Watershed Management Plan

Okatie River Watershed – HUC 030502080606

Prepared for Beaufort County

Project No. 090099A

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Prepared By:

Ward Edwards ENGINEERING

CIVIL ENGINEERING & LAND DEVELOPMENT CONSULTING

PO Box 381, Bluffton, SC 29910
T 866.837.5250
F 843.837.2558
WardEdwards.com

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Executive Summary

The 16,321 acre Okatie River watershed (HUC 030502080606) is located primarily in Beaufort County South Carolina, but also spans a portion of Jasper County. The Okatie River is a saltwater river, with no freshwater inputs other than stormwater runoff and it drains to the Colleton River. The water quality within the watershed has been on a steady decline since the early 1990s as impairments for fecal coliform bacteria related to shellfish harvesting began to become apparent in 1995. Bacteria levels generally meet the recreational standards but exceed shellfish standards in portions of the river. The river has three shellfish harvesting areas listed as "restricted" and two listed as "approved" for harvesting (Figure 7-1). The restricted areas are between shellfish monitoring stations 18-07 and 18-08 (Figure 7-1). The impairments in the restricted areas are believed to be improvable based on water quality modeling done as part of the 2006 Beaufort County Stormwater Master Plan (SWMP).

Beaufort County initiated the plan to address water quality in the Watershed in 2002 with the release of the first *Okatie River Watershed Management Plan*. The 2006 *Stormwater Master Plan* presented multiple regional retrofit BMP options to treat existing impairment issues within the watershed, and the Watershed Management Plan was amended in 2008 as part of a 319 Grant; intended to implement some of the management strategies. The 2009 Regional Retrofit Study refined the retrofit plan, adding an additional regional retrofit and provided a basic implementation plan for the projects. Beaufort County is leading the efforts to address the Okatie impairments, and has implemented one of the regional retrofits as well as some other non-regional retrofits. LOCOG in cooperation with Beaufort County, acquired a 319 grant to initiate some watershed management strategies. That grant was closed out in 2014 with mixed results. This Management Plan is building upon the knowledge gained from the previous management efforts, combined with the numerous studies of the watershed completed over the past twenty years. The County plans to address the impairments by partnering with the other local municipalities to implement the strategies found within this Okatie River Watershed Management Plan (WMP).

The WMP calls for many different structural and non-structural BMPs, as well as outreach and education programs. Strategies include four regional water quality retrofits, five non-regional retrofit strategies, two preservation/development policy strategies, and three education/outreach policies. The County has already initiated many of the management strategies including one regional project and several non-regional projects. The implementation plan identifies the strategies already underway and sets a timeline for implementation of the other strategies. First among the new strategies is the implementation of the Okatie West Regional Retrofit, which involves redirecting basin runoff to and proposed to be constructed within a nearby upland area. The regional retrofit plan calls for the flow from the 1,200 acre upstream basin to be diverted to the proposed pond. An outfall structure will be added to the pond to provide attenuation of the upstream runoff, and release the stored stormwater at rates less than current conditions. It is expected that the pond will provide effective removal of bacteria from the runoff.

The management strategies are expected to benefit the water quality within the watershed by reducing the amount of runoff, and thus the amount of pollutants reaching the river. The regional structural BMPs proposed will treat the runoff for bacteria before discharging runoff to the river while the non-regional strategies will help reduce the sources of bacteria and runoff volumes. The education and outreach strategies will improve future stormwater BMP designs. Milestones and evaluation criteria are established in the WMP. It is believed that implementation of the plan could eventually result in the restoration of shellfish harvesting from currently restricted areas.

1.0 Introduction:

Located in the South Carolina lowcountry, the Okatie River watershed (HUC 030502080606) is approximately 16,321 acres in size and spans Beaufort County and Jasper County. The majority of the watershed (12,325 acres) is in Beaufort County while the remaining portion (3,395 acres) is in Jasper County. Within Beaufort County, the majority is in unincorporated Beaufort County and the rest is in the Town of Bluffton. The Okatie River is a euhaline river, with no freshwater inputs other than stormwater runoff and it drains to the Colleton River, which in turn drains to Port Royal Sound and the Atlantic Ocean. The river is classified as shellfish harvesting waters, although the upper reaches of the river are restricted due to fecal coliform bacteria contamination.

In 1995, the South Carolina Department of Health and Environmental Control (SCDHEC) began restrictions on harvesting of shellfish for approximately 670 acres of the upper reaches of the Okatie River out to shellfish monitoring station 18-17 (*Blueprint for Clean Water*). In years following, additional areas were restricted, extending out to SCDHEC shellfish monitoring station 18-07 to include up to as much as 1,132 acres (*TMDL Okatie River*). Non-point source pollution from growth and development were generally to blame for bacteria contamination throughout the County, but the Okatie River, Broad Creek and the May River faced the highest development pressure within the County. Beaufort County responded to the shellfish bed closures in the Okatie and other rivers by implementing a number of strategies. In 1997, a "Clean Water Taskforce" comprised of volunteer citizens, with the support of many public officials completed a study that produced specific recommendations intended to reverse the downward water quality trend and allow for smart growth in the area. Among the recommendations were improvements to the County's stormwater standards for new development, implementation of a Stormwater Utility in cooperation with the local municipalities, and the completion of a baseline study for the Okatie River. To address the County's' stormwater standards for new development, Beaufort County's first version of the *Manual for Stormwater Best Management Practices* was implemented in 1998. SCDHEC aided in the recommendation for a baseline water quality by completing a combined baseline study of the Okatie River and Broad Creek in 2000. Most importantly, the County's Stormwater Utility was created in 2001. The Stormwater Utility included the participation of all the local municipalities and all subsequent water quality studies and initiatives in the County were implemented by or supported by the Stormwater Utility. Since the Utility's creation, the following water quality studies related to the Okatie River have been commissioned and completed:

- *Beaufort County Special Area Management Plan* – 2002
- *Okatie River Watershed Management Plan* – 2002
- *Beaufort County Stormwater Master Plan* – 2006
- *Beaufort County Regional Stormwater Quality Retrofit Study* – 2009
- *TMDL Okatie River* - 2010
- *Summary Report for Okatie River Watershed Plan 319 Grant* - 2014
- *Quantifying Water Budget in Beaufort County* – 2014

1.1 Watershed Management Plan Purpose

The 2006 *Beaufort County Stormwater Master Plan* (SWMP) was prepared with the intent to develop a county-wide infrastructure inventory and to recommend improvements addressing known water quantity and water quality problem areas. The study identified eight priority basins throughout the County based on documented impairments with anticipated degradation from ongoing development. Portions of the Okatie River watershed contains a few of the eight priority basins identified, based on fecal coliform bacteria impairment and a use classification of Shellfish Harvesting (SF).

The Okatie River basin and the other priority basins were studied further in 2009 to develop regional water quality retrofit plans for each and to prioritize implementation of the retrofits. The Okatie River basins were selected as priority areas given the following factors:

- The fact that the shellfish classification for portions of the river have changed back and forth between Restricted and Approved over the past 20 years indicates the River's quality may be at a tipping point.
- There were three potential regional stormwater retrofits within the Okatie River watershed that along with non-regional management strategies, could swing the water quality back from the tipping point.
- Ongoing monitoring resulted in identification of a bacteria hotspot located upstream of the restricted shellfish harvesting area between SCDHEC Shellfish Stations 18-08 and 18-07.
- Beaufort County has acquired property containing the site for one of the priority regional retrofit projects from the 2009 *Beaufort County Regional Stormwater Quality Retrofit Study*.

1.2 Management Team

The development and implementation of the Okatie River Watershed Management Plan will primarily be the responsibility of the Beaufort County Stormwater Utility; however, the Town of Bluffton is supporting the effort. The County's and Town's jurisdictions overlap with the Okatie River watershed and the May River watershed; but the County is taking the lead in managing the Okatie River. The Town supports the County's efforts and strategies within the Okatie Watershed. Similarly, the Town leads the management of the May River watershed with the County's support. The County and the Town maintain an intergovernmental agreement between the two participants that sets the groundwork for support and cooperation. Cooperation is generally in the sharing of resources, technical knowledge, and education efforts; however it is usually not financial.

2.0 Watershed Overview

2.1 Watershed Boundary and Land Use

Located in southern Beaufort County, the Okatie River's 16,321 acre watershed encompasses portions of unincorporated Beaufort County, unincorporated Jasper County, the City of Hardeeville, and the Town of Bluffton. (Figure 2-1). The outer boundary follows the ridgeline dividing the May River to the south, the Colleton River to the east, and the New River to the west. The northern boundary is the BJWSA water supply canal that provides an artificial separation between the Okatie River and Hazzard Creek. The overall watershed includes 2,371 acres of open water and saltwater marsh, with the remaining area being uplands and freshwater wetlands. The watershed is divided into seven sub-basins based on the modeling done in the Beaufort County SWMP. Table 1 shows the overall land use for each of the seven sub-basins, combining the three Jasper County sub-basins with the four Beaufort County sub-basins to which they respectively drain. The table also includes the totals for the watershed as a whole.

Table 1 – Okatie River Watershed Existing Land Use (Sub-watershed names from 2006 SWMP and data updated from 2014 aerial imagery)

Existing Land Use Type	Okatie River 1 Jasper 1 & 2	Okatie River 2	Okatie River 3	Colleton River 3 Jasper 3	Total Watershed	% of Watershed
Agriculture/ Pasture	373	140	293	252	**1058**	**6.5**
Commercial	16	30	112	16	**174**	**1.1**
Forest/Rural Open	1,311	129	2,165	550	**4,155**	**25.3**
Golf Course	528	10	334	108	**980**	**6.0**
High Density Residential	115	0	38	44	**197**	**1.2**
Industrial	159	0	0	0	**159**	**1.0**
Institutional	73	0	98	10	**181**	**1.1**
Low Density Residential	194	27	59	247	**527**	**3.2**
Medium Density Residential	900	91	1,575	121	**2,687**	**16.5**
Open Water/Tidal	942	276	56	605	**1,879**	**11.5**
Silviculture	569	6	74	166	**815**	**5.0**
Urban Open	140	39	205	36	**420**	**2.6**
Wetland/Water	2,274	56	766	103	**3,199**	**19.5**
Total	**7,484**	**804**	**5,775**	**2,258**	**16,321**	
Estimated Impervious (%)	**9%**	**9%**	**14%**	**6%**	**10%**	
2006 SWMP Estimated Impervious (%)	**8%**	**10%**	**10%**	**4%**	**8%**	
2006 SWMP Predicted Future Impervious (%)	**4%**	**14%**	**28%**	**27%**	**16%**	

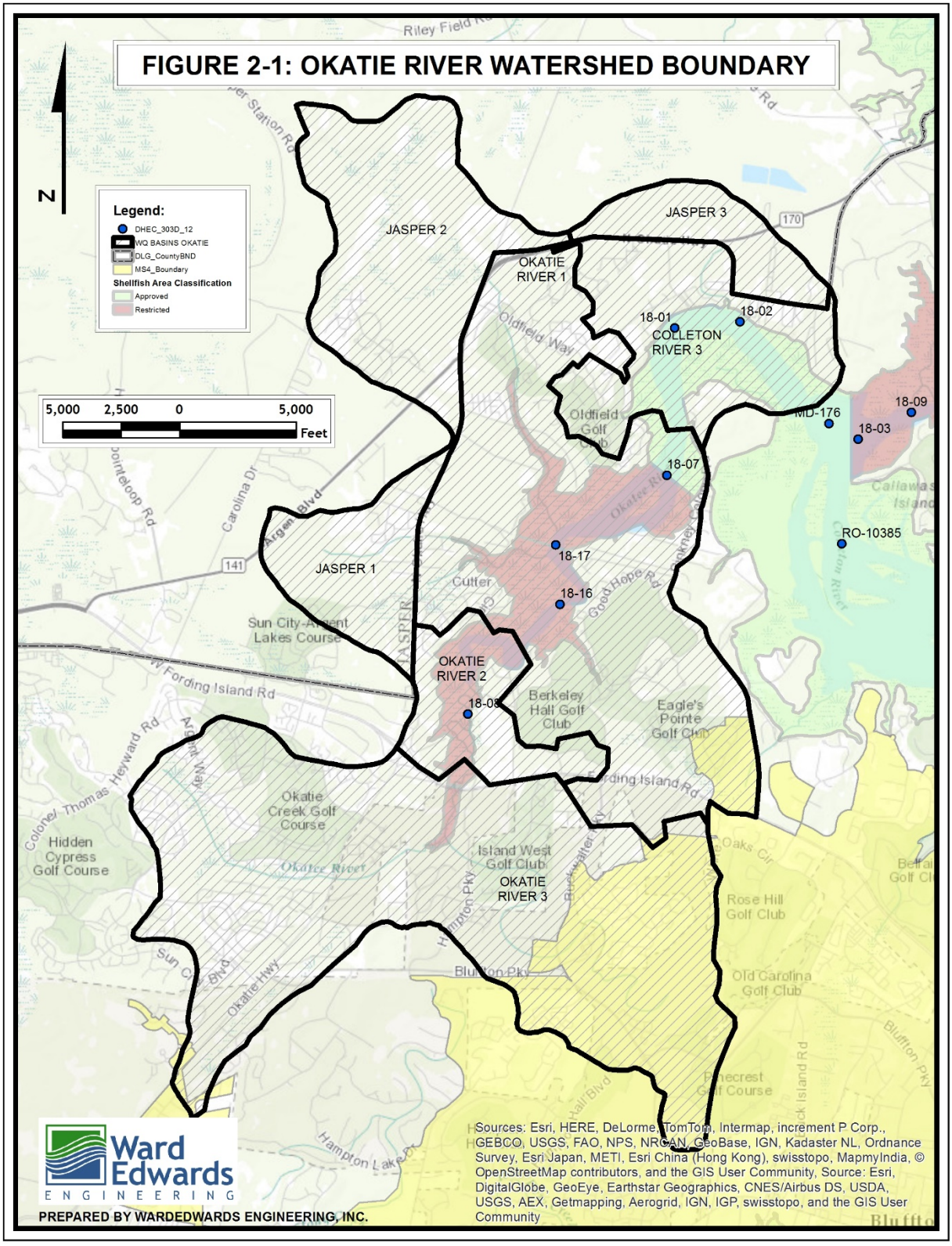

Figure 2-1 - Watershed Boundary

The area identified in the County SWMP as 'Colleton River 3' is actually part of the Okatie River and is the downstream most section of the river, including the confluence with Colleton River. This sub-basin includes shellfish monitoring stations 18-01 and 18-02. The land-uses within the sub-basin includes mostly rural residential, pastures, and undeveloped forest. Many of the residential properties are located directly adjacent to the river and are served by septic systems. Also included in this sub-basin are portions of the Oldfield development, which includes a golf course development and medium density residential. The Oldfield community utilizes a stormwater irrigation reuse system for its golf course; capturing stormwater in the existing community lagoons and using it as the secondary source of irrigation. The system's primary irrigation source is treated effluent from BJWSA, but the amount current supplied doesn't meet the irrigation needs, so captured stormwater is used as well. An analysis of the irrigation reuse system completed in 2012, found that the system is operated such that the community captures and uses an amount of stormwater greater than the 95th percentile rain event on an annual basis. Upstream and to the north of the Beaufort County sub-basin is an area within Jasper County, identified as 'Jasper 3'. The land within Jasper County includes some medium density residential, commercial, and silviculture land uses; although a large portion of the sub-basin is part of a planned unit development that will include higher density mixed use development.

'Okatie River 1' is one of the two middle portions of the river that starts near shellfish monitoring Station 18-07 and extends to the south of Station 18-16. This sub-basin contains much of the medium density residential developments with golf courses in the overall watershed; including Eagle's Point, Berkeley Hall, and portions of Oldfield. It also includes some smaller medium and low density residential development along with Okatie Elementary School. On the western side of Highway 170, 'Jasper 1' and 'Jasper 2' drain through the Beaufort County lands to reach the river. 'Jasper 2' is primarily undeveloped, although it does contain small commercial developments along the highway. 'Jasper 1' also contains undeveloped forest and some highway commercial, but it also contains medium density residential in the form of a portion of the Sun City development that is within the sub-basin.

'Okatie River 2' is the other middle portion of the watershed centered around shellfish monitoring station 18-08. It is the smallest sub-basin within the watershed and contains a mixture of highway commercial low density residential, and rural open space. The sub-watershed contains the Highway 278 – Highway 170 intersection, which is under a lot of development pressure due to the high traffic volumes.

'Okatie River 3' is the headwaters portion of the watershed and braches to the east toward the Town of Bluffton, and West toward Jasper County. The boundary between the 'Okatie River 2' and 'Okatie River 3' is approximately the transition area from saltwater to freshwater. The saltwater critical line does extend into 'Okatie River 3' approximately 4,000 feet to the point where the east and west branches form. At the east-west branch, there is much more freshwater entering the river but the branch channels remain tidally influenced. The eastern branch of the headwaters contains some land within the Town of Bluffton's jurisdiction and some within unincorporated Beaufort County. The western branch also has some land in the Town of Bluffton, but a greater amount is in the County. Much of the eastern branch is developed as medium density residential and light commercial land uses. The

undeveloped land within the eastern branch is mostly forested wetland, although there are undeveloped uplands areas that are within approved planned unit developments. This means that the currently undeveloped forested uplands are already approved for medium-density residential, high-density residential, and commercial development. Much of the western branch is medium density residential development in the form of the Sun City community. There is some developable land within the western branch along the Highway 170 corridor, some of which is already approved for mixed-use planned unit developments. Given the high traffic volumes along the highway that is currently being widened, the western branch sub-basin could be considered to be under high development pressure.

2.2 Hydrology

Climate and Precipitation

The climate for Beaufort County and the surrounding South Carolina lowcountry is considered humid subtropical, with the average annual temperature in the mid 60's (degrees Fahrenheit). The average winter temperatures are typically in the low 50's and the summer averages in the mid 70's. Precipitation totals are generally higher in the summer months and lesser in the fall. Thunderstorms produce much of the rainfall during the summer months, but the area is also impacted by tropical storms and hurricanes from summer to early fall.

Table 2a - Average Temperature and Rainfall for Beaufort County, 1930-2005 (SC State Climatology Office)

	Jan	Feb	Mar	Apr	May	Jun
Average Max. Temperature (F)	60.7	63.2	69.4	76.9	83.3	88.2
Average Min. Temperature (F)	39.9	41.6	47.3	54.8	63.1	69.8
Average Total Precipitation (in.)	3.37	3.12	3.91	2.81	3.58	5.62

Table 2b - Average Temperature and Rainfall for Beaufort County, 1930-2005 (SC State Climatology Office)

	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	90.3	89.2	85.1	77.5	69.5	61.7	76.3
Average Min. Temperature (F)	72.7	72.1	67.9	57.7	48.3	41.3	56.4
Average Total Precipitation (in.)	6.28	6.83	5.2	2.76	2.16	2.86	48.50

Rainfall patterns for individual storms in the Beaufort area are typically modeled assuming a SCS Type III Distribution with a 323 Peaking Factor. Measured rainfall depths for common statistical return periods are shown in Table 3. Based on a study of historical rainfall data commissioned by Beaufort County Stormwater Utility, the 95th percentile rainfall depth is 1.95 inches, meaning 95% of all storm events occurring in Beaufort County have less than 1.95 inches of rainfall.

Table 3 - Statistical Rainfall Amounts for Beaufort County

Rainfall Event	95th Percentile	2-yr	10-yr	25-yr	50-yr	100-yr
Rainfall Depth (in.)	1.95	4.5	6.9	8.4	9.7	11.0

Topography

Elevations within the watershed vary greatly, ranging from sea level up to as high as 38 feet above sea level. The highest elevations within the watershed are located in the southwestern portion of the 'Okatie River 3' sub-basin. This high sandy ridge runs north to south and has elevations ranging between 20-ft to 38-ft. Highway 170 runs along the ridge and there is some medium density residential development located in the ridge. The elevations of the upland areas in the remainder of the watershed range between 15-ft to 20-ft. There is a significant bluff adjacent to the river along the western edge of the river, with steep slopes from the upland area down to the saltwater critical line. The eastern edge of the river generally has a more gradual slope from the critical line up to the buildable land. The eastern and western tributaries of the headwaters includes some relatively large and flat freshwater wetlands. These jurisdictional wetlands meander through the higher upland areas in natural patterns, but they also contain purposely excavated channels dug 50 to 100 years ago to drain the wetlands and improve conditions for silviculture. Figure 2-2 includes the digital elevation model provided by Beaufort County and shows the higher elevations as white and the lower elevations as darker grays.

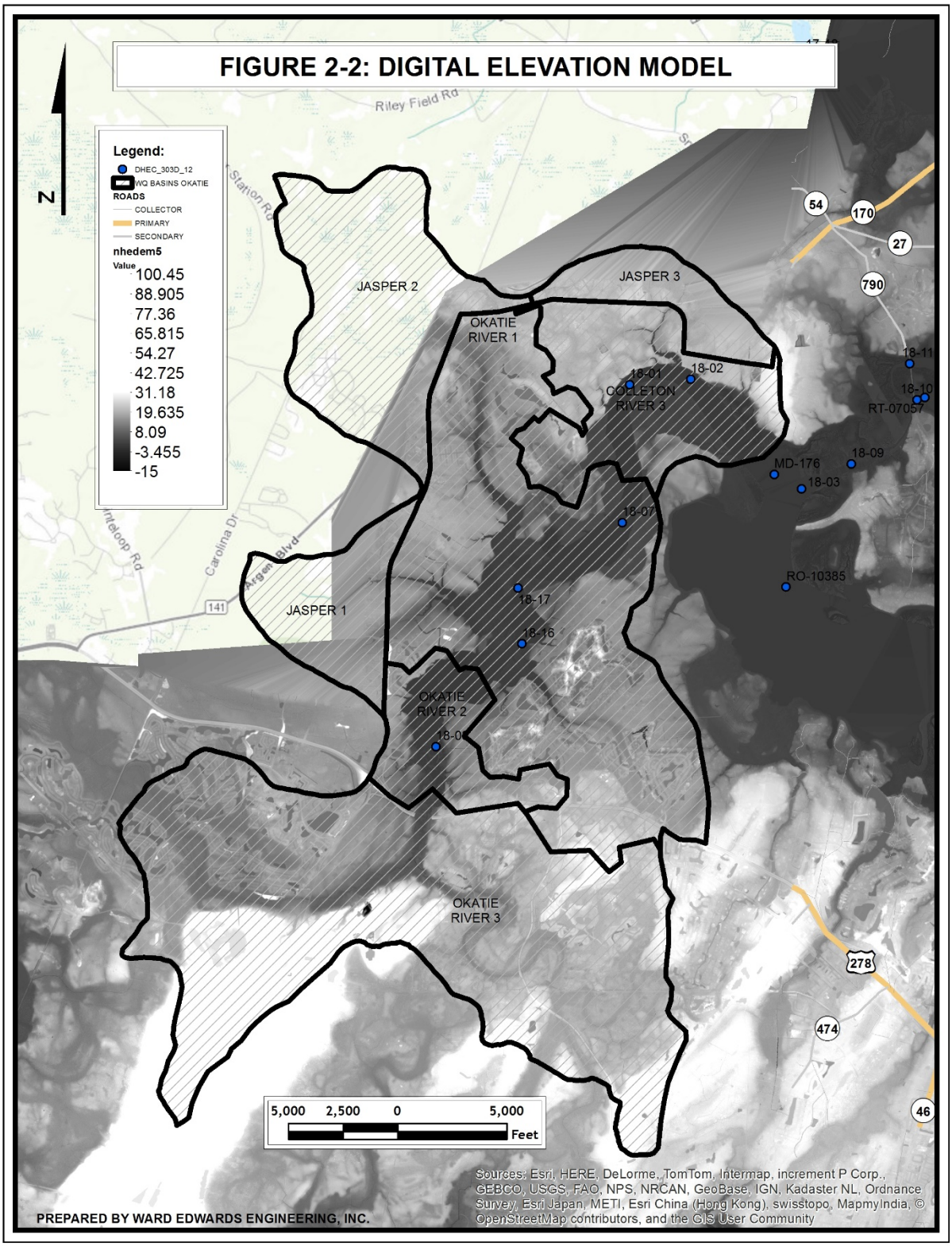

Figure 2-2 - Digital Elevation Model

Soils and Groundwater

The soils in the higher elevations are generally very sandy with good drainage characteristics. They are mostly classified as Hydrologic Soil Group A and have deep groundwater conditions. For this reason, many properties in these areas contain borrow pits where soils were excavated and used for development or roadway projects in the areas. Soils in the flatter, lower areas tend to have higher clay content and groundwater elevations closer to the surface. Consequently these areas have poor drainage characteristics. Development has typically occurred in the areas with better-drained soils, although as development pressure rose, the areas with poorer soils have been developed as well. The Jasper County sub-basins to west have particularly poor soils, and these areas haven't been developed to as great an extent as the land within Beaufort County. Since poor soils and high groundwater conditions produce larger amounts of runoff, providing stormwater quality controls for development in these areas with poor soils is highly important.

Surface Waters

There are very few natural surface waters in the Okatie River watershed with the obvious exception being the river itself. The river and the surrounding saltwater marsh account for 15% of the watershed area. The other surface waters within the watershed are all manmade ponds or brackish impoundments. The small freshwater ponds are mostly stormwater detention ponds, although some may have been constructed as recreational ponds or dug as borrow pits for past road construction. The other surface waters of note are freshwater wetlands located in much of the remaining natural area. Wetlands account for approximately 10% of the watershed area, and are predominantly located in the headwaters and Jasper County portions of the watershed, where grades are flatter and elevations are lower. The wetlands appear to be mostly interconnected jurisdictional wetlands, as opposed to small isolated pocket wetlands.

2.3 Political Boundaries and Future Land Use Plan

The future land-use within the Okatie watershed could be quite different than the current land-use given that the watershed in under development pressure and is at the border of four different political jurisdictions. Much of the land is currently within unincorporated Beaufort County and Jasper County, but both the Town of Bluffton and the City of Hardeeville have annexed land within the watershed. The intersection of two high volume highways (Hwy 170 & 278) is within the headwaters portion of the basin, and both highways traverse other areas within the basin. The high volume roadways attract commercial development, particularly near the intersection of the two and the potential commercial tax base is an attractant to the municipalities seeking annexation. Each jurisdiction has their own set of guiding documents for future growth and redevelopment.

Beaufort County

The majority of the Okatie River watershed is within unincorporated Beaufort County and the County is leading the efforts for preservation and restoration of the River. The Beaufort County Stormwater Utility is working to coordinate with Jasper County and the area municipalities on stormwater standards. The *Beaufort County Comprehensive Plan* was last updated in 2010 and includes future land-use within the Okatie River watershed. The anticipated land uses include growth of mixed uses within the watershed, replacing land that is currently rural. The change in land use could result in additional stormwater runoff if the stormwater regulations are not strictly enforced and updated to meet emerging knowledge. Beaufort County's *Manual for Stormwater Best Management Practices* and the County's *Stormwater Volume Control Ordinance* will guide the future development toward meeting the goals of this Management Plan; however it will take additional retrofits and improvements to current standards to improve water quality in the watershed.

