ATLANTIC BEACH

WATERSHED RESTORATION & STORMWATER RESILIENCE PLAN

Contributing Partners

Town of Atlantic Beach

East Carolina Council of Governments

LDSI, Inc

North Carolina Coastal federation

Acknowledgements

Division of Water Resources

NC DMF – Shellfish Sanitation

NC DOT Hydraulics Unit

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Guide to Nine Minimum Elements

This table serves as a reference guide to where the Environmental Protection Agency's (EPA) Nine Minimum Elements can be found within this watershed restoration and stormwater resilience plan.

	EPA Nine Minimum Elements	Location in 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 1: Watershed Description Section 2: Watershed Conditions Section 4: Goals
2	An estimate of the load reductions expected from management measures.	Section 3: Runoff Volume Reduction Section 4: Goals Appendix B: Additional Watershed Characterization
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 3: Runoff Volume Reduction Section 4: Goals Section 5: Management 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: Management 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 5.2: Education and Outreach
6	Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.	Section 6: Implementation Schedule
7	A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.	Section 6.2: Milestones
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: Goals Section 5: Management Strategies Section 6: Implementation Schedule
9	A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the established criteria.	Section 4: Goals Section 6.3: Monitoring

Executive Summary

The Town of Atlantic Beach has chosen to proactively develop a watershed restoration and stormwater resilience plan to actively reduce stormwater runoff within two of its three 12-digit HUCs (Drum Shoals & Beaufort Inlet). 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. Thorough analysis has determined that since the 1980's, the volume of runoff caused by a 2-year 24-hour storm has increased by 28.6 acre-feet. Reducing the stormwater runoff by 28.6 acre-feet is equivalent to a reduction of approximately 0.19 gallons per square foot across the entire land-area of Atlantic Beach. 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 can have a negative impact on water quality and excessive amounts can cause hazardous flooding conditions. Based on aerial imagery and the analysis conducted within this report, a large increase in impervious surfaces resulting from development has caused a large increase in runoff. This plan lays out cost effective methods for reducing and attenuating stormwater runoff, reducing residential flooding, improving water quality of runoff, helping to restore the usefulness of the water resources, and increasing stormwater resilience of the Town of Atlantic Beach. This plan includes 25 proposed stormwater project site locations, proposed stormwater treatment methods, and suggested local ordinance language to implement within the Town of Atlantic Beach. 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 Town's fast-draining, sandy soils to mitigate flooding while subsequently enhancing the water quality of the infiltrated stormwater. The Atlantic Beach Watershed Restoration & Stormwater Resilience 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 office guidelines, and the practiced coastal watershed restoration methodology developed by the plan's partners.

Introduction

This Watershed Restoration & Stormwater Resilience Plan provides a comprehensive framework to address water quality impairments within two of the three Atlantic Beach watersheds. The watersheds have experienced increased volumes of stormwater runoff as a result of changes in land coverage and land use. Stormwater runoff can transport harmful bacteria and other contaminants into surrounding water bodies and impair the water quality and usefulness of these resources. Additionally, the watersheds have experienced nuisance flooding in residential areas as a result of stormwater runoff. By reducing, storing, and re-routing stormwater runoff, water quality can be enhanced in the surrounding water bodies while reducing nuisance flooding.

Stormwater runoff is one of the primary contributing factors to the degradation of water quality within the Atlantic Beach watersheds and surrounding water bodies. Increased development and impervious surface coverage across Atlantic Beach since the 1980's has altered the natural landscape, redirected surface flow, and minimized infiltration of stormwater runoff into the ground. The alterations to surface coverage have impacted the overall hydrology of the watershed by reducing the total area of naturally covered land that is infiltrated by stormwater. Consequently, stormwater that cannot infiltrate into the ground becomes runoff that travels across the surface and becomes contaminated with bacteria, nutrients, sediment, and other pollutants that are present within the watershed. This increase in stormwater runoff puts a strain on existing drainage infrastructure that may not have been initially designed to accommodate the current level of impervious surface. This plan seeks to address:

1. Restoring and maintaining the water quality of the two HUCs within Atlantic Beach
2. Reducing instances of localized flooding to improve safety and protect property
3. Improving the resilience of the Town's infrastructure by reducing the demand on stormwater infrastructure through nature-based stormwater retrofits
4. Prioritizing cost-effective Low Impact Development and stormwater retrofit techniques to address stormwater management
5. Analyzing the effects of sea level rise on existing stormwater infrastructure

Atlantic Beach's water resources have tremendous inherent value for recreation, tourism, and fishing. Significant recreational and habitat areas surround the watersheds including piers, sounds, islands, and the Atlantic Ocean. Improvements in water quality can be achieved by using stormwater management techniques that reduce the volume of stormwater runoff caused by new developments thereby lowering

the amount of runoff that must be treated or accounted for downstream. This plan combines low-cost, high-yield strategies such as community outreach initiatives and retrofit projects aimed at reducing the impact of impervious surface by mimicking the previous hydrology to reduce flooding, protect water quality, and enhance the overall usefulness of the water resources for the local community.

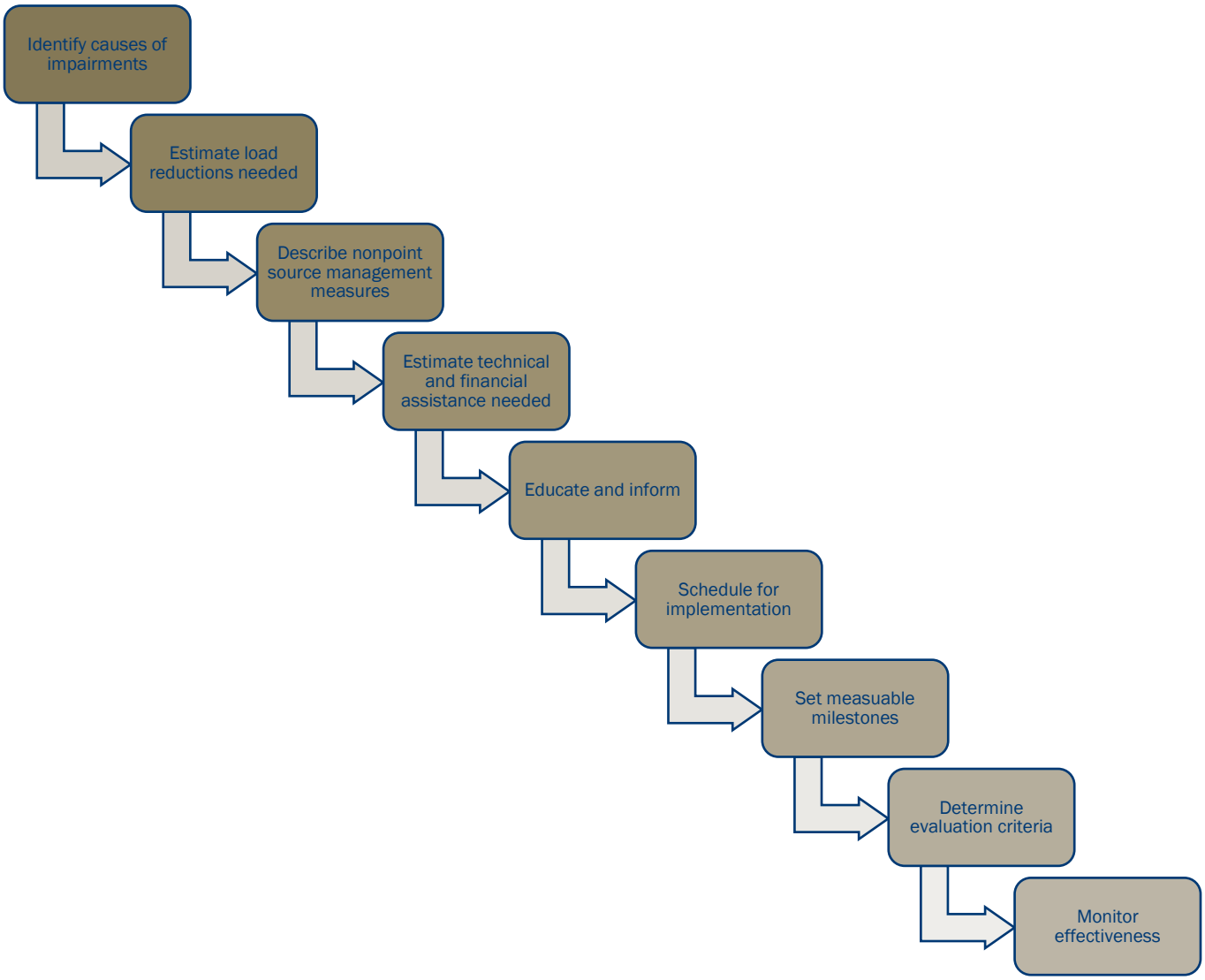


Figure 1-1: Simplified Version of EPA's Nine Elements

1 Watershed Description

Atlantic Beach contains the following three watersheds: Drum Shoals (HUC 0302010702), Beaufort Inlet (HUC 030203010704), and Shackleford Banks (HUC 030203010705). These watersheds are located within the Town of Atlantic Beach and its surrounding areas (Figure 1-2). These watersheds drain directly into the Atlantic Ocean and the Bogue sound. It is important to note that these watersheds extend beyond the boundaries of the Town of Atlantic Beach and this plan will only focus on those portions of the watersheds that are on dry land. This includes a total area of approximately 1,120 acres across all three watersheds. Residential and commercial development over the past few decades has caused an increase in impervious surfaces throughout Atlantic Beach, which has caused an increase in flooding issues as well as the volume of stormwater runoff that drains into the surrounding water bodies.

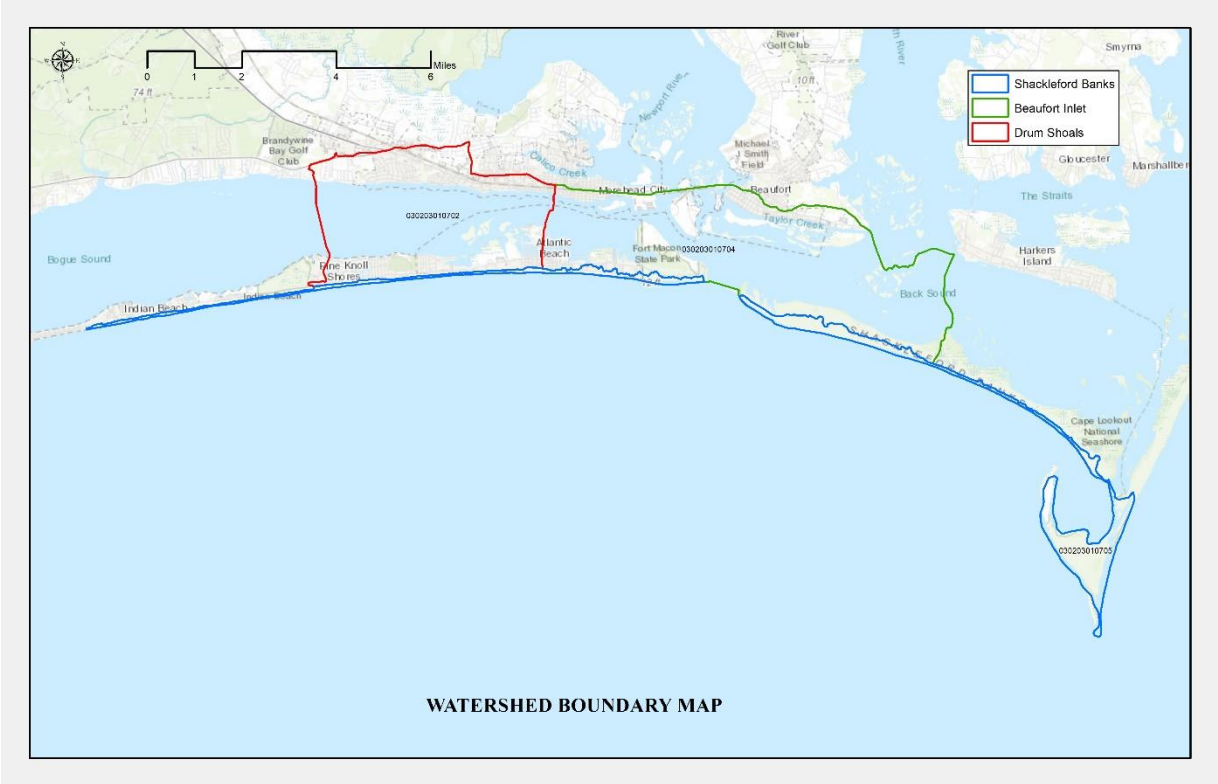


Figure 1-2: Atlantic Beach Watershed Boundaries Map[1]

[1] Carteret County Open GIS Data Site. (n.d.). Retrieved October 05, 2020, from https://gisdata-cc-gis.opendata.arcgis.com/search?collection=Dataset

1.1 Physical and Natural Features

Drum Shoals and Beaufort Inlet watersheds drain directly into the SA (commercial shellfishing), High Quality Waters (HQW) of the Bogue Sound.

	Atlantic Beach Watershed Name	12 - Digit HUC
1	Morehead City - Drum Shoals	30203010702
2	Carrot Island - Beaufort Inlet	30203010704
3	Bogue Banks - Shackleford Banks	30203010705

Table 1-1: Watershed Names and 12-digit HUCs

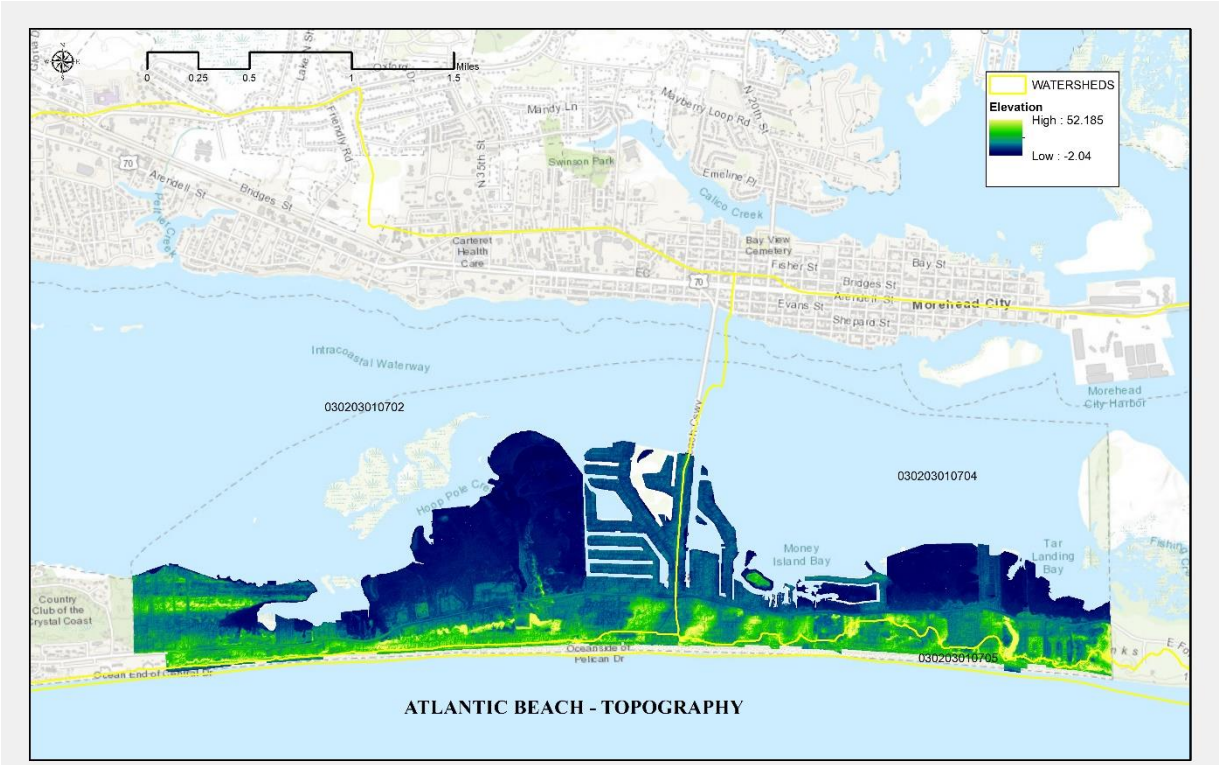


Figure 1-3: Atlantic Beach Topography and Elevations Map

1.1.1 Soils

Atlantic Beach Watersheds are predominated by Group A and Group A/D hydrologic soil per the United States Department of Agriculture Natural Resource Conservation Service (NRCS) data collected from Web Soil Survey (Figure 1-4). Soil Group A is prominent across the entire Island while soil group A/D is primarily found within or along the banks of the sound.

Four hydrologic soil groups (HSG; A, B, C, D) exist with progressively decreasing infiltration potential characteristics; soils classified under Group A have the highest infiltration potential and are often the quickest draining soils, while soils classified under Group D have the highest runoff potential. It is possible to have a soil type that has characteristics from two hydrologic groups; for example, a soil can be designated as Group A/D, which means it has characteristics of both Group A and Group D. This is because of the changing nature of soil when it is saturated. Once a soil is saturated, that "wet" soil behaves like soil from a different group 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.

The following is the US Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) summary description for each soil group[2]:

- **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.

[2] 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 possess 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 LDSI, Inc. 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.

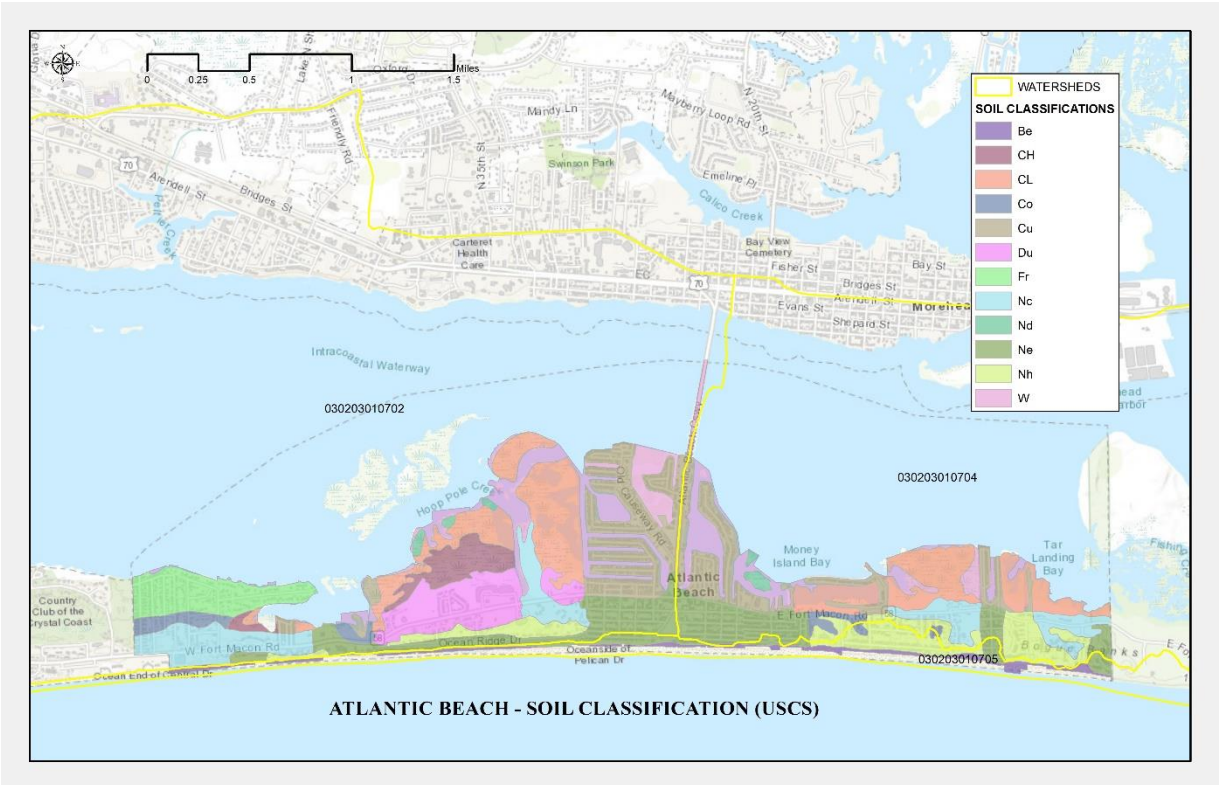


Figure 1-4: Atlantic Beach Soils[3]

[3] 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

1.2 Land Use

Atlantic Beach experienced its initial large scale residential development in the early 1930's which included the parceling of land and the addition of several roads. Over the past five decades specifically, all three Atlantic Beach watersheds have experienced a significant increase in residential and commercial development. This has increased the density of impervious surfaces in all three watersheds.

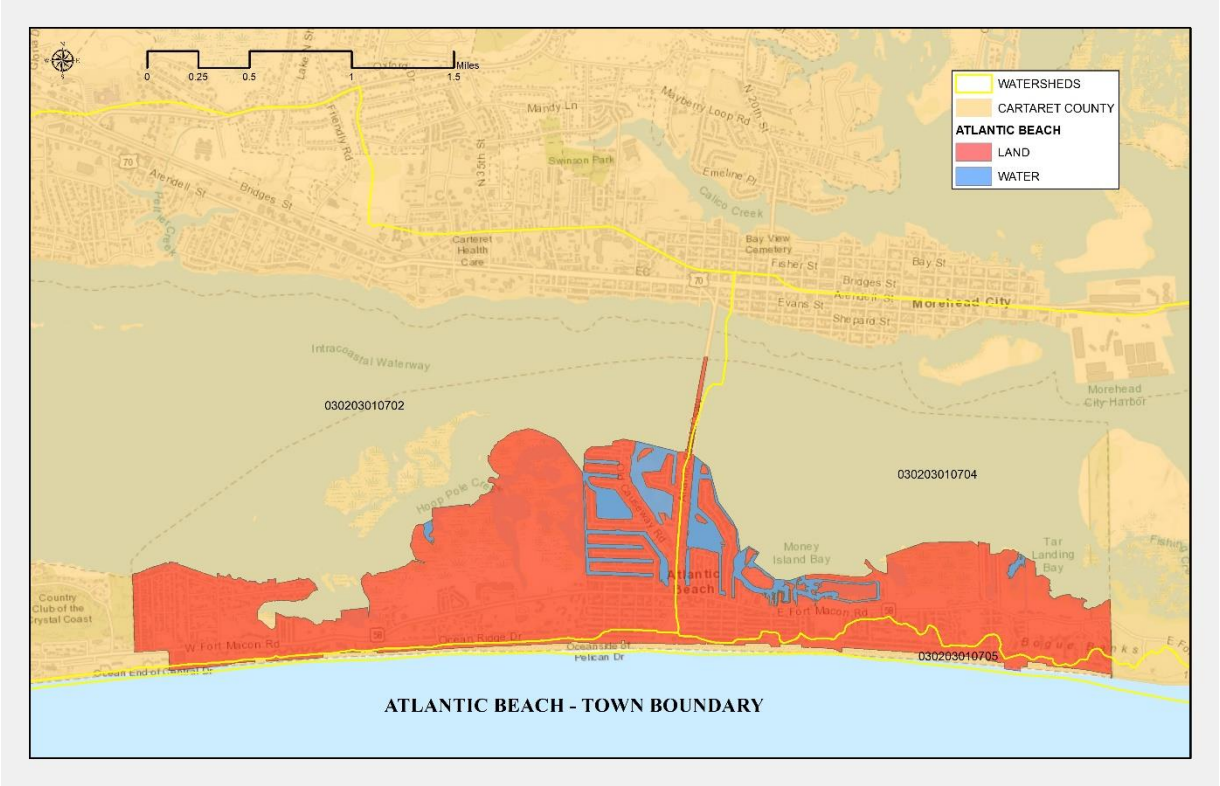


Figure 1-5: Atlantic Beach Town Limits[1]

The Drum Shoals and Beaufort Inlet watersheds are the two most developed watersheds within this plan. These watersheds encompass almost the entirety of the commercial business and residential areas of Atlantic Beach. This is relevant when considering the amount of impervious surface coverage due to parking lots, roof coverage, connected impervious surfaces, and often reduced vegetated coverage. In addition, the marinas located within the watershed boundaries (Table 2-1) are important to note as shellfishing is prohibited near marinas.

The Atlantic Beach watersheds are mixed use development but parcels are predominantly one of four primary uses: commercial use (any business, commercial, or industrial usage), residential use, still

undeveloped parcels, and institutional use (local, state, or federal land uses) (Figure 1-6). These categories were primarily designated by the Carteret County GIS Department's Carteret County Land Use shapefile. To aid in visualizing how the lands within the watershed are used, a simplified usage category has been created with these four categories. These categories represent the current designated land uses for the parcel and do not mean that the land has been altered or developed. Land use broken down by parcel is also included to further distinguish categories (Figure 1-7). 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.

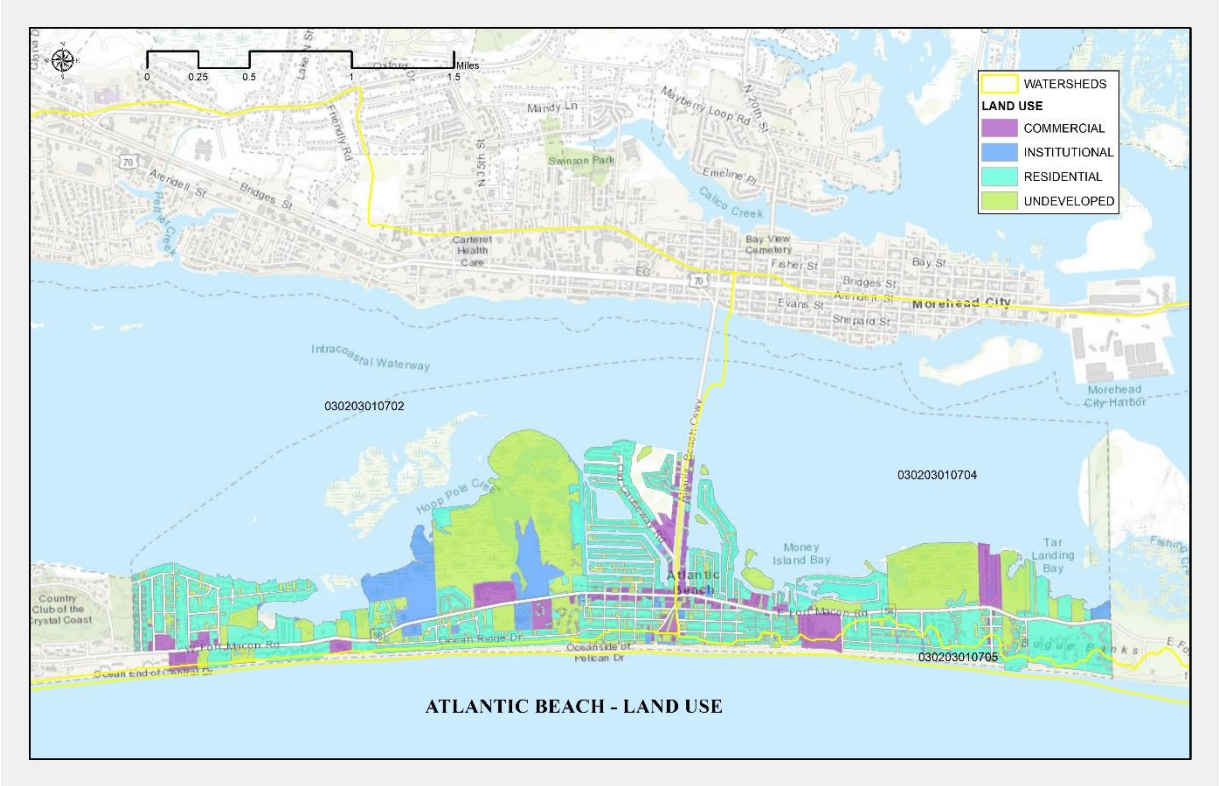


Figure 1-6: Atlantic Beach Land Use Classification[1]

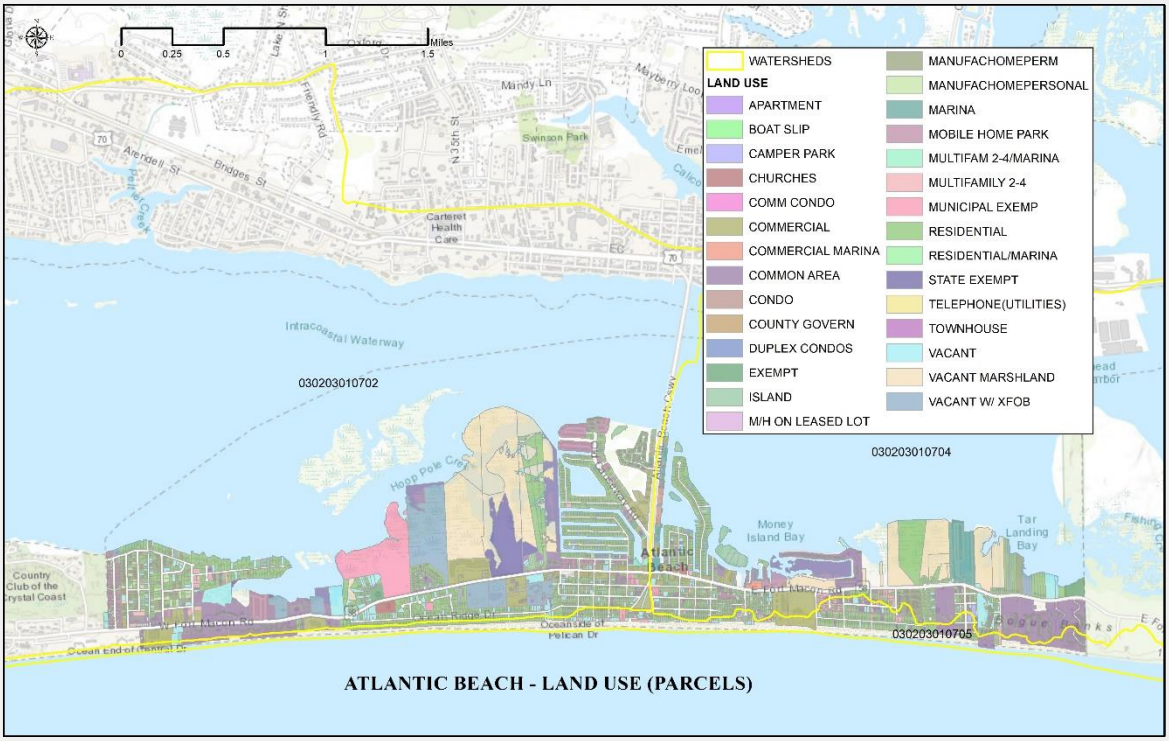


Figure 1-7: Atlantic Beach Land Usage Parcels[1]

2 Watershed Conditions

Land development and land use change has impacted the condition of the Atlantic Beach 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. Watershed conditions and water quality monitoring data are presented below.

2.1 Water Quality

North Carolina has various methods to measure water quality. This plan uses two: the state's water classification system, which is reported on the 303(d) list, and swimming usage tier scale system (Figure 2-1; refer to Appendix C for detailed guide of water quality classification).

While Atlantic Beach has both SA and SB waters (refer to Figure 2-1), the two watersheds that will be focused on throughout this plan are both Class SA according to the NC Department of Environmental Quality (Figure 2-2). The waters of the Drum Shoals and Beaufort Inlet watershed are designated as

Class SA waters, and should be able to support direct contact recreation and commercial shellfishing uses. Portions of the Beaufort Inlet watershed contain marinas, which necessitate a buffer and will always be prohibited for shellfishing within the marina buffers.

The tier scale effects the prioritization of sampling and the minimum water quality in swimming waters with Tier I being the highest priority and are locations that are used daily, Tier II are not used as heavily and see the most use on the weekend, and Tier III sites are used less frequently (refer to Figure 2-1). 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).

Name	Marina Type
Town Creek Marina	Commercial marina
70 West Marina	Commercial marina
The Harbor Master	Commercial marina
Discovery Dive Center Marina	Private marina
Beaufort Inn Docks	Private marina
Peletier Creek Marina	Commercial marina
Portside Marina	Commercial marina
Old Towne Yacht Club	Commercial marina
Eurys Landing	Private marina
Sound View Isles Marina	Private marina
Sound View Isles Marina	Private marina
Sound View Isles Marina	Private marina
Sound View Isles Marina	Private marina
Sound View Isles Marina	Commercial Marina
Capt Stacy Fishing Center	Commercial marina
Sound View Isles Marina	Commercial Marina
Sea Water Marina Club	Commercial marina
Sound View Isles Marina	Commercial Marina
The Causeway Club	Private marina
Sea Spray	Private marina
Snug Harbor Marina	Residential Marina
Snug Harbor Marina	Residential Marina
TCBB LLC	Residential Marina
Sound View Isles Marina	Private marina
Homer Smith Docks & Marina	Working Waterfront Marina
Osprey Oaks Marina	Commercial marina
Morehead City Gulf Docks	Commercial marina

Radio Island Marina Club Inc	Commercial marina
Dudleys Marina	Commercial marina
Triple S Marina Boat Slips	Commercial marina
Calico Jacks Marina	Commercial marina
Cape Pointe Marina	Commercial marina
Willis Rental	Commercial marina
Morehead Bluffs	Commercial marina
Atlantic Harbor	County Marina
Coral Bay Marina	Commercial marina
Crows Nest Yacht Club	Commercial marina
Dockside Yacht Club	Commercial marina
Fort Macon Marina	Commercial marina
Jarrett Bay	Commercial marina
Morehead Yacht Basin	Commercial marina
Pine Knoll Shores Assoc Marina	Commercial marina
Salty Shores Boat Slips	Commercial marina
Spooners Creek Marina	Commercial marina
Harkers Island Harbor of Refuge	County Govt Marina
Tradewinds Marina	Commercial marina

Table 2-1: Marinas within Atlantic Beach Watersheds

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 2-1: Bacteriological Water Quality Standards for North Carolina Quick Guide (Refer to Appendix C for a complete guide to water quality standards.)

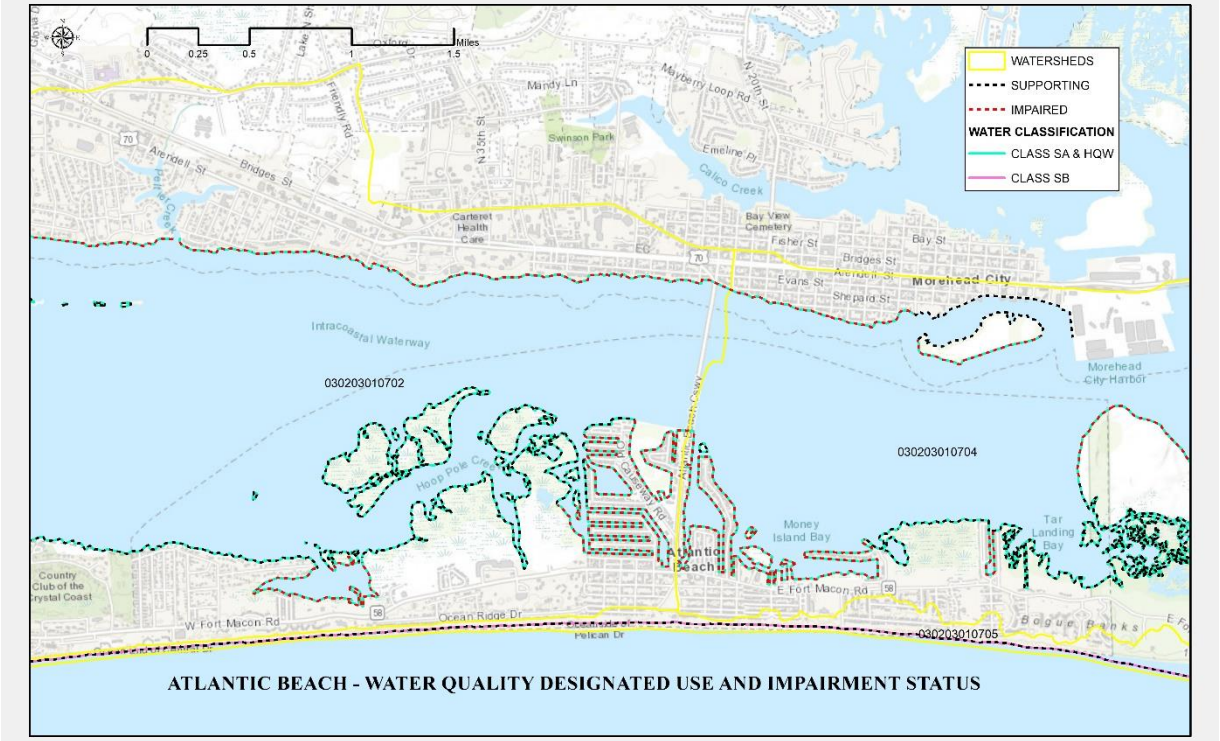


Figure 2-2: Water Quality Designated Use[4]

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 Drum Shoals and Beaufort Inlet watersheds have been designated as prohibited from shellfishing 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 two sound side watersheds being placed on the state's 303(d) list for impairment. Table 2-2 is a summary of the water quality for all the watersheds and Figures 2-4 through 2-9 depict the shellfish closure boundaries over time.

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

Watershed	Designated Use	Shellfish Sanitation Closure Year	Shellfish Status
Drum Shoals	SA	1975	Peltier Creek and nearby shoreline - closed; Shoreline on North side of Bogue Sound excluding Peltier Creek - conditionally approved open; Bogue Shores - conditionally approved closed; Cedar Hammock - closed
Beaufort Inlet	SA	1975	Harbor Channel and adjacent waters along North Shore of Bogue Sound East of S 16th St. - closed; North shore of Bogue Sound West of S 16th St. - conditionally approved open; Money Island Bay - closed; Waters adjacent to Triple S Marine - closed
Shackleford Banks	SB	NA	NA

Table 2-2: Water Quality Summary of Atlantic Beach Watersheds

There are numerous monitoring stations utilized by N.C. DMF Shellfish Sanitation Section to classify shellfish growing waters to determine which waterbodies 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 (Refer to section 6-3 for more information on monitoring). Every three years N.C. Shellfish Sanitation staff ground truth 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.

Stations exceeding fecal coliform levels of Class SA (GM >14/100 ml; specifically, fecal coliform group not to exceed GM 14/100 ml and not more than 10 percent of the samples shall exceed GM 43/100 ml in those areas most probably exposed to fecal contamination during the most unfavorable hydrologic and pollution conditions; Appendix C) appear to maintain frequency over the last two decades. Understanding how often water quality stations have exceeded a single sample reading of 14/100 ml will aid in the development of milestones and assist in the monitoring of progress.

