shall be defined as any water area with a structure (dock, basin, floating dock, etc.) which is utilized for docking or otherwise mooring vessels and constructed to provide temporary or permanent docking space for more than 10 boats.
- **Open System** – An open-system marina is a marina constructed in an area where tidal currents have not been impeded by natural or man-made barriers.
- **Closed System** – A closed-system marina is a marina constructed in a canal, basin, tributary, or other area with restricted tidal flow.
- **Commercial Marina** – A commercial marina is defined as a marina that offers one or more of the following services: Fuel, transient dockage, haul-out facilities, or repair services.
- **Private Marina** – A private marina includes any marina that is not defined as a commercial marina.
- **Entrance Canal** – The entrance canal will be defined as the canal which is created or significantly altered during marina construction to provide access for boats to that facility.
- **Cabin** – An enclosed space on board a boat that can provide overnight shelter.

Defining Slips

When conducting a marina inspection, the following items will be counted as slips, in the manner defined below:

- 1) Finger Pier Dockage -- A narrow pier; may project from the shore, larger pier, or dock.

³⁰ Shellfish Sanitation. (2015). *Shoreline Survey Program Standard Operating Procedures*. North Carolina Department of Environmental Quality, Division of Marine Fisheries, Shellfish Sanitation and Recreational Water Quality Section.

- 2) Linear Dockage – Typically, a slip will be counted for every 25 feet of linear dockage available. However, in cases where all boats using the facility are greater than 25 feet in length, a reasonable estimate of typical boat length can be substituted to determine the slip count.
- 3) Dockage Areas for Fueling or Sewage Pump out Use – A slip will be counted for every 50 feet of linear dockage at any fueling dock or sewage pump out dock.
- 4) Moorings associated with the marina, or within 100 feet of the last slip.

****Note:** In open-system marinas subject to significant wave or wake action, cleats or tie-ups not associated with defined boat slip structures such as pilings or finger piers will not be included in the total slip count unless it can be shown that the area in question is being used for the dockage of boats. If a boat is seen tied up in one of these areas, confer with DCM officials to determine if this situation warrants further investigation. **

When conducting a marina inspection, the following items will not be counted as slips:

- 1) Temporary Tie-Ups Associated with A Boat Ramp - Temporary tie-ups associated with boat ramps will be considered as any areas where the permanent dockage of boats would prohibit or significantly impede the use of an active boat ramp.
- 2) Staging Areas Associated with Haul Outs or Dry Stack Drop Zones – Staging areas will be considered as any areas where the permanent dockage of boats would prohibit or significantly impede the use of an active haul-out or drop zone.
- 3) Moorings not associated with the marina that are more than 100 feet from the last slip.
- 4) Jet Ski Slips

****Note:** If there is evidence at a marina that any of these docking types are being used for permanent dockage, then they will be considered slips and will be included in the total slip count for the marina. **

Stormwater Conveyance

Stormwater conveyances evaluated during the shoreline survey include any ditches, swales, or pipes that drain residential areas, roads, farms, golf courses, or other human-altered landscapes into shellfish harvest waters. Conveyances not evaluated include small ditches dug by individual homeowners, pipes draining single-home gutter systems, or any drainage not reaching shellfish harvest waters. Photographs of each conveyance should be taken indicating the type of conveyance and the type of land use(s) drained.

Definitions

- “Conveyance” – Indicate the type(s) of stormwater conveyance that drain to the area being evaluated. Select from: “Ditch/Swale to Pipe,” “Ditch/Swale,” “Curb/Gutter to Pipe,” “Curb/Gutter to Ditch/Swale,” “Pipe to Pipe End,” “Pipe End to Ditch/Swale,” or “Other.” If “Other” is selected, describe the conveyance system in the comments section.
- “Diameter” – If applicable, indicate the diameter of the last pipe the stormwater flows through before discharging (including culvert pipes). If more than one pipe is used, indicate the combined diameter of all pipes. The most common pipe diameters are available from the drop-down menu, or you can select “Other” and indicate the pipe

diameter in the comments section. If a pipe is present but you cannot determine its diameter, select "Unknown." If no pipe is present, select "Not Applicable."

- "Ditch Size" – If applicable, enter the depth and width, in feet, of the ditch or swale here
- "Sys Size" – This data field serves as an indicator of the size of the area drained by the conveyance being evaluated. If a pipe diameter can be determined, then the following criteria will be used to determine system size:
 - Low = ≤ 18 inches
 - Medium = 19-35 inches
 - High = ≥ 36 inches
- If no pipe is present, use best professional judgement to determine the relative size of the drainage area.
- "FC Conc" – This data field serves as an indicator of the potential peak bacteria concentration discharged by the conveyance being evaluated. It is a subjective measure based on your experience, although some relative guidelines are provided:
 - Low = Drains a small area or an area with low-impact land uses; good buffers;
 - little to no potential inputs; good filtering prior to discharge
 - Medium = Drains a larger area or an area with mixed impact land-uses; some buffers; some potential inputs, nonmajor; little filtering prior to discharge
 - High = Drains a large area or an area with predominantly high impact land-uses; little to no buffer; numerous potential sources or major sources; little to no filtering prior to discharge
- "FC Load" – This data field is a composite of the "System Size" and "FC Concentration" fields and indicates the relative contribution of this stormwater conveyance to the total bacterial load within the growing area. Average the values determined for "System Size" and "FC Concentration" to determine this value.
- "Rain 24 Hr." – Select "Yes" if there has been rainfall in the area within the last 24 hours, or "No" if not.
- "Flow" – If there is a flow moving through the conveyance, select "Yes."
- "Illicit" – If there has not been a recent rainfall, but there is flow moving through the conveyance, it could be an indicator of an illicit discharge. If you have reason to believe that the flow through this conveyance is the result of an illicit discharge, select "Yes." If not, select "No," or if it is unclear, select "Maybe/Uncertain."
- "Source" – Indicate the primary potential or actual pollution source drained by the conveyance. Select from "Agricultural Runoff," "Animal Operations," "Dog Pens," "Leaking Sewer Pipes," "Roadway/Residential," "Septic Failure," "Sewer Overflow," "Wildlife," "Other," or "Unknown"
- "Visible" – If there are any pollution sources visibly impacting the stormwater conveyance being evaluated, select "Yes."