City of Hardeeville:

The City of Hardeeville's current boundaries extend into the 'Okatie River 3' and 'Jasper County 1' sub-basins. Their boundaries include parts of the Sun City residential development, the Okatie Center commercial development, and the independent highway commercial developments along Hwy 170. The City jurisdiction also include some undeveloped land currently under development agreements or planned-unit-developments. The *City of Hardeeville's Comprehensive Plan* last updated in 2009 indicates development and growth within these sub-basins, specifically mentioning the Okatie Crossing development that will be located near the intersection of Hwy 278 and Hwy 170. A portion of this development would be located in the Okatie River watershed, so careful consideration should be given to water quality and runoff volume from any the future developments occurring in the watershed that are within City jurisdiction. The City's Comprehensive plan does address the importance of maintaining water quality and protecting natural resources; however the City's current stormwater water quality requirements are not as strict as other jurisdictions in the area.

Jasper County

Jasper County's boundaries extend into the Okatie River watershed and were identified as separate water quality sub-basins in the Beaufort County SWMP. The Jasper land in the watershed includes mostly undeveloped land, but does include some commercial and mixed-use zoned development along Highway 170. The *Jasper County Comprehensive Plan* was updated in 2014 and includes sections on stormwater quality, natural resources protection, land preservation, and future land-use. All of these are important factors to the preservation and restoration of the Okatie River. However, the Comprehensive Plan doesn't specifically mention the Okatie River as a priority natural resource. The Projects Land Use Map doesn't specifically mention the anticipated growth for the land within the watershed. It does list the intersections of Hwy 170 with Highway 462 and Argent Road as future "Community Village Districts", which are considered areas that will grow at higher densities to support the surrounding rural areas. Stormwater controls, BMPs, and development standards in these areas will be important to the future water quality of the Okatie River.

Town of Bluffton

The Town of Bluffton's boundaries extend into the headwaters ('Okatie River 3' water quality sub-basin) portion of the watershed, which is the most sensitive to water quality impairments. The existing land-uses within the watershed include a mixture of medium density residential, commercial, and undeveloped land. The *Town of Bluffton's Comprehensive Plan* was last updated in 2007. The document includes a section on natural resources protection and specifically mentions the Okatie River and a priority resource. The Town is very familiar with the challenges of dealing with fecal coliform bacteria contamination for shellfish harvesting, as they are dealing with similar problems in the May River watershed. Beaufort County and the Town of Bluffton have a memorandum of agreement that sets the standards for cooperation within the Stormwater Utility. Part of that MOA is an understanding that Beaufort County will lead the efforts to restore the Okatie River with support from the Town of Bluffton. Similarly, the Town will lead the efforts to restore the May River with the support from the County. Given this understanding and agreement, it is expected that the Town will grow responsibly within the Okatie River watershed and will contribute to the Okatie River Management Plan appropriately.

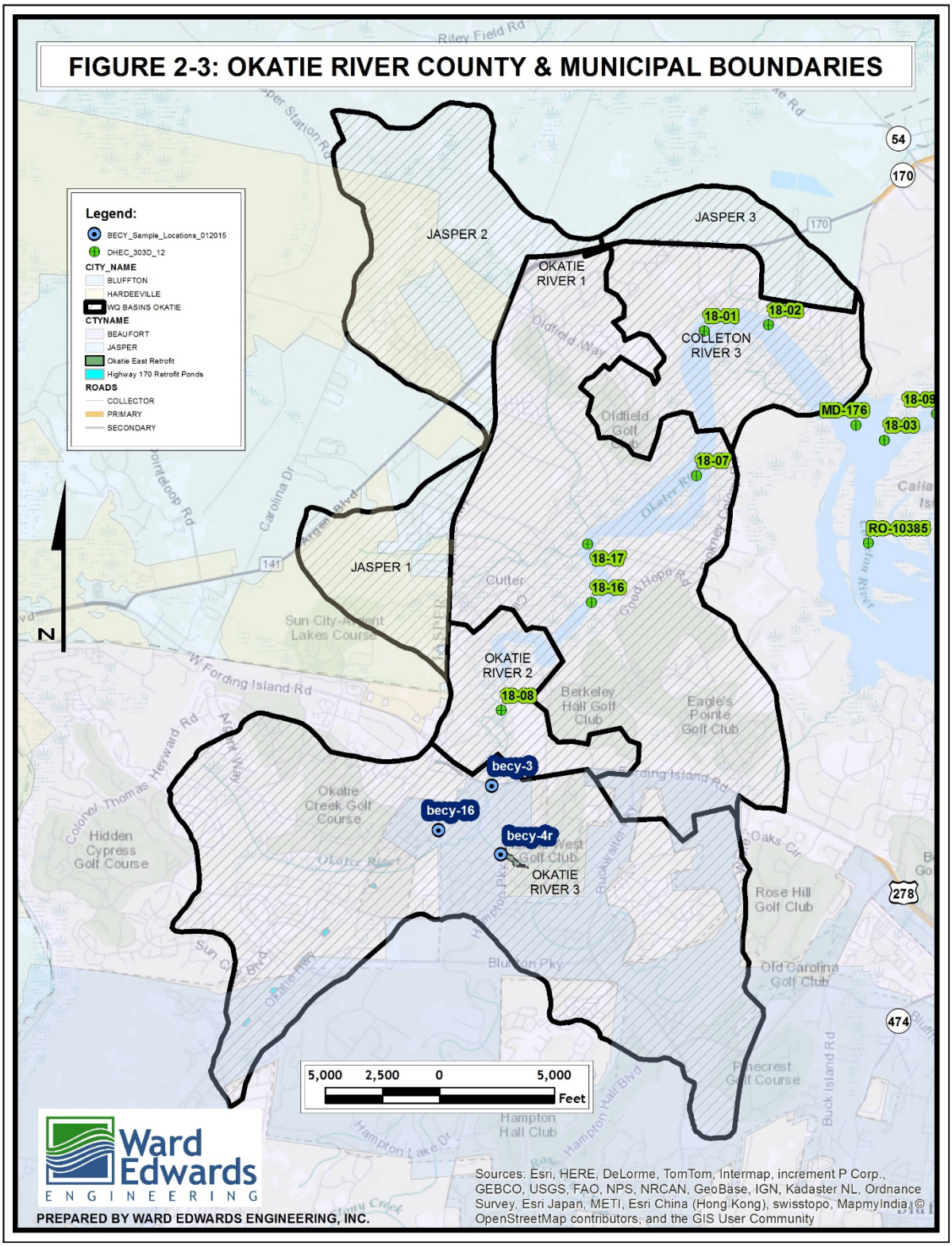

Figure 2-3 - County and Municipal Boundaries

2.4 Baseline Monitoring Data and Water Quality Modeling

Beginning in 2007, extensive monitoring data has been collected for the Okatie River watershed as part of the implementation of the 2006 *Beaufort County Stormwater Master Plan*. The SWMP recommended a County-wide monitoring plan that included three monitoring locations in Okatie River (BECY-3, BECY-4, & BECY-5). Over the past few years, the number and location of those stations has changed based on the observed monitoring results and the desire to collect more useful data. Two stations (BECY-4 and BECY-5) located in Okatie River 2 and Colleton River 2 respectively, were relocated due to high salinity that was possibly affecting the fecal coliform bacteria measurements. In 2009, BECY-4 was relocated to an alternate location and renamed BECY-4r. The location for BECY-4r was selected to better monitor the eastern fork of the Okatie River headwaters within the Okatie River 3 sub-basin. To measure the quality of the western fork of the headwaters basin, BECY-16 was added at the same time that BECY-4 was moved to BECY-4r. Sampling at BECY-5 was discontinued in 2010 due to consistently high salinity concentrations that may have been skewing results. The three remaining County monitoring locations within the Okatie River are now BECY-3, BECY-4r, and BECY-16. Figure 2-4 shows the current Beaufort County monitoring stations, as well as the State monitoring locations.

Pollutants that are monitored as part of the County program include Ammonia-Nitrogen (NH_3), Biochemical Oxygen Demand (BOD_5), Total Cadmium, Chlorophyll-a, Total Chromium, Conductivity, Total Copper, Dissolved Oxygen (DO), Fecal Coliform, Total Iron, Total Lead, Total Manganese, Total Mercury, Total Nickel, Nitrate-Nitrite (NO_x), pH, Total Phosphorus, Salinity, Temperature, TKN, Total Organic Carbon (TOC), Total Suspended Solids (TSS), Turbidity, and Total Zinc. Results of past and current monitoring results can be found in the annual reports prepared by GEL Engineering, LLC on the Beaufort County Stormwater Utility website (http://www.bcgov.net/departments/Engineering-and-Infrastructure/stormwater-management/water-quality-monitoring.php)

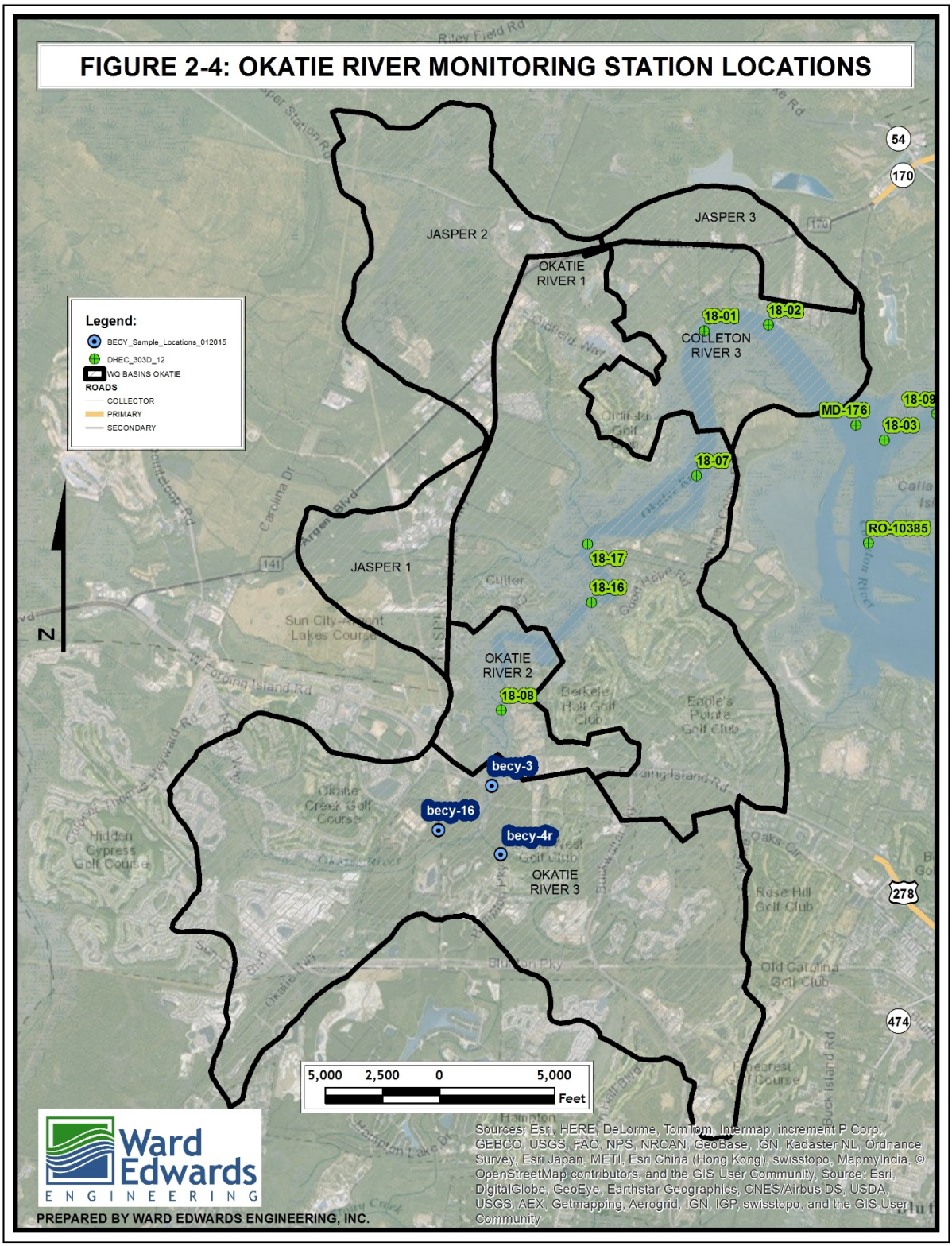

Figure 2-4 – Monitoring Station Map

Monitoring was also completed prior to 2007 for use in preparation of the 2006 SWMP and to calibrate the water quality models developed for the SWMP. The SWMP modeling involved the use of the Watershed Management Model (WMM) software and the Water Quality Analysis Simulation Program (WASP) for analysis of the Colleton River watershed, in which the Okatie River watershed is a sub-basin. WMM was used to estimate the average annual flow and pollutant loads for a range of pollutants. The pollutants modeled were fecal coliform bacteria, total phosphorus, total nitrogen, lead, zinc, BOD and total suspended solids. The geometric mean bacteria concentration in the flows from the uplands to the river system was estimated in the WMM. This information was used as input in the WASP model to determine the effects of tidal mixing and natural bacteria die-off in the tidal river system. Measured data such as bacteria concentrations and salinity were used to calibrate the model by adjusting parameters such as the bacteria loss rate coefficient and the tidal mixing coefficient.

The water quality modeling was executed for both existing (2006) and estimated future conditions. The results for the two conditions were compared and used to determine the watershed management needs and strategies for the SWMP, with focus on large regional retrofits. The average annual pollutant loads reaching the Okatie River as predicted by the WMM are shown for the seven sub-basins in Table 4 (existing land use) and Table 5 (future land use).

Table 4 – Estimated Average Annual Loads from SWMP-WMM for Existing Land Uses

Water Quality Sub-basin	Area (acres)	Flow (ac-ft)	BOD (lb/yr)	TSS (lb/yr)	Total P (lb/yr)	Total N (lb/yr)	Lead (lb/yr)	Zinc (lb/yr)	Fecal Coliform (#/yr)
Colleton River 1	3,740	10,534	99,711	424,000	5,047	38,113	183	3,694	9.47E+14
Okatie River 1	4,348	8,882	97,296	576,000	4,504	33,540	140	2,235	9.38E+14
Okatie River 2	930	2,025	23,998	169,000	1,045	8.176	38	280	2.62E+14
Okatie River 3	3,451	5,092	66,409	653,000	2,887	20,804	84	713	6.50E+04
Jasper 1	618	752	9,113	94,217	347	2,981	11	70	4.46E+13
Jasper 2	1,892	2,322	21,541	209,000	933	8,477	22	141	1.41E+14
Jasper 3	413	464	4,243	39,976	195	1,544	3	16	2.47E+13
Total	15,392	30,071	322,311	2,165,193	14,958	105,467	481	7,149	2.36E+15

Table 5 - Estimated Average Annual Loads from SWMP-WMM for Future Land Uses

Water Quality Sub-basin	Area (acres)	Flow (ac-ft)	BOD (lb/yr)	TSS (lb/yr)	Total P (lb/yr)	Total N (lb/yr)	Lead (lb/yr)	Zinc (lb/yr)	Fecal Coliform (#/yr)
Colleton River 1	3,740	10,572	101,000	425,000	5,108	38,362	184	3,702	9.61E+14
Okatie River 1	4,348	9,501	113,000	614,000	4,852	37,918	149	2,378	1.12E+15
Okatie River 2	930	2,471	33,509	198,000	1,181	10,171	44	682	3.09E+14
Okatie River 3	3,451	6,584	105,000	742,000	3,509	25,162	109	1,030	7.39E+14
Jasper 1	618	1,763	33,122	148,000	841	7,648	20	290	1.93E+14
Jasper 2	1,892	3,008	42,121	229,000	1,600	11,568	27	254	3.98E+14
Jasper 3	413	696	12,175	54,153	456	2,771	8	62	1.26E+14
Total	15,392	34,595	439,927	2,410,153	17,547	133,600	541	8,398	3.85E+15
% Change over existing		15%	36%	11%	17%	27%	12%	17%	57%

The results of the SWMP modeling show an 11% to 57% increase in all constituents between assumed future conditions and estimated current conditions, with the fecal coliform bacteria having by far the largest increase of 57%. It is important to note that the future conditions model assumed improved BMP coverage and efficiency for development and re-development within the Okatie River watersheds, based on evolving water quality requirements within Beaufort County. However, the watershed also contains parcels that fall under the jurisdiction of Jasper County, The Town of Bluffton and the City of Hardeeville; all of which have differing water quality and stormwater BMP requirements. Not accounted for in the future average annual loads were the impacts of the volume control requirements in Beaufort County, Jasper County, and the Town of Bluffton; as these standard were all adopted after the release of the 2006 SWMP. Limiting post-development runoff volume to pre-development conditions should help reduce the magnitude of the pollutant load increase between existing and future conditions.

The magnitude of the estimated increase in fecal coliform loads in the Okatie River are most alarming, given that the River's impairment is for bacteria based on shellfish harvesting standards. According to the estimates from the 2006 SWMP, the waters would not just remain impaired for shellfish harvesting, but would get much worse than current conditions. This demonstrates that additional stormwater controls and management strategies are needed within the watershed.

To help develop strategies and to determine the most effective locations for controls, a sensitivity analysis was conducted as part of the 2006 SWP, using the established water quality models. The

sensitivity model involved running a "best case" and "worst case" analysis of the sub-watersheds and comparing the two conditions. The best case scenario assumed that all existing development was served by BMPs designed to treat for bacteria, and the worst case assumed no developments are served by BMPs. The benefits of implementing retrofit BMPs are indicated by comparing the two scenarios. The results were presented by establishing a "Level of Service" based on long-term geomean fecal coliform bacteria concentrations. Information about the Level of Service criteria as presented in Section 2.6.2 of the SWMP are as follows:

- Level of Service A – River sections expected to have a long-term geomean of less than or equal to 7/100 ml and meet the geomean standard (14/100 ml) and the 90th percentile standard (43/100 ml) for any 36-sample period.
- Level of Service B – River sections expected to have a long-term geomean of greater than 7/100 ml and less than or equal to 8.7/100 ml. They are expected to meet the geomean standard (14/100 ml) for any 36-sample period and are expected to meet the 90th percentile standard in the long-term, but the 90th percentile standard is expected to be exceeded during some 36-sample periods.
- Level of Service C – River sections expected to have long-term geomean greater than 8.7/100 ml and less than or equal to 10/100 ml. They are expected to meet the geomean standard (14/100 ml) for any 36-sample period, but are not expected to meet the 90th percentile standard in the long-term.
- Level of Service D – River sections expected to exceed the geomean standard (14/100 ml) for some 36-sample periods, and are expected to exceed the 90th percentile standard for long-term and during some 36-sample periods.

Fecal Coliform Modeling Results for the Okatie River watershed indicate that two of the sub-basins would not meet shellfish standards in current conditions and three would not for future conditions. Table 6 shows the modeling results.

Table 6 - Fecal Coliform Modeling Results for Existing and Future Conditions

Watershed Sub-basin	Modeled Geomean Concentration (#/100 ml)		Modeled Level of Service	
	Existing	Proposed	Existing	Proposed
Colleton River 1	3.5	3.5	A	A
Okatie River 1	7.8	10.1	B	D
Okatie River 2	15.7	19.5	D	D
Okatie River 3	47.2	60.8	D	D

The BMP sensitivity analysis indicated that all three of the impaired watershed sub-basins would be very responsive to BMP retrofits through new development re-development, although it is possible that there would not be an effective Level of Service Improvement for two of the sub-basins. Okatie River 2 and Okatie River 3 would see a big reduction in load with the implementation of BMPs, but the Levels of

Service for both would remain at 'D'; meaning they would still not meet the SCDHEC shellfish standards. However, it is important to keep in mind that these results are part of the future conditions water quality modeling done for the 2006 SWMP and they pre-date the stormwater control concepts and regulatory requirements of Volume Control. Including stormwater runoff volume control BMPs in new development and retrofitting future developments with volume control BMPs may improve future Levels of Service in the Okatie River sub-basins. It is also important to note that the predicted future conditions assumed a much larger increase in the percentage of impervious area than is occurring. Beaufort County's development standards along with the Rural and Critical Lands program is helping to maintain impervious percentages well below the future conditions predicted by the 2006 SWMP. Table 7 shows the sensitivity analysis results. ***Beaufort County will be updating the SWMP in the following year, including the future conditions water quality modeling and level of service analysis. It is expected that the modeled levels of service for each sub-basin will be greatly improved with the updated modeling based on the new management strategies, development ordinance improvements, and land conservation that has occurred since the 2006 SWMP.***

Table 7 - Sensitivity Analysis Results for 100% BMP Coverage versus 0% BMP Coverage

Watershed Sub-basin	Modeled Geomean Concentration (#/100 ml)		Modeled Level of Service	
	Best Case	Worst Case	Best Case	Worst Case
Colleton River 1	3.0	3.6	A	A
Okatie River 1	6.6	13.8	A	D
Okatie River 2	12.0	34.6	D	D
Okatie River 3	35.8	118.6	D	D

Notes:

1. Best case represents existing land use with wet detention BMPs serving all existing development
2. Worst case represents future land use with no BMPs.

3.0 Pollutant Source Assessment

The pollutant of concern (Fecal Coliform) is a pollutant that can be delivered to a water body as a non-point source or point source pollutant. Based on the land use data from the 2006 *Beaufort County Stormwater Master Plan*, the most likely non-point source inputs into the Okatie River would be generated from impervious surfaces, pet waste, land disturbance, failing septic systems, wildlife, silviculture, boat activities and fertilizer & pesticide use. There could also be point source inputs of fecal coliform into the river from industrial activities, sanitary sewer overflows, and combined sewer overflows.

3.1 Non-point Sources

Non-point source (NPS) pollution occurs when rain or irrigation water flowing over hard surfaces or loose soil, picks up pollutants and deposits them into the nearest wetland, creek, estuary or groundwater supply. The EPA has identified NPS pollution as the number one source of pollution and the nation's largest water quality problem. The most common NPS pollutants are sediment, bacteria

and nutrients. Sediment is generated by land disturbing activities and can impact the estuarine habitat by smothering some benthic species, blocking out sunlight used by plankton for photosynthesis, and prolonging the survival of bacteria in the water column. Bacteria come from faulty septic systems, domestic and wild animal waste, and combined sewer overflows. A specific type of bacteria called fecal coliform is used as an indicator organism for determining how safe it is to use an estuary for recreation or shellfish harvesting. Nutrients come from fertilizer, pet waste and failing septic systems, and cause the harmful algae blooms that produce toxins that can poison fish, humans and birds.

3.1.1 Stormwater Runoff from Development

Typically an impervious percentage of 10-20% indicates that the receiving water body will show signs of decreased water and aquatic habitat quality; when using fecal coliform as in indicator. The reason for this is that runoff generated from impervious surfaces contains pollutants and increases the rate and runoff volume in the watershed. When this increased rate and volume of stormwater is delivered to the receiving water body the pollutants in the runoff are transported downstream, because the natural filtering process is unable to treat the increased rate and volume of runoff. This effect is compounded the more an area is developed, thus pollutants are carried further and further downstream. (Schuler and Holland) Beaufort County development standards have placed an emphasis on the use of water quality BMPs for the past 15 to 20 years; the timeframe in which most of the development within the Okatie River watershed has occurred. For this reason, most of the development in the watershed should have included stormwater BMPs. The Jasper County and City of Hardeeville water quality standards have lagged behind Beaufort County's so there may be some development within these jurisdictions that do not utilize BMPs. It is also important to note that Beaufort County and Jasper County have adopted stormwater runoff volume control requirements within the past five years. Development in the watershed has occurred at a slower rate since the adoption of the volume standards, but any development that occurred since those standards should include runoff volume reducing BMPs in addition to the water quality BMPs.

The installation of impervious surfaces within the Okatie River watershed has increased as a result of development in the area, and the watershed has an impervious coverage percentage of approximately 10%. This is right at the threshold expected to cause water quality issues in the receiving water body, and the closure of shellfish beds are an indication of the declining water quality. This supports the documented ecological response to exceeding the impervious coverage threshold. The Okatie River continues to face significant development pressure which will further increase the impervious surface coverage of the watershed, and the risk of further water quality degradation.

3.1.2 Pet Waste

An increase in surface water pollution can result from not properly disposing of pet waste. If not collected, the pet waste will be conveyed in runoff and become incorporated into the stormwater system as a source for pollution. Pet waste contains high levels of fecal coliform as well as other bacteria, viruses and parasites that can pose a health risk. A survey by the Center for Watershed Protection revealed that 41% of respondents will rarely or never clean up after their dog (USA Today). This source of pollution can have an even bigger impact in areas that have out dated stormwater

systems that do not filter the runoff through a BMP prior to discharge. The higher percentage of residential development in the watershed (20.9%) would tend to indicate pet waste may be a noteworthy source of bacterial contamination and should be considered in the watershed management strategy.

3.1.3 Construction Land Disturbance

Land Disturbance from construction activities can erode at rates 2 to 40,000 times greater than pre-construction conditions (Harbor), and the elevated rate of erosion contributes to higher levels of suspended sediments in runoff. When the sediment is deposited in the estuary, it settles to the bottom, and smothers benthic species and habitat. Some of the sediment will stay suspended in the water column and block sunlight used by plankton for photosynthesis. The suspended sediments also provide a surface for bacteria to attach to that protects it from UV radiation and predation, and prolong their survival in the estuarine environment. The proper implementation and maintenance of erosion and sediment control BMPs are critical to managing the potential discharge of pollutants from construction activities. The plan for increased development in the Okatie River watershed as described in long range plans for Beaufort County, Jasper County, the Town of Bluffton, and the City of Hardeeville will place this issue at the forefront of ongoing efforts to improve and preserve water quality.

3.1.4 Septic Systems

Approximately 30% of the existing developed acreage in the Okatie River watershed is serviced by septic tanks, and it is likely that some of these tanks are failing to provide proper treatment. Reasons for septic tank failure include high water table, structural failure, unsuitable soils, direct connection between a septic tank and the receiving water, and failure to provide maintenance for the septic tank. Failing septic tanks are expected to discharge high concentrations of nutrients and bacteria; including fecal coliform. (BC Stormwater Management Plan). The Okatie River TMDL prepared in 2010 estimated 919 septic tanks were within the watershed. The 2006 SWMP also estimated the septic tank coverage within the watershed and the results are summarized in Table 8.