Survey Report Cycle	1983 - 1984	1985 - 1987	1988 - 1991	1991 - 1994	1994 - 1999	1997 - 2002	2002 - 2007	2005 - 2010	2009 - 2014	2012 - 2017
Station No.										
E-3 STA 1	6/11	5/14	7/16	10/20	14/30	12/30	17/30	12/30	10/30	14/30
E-3 STA 2	2/11	0/14	2/16	1/20	2/30	3/30	1/30	1/30	1/30	2/30
E-3 STA 3	2/11	0/14	0/16	2/20	2/30	3/30	3/30			
E-3 STA 5	3/11	0/14	0/16	1/20	2/30	3/30	3/30	2/30	1/30	
E-3 STA 23	1/11	0/14	2/16	2/20	2/30	1/30	1/30	1/30	0/30	
E-3 STA 24	1/11	1/14	0/16	3/20	2/30	3/30	0/30	0/30	0/30	1/30
E-3 STA 31	1/11	1/14	2/16	2/20						
E-3 STA 32	1/11	3/14	3/16	3/20						
E-3 STA 34	0/11	1/14	1/16	2/20	6/30	4/30	4/30	1/30	2/30	
E-3 STA 35	3/11	1/14	3/16	2/20	6/30	4/30	2/30	1/30	1/30	1/30
E-3 STA 36	4/11	1/14	5/16	2/20	4/30		6/30	1/30	1/30	1/30
E-3 STA 37	3/11	1/14	2/16	2/20	7/30		4/30	2/30	1/30	1/30
E-3 STA 45	10/11	8/14	14/16	14/20	23/30	16/30	18/30	17/30	14/30	17/30
E-3 STA 46	2/11	0/14	2/16	2/20	5/30	3/30	6/30	3/30	2/30	1/30
E-3 STA 47	3/11	0/14	4/16	2/20	4/30	8/30	7/30	5/30	4/30	5/30
E-3 STA 48	2/11	0/14	2/16	3/20	3/30	3/30	4/30	2/30	1/30	1/30
E-3 STA 48A							8/30	3/30	4/30	
E-3 STA 48B							10/30	7/30	4/30	
E-3 STA 48C							5/30	0/30	2/30	2/30
E-3 STA 49	0/11	2/14	2/16	0/20	9/30		2/30	3/30	2/30	2/30
E-3 STA 50	3/11	0/14	1/16	3/20	4/30		2/30	1/30	2/30	2/30
E-3 STA 51	0/11	1/14	2/16	2/20	6/30		6/30	2/30	3/30	3/30
E-3 STA 52	5/11	1/14	5/16	3/20	7/30		6/30	3/30	1/30	3/30
E-3 STA 6	6/11	0/14	4/16	5/20	11/30	11/30	8/30	10/30	11/30	13/30
E-3 STA 6A	1/1				17/26	12/30	12/30			
E-3 STA 6B								3/15	6/30	4/30
E-3 STA 7	1/11	3/14	0/16	2/20	2/30	2/30	7/30	4/30	5/30	2/30
E-3 STA 8	2/11	2/14	1/16	2/20	6/30	4/30	9/30	7/30	6/30	5/30
E-3 STA 8A										1/16
E-3 STA 9	1/11	1/14	7/16	9/20	8/30	11/30	10/30			
E-3 STA 10	4/11	5/14	7/16	7/20	10/30	7/30	12/30	6/30	7/30	5/30
E-3 STA 10A								3/15	10/30	6/30
E-3 STA 10B								5/15	11/30	
E-3 STA 11	5/11	5/14	5/16	6/20	11/30	8/30	11/30	6/30	6/30	6/30
E-3 STA 12	4/11	3/14	6/16	9/20						
E-3 STA 13	2/10	8/14	7/16	6/20	10/30	13/30	8/30	8/30	9/30	10/30
E-3 STA 14	3/11	9/14	12/16	13/20						
E-3 STA 15	4/11	5/14	5/16	8/20	10/30	9/30	12/30	6/30	5/30	6/30
E-3 STA 16	5/11	2/14	5/16	5/20						
E-3 STA 17	2/11	5/14	5/16	2/20						
E-3 STA 18	5/11	6/14	7/16	8/20	14/30	14/30	9/30	9/30	11/30	4/30
E-3 STA 19	0/11	1/14	2/16	6/20	6/30	3/30	0/30	1/30	2/30	2/30
E-3 STA 20	1/11	2/14	3/16	4/20	9/30	7/30	9/30	6/30	5/30	3/30
E-3 STA 21	0/11	0/14	2/16	3/20	8/30	9/30	6/30	4/30	4/30	3/30
E-3 STA 40	0/11	1/13	1/16	3/20	6/30	7/30	8/30	5/30	10/30	2/30
E-3 STA 41	1/11	1/14	0/16	3/20	4/30	3/30	10/30	5/30	7/30	2/30
E-3 STA 42	1/11	1/14	2/16	1/20	5/30	2/30	11/30	5/30	5/30	5/30
E-3 STA 42A								1/15	6/30	3/30
E-3 STA 44	0/11	2/14	6/16	6/20						
E-3 STA 44A					6/26	5/30	5/30	2/30	4/30	4/30
E-3 STA 59					11/26	14/30	13/30			
E-3 STA 60					11/26	7/30	10/30			
>50% of samples exceed SA standards					**25-49% of samples exceed SA standards**			**10-24% of samples exceed SA standards**		**<10% of samples exceed SA standards**

Table 2-3: Frequency of samples exceeding MPN 14/100 mL at monitoring stations

**Note: These number represent the number of times during the reporting cycle that in a single sample in which 14/100ml was exceeded. For example, "3/30" indicates 3 samples exceeded this rate per a total of 30 samples in that reporting cycle; "5/16" indicates that 5 samples exceeded this rate per a total of 16 samples in that reporting cycle. The percentages represent the percent of samples that exceeded 14/100ml in the reporting cycle. For example, green indicates less than 10% of samples exceeded that rate "0/30" would be equivalent to 0%, "1/30" would be equivalent to 3%, and so on.*

Survey Report Cycle	1983 - 1984	1985 - 1987	1988 - 1991	1991 - 1994	1994 - 1999	1997 - 2002	2002 - 2007	2005 - 2010	2009 - 2014	2012 - 2017
Station No.										
E-3 STA 1	4/11	2/14	3/16	2/20	10/30	4/30	9/30	6/30	4/30	4/30
E-3 STA 2	0/11	0/14	1/16	1/20	2/30	1/30	0/30	0/30	0/30	1/30
E-3 STA 3	0/11	0/14	0/16	0/20	0/30		0/30			
E-3 STA 5	1/11	0/14	0/16	0/20	1/30		0/30	1/30	1/30	
E-3 STA 23	0/11	0/14	1/16	1/20	1/30		0/30	0/30	0/30	
E-3 STA 24	0/11	0/14	0/16	0/20	0/30	0/30	0/30	0/30	0/30	0/30
E-3 STA 31	0/11	0/14	0/16	1/20						
E-3 STA 32	1/11	1/14	1/16	1/20						
E-3 STA 34	0/11	1/14	1/16	1/20	2/30		3/30	0/30	1/30	
E-3 STA 35	1/11	1/14	1/16	0/20	2/30	1/30	0/30	0/30	1/30	1/30
E-3 STA 36	1/11	1/14	1/16	0/20	1/30	1/30	0/30	0/30	1/30	1/30
E-3 STA 37	0/11	0/14	0/16	0/20	3/30	0/30	1/30	0/30	0/30	0/30
E-3 STA 45	10/11	5/14	14/16	9/20	16/30	10/30	9/30	6/30	4/30	10/30
E-3 STA 46	1/11	0/14	0/16	0/20	2/30	0/30	1/30	0/30	0/30	0/30
E-3 STA 47	2/11	0/14	2/16	0/20	2/30	1/30	3/30	0/30	0/30	1/30
E-3 STA 48	1/11	0/14	1/16	0/20	0/30	0/30	0/30	2/30	0/30	0/30
E-3 STA 48A							1/30	1/30	1/30	
E-3 STA 48B							2/30	2/30	2/30	
E-3 STA 48C						1/30	2/30	0/30	1/30	1/30
E-3 STA 49	0/11	2/14	0/16	0/20	2/30	2/30	2/30	1/30	2/30	2/30
E-3 STA 50	0/11	0/14	0/16	0/20	2/30	1/30	0/30	0/30	0/30	1/30
E-3 STA 51	0/11	0/14	0/16	0/20	2/30	0/30	2/30	0/30	0/30	0/30
E-3 STA 52	2/11	0/14	2/16	0/20	2/30	2/30	2/30	1/30	1/30	2/30
E-3 STA 6	2/11	0/14	1/16	2/20	2/30	1/30	4/30	5/30	3/30	1/30
E-3 STA 6A	1/1				7/26		5/30			
E-3 STA 6B						2/30		0/30	1/30	2/30
E-3 STA 7	0/11	0/14	0/16	0/20	2/30	1/30	3/30	1/30	2/30	1/30
E-3 STA 8	1/11	0/14	1/16	1/20	11/30	1/30	3/30	3/30	1/30	1/30
E-3 STA 8A						0/16				0/16
E-3 STA 9	1/11	0/14	2/16	1/20	2/30		2/30			
E-3 STA 10	0/11	1/14	0/16	3/20	3/30	3/30	5/30	4/30	3/30	3/30
E-3 STA 10A						1/30		1/15	1/30	1/30
E-3 STA 10B								2/15	4/30	
E-3 STA 11	0/11	1/14	2/16	0/20	2/30	2/30	3/30	2/30	1/30	2/30
E-3 STA 12	3/11	1/14	3/16	6/20						
E-3 STA 13	1/10	4/14	0/16	1/20	5/30	1/30	2/30	2/30	1/30	1/30
E-3 STA 14	1/11	3/14	7/16	1/20						
E-3 STA 15	1/11	2/14	1/16	2/20	3/30	1/30	3/30	0/30	1/30	1/30
E-3 STA 16	1/11	1/14	1/16	1/20						
E-3 STA 17	2/11	3/14	2/16	1/20						
E-3 STA 18	1/11	2/14	5/16	4/20	6/30	1/30	3/30	5/30	3/30	1/30
E-3 STA 19	0/11	0/14	0/16	0/20	0/30	0/30	0/30	0/30	0/30	0/30
E-3 STA 20	1/11	2/14	0/16	2/20	4/30	1/30	2/30	1/30	2/30	1/30
E-3 STA 21	0/11	0/14	1/16	2/20	1/30	0/30	3/30	0/30	0/30	0/30
E-3 STA 40	0/11	0/13	0/16	0/20	1/30	0/30	3/30	0/30	0/30	0/30
E-3 STA 41	0/11	0/14	0/16	0/20	0/30	0/30	2/30	1/30	1/30	0/30
E-3 STA 42	1/11	0/14	0/16	0/20	1/30	0/30	2/30	2/30	1/30	0/30
E-3 STA 42A						0/30		0/15	0/30	0/30
E-3 STA 44	0/10	0/14	2/16	3/20						
E-3 STA 44A					2/26	1/30	3/30	1/30	0/30	1/30
E-3 STA 59					8/26		6/30			
E-3 STA 60					3/26		3/30			
>50% of samples exceed SA standards		25-49% of samples exceed SA standards			10-24% of samples exceed SA standards			<10% of samples exceed SA standards		

Table 2-4: Frequency of samples exceeding MPN 43/100 mL at monitoring stations

**Note: These number represent the number of times during the reporting cycle that in a single sample in which 43/100ml was exceeded. For example, "3/30" indicates 3 samples exceeded this rate per a total of 30 samples in that reporting cycle; "5/16" indicates that 5 samples exceeded this rate per a total of 16 samples in that reporting cycle. The percentages represent the percent of samples that exceeded 43/100ml in the reporting cycle. For example, green indicates less than 10% of samples exceeded that rate "0/30" would be equivalent to 0%, "1/30" would be equivalent to 3%, and so on. Samples that exceed 200/100 ml exceed Class SB standards, however; this represents a single sample and not necessarily 5 consecutive samples.*

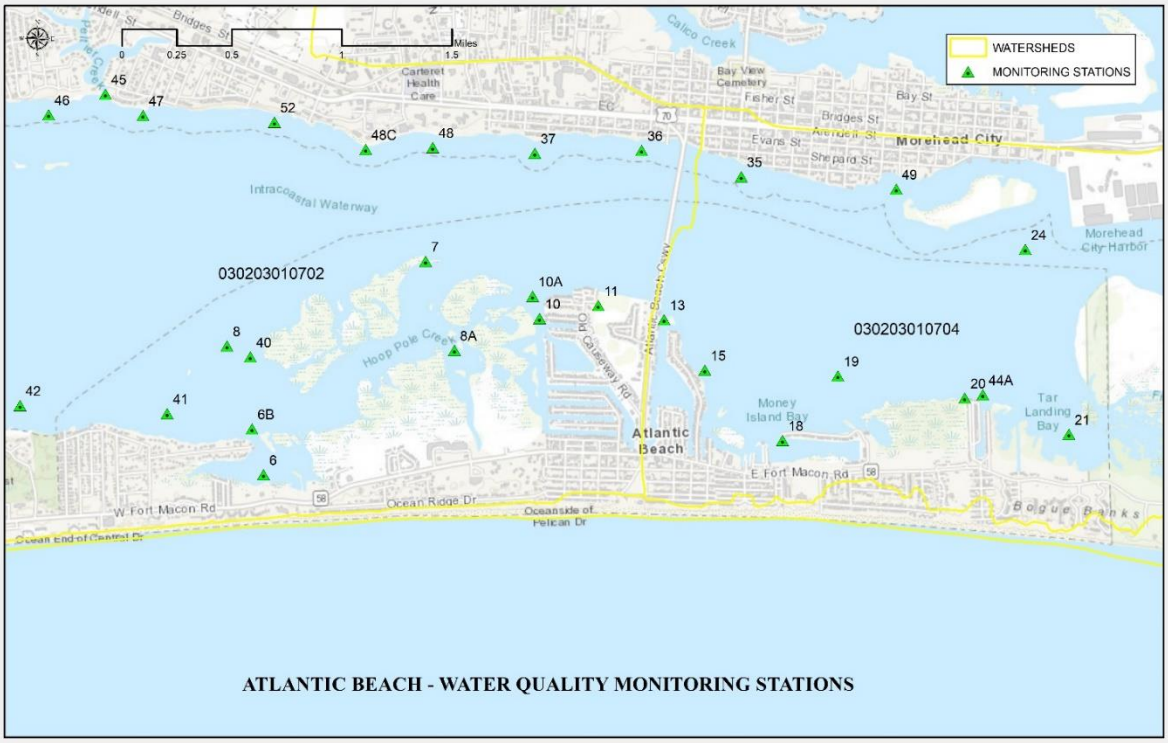


Figure 2-3: E-3 Water Quality Monitoring Stations

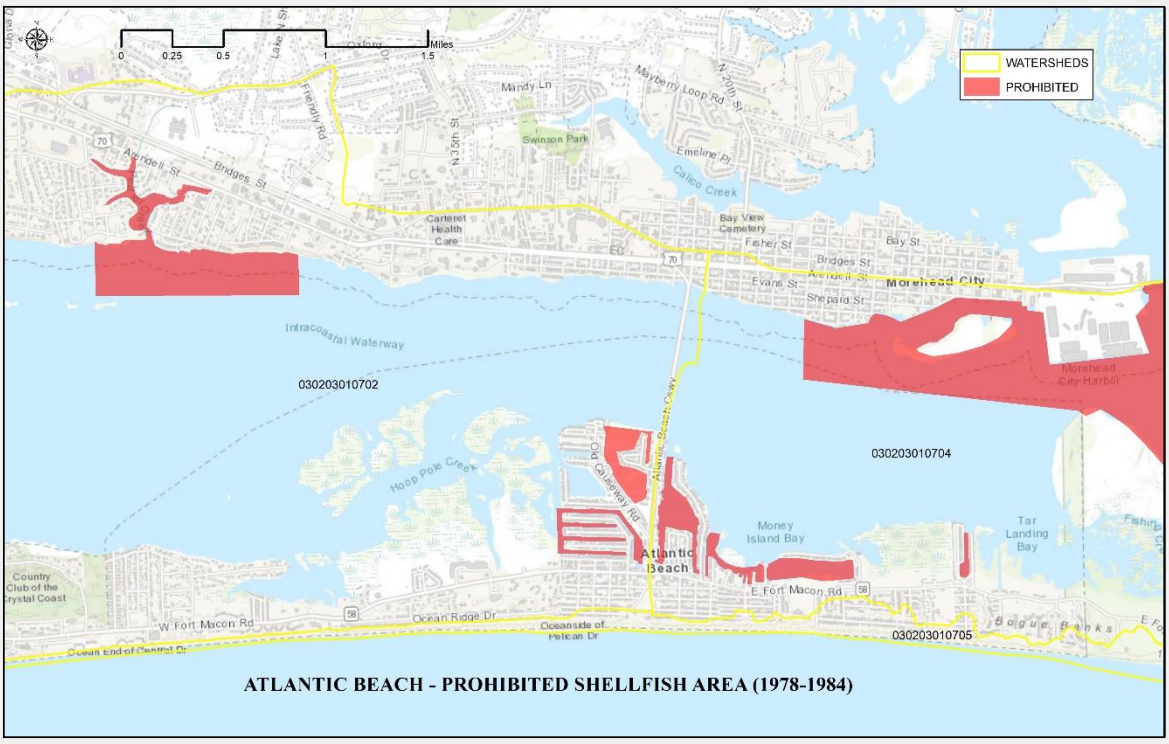


Figure 2-4: Atlantic Beach Shellfish Prohibited Area 1978-1984

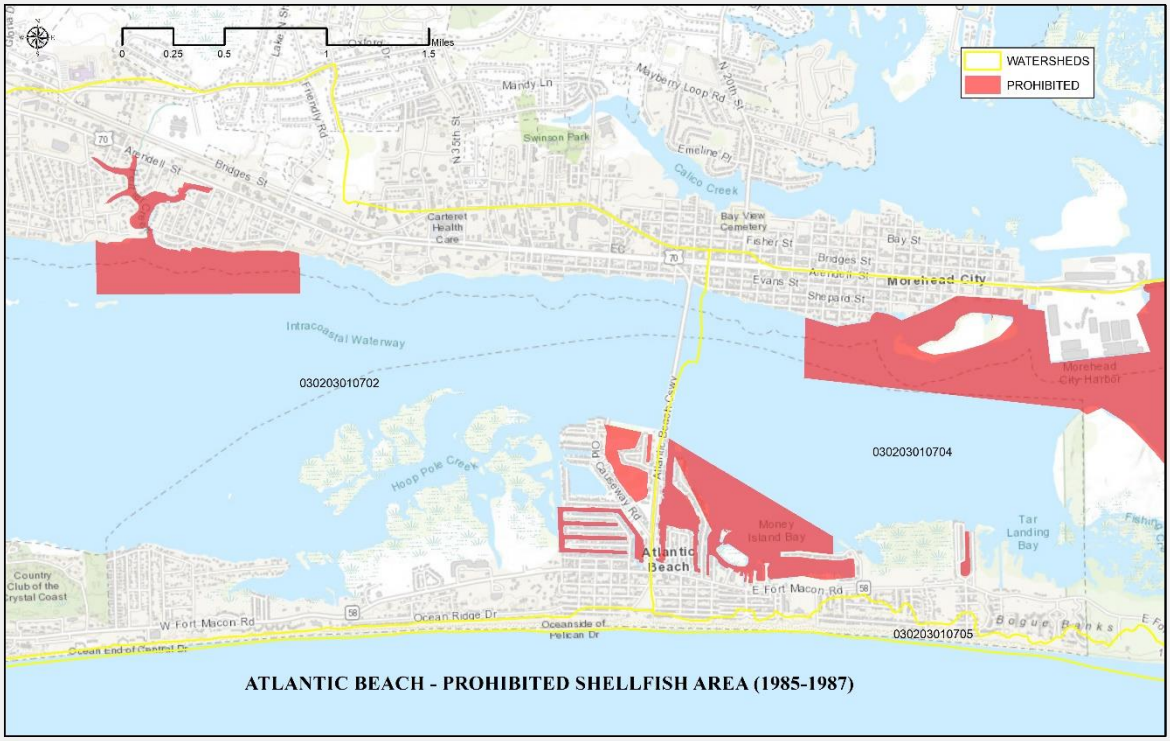


Figure 2-5: Atlantic Beach Shellfish Prohibited Area 1985-1987

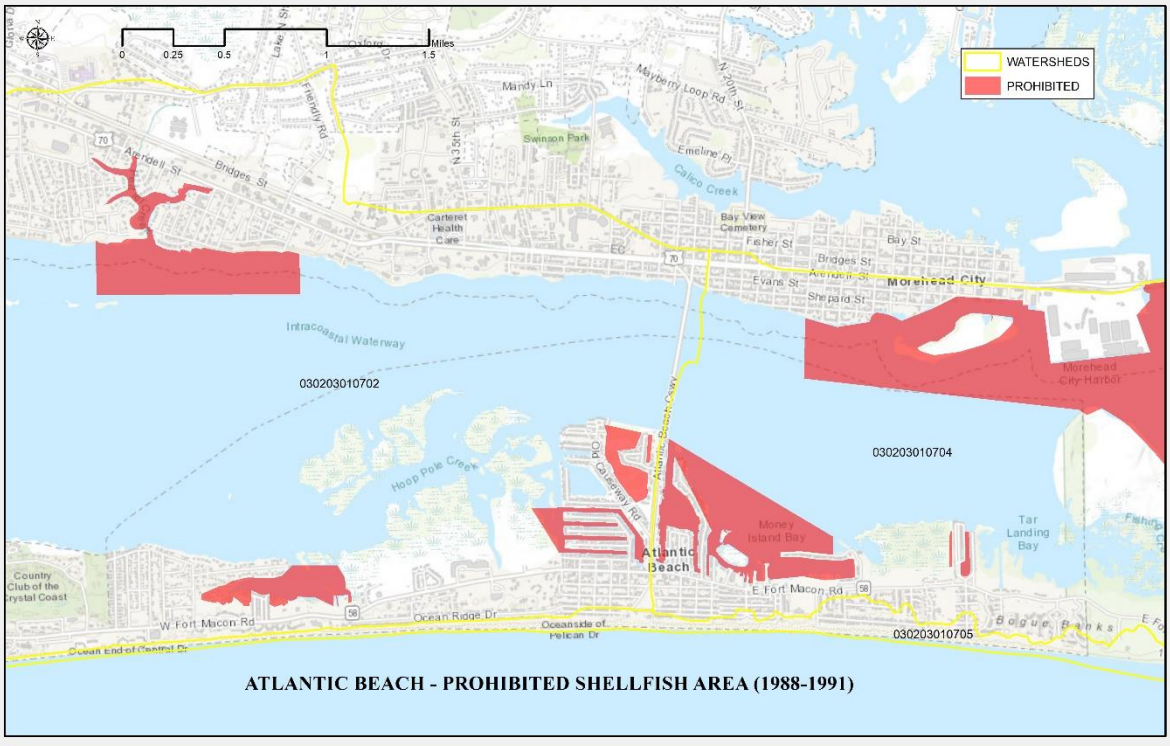


Figure 2-6: Atlantic Beach Shellfish Prohibited Area 1988-1991

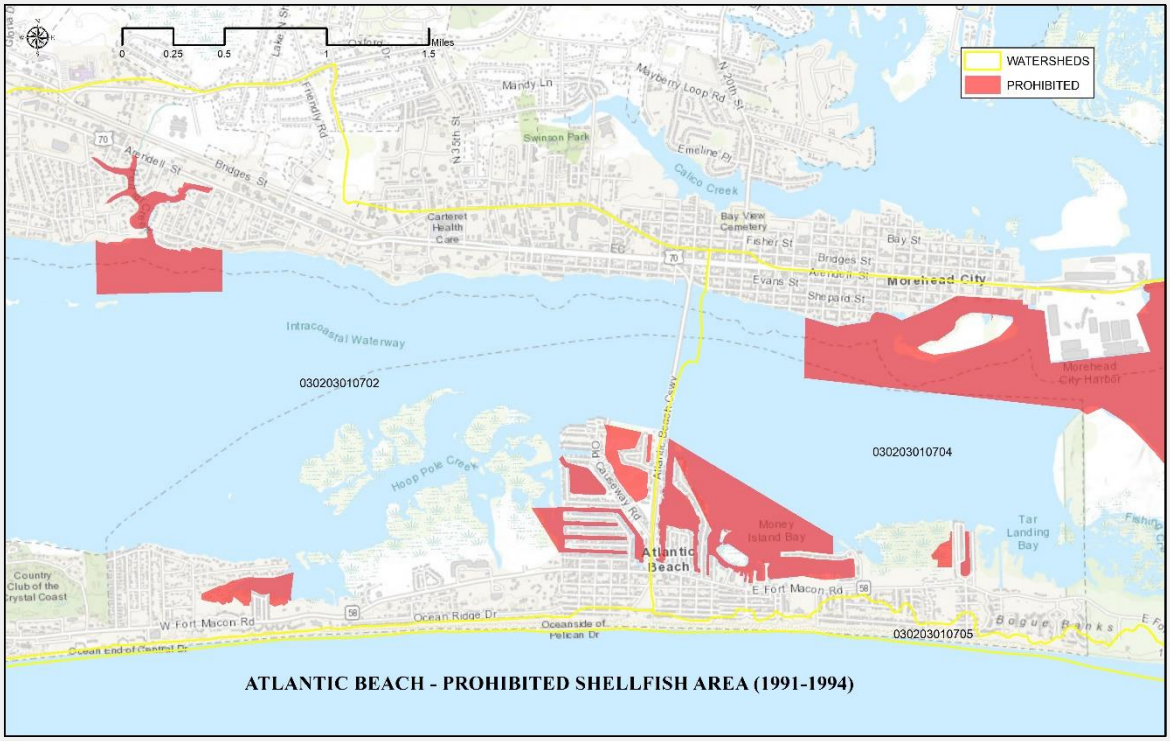


Figure 2-7: Atlantic Beach Shellfish Prohibited Area 1991-1994

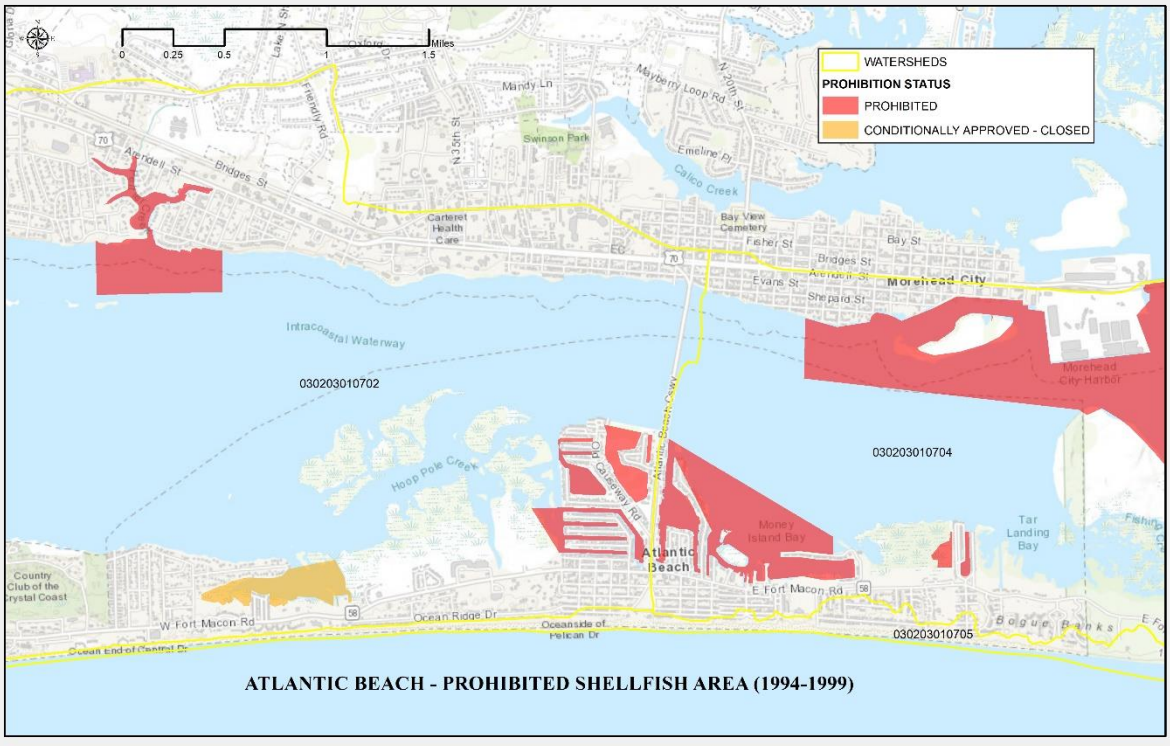


Figure 2-8: Atlantic Beach Shellfish Prohibited Area 1994-1999

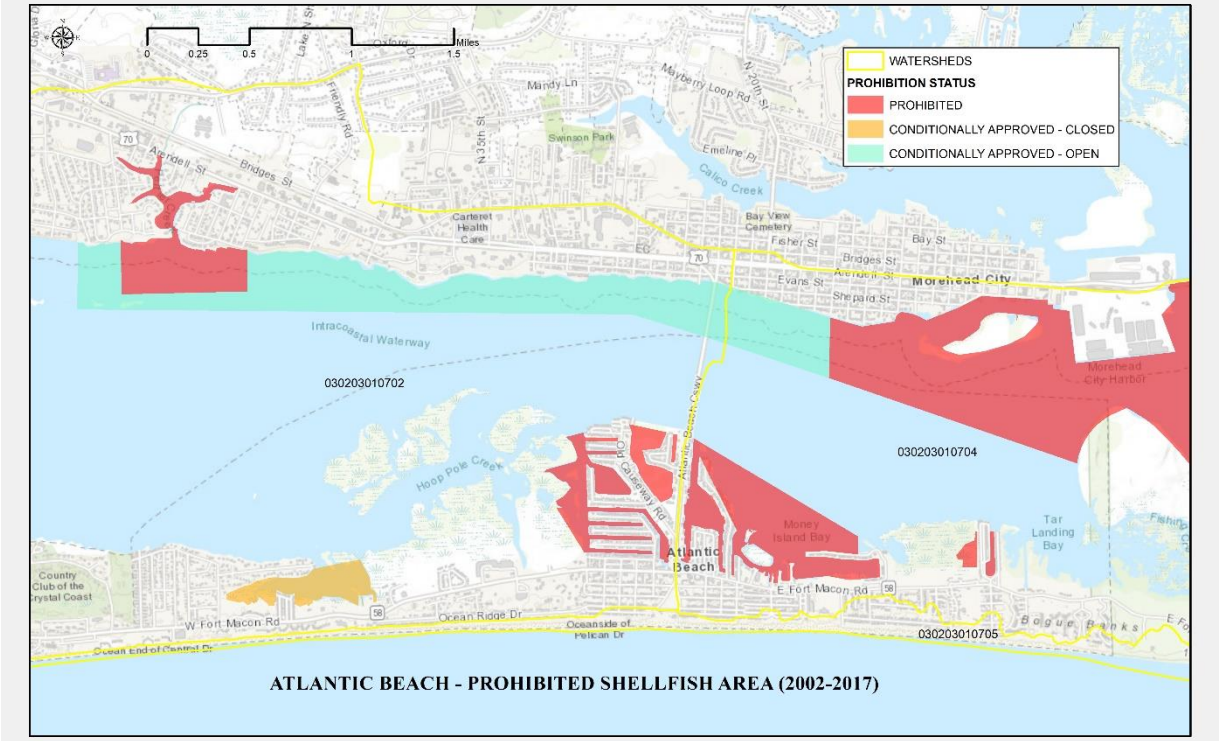


Figure 2-9: Atlantic Beach Shellfish Prohibited Area 2002-2017

The Clean Water Act (CWA) requires that steps be taken to remove impairments from 303(d) listed waterways (refer to Appendix C for more details on water quality assessment categories). When surface waters no longer comply with federal water quality standards, the federal Clean Water Act (CWA) mandates that steps be taken 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 $52,000[5]. Often, time and financial resources are not sufficient to allow for TMDL development in smaller waterbodies dominated by nonpoint source pollution. There is currently no TMDL reports completed for the impaired waters of the Atlantic Beach 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 2-6 is a detailed list of the area's impaired water

[5] 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.

bodies and Figure 2-10 is the associated map. Table 2-7 is a summary list of waterbodies in the Atlantic Beach region currently on the 303(d) list published in 2018, that do not meet their designated uses.

Recreational water advisories warn people about potentially hazardous water conditions due to increased bacteria levels caused by stormwater runoff. All three watersheds located within Atlantic Beach have sampling stations (Figure 2-10) for these recreational water advisories, however, since 2006 there have only been advisories posted for the Shackleford Banks watershed. While this watershed is not included with the other two as being a focus within the plan, it is worth noting that portions of the other two watersheds drain into the Shackleford Banks watershed via stormwater infrastructure. This means that water quality improvements within the two target watersheds should also improve water quality within the Shackleford Banks watershed that drains directly into the Atlantic Ocean. Since 2006 the Shackelford Banks watershed has experienced 12 recreational water advisories along with 16 recreational water alerts (Table 2-6).