Table 8 - Estimated Septic Coverage (% of residences served by septic vs. public sewer) from 2006 SWMP

Land Use	Colleton River 1	Okatie River 1	Okatie River 2	Okatie River 3	Jasper County 1	Jasper County 2	Jasper County 3
Commercial	0%	59%	1%	0%	0%	0%	0%
High Density Residential	0%	0%	14%	0%	0%	0%	0%
Industrial	8%	22%	31%	26%	0%	17%	0%
Institutional	0%	0%	0%	0%	0%	0%	0%
Low Density Residential	0%	48%	80%	70%	0%	100%	0%
Medium Density Residential	6%	15%	0%	0%	0%	100%	0%
Total	3%	37%	52%	31%	0%	43%	0%

3.1.5 Wildlife

Even before the development of the Okatie River watershed, wildlife was a natural source of fecal coliform. There are however several factors that can increase the effect of wildlife once an area is developed. Upland habitat is typically the first to be developed and this change in land use forces the redistribution of wildlife to the remaining undeveloped areas. The areas left undeveloped are low lying areas that are typically classified as jurisdictional wetlands, and typically feature drainage ditches that were constructed in the past for agricultural purposes. Jurisdictional wetlands offer an attractive habitat for wildlife, the areas are extensively connected which allows wildlife to move unimpeded throughout the watershed and the mature hardwoods with a well-established understory offer forage and bedding areas. The development of the area has also provided more foraging opportunities in fertilized and irrigated residential landscaping and a reduction of the predatory population. This contributes to wildlife populations that exceed the natural carrying capacity of the watershed. This could result in a higher and more immediate input of fecal coliform due to the wildlife habitat and population existing in the same area as the watershed drainage corridors.

The loading contribution from waterfowl is one of the easiest to observe and is an immediate input of bacteria and nutrients into the Okatie River. Approximately 1,879 acres (2.9 sq. mi.) or roughly 11% of the watershed is open water or tidally influenced wetlands. These areas offer habitat and food sources that attract various species of waterfowl on a year round basis. There are also approximately 96 docks along the Okatie River that can potentially serve as bird roosting areas. The bacteria and nutrient input of wildlife is hard to quantify without population estimates or pollutant source tracking testing. Beaufort County attempted bacteria source tracking as part of initial water quality monitoring efforts, but most of the results were inconclusive (*Beaufort County Water Quality Monitoring Reports*). The Okatie River TMDL referenced a number of sources with typical wildlife densities for raccoons and deer, including an estimate from a 2008 deer density study prepared by SCDNR that estimated 30 to 45 deer per square mile within the Okatie River TMDL watershed. The TMDL also noted that the watershed includes at least one natural bird rookery. Given the findings from the TMDL and the land use estimates for the amount of forests and wetlands within the watershed, the contribution of fecal coliform bacteria from wildlife sources may be significant.

3.1.6 Agricultural

The agricultural activity still present in the Okatie River watershed includes pine silviculture, grass pastures, and recreational farming. Silviculture practices result in moderate increases in the volume and rate of runoff as compared to a naturally wooded system. The increase is due to the periodic burning to clear underbrush that increases the risk of canopy fires, and the installation of ditch networks to improve drainage so pine saplings can become established. However, the largest threat to water quality in the silviculture practice is the process of harvesting the pine trees. Harvesting introduces a very abrupt change in the land cover characteristics and disturbs several acres at once. These activities increase the erosion rate and lead to an increase in suspended sediment in runoff. Potential stormwater impacts from pasture and grass farming are similar to pine silviculture in that stormwater

runoff from pasture land-uses are typically higher than natural wooded land-uses. Harvesting also can result in spikes in runoff volumes and suspended sediment reaching the receiving waters.

Recreational farming, including equestrian uses pose a larger fecal coliform contamination threat than other agricultural land-uses, depending on the manure management practices. Commercial agricultural facilities are regulated by SCDHEC Regulation R 61-43 and require operating permits to manage the storage, treatment and disposal of manure and litter associated with the agriculture activity (*Okatie River TMDL*). Non-commercial agricultural activities associated with residential developments are not regulated to the same commercial standards and although they are typically much smaller than commercial farms, can contribute to water quality contamination.

There are several unregulated agricultural operations in the Okatie River watershed, including a few that are directly adjacent to the river. These operations are identified in the Okatie River TMDL and efforts to educate the owners to recommended best management practices have taken place as part of previous watershed management efforts. BMPs such as manure composting and pasture runoff control were introduced to the largest residential accessory farm as part of a 319 Grant administered by the Lowcountry Council of Governments in partnership with the Beaufort County Soil and Water District (BCSWD) and U.S. Department of Agriculture – National Resource Conservation Service (USDA-NRCS). The details and results are presented in the summary report dated March 2014.

3.2 Point Sources

3.2.1 NPDES Permits

The National Pollutant Discharge Elimination System (NPDES) Program was created by Section 402 of the Clean Water Act. The NPDES Program is administered by each state with the authority granted by the EPA. The NPDES Program requires that any point source discharge to surface waters obtain an NPDES Permit or coverage under an applicable General Permit. The most common point source discharges are produced by wastewater treatment facilities, municipal storm sewer systems, stormwater from industrial activities, and stormwater from construction sites. These discharges have the potential to increase pollutant loads and impact the water quality of the receiving water body.

3.2.2 Continuous Point Sources

Municipal and private sanitary wastewater treatment facilities are considered to be continuous point sources. These systems often discharge treated effluent directly to receiving waters at designed and permitted flow rates. The effluent is typically treated to specific permitted limits for fecal coliform intended prevent contributions to bacteria contamination; however it is possible for temporary or systematic failures in treatment systems, particularly privately operated systems. .

Currently, there are no wastewater treatment facilities within the Okatie River watershed (*Okatie River TMDL*). Any future systems proposed for the area would be required to meet the waste load allocations and limits required by the Okatie River TMDL. It is highly unlikely that any sort of wastewater treatment system will be proposed within the watershed given that the properties within the watershed fall within the jurisdiction of Beaufort Jasper Water and Sewer Authority (BJWSA). BJWSA operates a number of

treatment plants in the area and already have permitted effluent discharge locations within other receiving waters not sensitive to bacteria contamination.

3.2.3 SSOs & CSOs

In South Carolina, over the last 10 years, an average of almost 600 sanitary sewer overflows (SSOs) have been reported each year. These overflows release untreated sewage that can reach a receiving water body and cause significant water quality problems. Wastewater overflows happen for a variety of reasons. Some occur during dry weather due to blockages in the system, vandalism, construction activities, pipe failures, pumping failures, grease accumulation, root intrusion into sewer lines, a lack of proper maintenance and a myriad of other reasons. Other overflows occur during wet weather when inflow and infiltration into sewer lines overwhelms the sewer system.

The chances that an overflow will occur during wet weather increases when the sanitary and stormwater flows are incorporated into the same system. When this occurs it is called a combined sewer system, and is typically seen in older urban areas. These combined sewer systems can cause an overflow by over inundating the sanitary sewer system with stormwater during a rain event, or they can discharge directly into a receiving water body. While SSOs are easy to identify, and any overflow greater than 500 gallons has to be reported to the SCDHEC Bureau of Water, combined sewer overflows have to be identified through field investigation and regulation of illicit connections to the storm sewer system. SSOs and CSOs contain high levels of bacteria and nutrients that greatly impact water quality, dissolved oxygen levels, and estuarine habitat.

The development within the Okatie River watershed has mostly occurred within the past 25 year, with the great majority of it being within the past 15 years. Given that the sanitary sewer infrastructure is relatively new and constructed to modern standards and specifications, the probability of SSOs are low. BJWSA maintains their sewer systems actively and progressively to prevent SSOs, so point source contributions from SSOs and CSOs are highly unlikely.

3.2.3 Fertilizer & Pesticides

The leading applicators of fertilizer in Beaufort County are the agriculture and golf industries and these two land-use groups are found in relatively small proportions in the Okatie River watershed. Pasture land-use and golf course land use comprise approximately 6.5% and 6.0% of the overall watershed respectively. According to the *Okatie River TMDL* published in 2010, there are 'hobby' farms located in the headwaters portion of the Okatie River, many of them directly adjacent to the river. The Oldfield residential development in the Okatie River 1 sub-basin includes a horse farm as part of the community's amenities. Golf courses within the watershed include courses associated with Oldfield, Berkeley Hall, Eagles Point, and Sun City residential developments. However, the pesticide and fertilizer application for these golf courses are done by licensed professionals, often using liquid fertilizer that is less likely to be captured in runoff. Of greater concern in the use of pesticides and fertilizers is the application and use by individual homeowners.

While the application of fertilizer in residential areas is done on a smaller scale than in the agricultural and golf industry, the homeowner is typically unaware of the proper application rate. This typically

leads to the over application of fertilizer, and during a rain events, the excess nutrients are picked up by runoff. When the excess nutrients are carried to the receiving water body they encourage the growth of harmful algae blooms that release toxins that are poisonous to fish and humans, lower dissolved oxygen levels, and block UV radiation.

The NPDES General Permit covering pesticide application is required for applicators who exceed a specific quantity annually, and is commonly needed for agriculture, golf course and right of way maintenance operations. Given that a relatively small percentage of the watershed are farming and golf courses, the application of pesticides are most commonly associated with utility and road right of way maintenance, and residential landscaping. The application of pesticides by the professional community is regulated and the training requirements reduce the chance that they will over apply. An individual resident will not approach the application quantity requiring coverage under the NPDES General Permit, but they are often unaware of the proper application rate and tend to over apply. With the application of any pesticide, it is un-avoidable that some of that pesticide will end up in the receiving water body, possibly resulting in negative impacts to water quality and the estuarine ecosystem.

4.0 Watershed Goals and Objectives

The goals and objectives for the Okatie River watershed have been established by the Beaufort County Stormwater Utility, with support from the Town of Bluffton. The goals and objectives are based on the County's ongoing commitment to restoring and protecting the Okatie River, initially set forth in the 1997 study titled *A Blueprint for Clean Water – Strategies to Protect and Restore Beaufort County's Waterways*. Also contributing to the goals and objectives are the follow-up studies including *The Okatie River Watershed Management Plan*, the *Beaufort County Special Area Management Plan*, and the *Beaufort County Stormwater Management Plan*. The Stormwater Utility's Vision and Mission Statements apply to the entire County but are focused on the Okatie River watershed:

- Beaufort County Stormwater Utility Vision Statement – "Efficient Utility Addressing the Stormwater Needs of the County, while Protecting its Water Resources"
- Beaufort County Stormwater Utility Mission Statement – "Dedicated to the management, construction, maintenance, protections, control, regulation, use and enhancement of stormwater systems and programs in Beaufort County in concert with other water resource management programs."

The County has entered into Intergovernmental Agreements (IGA) with the Town of Bluffton for general stormwater management as well as for management of the Okatie River watershed specifically. Based on the IGA goals, specific watershed goals and objectives were set.

<u>Watershed Goals</u>

- Protect the Okatie watershed and the outstanding natural water resources.
- Develop partnerships for safeguarding of the watershed.
- Improve water quality in the Okatie River

- Management strategies within the Okatie River watershed will be model projects for implementation in other developed and developing watershed within the County

Watershed Objectives

1. Meet the appropriate water quality standards for fecal coliform bacteria in portions of the river classified for shellfish harvesting that have historically met shellfish standards.
2. Treat runoff from existing developments that currently have no stormwater BMPs by installation of large regional stormwater BMPs.
3. Reduce impacts of future growth and redevelopment by promoting low impact designs using development ordinances, stormwater regulations, and professional development education programs for engineers and developers.
4. Protect and restore critical natural resources such as isolated wetlands, jurisdictional wetlands, and stream buffers.
5. Reduce bacteria loads from domesticated pets and agricultural activities

With the goals and objectives in mind, management strategies designed to achieve the objectives were developed. The strategies are described in detail in Section 5.

5.0 Management Strategies

Management strategies were developed to meet the established goals and objectives. The strategies were based on methods currently being implemented in other portions of the County such as the Battery Creek and May River watersheds. The Beaufort County Stormwater Utility has implemented many projects throughout the County with varying degrees of success. The strategies listed below are ones that have been implemented with some positive results, whether major or minor. Strategies with lesser success rates are still valuable when approached with the belief that multiple smaller returns will eventually add up to greater returns over time. However, projects with higher rates of return will be the initial focus of the implementation plan.

Some of these management strategies were implemented in the previous 2002 Okatie River Watershed Management Plan and the supplemental 2008 319 Grant Project. The 319 grant funded a number of small regional and non-regional projects such as a septic tank inspection program, a pet waste education program, and an irrigation reuse program. The project was completed in 2014 and a summary report was published by LOCOG. The project's goal was to address the bacteria contamination problem in the River and reopen the shellfish beds to harvesting; however, the results fell short of that goal. This new *Okatie River Watershed Management Plan* will build on the previous successes and learn from the failures in order to implement larger strategies intended to address the contaminant sources. The ultimate goal is of the overall watershed based plan is to improve water quality such that the shellfish beds within the watershed are reopened for harvesting.

Many of the management strategies will focus on stormwater runoff volume reduction. Increases in stormwater volume from development are believed to be contributing to higher bacteria counts in the saltwater rivers. Higher bacteria measurements have been observed with lower salinities in estuarine water bodies and it is believed to be related to higher fecal coliform mortality rates in higher salinities. Previous stormwater regulations required the analysis of pre-post peak discharge rates, but not pre-post volume control. The likely result of these standards is that land development over the past twenty years is producing large slugs of freshwater discharges in high volumes inconsistent with natural pre-development hydrology and hydraulics. Monitoring by Beaufort County has also noted high fecal coliform counts occurring in discharge from wetlands and open space areas. It is suspected that increases in volume and concentration of flow through natural wetland systems may be transporting natural re-growth bacteria to the receiving waters. For these reasons, Beaufort County enacted a stormwater volume control ordinance in 2009 to supplement the existing water quantity and quality standards.

The first phase of the Volume Control Ordinance required all new development to limit post-development runoff volume for the 95th percentile storm to pre-development rates. The second phase of the Ordinance, passed in 2011, required residential lots that have been subdivided but no yet built to provide on-lot volume control BMPs. The purpose of this ordinance is to reduce the runoff volume impact from developments that were approved prior to the Volume Control Ordinance but haven't yet been constructed. The first two phases of the Volume Control Ordinance were anti-degradation efforts, meaning they would only prevent volume related water quality issues from getting worse. In order to improve existing water quality problems, retrofits of existing developments and strategies that reduce the existing runoff volumes will be needed.

5.1 Regional Structural Stormwater BMPs

Large structural stormwater BMPs will be used as regional BMPs to serve existing developments that currently have sub-standard or no stormwater treatment controls. These BMPs will receive and treat the runoff prior to discharging it back to the receiving waters. The design of the BMPs will focus on treatment of bacteria and runoff volume reduction, however, it is expected that they will benefit water quality for other pollutants as well. Many of the planned retrofits are projects that resulted from the County Stormwater Master Plan and the subsequent Regional Retrofit Study.

5.1.1 Okatie East Wetland Enhancement

The original Okatie River Watershed Management Plan recommended hydrologic restoration as a strategy within the Okatie River headwaters. Specifically it recommended restoring jurisdictional wetlands that had been altered by silviculture practices such as ditching and dredging constructed to improve the growing capacity of the land. The Okatie East Wetland Enhancement is a hydrologic restoration project located in the Okatie River 3 water quality sub-basin that was first envisioned in the County's 2009 *Regional Retrofit Study* to replace a conceptual pond BMP project originally proposed in the 2006 *Stormwater Master Plan*. The original site from the SWMP became a commercial development shortly after the release of SWMP and there were no remaining uplands available in the vicinity for a new BMP location. The 2009 *Regional Retrofit Study* found no large, undeveloped parcels within the

Okatie East sub-basin capable of containing a serviceable stormwater pond BMP and it became apparent that an alternate treatment strategy would need to be found.

During field investigations, it was discovered that to the east of Hampton Parkway, was an old logging road that contained a large culvert constructed from an old steel boiler. The east basin's main outfall channel ran through the culvert, but didn't appear to be a flow impediment during the normal baseflow. However it was believed that this culvert combined with the other upstream road culverts had over time, channelized the flow through the wetland system. The flow channelization was believed to have increased the total volume reaching the Okatie River by reducing the frequency of wetland inundation and thus the evapotranspiration potential. The concept of detaining the wetland baseflow to increase inundation and ET was discussed as a possible BMP for the east basin, in lieu of a wet detention pond. The detention/inundation concept would be accomplished by replacing the existing boiler culvert with an outlet control structure. Given its location in the sub-basin, the control structure would receive flow from approximately 1,200 acres of land upstream of the logging road.

The project was designed and permitted in 2013 and constructed in 2014. The design and construction of this BMP were used as the match for a 2010 319 Grant acquired by LOCOG through a partnership with Beaufort County. The design included a canal gate at the downstream end of the culvert to allow for adjustability in the function and discharge rates. The County is actively monitoring and adjusting the function of the BMP to optimize the detention time, wetland health and evapotranspiration potential. The County is also monitoring streamflow from the wetland and the fecal coliform bacteria concentrations downstream of the BMP (County monitoring station BECY4-r). The County will continue to actively monitor and adjust the BMP until optimum operation is achieved and until the benefits to water quality are determined. If it is found that the wetland enhancement is effective in reducing bacterial contamination to the Okatie River, similar projects may be implemented elsewhere.

Figure 5-1 shows the wetland enhancement location within the sub-basin and Figure 5-2 shows the estimated wetland inundation size and configuration. Figure 5-3 shows the constructed outfall structure and the wetland inundation.

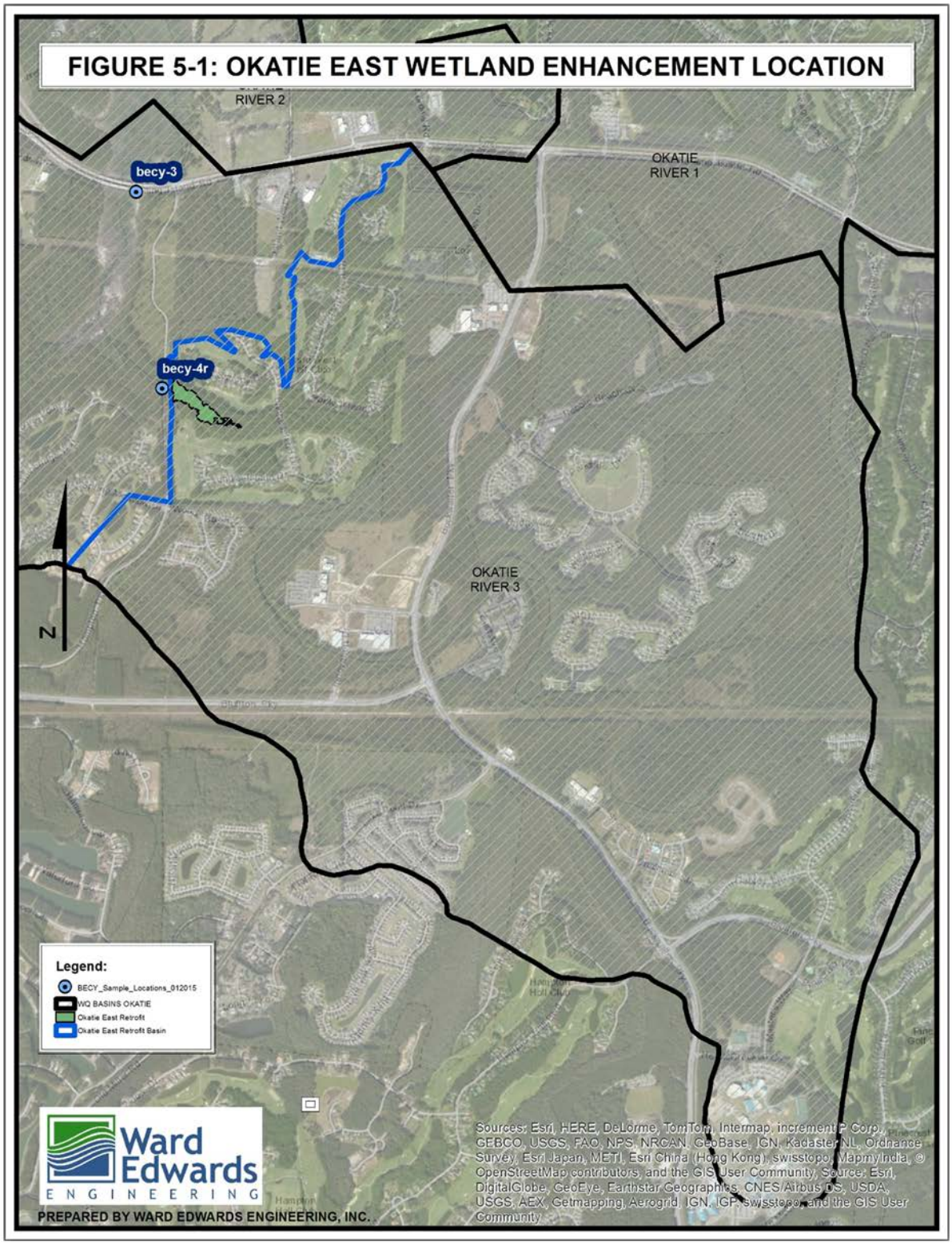

Figure 5-1 – Okatie East Wetland Enhancement Location – BMP has been constructed and is in monitoring phase

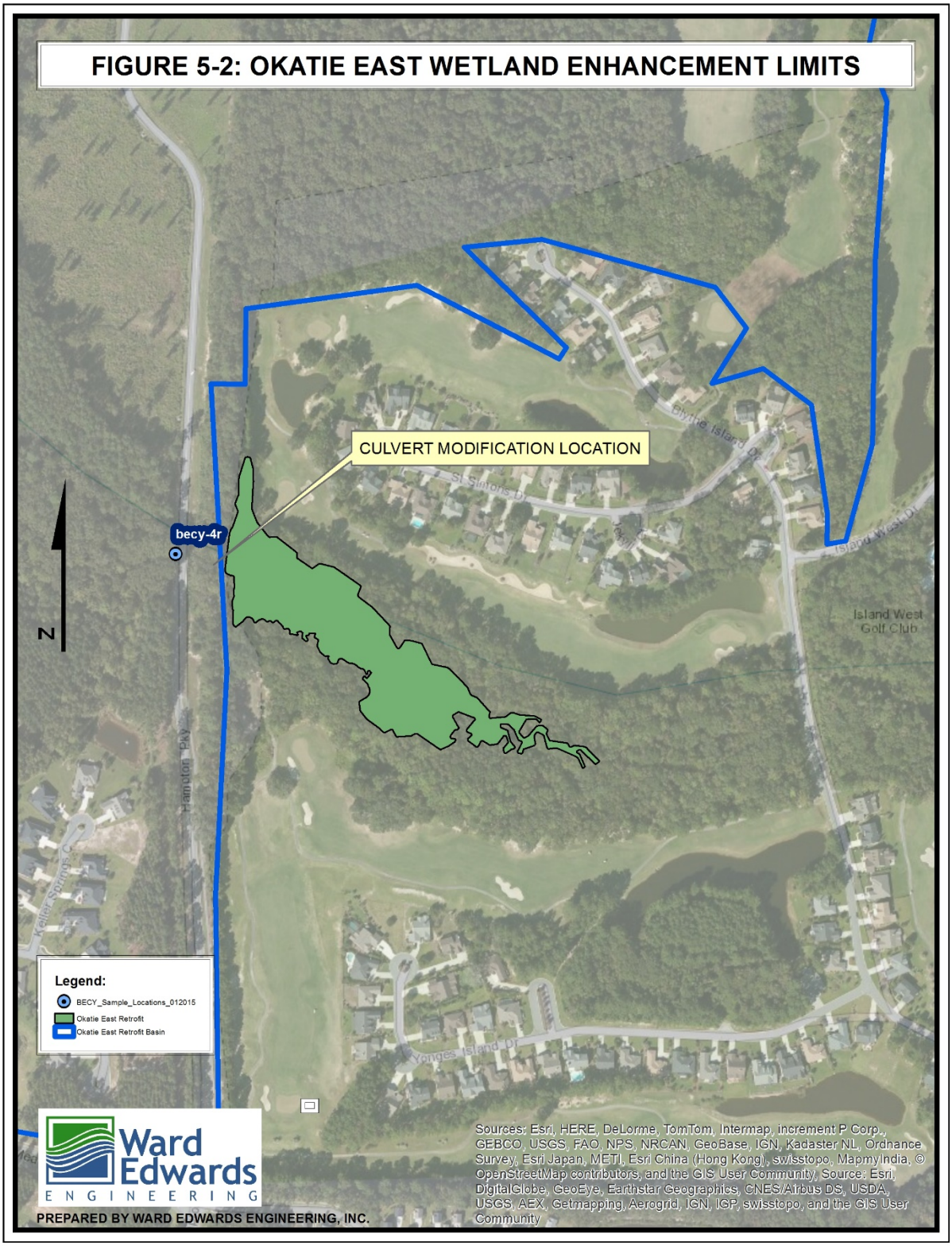

Figure 5-2 – Okatie East Wetland Enhancement Inundation Limits

Figure 5-3 – Okatie East Wetland Enhancement Outlet Structure and Wetland Enhancement

BMP Implementation Priority

The implementation of this BMP is mostly complete and it is in the monitoring and evaluation stage. The County should continue to monitor the stream flow from the wetland control structure and continue to monitor the fecal coliform concentration to determine if the BMP is functioning as intended. This is a high priority but shouldn't impede implementation of other structural BMPs.

5.1.2 Okatie West Regional Retrofit

The Okatie West branch is located within the Okatie 3 water quality sub-basin and is the opposite branch to the Okatie East. The County's SWMP originally recommended the Okatie East retrofit project as the only regional BMP within the Okatie 3 sub-basin, but the *2009 Regional Retrofit Study* recommended the addition of a regional BMP in the western branch to treat runoff from the 1,200 acre sub-basin. The western branch sub-basin contains a mixture of land-uses including single family residential (Sun City – Del Webb), small commercial, medical, institutional, and Highway 170. Much of

the residential and commercial uses within the basin were developed with relatively current water quality standards, but preceded the most recent volume control standards. The existing highway was constructed and later widened prior to all current water quality standards and volume control standards. For these reasons, it is believed that a regional stormwater pond would benefit water quality within the western branch. Figure 5-4 shows the Okatie West and Okatie East branches within the Okatie River 3 water quality sub-basin.

During the 2009 Regional Retrofit Study, a site was identified as the optimal location for a regional pond BMP. The site consists of two parcels under previously common ownership, totaling 111 acres. The County purchased the property in 2015 as part of the Rural and Critical Land program for two purposes. The first purpose is to limit development of the property due to its location in the sensitive headwaters of the Okatie River watershed. The second purpose was to allow for the construction of the Okatie West regional BMP and two smaller non-regional BMPs detailed in later sections of this report. The acquired property borders Hwy 170 to the west and partially developed parcels to the north, east, and south. A large jurisdictional wetland containing the main flow path for the western tributary separates the two parcels. A wetland delineation from 2009 showed a 4.8 acres upland area located near the main conveyance channel, surrounded on three sides by wetlands. The existing elevations in the uplands are roughly equal to the elevations in the wetlands. The low elevations of the uplands and its proximity to the conveyance channel make the area well suited to accepting re-routed runoff from the channel and treating it in a stormwater pond BMP. Ponds have been found to be effective in treating stormwater for bacteria removal in Beaufort County. Ponds can also be designed to reduce flashy discharges of runoff volume. When used as a source for irrigation reuse, or when designed using littoral shelves, the ponds can also reduce the total runoff volume. Being fairly close to the downstream sub-basin discharge point would allow the pond to serve the majority of the 1,200 acre sub-basin, which would help supplement the existing upstream stormwater treatment BMPs. Figure 5-5 shows the proposed pond location within the sub-basin and Figure 5-5 shows the proposed pond size and configuration.