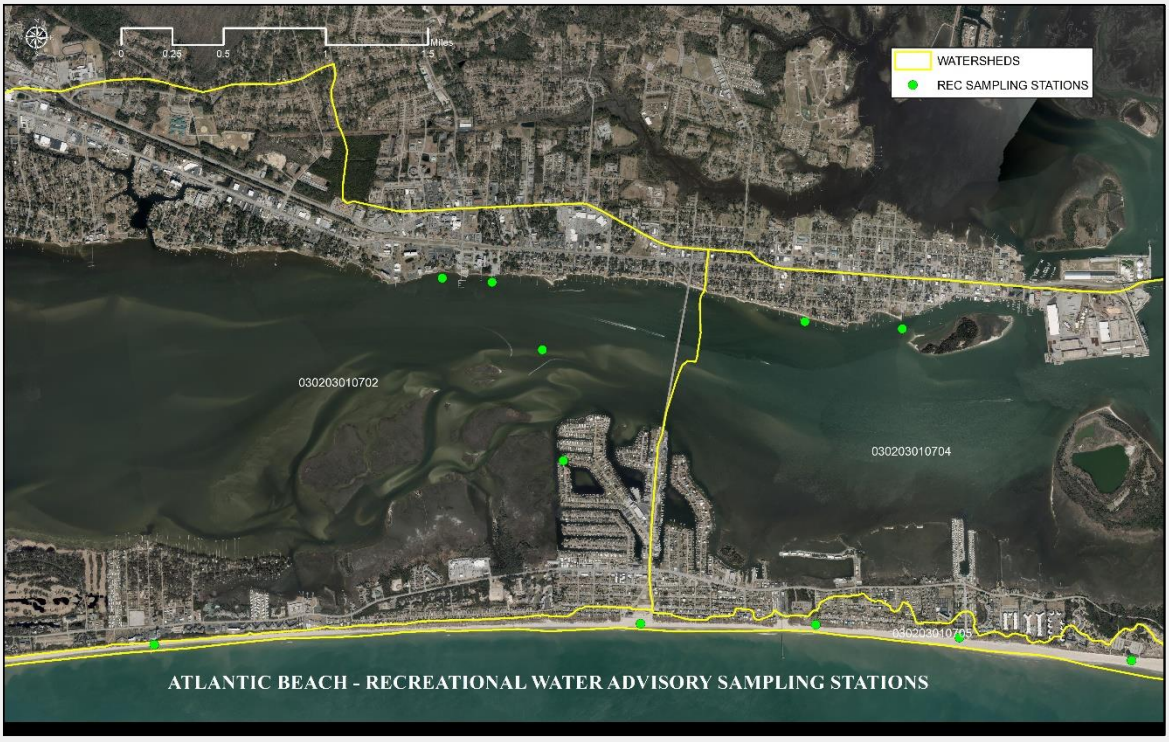


Figure 2-10: Recreational Water Advisory Sampling Stations

Atlantic Beach Historic Swimming Alerts and Advisories				
Type	Start Date	End Date	Side	Station
Alert	11-Jul-06	12-Jul-06	Sound	C51B - West end of Sugarloaf Island, Morehead City
Advisory	24-May-06	25-May-06	Ocean	C4A - Mile Post 4 1/2, oceanside of Pelican Dr.
Alert	30-Sep-08	1-Oct-08	Ocean	C4A - Mile Post 4 1/2, oceanside of Pelican Dr.
Alert	23-Sep-08	24-Sep-08	Ocean	C3 - Ocean end of Henderson Blvd., AO
Advisory	23-Sep-08	24-Sep-08	Ocean	C4 - Public beach access off Atlantic Boulevard in Atlantic Beach
Alert	29-Jul-08	30-Jul-08	Ocean	C3 - Ocean end of Henderson Blvd., AO
Alert	29-Jul-08	30-Jul-08	Ocean	C3A - Ocean end of New Bern St., AO
Alert	28-Sep-10	29-Sep-10	Ocean	C3A - Ocean end of New Bern St., AO
Alert	19-Jul-11	20-Jul-11	Ocean	C3A - Ocean end of New Bern St., AO
Alert	16-Oct-12	17-Oct-12	Ocean	C4A - Mile Post 4 1/2, oceanside of Pelican Dr.
Alert	5-Sep-12	6-Sep-12	Ocean	C4 - Public beach access off Atlantic Boulevard in Atlantic Beach
Alert	29-May-13	30-May-13	Ocean	C4A - Mile Post 4 1/2, oceanside of Pelican Dr.
Advisory	22-Jul-14	23-Jul-14	Ocean	C4A - Mile Post 4 1/2, oceanside of Pelican Dr.
Advisory	24-Sep-14	7-Oct-14	Ocean	C4 - Public beach access off Atlantic Boulevard in Atlantic Beach
Alert	23-Sep-14	24-Sep-14	Ocean	C4 - Public beach access off Atlantic Boulevard in Atlantic Beach
Advisory	23-Sep-14	7-Oct-14	Ocean	C3A - Ocean end of New Bern St., AO
Advisory	22-Jul-14	23-Jul-14	Ocean	C3A - Ocean end of New Bern St., AO
Advisory	24-Sep-14	9-Oct-14	Ocean	C3 - Ocean end of Henderson Blvd., AO
Alert	23-Sep-14	24-Sep-14	Ocean	C3 - Ocean end of Henderson Blvd., AO
Advisory	30-Jul-14	8-Aug-14	Ocean	C3 - Ocean end of Henderson Blvd., AO
Advisory	22-Jul-14	23-Jul-14	Ocean	C3 - Ocean end of Henderson Blvd., AO
Advisory	12-Aug-14	19-Aug-14	Ocean	C2 - FORT MACON beach access at Bathhouse
Advisory	30-Jul-14	8-Aug-14	Ocean	C2 - FORT MACON beach access at Bathhouse
Advisory	22-Jul-14	23-Jul-14	Ocean	C2 - FORT MACON beach access at Bathhouse
Alert	29-Sep-15	30-Sep-15	Ocean	C4A - Mile Post 4 1/2, oceanside of Pelican Dr.
Alert	29-Sep-15	30-Sep-15	Ocean	C4 - Public beach access off Atlantic Boulevard in Atlantic Beach
Alert	29-Sep-15	30-Sep-15	Ocean	C3A - Ocean end of New Bern St., AO
Alert	29-Sep-15	30-Sep-15	Ocean	C3 - Ocean end of Henderson Blvd., AO
Alert	29-Sep-15	30-Sep-15	Ocean	C2 - FORT MACON beach access at Bathhouse

Table 2-5: Atlantic Beach Historic Swimming Alerts and Advisories

Watershed	303(d) Year	Parameter of Interest	Categories Within Watershed
Drum Shoals	2018	Shellfish Growing Area Status (Fecal, SH, SA)	5
Beaufort Inlet	2018	Shellfish Growing Area Status (Fecal, SH, SA)	5

Table 2-6: Water Quality Summary of Atlantic Beach Watersheds

AU Number	Nearest Watershed	Name	Description	Acres	Designated Use	Category
20-36-10	Drum Shoals	Spooner Creek	From source to Bogue Sound	29	SA;HQW	5
20-36-(8.5)g	Drum Shoals	Bogue Sound (Including Intracoastal Waterway to Beaufort Inlet)	DEH closed area at mouth of Spooner Creek	48	SA;HQW	5
20-36-(8.5)h	Drum Shoals	Bogue Sound (Including Intracoastal Waterway to Beaufort Inlet)	DEH closed area at mouth of Peltier Creek	93	SA;HQW	5
20-36-(8.5)i	Drum Shoals	Bogue Sound (Including Intracoastal Waterway to Beaufort Inlet)	DEH closed area near Hoop Pole Creek west of Atlantic Beach	41	SA;HQW	5
20-36-(8.5)j	Drum Shoals	Bogue Sound (Including Intracoastal Waterway to Beaufort Inlet)	DEH closed areas west at Atlantic Beach Bridge and Cedar Hammock	47	SA;HQW	5
20-36-(8.5)k	Beaufort Inlet	Bogue Sound (Including Intracoastal Waterway to Beaufort Inlet)	DEH closed area from Newport River Restricted area to Fort Macon Creek	355	SA;HQW	5
20-36-13a	Beaufort Inlet	Money Island Bay	Closed DEH area in western portion of Bay	107	SA;HQW	5
20-36-13b2	Beaufort Inlet	Money Island Bay	DEH approved area near Allen Slough in eastern portion of Bay. Bogue Banks Atlantic Beach Area	21	SA;HQW	5
20-36-13-1	Beaufort Inlet	Money Island Slough	From source to Money Island Bay	11	SA;HQW	5

Table 2-7: Water Quality Assessment 303(d) List Summary

Figure 2-11: Water Quality Assessment Categories[6]

[6] Williams, M. M. (2019, August 1). 2018 Integrated Report Overall Category. Retrieved October 05, 2020, from https://ncdenr.maps.arcgis.com/home/item.html?id=aa9d7582afae4fc085d84dbe1978e95c

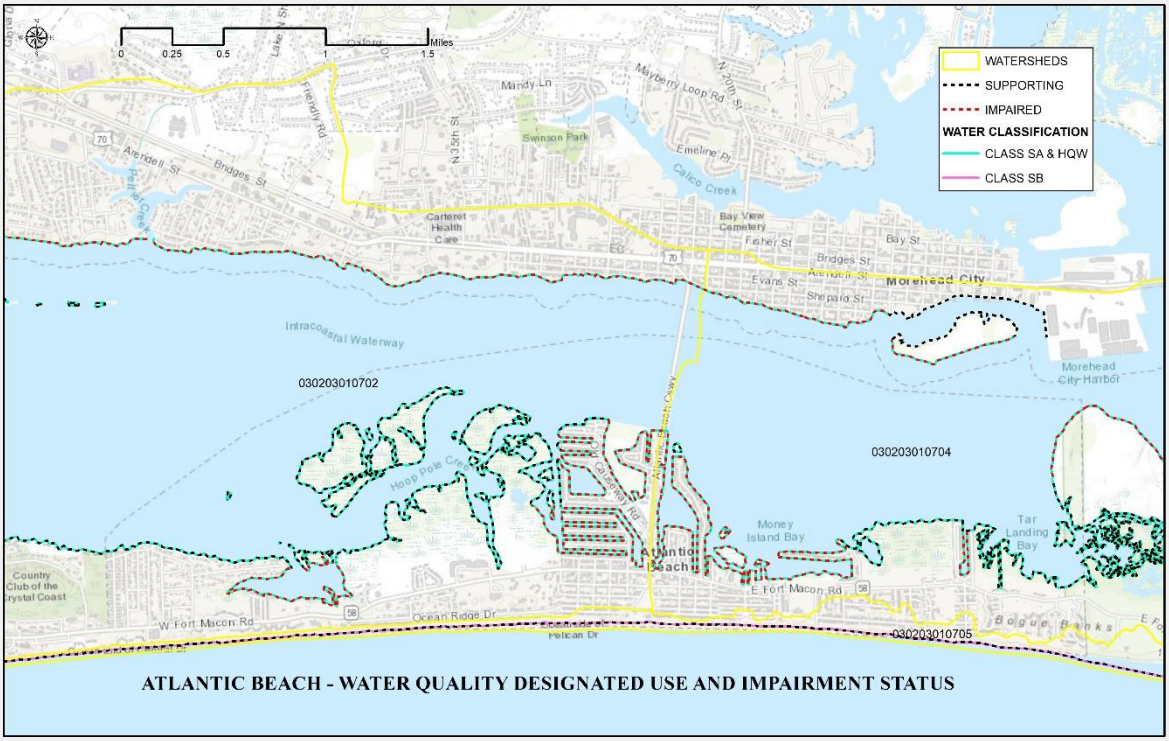


Figure 2-12: Water Quality Designated Use and Impairment Status[6]

The National Oceanic and Atmospheric Administration (NOAA) precipitation models state that a 1-year, 24-hour storm event for Atlantic Beach, NC results in **3.66** inches of precipitation and a 2-year, 24-hour storm results in **4.46** inches (Table 2-8). Both estimations are 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 shellfishing waters (Class SA) in North Carolina by DEQ. The 2-year, 24-hour storm event depth of precipitation will also be necessary as part of developing hydrographs of the data.

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.48	0.56	0.66	0.73	0.83	0.90	0.98	1.05	1.15	1.23
10-min	0.76	0.90	1.05	1.17	1.32	1.44	1.55	1.67	1.81	1.93
15-min	0.95	1.13	1.33	1.49	1.68	1.82	1.96	2.1	2.28	2.42
30-min	1.31	1.56	1.89	2.15	2.48	2.75	3.01	3.27	3.63	3.92
60-min	1.63	1.96	2.42	2.8	3.31	3.72	4.14	4.59	5.21	5.73
2-hr	2.04	2.48	3.14	3.71	4.48	5.14	5.84	6.6	7.66	8.56
3-hr	2.21	2.68	3.41	4.06	4.96	5.76	6.62	7.55	8.93	10.1
6-hr	2.67	3.23	4.12	4.91	6.03	7.02	8.09	9.27	11	12.5
12-hr	3.17	3.85	4.92	5.9	7.3	8.55	9.91	11.4	13.7	15.7
24-hr	**3.66**	**4.46**	5.76	6.86	8.49	9.89	11.4	13.1	15.7	17.9
2-day	4.22	5.11	6.56	7.81	9.69	11.3	13.2	15.2	18.3	20.9
3-day	4.5	5.45	6.97	8.25	10.1	11.8	13.5	15.5	18.5	21.1
4-day	4.78	5.8	7.37	8.68	10.6	12.2	13.9	15.8	18.7	21.3
7-day	5.52	6.65	8.35	9.76	11.8	13.5	15.3	17.2	20.1	22.4

Table 2-8: NOAA precipitation frequency table for Atlantic Beach

2.2 Source Assessment

The primary source addressed by this plan will be stormwater runoff, which carries contaminants such as bacteria. State reports and TMDL studies identified bacteria as the most predominate impairment.

2.2.1 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 shellfishing 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 amount of stormwater entering waterways. Stormwater runoff can convey a variety of nonpoint source contaminants from a variety of sources. Potential nonpoint sources range from animal sources to connected conveyance systems. There are multiple lift stations within the Atlantic Beach Watersheds. Figure 2-13 details the locations of 12 lift stations in the Atlantic Beach Watersheds.

Figure 2-13: Map of Lift Stations within Atlantic Beach[1]

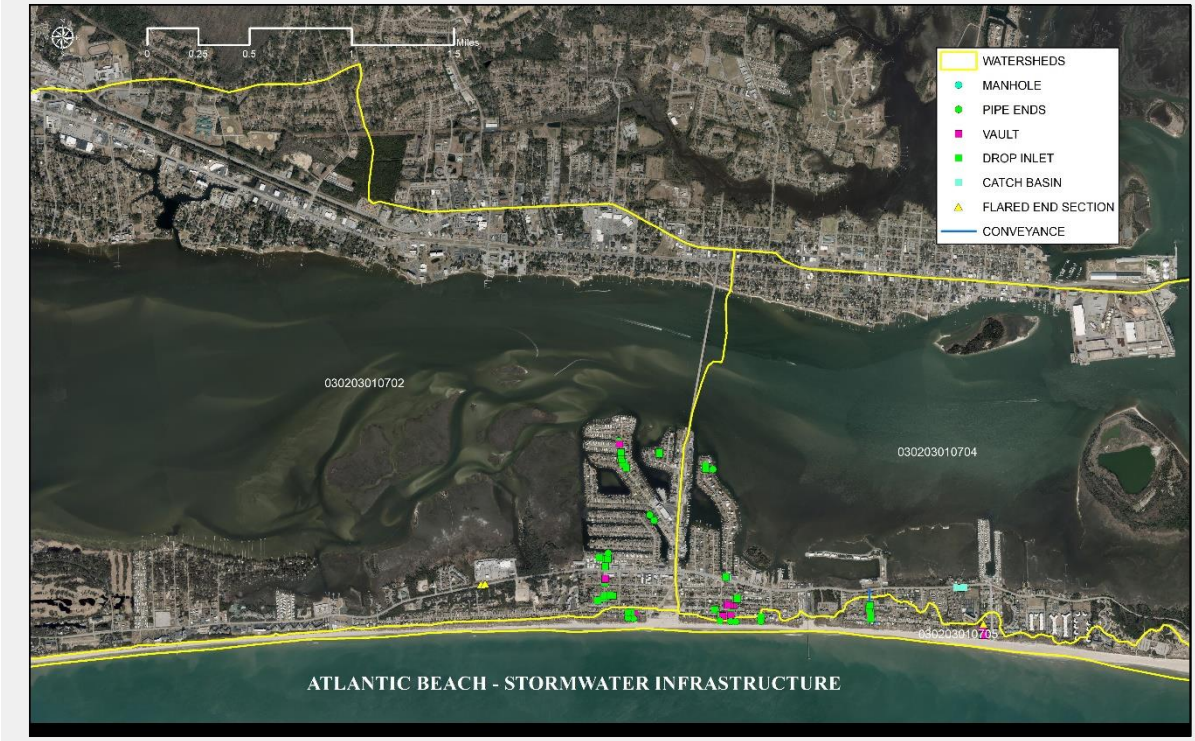


Figure 2-14: Recently Surveyed Stormwater Infrastructure within the Atlantic Beach Watersheds

A variety of potential nonpoint sources exist within the watersheds that can be attributed to water quality degradation. There are 21 potential nonpoint wastewater sources within the Atlantic Beach watersheds (Figure 2-15). 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 E-3. 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.

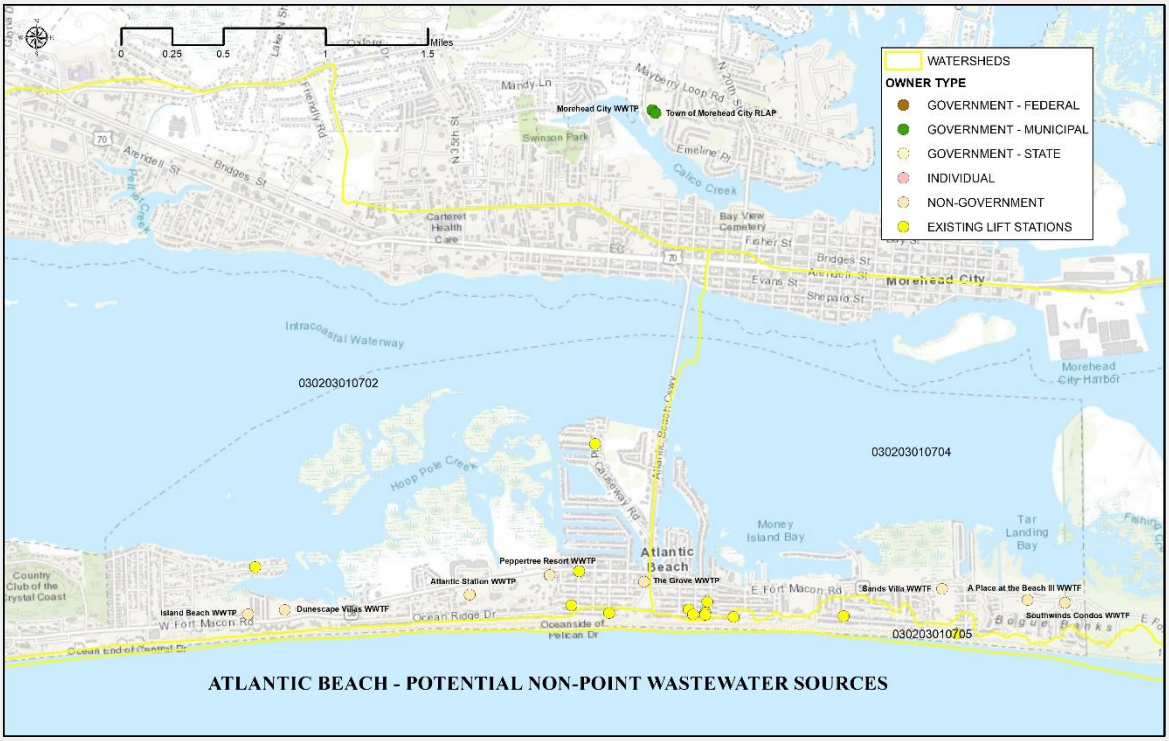


Figure 2-15: Potential Nonpoint Wastewater Sources[1]

There are numerous docks and boat ramps within the Drum Shoals and Beaufort Inlet watersheds (Figure 2-16). Issues concerning nonpoint source pollution from dockages stem from boat cleaners, litter, and fuel discharge. In addition to the dockages noted, there are numerous personal docks in both sound-side watersheds (see Appendix D for definition of each dockage). The Town should consider working with dock and marina managers to promote best management practices to ensure that potential risks are minimized.

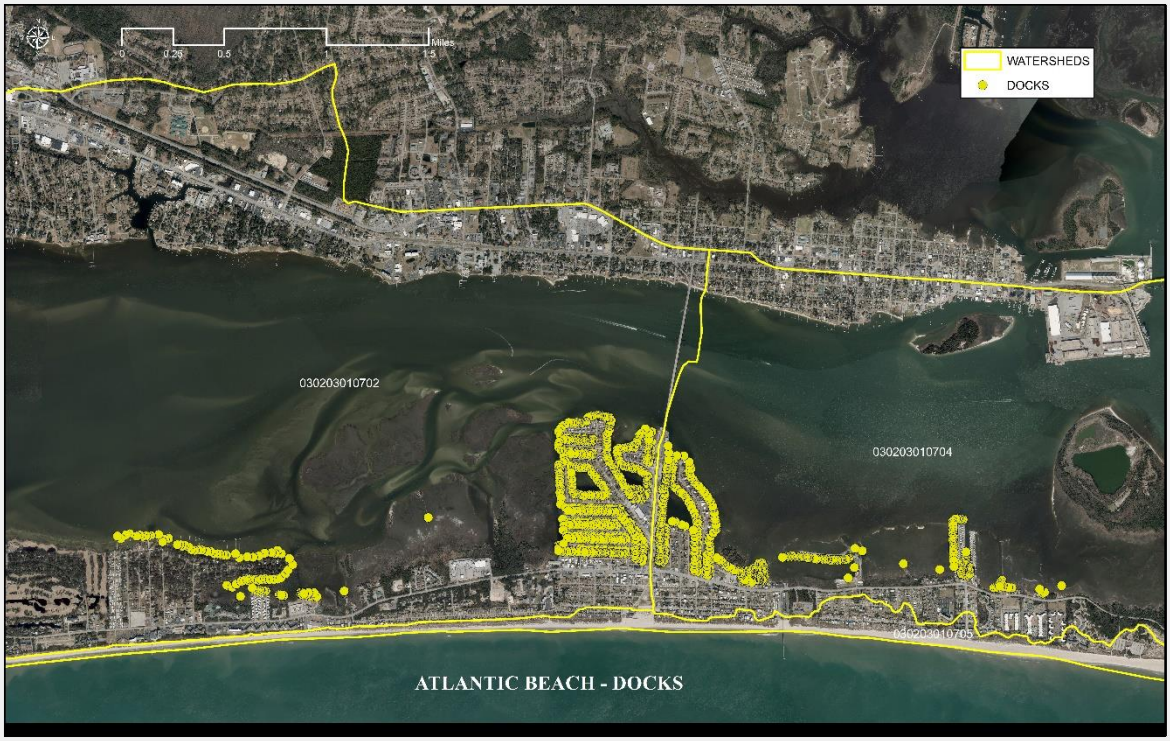


Figure 2-16: Dockage Sources

There are multiple access points that potentially enable direct access of stormwater to the waterbodies of the watershed or prevent stormwater from naturally infiltrating into the soil. These access points include curb and gutters, connected ditches, connected swales, and pipe systems that quickly transport stormwater runoff. Disconnecting connected conveyance systems to promote infiltration and slow the flow rate of runoff are some of the most effective measures to reduce the volume of stormwater runoff reaching waterways. There are 13 “Hot Spots” that experience nuisance flooding during storm events (Figure 2-17). Future projects should consider utilizing these points as potential project opportunities to both improve water quality and reduce the instances of nuisance flooding within the Town.

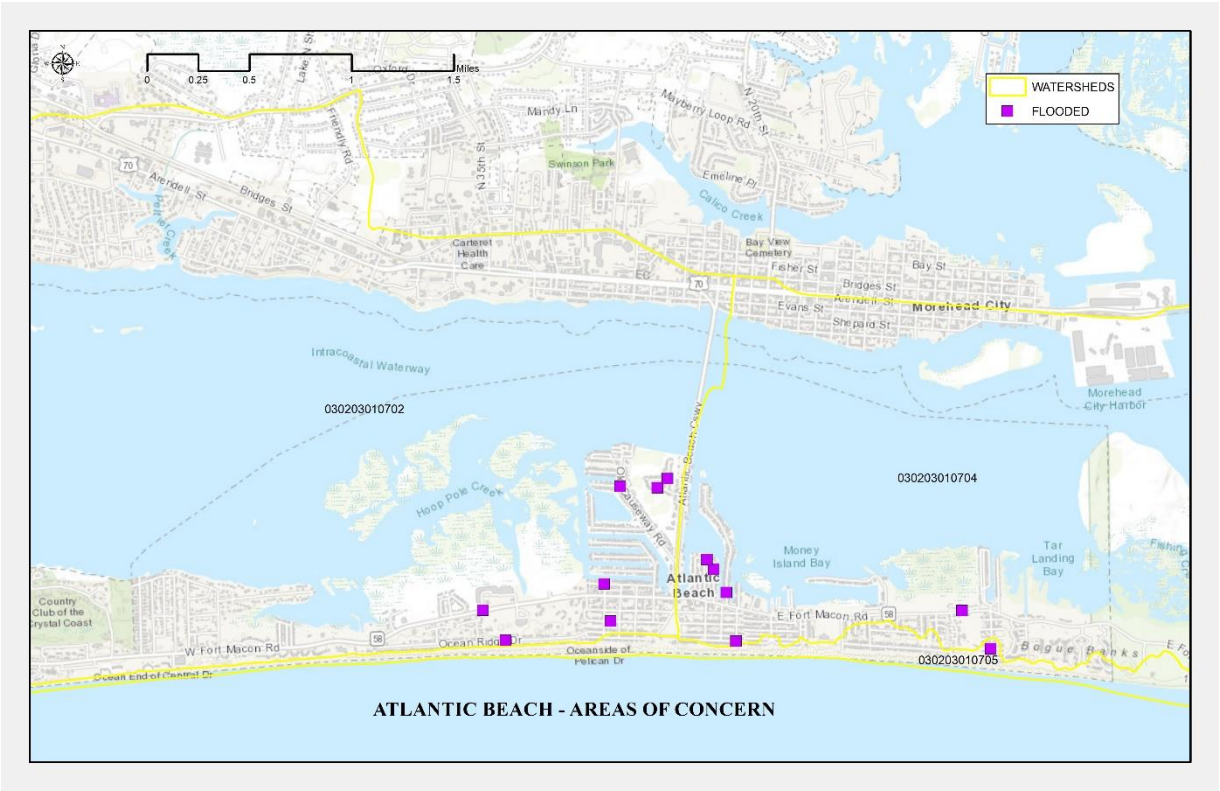


Figure 2-17: Hotspot Flooding Locations throughout Atlantic Beach

There are multiple subdivisions that are potential sources of nonpoint source pollution (Figure 2-18). Pollutants from subdivisions have the potential to be concentrated because of significant hydrologic alteration. Subdivisions can often be a source of concentrated pollution from fertilizer nutrients, pesticides, yard debris, and bacteria from domestic pets. Subdivisions often utilize conventional stormwater management such as downspouts to impervious surfaces and connected conveyance systems. It is recommended that future partnerships be developed with Homeowners Associations and that education and outreach plans be designed that emphasize residential lot-level solutions for watershed improvement.

Figure 2-18: Existing Subdivisions[1]

2.2.2 Point Sources

Point source pollution can impair water quality and represent direct sources of pollution that often have the potential to be mitigated. Point sources of pollution, unlike the diffuse nonpoint sources, are any single identifiable source of pollution from which pollutants are discharged, such as a pipe or ditch. They can pollute the water, but their effects can often be lessened or eliminated through management strategies.

There are numerous State Stormwater Permits along with three NPDES Stormwater Permits within the two watersheds (Figure 2-19, Table 2-9, Table 2-10).

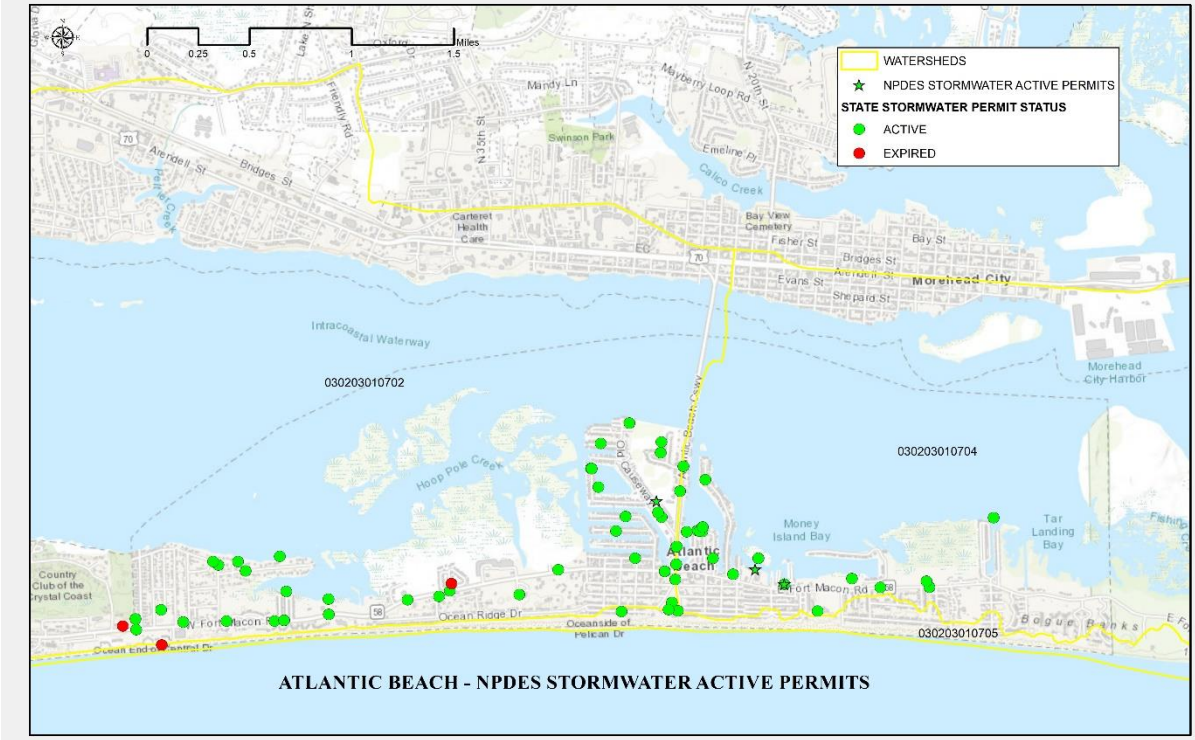


Figure 2-19: NPDES and State Stormwater Permits[1]

The following State Stormwater and NPDES permits exist:

Permit Number	Facility Name	Address
SW8040517	Alton B. Smith Pier Extension	410 Lee Dr
SW8120321	Wallace Private Docking Project	104 Forest Knoll Dr
SW8170415	Wall Docking Facility Project	108 North Ct
SW8050836	PWC Lift – Connie Lynn Ford	146 Hoop Pole Creek Dr
SW8170818	Hamlin Residential Pier Extension	122 Hoop Pole Creek Dr
SW8010544	Money Island Tract 4	Monkey Island Slough

SW8011224	N.C. Aquarium Shoreline Stabilization/Marsh Restoration Project	NC Aquarium
SW8030213	Charles R. & Katherine F. Wicker Pier	256 Oalkleaf Dr
SW8040221	Mariner's Point Marina and Maintenance Dredging	54 Miles W Of Atlantic Beach
SW8080609	Roosevelt Cove formerly Taylor Tract at Indian Beach	Indian Beach
SW8100411	Atlantic Beach Circle Recreation	Within Atlantic Ocean
SW8111120	Coral Bay Apartments Chestnutt Dredging Project	1708 And 1715 Fort Macon Rd
SW8120202	Royal Channel Maintenance Excavation	Bogue Sound
SW8090628	Sunset Villas	103 105 107 109 111 Old Causeway Rd
SW8900312	Pine Knoll Shores Storm Drainage Improvements	Various Streets
SW8961219	Old Oaks Subdivision Lots 1-6 & Reserved	Greyson Ln
SW8010923	Fort Macon State Park	2300 E Fort Macon Rd
SW8120519	Coral Bay Club Docking Facility Project	Adjacent To 1715 W Fort Macon Rd
SW8121210	Grady Pier and Boatlift Project	2200 Fort Macon Rd
SW8160724	Bogue Shores Condos Docking Facility Project	1981 W Fort Macon Rd
SW8050933	Bogue Shores	1300 W Fort Macon Rd
SW8151214	Town of Atlantic Beach Public Works Facility	1400 Fort Macon Rd
SW8880622	Island Quay Subdivision	Fort Macon Rd
SW8950834	Peppertree Villas III	715 W Fort Macon Rd
SW8010403	The Cottages At Bay Ridge	Hwy 58 Beside Atlantic Station Shopping Ctr
SW8160905	Atlantic Beach Town Park	915 Fort Macon Rd
SW8070752	Dawkins Property	231 Pond Dr
SW8080840	Lee Bulkhead Project	222 Pond Dr
SW8161113	Davis Private Docking Facility	210 Pond Dr
SW8150319	North Shore MHP Dredging	N Shore Dr I And II
SW8080928	The Grove Oceanside	W Boardwalk
SW8110719	Williamson Boatlift Project	512 N Kinston Ave
SW8110420	Mangum Boat Slip Project	125 Bowen St
SW8040532	Pirates Den Homeowners Association	127 Old Causeway
SW8020114	Seascape Condominiums	121 Old Causeway Rd
SW8131018	Jake Taylor Residential Pier	213 Smith St
SW8010915	Beach Mobile Home Court	247 Moonlight Dr
SW8181001	Windfare Condominiums	402 Causeway Rd
SW8060271	AWWI Access Channel	HWY 58
SW8051230	Channel Dredging Town of Atlantic Beach	Atlantic Beach W Of Atlantic Beach
SW8080839	Causeway Channel Dredging	Waters Of Bogue Sound
SW8140109	The Grove East and West Drives	E And W Drives
SW8890710	Maritime Village	NC 58
SW8890820	Coral Cay	Off Salter Path Rd
SW8920915	Atlantic Beach Water System Improvements	NA
SW8990316	Town Of Atlantic Beach Channel Dredging	NA
SW8050715	The Grove	Atlantic Beach Cir
SW8140910	The Grove ll	Atlantic Blvd
SW8120912	Ocean King Condominiums	Atlantic Blvd And E Dr
SW8090344	Piner Family Boatlift	200 Davis Blvd
SW8020525	Demus L. Thompson Boat Slip & Maintenance on Seawall	205 Atlantic Beach Causeway
SW8091024	El Zarape in Atlantic Beach	204 Atlantic Beach Causeway

SW8021223	Dewar Dockage	235 Bayview Blvd
SW8091021	McCurdys Restaurant Dock Project	505 Atlantic Beach Causeway
SW8020606	Hales Estate Pier Extension	612 Atlantic Beach Causeway
SW8020313	Beard Trust	105 Shore Dr
SW8041107	Soundview Isles-Block 15, Lot1	107 Shore Dr
SW8070751	Loft Hooper Boatlift	103 Shore Dr
SW8080741	Trevathan Residence	105 Shore Dr
SW8170326	No Excavation Project	107 Shore Dr
SW8020827	West Bogue Condo Association	113 Bogue Sound Dr
SW8170608	300 Atlantic Beach Causeway Docking Facility	300 Atlantc Beach Causeway
SW8010528	Money Island-Tracts I, 2,3,& 4	N Of Brooks Ave Across From Money Is Subdiv
SW8010542	Money Island- Tract 2	Money Is
SW8010543	Money Island Tract 3	Monkey Island Slough
SW8110917	Anchorage Marina	517 E Fort Macon Rd
SW8140333	Cannon Dock and Boatlift Project	102 Bayview Blvd
SW8950912	NCSPA Morehead Woodchip Handling Expansion	100 Port Terminal Rd
SW8020303	Dunes Club	Ft Macon Blvd
SW8021108	8 ½ Marina Homeowners Assoc. Floating Dock & Boat Slips (3)	1013 E Fort Macon Rd
SW8060317	Asbury Beach Maintenance	E Fort Macon Rd
SW8061003	The Pinnacle	431 E Fort Macon Rd
SW8170226	Triple ESS Dredging Project	Bogue Sound
SW8990714	Seaside Villas formerly Jungleland Family Theme Park	2800 W Fort Macon Rd

Table 2-9: List of State Stormwater Permits within Atlantic Beach Watersheds

Permit Number	Facility Name	Address
NCG190049	Crows Nest Yacht Club – Atlantic Beach	407 Atlantic Beach Causeway
NCG190036	Fort Macon Marina – Atlantic Beach	417 Fort Macon Rd
NCG190002	Anchorage Marina	517 E Fort Macon Rd

Table 2-10: List of NPDES Permits within Atlantic Beach Watersheds

2.2.3 Additional Sources

There is one registered brownfield site within the Drum Shoals Watershed across the sound from Atlantic Beach along with two regulated hazardous waste sites and one hazardous substance spill/disposal site. In addition to these, there are numerous regional underground storage tanks throughout both the Drum Shoals watershed as well as the Beaufort Inlet watershed.

Figure 2-20: Stormwater Areas of Concern

3 Runoff Volume Reduction

Coastal areas have undergone significant change as land use practices have intensified through the increase in agriculture, forestry, and development. Prior to human alteration, rainwater was absorbed into the ground, evaporated, or used by vegetation through natural hydrologic processes. Specifically, when rainwater is absorbed through the ground, bacteria and other contaminants are filtered out. Intensive land use can overwhelm the effectiveness of stormwater systems. Certain stormwater management methods such as discharging directly into water bodies via pipes contribute to water quality degradation and flooding. As impervious surfaces and stormwater runoff increase, the hydrology of the land is altered which 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, stormwater runoff flows over impervious surfaces and into waterbodies with limited opportunity to naturally absorb into the environment. Impervious surfaces increase the volume of water being transported to stormwater conveyance systems, which increases instances of nuisance flooding. As water travels across impervious surfaces, bacteria and other contaminants are collected and transported through connected conveyance systems, such as curbs and pipes that discharge directly into our waterways. By reducing the volume of stormwater runoff, we can reduce the amount of stormwater flowing through conveyance systems. This reduces the number of instances, the impacted area, and the duration of nuisance flooding. Reducing stormwater runoff can also reduce the transport of bacteria and other contaminants such as total suspended solids, nutrients, pesticides, and heavy metals.

Rather than focusing on reducing sources of contamination or attempting the difficult task of treating contaminants from stormwater runoff, ***the management techniques identified in this plan focus on reducing the overall volume of stormwater runoff to limit the conveyance from the land into coastal waters***. Low-impact development (LID) 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 is affected by the following factors: the natural mortality of fecal coliform and enterococcus bacteria, the prevention of bacteria and contaminants from entering waterbodies, and the reduction in the velocity of waters entering water bodies as a result of lower flows. Infiltration of rainfall into the ground can serve as an effective filtration system of bacteria and other

contaminants. 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 one of the primary causes of increased fecal coliform impairments and localized flooding within the Atlantic Beach Watersheds.