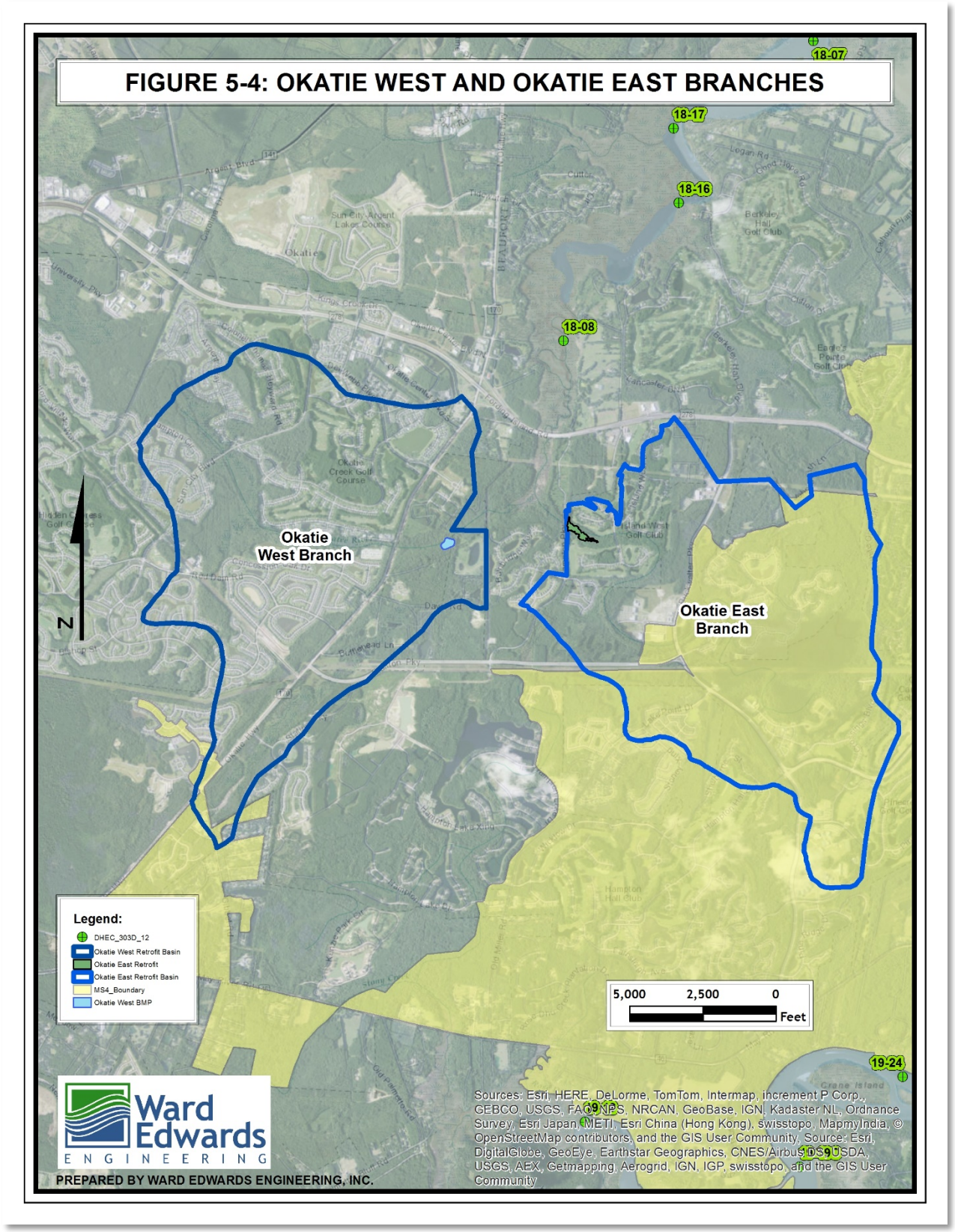

Figure 5-4 – Okatie West and Okatie East Branches of the Okatie River 3 Water Quality Sub-basin

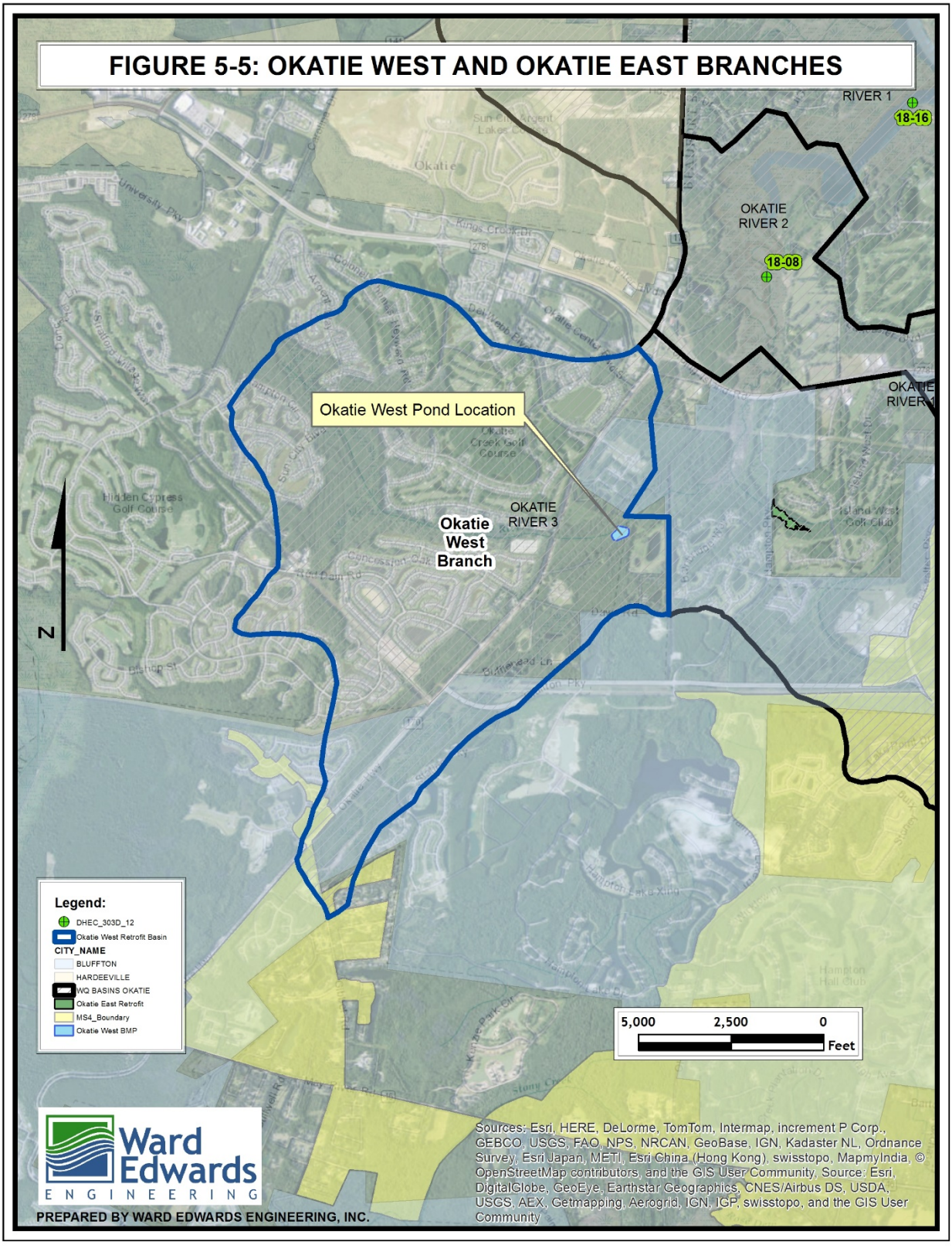

Figure 5-5 – Okatie West Pond Location

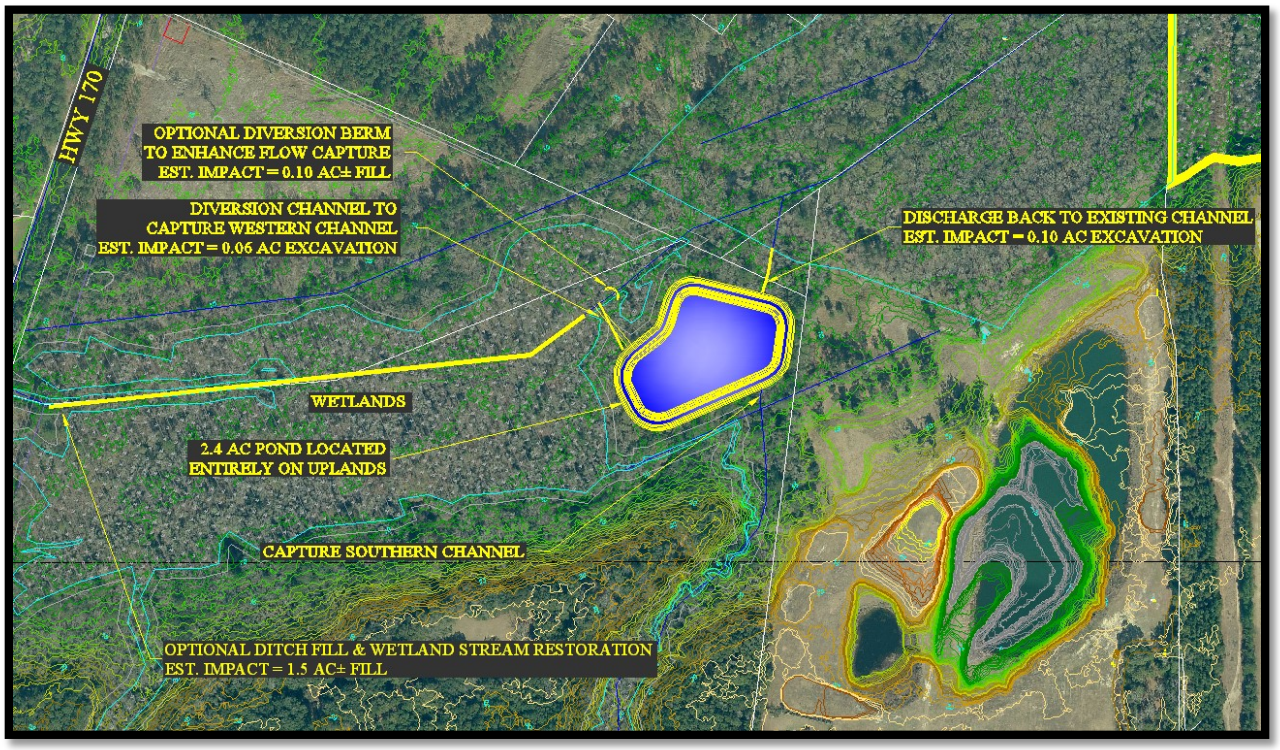

Figure 5-6 – Okatie West Pond Conceptual Design

Beaufort County recently acquired the property that would contain the proposed pond, with the express intent of implementing this project. Obtaining the property was perhaps the biggest challenge to overcome in the implementation, but there are a number of other design challenges associated with this site. These challenges were identified in the Regional Retrofit Study and will have to be addressed in a feasibility study prior to implementation of the BMP:

- The 2009 wetland delineation has expired, so a new delineation verification will be necessary. It is possible that the size and shape of the upland area in which the pond is planned may change. Any changes in the pond size and shape would impact the effectiveness of the proposed BMP.
- The existing ground elevations and the elevations on the adjacent parcel may require portions of the pond banks to be constructed as berms. The berms would be needed in order to provide enough vertical detention volume to make the pond effective. This challenge will require ground run survey to evaluate fully.
- The pond design will have to include an emergency overflow weir sized to limit peak pond stages and to prevent flooding upstream of the pond.
- Redirecting flow to the pond will likely require wetland impacts. These impacts could be permitted as nationwide permits, which will simply the permit process and timeline.
- Access for temporary construction and long term maintenance will have to be provided to the pond site. The access location will be dependent on the conceptual pond layout and may require approval from SCDOT.

- Excavation of the pond will result in a large amount of soil that will need to be used or disposed of offsite, which will drive up the construction costs.

Detailed information on the proposed BMP sizing calculations and predictive modeling analyses are presented in the *Regional Retrofit Study*. Results of the conceptual modeling analyses estimate a 20% reduction in peak flow rate and a 6% reduction in runoff volume at the Okatie River outfall. Table 9 shows the peak stage results, comparing the rates at the downstream East-West confluence, at the pond, just upstream of the pond, and further upstream of the pond. Table 10 shows the 95th percentile storm runoff volume modeling results at the outfall to the river.

Table 9 – Okatie West Conceptual Peak Flow Results - 95th Percentile Storm

Node	Model Node Name	Pre Max Inflow (cfs)	Post Max Inflow (cfs)
Downstream East-West Confluence	OW_M-56	46.75	36.97
Upstream Near Pond	OW_M-77	55.01	55.01
Far Upstream of Pond	OW_M-99	67.30	67.30
Pond	POND_OW	N/A	24.93

Table 10 – Okatie West Conceptual Pre-Post Volume Comparison for 95th Percentile Storm

Node	Model Node Name	Pre Volume High Tide (acre-ft)	Post Volume High Tide (acre-ft)
Okatie River East-West Confluence	OW_M-56	49.5	46.2

The cost to implement this BMP will be much more than what is cost the County to implement the Okatie East project, but less than some of the other regional BMPs identified in the *Regional Retrofit Study*. The cost will be highly dependent on whether or not the County can find a use for the excavated soil. The Regional Retrofit Study estimated around $1,211,100, and a 2014 update increased the estimate to $1,940,400; although those estimates included the costs to acquire the property, which has already been done. The costs could also be reduced if the material excavated from the pond is suitable as fill material for any nearby construction projects.

Table 11 – Okatie West Conceptual Construction Cost Estimate

	Units	Unit Cost	Quantity	Cost
Mobilization	EA	$10,000	1	$10,000
Site Prep/Restoration Erosion & Sediment Control	EA	$7,500	1	$7,500
Clearing	AC	$5,500	8	$44,000
Gravel Access Road	SY	$25	4,400	$110,000
Excavation & Offsite Disposal	CY	$20	43,000	$860,000*
30" RCP	LF	$50	150	$7,500
Outlet Control Structure	EA	$10,000	1	$10,000
Rip Rap Overflow Weir & Outlet Protection	SY	$150	250	$37,500
Grassing & Stabilization	SY	$0.50	27,000	$13,500
		Subtotal		$1,100,000*
Contingency (10%)				$110,000*
Engineering/Legal/Admin (10%)				$110,000*
		Total		**$1,320,000***

*Cost could be significantly reduced if material is suitable as fill material

BMP Implementation Priority

This BMP site is located in the headwaters portion of the Okatie River, which is the most sensitive sub-basin within the river to bacteria contamination. The Headwaters Reach is also the section in the *Okatie River TMDL* requiring the largest percent reduction in bacterial loading to achieve the TMDL standard. The proposed BMP will have the largest service area of all the recommended regional BMPs and thus has the greatest potential for positive impact. Implementing the Okatie West Regional BMP would be the highest priority given the watershed management objectives and the potential benefits. Without this BMP, any other improvements for the shellfish restricted area would have to come through smaller non-regional BMPs or through water quality improvements to less sensitive areas within the watershed. Improvements to adjacent areas may provide secondary benefits to Station 18-08 by reducing the fecal counts reaching the area through tidal action. Additional information on implementation recommendations are presented in Section 6.1

5.1.3 Camp St. Mary's M2 Regional Retrofit

The *2006 Beaufort County SWMP* recommended a regional retrofit within the Camp St. Mary's M2 water quality sub-basin that sits within the Colleton River 3 water quality basin. The sub-basin associated with this project is approximately 500 acres in size and includes a mixture of single family, multi-family, silviculture, and undeveloped land-uses. It also receives runoff from the Jasper County 3 sub-basin which currently consists of institutional and silviculture land-uses. It is important to note that the silviculture portion of the Jasper sub-basin is part of a planned use development that is approved for mixed-use commercial and residential development, so the future land use could be quite different than the current land use. Figure 5-7 shows the proposed Camp St. Mary's BMP service area, the location of the proposed BMP, and the Jasper County 3 and Colleton River 3 water quality sub-basins. The County's *2009 Regional Retrofit Study* further evaluated the proposed BMP site and found that the proposed location wouldn't effectively serve the sub-basin, as runoff from much of the sub-basin would easily bypass the site. An alternate site was proposed in a location that would better capture runoff from the sub-basin. The alternate site is an undeveloped parcel to the east of Camp St. Mary's Road and to the south of Highway 170 that contains two main outfall channels for the sub-basin; allowing for a convenient method to capture the majority of the runoff. The site grades also allow for greater than average vertical freeboard, providing a large amount of potential detention volume.

The regional BMP proposed for this sub-basin was a wet detention pond, as ponds have been found to be effective in treating stormwater for bacteria removal in Beaufort County. As previously mentioned, ponds can also be designed to reduce flashy discharges of runoff volume. When used as a source for irrigation reuse, or when designed using littoral shelves, the ponds can also reduce the total runoff volume. Being fairly close to the downstream sub-basin discharge point and nearby the two main outfall channels would allow the pond to serve the majority of the 500 acre sub-basin, which would help supplement the existing upstream stormwater treatment BMPs. Figure 5-8 shows the proposed pond conceptual design and the proximity to the two main outfall channels.

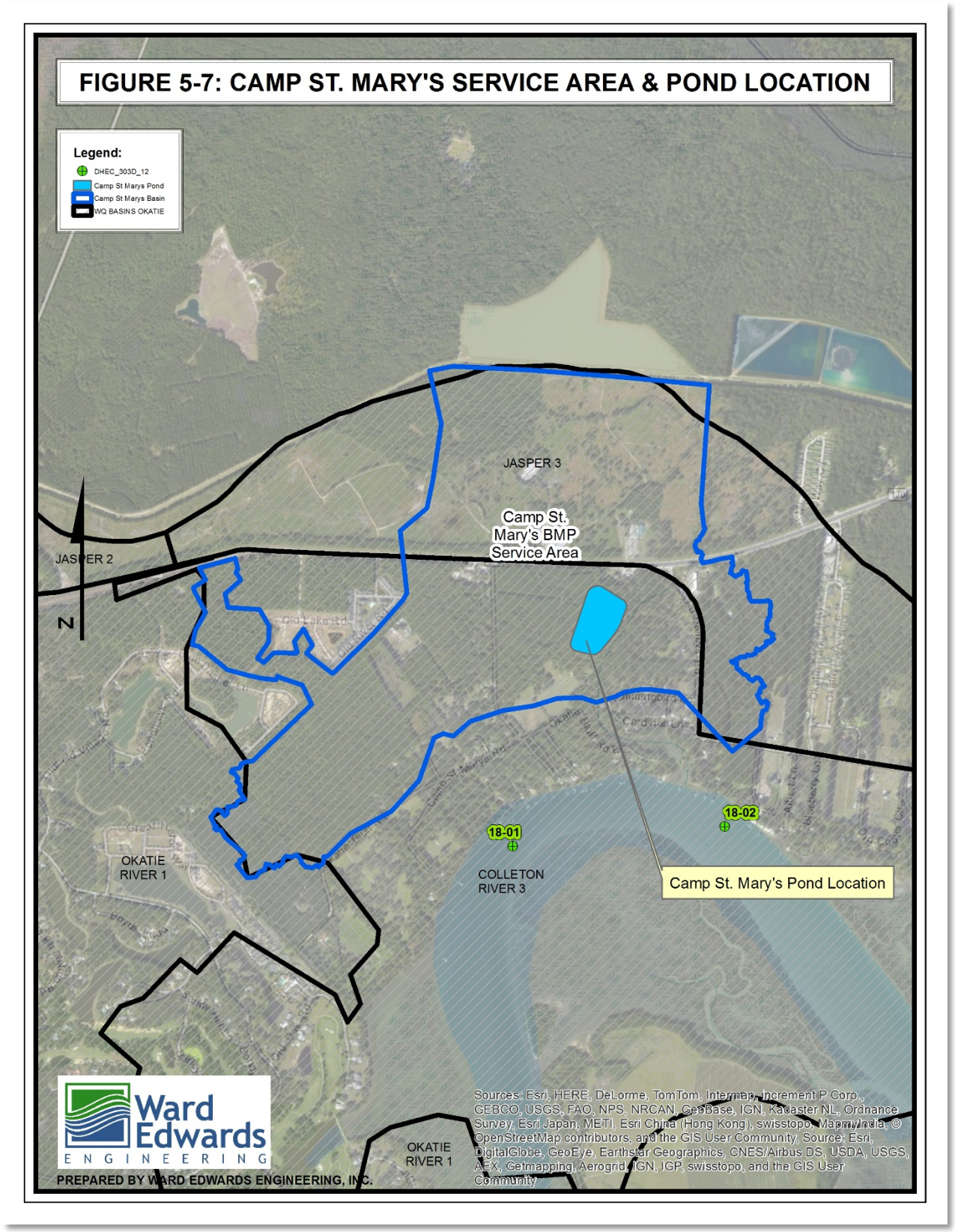

Figure 5-7 – Camp St. Mary's Service Area and BMP Location

Figure 5-8 – Burton Hill M2 Regional Retrofit Location

There are a number of management and design challenges associated with this site. These challenges were identified in the Regional Retrofit Study and will have to be addressed in a feasibility study prior to implementation of the BMP:

- Beaufort County will have to obtain the property or obtain easements to construct the proposed pond on the property. Based on the County's experience with other regional BMPs, this is perhaps the biggest challenge.
- The main conveyance channel is most likely a jurisdictional wetland and quite possibly tidally influenced. It is unknown at this time how far the OCRM critical area extends up into the channel, but it is possible that it borders the proposed site. The degree of difficulty in permitting the needed channel impacts will depend upon the delineation and classification of the wetland channel, but if classified as critical area, impacts to the channel would be extremely difficult or impossible to permit.

- The pond design will have to include an emergency overflow weir sized to limit peak pond stages and to prevent flooding upstream of the pond.
- The pond will need to collect runoff from two different inflow points in order to serve the whole 560 acres targeted for treatment.
- The existing grades of the site and the conveyance channel will require a large amount of excavation. While this will be a benefit in that it will provide for a great amount of detention storage, it will also result in a large amount of soil that will need to be used or disposed of offsite.

Detailed information on the proposed BMP sizing calculations and predictive modeling analyses are presented in the *Regional Retrofit Study*. Results of the conceptual modeling analyses estimate an 81% reduction in peak flow rate and a 63% reduction in runoff volume at the Okatie River outfall in high tide conditions. These benefits will occur with little to no increase in the upstream peak stages. Table 12 shows the peak stage results, comparing the rates at the downstream East-West confluence, at the pond, just upstream of the pond, and further upstream of the pond. Table 13 shows the 95th percentile storm runoff volume modeling results at the outfall to the river.

Table 12 – Camp St. Mary's M2 Conceptual Peak Flow Results - 95th Percentile Storm

Node	Model Node Name	Pre Max Inflow (cfs)	Post Max Inflow (cfs)
Okatie River	CS_M-0	36.71	6.96
West Branch Upstream Near Pond	CS_M-18	30.81	30.81
West Branch Far Upstream of Pond	CS_M-25	30.81	30.81
East Branch Upstream Near Pond	CS_T-15	1.45	1.45
East Branch Far Upstream of Pond	CS_T-19	1.45	1.45
Pond	POND_CSM	N/A	31.49

Table 13 – Camp St. Mary's M2 Conceptual Pre-Post Volume Comparison for 95th Percentile Storm

Node	Model Node Name	Pre Volume High Tide (acre-ft)	Post Volume High Tide (acre-ft)
Okatie River	CS_M-0	28.5	12.3

The cost to implement this BMP will be much more than most of the other regional and non-regional BMPs identified in the Watershed Management Plan. The cost will be highly dependent on whether or not the County can find a use for the excavated soil. The *Regional Retrofit Study* originally estimated around $1,544,400, and but updating the unit costs to reflect current construction costs increases the estimate to $2,598,750. The costs could also be reduced if the material excavated from the pond is suitable as fill material for any nearby construction projects. Based on the NRCS Soil Survey, the majority of the soils are Coosaw loamy fine sand, which may be suitable for structural fill. If any construction projects are needing soil in the near future, the construction costs could be dramatically reduced by constructing the proposed pond while using the material offsite.

Table 14 – Camp St. Mary's M2 - Conceptual Construction Cost Estimate

	Units	Unit Cost	Quantity	Cost
Mobilization	EA	$10,000	1	$10,000
Site Prep/Restoration Erosion & Sediment Control	EA	$7,500	1	$7,500
Land Purchase	AC	$6,500	29	$188,500
Clearing	AC	$5,500	16	$88,000
Gravel Access Road	SY	$25	2,000	$50,000
Excavation & Offsite Disposal	CY	$20	73,000	$1,460,000*
30" RCP	LF	$50	150	$7,500
Outlet Control Structure	EA	$10,000	1	$10,000
Rip Rap Overflow Weir & Outlet Protection	SY	$150	125	$90,000
Grassing & Stabilization	SY	$0.50	27,000	$13,500
		Subtotal		$1,925,000*
Contingency (20%)				$385,000*
Engineering/Legal/Admin (15%)				$288,750*
		Total		**$2,598,750***

*Cost could be significantly reduced if material is suitable as fill material

BMP Implementation Priority

This BMP site is located in the downstream end of the Okatie River watershed, which is the least sensitive sub-basin within the river to bacteria contamination. This area is identified as Reach 5 in the Okatie River TMDL requiring no reduction in bacterial loading to achieve the TMDL standard. The proposed BMP will have small service area compared to the cost of construction and thus have a higher cost-benefit ratio. Implementing this BMP would be a low priority given these factors, however, if the undeveloped land within this area begins to face more development pressure, the priority of this project may rise. Additional information on implementation recommendations are presented in Section 6.1

5.1.4 Aquifer Storage and Recovery Project

In 2011, Beaufort County commissioned a water budget study of a small section of the Okatie West sub-basin; specifically the single family development of Sun City – Del Webb. Completed in 2014 and summarized in a report titled *Quantifying Water Budgets in Beaufort County, SC*; the purpose of the study was to quantify the following components of the hydrologic cycle within the study area:

- The amount of rainfall
- The amount of water imported for irrigation purposes
- The amount of water discharging to the Okatie River (via the Okatie West tributary)
- The change in storage of the shallow groundwater aquifer
- The change in storage of the stormwater detention ponds
- The amount of water dissipated by evapotranspiration

Also included in the study objectives were determinations and comparisons of the study area's runoff coefficients to other developing and undeveloped watersheds. Beaufort County actively participated in the Study with two partners, including Southern Water Resources and Clemson University.