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	Volume of water

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

3.1 Calculation Methodology

Stormwater runoff for Atlantic Beach was calculated using the SCS Curve number method. In order to compare the watersheds over time and to set a volume reduction goal, historic aerial imagery was used to determine the curve numbers of specific land sections. This included tracing out sections of the island and assigning those sections to specific pre-determined cover conditions with corresponding curve numbers based on the soil types found within Atlantic Beach. Sections of Atlantic Beach were placed into the category that most nearly represented their condition based on aerial imagery observation rather than parcel information. For example, if a portion of land had the same impervious coverage as a typical 1-acre residential tract, it was analyzed as having the same curve number as a 1-acre residential tract with HSG A soils. This methodology was used for consistency across all analysis due to the development of the island over the last five decades as well as the lack of historic parcel information. Additionally, a typical curve number based on residential parcel information would be reflective of urban and suburban areas whereas the residential areas within Atlantic Beach are compact with buildings situated closely together. Utilizing this aerial imagery method allowed for watershed specific curve numbers to be calculated for each decade being analyzed. Previous analyses have utilized current NOAA ATLAS 14 values for rainfall depth as well as rainfall intensity. To have a better understanding of historic rainfall runoff conditions within Atlantic Beach, time accurate historic rainfall depth and intensity values were

used. This resulted in lower values for historic stormwater runoff volume as well as lower peak flow values while providing more accurate sense of what stormwater conditions have historically been. Hydrographs were developed using Dr. Malcolm's Small Watershed Method for each of the three watersheds located in Atlantic Beach across each analysis period resulting in a total of 15 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 following land cover classifications and curve numbers were used in all calculations

The following designations were utilized to categorize land use:

Land Surface Cover	Description	Impervious Percentage	Curve Number
0.125 acre	Those areas within the watershed which exhibit impervious coverage similar to that of a 0.125 acre residential lot	65	77
0.25 acre	Those areas within the watershed which exhibit impervious coverage similar to that of a 0.25 acre residential lot	38	61
0.33 acre	Those areas within the watershed which exhibit impervious coverage similar to that of a 0.33 acre residential lot	32	57
0.5 acre	Those areas within the watershed which exhibit impervious coverage similar to that of a 0.5 acre residential lot	27	54
1 acre	Those areas within the watershed which exhibit impervious coverage similar to that of a 1 acre residential lot	22	51
2 acre	Those areas within the watershed which exhibit impervious coverage similar to that of a 2 acre residential lot	13	46
COMMERCIAL	Those areas within the watershed which exhibit impervious coverage similar to that of commercially developed land	84	89
IMPERVIOUS	Those areas within the watershed which exhibit impervious coverage that inhibits stormwater infiltration	99	98
PERVIOUS	Those areas within the watershed that experience minimal impervious coverage and are effectively undeveloped	2	39

Table 3-2: Land Surface Cover Characterization

3.2 Runoff Calculations

The following were found for each of the three watersheds in Atlantic Beach

	Drum Shoals			Beaufort Inlet			Shackleford Banks		
1970's	**COVER**	**AREA (acres)**	**Δ (acres)**	COVER	**AREA (acres)**	**Δ (acres)**	COVER	**AREA (acres)**	**Δ (acres)**
	0.125 acre	61.2	NA	0.125 acre	42.5	NA	0.125 acre	26.7	NA
	0.25 acre	28.5	NA	0.25 acre	33.3	NA	0.25 acre	9.4	NA
	0.33 acre	9.1	NA	0.33 acre	10.2	NA	0.33 acre	0.0	NA
	0.5 acre	31.3	NA	0.5 acre	12.2	NA	0.5 acre	0.0	NA
	1 acre	10.9	NA	1 acre	2.8	NA	1 acre	0.0	NA
	2 acre	69.8	NA	2 acre	2.9	NA	2 acre	2.3	NA
	COMMERCIAL	41.0	NA	COMMERCIAL	19.0	NA	COMMERCIAL	9.9	NA
	IMPERVIOUS	15.2	NA	IMPERVIOUS	26.4	NA	IMPERVIOUS	4.0	NA
	PERVIOUS	381.2	NA	PERVIOUS	192.0	NA	PERVIOUS	77.9	NA
	CN	**50**	NA	CN	**54**	NA	CN	**54**	NA

	Drum Shoals			Beaufort Inlet			Shackleford Banks		
1980's	**COVER**	**AREA (acres)**	**Δ (acres)**	COVER	**AREA (acres)**	**Δ (acres)**	COVER	**AREA (acres)**	**Δ (acres)**
	0.125 acre	154.1	92.9	0.125 acre	86.1	43.6	0.125 acre	31.4	4.7
	0.25 acre	117.1	88.6	0.25 acre	67.6	34.3	0.25 acre	10.7	1.3
	0.33 acre	22.4	13.3	0.33 acre	10.3	0.2	0.33 acre	4.0	4.0
	0.5 acre	25.4	-6.0	0.5 acre	6.7	-5.5	0.5 acre	0.4	0.4
	1 acre	9.1	-1.8	1 acre	0.0	-2.8	1 acre	0.0	0.0
	2 acre	0.0	-69.8	2 acre	0.0	-2.9	2 acre	0.0	-2.3
	COMMERCIAL	75.6	34.6	COMMERCIAL	60.3	41.3	COMMERCIAL	11.2	1.3
	IMPERVIOUS	18.6	3.3	IMPERVIOUS	26.3	-0.1	IMPERVIOUS	4.0	0.0
	PERVIOUS	226.0	-155.3	PERVIOUS	86.1	-105.9	PERVIOUS	68.6	-9.3
	CN	**61**	11.0	CN	**67**	13.0	CN	**57**	3.0

	Drum Shoals			Beaufort Inlet			Shackleford Banks		
1990's	COVER	AREA (acres)	Δ (acres)	COVER	AREA (acres)	Δ (acres)	COVER	AREA (acres)	Δ (acres)
	0.125 acre	192.2	38.1	0.125 acre	87.9	1.8	0.125 acre	32.4	1.0
	0.25 acre	84.5	-32.6	0.25 acre	70.8	3.2	0.25 acre	9.8	-0.9
	0.33 acre	25.6	3.2	0.33 acre	22.3	12.0	0.33 acre	4.0	0.0
	0.5 acre	29.5	4.1	0.5 acre	0.4	-6.3	0.5 acre	6.7	6.3
	1 acre	13.6	4.5	1 acre	0.0	0.0	1 acre	0.0	0.0
	2 acre	0.0	0.0	2 acre	0.0	0.0	2 acre	0.0	0.0
	COMMERCIAL	90.1	14.5	COMMERCIAL	61.9	1.7	COMMERCIAL	11.2	0.0
	IMPERVIOUS	18.8	0.3	IMPERVIOUS	26.3	0.0	IMPERVIOUS	4.0	0.0
	PERVIOUS	193.9	-32.1	PERVIOUS	73.7	-12.4	PERVIOUS	62.1	-6.5
	CN	**63**	2.0	CN	**68**	1.0	CN	**58**	1.0
	Drum Shoals			**Beaufort Inlet**			**Shackleford Banks**		
2000's	COVER	AREA (acres)	Δ (acres)	COVER	AREA (acres)	Δ (acres)	COVER	AREA (acres)	Δ (acres)
	0.125 acre	247.1	54.9	0.125 acre	95.3	7.4	0.125 acre	37.9	5.5
	0.25 acre	124.2	39.7	0.25 acre	76.5	5.7	0.25 acre	14.6	4.9
	0.33 acre	29.5	3.8	0.33 acre	15.2	-7.1	0.33 acre	10.7	6.7
	0.5 acre	0.0	-29.5	0.5 acre	0.0	-0.4	0.5 acre	0.0	-6.7
	1 acre	7.7	-5.9	1 acre	0.0	0.0	1 acre	0.0	0.0
	2 acre	0.0	0.0	2 acre	0.0	0.0	2 acre	0.0	0.0
	COMMERCIAL	93.2	3.0	COMMERCIAL	65.2	3.3	COMMERCIAL	8.2	-3.0
	IMPERVIOUS	18.8	0.0	IMPERVIOUS	26.3	0.0	IMPERVIOUS	4.0	0.0
	PERVIOUS	127.7	-66.1	PERVIOUS	64.8	-9.0	PERVIOUS	54.8	-7.3
	CN	**68**	5.0	CN	**69**	1.0	CN	**59**	1.0
	Drum Shoals			**Beaufort Inlet**			**Shackleford Banks**		
2010's	COVER	AREA (acres)	Δ (acres)	COVER	AREA (acres)	Δ (acres)	COVER	AREA (acres)	Δ (acres)
	0.125 acre	247.1	0.0	0.125 acre	99.1	3.7	0.125 acre	38.6	0.7
	0.25 acre	122.6	-1.6	0.25 acre	72.4	-4.1	0.25 acre	13.6	-1.0
	0.33 acre	30.1	0.6	0.33 acre	14.9	-0.4	0.33 acre	10.7	0.0
	0.5 acre	0.0	0.0	0.5 acre	0.0	0.0	0.5 acre	0.0	0.0
	1 acre	12.7	4.9	1 acre	0.0	0.0	1 acre	0.0	0.0
	2 acre	0.0	0.0	2 acre	0.0	0.0	2 acre	0.0	0.0
	COMMERCIAL	90.8	-2.4	COMMERCIAL	65.2	0.0	COMMERCIAL	8.2	0.0
	IMPERVIOUS	18.8	0.0	IMPERVIOUS	26.3	0.0	IMPERVIOUS	4.0	0.0
	PERVIOUS	126.2	-1.5	PERVIOUS	65.5	0.7	PERVIOUS	55.1	0.3
	CN	**67**	-1.0	CN	**69**	0.0	CN	**59**	0.0

Table 3-3: Summary of Watershed Specific Land Cover and Curve Number Changes by Decade within Atlantic Beach

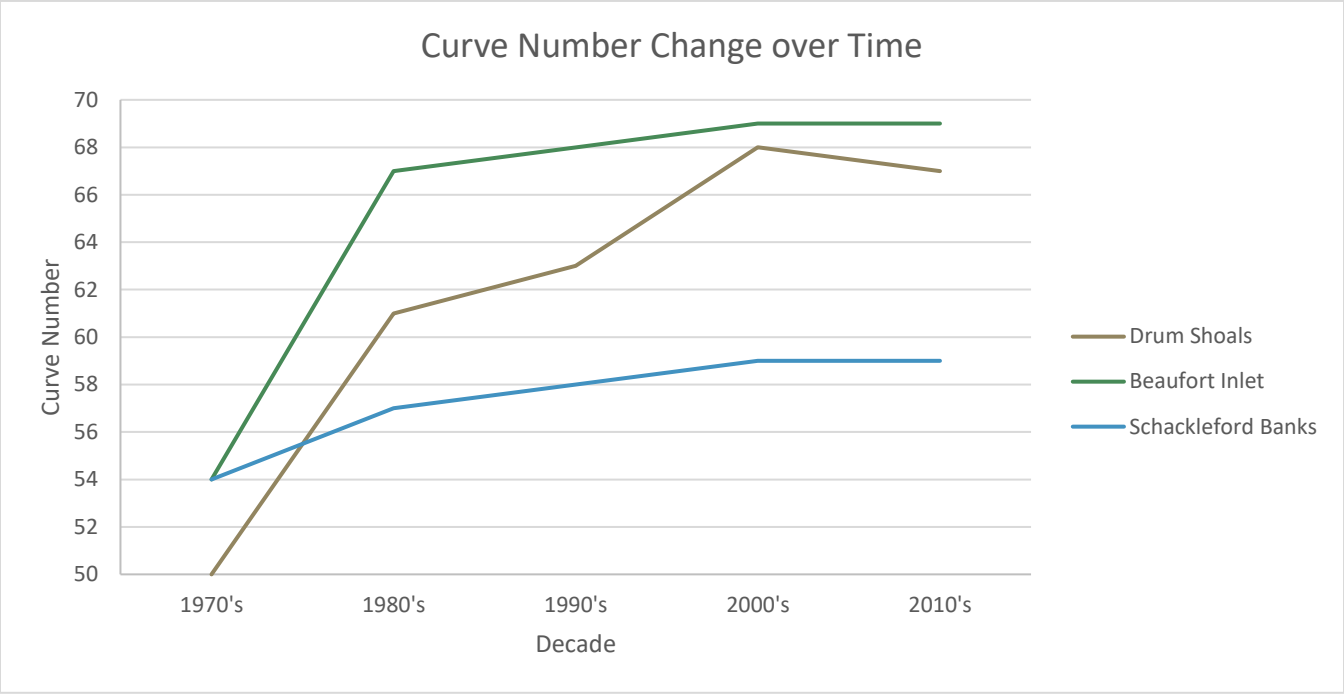


Figure 3-1: Atlantic Beach Watersheds Curve Number Change over Time

DECADE	HUC 030203010702 Drum Shoals			
	SCS Runoff Volume (AC-FT)	Rational Method Peak Flow (CFS)	Simple Method Runoff Volume (AC-FT)	Dimensionless Hydrograph Peak Flow (CFS)
1970's	26.3	164	18.7	47
1980's	56.8	240	31.8	128
1990's	65.2	251	34.8	153
2000's	79.7	289	39.8	194
2010's	79.2	284	39.6	193
DECADE	HUC 030203010704 Beaufort Inlet			
	SCS Runoff Volume (AC-FT)	Rational Method Peak Flow (CFS)	Simple Method Runoff Volume (AC-FT)	Dimensionless Hydrograph Peak Flow (CFS)
1970's	19.8	255	12.6	82
1980's	41.1	374	20.7	216
1990's	43.1	389	21.3	226
2000's	45.6	396	22.2	239
2010's	45.9	396	22.2	241
DECADE	HUC 030203010705 Shackleford Banks			

	SCS Runoff Volume (AC-FT)	Rational Method Peak Flow (CFS)	Simple Method Runoff Volume (AC-FT)	Dimensionless Hydrograph Peak Flow (CFS)
1970's	7.4	67	4.7	17
1980's	8.8	74	5.4	29
1990's	9.3	76	5.6	32
2000's	10.2	78	5.9	35
2010's	10.2	78	5.9	35
DECADE	TOTAL			
	SCS Runoff Volume (AC-FT)	Rational Method Peak Flow (CFS)	Simple Method Runoff Volume (AC-FT)	Dimensionless Hydrograph Peak Flow (CFS)
1970's	53.5	486	36.1	145
1980's	106.7	689	57.8	373
1990's	117.6	716	61.7	410
2000's	135.5	764	67.8	469
2010's	135.3	758	67.8	469

Table 3-4: Summary of the Total Runoff Volume Reduction Goals of the Atlantic Beach Watersheds

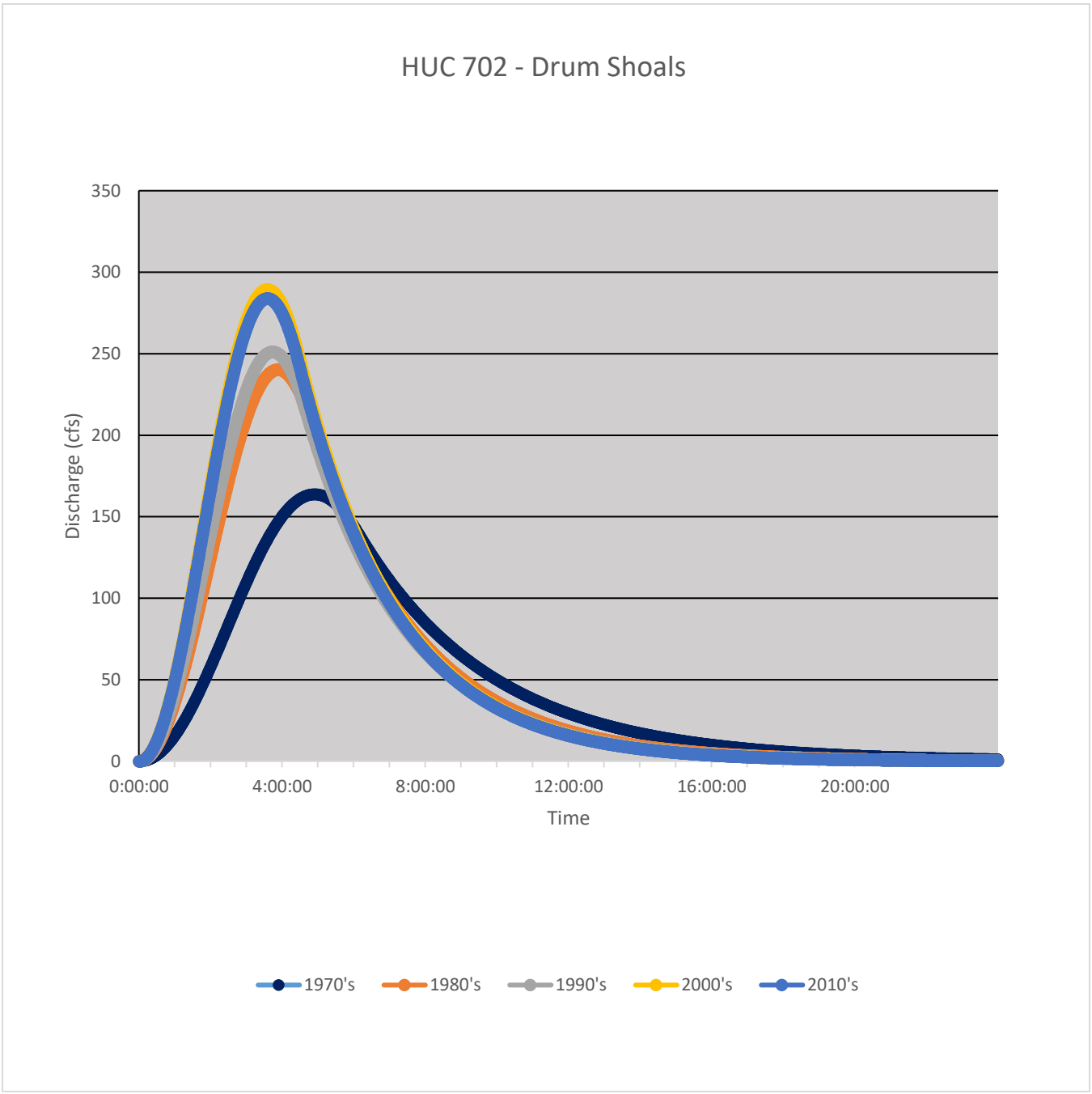


Figure 3-2: Stormwater Runoff Within the Drum Shoals Watershed from the 1970's to the 2010's

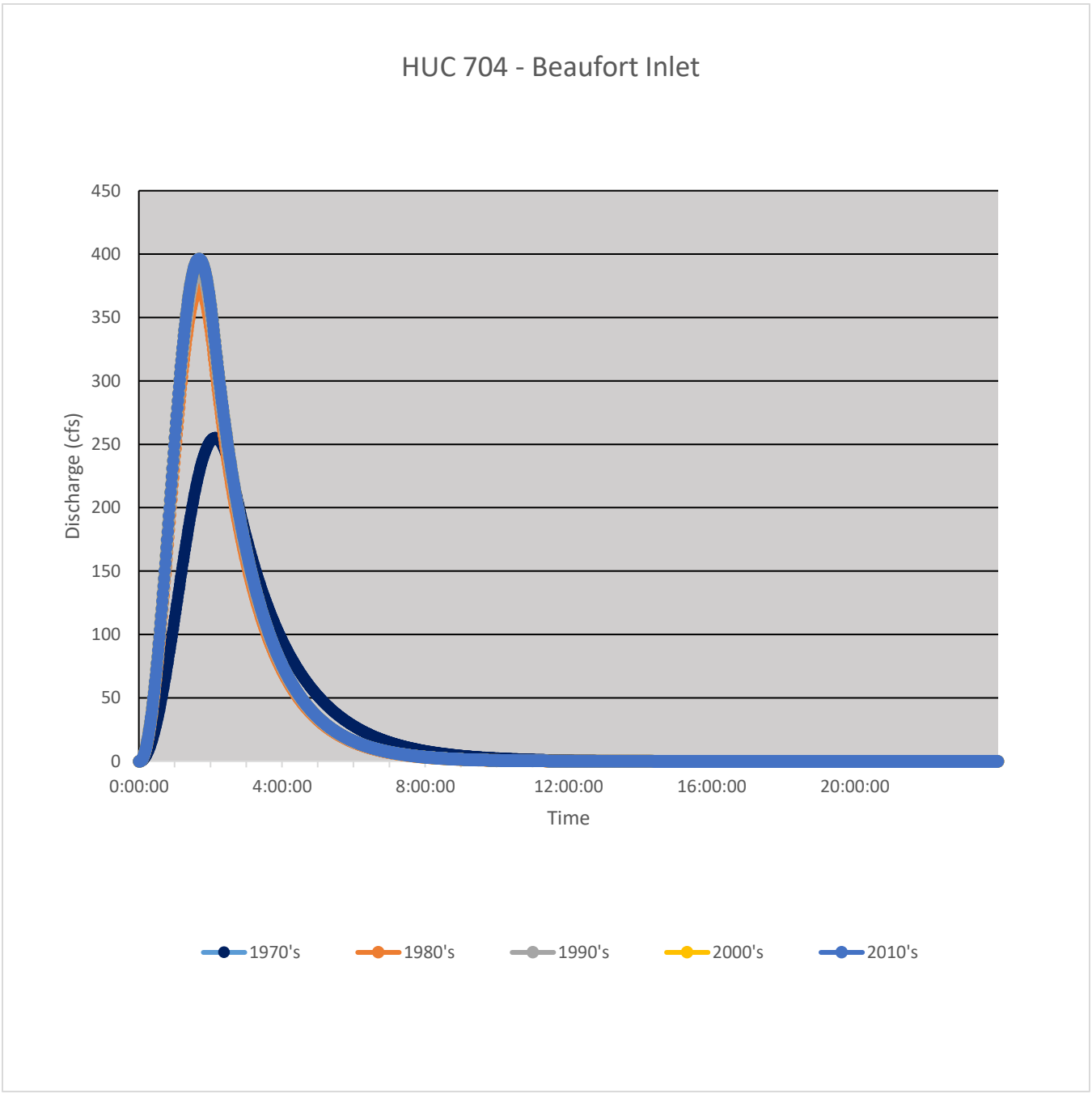


Figure 3-3: Stormwater Runoff within the Beaufort Inlet Watershed from the 1970's to the 2010's

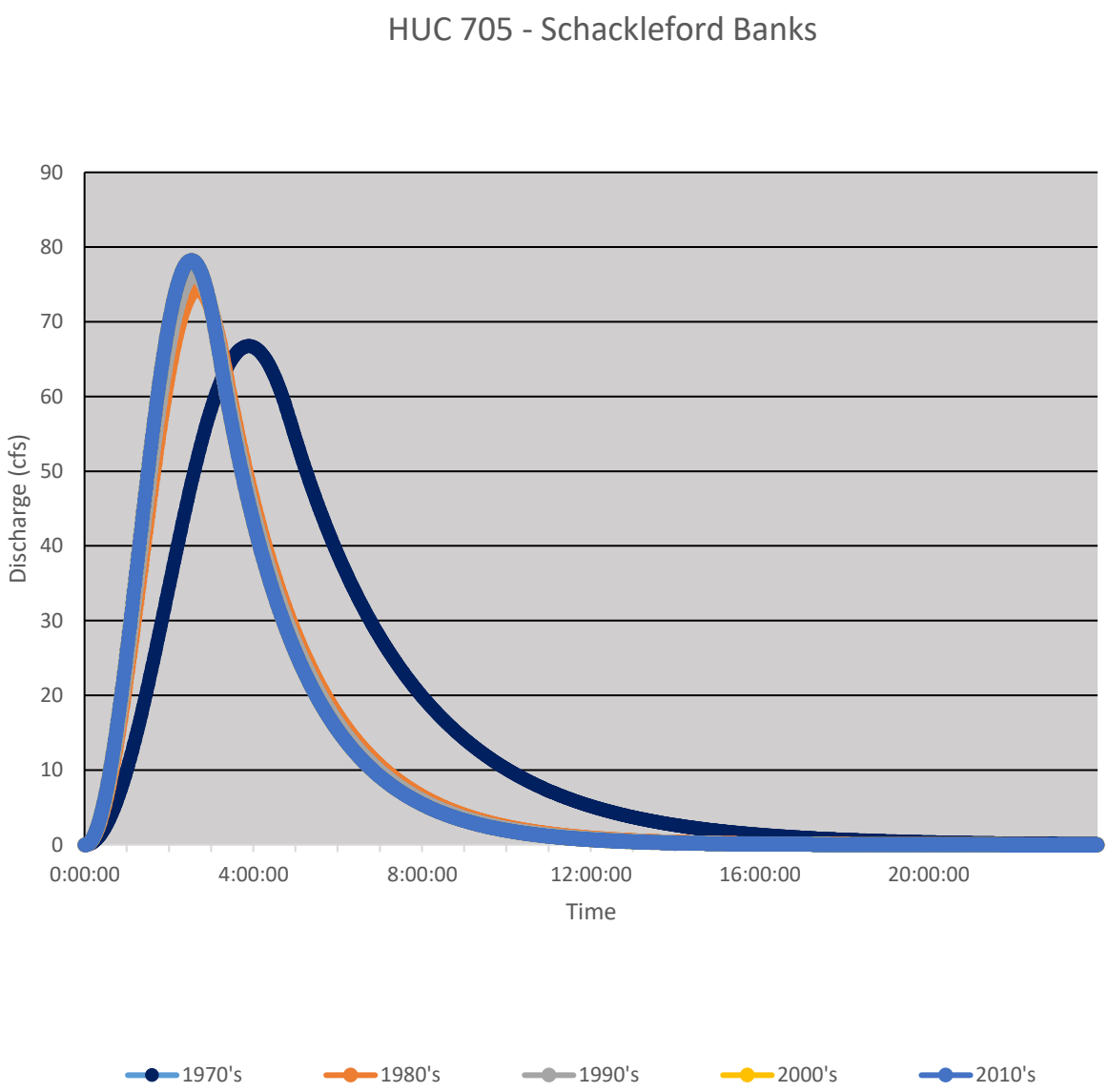


Figure 3-4: Stormwater Runoff within the Shackleford Banks Watershed from the 1970's to the 2010's

4 Goals

The Town of Atlantic Beach seeks to utilize various stormwater reduction techniques to reduce stormwater runoff by 0.19 gallons per square foot. This will be achieved through targeted stormwater retrofits and projects that infiltrate, store, divert, and attenuate stormwater before it reaches surface waters. Mimicking the natural hydrology and processes of drainage reduces flooding and improves water quality. The comprehensive plan will require Town and community commitment and involvement for implementation.

4.1 Primary Goal

The goal of this plan is to restore impaired water quality, reduce nuisance flooding, and enhance resilience within two of the three Atlantic Beach watersheds. This will be accomplished by combining low-cost, high-yield strategies such as community outreach initiatives and lot level retrofit projects that reduce the impact of impervious surface by mimicking natural hydrology to reduce flooding, protect water quality, and provide the community with clean, usable waters. **This goal will be accomplished over the coming 20 years by achieving objectives and management actions identified below.** This plan uses the innovative approach of reducing runoff volumes within the Atlantic Beach watersheds to reduce existing water quality impairments and restore water quality. As with other plans that incorporate this volume reduction philosophy, this plan emphasizes six restoration objectives to accomplish its goals (Table 4-1).

Primary Goal *Restore impaired water quality, reduce nuisance flooding, and enhance resilience in two of the three Atlantic Beach watersheds*	
Objectives	
1	Data collection and analysis is conducted to accomplish the plan objectives.
2	New developments and redevelopments do not create additional water quality impairments or nuisance flooding.
3	Stormwater reduction techniques are applied on public properties.
4	The volume of stormwater runoff is reduced from existing private land uses.
5	Periodic monitoring and review is conducted to ensure the goal and objectives of the plan are being met.
6	The community is educated about stormwater needs and engaged in accomplishing plan objectives.

Table 4-1: Primary Goal

4.1.1 Objective 1

This objective seeks to conduct and organize research to aid watershed decision makers in implementing the best course of actions based on the most up-to-date data.

Objective 1: *Data collection and analysis is conducted to accomplish the plan objectives.*	
Action #	Specific Action
1-1	Seek funding to conduct a thorough analysis of the region's soils to determine the region's potential for infiltration, which will be of value to both existing and new development, the town, and future stormwater reduction projects.
1-2	Seek funding to conduct more thorough analysis of water quality and quantity, discharge characteristics, and water table height. Utilize findings to aid in future land management and retrofit decisions to best use the natural hydrology.
1-3	When possible, encourage and work with local researchers, organizations, and academia to conduct research that would align with the needs of the plan.
1-4	If necessary, collate past, present, and proposed research into a single source or database to make data analysis and research easier for future needs.
1-5	Continue water quality sampling with Dr. Noble on an annual basis as a supplement to the data from shellfish sanitation

Table 4-2: Objective 1

4.1.2 Objective 2

This objective is to ensure that new development and redevelopment do not produce additional water quality impairments to the watershed

Objective 2: ***New developments and redevelopments do not create additional water quality impairments.***	
Action #	Specific Action
2-1	A subcommittee will review existing town codes and ordinances to determine impediments to low impact stormwater designs for new development and redevelopment. The findings will be presented to the Town with any suggested amendments and discussion of any potential incentive plans (see Appendix F for various engagement plans).
2-2	Adopt a stormwater management program to supplement gaps in the state's stormwater program and the Town's needs. Some gaps identified thus far include: • Redevelopment • Smaller projects not covered under the State's Stormwater Program • Oversight of installation and maintenance of State permitted systems

Table 4-3: Objective 2

4.1.3 Objective 3

The volume of stormwater runoff being transported over land to waterways needs to be reduced to restore water quality with the goal of reducing the volume of stormwater conveyed to levels that occurred during the baseline decade of 1980. By focusing one of the objectives on efforts at public lands and conveyance systems, the Town can lead by example and demonstrate commitment to improving watershed health to the community

Objective 3: ***Stormwater reduction techniques are applied on public properties.***	
Action #	Specific Action
3-1	Identify stormwater reduction measure opportunities on town streets, rights-of-ways, buildings, parks, parking lots, drainage systems, and other public properties. Prioritize retrofits at public buildings and properties that can serve as demonstration sites of stormwater retrofits.

3-2	Evaluate existing stormwater systems on public properties for potential volume reduction enhancements, and if feasible, retrofit them to achieve volume reduction.
3-3	Investigate stormwater grants and other funding sources annually to supplement the Town's expenditure on retrofits and projects
3-4	Incorporate, where practical, Green Street Designs (see Appendix G) into future capital improvements of town streets.
3-5	Pursue strategy with N.C. Department of Transportation (DOT) to incorporate retrofits into the highway 58 drainage system. Pursue strategy with DOT that any new road upgrades or maintenance plans include plans for reducing runoff.
3-6	Training with public works staff on street sweeping and grading of "micro-dune" near the road edge that causes water pockets to form on the road.

Table 4-4: Objective 3

4.1.4 Objective 4

The objective is intended to address existing stormwater runoff from private land use by identifying and promoting cost effective strategies private residence and businesses can incorporate.

Objective 4: ***The volume of stormwater runoff is reduced from existing private land uses.***	
Action #	Specific Action
4-1	Identify retrofit sites with private partners, prioritizing sites by potential for volume reduction cost-benefit, such as sites identified as exceptional because of the physical and natural characteristics, accessibility, cost, public outreach opportunity, and current land uses.
4-2	Investigate stormwater grants and other funding sources annually to supplement the Town's expenditure on retrofits and projects
4-3	Work with governmental agencies and NGOs to secure grants to provide funding to install lot-level, low-cost retrofits that disconnect impervious surfaces and enhance stormwater infiltration.
4-4	Provide landowners incentives to disconnect impervious surfaces or minimize stormwater runoff from their property (see Appendix F for various strategies).
4-5	Explore opportunities with Community Conservation Assistance Program (CCAP).
4-6	Coordinate stormwater management practices with maritime forest management to ensure evapotranspiration by current vegetation is optimized. *This can be coordinated during regularly scheduled planning board meetings to keep issue on the agenda.*

Table 4-5: Objective 4

4.1.5 Objective 5

Accomplishing the actions in this plan requires monitoring of 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 will be measured. This plan will be adapted as necessary based upon the results of this monitoring.

Objective 5: ***Periodic monitoring and review is conducted to ensure the goal and objectives of the plan are being met.***	
Action #	Specific Action
5-1	Maintain an inventory and monitor performance of stormwater reduction retrofits that have been installed within the watersheds.
5-2	Conduct yearly, scheduled assessment of the plan and progress made to date with the project team.
5-3	Update the plan every five years based upon findings from water quality data and the status of implementation and findings from yearly assessment review of plan implementation (see Action 5-1).
5-4	Document the volume of stormwater reduced by each retrofit by utilizing the Runoff Reduction Calculator Tool or other appropriate volume calculation methodology, which will be maintained by the Town.

Table 4-6: Objective 5

4.1.6 Objective 6

Community education will be a necessary component to achieving the primary goal of this plan. Education of all members of the community including residents, property owners, developers and others can help ensure understanding of the issues and need for action.

Objective 6: ***The community is educated about stormwater pollution and volume reduction needs and engaged in accomplishing the plan objectives.***	
Action #	Specific Action
6-1	Collaborate with partners to implement education and engagement activities for property owners, businesses, and K-12 students and their families.
6-2	Provide technical training opportunities for planners, engineers, developers, landscapers and local government staff on techniques to reduce volume of stormwater within the town.

6-3	Work with existing water quality outreach professionals, including: North Carolina Coastal Federation, UNC Institute of Marine Sciences, Duke University Marine Laboratory, Scientific Research & Education Network (SciREN), and N.C. Coastal Reserve on a stormwater education initiatives.
6-4	Include education signage at select retrofits and place emphasis on highlighting the town's commitment to native vegetation planting.
6-5	Printing and mailing of Smart Yard (or similar outreach material designed for the Town) to residents with additional prints made available at the Town Hall

Table 4-7: Objective 6

5 Management Strategies

The management solutions, strategies, and techniques within this section and Section 6 are strictly intended to be potential opportunities that the town can consider based on the information compiled during the development of this plan. The solutions listed are general in scope and do not reflect actual projects that are being planned for implementation. Site assessments, additional considerations, and research should be conducted before implementing any management solution.

5.1 Reduction Techniques

Various stormwater management techniques can be implemented. Retrofits that reduce the volume of stormwater runoff will be prioritized over other project types. For residential areas, emphasis will be placed on various single-family home retrofits, such as downspout retrofits, rain gardens, backyard wetlands, rain barrels and other residential level retrofits. Emphasis will be placed on block-by-block retrofit projects that aim at managing rainwater on site and minimizing the amount of runoff from a property. Businesses can easily incorporate small-scale features like native vegetation plantings, shade tree plantings, or box planters to reduce the amount of runoff leaving the property. Businesses can then consider incorporating stormwater retrofit techniques into future developments or capital improvement projects (see Appendix E for various incentive program solutions).

The town may consider amending or adding ordinances to better address stormwater runoff. Possible changes and amendment could include preserving tree coverage and vegetated areas and the consideration of ordinances to minimizing the amount of clearing and tree removal that can occur. Similar regulations have been used in other nearby coastal communities. The town can also consider landscaping policies that emphasize the use of native plants and reduce the use of fertilizers and pesticides. Pet waste regulations and the installation of waste cleanup stations can also be considered

at public spaces. Future maintenance and capital improvement projects at town-owned buildings, parks, parking lots, and drainage systems will consider the incorporation of LID techniques and other Green Street Designs (Appendix F).

Figure 5-1 and Table 5-1 present a variety of potential projects that can be considered as funding becomes available. The list represents potential ideas for projects and can be used as the basis for future projects (the detailed list should be updated by the Town annually). The list will likely evolve to suit the condition and needs of the watersheds, stormwater concerns, climatic changes, and degrading/failing infrastructure. In addition to this list, the town is developing and maintaining a list of potential collaborative opportunities with local businesses and commercial properties that will be added to the runoff reduction volume upon completion of a project. The total number of indicators or specific details of each project can vary based on funding and future needs that develop. The proposed management solutions, strategies, and techniques are based on the information compiled during the development of this plan. These solutions are not actual planned projects but are meant to illustrate the types of solutions that can be implemented. Before implementing any project or management solution, further consideration and research is recommended on individual site feasibility. Consultations with knowledgeable stormwater engineers, consideration of the effects of the proposed project on the community and watershed, and true economic costs of implementing a project will aid in determining the feasibility of a site. See Appendix A for photos of potential project sites and a Multi-Criteria Decision Analysis (MCDA) of the potential projects.

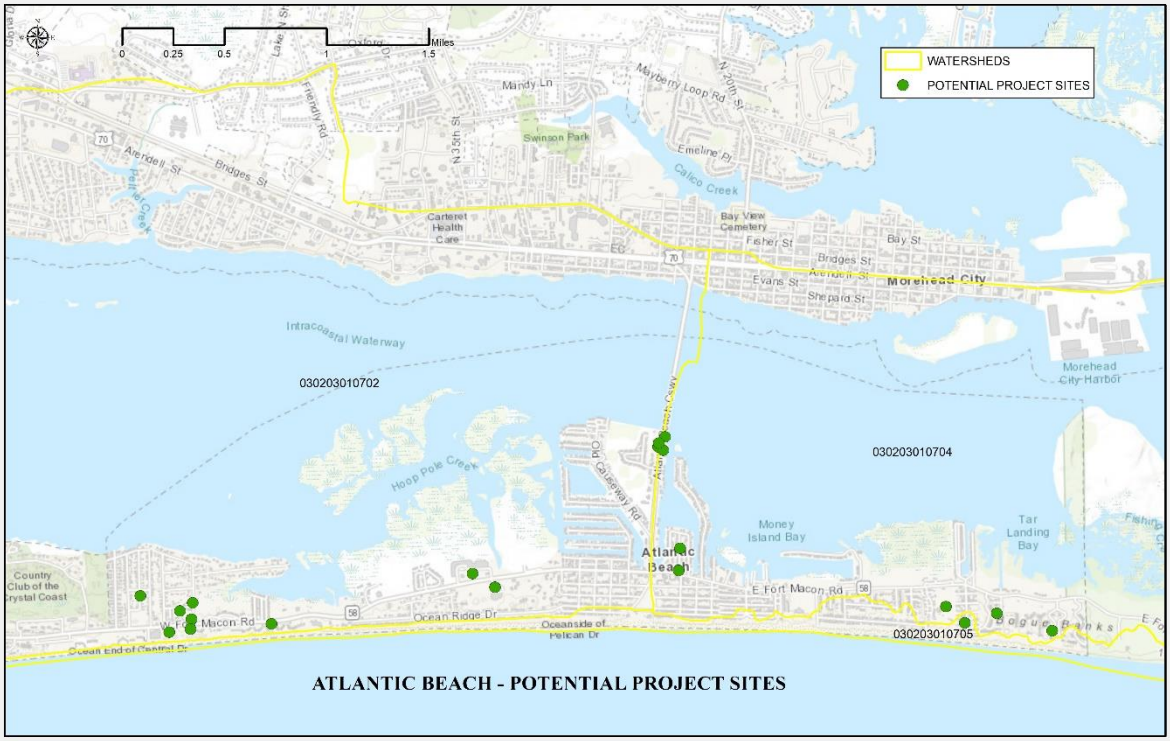


Figure 5-1: Potential Project Sites

5.1.1 Potential Project Opportunities

Potential Projects					
No	**Location**	**Project Type**	**Approximate Footprint* (SFT)**	**Approximate Treatment Volume* (CUFT)**	**Opinion of Probable Cost* ($)**
1	702 Atlantic Beach Causeway	Permeable Pavement / Infiltration Basin	5850 / 765	6750 / 2300	117000 / 4250 - 19125
2	407 Atlantic Beach Causeway	Permeable Pavement	10800	15000	216000
3	1010 W Fort Macon Road	Permeable Pavement Upgrade	45000	48250	900000
4	915 W Fort Macon Road	Enhanced Pond	1890 - 2520	1350 - 2700	5400 - 54000
5	Hoop Pole Creek Nature Trail	Linear Wetland	63000	189000	300000
6	Double Tree Hotel and Surounding Infrastructure	Dune Infiltration	2500	38000	115000
7	Southwinds Condominiums	Dune Infiltration	2500	38000	115000
8	2604 W Fort Macon Road	Pond / Infiltration Basin	18000	54000	75000
9	Island Beach and Racquet Club	Permeable Pavement / Bioretention Cells	33750 / 9000	15625 / 9450	675000 / 65000 - 300000
10	Dunescape Villas	Permeable Pavement / Bioretention Cells	12375 / 9900	20900 / 13500	247500 / 71500 - 330000
11	Sand Villas	Permeable Pavement / Bioretention Cells	27000 / 9900	30000 / 27000	540000 / 71500 - 330000
12	Asbury Avenue	Permeable Pavement / Regrading	4950	5400	99000 / 120000
13	101 Dogwood Street	Bioswale	1440	1080	8800 - 34400
14	E Fort Macon / Center Drive	Curb Cut Bioretention Cell (Tree)	90	3380	6300 - 20000
15	106 Dogwood Street	Bioswale	900	680	5500 - 21500
16	Paid Parking on W Atlantic Blvd	Permeable Pavement	4500	4125	90000

17	108 E Terminal Blvd	Bioswale / Infiltration Basin	1260 / 2250	950 / 6750	7700 - 30100 / 12500 - 56250
18	Grassy Section at End of Causeway Below E Bogue Blvd	Bioswale / Infiltration Basin	3915 / 9000	27000	24000 - 94000 / 50000 - 225000
19	108 Charlotte Ave	Bioswale	900	680	5500 - 21500
20	109 Cedar Lane	Bioswale	1215	900	7425 - 29025
21	E Fort Macon / W Bogue	Bioswale	1215	900	7425 - 29025
22	Center Drive	Bioswale	2070	1550	12650 - 49500
23	207 Fairview Street	Infiltration Basin	2700	8100	15000 - 67500
24	207 Lee Drive	Bioswale / Stream Detour	1350	1030	8250 - 32300 / 350000
25	302 Coopers Ext	Infiltration Basin	1800	5400	10000 - 45000

Table 5-1: Potential Projects

**Approximate footprint, treatment volume, and opinion of probable cost are based on averages of similar projects and are subject to change based on further analysis, feasibility, and site conditions.*

Project 1

The currently unused motel along the Atlantic Beach causeway sits on a large, paved lot that drains directly into the Sound. The pavement is graded in the front of the building so that runoff flows along a very shallow depression and into the sound. The pavement in the back is in very poor conditions, particularly near the sea wall. This parking lot would be an excellent candidate for permeable pavement to reduce the amount of stormwater runoff draining directly into the Sound. Additionally, there is an in ground pool that is not in use that could be used for storage or infiltration if modified.

Project 2

There is a large parking lot that sits in front of Crows Nest Yacht club. This lot is graded so that water flows down to the boat ramp and enters the Sound. This parking lot would be a good candidate for permeable pavement as approximately 2.5 Acres of impervious surface drain untreated into the Sound.

Project 3

The parking lot in front of the Food Lion and its nearby stores has experienced nuisance flooding during rain events. This is due to its current permeable pavement being clogged and not functioning properly. This location is a good opportunity to upgrade or maintain the permeable pavement that is currently in place. Additionally, alternative project types should be considered such as routing the runoff from the large parking lots into an SCM that would allow for infiltration of treatment prior to discharging into receiving waters.

Project 4

There is currently a pond located at the family park at 915 W Fort Macon Road. This pond could potentially be retrofitted to receive stormwater from nearby areas and treat it in a variety of ways. This could include the pond adding a forebay section that behaves more like a wetland, increasing volume to handle stormwater routing, or connecting it to existing stormwater infrastructure to allow for wet pond water quality enhancements prior to discharging to receiving waters.

Project 5

Hoop Pole Creek could be modified so that additional stormwater is routed towards it and experiences treatment prior to entering the creek. This could include adding a large bioswale in front to treat stormwater runoff from the nearby Food Lion parking lot. This could include designing stormwater infrastructure so that stormwater sheet flows across large amounts of vegetation and a large portion infiltrates prior to entering the creek. Additionally, this could include a connection with the small pond at the children's park across the street. This site should be further analyzed as a useful location to assist with alleviating stormwater infrastructure deficiencies.

Project 6

The Double Tree Hotel and its surrounding infrastructure could be a good candidate for a dune infiltration retrofit. Existing infrastructure could be tied into a subsurface dine infiltration system allowing stormwater to be naturally filtered by the dunes.

Project 7

The Southwinds Condominiums experience standing water well after rain events. Additionally, there is evidence of stormwater driven erosion at several locations across the property. This location could be a good candidate for increased/improved stormwater infrastructure that ties into a dune infiltration system.

Project 8

The empty lot behind 2604 W Fort Macon road would be a good candidate for a stormwater project. A variety of projects would be feasible such as a pond, infiltration basin, etc. The large undeveloped section of land could be a good place to route stormwater to once a project type is selected.

Project 9

The Island Beach Racquet Club has multiple buildings and parking lots that could be retrofitted with permeable pavement and bioretention cells to infiltrate and treat stormwater runoff prior to it entering drainage infrastructure or water bodies.

Project 10

Dunescape Villas would be an excellent candidate for permeable pavement or bioretention cells. The roof gutters from the buildings currently drain directly onto the parking lot and have no opportunity for infiltration. Permeable pavement would be able to infiltrate a portion of this runoff and bioretention cells incorporated into the parking lot would be able to collect and treat a large portion of this runoff as well.

Project 11

Sand Villas would be a good candidate for stormwater projects such as permeable pavement, infiltration basins, and bioretention cells. Nuisance flooding during rain events could be alleviated through the use of one or more of the aforementioned SCMs.

Project 12

Asbury Avenue has experienced large amount of nuisance flooding and standing water well after rain events stop. This would be a good candidate for street regrading that incorporates large sections of permeable pavement to alleviate flooding and prevent standing water in front of resident's properties.

Project 13

Jungle Drive and its connection to Dogwood Street appeared to be experiencing erosion when observed on a site visit during a rain event. There is currently slight grading so that water flows into a drop inlet but the section along Jungle Drive could be regraded into a bioswale that would capture stormwater runoff and allow it to infiltrate into the ground.

Project 14

The intersection of East Fort Macon and Center Drive experiences nuisance flooding and standing water. This location would be a good candidate for a curb cut bioretention cell to alleviate nuisance flooding and allow runoff to infiltrate into the ground.

Project 15

The lot at 106 Dogwood Street would be a good candidate for a bioswale installation along the roadside.

Project 16

The paid parking on W Atlantic Blvd experiences standing water. This location would be a good candidate for permeable pavement installation at the lower elevation sections of the parking lot.

5.2 Education and Outreach

Atlantic Beach residents, property owners, local businesses, and community groups will be the target audiences of the education and outreach component of this plan. Community outreach and engagement are critical to the long-term success of any watershed restoration plan. Before implementing any education or outreach activity presented here, the Town may want to consider assembling a community stormwater outreach committee to finalize an education and outreach plan and ensure its implementation. Atlantic Beach can recruit input and involvement from many local resources such as the North Carolina Coastal Federation, local garden clubs, and regional academia.

The primary purpose of conducting education and outreach within the Town is to ensure audiences understand the impacts of stormwater and the individual role they can and should play to reduce the volume of runoff. Collective embracement of the problem and solution will result in the greatest community impact. Education and outreach will enhance public understanding of watersheds, water quality, coastal stormwater, and local flooding. Outreach messages should reinforce how reducing stormwater runoff volumes will benefit individuals and the community and improve local water quality.

The following are general ideas for consideration in implementing education and outreach in the Town:

- Assemble a community stormwater outreach committee to steer outreach and education efforts within the community. Include regional partners as resources.
- Identify outlets to reach community members and target audiences such as the Town's Ocean Breeze newsletter, utility bill messaging, social media and print messaging posted at community facilities.
- Develop messaging for various audiences but focus primarily on the general public.
- Promote Smart Yards brochure (adopted by Town and includes Atlantic Beach Logo). Post on social media, in addition, print publications and have available at community public locations such as Town Hall.
- Create signage for completed retrofits and incorporate into Walk Atlantic Beach Maps to educate community members when possible.
- Consider a series of demonstrations that can be installed at Town Park at 915 W Fort Macon Road to showcase simple techniques like painted rain barrels, downspout disconnection and native plantings or rain gardens.

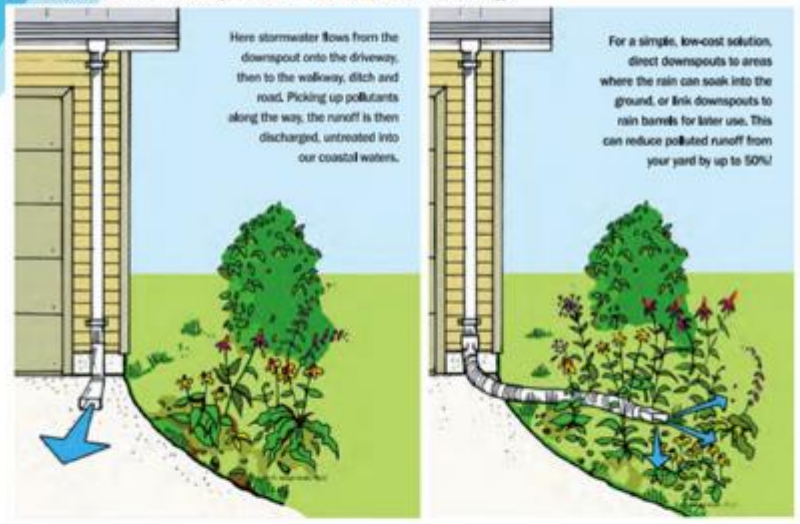
- Host community planting event to add native planting and pollinator gardens at Town Park and develop signage promoting impact of simple techniques.
- Offer gutter downspout giveaway and track numbers distributed. Ask for pre-post photos and post on social media for community involvement and interaction.
- Prepare and promote a simple annual report on plan progress and simple tasks people can do on their properties like the current Annual Drinking Water Quality Report.

What is stormwater runoff and how does it affect me?

Each time it rains, rainwater flows along rooftops, driveways, and other developed surfaces into streets, gutters and ditches, where it eventually flows into our coastal waters. Along the way, this rainwater collects pollutants and bacteria that can make our rivers and coasts unsafe for swimming, shellfishing, and other activities. During heavy rain, stormwater runoff can also cause flooding and erosion. Addressing this problem not only creates a healthier and safer environment for us all to enjoy, but can also provide economic and other benefits to your property

What can I do about it?

The Town of Beaufort is working to reduce stormwater runoff on municipal property. But, there are also many simple and low-cost actions that Town residents can take to help direct stormwater on their property to places where soil, plants, or containers can capture the rain before it becomes polluted runoff.



Downspout disconnectors: If a downspout from a gutter empty into a driveway, sidewalk, or parking lot, simply re-directing the downspout to an area that can filter the water naturally will reduce polluted runoff. A flexible downspout extension can be purchased at a local home improvement store for less than $10, and used to direct water to vegetated areas. Directing rainwater to a lawn or garden that normally needs watering could result in savings on your water bill.

Rain barrels: Another option is to collect rainwater in a container for later use. If you have a garden or other plants that require watering, connecting a rain barrel to your gutters can provide a free source of water for your landscaping, while also preventing it from becoming polluted runoff. The North Carolina Coastal Federation (www.nccoast.org) has barrels available for sale, or visit your preferred local garden supply retailer. Rain gardens: Planting areas of native vegetation in a shallow depression that will capture and absorb runoff can reduce the amount of stormwater that leaves your property while providing aesthetic benefits to your lawn or garden. For more information about rain gardens and plant selection, visit the NC State University Rain Garden Guide: https://www.bae.ncsu.edu/topic/raingarden/

This information was adapted from Smart Yards, *a publication of the North Carolina Coastal Federation. For more information please visit* http://www.nccoast.org/wp-content/uploads/2014/12/SmartYardsGuide_OI-version-1.pdf

Figure 5-2: Example Education and Outreach Flyer Discussing Residential Retrofits

6 Implementation Schedule

The following section discusses a potential implementation schedule of projects, milestones and monitoring work to occur. The proposed management solutions in this section and in Section 5 are opportunities the Town can take advantage of to address improving water quality, reducing the quantity of runoff, reducing instances of localized flooding, and increasing community knowledge on the watershed and water quality. Before implementing any projects presented here, the Town should research its cost and feasibility and consult with relevant professionals. Atlantic Beach will manage the implementation of any goals, objectives, and actions associated with this restoration plan. Ultimately, decisions on how to best approach and carry out actions to meet the plan's objectives should be determined by the Town.

6.1 Project Implementation Schedule

Action #	Specific Action	Timeframe
1-5	Continue water quality sampling with Dr. Noble on an annual basis as a supplement to the data from shellfish sanitation	Year 1, Annually
2-1	Review existing town codes and ordinances to determine impediments to low impact stormwater designs for new development and redevelopment. The findings will be presented to the Town with any suggested amendments and discussion of any potential incentive plans (see Appendix F for various engagement plans).	Year 1, Annually
2-2	Adopt a stormwater management program to supplement gaps in the state's stormwater program and the Town's needs. Some gaps identified thus far include: • Redevelopment • Smaller projects not covered under the State's Stormwater Program • Oversight of installation and maintenance of State permitted systems	Year 1
3-1	Identify stormwater reduction measure opportunities on town streets, rights-of-ways, buildings, parks, parking lots, drainage systems, and other public properties. Prioritize retrofits at public buildings and properties that can serve as demonstration sites of stormwater retrofits.	Year 1
3-2	Evaluate existing stormwater systems on public properties for potential volume reduction enhancements, and if feasible, retrofit them to achieve volume reduction.	Year 1, Annually
3-3, 4-2	Investigate stormwater grants and other funding sources annually to supplement the Town's expenditure on retrofits and projects	Year 1, Annually
3-4	Incorporate, where practical, Green Street Designs (see Appendix G) into future capital improvements of town streets.	Year 1, Annually
3-5	Pursue strategy with N.C. Department of Transportation (DOT) to incorporate retrofits into the highway 58 drainage system. Pursue strategy with DOT that any new road upgrades or maintenance plans include plans for reducing runoff.	Year 1
3-6	Training with public works staff on street sweeping and grading of "micro-dune" near the road edge that causes water pockets to form on the road.	Year 1, Annually
4-1	Identify retrofit sites with private partners, prioritizing sites by potential for volume reduction cost-benefit, such as sites identified as exceptional because of the physical and natural characteristics, accessibility, cost, public outreach opportunity, and current land uses.	Year 1, Annually
4-3	Work with governmental agencies and NGOs to secure grants to provide funding to install lot-level, low-cost retrofits that disconnect impervious surfaces and enhance stormwater infiltration.	Year 1, Annually

4-4	Provide landowners incentives to disconnect impervious surfaces or minimize stormwater runoff from their property (see Appendix F for various strategies).	Year 1, Annually
4-5	Explore opportunities with Community Conservation Assistance Program (CCAP).	Year 1, Annually
4-6	Coordinate stormwater management practices with maritime forest management to ensure evapotranspiration by current vegetation is optimized. *This can be coordinated during regularly scheduled planning board meetings to keep issue on the agenda.*	Year 1, Annually
5-1	Maintain an inventory and monitor performance of stormwater reduction retrofits that have been installed within the watersheds.	Year 1, Annually
5-2	Conduct yearly, scheduled assessment of the plan and progress made to date with the project team.	Year 1, Annually
5-3	Update the plan every five years based upon findings from water quality data and the status of implementation and findings from yearly assessment review of plan implementation (see Action 5-1).	Year 1, Every Five Years
5-4	Document the volume of stormwater reduced by each retrofit by utilizing the Runoff Reduction Calculator Tool or other appropriate volume calculation methodology, which will be maintained by the Town.	Year 1, Annually
6-1	Collaborate with partners to implement education and engagement activities for property owners, businesses, and K-12 students and their families.	Year 1, Annually
6-2	Provide technical training opportunities for planners, engineers, developers, landscapers and local government staff on techniques to reduce volume of stormwater within the town.	Year 1, Annually
6-3	Work with existing water quality outreach professionals, including: North Carolina Coastal Federation, UNC Institute of Marine Sciences, Duke University Marine Laboratory, Scientific Research & Education Network (SciREN), and N.C. Coastal Reserve on a stormwater education initiatives.	Year 1, Annually
6-4	Include education signage at select retrofits and place emphasis on highlighting the town's commitment to native vegetation planting.	Year 1
6-5	Printing and mailing of Smart Yard (or similar outreach material designed for the Town) to residents with additional prints made available at the Town Hall	Year 1

Figure 6-1: Overview of the overall Implementation Schedule for Project Goals

6.2 Milestones

Milestones are measurable accomplishments utilized to track positive changes and the success of the plan. If a milestone is not met, an assessment will be conducted at the time of the annual plan review to determine the cause and the appropriate steps that can be taken to address any shortcomings or

unforeseen circumstances. The milestones of the Atlantic Beach watersheds for restoring water quality through volume reduction of surface runoff are:

6.2.1 Short-Term (< 5 years)

- Implement a new construction downspout ordinance
- Disconnect 500 existing downspouts
- Implement an education and outreach program
- Hold quarterly education and outreach events
- Reach out to property owners of identified potential project sites and begin discussing implementation
- Reduce stormwater runoff by approximately 2.8 ac-ft of 28 ac-ft (10%) through the implementation of stormwater reduction techniques identified in this plan (including impervious surface disconnects)

6.2.2 Mid-Term (< 10 years)

- Disconnect 2500 existing downspouts
- Conduct a feasibility analysis of the remaining potential projects
- Implement 10 stormwater reduction projects
- Hold quarterly education and outreach events
- Reduce stormwater runoff by approximately 7 ac-ft of 28 ac-ft (25%) through the implementation of stormwater reduction techniques identified in this plan (including impervious surface disconnects)

6.2.3 Long-Term (< 20 years)

- Disconnect 90% of existing downspouts
- Hold quarterly education and outreach events
- Reduce stormwater runoff by approximately 28 ac-ft (100%) through the implementation of stormwater reduction techniques identified in this plan (including impervious surface disconnects)

6.3 Monitoring

NC Shellfish Sanitation and the Recreational Water Quality section of the Division of Marine Fisheries (DMF) is responsible for monitoring the bacteria levels in coastal waters. They have the authority to close waters for shellfishing and issue swimming advisories when bacterial levels are unacceptable. The NC Shellfish Sanitation water quality monitoring stations within the Atlantic Beach watersheds can be seen in figure 2-3 with the station names and recent monitoring data seen in tables 2-3 and 2-4. Every three years, the NC Shellfish Sanitation staff ground truth the entire shoreline of shellfish growing areas to document current and potential pollution sources. The data collected is made publicly available and is one of the primary sources used for the historic and present day analysis of water quality within this report. Utilizing this data in the future will allow the results of this plan to be monitored without requiring additional data collection and monitoring programs. NC DMF water quality monitoring stations for swimming advisories can be seen in figure 2-10.

Monitoring will be conducted by using the NC Shellfish Sanitation reports to analyze for fecal coliform as seen in Tables 2-3 and 2-4. Additional monitoring efforts will analyze the DMF swimming advisories over time to see if the number of advisories is increasing or decreasing annually. It should be noted that there has not been a DMF advisory posted for an Atlantic Beach station since 2015.

6.4 Evaluation

To ensure that the Atlantic Beach Watershed Restoration and Resilience Plan is meeting the needs of the watershed and community, the plan should be evaluated on a regular basis to determine effectiveness. The Town will track progress on plan implementation including educational events, project development, running totals of projected runoff reduction, and monitoring records.

6.5 Funding, Cost, and Technical Needs

The total cost to implement a project varies greatly due to parameters such as location of the project, size of project, design complexity, labor and materials, and market changes. As such, once a project is selected, the Town will need to determine project estimates. Annual maintenance should always be considered and budgeted for accordingly. Project partners can 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.

As presented the projects in this report have been reviewed by our stakeholder team which includes regulatory partners, Town staff, members of the North Carolina Coastal Federation, and our engineering firm LDSI, Inc. These projects were reviewed and analyzed from a feasibility level only and would need more detailed analysis for the “actual” implementation of the project. Additionally, opinions of probable cost and rough volumetric sizing were determined as a part of this feasibility analysis. Future technical needs include consultation with engineers for individual project design as well as development of partnerships with state agencies, local organizations, or professionals within academia such as Dr. Noble who can assist with education and outreach projects and provide scientific information regarding hydrology and water quality. Simple projects such as downspout disconnects can rely on volunteer work for installation and maintenance.

7 Resilience

Long term resilience is a key factor to consider for Atlantic Beach. A variety of data sources were analyzed such as the North Carolina Institute for Climate Studies (NCICS) North Carolina Climate Science Report and NOAA's Sea Level Rise Viewer. According to the NCICS Climate Science Report, Beaufort has seen an annual relative sea level rise of 0.122 ± 0.0138 inches per year from 1953-2018. Figure 7-1 Shows the observed relative sea level rise (black line) for the years 2000-2018 and the projected relative sea level rise through 2100. The lower section of the figure shows the projected number of high tide flooding days considering only relative sea level rise and astronomical tides. High tide floods in this figure are defined as water levels reaching 1.8 feet above the present Mean High Water.[7] [8]

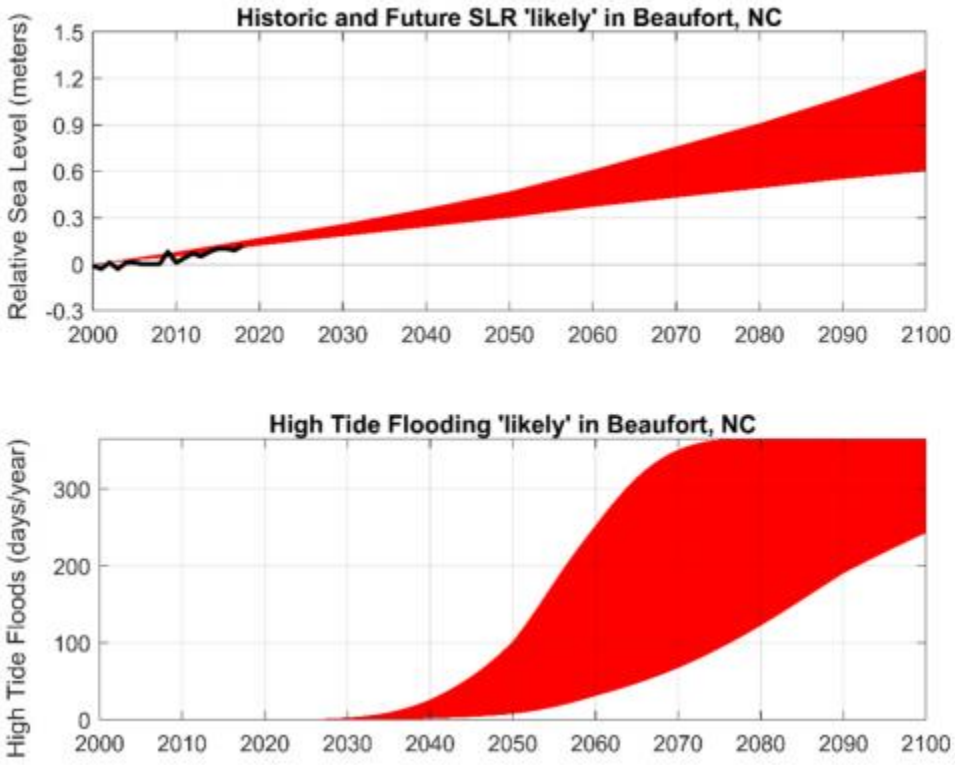


Figure 7-1: Projected Sea Level Rise and High Tide Flooding in Beaufort

[7] https://ncics.org/wp-content/uploads/2020/10/NC_Climate_Science_Report_FullReport_Final_revised_September2020.pdf
[8] https://repository.library.noaa.gov/view/noaa/20691

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. The Beaufort station was selected within the model for its proximity to Atlantic Beach. Using the tool for a 40 year predicted value of sea level rise in Beaufort shows an intermediate low level of 1.21 feet, and intermediate value of 2.00 feet, an intermediate high value of 2.89 feet, a high value of 3.87 feet, and an extreme value of 4.59 feet in the year 2060 (Figure 7-2). It should be noted that the model reports the 2020 values for sea level rise as an intermediate low of 0.39 feet, and intermediate of 0.56 feet, and intermediate high of 0.69 feet, high of 0.82 feet, and an extreme of 0.85 feet.

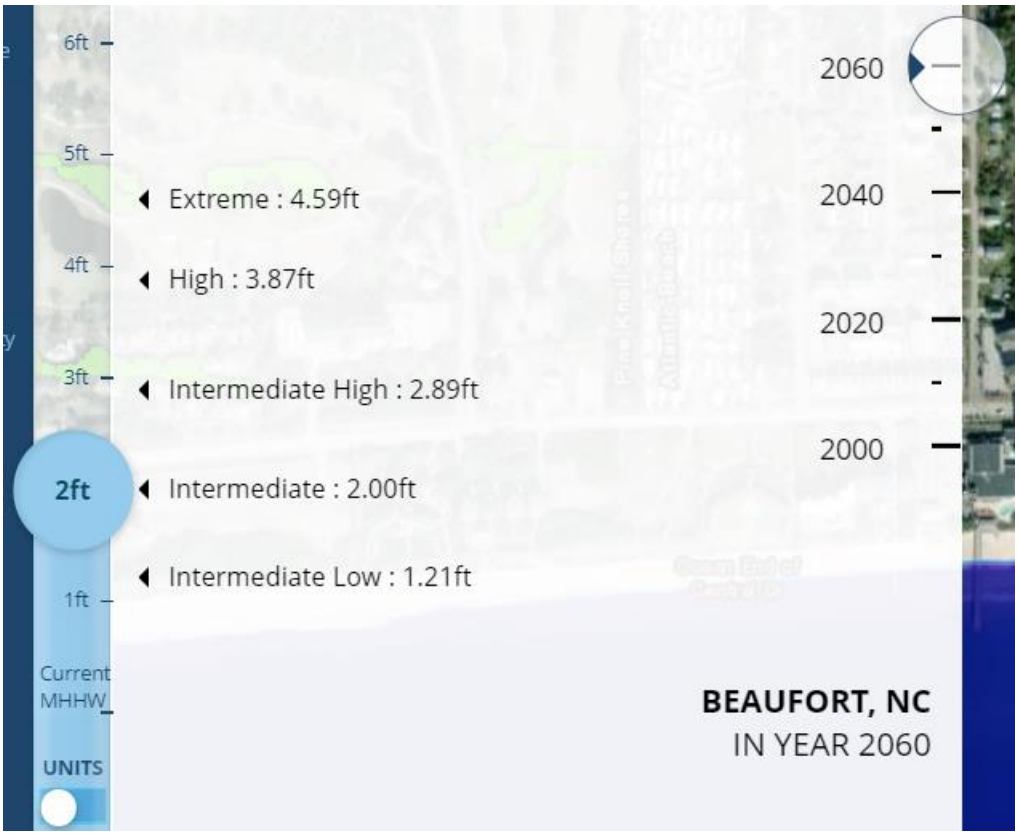


Figure 7-2: 2060 Projected Sea Level Rise in Beaufort

NOAA's Sea Level Rise Viewer includes a top down view of predicted sea level. Analyzing the intermediate 40-year predicted sea level rise condition of 2 feet shows water effecting the Sound side of Atlantic Beach. The predicted water level appears to cover multiple docks, residential lots, and some commercial real estate without overtopping any roads (Figure 7-3). It should be noted that this portion of

the resilience analysis only accounts for a visual inspection of NOAA's Sea Level Rise viewer predictions and does not include any additional measurements or calculations. The impact of long term predicted sea level rise on the Town of Atlantic Beach's drainage infrastructure has not been analyzed within this report and the findings of this report and the predicted effects of the potential projects do not account for any changes in outlet conditions, groundwater, or tailwater from sea level rise.

Figure 7-3: 2060 Projected Sea Level Based on Beaufort Scenario

Acronyms & Definitions

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 study and 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 shellfishing-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, often measured in cubic feet per second (cfs), flowing in a stream or through a stormwater conveyance system.
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 of time.
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 shellfishing 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
WWTP	Wastewater Treatment Plant

Appendix A: Photos of Potential Projects & MCDA

Project 1

Degraded parking lot in front of building

Sediment accumulation at low point on North side of building

Direct outlet to Bogue Sound on North West corner of parking lot

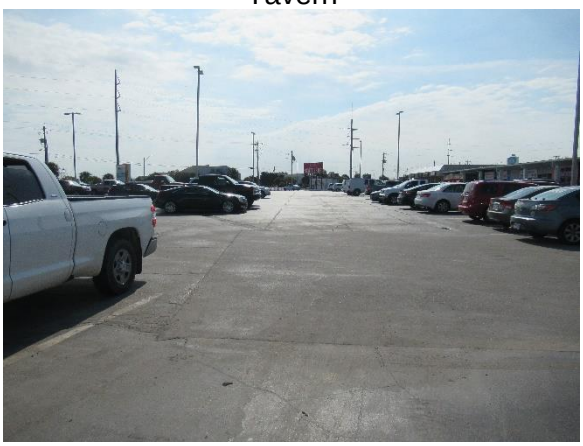
Degraded pavement and sediment accumulation on West side of building

Project 2

Drop inlet on West corner of Tipsy Turtle Tavern

Facing East from West corner of Tipsy Turtle Tavern

Facing West from drop inlet



Facing South East showing large parking lot that drains directly into Bogue Sound

Project 3

Existing pervious pavement cutouts

Existing pervious pavement cutouts

Existing pervious pavement cutouts

Existing pervious pavement cutouts

Project 4

Existing pond at Public Park

Project 5

Large CMP discharging into Hoop Pole Creek

View from the trail at Hoop Pole Creek

Side of road draining into Hoop Pole Creek

Project 6

West parking lot at Hilton Double Tree

East parking lot at Hilton Double Tree

Roadside on West side of Hilton Double Tree

Unpaved lot West of Hilton Double Tree

Project 7

Stormwater erosion

Stormwater erosion

Stormwater erosion and ponding

Project 8

Undeveloped lot behind Kitty Hawk Kites

Parking lot draining to undeveloped lot

Ponding on the corner of undeveloped lot

Degraded parking lot behind Kitty Hawk Kites

Project 9

Stormwater ponding

Roof downspouts flowing into parking lot

Island in parking lot

Sediment buildup and erosion from stormwater

Project 10

Roof downspouts discharging into parking lot


Stormwater ponding


Degraded pavement and stormwater pipe


Existing drop inlet

Project 11

Degraded pavement and stormwater ponding

Degraded pavement and stormwater ponding

Stormwater runoff from tennis court flowing across mulch and into parking lot

Stormwater ponding

Project 12

Heavily degraded pavement not draining into stormwater infrastructure

Heavily degraded pavement and stormwater ponding

Project 13

Roadside grass experiencing erosion from stormwater

Project 14

Excessive stormwater ponding in parking lot

Project 15

Undeveloped lot

Undeveloped lot

Project 16

Parking lot experiencing stormwater ponding

Stormwater runoff from parking lot to the beach

Channelized flow from parking lot to the beach

Channelized flow from parking lot to the beach

MCDA							
Location	**Project Type**	**Approximate Treatment Volume (CUFT)**	**Opinion of Probable Cost ($)**	**Water Quality**	**Water Quantity**	**Bacteria Removal**	**Public Interest**
702 Atlantic Beach Causeway	Permeable Pavement / Infiltration Basin	6750 / 2300	117000 / 4250 - 19125	High	High	High	High
407 Atlantic Beach Causeway	Permeable Pavement	15000	216000	High	High	High	High
1010 W Fort Macon Road	Permeable Pavement Upgrade	48250	900000	High	High	High	High
915 W Fort Macon Road	Enhanced Pond	1350 - 2700	5400 - 54000	Low	Low - Med	Low	High
Hoop Pole Creek Nature Trail	Linear Wetland	189000	300000	High	Very High	Med	High
Double Tree Hotel and Surounding Infrastructure	Dune Infiltration	38000	115000	High	Very High	High	High
Southwinds Condominiums	Dune Infiltration	38000	115000	High	Very High	High	High
2604 W Fort Macon Road	Pond / Infiltration Basin	54000	75000	Low/High	High	Low/High	Med
Island Beach and Racquet Club	Permeable Pavement / Bioretention Cells	15625 / 9450	675000 / 65000 - 300000	High	High	High	Med
Dunescape Villas	Permeable Pavement / Bioretention Cells	20900 / 13500	247500 / 71500 - 330000	High	High	High	Med
Sand Villas	Permeable Pavement / Bioretention Cells	30000 / 27000	540000 / 71500 - 330000	High	High	High	Med
Asbury Avenue	Permeable Pavement / Regrading	5400	99000 / 120000	High/Low	High	High/Low	High
101 Dogwood Street	Bioswale	1080	8800 - 34400	High	Med	High	Med

E Fort Macon / Center Drive	Curb Cut Bioretention Cell (Tree)	3380	6300 - 20000	High	High	High	High
106 Dogwood Street	Bioswale	680	5500 - 21500	High	Med	High	Med
Paid Parking on W Atlantic Blvd	Permeable Pavement	4125	90000	High	High	High	Med
108 E Terminal Blvd	Bioswale / Infiltration Basin	950 / 6750	7700 - 30100 / 12500 - 56250	High	Med	High	Med
Grassy Section at End of Causeway Below E Bogue Blvd	Bioswale / Infiltration Basin	27000	24000 - 94000 / 50000 - 225000	High	Med	High	High
108 Charlotte Ave	Bioswale	680	5500 - 21500	High	Med	High	Med
109 Cedar Lane	Bioswale	900	7425 - 29025	High	Med	High	Med
E Fort Macon / W Bogue	Bioswale	900	7425 - 29025	High	Med	High	Med
Center Drive	Bioswale	1550	12650 - 49500	High	Med	High	Med
207 Fairview Street	Infiltration Basin	8100	15000 - 67500	High	Med	High	Med
207 Lee Drive	Bioswale / Stream Detour	1030	8250 - 32300 / 350000	High	Med	High/Low	Low
302 Coopers Ext	Infiltration Basin	5400	10000 - 45000	High	Med	High	Med

Figure A-1: Multi-Criteria Decision Analysis

Stormwater Project Type	Removal of Bacteria	% TN Removal	% TP Removal
Bioretention	Excellent	35-65	45-60
Infiltration	Excellent	84	84
Subsurface Dune Infiltration[1]	Excellent	N/A	N/A
Permeable Pavement (Infiltration)	Excellent	84	84
Permeable Pavement (Detention)	Good	30	30
Wet Pond	Fair	30	30
Stormwater Wetland	Good	44	40
Rainwater Harvesting	Good	Variable	Variable
Disconnected Impervious Surfaces	Good	30	35
Level Spreader - Filter Strip	Poor	30	35

Figure A-2[9] [10]: Recommended Stormwater Project Types and their Water Quality Benefits

[9] https://files.nc.gov/ncdeq/Energy%20Mineral%20and%20Land%20Resources/Stormwater/BMP%20Manual/SCM-Credit-Doc-2018-11-7.pdf

[10] https://content.ces.ncsu.edu/dune-infiltration-systems-for-reducing-stormwater-discharge-to-coastal-recreational-beaches

Appendix B: Additional Watershed Characterization

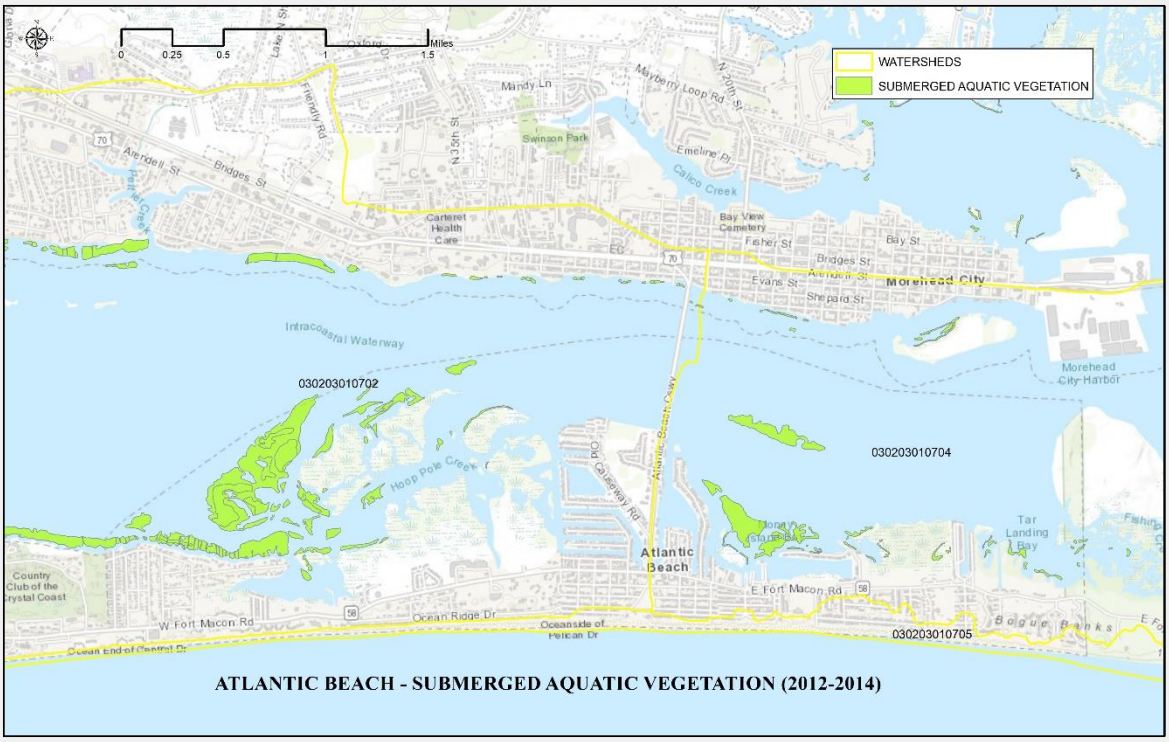


Figure B-1: Submerged Aquatic Vegetation[1]

Figure B-2: North Carolina Natural Heritage Program Areas[1]

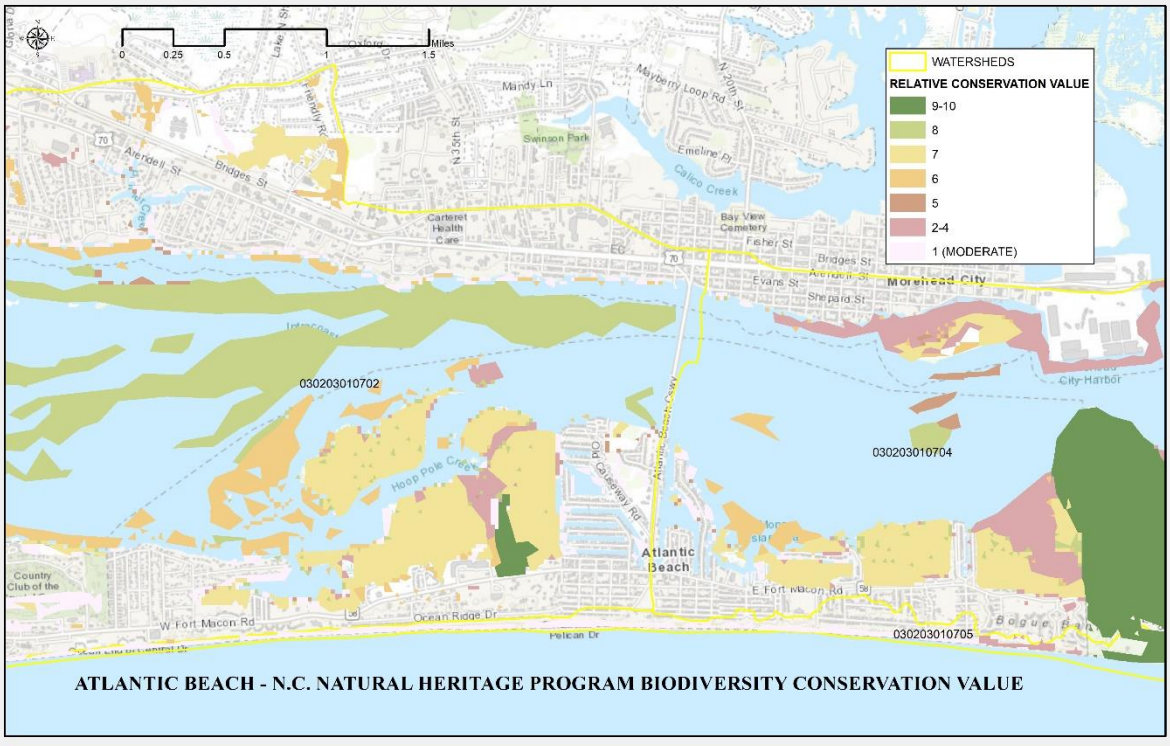


Figure B-3: North Carolina Natural Heritage Program Conservation Values[1]

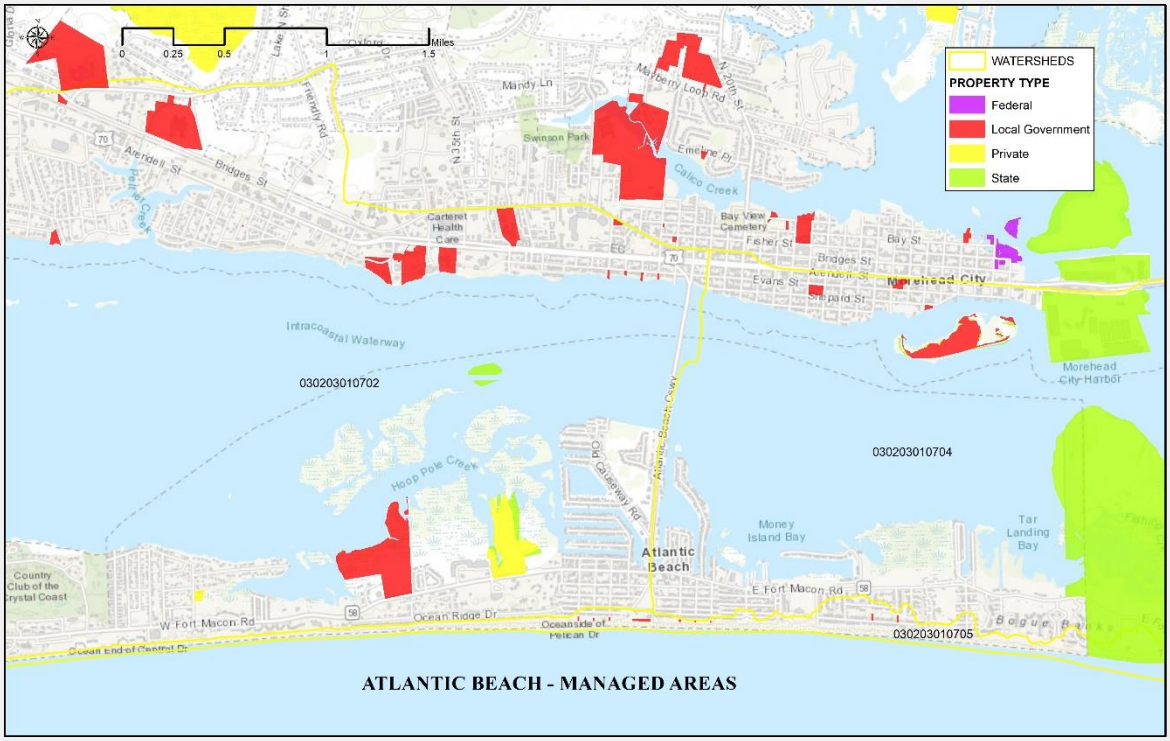


Figure B-4: Managed Areas[1]