Based on the summary report, there were challenges in the collection of field data such as the surface runoff and actual evapotranspiration. The field measurement difficulties limited the abilities to quantify every component of the water budget, so instead, general trends were analyzed to develop the study recommendations. The study recommendations for controlling runoff from developed watersheds include:

- Pond surface water level management: The study recommends controlling stormwater ponds water levels such that they have excess capacity to receive and detain water during rainfall events. The water surface elevations for many ponds in residential developments are maintained artificially higher for aesthetic reasons, limiting their storage capacity. Drawing water from ponds for irrigation reuse is an effective method for pond surface water level management and is occurring in a couple of developments within the Okatie River watershed.
- Utilization of aquifer storage and recovery systems (ASR). These systems involve pumping captured surface water into a groundwater aquifer for later use. These systems are used elsewhere in South Carolina to help balance potable water demands during high use-low availability periods. The water pumped into the aquifers must meet state and federal water quality standards, so pre-treatment may be required.

The application of ASR to stormwater treatment would be a little different in the case of the Okatie River, in that the water would not be recovered for potable uses. The water may be recovered for irrigation reuse or may not be recovered at all. The study notes that adding water to the deep aquifers in the coastal area could help control salt water intrusion that is occurring in the region. Pre-treatment would likely still be required, especially if the water is pumped to deep aquifers commonly used as potable water sources by public utilities in the region.

There are no specific plans for an ASR system in the watershed, but it could be used to reduce runoff discharge from either the Okatie East or Okatie West tributaries. The ASR infrastructure would probably be a low initial cost for construction, but would require consistent and ongoing operating costs that the other BMPs wouldn't typically require. Treating the runoff to drinking water standards prior to injection to the aquifers could prove too costly. Beaufort County may consider partnering with Beaufort Jasper Water and Sewer Authority on an ASR project. Figure 5-9 shows potential sources from which an ASR system could draw stormwater. The ASR system would draw water from these ponds or inundated wetlands, draw them down to lower water stages, and create additional storage for future rainfall capture.

BMP Implementation Priority

Aquifer storage and reuse has not been used for stormwater runoff control and still has many feasibility issue to work out before being considered viable. However, the benefits could well be worth the effort to study the feasibility and possibly implement; particularly in the headwaters of the Okatie River. The proposed BMP will have large service areas and could greatly enhance the benefits of existing and proposed regional BMPs. The County should begin discussions with SCDHEC, BJWSA, and other potential partners to study the feasibility and estimate the potential costs. The implementation priority will depend on the results of the feasibility study. Additional information on implementation recommendations are presented in Section 6.1

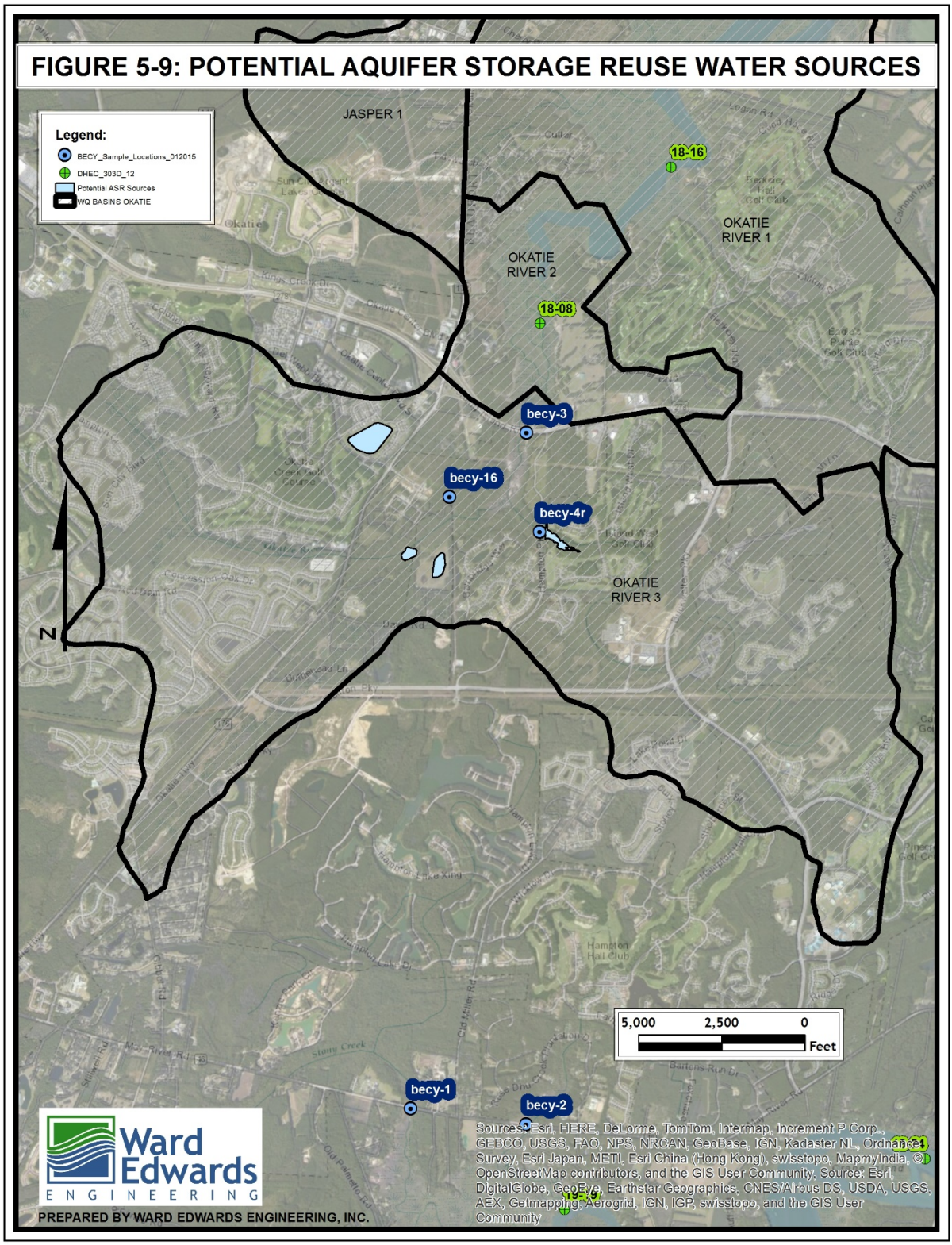

Figure 5-9 - Potential surface water sources for Aquifer Storage Reuse systems. ASR would provide additional storage and reduce runoff to the river

5.2 Non-Regional BMPs

5.2.1 Hwy 278 Widening Retrofits

Beaufort County, in partnership with SCDOT began widening a 5 mile stretch of Highway 278 in 2011, with the construction completed late in 2013. The widening plans were designed using SCDOT's requirements for stormwater quantity and quality control, which are less stringent than Beaufort County's standards. Furthermore, Beaufort County enacted stormwater runoff volume control standards during design of the highway widening and these standards weren't accounted for during the design. Given that approximately 2.5 miles of the widening is within the impaired Okatie River watershed, Beaufort County decided it was appropriate and important to retrofit the highway design to meet the stricter Beaufort County stormwater standards. The County had the highway engineers design four small pond retrofits, sized to handle the County stormwater requirements. Implementation of the ponds required additional permitting that would have delayed the highway widening construction had the County not treated the retrofits as separate projects. While the highway widening was completed, the County began permitting the retrofits and started procuring construction services separate from the highway contract. Construction was underway on the retrofit ponds at the time of preparation of this Water Management Plan and is expected to be completed within six to nine months. The County will evaluate monitoring options for the ponds to determine their effectiveness, but the ponds are expected to provide bacteria treatment of runoff from the highway's impervious surfaces and limit contaminant loads to better than pre-widening levels. Figure 5-10 shows the designed locations for the four non-regional ponds.

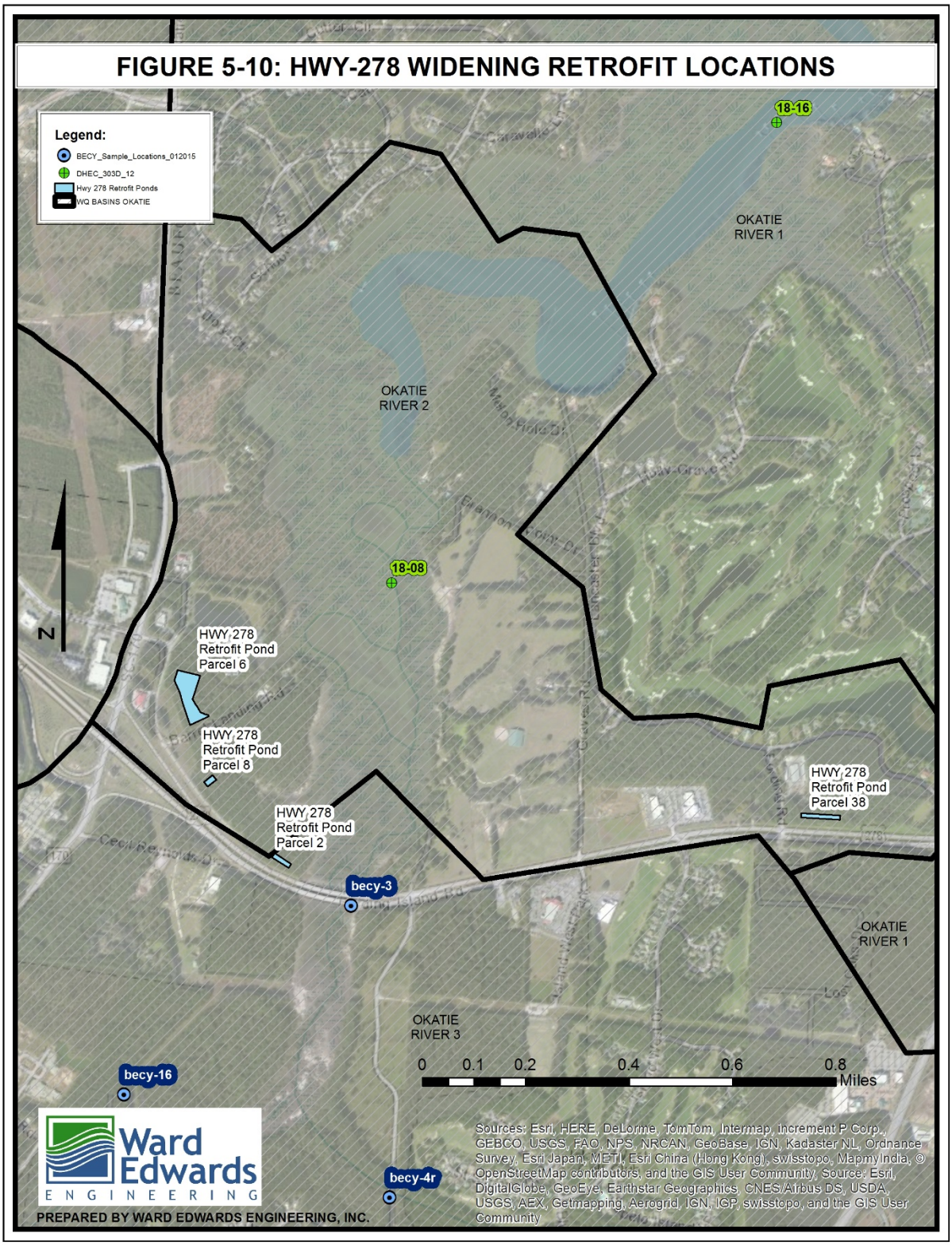

Figure 5-10 – Highway 278 Widening Retrofit Pond Locations

5.2.2 Hwy 170 Widening Retrofits

Beaufort County and SCDOT are currently widening Highway 170 between US-278 and Highway 46 from two lanes to four lanes. 3.2 miles of the highway widening project are located in the Okatie River watershed, specifically the Okatie West branch of the Okatie River 3 water quality sub-basin. The original highway construction pre-dated all stormwater quality regulations and thus had no stormwater treatment BMPs. The widening plans were prepared using SCDOT's stormwater standards for water quantity and water quality, which are not as stringent as the County's water quality and volume control standards. The conventional stormwater design called for seven permanent sediment detention basins at difference locations along the length of the proposed widening. The basins were sized and intended to remove sediment from the first flush runoff and may provide some basic water quality treatment; however they weren't sized to meet Beaufort County's water quality treatment standards or the County's stormwater volume control ordinance.

The County studied the highway project area and identified some possible BMP retrofits to address the water quality and volume control deficits. After their initial study, they commissioned a more detailed study to evaluate and prioritize the BMP concepts. The primary objectives of the BMPS are to meet the County's standards for:

- Pre-development vs. Post-development attenuation standards
- Water quality treatment standards for the three main indicator pollutants (Phosphorus, Nitrogen, and Fecal Coliform Bacteria)
- Stormwater runoff volume control standards for the 95th percentile storm event

One of the original nine sites is located in the May River watershed, so it is not addressed in the Management Plan. One of the sites within the Okatie River watershed (Site 2) was determined to be not feasible and thus is not discussed in this study either. Figure 5-11 shows the locations of the seven feasible BMPs within the watershed. The BMPs are considered non-regional because they are intended to only serve the widened highway sections. The *SC170 Highway Retrofit Study* provides specific details about each basin, ranks them by priority, and provides construction cost estimates for each. Each BMP is described in greater detail below and summary tables of the BMP effectiveness and construction costs area provided below.

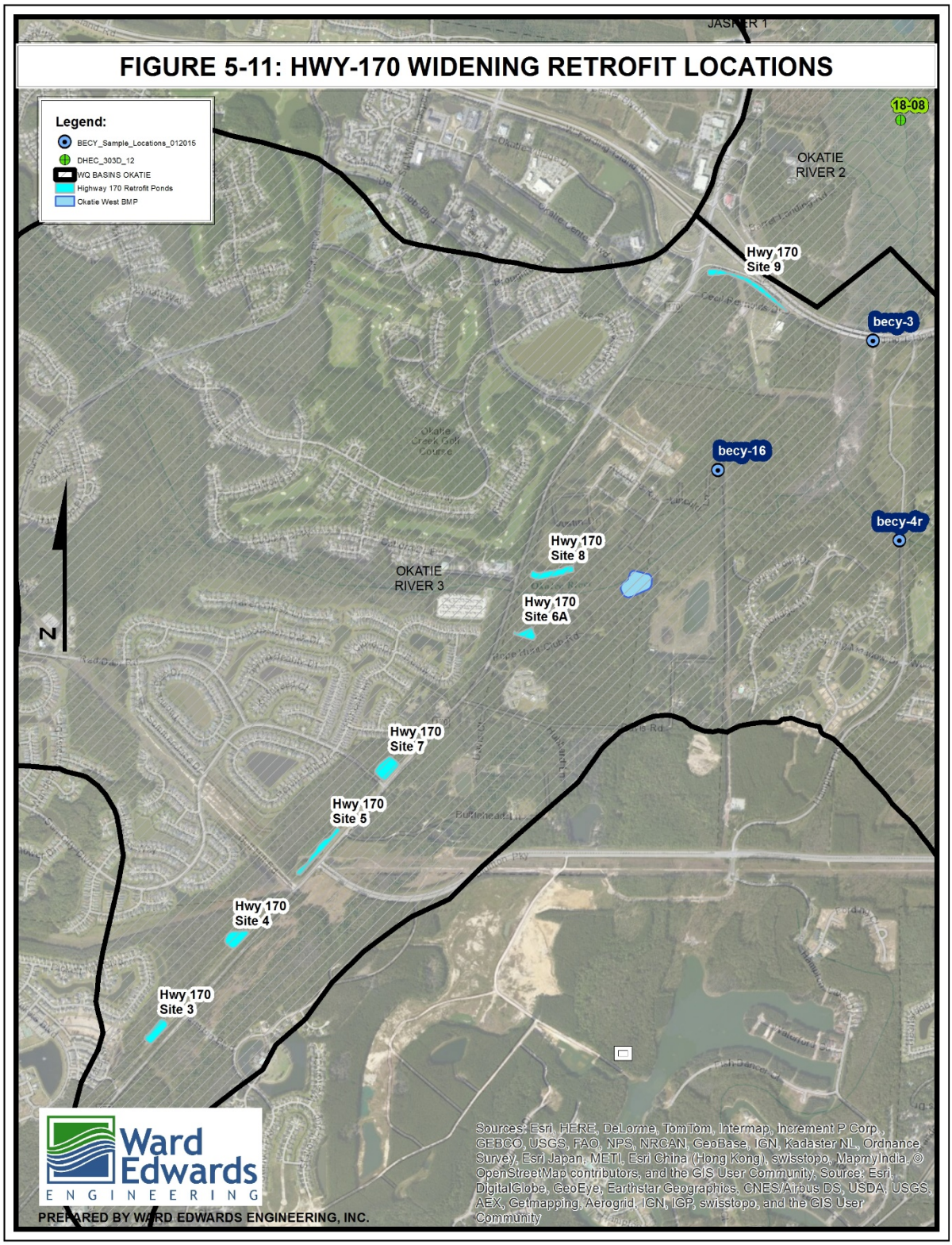

Figure 5-11 – Highway 170 Widening Retrofit Study BMP Locations

Table 15: Highway 170 Widening Retrofit Priorities and Construction Costs

Site & Watershed	Service Area (ac)	Recommended Priority	Estimated Costs (Wet Detention)	Estimated Costs (Dry Detention)	Notes
3 Okatie	6.9	Yes	$595,212	$451,212	Large service area & benefit
4 Okatie	9.1	Yes	$615,672	$414,672	Large service area & benefit but some potential conflicts with utilities
5 Okatie	5.3	No	N/A	N/A	Limited land availability Difficult to isolate runoff from large offsite basin
6A Okatie	3.2	Yes	$570,300	$486,300	Land under foreclosure, close proximity to Okatie headwaters
7 Okatie	7.5	Possibly	$690,300	$455,100	County owned land - Hold in Reserve if others don't work
8 Okatie	12.1	Yes	$945,840	$835,450	Large service area and benefit, close proximity to Okatie headwaters
9 Okatie	16.0	Yes	$424,116	$424,116	Large service area & benefit May be difficult to permit with SCDOT

Note that the BMPs are not number ranked by priority because the feasibility of each are very dependent on the land availability, physical features, potential utility conflicts, and potential natural resources impacts. It was recommended that the County pursue land acquisition and financing for all and investigate feasibility in greater detail. Site 6A is part of the property the County recently acquired for the Okatie West Regional Retrofit project and is most likely to occur first.

The below descriptions and exhibits of the proposed BMP sites were taken from the *SC170 Highway Retrofit Study.* More detail about each site can be found in the original report.

5.2.2.1 – Hwy 170 Retrofit Site 3

Site 3 serves a relatively large area and would treat a large amount impervious area. I would involve the expansion of an existing sedimentation pond, lessening the cost to construct. The pond has no clear outfall, meaning the normal water level will be more difficult to predict and control. If a lower outfall is required to make the pond functional, then wetland impacts may be needed. There are wetlands nearby that appear to have platted wetland buffers. There should be sufficient room to construct the pond without impacting the wetlands or buffers, but permitting of the project will require a current wetland delineation. It is unknown if the USACE wetland delineation for this parcel is current or if it has expired. The wetland line will have to be delineated and verified with the USACE prior to pond design efforts. Further complicating the project is the possibility that utility/power pole may be impacted.

The Retrofit Study recommended this site for implementation given its large basin area and given the amount of upland area available for the proposed pond. Figure 5-12 shows the proposed BMP.

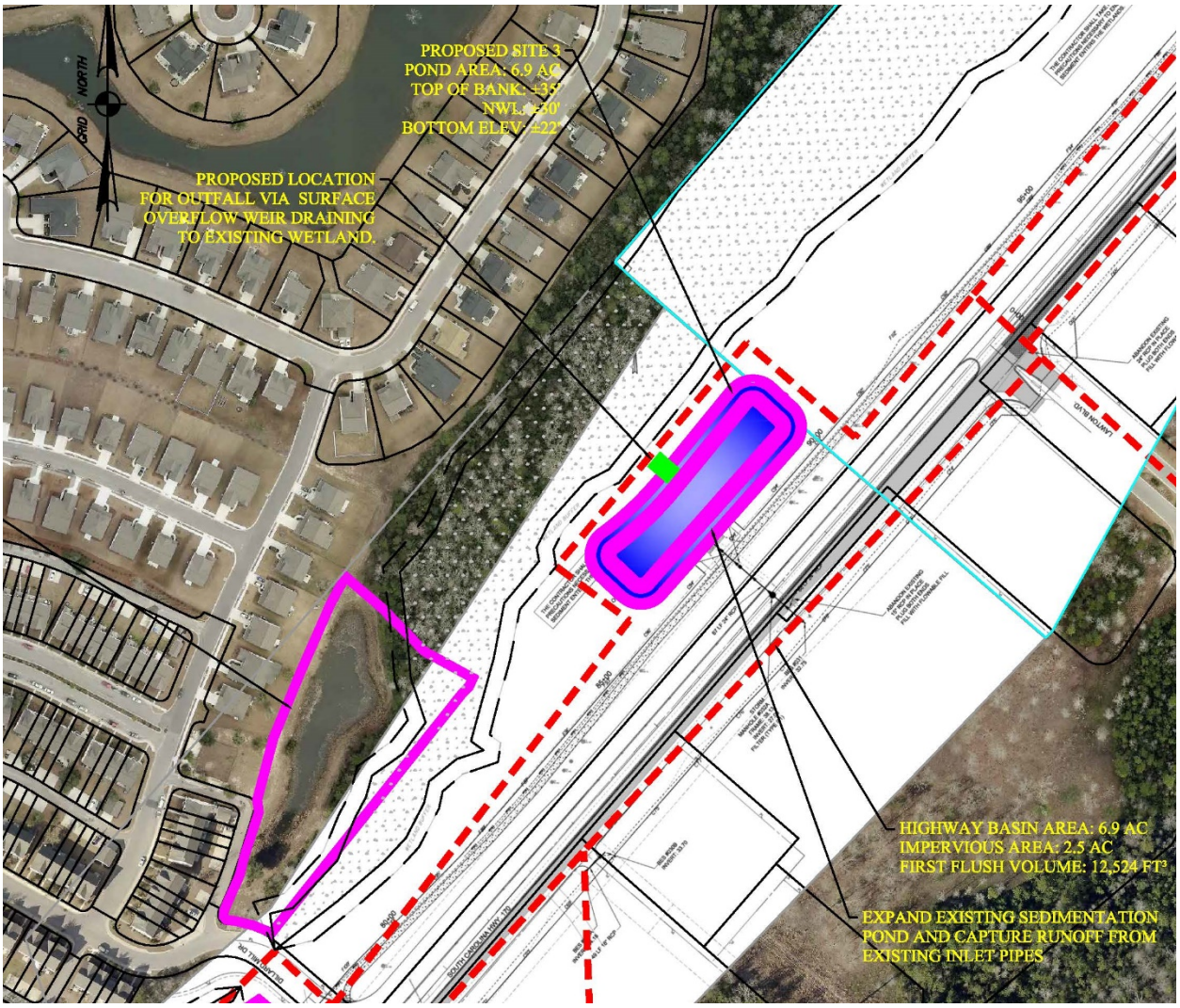

Figure 5-12 – Hwy 170 Retrofit Site 3

5.2.2.2 Hwy 170 Retrofit Site 4

Site 4 would serve a relatively large area and treat a large amount of impervious area. The project would involve the expansion of an existing sedimentation pond so it should cost less to construct than a completely new pond. However the sedimentation pond in this area is very small, so construction cost savings are a little less pronounced than other sites. There is a good amount of land nearby available for the BMP so the layout of the pond could vary greatly. The existing drainage collection system may require modification in order to capture the runoff. There is no clear outfall, meaning the normal water level will be more difficult to predict and control. If a lower outfall is required, then wetland impacts may be needed. Permitting of the project will require a current wetland delineation. It is unclear if the USACE wetland delineation for this parcel is current or if it has expired. The line needs to be delineated

and verified with the USACE prior to pond design efforts. Wetland permitting and modifications to existing protective covenants may be required. There may be possible impact to existing utility/power poles. This site was recommended for implementation given its large service area, however, there may be some difficulty working around existing utilities. This site would be a lower priority compared to other recommended sites if utility conflicts become too costly to address.

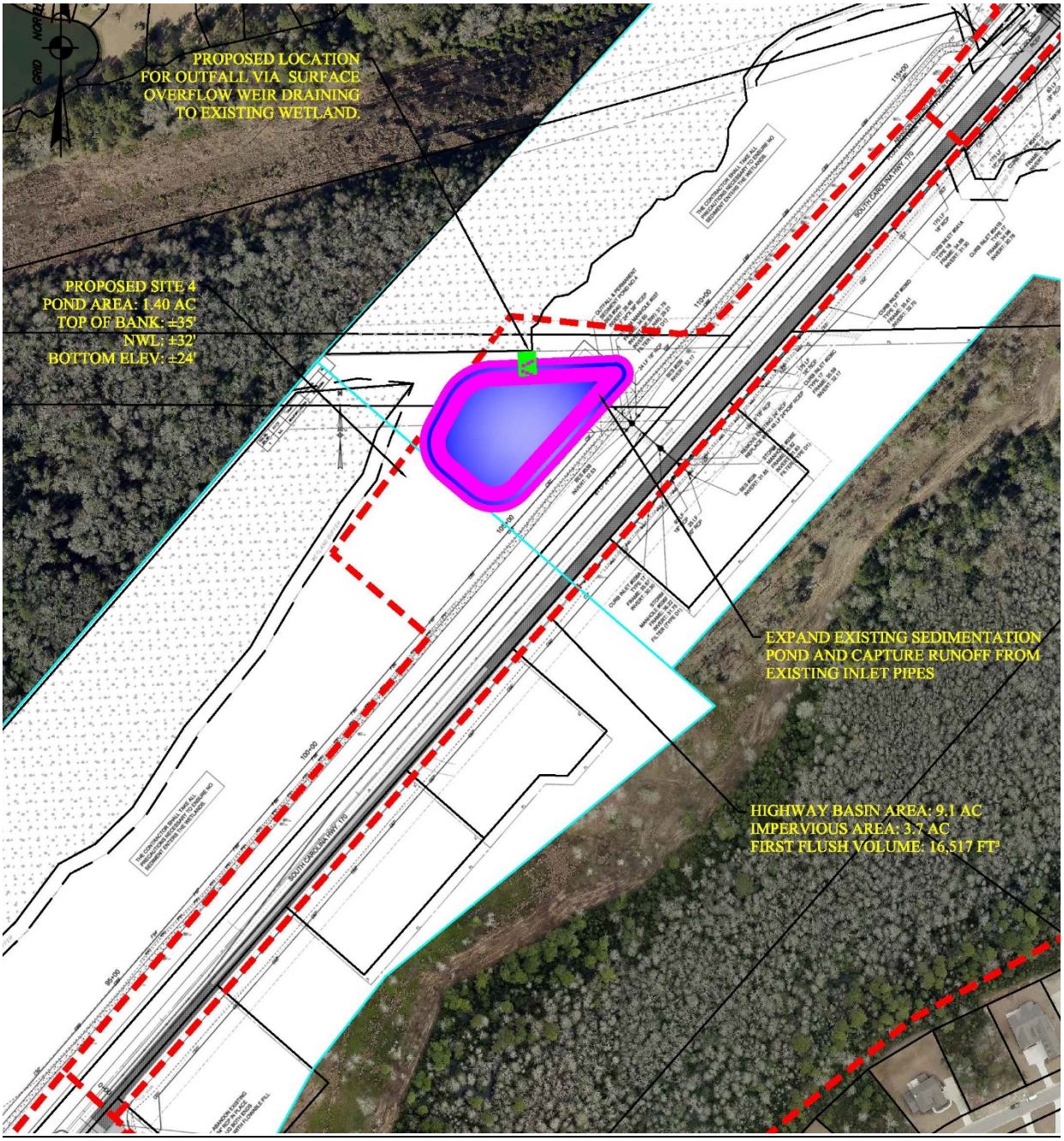

Figure 5-13 – Hwy 170 Retrofit Site 4

5.2.2.3 Hwy 170 Retrofit Site 5

This site would be located in drainage area where there is currently no form of proposed treatment. The highway widening design didn't provide a sedimentation pond, so adding a pond would improve treatment. However, it would serve a relatively small service area and would treat only a small impervious area. Re-routing flows to the pond would require impacts and modifications to an existing driveway curb cut and the associated drainage structures. There are wetlands nearby that appear to have platted wetland buffers. There should be sufficient room to construct the pond without impacting the wetlands or buffers, but permitting of the project will require a current wetland delineation. It is unclear if the USACE wetland delineation for this parcel is current or if it has expired. The line needs to be delineated and verified with the USACE prior to pond design efforts. There are also possible impacts to existing utility/power poles. This site was not recommended for implementation due to the small amount of upland area available for a pond and given the difficulty capturing runoff from the highway drainage system. However, it may warrant further evaluation at a later date if other sites are unable to be implemented.