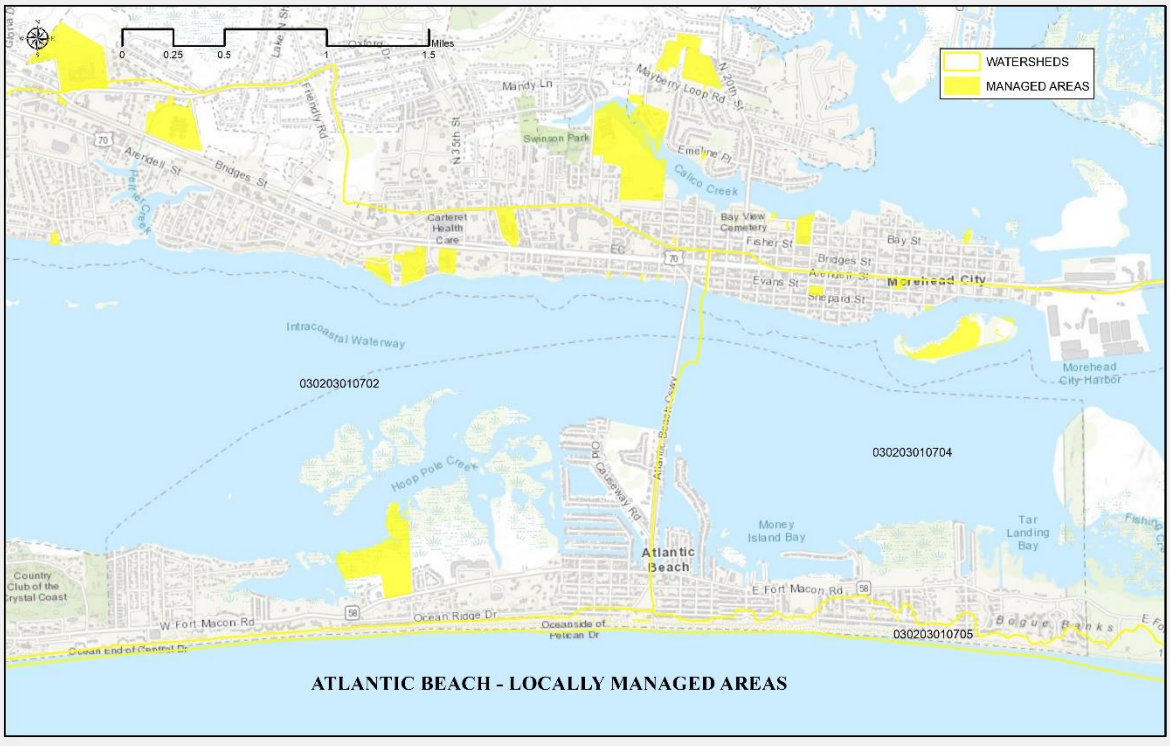


Figure B-5: Locally Managed Areas[1]

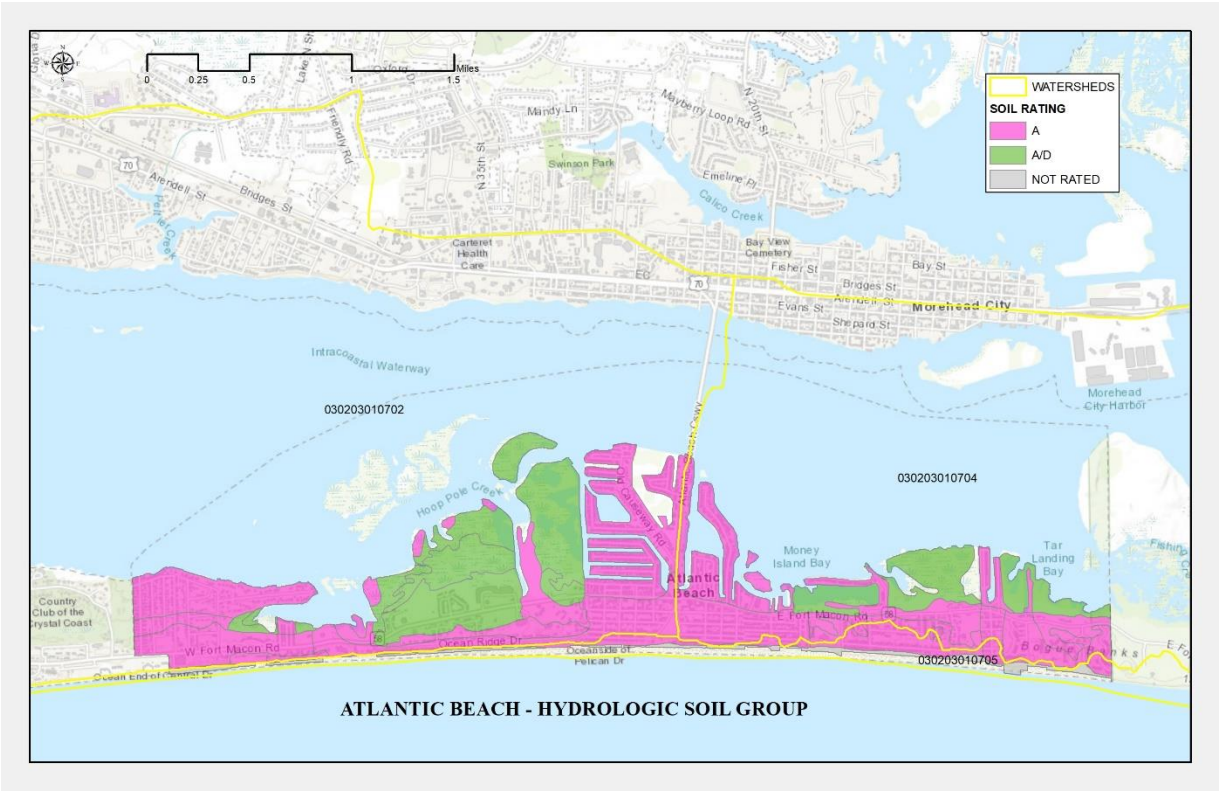


Figure B-6: Hydrologic Soil Groups

The calculation methodology used in section 3.1 was done with the assumption that modern rainfall applied with historic land cover would provide an accurate and representative depiction of stormwater runoff at those points in history. This assumption served to "normalize" the results of the hydrologic analysis of Atlantic Beach. However, rainfall has changed over time and a different approach to determining historic rainfall would include utilizing historic rainfall data during the analysis to determine historic runoff values. Due to the increase in rainfall over time, this process would actually make the goals of this watershed restoration and stormwater resilience plan more ambitious as it would have to account for both changes in land coverage as well as changes in rainfall itself. The target volume reduction across Atlantic Beach would increase from 0.19 gallons per square foot to 0.22 gallons per square foot. Table B-1 and Figures B-6 – B-8 show the outcomes of applying the same calculations used in Section 3 but with historic rainfall data rather than current rainfall data.

DECADE	HUC 030203010702 Drum Shoals			
	SCS Runoff Volume (AC-FT)	Rational Method Peak Flow (CFS)	Simple Method Runoff Volume (AC-FT)	Dimensionless Hydrograph Peak Flow (CFS)
1970's	24.8	151	18.7	44
1980's	54.4	221	31.8	122
1990's	62.6	231	34.8	147
2000's	81.2	258	39.8	198
2010's	79.2	284	39.6	193
DECADE	HUC 030203010704 Beaufort Inlet			
	SCS Runoff Volume (AC-FT)	Rational Method Peak Flow (CFS)	Simple Method Runoff Volume (AC-FT)	Dimensionless Hydrograph Peak Flow (CFS)
1970's	18.8	221	12.6	78
1980's	39.6	324	20.7	208
1990's	41.5	337	21.3	218
2000's	46.4	399	22.2	244
2010's	45.9	396	22.2	241
DECADE	HUC 030203010705 Shackleford Banks			
	SCS Runoff Volume (AC-FT)	Rational Method Peak Flow (CFS)	Simple Method Runoff Volume (AC-FT)	Dimensionless Hydrograph Peak Flow (CFS)
1970's	7.0	57	4.7	57
1980's	8.4	64	5.4	64
1990's	8.9	65	5.6	65
2000's	10.4	73	5.9	73
2010's	10.2	78	5.9	78
DECADE	TOTAL			
	SCS Runoff Volume (AC-FT)	Rational Method Peak Flow (CFS)	Simple Method Runoff Volume (AC-FT)	Dimensionless Hydrograph Peak Flow (CFS)
1970's	51	429	36	179
1980's	102	609	58	394
1990's	113	633	62	430
2000's	138	730	68	515
2010's	135	758	68	512

Table B-1: Summary of the Total Runoff Volume Reduction Goals of the Atlantic Beach Watersheds

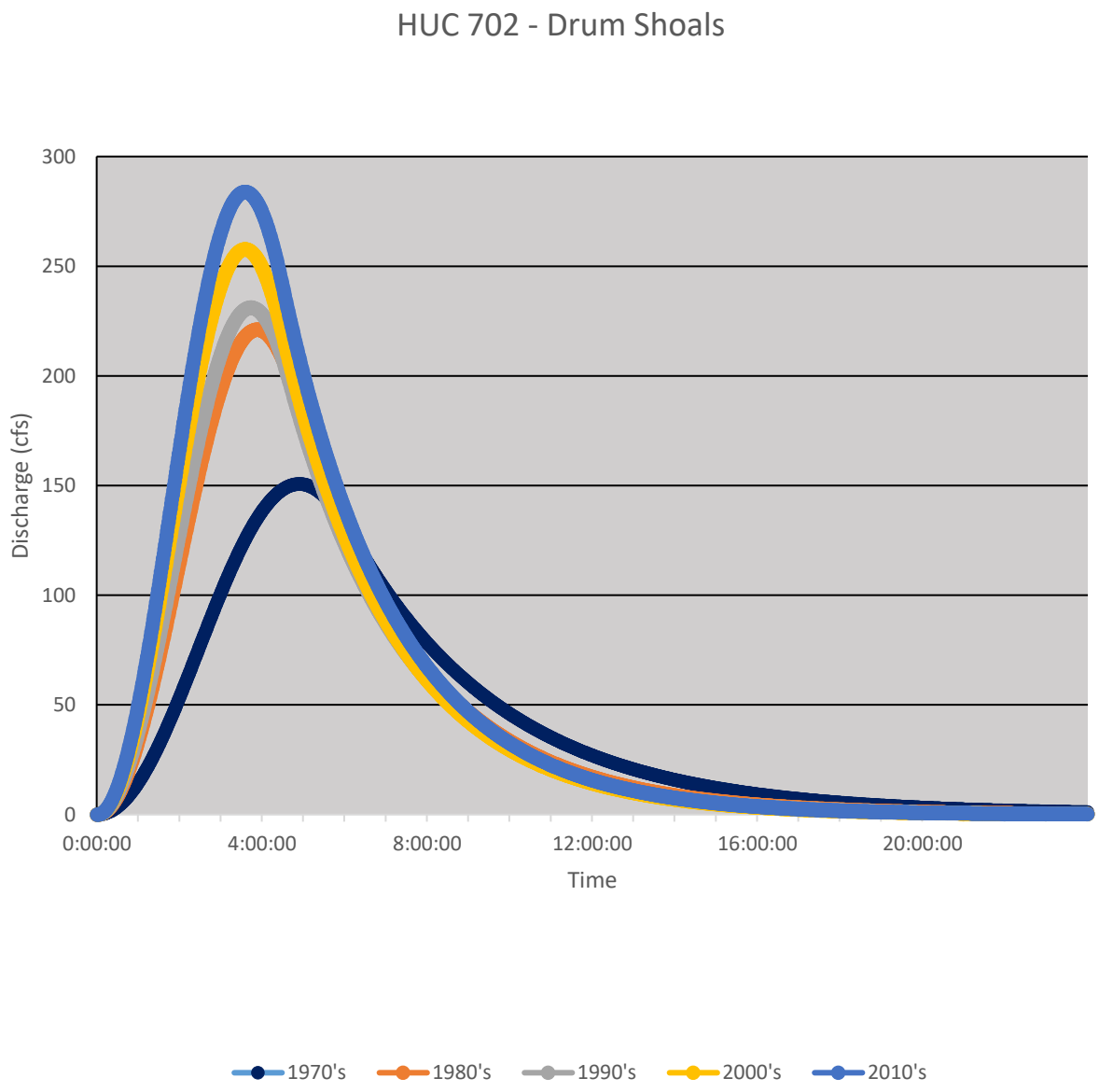


Figure B-7: Stormwater Runoff within the Drum Shoals Watershed from the 1970's to the 2010's

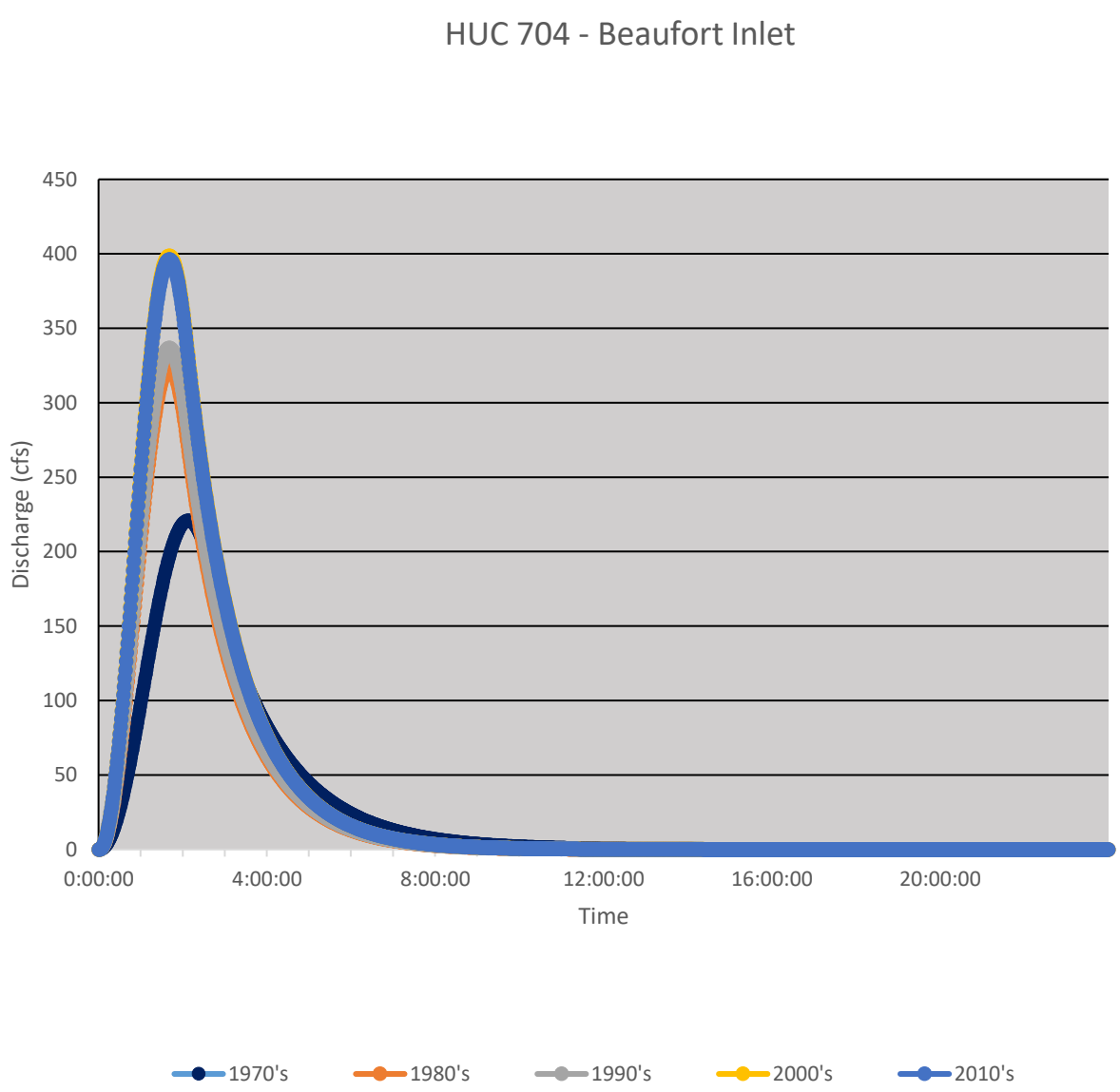


Figure B-8: Stormwater Runoff within the Beaufort Inlet Watershed from the 1970's to the 2010's

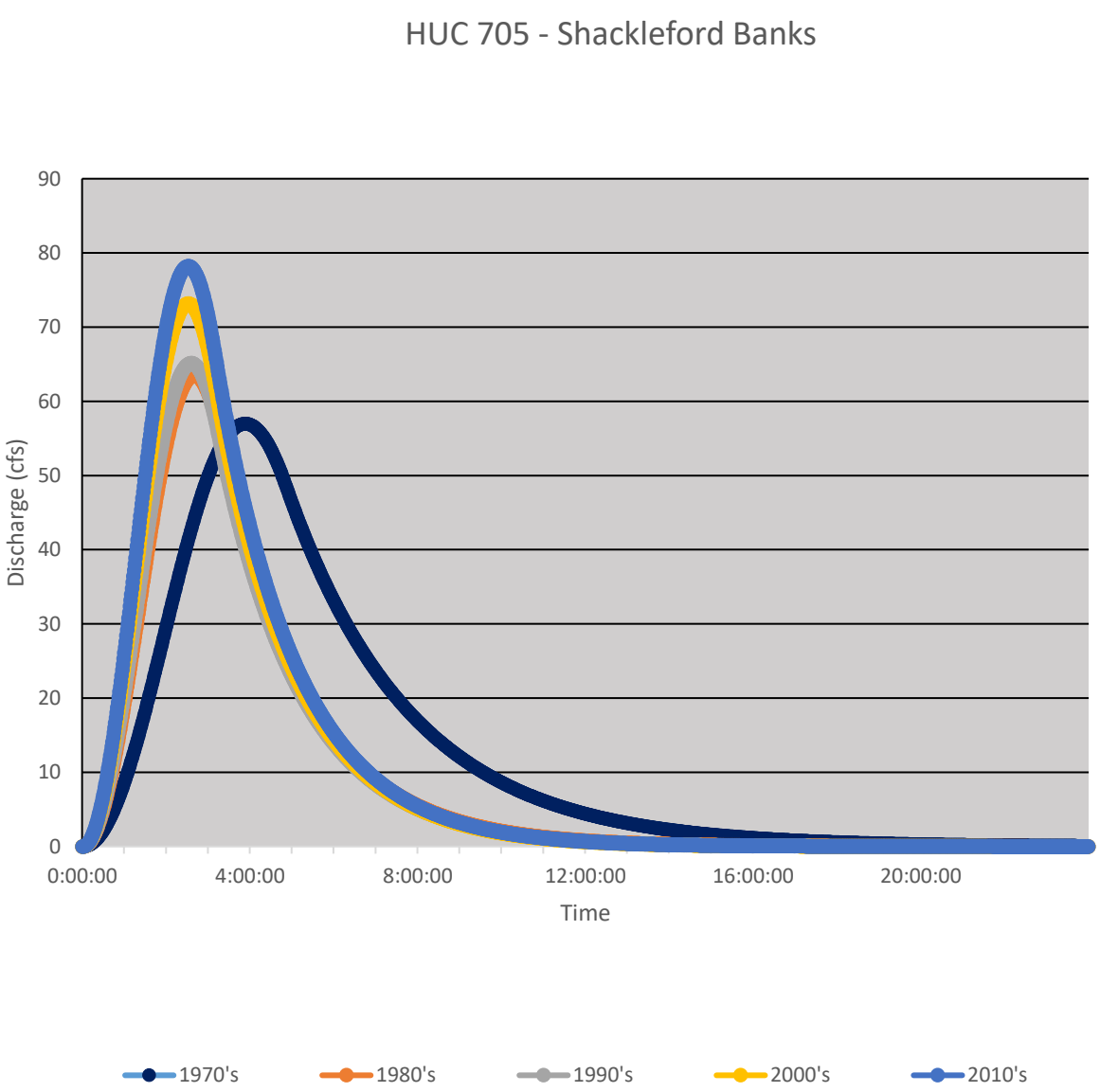


Figure B-9: Stormwater Runoff within the Shackleford Banks Watershed from the 1970's to the 2010's

Appendix C: Water Quality Standards

Further information regarding 303(d) List and its reporting categories[11]:

> *"The term "303(d) list" or "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."*

Table C-1: EPA 303(d) List Integrated Report Categories

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 of time.
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.
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.

[11] Environmental Protection Agency. Retrieved from https://www.epa.gov/tmdl/program-overview-303d-listing

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. To view the regulatory differences between the currently implemented classifications for tidal saltwaters, click here for the tidal saltwaters classifications table.

Table C-2. North Carolina Surface Water Classifications. Full Descriptions Available on DEQ Website.

Primary Use Classifications	
SA	Commercial Shellfishing
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 C

Waters protected for uses such as secondary recreation, fishing, wildlife, fish consumption, aquatic life including propagation, survival and maintenance of biological integrity, and agriculture. Secondary recreation includes wading, boating, and other uses involving human body contact with water where such activities take place in an infrequent, unorganized, or incidental manner.

Class B

Waters protected for all Class C 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.

Water Supply I (WS-I)

Waters protected for all Class C uses plus waters used as sources of water supply for drinking, culinary, or food processing purposes for those users desiring maximum protection for their water supplies. WS-I waters are those within natural and undeveloped watersheds in public ownership. All WS-I waters are HQW by supplemental classification. More information: Water Supply Watershed Protection Program Homepage

Water Supply II (WS-II)

Waters used as sources of water supply for drinking, culinary, or food processing purposes where a WS-I classification is not feasible. These waters are also protected for Class C uses. WS-II waters are generally in predominantly undeveloped watersheds. All WS-II waters are HQW by supplemental classification. More information: Water Supply Watershed Protection Program Homepage

Water Supply III (WS-III)

Waters used as sources of water supply for drinking, culinary, or food processing purposes where a more protective WS-I or II classification is not feasible. These waters are also protected for Class C uses. WS-III waters are generally in low to moderately developed watersheds. More information: Water Supply Watershed Protection Program Homepage

Water Supply IV (WS-IV)

Waters used as sources of water supply for drinking, culinary, or food processing purposes where a WS-I, II or III classification is not feasible. These waters are also protected for Class C uses. WS-IV waters are generally in moderately to highly developed watersheds or Protected Areas. More information: Water Supply Watershed Protection Program Homepage

Water Supply V (WS-V)

Waters protected as water supplies which are generally upstream and draining to Class WS-IV waters or waters used by industry to supply their employees with drinking water or as waters **formerly used as**

water supply. These waters are also protected for Class C uses. More information: Water Supply Watershed Protection Program Homepage

Class WL

Freshwater Wetlands are a subset of all wetlands, which in turn are waters that support vegetation that is adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. These waters are protected for storm and flood water storage, aquatic life, wildlife, hydrologic functions, filtration and shoreline protection.

Class SC

All tidal salt waters 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 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 shellfishing or marketing purposes and are also protected for all Class SC and Class SB uses. All SA waters are also HQW by supplemental classification.

Class SWL

These are saltwaters that meet the definition of coastal wetlands as defined by the Division of Coastal Management and which are located landward of the mean high water line or wetlands contiguous to estuarine waters as defined by the Division of Coastal Management.

DWR SUPPLEMENTAL CLASSIFICATIONS

Supplemental classifications are sometimes added by DWR to the primary classifications to provide additional protection to waters with special uses or values.

Future Water Supply (FWS)

Supplemental classification for waters intended as a future source of drinking, culinary, or food processing purposes. FWS would be applied to one of the primary water supply classifications (WS-I, WS-II, WS-III, or WS-IV). Currently no water bodies in the state carry this designation.

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 shellfishing),
- 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.

Swamp Waters (Sw)

Supplemental classification intended to recognize those waters which have low velocities and other natural characteristics which are different from adjacent streams.

Trout Waters (Tr)

Supplemental classification intended to protect freshwaters which have conditions which shall sustain and allow for trout propagation and survival of stocked trout on a year-round basis. This classification is not the same as the NC Wildlife Resources Commission's Designated Public Mountain Trout Waters designation.

Unique Wetland (UWL)

Supplemental classification for wetlands of exceptional state or national ecological significance. These wetlands may include wetlands that have been documented to the satisfaction of the Environmental Management Commission as habitat essential for the conservation of state or federally listed threatened or endangered species.

Table C-3: North Carolina Water Quality Classification and Standards.

Classification	Description
Class SA	Tidal salt waters that are used for commercial shellfishing or marketing purposes and are also protected for all Class SC and Class SB uses. All SA waters are also HQW by supplemental classification. The following water quality standards apply to surface waters that are used for shellfishing 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. (1) Best Usage of Waters. Shellfishing 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: 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.**
Class SB	Tidal salt waters 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. The following water quality standards apply to surface waters that are used for primary recreation, including frequent or organized swimming, and are classified SB. 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 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 salt water 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 shellfishing 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 considered to 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 embayments, 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 radio-nuclides) 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 saltwaters: (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) Polycholorinated 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 bioaccumulative 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

Table C-4: Classifications Used by Shellfish Sanitation for Shellfish Harvesting Waters

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 of time, 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	"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. 1. The enterococcus level in a Tier I swimming area shall not exceed either: 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. Tier I Swimming areas: (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. 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.
Tier II	"Tier II swimming area" means a swimming area used an average of three days a week during the swimming season. The enterococcus level in a Tier II swimming area shall not exceed a single sample of 276 enterococci per 100 milliliters of water. Tier II swimming areas: (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.

	(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. 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.
Tier III	"Tier III swimming area" means a swimming area used an average of four days a month during the swimming season. 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. 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.
Swimming Season	April 1 through October 31 of each year. The enterococcus level in a Tier III swimming area shall not exceed two consecutive samples of 500 enterococci per 100 milliliters of water.
Winter Season	November 1 through March 31 of each year.

Appendix D: 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 sources[12].

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.
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 pumpout dock.

[12] 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.

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 shellfishing waters. Conveyances not evaluated include small ditches dug by individual homeowners, pipes draining single-home gutter systems, or any drainage not reaching shellfishing 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, none major; 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 particular 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"

Appendix E: Potential Stormwater Incentive Strategies

Incentive Categories

The EPA has identified five basic incentive categories that can be utilized to encourage the reduction of stormwater[13]:

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.

[13] 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

Basic Strategies

The following is a compiled list of basic strategies and descriptions (summarized or quotes directly from Slo County[14] and EPA[15]; 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.
Environmentally Sensitive Large Lot Neighborhood Credit (aka Environmentally Sensitive Development Credit)	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.

[14] 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

[15] *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

Exemptions from local stormwater permitting	Allow redevelopment projects from being exempt from local stormwater permitting requirements if they can: • 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	Provide priority status to LID projects with decreased time between receipt and review.
Green Roof Bonus	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.
LID Point system	Require a certain number of LID points and provide points when using approved LID IMP practices.
Managed Conservation Area Credit	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.
Modify building and inspection codes to include LID	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. http://www.econw.com/media/ap_files/ECONorthwest_Publication_LID-Clackamas-County-Case-Study_2009.pdf
Natural Area Conservation Credit	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.
Property tax reduction	Reduce or waive property taxes on an LID project for a given number of years.
Reduction of municipal submittal fees	Projects that infiltrate 100 percent of stormwater receive up to 50% reduction in the stormwater utility fee

Steam and Vegetated Buffer Credit (aka Stream Buffer Credit or Sheet flow to Buffer Credit)	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.
Tree canopy credit	Reduce stormwater treatment volume requirements as a ratio of the number of acceptably sized trees planted on the project
Vegetated Channel Credit (aka Grass Channel Credit (in lieu of Curb and Gutter)	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.
Education Strategy	• 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 • 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	Communication about grant opportunities, partnerships, awards, competitions, and regulations via email, newsletter, website, etc. directed directly at business owners and commercial land owners to encourage participation and encourage a vested interest in the community

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)."[16]
- 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:

- 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

[16] 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

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 EPA[17]:

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	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. Flow Chart for Rate Determination: http://www.cityoforlando.net/public_works/Stormwater/Utility%20Fee/FLOWCHART%20FOR%202008%20BILLING%20YEAR.pdf FAQs: http://www.cityoforlando.net/public_works/Stormwater/faq.htm#04.3

[17] *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

Stormwater Credits Program	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. Beneficiary: Property owner in Gwinnett County.
Utility Fee Credit	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
Stormwater Fee Discount	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 8 from the site. Wichita has not issued any credits, because the standards are difficult to achieve. Beneficiary: Residential

Drainage Charge Credit	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
Stormwater Surcharge Credit	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: • 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% Beneficiary: Commercial
Stormwater Enterprise Fund Fee Abatement	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.
Stormwater Quality Credit	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

NC CHARLOTTE Stormwater Services Credit	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
NC CHARLOTTE Stormwater Credit Fee	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. • 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. 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
NC DURHAM Stormwater Credit	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

NC RALEIGH Stormwater Facility Credit	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.
Clean River Rewards Incentive and Discount Program	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, 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
Sixty-Five-Ten Discount	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
Surface Water Utility Reductions	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

Development Incentive	
Incentive Name	Description
Green Building and Green development Program	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. Beneficiary: Qualified developer in Sarasota County.
Green Permit Program	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. Beneficiary: Architects, developers, and building owners
Floor Area Ration Bonus	Projects that install ecoroofs in the Central City Plan District are eligible for a floor area ratio bonus, which increases the building's allowable area, and can use ecoroofs to conform to the Central City Design Guidelines. Buildings can receive bonus FAR based on three ranges of ecoroof 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 ecoroof respectively. Beneficiary: Commercial buildings in the Central City area of Portland. http://www.portlandonline.com/shared/cfm/image.cfm?id=53363, see 510-28
Stream and Vegetated Buffers Credit	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. Beneficiary: Developer

Use of Vegetated Channels	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. Beneficiary: Developer
Impervious Area Disconnection	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. Beneficiary: Developer
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.
Green Roof Improvement Fund	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. Beneficiary: Commercial
Community Watershed Stewardship Grant	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, ecoroofs, stormwater features, restoration, and naturescaping. Community organizations

Impervious Surface Cost Share and Credit Program	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. Beneficiary: Commercial
Aquatic Habitat Matching Grant	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. Beneficiary: Individuals or groups

Rebates Installation Financing Incentive	
Incentive Name	Descrpition
Rain Gutter Downspout Redirect Rebate, Rain Barrel Rebate, Cistern Rebate	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	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. Beneficiary: Residential, commercial, or governmental property owner in the City of Palo Alto, California.
River Smart Homes	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
City of Maitland Incentive Programs	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. Beneficiary: Property owner in Maitland, Florida

Roll Out the Barrel Events	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. Beneficiary: Residential
Rain Gardens for Rock Island	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. Beneficiary: Residential property owner in Rock Island, Illinois.
RainScapes Regards	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. Beneficiary: Residential and commercial properties
Rain Garden Retrofit Projects	$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. Beneficiary: Residential
Street Redesign and Reconstruction	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. Beneficiary: Residential RESOLVE. 2007. Public Funding Incentives for Private Residential and Commercial Watershed Protection Projects: Report on Key Case Studies and Community Workshop. http://www.resolv.org/rainscapesworkshop/Report.pdf.

Rain Barrel Discount Program	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. Beneficiary: Residential
Reverse Bidding Auction	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. Beneficiary: Residential property owner in the Shepherd Creek watershed.
Downspout Disconnection Program	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. Beneficiary: Residential

Awards and Recognition Incentive	
Incentive Name	Description
Mayor Daley's GreenWorks Award	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.
Business for an Environmentally Sustainable Tomorrow (BEST)	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
Eco-logical Business Program	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
Stormwater BMP Recognition Program	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

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Appendix F: 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

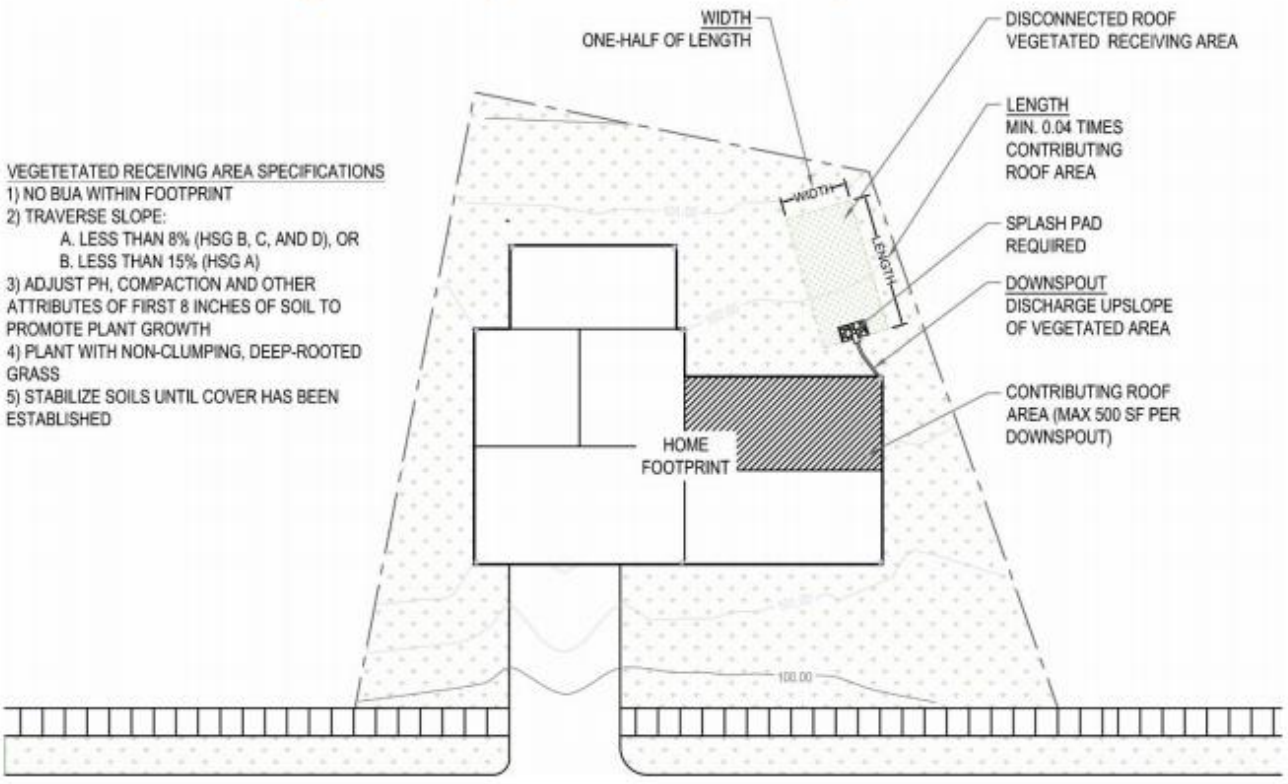


Figure 2: Example Disconnected Pavement: Plan View

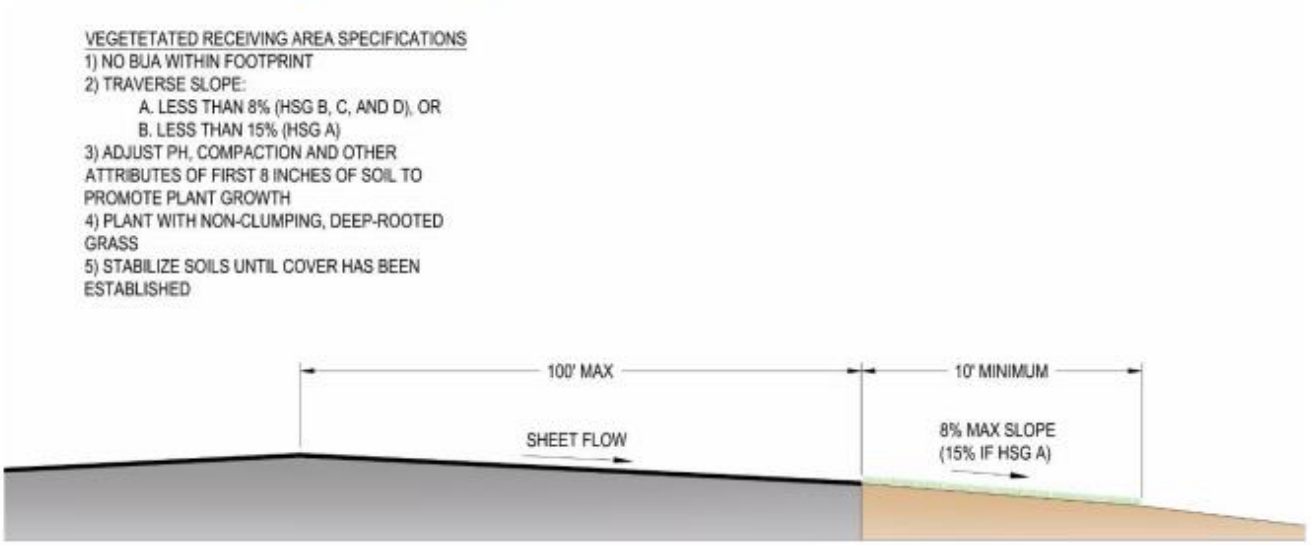


Figure 3. Outlet configuration with a foundation planting (Carmen, NCSU)

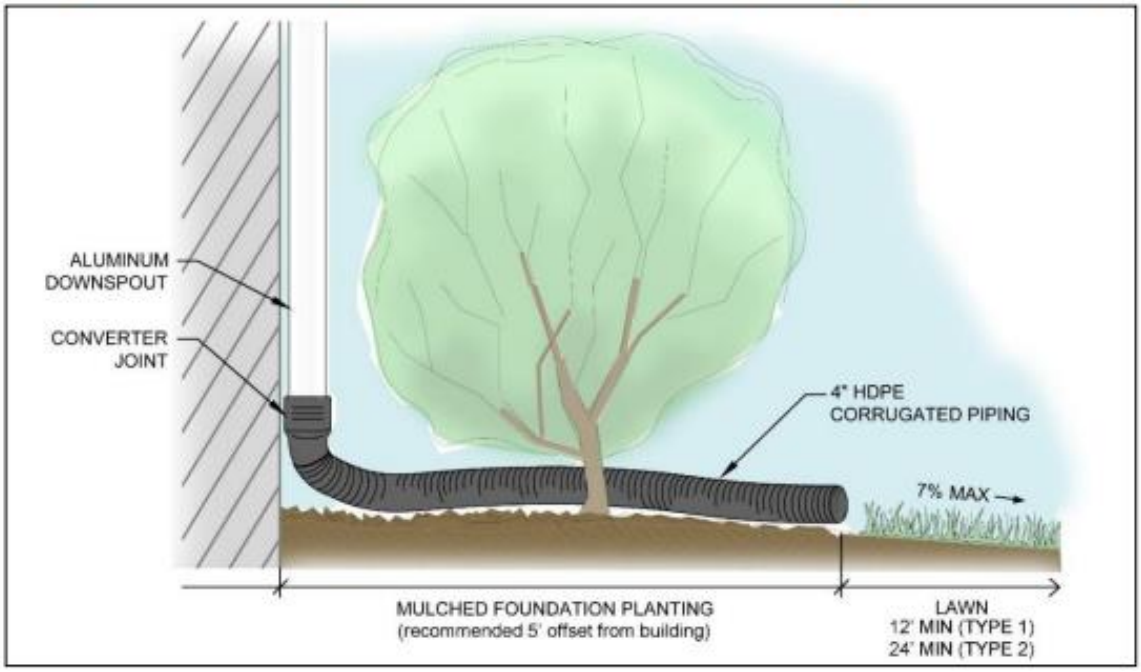


Figure 4. Hinged outlet configuration (Carmen, NCSU)

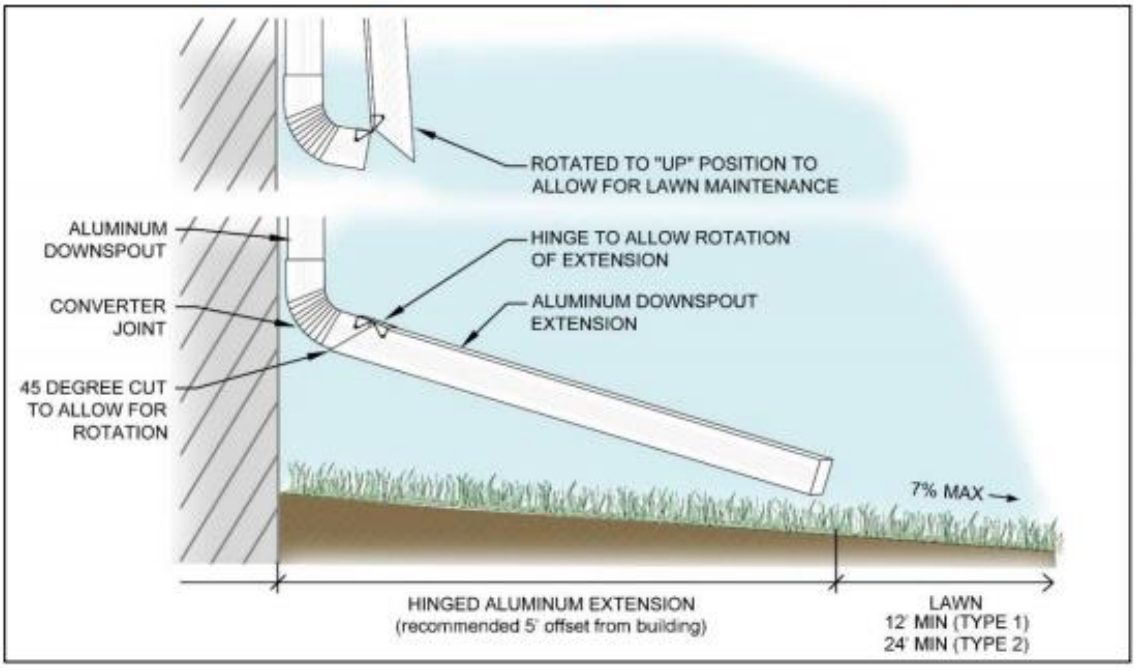
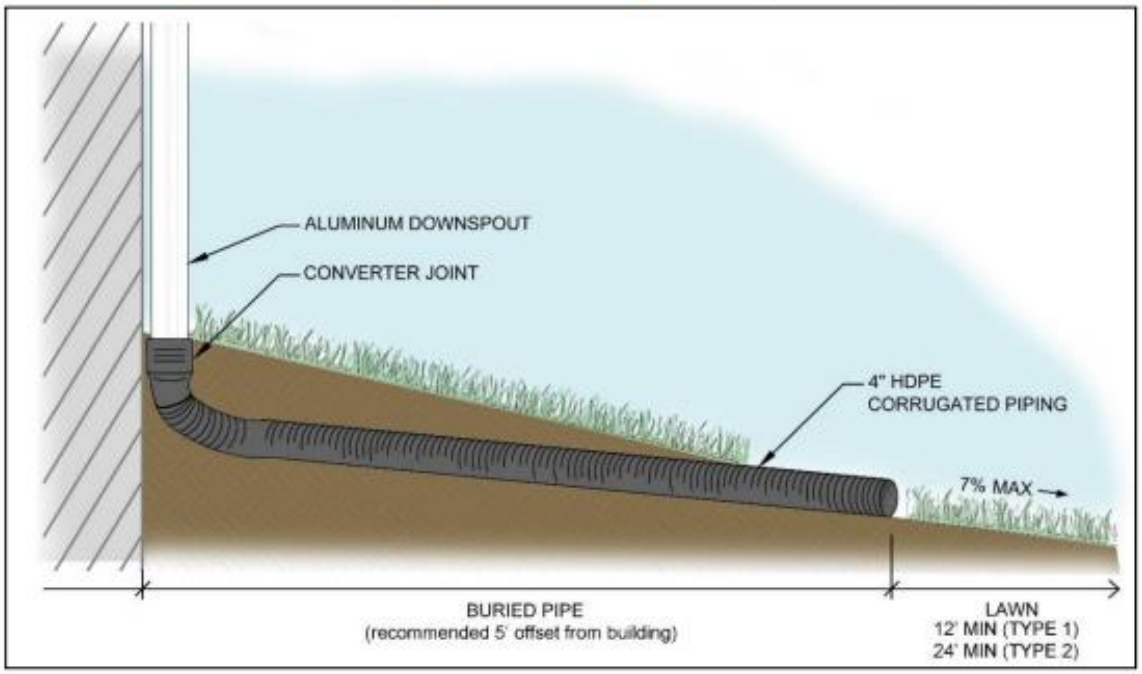


Figure 5. Buried pipe outlet configuration (Carmen, NCSU)



[18]

[18] https://stormwater.bae.ncsu.edu/resources/

Permeable Pavement

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

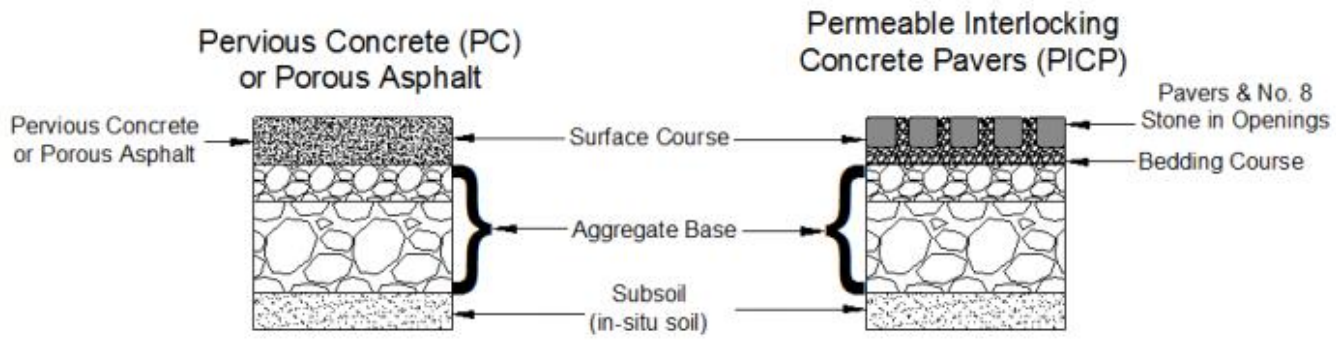


Figure 2. Permeable Pavement Example: Outlet for Infiltration System (NCSU-BAE)

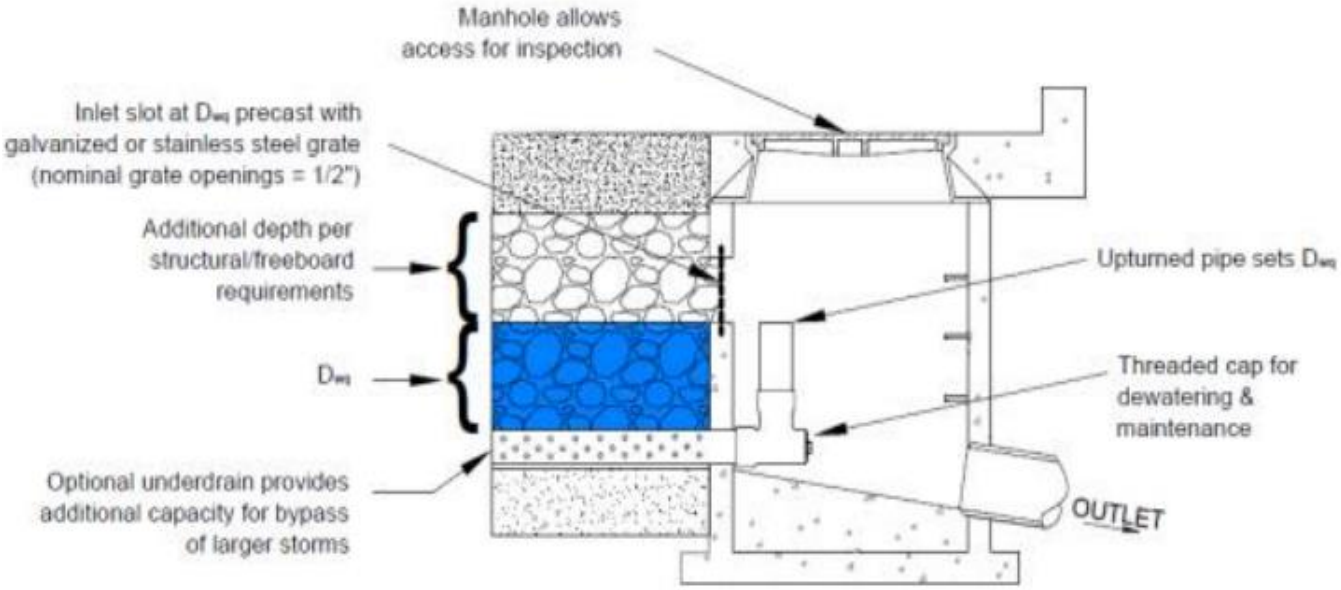
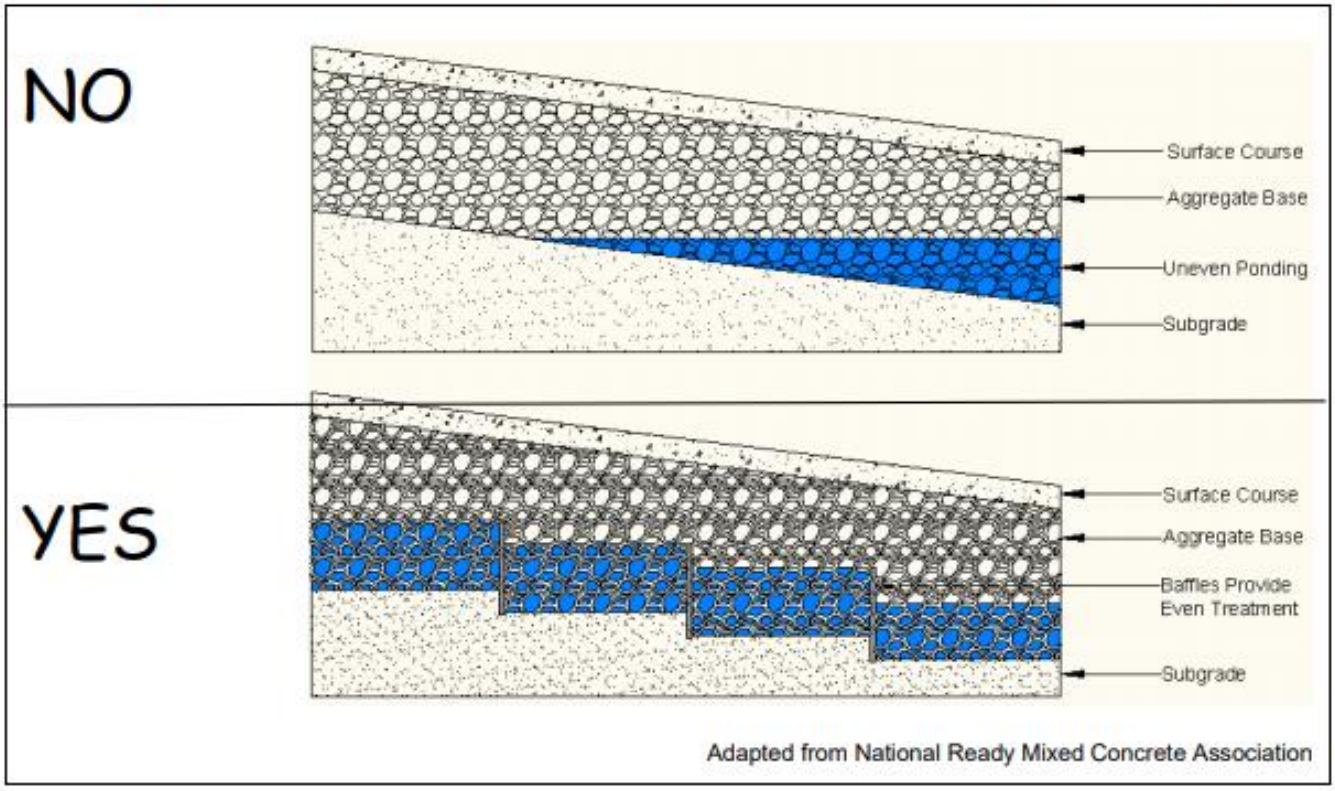


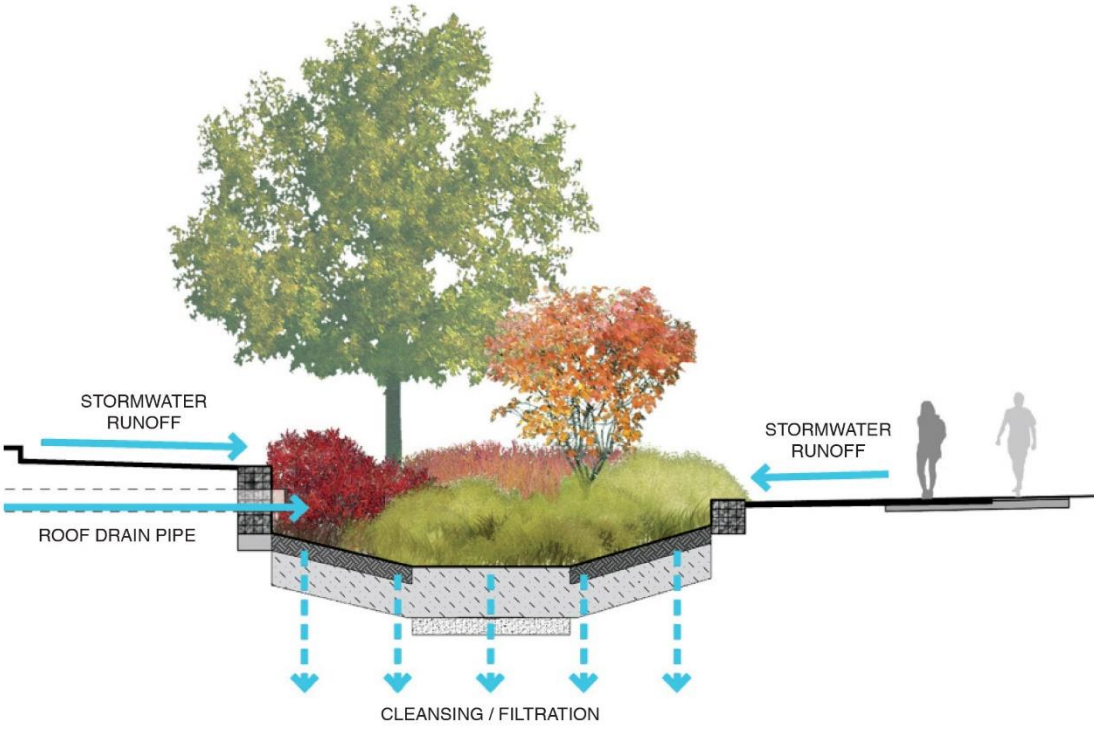
Figure 3. Terraces and Baffles under Permeable Pavement. (NCSU-BAE)



[19]

[19] https://www.ecorastergrid.com/about/

Bioswales



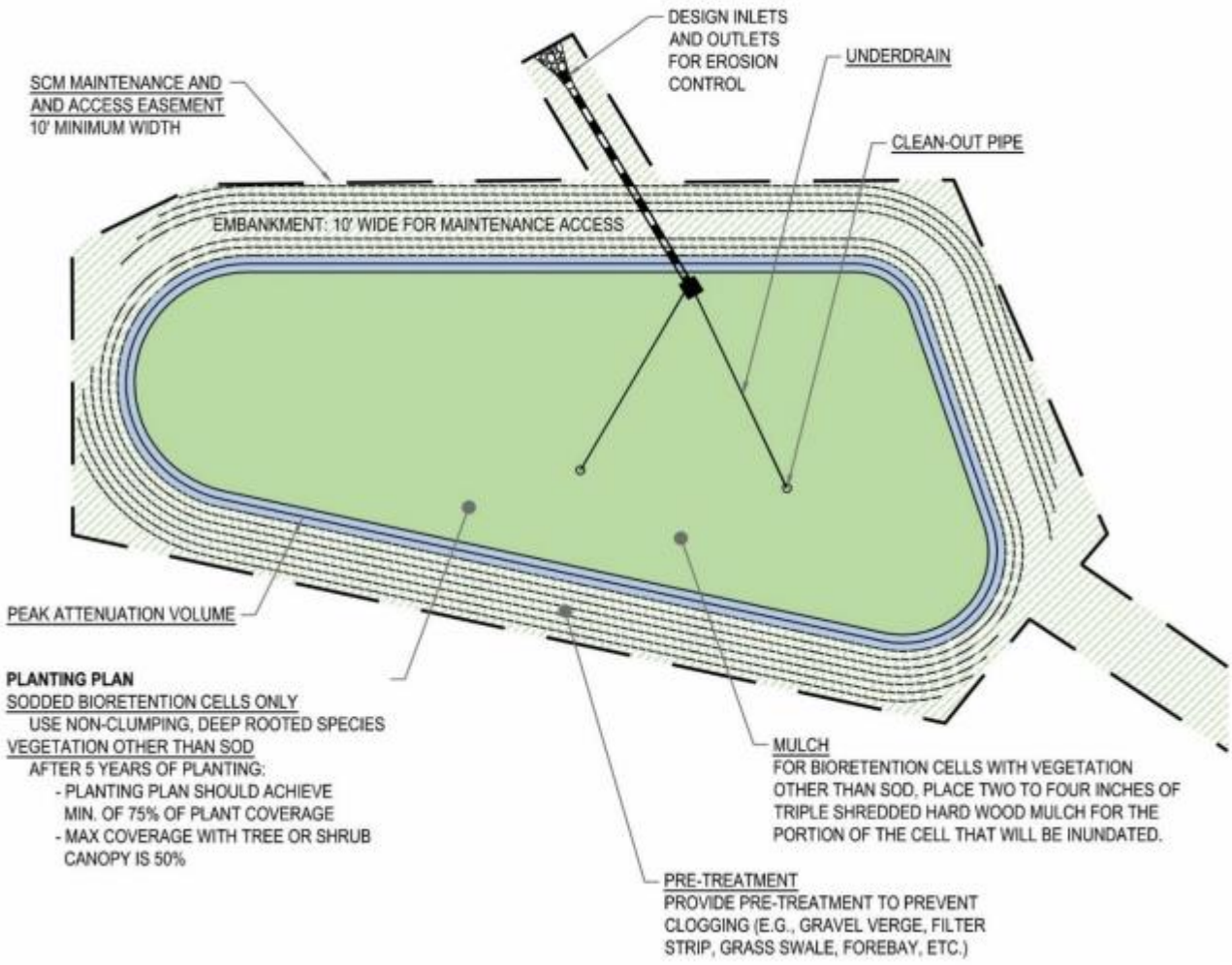
Bioswale cross-section

20

21

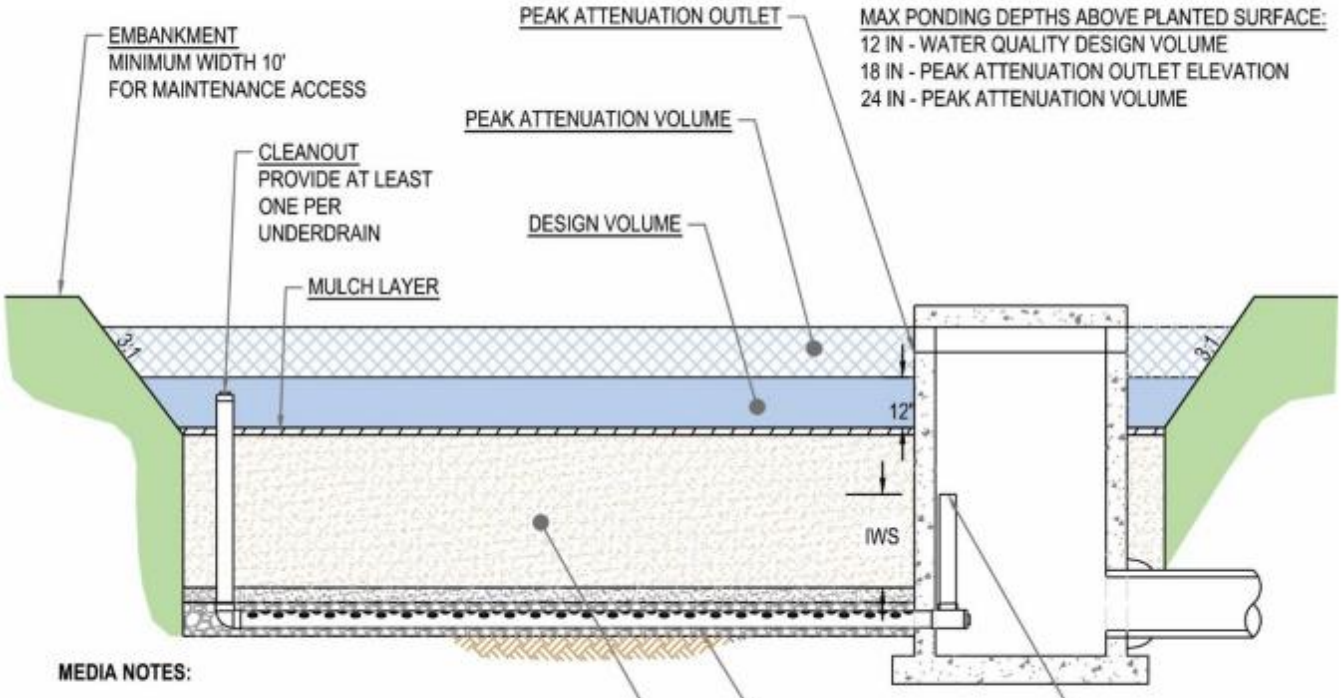
Bioretention

Figure 1: Bioretention Example: Plan View



[20] https://www.lwa-architects.com/sustainable-design/
[21] https://www.watershedcouncil.org/bioswale.html

Figure 2: Bioretention Example: Cross-Section



MEDIA NOTES:

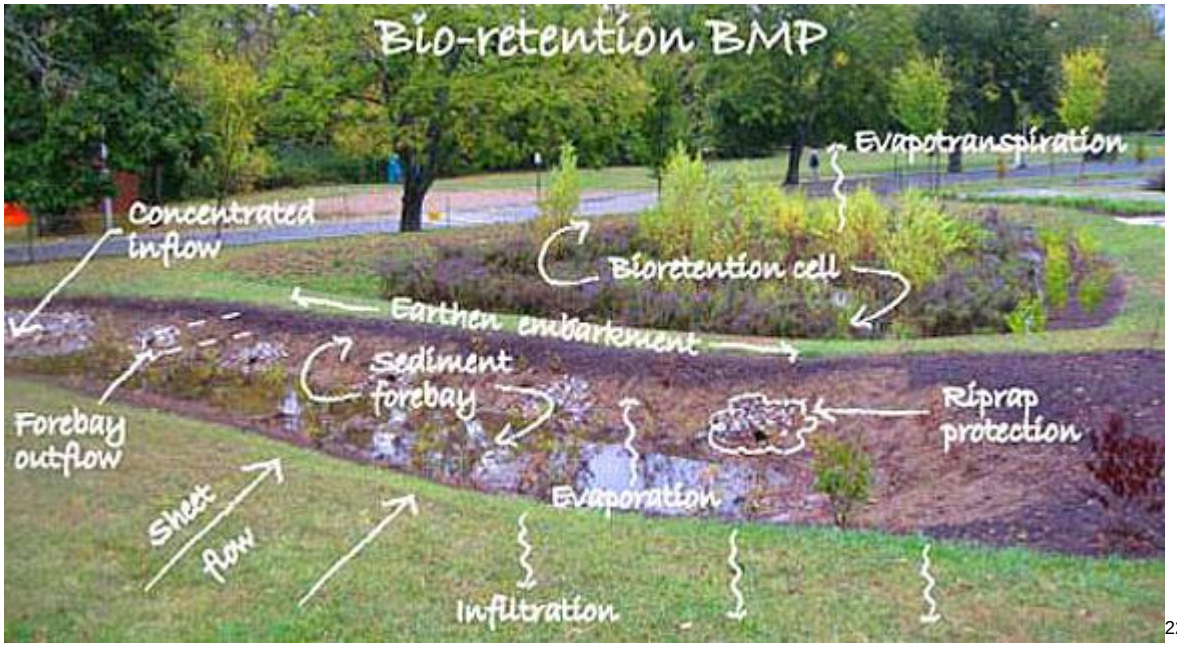
MEDIA MIX
THE MEDIA SHOULD BE COMPOSED OF A HOMOGENOUS MIX OF THE FOLLOWING:

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

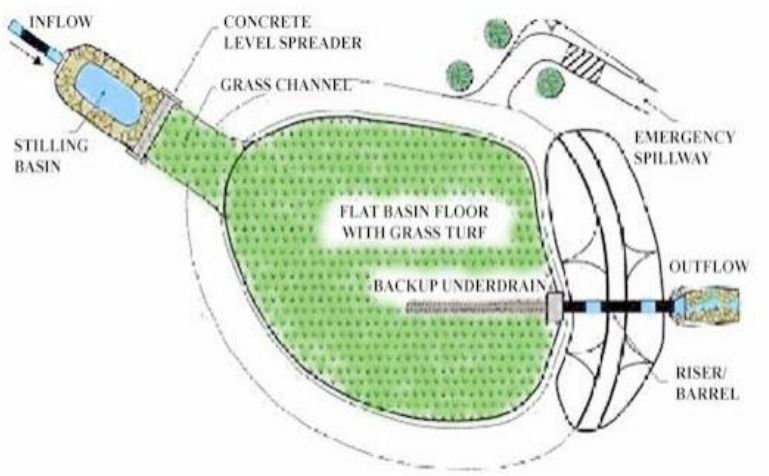
MEDIA MAINTENANCE
MAINTAIN MEDIA SUCH THAT INFILTRATION RATE IS AT LEAST 1 IN/R

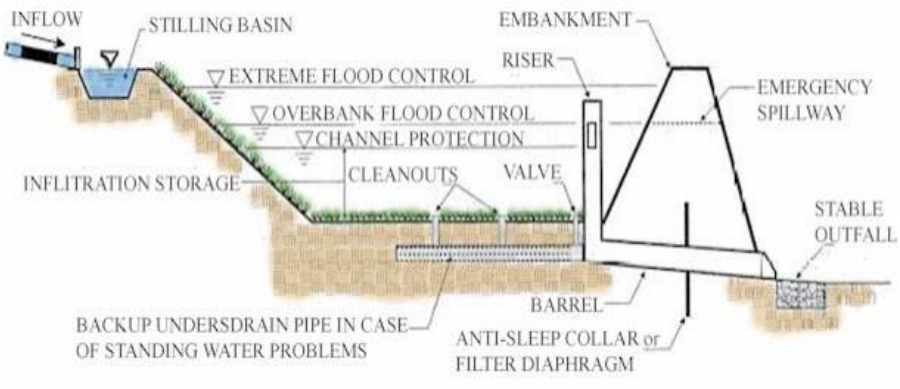


[22]

[22] https://nalandscape.com/retention.html

Infiltration Basins



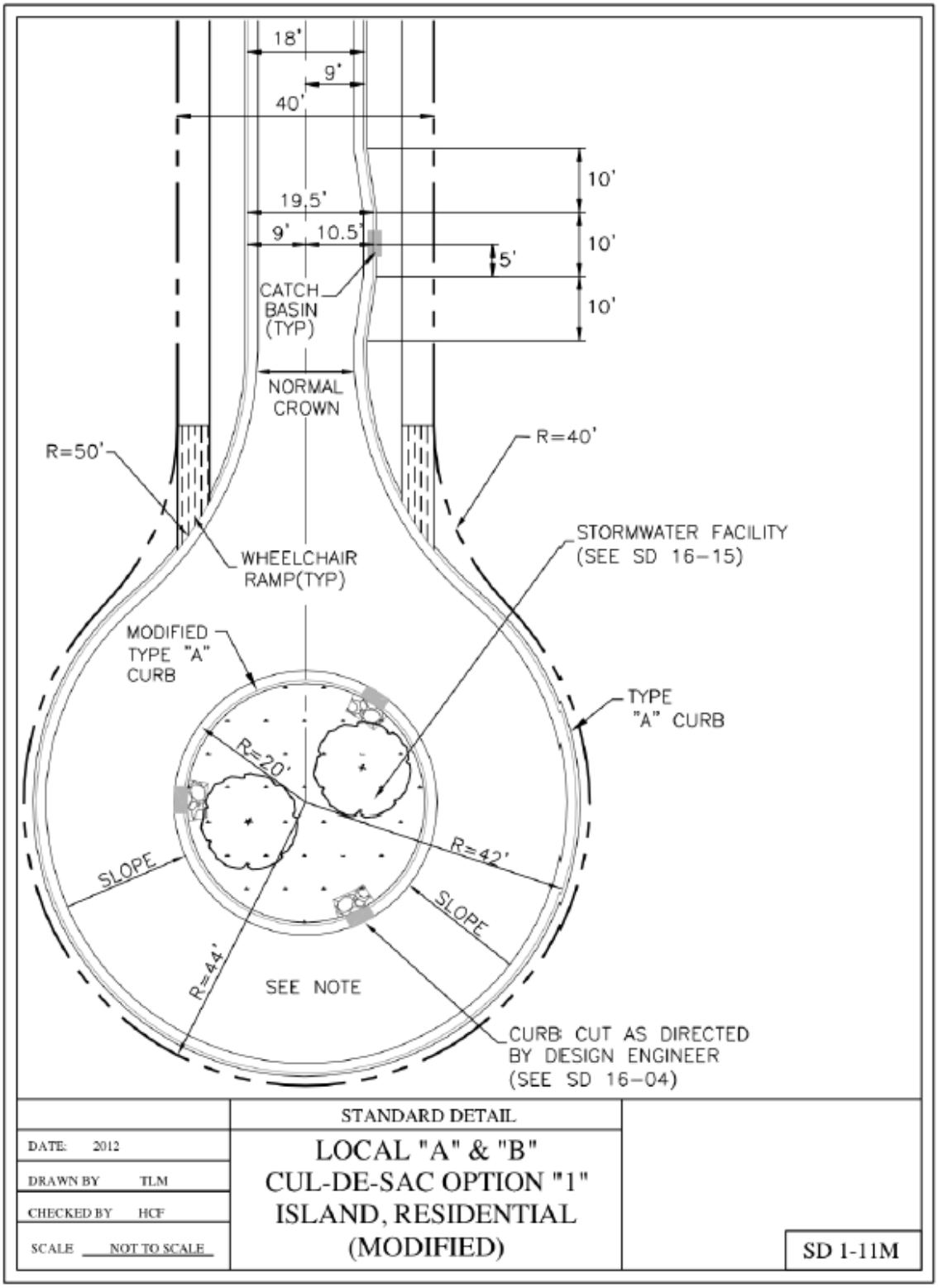


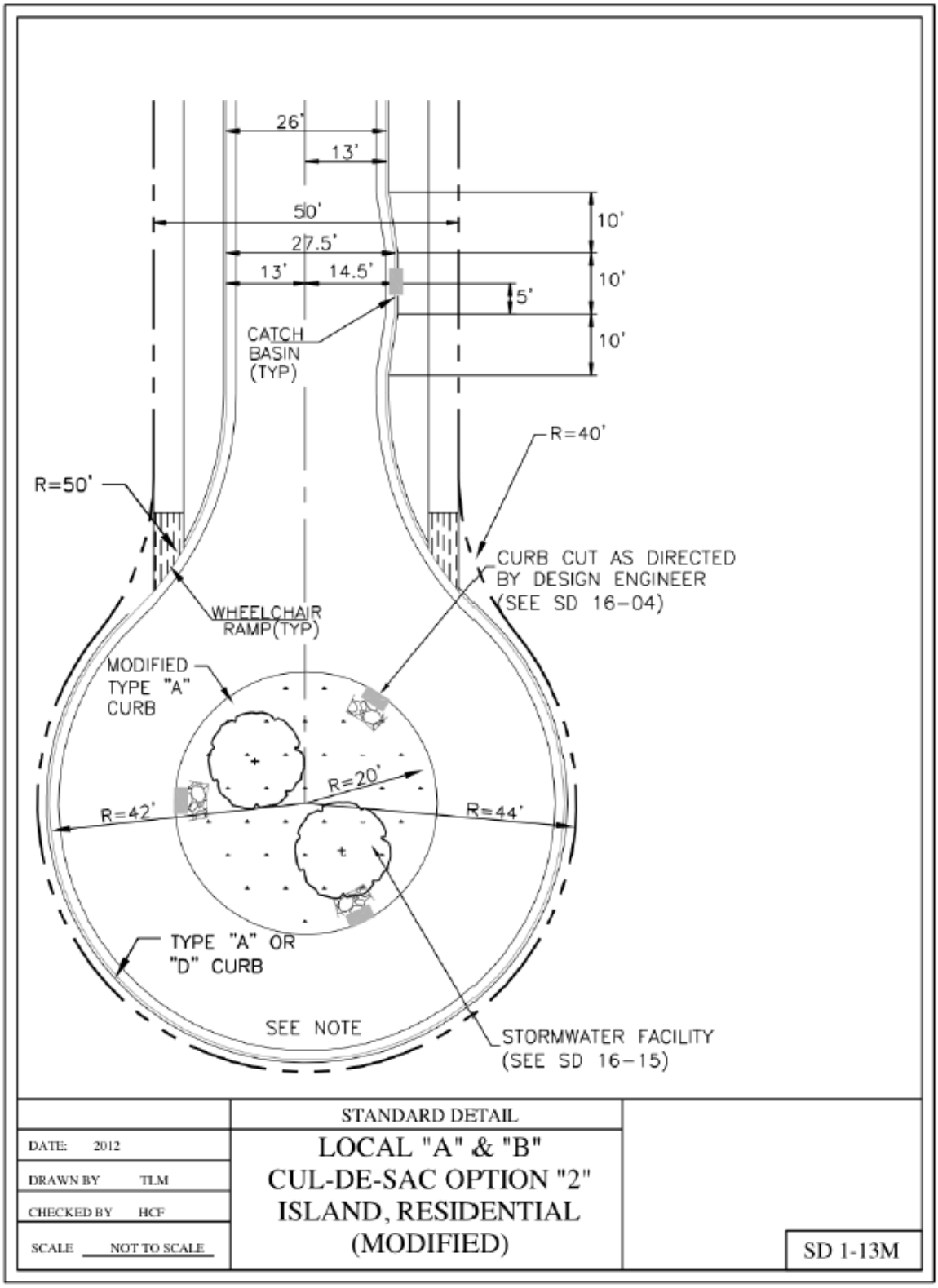
Dune Infiltration & Subsurface Dune Infiltration

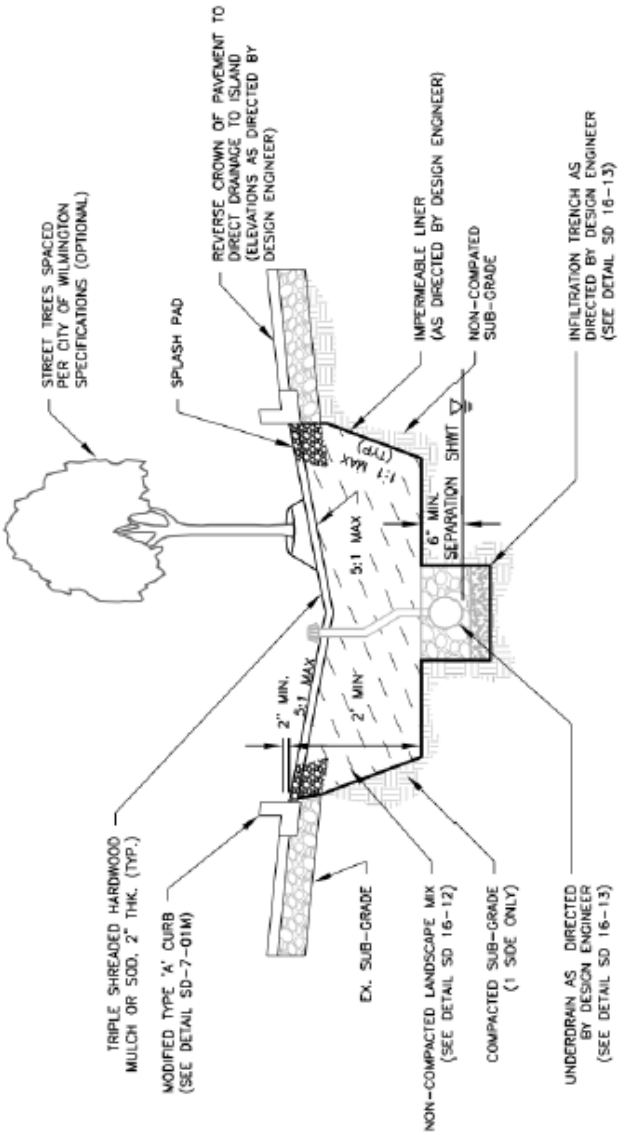
[23]