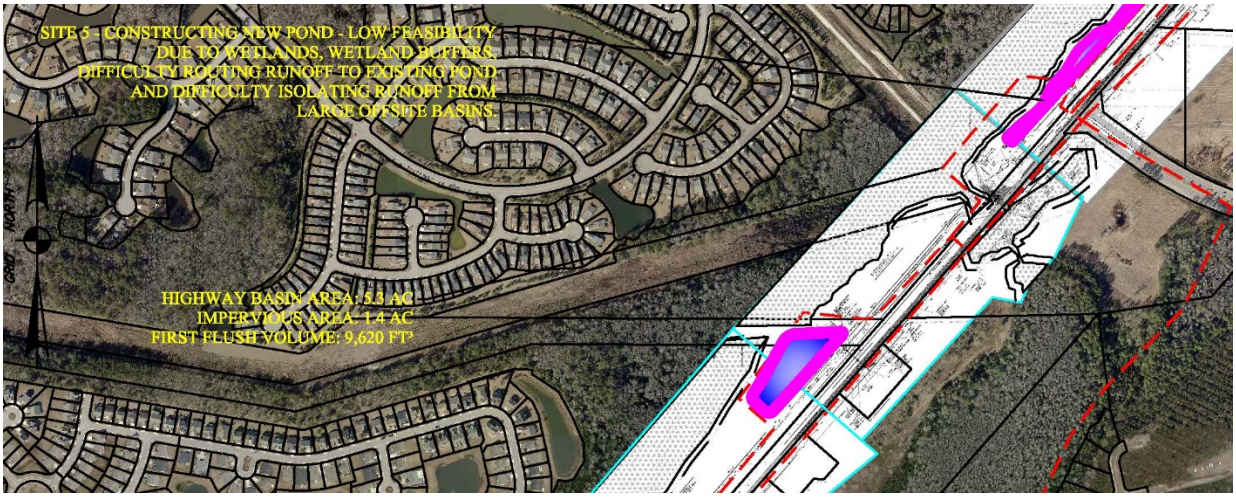

Figure 5-14 – Hwy 170 Retrofit Site 5

5.2.2.4 Hwy 170 Retrofit Site 6A

Site 6A is an alternate site to the original location for Site 6. The location of 6A was found to be more effective at capturing runoff and would treat a larger area. This site is one of the two sites that is closest to the main Okatie West tributary. It is part of the property recently acquired by Beaufort County and there is sufficient upland area to increase the proposed pond size if needed. It is located near a low point of the SC170 drainage system so it can easily capture runoff from the highway. The USACE wetland delineation for this parcel has expired and the last known verification is dated January 29, 2009 (SAC 2008-1752-1JQ). The wetland verification will have to be updated in order for the project to be designed and permitted. This site was recommended for implementation given the proximity to the Okatie River headwaters and given that the County was able to acquire the land needed to construct it.

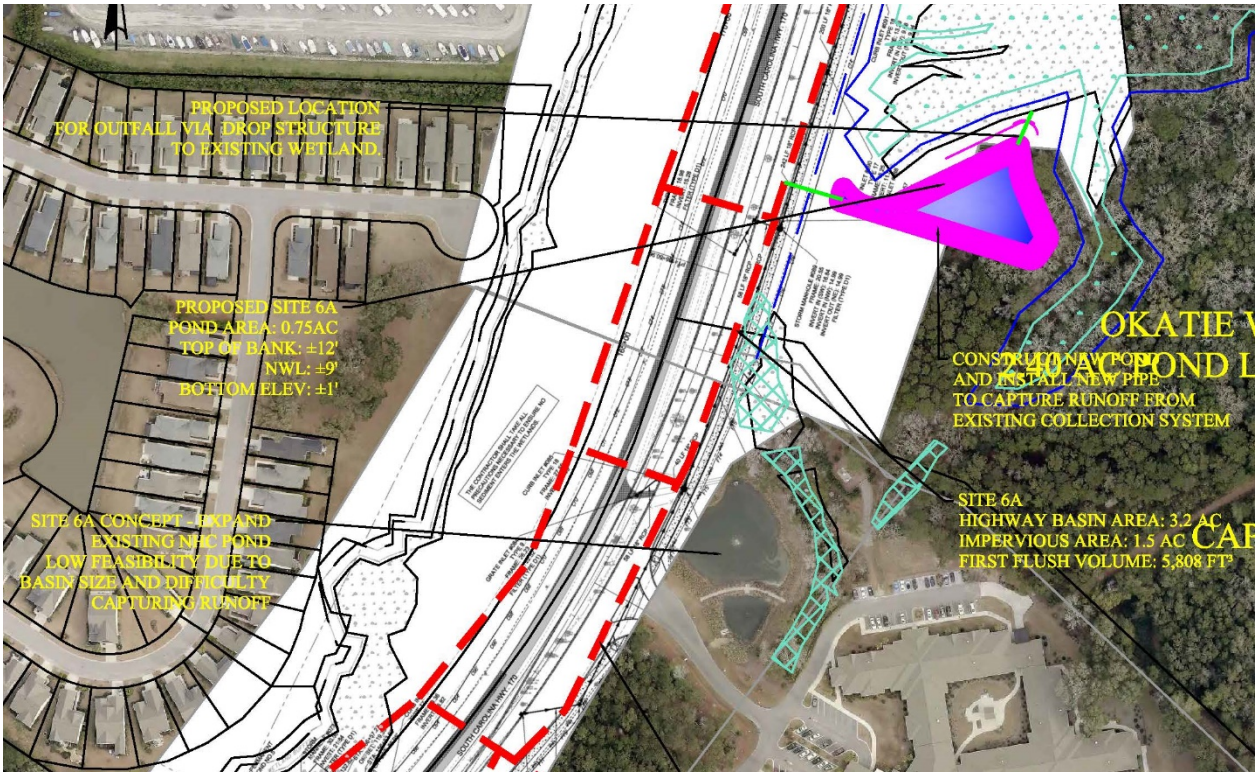

Figure 5-15 – Hwy 170 Retrofit Site 6A

5.2.2.5 Hwy 170 Retrofit Site 7

Site 7 is located in an area where there was no form of treatment designed as part of the highway widening, so adding a pond would improve treatment. The parcel is County owned which will save time and expense compared to the other retrofit sites. However re-routing flows to the pond would require impacts and modifications to Sun City Boulevard and the existing drainage system serving the road. The majority of the runoff from the road drains to the storm inlet on the opposite (south) side of the road, so new pipes would have to be installed under the road to drain the runoff to the pond. There are also possible impacts to existing utility/power poles. This site was recommended for implementation, but at a lower priority than the other sites, given the modifications needed to the existing roads and drainage systems.

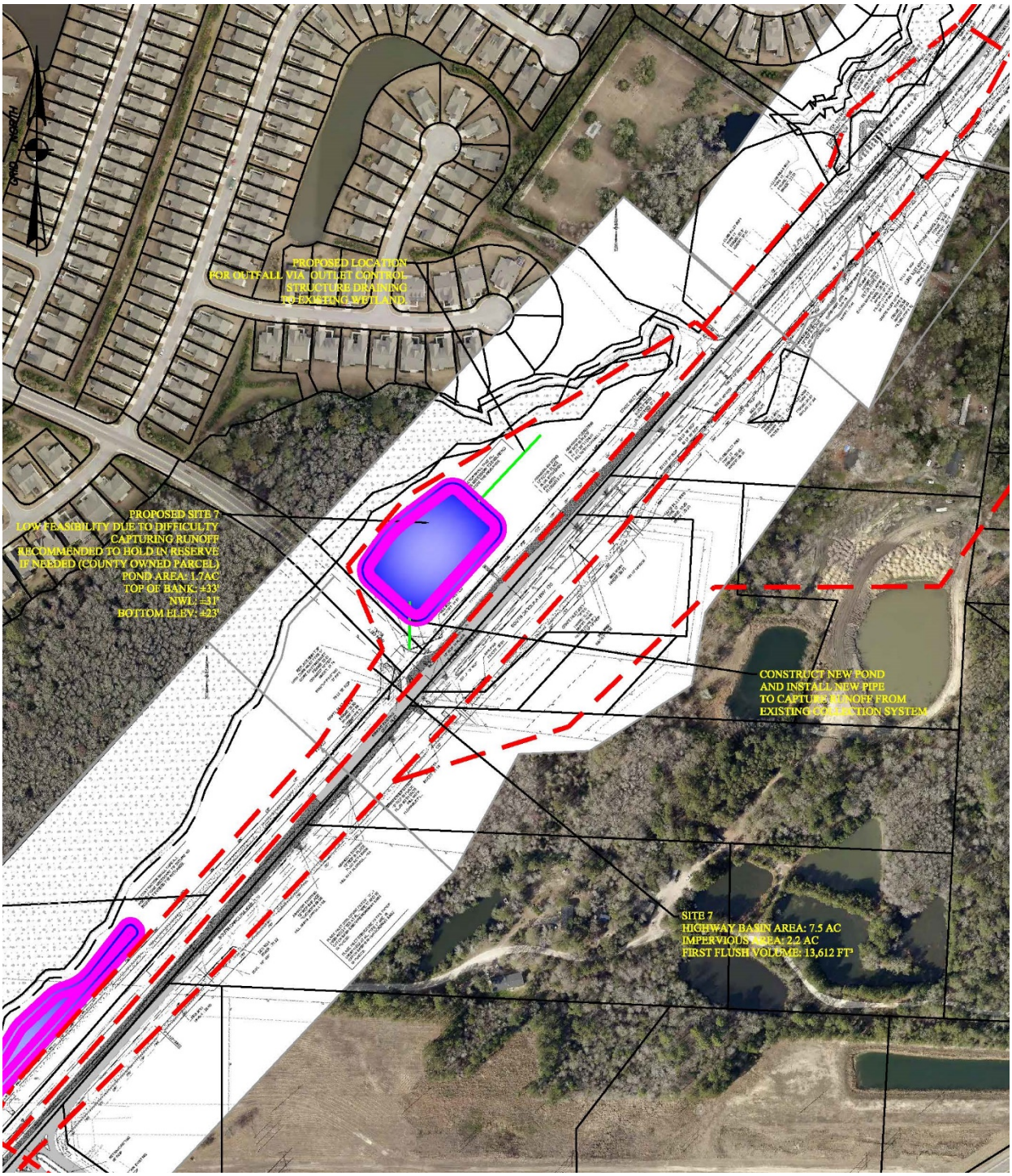

Figure 5-16 – Hwy 170 Retrofit Site 7

5.2.2.6 Hwy 170 Retrofit Site 8

Site 8 is the second of two sites located close to the Okatie West tributary, meaning it is closest to the impaired receiving waters. The site is adjacent to the highway and is located at a natural low point in the road. This means it is in an area where it can capture a sizable portion of the highway's paved surfaces. The property is part of a parcel that is entitled to 204 units of multi-family housing therefore, the property may be valuable and at a higher cost to acquire. The USACE wetland delineation for this parcel has expired. The last known verification is dated January 28, 2004 (SAC 81-2004-0055 (Q)) so the wetland verification would need to be updated prior to pond design efforts. This site was recommended for implementation given its large service area, large benefit, and its proximity to the Okatie River headwaters.

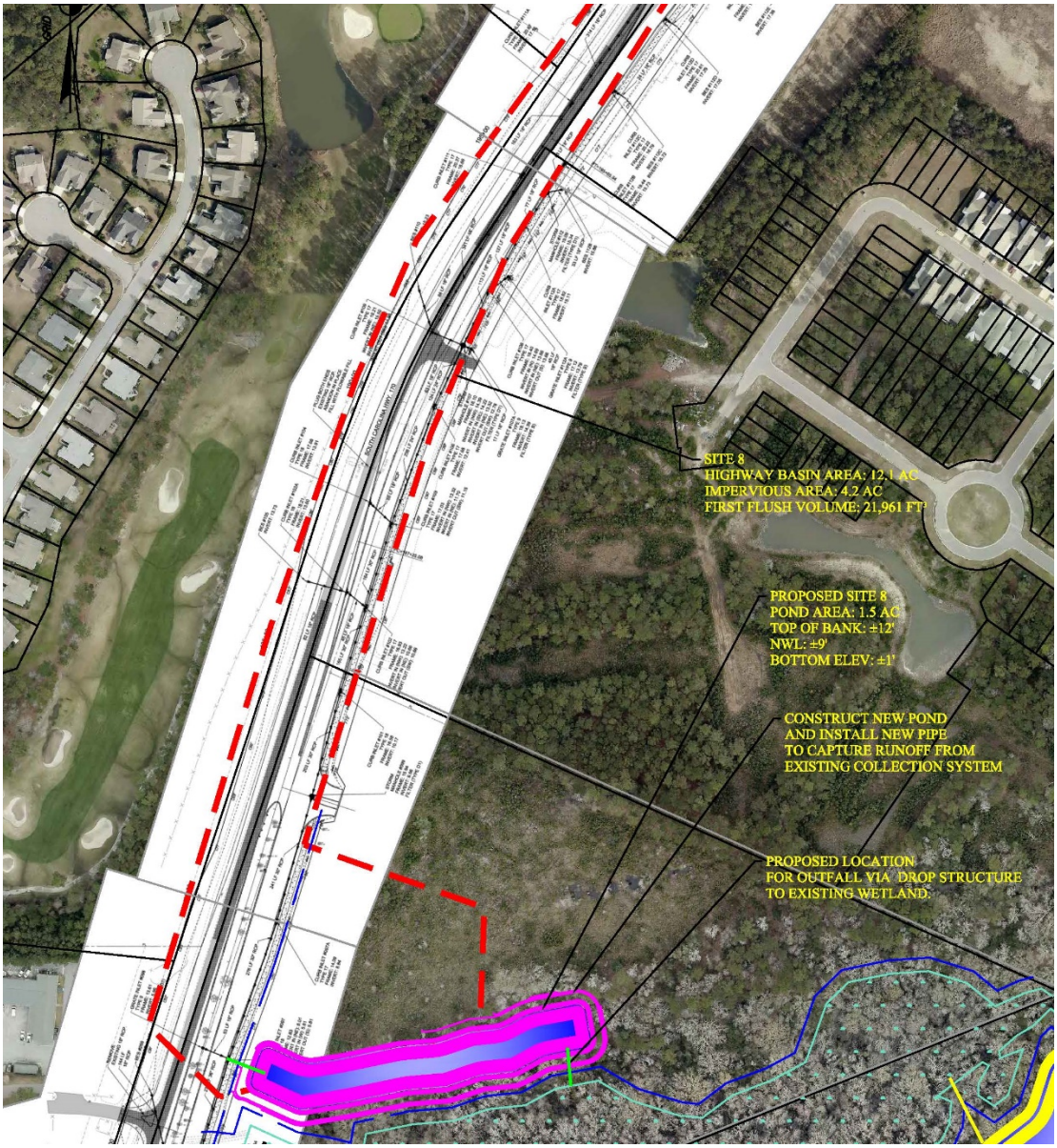

Figure 5-17 – Hwy 170 Retrofit Site 8

5.2.2.7 Hwy 170 Retrofit Site 9

Site 9 is proposed for an area near the intersection of Hwy 170 and Hwy 278. It would serve a relatively large area and treat a large amount of impervious surfaces. The project would involve the expansion of an existing sedimentation pond; therefore it should be less cost to construct than a completely new pond. However the proposed expansion will have to occur within the roadside SCDOT right-of-way. The proposed BMP would be an extended dry detention with the small wet pool area located where the sedimentation pond is proposed. This site is near the Okatie headwaters, so implementing it is likely to make a positive impact in water quality. SCDOT may oppose the construction of a detention system in the roadside area, so permitting the project may be difficult. The proposed modified dry detention BMP is generally less effective at bacteria treatment than wet detention BMPs, but wet detention wouldn't fit in the available area. Another potential roadblock to the BMP implementation is possible impacts to existing utilities. This site was recommended for implementation given its large basin area and its proximity to the Okatie River headwaters. A couple of alternate sites in the vicinity of this project were proposed as part of the Highway Retrofit Study, just in case SCDOT will not allow the BMP in the highway right-of-way.

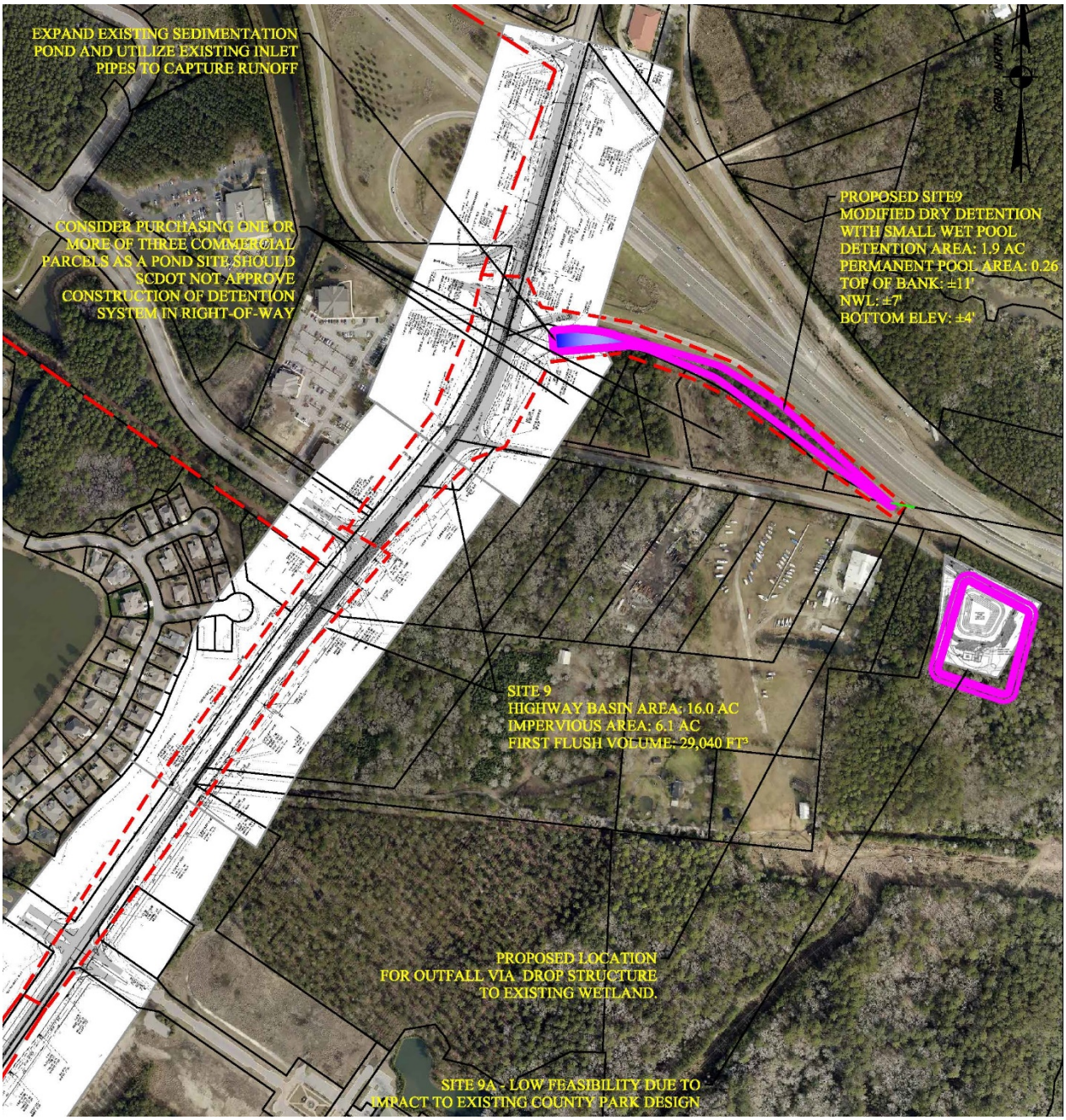

Figure 5-18 – Hwy 170 Retrofit Site 9

5.2.2.8 Water Quality Summary and Implementation

Table 16: Water Quality Results from SC170 Highway Retrofit Study

Site & Watershed	Water Quantity	First Flush	Phosphorus	Nitrogen	Bacteria	Volume Control
3 Okatie	Met (0 CFS)	Met (+0.3 Ac-ft)	Met	Not Met	Met	Not Met (-0.1 Ac-ft)
4 Okatie	Met (+5.17 CFS)	Met (+0.5 Ac-ft)	Met	Not Met	Met	Not Met (-0.3 Ac-ft)
5 Okatie	Not Met (-6.98 CFS)	Not Met (-0.2 Ac-ft)	Not Met	Not Met	Not Met	Not Met (-0.1 Ac-ft)
6A Okatie	Partially Met (-0.74 CFS)	Met (+0.5 Ac-ft)	Met	Not Met	Met	Met (0 Ac-ft)
7 Okatie	Met (+2.62 CFS)	Met (+0.5 Ac-ft)	Met	Met	Met	Not Met (-0.1 Ac-ft)
8 Okatie	Met (+4.45 CFS)	Met (+0.8 Ac-ft)	Met	Not Met	Met	Met (0 Ac-ft)
9 Okatie	Met (+16.63 CFS)	Met (+2.3 Ac-ft)	Met	Not Met	Met	Met (+0.3 Ac-ft)
Excess Area Untreated	Not Met (-9.03 cfs)	Not Met (-0.2 Sc-ft)	Not Met	Not Met	Not Met	Not Met (-0.2 Ac-ft)
Overall Combined	**Met (+12.12 CFS)**	**Met (+4.5 Ac-ft)**	**Met**	**Not Met**	**Met**	**Not Met (-0.5 Ac-ft)**

Note that the water quantity, quality, and volume control criteria were analyzed for each site individually, but the overall combined results are of equal importance. Although the projects are likely to be implemented separately and over an extended period of time, the County considers the combined sites when evaluating the overall effectiveness of retrofitting the highway widening project.

BMP Implementation Priority

The Highway 170 Widening Retrofits have varied priorities based on the individual sites. The sites closest to the Okatie West tributary should be implemented first, as they will have the greatest benefit. Site 6A will likely be the first since the County already owns the property and the project could be implemented at the same time as the Okatie West Regional Retrofit. Additional information on implementation recommendations are presented in Section 6.1

5.2.3 Irrigation Reuse Retrofits

The *Beaufort County Manual for Stormwater Best Management Practices* lists stormwater capture for irrigation reuse as an effective stormwater runoff volume control BMP. It is believed that flashy discharges of freshwater volume to saltwater rivers can negatively impact the die-off rate of bacteria by temporarily reducing the salinities in the receiving waters. Stormwater captured in cisterns, underground detention systems, and ponds can be stored and used as an irrigation source, reducing the total volume discharged offsite. A number of these reuse system have been implemented within the County in small scale and large scale applications. Two residential communities with golf courses within the Okatie River watershed are known to have reuse systems designed to pull water from the stormwater ponds and use it as the primary source for irrigation on their respective golf courses. Oldfield and Eagle's Point communities are the two communities with the golf course irrigation reuse systems and both have been studied to compare the pre-development and post-development runoff volumes. Both have found that their systems limit post-development runoff to less than pre-development conditions (*Oldfield Stormwater Runoff Volume Control Study* & *Eagle's Point Stormwater Water Quality Monitoring & Testing*). A similar system was implemented in the River Bend portion of Sun City as part of a prior 319 Grant for the Okatie River Watershed. Administered by the Lowcountry Council of Governments (LOCOG) in partnership with Beaufort County, the grant assisted the community in creating an irrigation system sourced from the community's twelve stormwater ponds (*Okatie River 319 Grant Project Closeout Report*).

There are other opportunities for small scale and large scale irrigation reuse systems to be implemented within the Okatie River watershed. There are two other residential golf course communities within the watershed that could construct similar systems. Other communities without golf courses could implement similar systems that draw water from their stormwater ponds and use it to irrigate common areas or perhaps even the private residential lawns. Institutional or recreational uses also provide excellent opportunities for irrigation reuse for common open space and athletic fields. Commercial developments could use similar systems to irrigate the landscaped areas, although commercial uses often have lower percentages of landscaping per acre than residential or institutional uses.

The County's current Volume Control Ordinance encourages use of stormwater capture for irrigation for new development and redevelopment, so it is expected than more of these systems will be used within the watershed. However, the County should look for opportunities to encourage or incentivize retrofits of these reuse systems on existing developments.

5.2.3 Existing Road Retrofits

There are over 19 miles of major SCDOT, Beaufort County, and Town of Bluffton roads within the Okatie River watershed. Most if not all of these roads were designed and constructed prior to current water quality and volume control regulations; meaning that most of the stormwater runoff from the associated impervious surfaces are collected and discharged directly to the receiving waters. This also means there are opportunities to incorporate non-regional BMPs into the road systems that will make small improvements in the runoff treatment and will reduce the runoff volumes reaching the Okatie

River. The potential non-regional project would be similar to what is being planned for the Highway 278 and Highway 170 widening project discussed in previous sections. Major roads with portions within the watershed include:

- Highway 170 (Okatie Highway)
- Highway 278 (Fording Island Road)
- Highway 462 (Lowcountry Drive)
- Old Bailey's Road
- Highway 141 (Argent Boulevard)
- Bluffton Parkway
- Hampton Parkway
- Buckwalter Parkway

Figure 5-19 shows the major road locations within the watershed. Potential non-regional improvements to existing roads include:

End of pipe improvements

The stormwater collection systems for the road each have a series of outfall points to the receiving waters or to ditches that drain to the receiving waters. There may be opportunities to install BMPs at the outfall points where the pipes do not discharge directly to saltwater critical area. These end of pipe improvements could include BMPs such as small wet detention systems, created wetlands, existing wetland enhancements, or bioswales. The type and size of the BMP would be dependent on topography and the amount of upland area available. These BMPs are the type of work that is being done for the Highway 278 and Highway 170 widening retrofits.