[23] https://content.ces.ncsu.edu/dune-infiltration-systems-for-reducing-stormwater-discharge-to-coastal-recreational-beaches

Standard Details

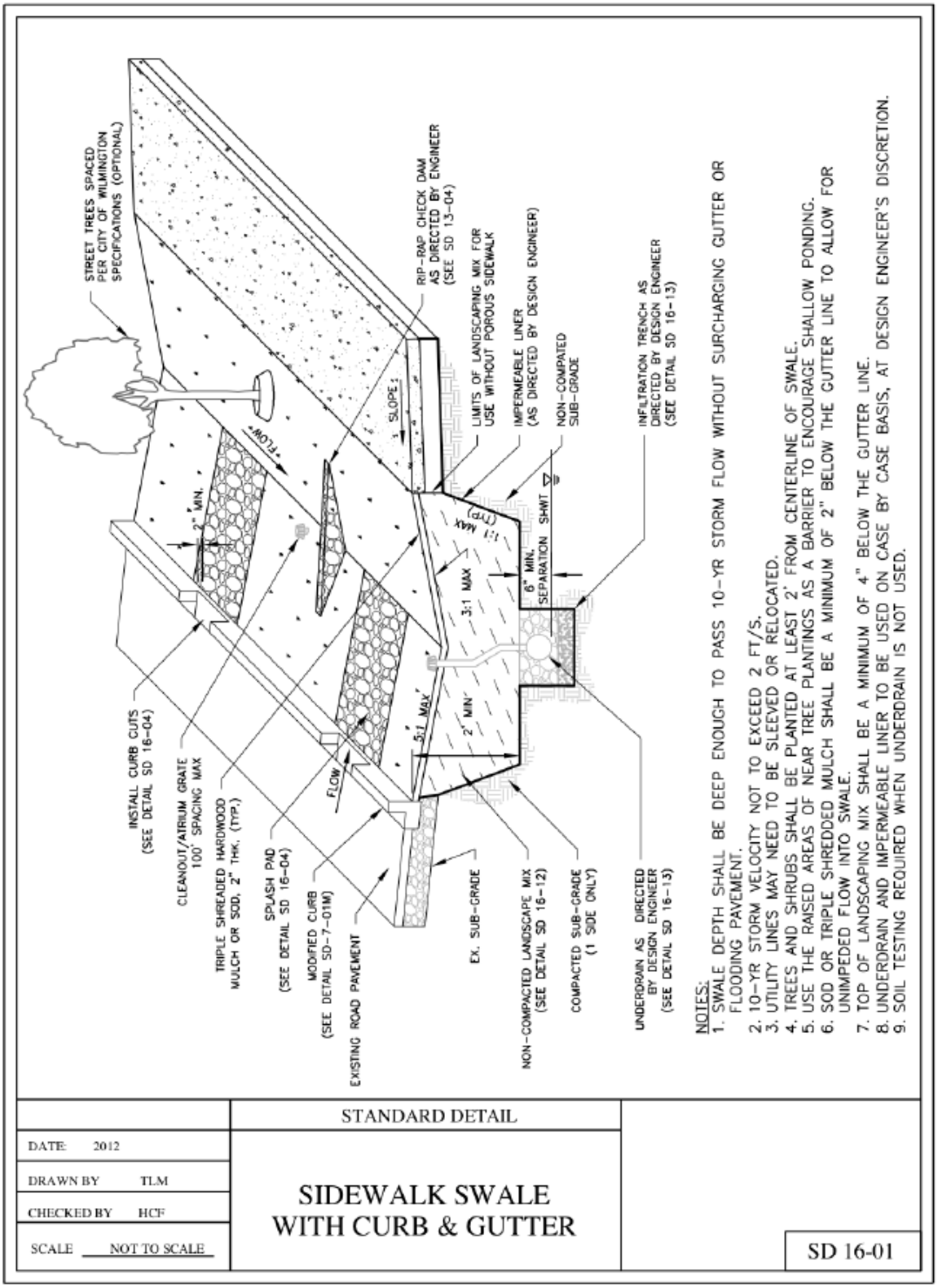



26'
13'
50'
27.5'
13'
14.5'
10'
10'
5'
10'
CATCH BASIN (TYP)
R=40'
R=50'
CURB CUT AS DIRECTED BY DESIGN ENGINEER (SEE SD 16-04)
WHEELCHAIR RAMP(TYP)
MODIFIED TYPE "A" CURB
R=20'
R=42'
R=44'
TYPE "A" OR "D" CURB
SEE NOTE
STORMWATER FACILITY (SEE SD 16-15)
STANDARD DETAIL
DATE: 2012
DRAWN BY TLM
CHECKED BY HCF
SCALE NOT TO SCALE
LOCAL "A" & "B"
CUL-DE-SAC OPTION "2"
ISLAND, RESIDENTIAL
(MODIFIED)
SD 1-13M



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 SHREDDED 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	
DATE: 2012	STORMWATER ISLAND CROSS SECTION	SD 16-15
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		



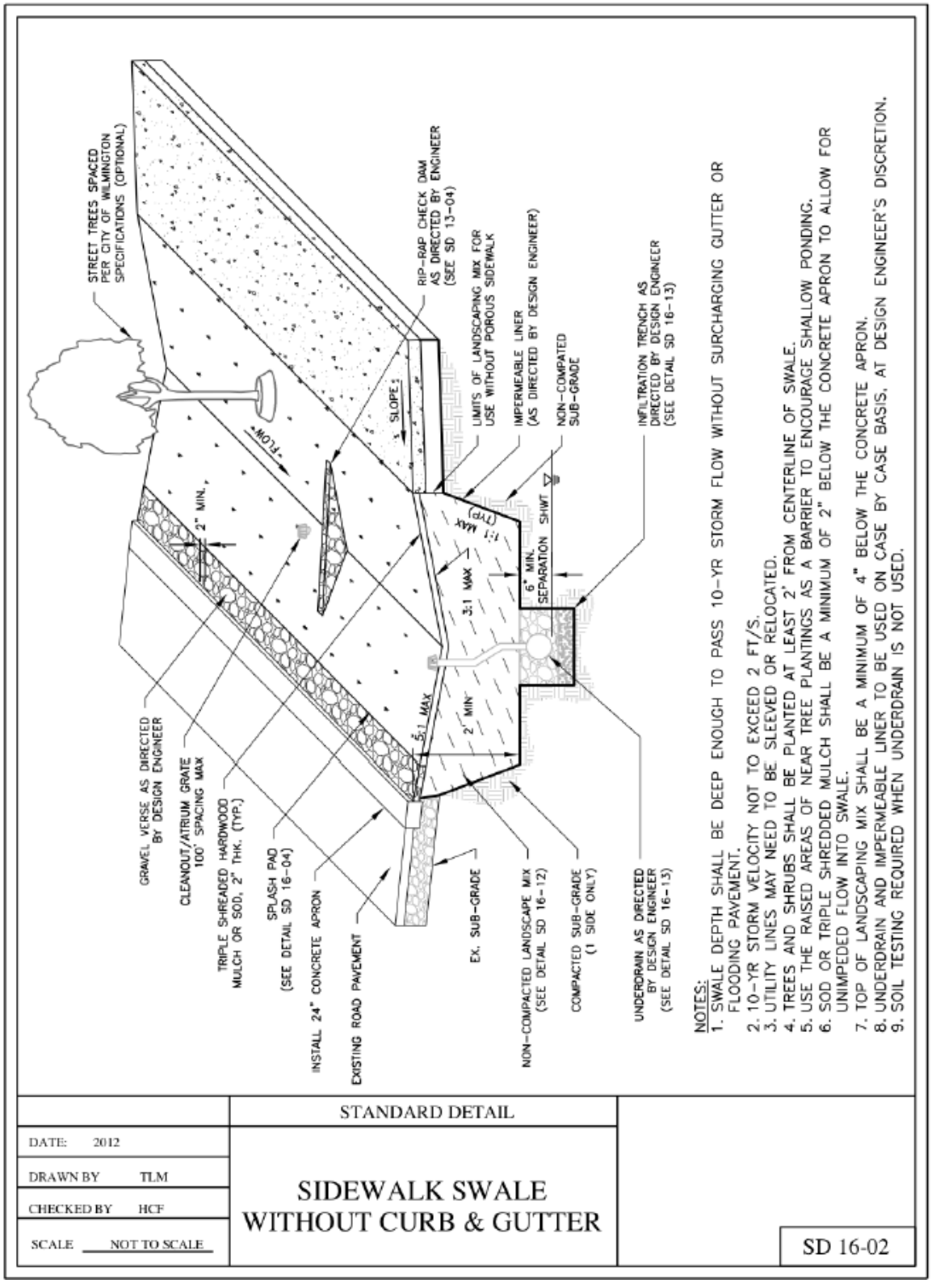
NOTES:
1. SWALE DEPTH SHALL BE DEEP ENOUGH TO PASS 10-YR STORM FLOW WITHOUT SURCHARGING GUTTER OR FLOODING PAVEMENT.
2. 10-YR STORM VELOCITY NOT TO EXCEED 2 FT/S.
3. UTILITY LINES MAY NEED TO BE SLEEVED OR RELOCATED.
4. TREES AND SHRUBS SHALL BE PLANTED AT LEAST 2' FROM CENTERLINE OF SWALE.
5. USE THE 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.

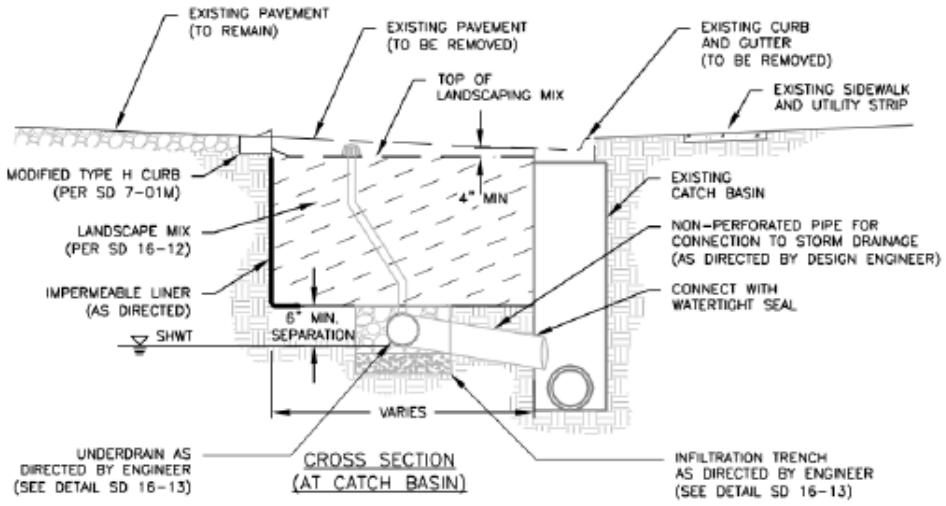
STANDARD DETAIL

DATE:	2012
DRAWN BY	TLM
CHECKED BY	HCF
SCALE	NOT TO SCALE

SIDEWALK SWALE WITH CURB & GUTTER

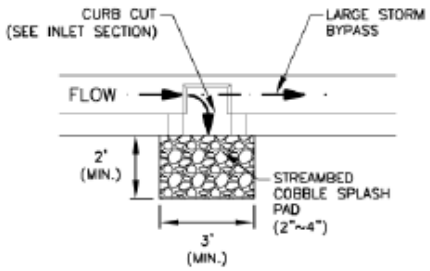
SD 16-01


STREET TREES SPACED PER CITY OF WILMINGTON SPECIFICATIONS (OPTIONAL)
RIP-RAP CHECK DAM AS DIRECTED BY ENGINEER (SEE SD 13-04)
LIMITS OF LANDSCAPING MIX FOR USE WITHOUT POROUS SIDEWALK
IMPERMEABLE LINER (AS DIRECTED BY DESIGN ENGINEER)
NON-COMPACTED SUB-GRADE
INFILTRATION TRENCH AS DIRECTED BY DESIGN ENGINEER (SEE DETAIL SD 16-13)
FLOW
SLOPE
2" MIN.
1:1 MAX (TYP.)
3:1 MAX
6" MIN. SEPARATION SHWT
5:1 MAX
2' MIN
GRAVEL VERSE AS DIRECTED BY DESIGN ENGINEER
CLEANOUT/ATRIUM GRATE 100' SPACING MAX
TRIPLE SHREADED HARDWOOD MULCH OR SOD, 2" THK. (TYP.)
SPLASH PAD (SEE DETAIL SD 16-04)
INSTALL 24" CONCRETE APRON
EXISTING ROAD PAVEMENT
EX. SUB-GRADE
NON-COMPACTED LANDSCAPE MIX (SEE DETAIL SD 16-12)
COMPACTED SUB-GRADE (1 SIDE ONLY)
UNDERDRAIN AS DIRECTED BY DESIGN ENGINEER (SEE DETAIL SD 16-13)
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 CONCRETE APRON TO ALLOW FOR UNIMPEDED FLOW INTO SWALE.
7. TOP OF LANDSCAPING MIX SHALL BE A MINIMUM OF 4" BELOW THE CONCRETE APRON.
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
DATE: 2012
DRAWN BY TLM
CHECKED BY HCF
SCALE NOT TO SCALE
SIDEWALK SWALE
WITHOUT CURB & GUTTER
SD 16-02

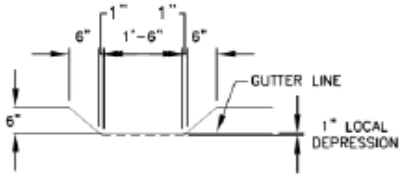


NOTES:
SOIL TESTING REQUIRED WHEN NOT USING UNDERDRAIN

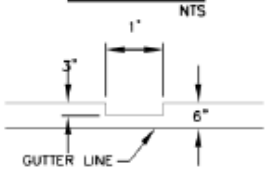
	STANDARD DETAIL	
DATE: 2012	CURB EXTENSION (2 OF 3)	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-03b



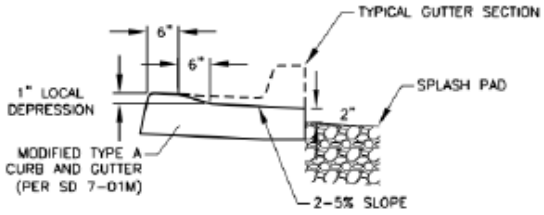
CURB CUT INLET PLAN
NTS



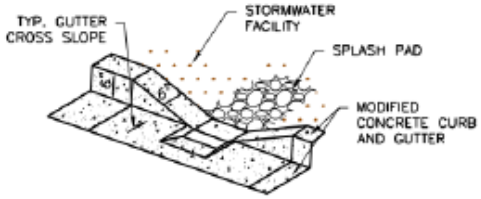
INLET SECTION
NTS



OUTLET SECTION
NTS

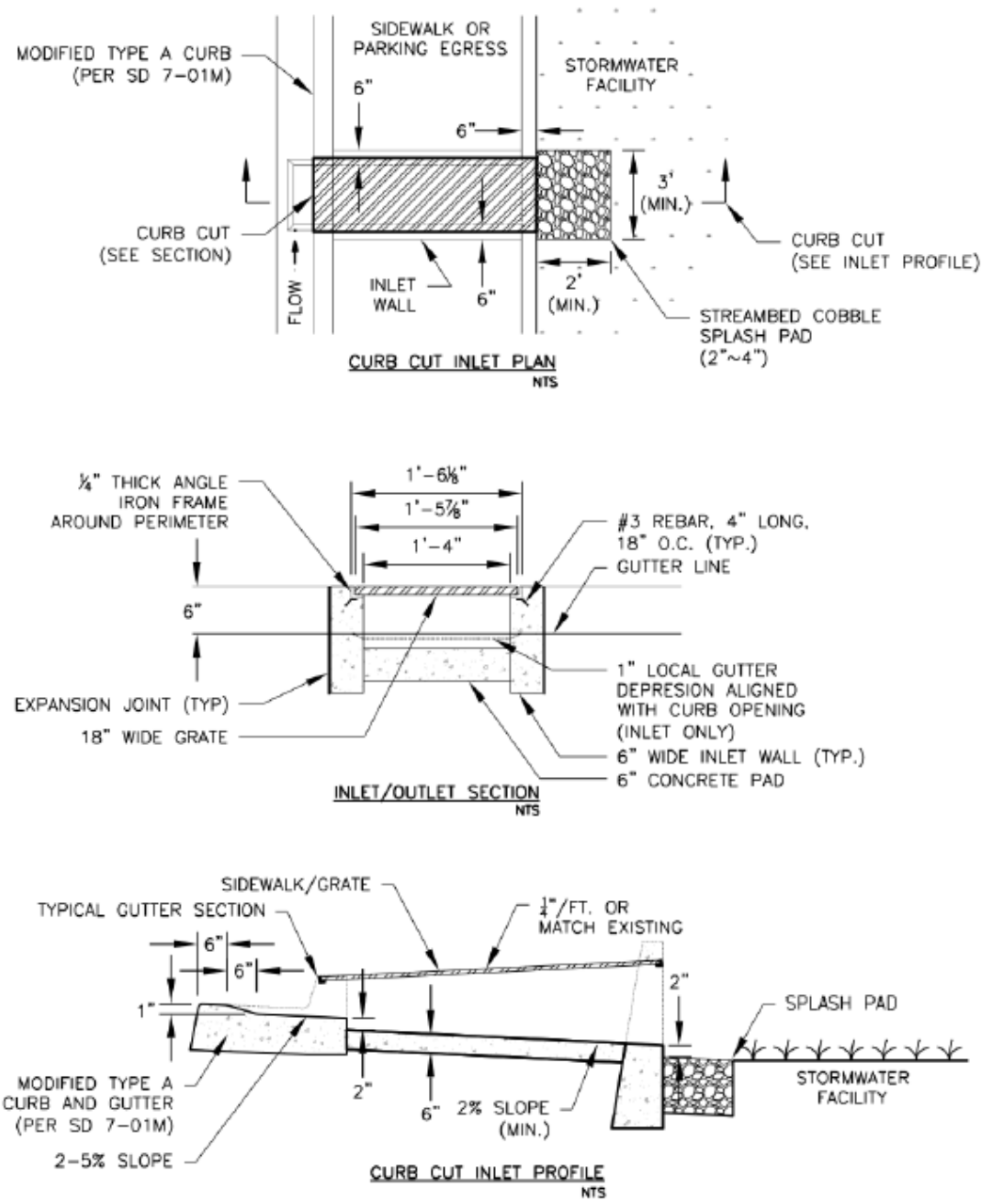


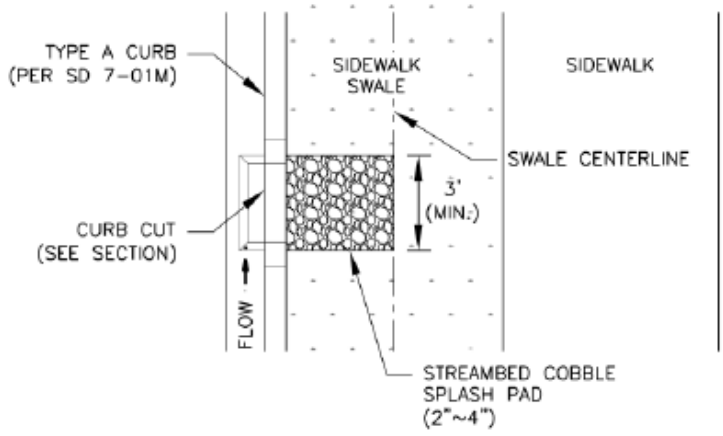
CURB CUT INLET PROFILE
NTS



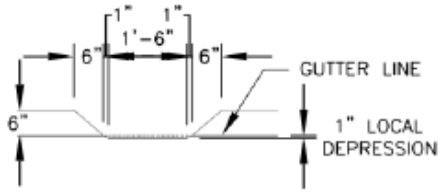
ISOMETRIC VIEW
NTS

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

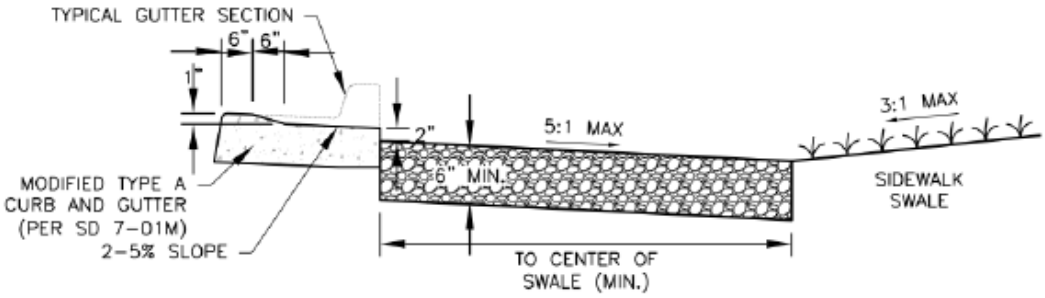

MODIFIED TYPE A CURB
(PER SD 7-01M)
SIDEWALK OR
PARKING EGRESS
STORMWATER
FACILITY
6"
6"
3'
(MIN.)
CURB CUT
(SEE SECTION)
CURB CUT
(SEE INLET PROFILE)
FLOW
INLET
WALL
6"
2'
(MIN.)
STREAMBED COBBLE
SPLASH PAD
(2"~4")
CURB CUT INLET PLAN
NTS
¼" THICK ANGLE
IRON FRAME
AROUND PERIMETER
1'-6⅛"
1'-5⅞"
1'-4"
#3 REBAR, 4" LONG,
18" O.C. (TYP.)
GUTTER LINE
6"
1" LOCAL GUTTER
DEPRESION ALIGNED
WITH CURB OPENING
(INLET ONLY)
EXPANSION JOINT (TYP)
18" WIDE GRATE
6" WIDE INLET WALL (TYP.)
6" CONCRETE PAD
INLET/OUTLET SECTION
NTS
SIDEWALK/GRATE
TYPICAL GUTTER SECTION
¼"/FT. OR
MATCH EXISTING
6"
6"
1"
2"
SPLASH PAD
MODIFIED TYPE A
CURB AND GUTTER
(PER SD 7-01M)
2"
6"
2% SLOPE
(MIN.)
STORMWATER
FACILITY
2-5% SLOPE
CURB CUT INLET PROFILE
NTS
STANDARD DETAIL
DATE: 2012
DRAWN BY TLM
CHECKED BY HCF
SCALE NOT TO SCALE
CURB CUTS
(CHANNEL AND GRATE)
SD 16-05



CURB CUT INLET PLAN
NTS

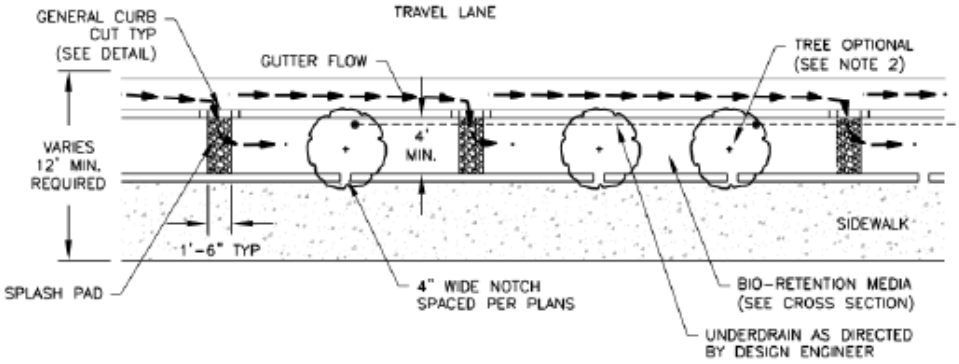


INLET SECTION
NTS

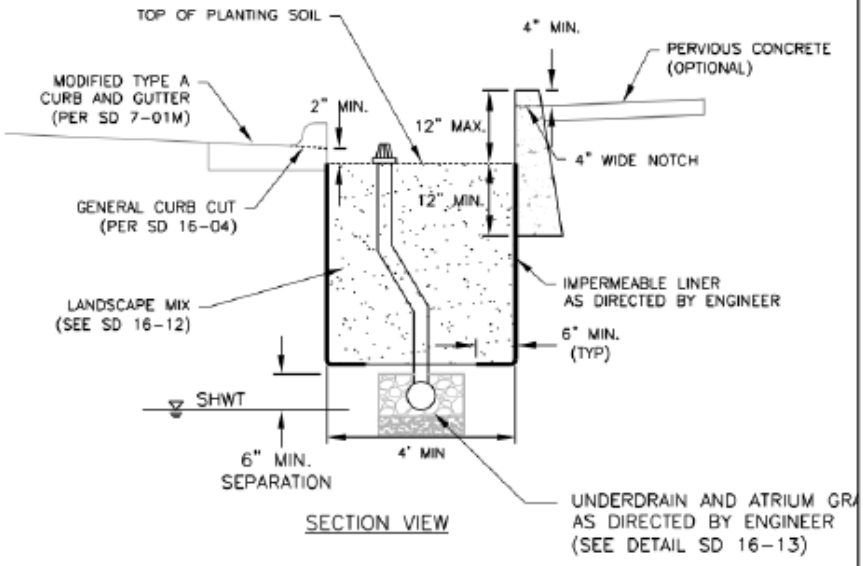


CURB CUT INLET PROFILE
NTS

	STANDARD DETAIL	
DATE: 2012	CURB CUTS (CHANNEL AND GRATE)	SD 16-06
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		



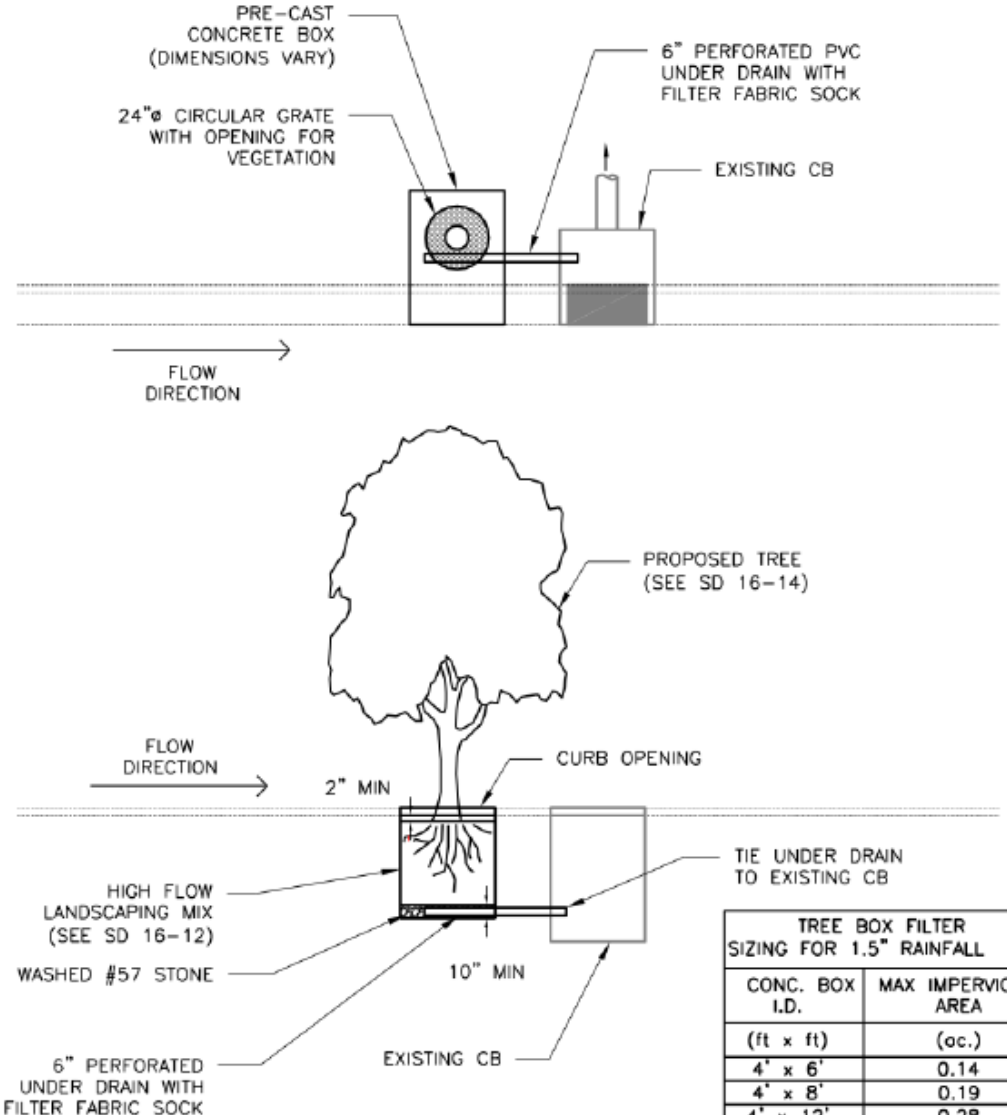
PLAN VIEW



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)	SD 16-08
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		



TREE BOX FILTER SIZING FOR 1.5" RAINFALL	
CONC. BOX I.D.	MAX IMPERVIOUS AREA
(ft x ft)	(ac.)
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

DATE: 2012

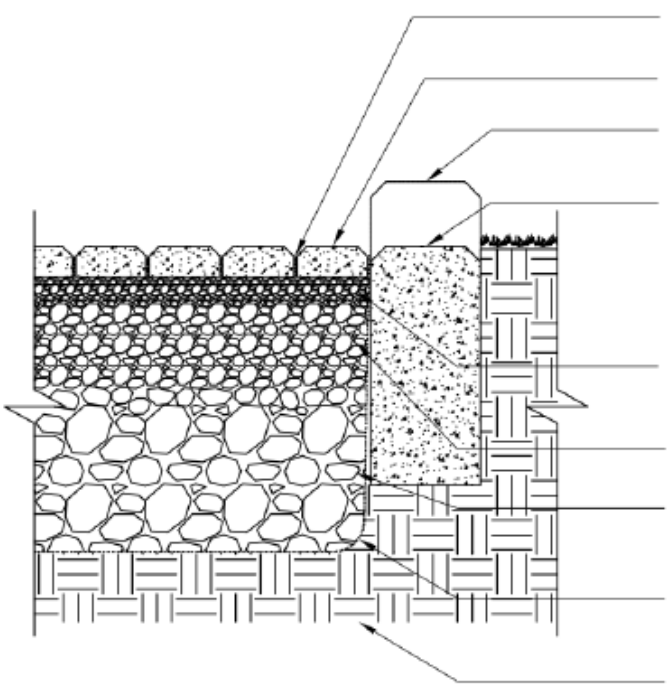
DRAWN BY TLM

CHECKED BY HCP

SCALE NOT TO SCALE

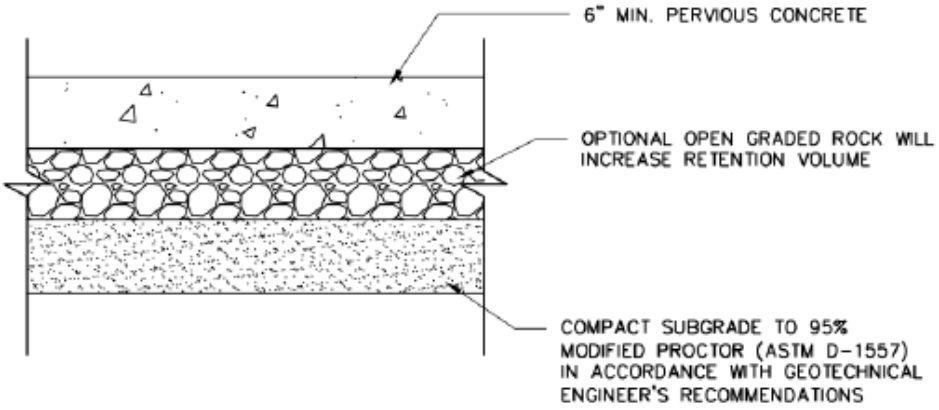
STANDARD URBAN TREE PLANTER BOX

SD 16-09



NOTES:
1. 2⅜" (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 NOT TO SCALE		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 SEPCIFICATIONS.

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 DISTRIBUTON
   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.

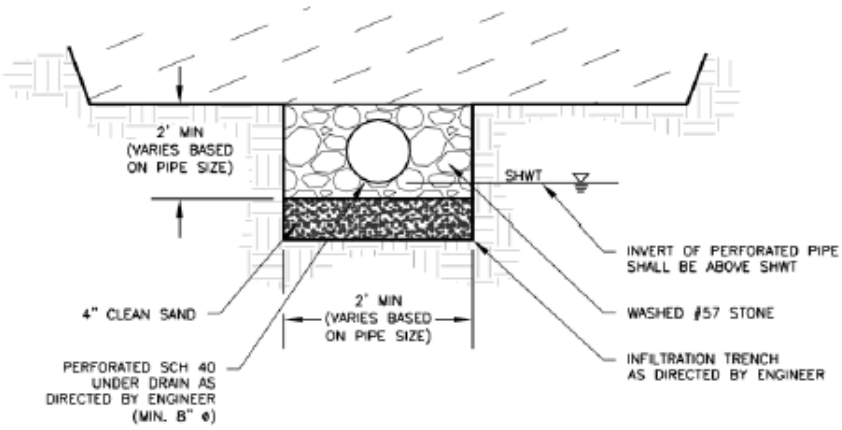
ENGINEERED HIGH FLOW MEDIA SHALL MEET THE FOLLOWING SPECIFICATIONS

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 > 50INCHES / 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	
DATE: 2012	STANDARD UNDERDRAIN AND TRENCH	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-13

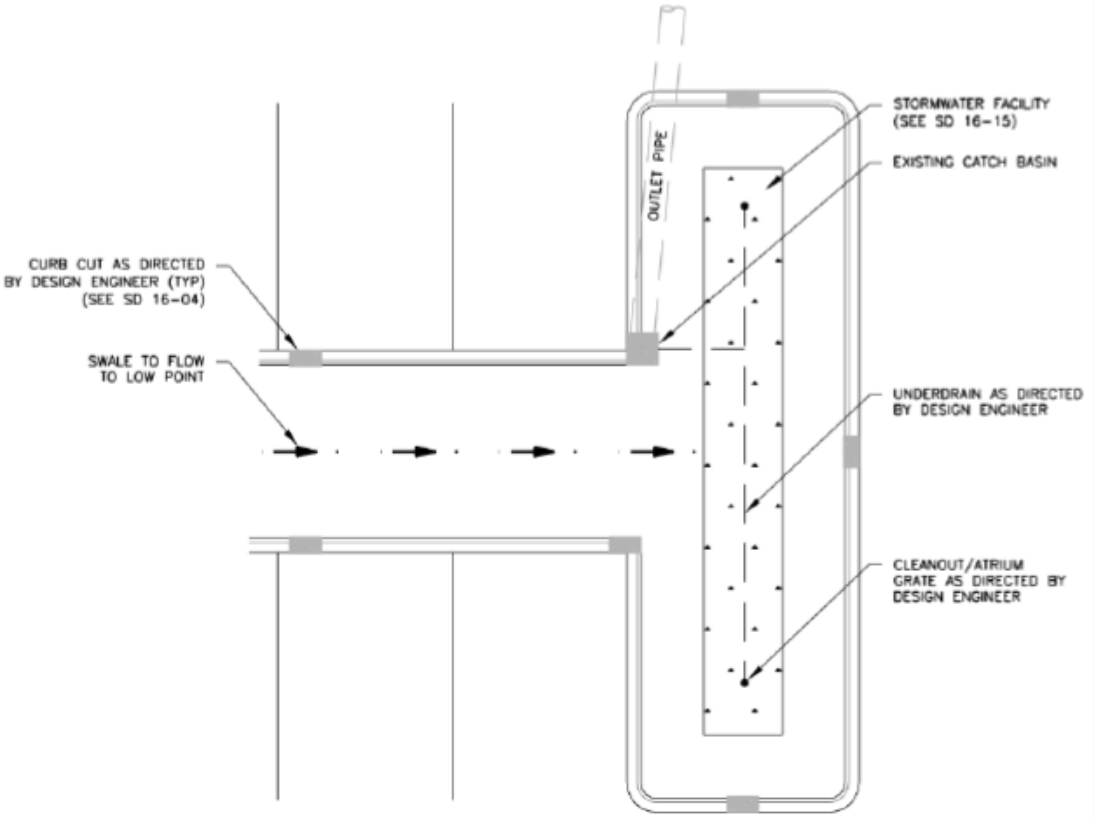
RECOMMENDED PLANTS LIST FOR ALL STORMWATER DETAILS:

SCIENTIFIC NAME	COMMON NAME
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:

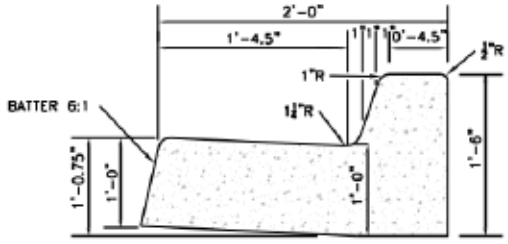
OTHER PLANTS, INCLUDING TREES, SHRUBS, AND GROUND COVERS, MAY BE PERMITTED ON A CASE BY CASE BASIS AS APPROVED BY CITY STAFF.

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

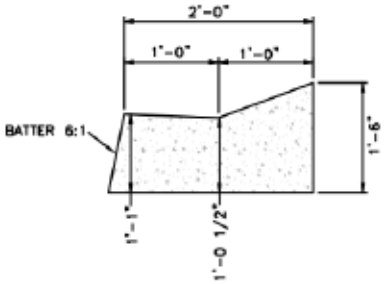


NOTES:
1. DESIGN ENGINEER TO PROVIDE DIMENSIONS OF ISLANDS.
2. SWALE DEPTH SHALL BE DEEP ENOUGH TO PASS 10-YR STORM FLOW WITHOUT SURCHARGING GUTTER OR FLOODING PAVEMENT.
3. 10-YR STORM VELOCITY NOT TO EXCEED 2 FT/S.
4. MAXIMUM PONDING DEPTH SHALL BE 6".
5. UTILITY LINES MAY NEED TO BE SLEEVED OR RELOCATED.
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	
DATE: 2012	STORMWATER PARKING ISLAND	
DRAWN BY TLM		
CHECKED BY HCF		
SCALE NOT TO SCALE		SD 16-16



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