For areas where pipes discharge to freshwater wetlands, wetland enhancements would be the preferred BMP. The goal of enhancements is to modify the discharge from the freshwater wetland such that additional runoff from smaller storm events is stored in the wetland and dissipated through evapotranspiration. Improving the wetlands to increase the evapotranspiration will reduce the runoff volume reaching the receiving waters. Beaufort County has a regional retrofit project involving wetland enhancement in the Okatie River watershed. Referred to as "Okatie East", the project will enhance a large freshwater wetland system to reduce runoff volume. The project will be monitored to determine the effectiveness in improving water quality for bacteria impairments. If found effective, then the wetland enhancements will be used on smaller, non-regional scales in other watersheds throughout the County, such as the Battery Creek watershed.

Locations for end of pipe improvements currently have not been identified. An inventory and evaluation of all road drainage systems will need to be conducted to identify, catalogue and prioritize opportunities. Cooperation with SCDOT and adjacent property owners will be critical for these types of retrofits.

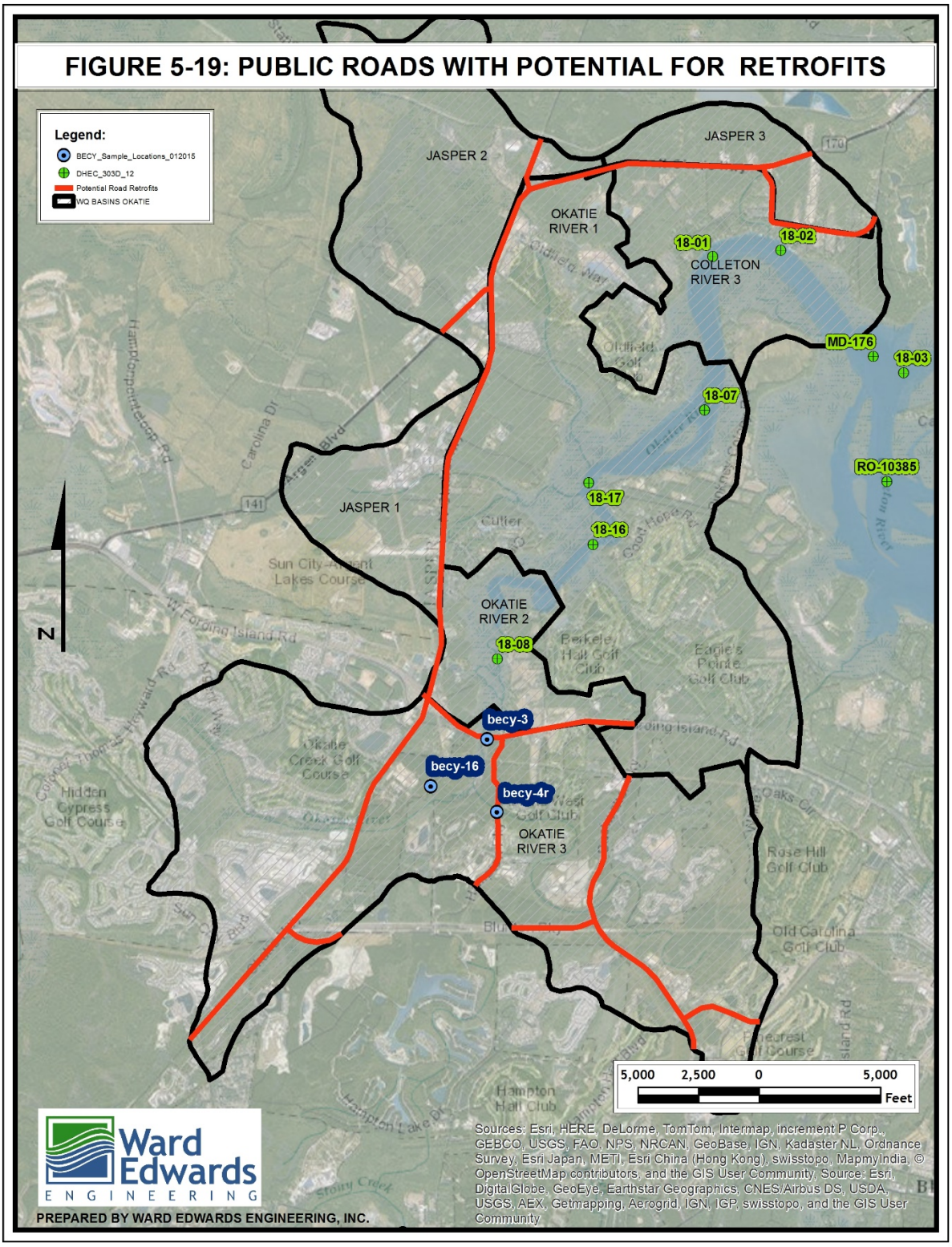

Figure 5-19 – Major Public Roads with Potential for Non-Regional Retrofits

Tree Boxes/Bioretention Boxes

The use of tree boxes or bioretention boxes is an effective method of addressing stormwater quality from existing streets and parking areas in highly urbanized areas. The boxes replace existing curb inlets with an inlet that incorporates landscaping such as trees or small shrubs. The boxes use an engineered soil media and carefully selected plants that function similar to bioretention systems or rain gardens. Collected runoff is temporarily stored in the soil media where it can be dissipated by infiltration and evapotranspiration. The boxes are sized to collect runoff from the smaller, more frequent storm events, while allowing the large runoff events to bypass and discharge normally to the storm sewer collection system. There are proprietary products available such as the *Filterra* box or systems can be custom designed. The boxes can be retrofitted alongside the existing curb inlets as shown in Figure 5-15; however it is unknown if these systems have yet to be used within SCDOT right-of-way, so permitting with SCDOT may be a challenge. These systems may be more useful and easier to implement on privately owned roads or roads owned and maintained by Beaufort County.

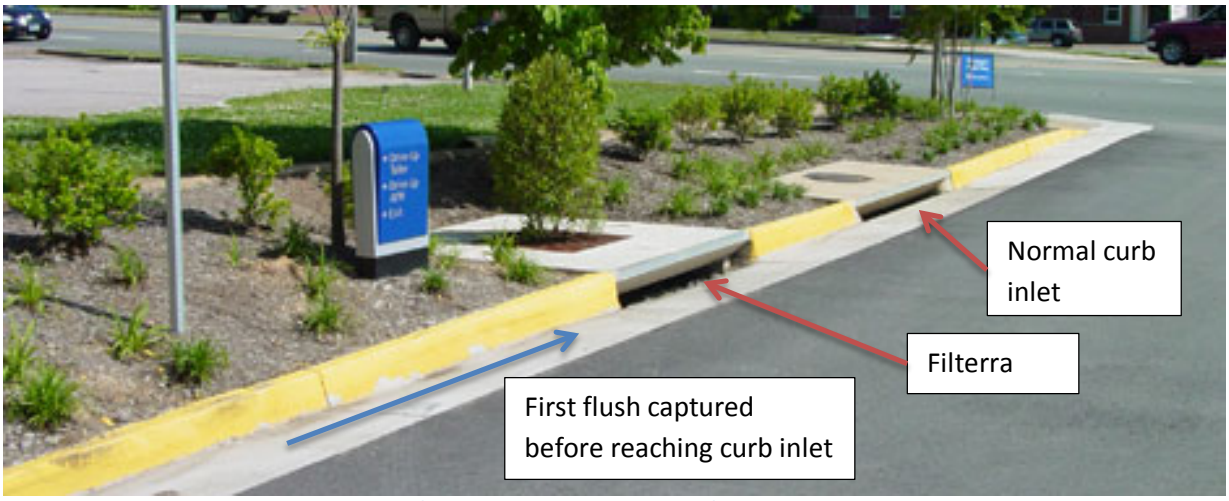

Figure 5-20 – Typical *Filterra* Installations (Picture from *Filterra* website)

Hydrodynamic separators and media filters

Hydrodynamic separators and media filters are proprietary water quality devices that can be connected to existing and proposed storm sewer collection systems. Hydrodynamic separators use baffles, veins and weirs to create vortices that facilitate deposition of suspended particles. They are effective at removing trash and sediment from runoff but their effectiveness at removing other pollutants is highly variable, depending on the installation, the pollutant concentrations, the type of pollutant, and the pollutants' interaction with sediment particles. Specifically, hydrodynamic separators are typically only effective for fecal coliform removal if the bacteria is attached to or associated with sediment particles. Given this, hydrodynamic separators are not likely to be used to directly achieve the goal of meeting the fecal coliform standards, but may be incorporated into designs to address secondary water quality concerns.

Media filters are another type of structure similar in function to hydrodynamic separators that are installed within a storm sewer collection system and are intended to treat the collected runoff. However, these structures include filtering components using sand or other proprietary media. Many units use replaceable cartridge filters within the structures, targeted to pollutants of concern. This makes them more effective than hydrodynamic separators at treating for bacteria. They are most effective for smaller drainage areas with low discharge flows. They also require more hydraulic head to operate properly, which is a challenge in the Beaufort and lowcountry region. They can be expensive to install, with high up-front materials costs, and can also be expensive to maintain due to media replacement costs. Use of hydrodynamic separators and media filters may not be feasible for this watershed, but will remain as a consideration given the right circumstances.

5.2.4 Cistern/Rain Barrel Programs

In areas where regional BMPs are not an option, the use of cisterns or rain barrels can help reduce runoff volume from residential rooftops. Cisterns are generally more effective than rain barrels because they provide greater storage volume and can capture runoff from multiple storms that occur in short periods; where rain barrels might fill up and not be drained prior to the next storm. However, cisterns are more expensive and require more installation space. Rain barrels are easier to implement by the homeowners without professional help. The use of rain barrels and cisterns by homeowners is usually dependent on education programs and material giveaway programs. The homeowners must regularly use the captured rainwater in order to provide storage capacity for the next rain event. Another roadblock to cistern and rain barrel programs are restrictions from home owners associations and restrictive covenants.

For example, LOCOG and BJWSA partnered as part of the previous 319 grant for the Okatie River watershed to implement a rain barrel program in the Sun City community. BJWSA was to provide rain barrels to residents in the community at a reduced price given a commitment from minimum number of houses. They were able to get enough households interested to meet the commitment, but the Sun City management was unable to administratively issue the special permits to each household, so the program was cancelled (*Okatie River 319 Grant Project Closeout Report*). A similar may be an option to pursue again at a later date if permit and HOA issues can be overcome. However, even on projects that are successful with getting rain barrels to resident, the successful operation and rate of return of these programs are difficult to evaluate. Due to the funding needs and the difficult evaluation, implementation of a rain barrel program may remain a low priority.

5.3 Preservation and New Development Policies

As discussed on Section 2.3, the undeveloped portions of the watershed will face development pressure in the near and extended future. The undeveloped greenfield parcels, particularly those with highway frontage, will face the greatest development pressure. It is possible that the municipalities will try to annex parcels and develop them at densities greater than the Counties would allow, which may results in greater runoff volumes. As discussed in Section 2.4, the assumed future conditions for the watershed show that the Level of Service will remain the same or degrade, even with full BMP coverages. If the watershed quality is to improve or at least avoid further degradation, future development will have to

occur at lower densities than predicted, and water quality regulations will need to be more stringent than what was predicted in the SWMP. Beaufort County's and Jasper County's runoff volume control standards have been added since the release of the SWMP, which is a step in the right direction, but preservation policies and efforts will have to be part of the management strategy as well.

5.3.1 Preservation Policies

Beaufort County, the Town of Bluffton, and Jasper County have historically been progressive in their policies on natural resource preservation. All three groups have ordinances that require natural open space preservation for developments, including stream and perimeter buffers. All value preservation of trees, wetlands, and other natural resources. Beaufort County has engaged in the process of implementing a new Form Based Code for development and re-development; however, the preservation policies should continue in the new codes. Among the many goals of the Form Based Code is the desire to create communities that preserve rural areas by clustering mixed use development and by encouraging infill rather than greenfield development.

Beaufort County citizens as a whole have been progressive about land preservation as well, and have voted for the Rural and Critical Lands Program, first enacted by Beaufort County in 2000. The program earmarks tax revenue for the preservation of identified parcels throughout the County. Preservation is achieved by fee simple purchase of land, purchase of conservation easements, and purchase of development rights. Overall, the program has preserved over 21,000 acres in Beaufort County and over 500 acres within the Okatie River Watershed.

As the County's Form Based Code are implemented and as the County and Municipalities set development priorities, the following preservation strategies should be considered:

- Riparian buffers should be provided along the Okatie River critical area and along the intermittent channels conveying runoff to the river
- Wetland should be preserved and restored and buffers along wetlands provided
- Transfer of Development Rights Program should be considered to allow further preservation of undeveloped land within the Okatie River and allow higher densities in less sensitive waters.
- Continuation of the Rural and Critical Lands Program
- Cooperation with the Town of Bluffton, the City of Hardeeville, and Jasper County on preservation of land within these jurisdictions.

5.3.2 New Development Policies

The most recent and perhaps most significant change to development policies is the stormwater volume control standards adopted by Beaufort County. As discussed in Section 5.0, the Volume Control standards were implemented in three phases and are intended to address water quality problems associated with non-point source pollution from land development. The first phase passed in 2009, requires all new development to limit post-development runoff volumes equal to or less than pre-development volumes. These standards apply to all projects regardless of use or size. The second phase, enacted in 2011, applies to residential lots that were subdivided prior to the 2009 Volume Ordinance, and have not been constructed yet. The third phase is the regional retrofit projects for

existing developments discussed in Section 5.1. The Town of Bluffton has entered into Inter-Governmental Agreements with Beaufort County, such that the County's volume control standards will apply to developments within the Town's municipality, although the standards are enforced in differing manners. Applying the volume control standards to new development will provide anti-degradation in the watershed. Applying volume control to re-development of existing non-conforming sites and to retrofit projects will help improve water quality in the watershed.

Jasper County has enacted a volume control ordinance for new development and re-development as well. Their standards don't apply to the "approved but not built" lots, but there aren't many of those in the Okatie River watershed.

Beaufort County should continue to work with Jasper County, the Town of Bluffton and the City of Hardeeville to unify standards within the Okatie River watershed. Other potential new development policies that Beaufort County should consider and promote to other jurisdictions include:

- Incentives or requirements for permeable paving in parking lots. The current development ordinances encourage permeable paving for sites to meet the maximum allowable impervious percentage requirements, but don't provide incentives to far reduce the overall impervious area. The Town of Bluffton's development ordinance requires that for sites with A or B soils, 50% of parking must be permeable paving. This typically results in lesser effective impervious percentages and less runoff volume.
- Incentives or requirements for recessed parking islands containing bio-swales or bio-retention. This requirement is best applied to sites with A and B soils, and can reduce runoff volumes through infiltration and evapotranspiration.
- Incentives or requirements to capture stormwater for irrigation reuse. This concept can be used for small and large projects alike and can also be used in large residential or commercial subdivisions. It is a very effective method to reduce runoff volumes reaching the receiving waters. As discussed in Section 5.2.3, there are a number of large planned communities in the watershed that have been using water from the stormwater detention ponds as irrigation for golf courses and residential common areas. Measured irrigation use data has demonstrated that millions of gallons a year are used from the ponds, significantly reducing the discharge to the nearby waters. These practices are current presented as one of many options to meet the County's volume control requirements, but aren't expressly required or incentivized.

5.4 Policies and Outreach

There are additional policies and outreach not associated with new development that can make an impact on water quality. Policies and outreach require public involvement during the development in order to ensure public buy-in. The County should continue to work with the other political jurisdictions to unify policies and public outreach. The following policies should be considered for implementation by Beaufort County, in cooperation with the other jurisdictions.

5.4.1 Homeowner Education and Policies

- Pet Waste Education: Pet waste is a recognized contributor to non-point source pollution, although the relative contribution compared to other sources is highly variable. It is difficult to estimate the exact magnitude that pet waste contributes to fecal coliform counts because of the many factors such as pet density, location, topography, land cover, and interaction with wildlife waste. Source tracking efforts within Beaufort County to quantify the relative contribution of pet waste versus wildlife waste has been inconclusive so far. Regardless, controlling pet waste through collection and proper disposal can make a positive impact on bacteria contamination. It is also one of the main ways for community members to be directly and actively involved in protecting their rivers. Education programs should inform residents of the importance of cleaning up after pets and the proper locations for its disposal. Policies that can be enacted include signage and pet waste stations at public parks, the creation of dedicated dog parks, and pet waste program requirements for planned development. The 319 Grant administered by LOCOG that was mentioned previously had a pet waste education component that was completed. LOCOG and Beaufort County partnered to do a pet-owner and POA education program in the Sun City community. The Grant Summary Report states that the Sun City Homeowners Association claims 100% compliance with the pet-waste disposal rules in the community. (*Okatie River 319 Grant Project Closeout Report*) Beaufort County could continue and expand upon the pet owner education program through its community outreach and education component of the Stormwater Utility.
- Septic Maintenance: The failure rates of septic systems are quite high in areas where soils are inadequate or where there are elevated groundwater conditions. System failures can result in untreated sewage reaching the nearby surface waters, resulting in high fecal coliform counts. Septic systems should be inspected every three to five years and cleaned as needed to prevent system failures. Education programs can remind homeowners to have their systems inspected and pumped. They can also instruct owners on proper waste disposal and on septic friendly products. However, the effectiveness of education programs is difficult to assess, so other policies may be needed. Septic questionnaires and inspection policies could allow municipalities to identify failing septic systems. However, residents often don't participate in the questionnaires and are reluctant to allow inspections of property. A more effective and less divisive policy is to simply work with the local sewer utility to extend public sewer to areas not served by septic. Public sewer extensions can be targeted to areas with poor soils and high groundwater elevations. Furthermore, ordinances for new development should prohibit new septic systems in areas where public sewer extension is feasible. The 319 Grant mentioned previously had a septic system repair and maintenance component. LOCOG worked with Beaufort County and Jasper County to identify septic systems in need of maintenance and repair within targeted areas near the River. The public response was mixed, with many residents expressing mistrust and misunderstanding of the program's goals. With persistent grassroots efforts and the support of a few residents, the grant partners were eventually able to repair or replace 40 septic systems. (*Okatie River 319 Grant Project Closeout Report*) Beaufort County

should continue to work with BJWSA develop a Okatie River Sewer Service Master Plan intended to extend sewer to areas currently served by septic systems.

- Rain Barrel Giveaway/Cost Supplement: Rain barrel giveaways or cost supplement programs can be a good way to get homeowners to use rain barrels. Such a program was done in the May River watershed in Bluffton, SC with good participation from residents. Beaufort Jasper Water and Sewer Authority has done reduced cost sale of rain barrels to encourage wise water use and reduce use of potable water being used for irrigation. However, installation of rain barrels does not guarantee their proper use. If homeowners are not using the captured water, the barrels can quickly fill and be bypassed during subsequent rain events. For this reason, rain barrel programs may not be the most effective use of funds beyond the educational and water quality awareness benefits.
- Riparian Buffer Education for Homeowners: With much of the banks of the Okatie River containing residential property, education to homeowners on the proper maintenance of riparian buffers could be effective in preserving and improving water quality in the river. Beaufort County already has policies on buffer preservation, but individual homeowner knowledge of those requirements are often lacking. Buffers are occasionally cleared of natural vegetation and replanted with turf grasses. Enforcement of the buffer policies is often difficult, as the only way the buffers are usually visible is from the water. Local officials often rely on neighboring citizens to inform them of possible buffer violations. Additional education efforts should be considered through homeowner workshops, correspondence with POA, and through the Beaufort County Stormwater Utility outreach program.

5.4.2 Illicit Discharge Ordinances and Inspection Plan

Jasper County, the City of Hardeeville, and the Town of Bluffton all prohibit illicit discharges as part of their development standards ordinances; however Beaufort County currently does not have an illicit discharge ordinance. Beaufort County is working on creating an IDO and implementing an inspection and enforcement plan. The Town of Bluffton also has inspectors and an enforcement plan. Although this is not expected to be a major contributor to the fecal coliform bacteria, the effect cannot be determined if it is not being examined. All four jurisdictions should continue to expand their inspection programs, possibly incorporating them with any existing or proposed construction inspection programs.

5.4.3 Engineer/Designer/Contractor/Owner Education Programs

Proper selection and design of stormwater BMPs by land planners, engineers and developers will be important to meeting watershed anti-degradation goals. There are a number of organizations such as the Center for Watershed Protection that offer frequent webcast on a variety of BMP design subjects. Over the past few years, the Beaufort County Stormwater Utility has hosted broadcast sessions of these webcast for local professionals and residents at no cost. This is an effective education program that takes advantage of recognized national experts. It is recommended that Beaufort County continue to offer these webcasts for the following subjects:

- Design of BMPs for volume control
- Selection and design of BMPs for effective pollutant removal

- Urban retrofit design
- Rainwater harvesting
- Sediment and erosion control
- Bioretention/rain garden design, installation and maintenance

5.5 Estimated Pollutant Reduction

The Beaufort County Stormwater Master Plan (SWMP) included extensive water quality modeling of basins throughout the County, including the Okatie River watershed. Modeling of the Okatie River watershed was included as part of the overall model for the Colleton River watershed, although the results were presented with smaller sub-basins delineated from the whole watershed. As discussed in previous sections, the Okatie River water quality modeling was performed assuming seven separate sub-basins. Three sub-basins were labeled as Okatie River 1 through 3 and included only the land within Beaufort County. One of the sub-basins was labeled as Colleton River 3 and included portions of the Okatie River and the Colleton River in Beaufort County. The remaining three were part of Jasper County and were labeled as such with numbers 1 through 3. The two regional retrofits originally proposed in the SWMP were proposed in water quality sub-basins Okatie River 3 and Colleton River 3. Okatie River 3 includes the Okatie East regional retrofit and the Okatie West retrofit was added as part of the *Regional Retrofit Study*. Colleton River 3 includes the Camp St. Mary's M2 regional retrofit.

As part of the County SWMP, the Watershed Management Model (WMM) was used to estimate the average annual runoff flows and the average annual loads of common pollutants including fecal coliform bacteria, total nitrogen, total phosphorus, lead, zinc, BOD and total suspended solids. The geometric mean bacteria concentrations in the runoff from the watersheds to the tidal rivers were also calculated in the WMM. The flows and concentration results were used in the Water Quality Analysis Simulation Program (WASP) which accounted for tidal mixing and bacteria loss within the saltwater rivers. The models were done for existing and future conditions. Future conditions were modeled for many different scenarios, including assumed worst case (no BMPs), assumed best case (100% BMP coverage), and for the proposed regional BMPs implemented. The best-case/worst-case scenario modeling was discussed in Section 2.4 of this report, but some of the results are repeated below.

The water quality modeling for the future conditions included estimated load reduction for the regional retrofit projects and for reduced septic tank coverage area. Table 17 and Table 18 show the estimated changes in septic tank coverage used between the existing conditions and assumed future conditions in the 2006 SWMP. Note that the SWMP predicted an increase in septic coverage throughout the watershed; however, new development standards in Beaufort County will require public sewer for all developments, so septic coverage should not increase.

Table 17 - Water Quality Septic Tank Coverage - Existing Conditions

Existing Land Use Type	Okatie River 1 (%)	Okatie River 2 (%)	Okatie River 3 (%)	Colleton River 1 (%)	Jasper County 1 (%)	Jasper County 2 (%)	Jasper County 3 (%)
Commercial	59 %	1%	0%	20%	0%	0%	0%
High Density Residential	0%	14%	0%	0%	0%	0%	0%
Industrial	22%	31%	26%	23%	0%	17%	0%
Institutional	0%	0%	0%	100%	0%	0%	0%
Low Density Residential	48%	80%	70%	80%	0%	100%	0%
Medium Density Residential	15%	0%	0%	14%	0%	100%	0%
Total	37%	52%	0%	34%	0%	42%	0%

Table 18- Water Quality Septic Tank Coverage - Future Conditions

Existing Land Use Type	Okatie River 1 (%)	Okatie River 2 (%)	Okatie River 3 (%)	Colleton River 3 (%)	Jasper County 1 (%)	Jasper County 2 (%)	Jasper County 3 (%)
Commercial	67%	25%	0%	14%	0%	0%	0%
High Density Residential	0%	14%	0%	0%	0%	0%	0%
Industrial	22%	31%	25%	23%	0%	17%	0%
Institutional	49%	0%	0%	100%	0%	0%	0%
Low Density Residential	54%	80%	49%	89%	0%	100%	0%
Medium Density Residential	31%	33%	0%	28%	0%	100%	0%
Total	45%	40%	10%	54%	0%	87%	0%

The average annual pollutant load results from the WMM for the existing conditions and future conditions are presented in Table 4 and Table 5 respectively in Section 2.4. The results include the full range of standard pollutants. Table 19 below shows the existing level of service related to fecal coliform contamination for the four water quality sub-basins within Beaufort County based on monitoring results Jasper County sub-basins were excluded from the SWMP Modeling results. Table 19 includes the associated SCDHEC monitoring stations, and the geomean and 90th percentile concentrations. Table 20 shows the modeled results comparing the level of service for the existing and future land use conditions. Note that the modeled results for existing conditions are close to the observed results from Table 19. The model results for the future conditions do not account for future retrofits or other management strategies. The results show an expected increase in geomean concentrations as the land use changes

from development and re-development. Note that the modeling results assume an increase in septic coverage which likely will not occur if Beaufort County zoning requires public sewer for any new development in the watershed. The results also don't take into account the newest regional retrofit projects.

Table 19 - Existing Level of Service for Okatie River Sub-basins from WMM Results

Water Quality Sub-Basin	SCDHEC Monitoring Stations	Fecal Coliform Concentrations				Level of Service
		Long Term Average		Maximum 36-Sample Values		
		Geomean (#/100 ml)	90th Percentile (#/100 ml)	Geomean (#/100 ml)	90th Percentile (#/100 ml)	
Okatie River 1	18-07, 18-16, 18-17	7.5	23	10.0	40	B
Okatie River 2	18-08	19.3	137	31.4	380	D
Okatie River 3	None	N/A	N/A	N/A	N/A	N/A
Colleton River 3	18-01, 18-02, 18-03	5.8	20	7.1	28	A

Table 20 - Fecal Coliform Modeling Results Comparing Existing and Future Conditions Assuming No New BMPs

Water Quality Sub-Basin	Fecal Coliform Concentrations			
	Modeled Geomean Conc. (#/100 ml)		Modeled Level of Service	
	Existing	Future	Existing	Future
Colleton River 1	3.0	3.6	A	A
Okatie River 1	6.6	13.8	A	D
Okatie River 2	12.0	34.6	D	D
Okatie River 3	35.8	118.6	D	D

The locations and proposed BMPs have been refined since the release of the SWMP, however the modeling has not been updated. ***It is expected that the refined and additional BMPs will produce higher reductions than predicted by the model results.*** The original model results and predicted pollutant reductions are presented in Table 21. Estimated pollutant reductions are provided for fecal coliform bacteria only, as it is the impairment within the Okatie River. Reductions for other pollutants are expected as well, but not modeled as part of this plan.

The predicted Levels of Service assuming the regional BMPs are implemented are presented in Table 22. Note that Level of Service for all of the basins did not improve; however, these model results from the SWMP don't account for the improved regional retrofit service areas, improved designs, and additional retrofits. They also don't account for non-regional efforts and implementation of the new volume control requirements. ***Beaufort County will be updating the SWMP in the next year or two, which should include new modeling that considers the improvements made since 2006.*** Full explanation of the modeling approach and results are presented in Section 2 and Section 6 of the 2006 *Beaufort County Stormwater Master Plan*, available from the Beaufort County Stormwater Utility.

Table 21 - Predicted Pollutant Reductions from Regional Retrofit Projects (from original SWMP)

Water Quality Basin ID	Regional Retrofit Site	Fecal Coliform Load (#/yr)	Fecal Coliform Removal (#/yr)	Existing Water Quality Basin Load (#/yr)	Water Quality Basin Bacteria Load Reduction (%)	Water Quality Basin Bacteria Geomean (#/100 ml)	Geomean with Regional Retrofits (#/100 ml)
Okatie River 3	Okatie East	4.21E+13	3.37E+13	6.50E+14	5%	964	914
Colleton River 3	Camp St. Mary's M2	7.12E+14	5.70E+14	1.83E+15	3%	1325	1284

Table 22 - Regional BMP Analysis Results and Predicted Levels of Service

Water Quality Sub-Basin	Modeled Geomean Conc. (#/100 ml)		Modeled Level of Service	
	Existing	Future With Regional BMPs	Existing	Future with Regional BMPs
Okatie River 1	7.8	7.7	B	B
Okatie River 2	15.7	15.0	D	D
Okatie River 3	47.2	44.8	D	D
Colleton River 3	6.0	5.9	A	A

Load reductions were modeled for regional retrofits and for changed septic tank use coverage only; however the other management strategies are expected to produce load reductions as well. Expected load reductions for fecal coliform are highly variable and generally unpredictable, particularly for non-regional BMPs and educational programs. Given the unpredictability in bacteria reductions, estimates for the non-regional BMPs were not made; however implementation of these strategies are of no less importance than the regional retrofit BMPs. The implementation plan, timeline, and milestones are presented in Section 6 of this report.

The pollutant removal predictions provided in Table 21 account only for the benefits from the regional retrofit BMPs. The other management strategies are expected to provide some benefit as well, but quantifying those benefits as percent removal efficiencies is difficult. Instead, typical pollutant reduction percentages are provided in Table 23.

Table 23 - Typical Pollutant Removal Percentages for Non-Regional BMPs, Policies, and Outreach

Strategy	Estimated Removal Effectiveness
Existing Road Retrofits – Pavement area reduction	Dependent on amount of impervious area reduced - Proportional to % impervious reduction
Existing Road Retrofits – End of pipe BMPs	Dependent on type and size of BMP 50% - 90% removal for service area*
Cistern/Rain barrel Programs	Unknown – likely proportional to runoff volume reduction
Homeowner & Professional Education Programs	Unknown – Expected to improve BMP design, installation, and maintenance of BMPs
Illicit Discharge Ordinances and Inspection	Unknown – Possibly large benefits dependent on illicit discharges discovered

*End of pipe removal efficiencies based on Beaufort County *Manual for Stormwater Best Management and Design Practices*

6.0 6.0 Watershed Plan Implementation

6.1 Phased Implementation Plan and Timeline

A phased implementation plan was developed while keeping in mind the primary objective of meeting the appropriate water quality standards for fecal coliform bacteria in portions of the river classified for shellfish harvesting. The implementation strategy is to focus initially on projects that will produce the best results for the least cost. The regional retrofits projects generally have high costs, but are also expected to produce good results, particularly in the headwaters. The phasing also considers strategies that will take time to implement, such as programs that will require public input, or retrofit projects that will require landowner cooperation. Projects such as these that will take longer to implement will begin early in the phasing process, but will finish later in the process as well.

The Phased Implementation Plan includes sixteen strategies/projects, broken down into short-term, mid-term, and long-term actions. Short-term actions are expected to be implemented within 1 to 2 years. These are generally time sensitive actions or actions needed to lay the ground-work for future actions within the individual strategy. Mid-term actions are expected to occur within the next 2 to 4 years, assuming the preceding short term actions have been completed. They generally involve program development for the longer-lived projects or securing funding and/or public support. Long-term actions are expected to occur 5 or more years away. They are often evaluation components of the short-lived projects or implementation of the longer-lived strategies. Long-term strategies are subject to the most change as short-term strategies and shorter lived projects alter the watershed needs.

1. **Hwy 278 Widening Pond Retrofits**: This project has been underway for a couple of years, with design and permitting complete and construction just beginning.
   Short-term actions: Project construction and closeout. Begin operation monitoring after completion of construction.
   Mid-term actions: The County doesn't plan to implement water quality monitoring of the ponds, as they are non-regional retrofit designed to provide water quality treatment were no BMPs were originally planned. However, the County will have to conduct routine post construction inspections to make sure the ponds are functioning as intended. For example, the County will need to make sure the normal water elevations are near the design elevations and that the ponds are drawing down to normal water levels within an appropriate amount of time after rainfall events. These are standard BMP inspection procedures that are important in making sure BMPs function as designed
   Long-term actions: Beaufort County will be responsible for long term maintenance of the BMPs to make sure storage volumes are maintained to design conditions.
2. **Okatie East Wetland Enhancement Monitoring & Refinement**: This project is currently being monitored and adjusted to get it to function as designed.
   Short-term action: Monitor flow from wetland and adjust canal gate as needed to optimize the wetland detention and function

Mid-term actions: Continue water quality monitoring downstream of the BMP for comparison to past pollutant concentrations. This information will be of use during the Stormwater Master Plan update and evaluating the BMP effectiveness.
Long-term actions: Beaufort County will be responsible for long term maintenance of the BMPs to make sure storage volumes are maintained to design conditions.

3. **Okatie West Regional Retrofit**: This project will serve the second half of the two headwaters tributaries, which is the portion of the watershed with the greatest need for treatment. Beaufort County recently acquired the land needed to implement the BMP, making this a high priority project that can be implemented soon.
   Short-term actions: Complete wetland delineation, design and permitting. Begin construction
   Mid-term actions: Monitor water quality results. This information will be used to determine the effectiveness of the regional retrofits and evaluate the pursuit of future regional retrofit projects.
   Long-term actions: Continue monitoring water quality results and maintain the BMP.
4. **Hwy 170 Widening Retrofit Site 6A**: This project is one of the lower cost non-regional highway retrofit projects that is within the sensitive headwaters portion of the watershed. It is proposed on land that the County recently purchased, meaning that it can be implemented soon.
   Short-term actions: Complete wetland delineation, design and permitting. Begin construction
   Mid-term actions: Monitor water quality results. This information will be used to determine the effectiveness of the regional retrofits and evaluate the pursuit of future regional retrofit projects.
   Long-term actions: Continue monitoring water quality results downstream and maintain the BMP.
5. **Illicit Discharge Ordinance**: Beaufort County is working on implementing an illicit discharge ordinance as part of their MS4 permit. Following adoption of the new ordinances, inspection and enforcement plans should be developed. The County's inspection and enforcement could focus on impaired watersheds such as the Okatie River, as they ramp up to full County coverage.
   Short-term action: Begin writing ordinances and start process of adoption.
   Mid-term action: Develop inspection and enforcement plan
   Long-term action: Implement and maintain inspection and enforcement
6. **Irrigation Reuse Retrofits**: This strategy involves encouraging or incentivizing the implementation of irrigation reuse in new developments or in retrofit of existing development. The County has a couple of success stories within the watershed that can be used as examples. This strategy would be effective at reducing the runoff volume without the use of land consuming structural BMPs. It will require public education and involvement; as well as potentially developing of new strategies and tools within the development ordinance.
   Short-term action: Gauge interest of property owners and property owner associations.
   Mid-term action: Develop plan for encouraging or incentivizing irrigation reuse.

7. **Septic System Program**: This program mainly involves encouraging the extension of public sewer into areas currently served by septic systems. Beaufort Jasper Water and Sewer Authority currently has a financing program to allow homeowner to spread the cost of connecting to public sewer out over a longer period of time. Infrastructure costs can be high and are typically born by BJWSA. CBDG funds may be available to extend sewer infrastructure into needy areas.
   Short-term action: Create the Okatie River Sewer Service Master Plan with BJWSA. Identify specific areas within the watershed that are currently served by septic and that would be well served by public sewer
   Mid-term action: Identify grants and funding sources. Develop partnerships between BJWSA and the respective municipality to drive implementation. Look for public-private partnership opportunities to fund projects.
   Long-term action: Implement funded sewer extension projects.
8. **Professional Education Program**: The Beaufort County Stormwater Utility has been offering free broadcasts of water quality related webcasts for residents and site development professionals. These webcasts benefit the area by improving awareness and knowledge of stormwater best management practices. The County should continue to offer these education programs and should look for other opportunities to educate the local professionals.
   Short-term action: Continue current webcast education program
   Mid-term action: Promote the webcasts to other professionals that may benefit from knowledge.
   Long-term action: Identify other education opportunities
9. **Hwy 170 Widening Retrofit Site 8**: This project is one of the lower cost non-regional highway retrofit projects that is within the sensitive headwater portion of the watershed. It is located near the Okatie West Regional Retrofit on property the County may be able to purchase.
   Short-term actions: Acquire property needed for the BMP
   Mid-term actions: Complete wetland delineation, design and permitting. Begin construction.
   Long-term actions: Monitor water quality results. This information will be used to determine the effectiveness of the regional retrofits and evaluate the pursuit of future regional retrofit projects. Continue monitoring water quality results downstream and maintain the BMP.
10. **Homeowner Education Program**: Topics recommended for the homeowner education program include pet waste disposal, septic system maintenance, and buffer maintenance. The Beaufort County Stormwater Utility has an education component to its administration, so the most efficient use of funds would be to continue the current education program and to incorporate the recommended subjects.
    Short-term action: Renew or refresh current Beaufort County Stormwater Utility
    Long-term action: Evaluate and refine education program based on homeowner reactions and needs.
11. **New Development Policies**: The new policies identified that may be of some benefit to anti-degradation efforts include incentives/requirements for permeable paving, requirements for recessed parking islands, and incentives for irrigation reuse. Incorporating these new policies

could be difficult and a lengthy process. It will likely take input from the public and will likely receive push-back from the development community. Not all policies recommended may be feasible or adoptable, and there may be other policies not mentioned that may be appropriate.
Short-term action: Gauge reaction from development community, politicians, and general public on new development standards
Mid-term action: Develop ordinance language and plan how to best incorporate into existing codes. Consider other policies as needed.
Long-term action: Adopt new development policies as feasible

12. **Hwy 170 Road Widening Retrofit – Other sites**: The Hwy 170 widening retrofit projects discussed in Section 5.2.2 should be implemented based on priority and as budgets allow. The relative priority of the sites compared to each other and compared to the other projects/strategies, will depend on the availability of the property needed to contain the BMPs.
Short-term action: work on acquiring the properties or easements needed for each site
Mid-term action: Budget and plan for BMP implementation as properties become available.
Long-term action: Design, permit, and construct BMPs.
13. **Aquifer Storage and Recovery**: This project requires further study into the feasibility and applicability to the watershed. It has potential to supplement the Okatie East and Okatie West Regional BMPs, and possibly to eliminate the need for other non-regional BMPs.
Short-term action: Feasibility study. Engage interest from potential partners such as Beaufort Jasper Water and Sewer Authority.
Mid-term action: If initial work finds the project feasible, being preliminary planning phases to locate the best possible site(s).
Long-term action: Design, permit, and construct BMP.
14. **Existing Road Retrofits**: As discussed in Section 5.2.3, there may be opportunities to retrofit non-regional BMPs to existing public roads within the watershed. These retrofit could be costly and would require the cooperation of SCDOT for any State owned roads, but the public roads are likely the largest amount of untreated developed area within the watershed.
Short-term action: Incorporate water quality BMPs into any new road improvement or widening projects
Mid-term action: Identify potential retrofit projects along existing public road identified in Exhibit 5-19.
Long-term action: Engage partners such as SCDOT and the Town of Bluffton to implement BMPs
15. **Camp St. Mary's M2 Regional Retrofit**: This is the regional retrofit proposed for the Colleton River 3 water quality sub-basin and is the most expensive retrofit to construct. This sub-basin is not a priority basin based on current and predicted Levels of Service. The feasibility of this retrofit will depend on the acquisition of the land needed. Given the implementation challenges and the cost, it is advisable that this retrofit follow after the previous regional retrofits if they fail to produce the improvements expected.
Short-term action: Gauge interest of property owner to participate in the retrofit.
Mid-term action: Perform additional feasibility study. Identify funding sources and grant opportunities. Acquire easements or property needed.

Long-term action: Implement BMP if monitoring results from previous work necessitates additional retrofits

16. **Rain barrel/cistern program**: The cost-benefit of this program is uncertain, given that residents often don't utilize and maintain the systems. However, it may be worth pursuing in time as homeowners become better educated on stormwater and water quality.
    Short-term action: None
    Mid-term action: Identify funding sources and partnerships to provide material costs and installations education to homeowners
    Long-term action: Implement give-away or cost sharing program.

6.2 Partnership Responsibilities and Funding

Beaufort County Stormwater Utility has led the water quality improvement efforts for the Okatie RIver watershed and for other watersheds throughout the County. They developed the Stormwater Master Plan that set the groundwork for the water quality monitoring that has occurred since 2007. The SWMP also provided the water quality modeling that helped predict the watersheds that might be best suited to regional water quality retrofits, and that provided the estimated pollutant reductions presented in Section 5.5. The stormwater Utility has been collecting stormwater fees for all properties within Beaufort County and using that money to lead improvements to water quality throughout. The Utility partners with the four Municipalities in the County through Inter-Governmental Agreements. 95% of the fees collected within the Municipalities by the Utility are distributed back to the Municipalities for their use in addressing drainage concerns.

Beaufort County will lead the efforts to improve and restore the Okatie River, but it will take the support and cooperation of the other three jurisdictions in the area; those being the Town of Bluffton, Jasper County, and the City of Hardeeville. The Beaufort County Stormwater Utility has led efforts to adopt more stringent water quality standards for development such as the runoff volume control requirements, and will continue to lead policies and programs related to water quality standards. The implementation of the MS4 program in the Bluffton area will involve some coordination and cooperation with the other jurisdictions, which will lay the groundwork for advancing unified water quality standards. The Utility has also led and will continue to lead water quality education programs throughout the County.

Beaufort County will administer the *Okatie River Watershed Management Plan* through the Stormwater Utility, creating partnerships with the Town of Bluffton, City of Hardeeville, and Jasper County as needed to implement strategies. The primary funding source for most projects will come directly or indirectly from the fees collected by the Stormwater Utility. The Utility has a reserve account, which can be used to directly fund projects such as the regional retrofits. Other funding sources for projects may include grants such as the 319 Grant Program, the State Revolving Fund, or support from local conservancy groups such as the Port Royal Sound Fund. The Beaufort County Rural and Critical Lands program may be able to acquire land needed for the regional retrofits, reducing the funds needed from the Utility for property or drainage easements.

Table 24 outlines the proposed strategies, the areas to which they will apply, the parties responsible for implementing the strategy, the estimated costs, and the potential funding sources. The estimated costs are conceptual in nature and are intended for project programming and budgeting purposes only. Costs for the Okatie West and the Camp St. Mary's M2 retrofit projects are from the Regional Retrofit Study prepared by Ward Edwards in 2011. Other costs provided are based on the best available information at the time of this report and subject to change. Costs should be re-evaluated and updated as milestones are reached and implementation phases are completed.

Table 24 - Partnership Responsibilities and Potential Funding Sources

Management Strategy	Location	Responsible Parties and Potential Partners	Estimated Cost	Potential Funding
Hwy 278 Widening Project	Okatie River 1, 2, & 3	Beaufort County	$350,000	County Stormwater Utility Fund
Okatie East Wetland Enhancement Monitoring	Okatie River 3	Beaufort County	$75,000	County Stormwater Utility Fund
Okatie West Regional Retrofit	Okatie River 3	Beaufort County	$1,320,000	County Stormwater Utility Fund + 319 Grant
Highway 170 Retrofit Site 6A	Okatie River 3	Beaufort County	$600,000	County Stormwater Utility Fund + 319 Grant
Illicit Discharge Ordinance	County-wide	Beaufort County,	$75,000 annual for inspectors & equipment	County Stormwater Utility Fund
Irrigation Reuse Retrofits	Entire Watershed	Beaufort County, Town of Bluffton(partner), City of Hardeeville (partner) & Jasper County (partner)	Unknown – Project dependent	County Stormwater Utility Fund + 319 Grant
Septic System Program	Entire Watershed	Beaufort County BJWSA (partner)	Unknown – Project dependent	Beaufort Jasper Water and Sewer Authority Capital Improvements + CBDG
Professional Education Program	County-wide	Beaufort County Town of Bluffton (partner)	$5,000 annual	County Stormwater Utility – Education Budget
Hwy 170 Widening Retrofit Site 8	Okatie River 3	Beaufort County	$950,000	County Stormwater Utility Fund + 319 Grant
Homeowner Education Programs	County-wide	Beaufort County	$15,000 annual	County Stormwater Utility – Education Budget

Management Strategy	Location	Responsible Parties and Potential Partners	Estimated Cost	Potential Funding
New Development Policies	County-wide	Respective Jurisdiction	N/A	N/A
Hwy 170 Widening Retrofit Remaining Projects	Okatie River 3	Beaufort County	$1,800,000	County Stormwater Utility Fund + 319 Grant
Aquifer Storage & Recovery	Okatie River 3	Beaufort County Town of Bluffton (partner) BJWSA (partner)	Unknown – Project dependent	County Stormwater Utility Fund + 319 Grant + BJWSA CIP + Research Grants
Existing Road Retrofits	Entire Watershed	Beaufort County, Town of Bluffton (partner) SCDOT (partner)	Unknown – Project dependent	Included in road construction costs – Example: County Transportation funding for highway widening
Camp St. Mary's M2 Retrofit	Colleton River 3	Beaufort County	$2,600,000	County Stormwater Utility Fund + Grants
Rain Barrel / Cistern Program	Entire Watershed	Respective Jurisdiction	$40,000	County SW Utility Fund or respective municipality budget

6.3 Interim Implementation Milestones

The Phased Implementation Plan as presented in Section 6.1 is separated into short-term, mid-term, and long-term actions, thus creating the overall implementation timeline. The actual implementation schedule will likely vary from the plan presented in Section 6.1 and will be highly dependent on funding, cooperation of property owners, permitting requirements, public input, and success/failure of preceding efforts. The schedule and implementation plan should be reevaluated and revised annually based on overall progress. Interim milestones provided below will be used to track the project success and to revise the implementation plan to aid in progression.

Interim Milestones

Year 1 – 3:

- Complete construction of Hwy 278 Widening retrofits
- Continue monitoring and optimization of Okatie East Wetland Enhancement
- Complete wetland delineation, design, and permitting for Okatie West Regional Retrofit
- Complete wetland delineation, design, and permitting for the Hwy 170 Widening Retrofit Site 6A
- Adopt illicit discharge ordinance
- Gauge interest of property owners and POAs on Irrigation Reuse
- Identify areas targeted for extension of public sewer
- 4 to 6 webcasts per year for professional education

- Acquire property needed for Hwy 170 Widening Retrofit Site 8
- Continuation of current Stormwater Utility education/outreach plan
- Complete list of potential development policy revisions for Beaufort County
- Acquire land for remaining Hwy 170 Widening Retrofit Projects
- Incorporate water quality BMPs into designs of any new public road improvements.
- Gauge interest of property owner to participate in Camp St. Mary's M2 Regional Retrofit
- Yearly updates to Okatie River Watershed Management Plan

Years 3 – 6:

- Continue BMP inspections of Hwy 278 Retrofit Ponds to make sure the ponds are functioning as designed.
- Continue monitoring and inspections of Okatie East Wetland Restoration
- Monitor water quality downstream of Okatie West Regional Retrofit
- Monitor water quality downstream of the Hwy 170 Widening Retrofit Site 6A
- Begin inspection and enforcement of illicit discharges
- Develop Plan for encouraging or incentivizing irrigation reuse
- Plan and fund sewer extension projects with BJWSA
- Continue 4 to 6 webcasts per year for professional education, adjusted with new webcast providers for a variety of knowledge
- Complete wetland delineation, design, permitting, and construction for Hwy 170 Widening Retrofit Site 8
- Continuation of current Stormwater Utility education/outreach plan
- Develop ordinance language and plan how to best incorporate into existing codes.
- Budget and plan for the remaining sites of the Hwy 170 Widening Retrofits
- Begin preliminary planning for Aquifer Storage and Recovery BMP
- Identify other potential road retrofit projects
- Complete feasibility study and prepare conceptual design of Camp St. Mary's M2 Regional Retrofit
- Identify funding sources and partnerships for rain barrel program
- Yearly updates to Okatie River Watershed Management Plan

Year 6 and beyond:

- Continue routine maintenance of Hwy 278 Retrofit Ponds
- Ongoing maintenance of Okatie East Wetland Restoration
- Ongoing maintenance of Okatie West Regional Retrofit
- Ongoing maintenance of the Hwy 170 Widening Retrofit Site 6A
- Continue inspection and enforcement of illicit discharges
- Implement funded sewer extension projects

- Continue 4 to 6 webcasts per year for professional education, adjusted with new webcast providers for a variety of knowledge
- Monitor water quality downstream of the Hwy 170 Widening Retrofit Site 8
- Continuation of current Stormwater Utility education/outreach plan
- Implement development ordinance revisions
- Design, permit, and construct remaining sites for the Hwy 170 Widening Retrofit BMPs
- Design, permit, and construct aquifer storage and recovery BMP
- Identify and implement other potential road retrofit projects
- Complete design, permitting and construction of Camp St. Mary's M2 Regional Retrofit
- Implement rain barrel program
- Yearly updates to Okatie River Watershed Management Plan

7.0 7.0 Watershed Plan Evaluation

7.1 Evaluation Criteria

The primary goal of the Watershed Management Plan is to address impairments for fecal coliform bacteria at the areas within the river currently restricted for shellfish harvesting. Given this, the primary evaluation criteria will be compliance with shellfish standards for bacteria at SCDHEC monitoring stations 18-07, 18-17, 18-16, and 18-08. If these areas are removed from "restricted" classification and moved to "approved", then the management plan could be considered a success. However, there are a number of other criteria that could be used to evaluate interim success and demonstrate the management plan is tracking with sufficient progression. The below list includes the primary evaluation criteria discussed above along with interim evaluation criteria.

Primary Evaluation Criteria:

- Area between shellfish monitoring stations 18-07 and 18-08 currently classified as "Restricted" re-classified to "Approved"
- De-listing of Okatie River from the 303(d) Impaired Water body List

Interim Evaluation Criteria:

- Gradual decrease and stabilization in fecal coliform bacteria counts at Beaufort County monitoring stations BECY-3 and BECY-16 after completion of the Okatie West Regional Retrofit.
- Gradual decrease and stabilization in fecal coliform bacteria counts at Beaufort County monitoring stations BECY-4r after refinement of the Okatie East Wetland Enhancement.
- Gradual decrease and stabilization in fecal coliform bacteria counts at Beaufort County monitoring stations BECY-3 and BECY-16 after completion of the Hwy 170 Widening Retrofit sites.

7.2 Monitoring Plan

Beaufort County currently has a monitoring plan in place based on the original recommendations of the *Beaufort County Stormwater Master Plan*. The monitoring plan has been revised over the years based on the refinement of the *Regional Retrofit Study* and analysis of the monitoring results. The monitoring has been conducted by GEL Engineering LLC since its inception. The current monitoring plan will continue to be funded by the Beaufort County Stormwater Utility, but will transition operation to the recently established University of South Carolina Beaufort lab. USCB will replace GEL Engineering as the party responsible for collecting and analyzing the data, but Beaufort County will remain in control of selecting monitoring locations. The County will pay the lab for the monitoring services and is also purchasing specialized equipment for the lab's operation.

The locations originally chosen for monitoring by the County were based on the water quality sensitivity analysis modeling completed as part of the SWMP. Also considered were the existing levels of service for water quality sub-basins, and the future land use classifications. The SCDHEC monitoring stations are located in open water locations, so it was decided that the County monitoring efforts would focus on tributary and BMP monitoring. The initial County program included 14 grab sample locations and 8 automatic samplers throughout the County. For the Okatie River watershed, there were originally three sampling locations, all of them collected as grab samples. The sampling locations have changed over the years as the monitoring plan was optimized. The locations currently being monitored in the Okatie River Watershed include BECY-3 (Okatie headwaters confluence), BECY-4r (Okatie East), BECY-16 (Okatie West. Past monitoring stations in the watershed that have been abandoned include BECY-4 (Eagle's Point) and BECY-5 (Camp St. Mary's M2).

All of the locations currently being monitored by the County are sampled for Ammonia-Nitrogen (NH_3), Biochemical Oxygen Demand (BOD_5), Total Cadmium, Chlorophyll-a, Total Chromium, Conductivity, Total Copper, Dissolved Oxygen (DO), Fecal Coliform, Total Iron, Total Lead, Total Manganese, Total Mercury, Total Nickel, Nitrate-Nitrite (NO_x), pH, Total Phosphorus, Salinity, Temperature, TKN, Total Organic Carbon (TOC), Total Suspended Solids (TSS), Turbidity, and Total Zinc. Samples are collected following a storm event that is greater than 0.1 inches in magnitude per hour and that occur at least 72 hours from a previously measurable storm event. Sampling is done once a month provided there is a qualifying rain event each month. Summaries of past results can be found in the annual reports prepared by GEL Engineering, LLC on the Beaufort County Stormwater Utility website (http://www.bcgov.net/departments/Engineering-and-Infrastructure/stormwater-management/water-quality-monitoring.php)

Table 25 lists the past and present sampling locations. Figure 7-1 shows the current and past monitoring stations, as well as the recommended future monitoring locations.

Table 25 - Past and Present Sampling Locations and Type of Sampling

Sampling Station Name	Location	Sampling Method	Purpose	Current Status
BECY-3	Okatie River Headwaters at East-West Confluence	Monthly Grab after 0.1 inches/hour of rainfall	Trend Analysis	Active
BECY-4	Eagles Point Pond Outfall	Monthly Grab after 0.1 inches/hour of rainfall	Trend Analysis and Existing Pond BMP Evaluation	Abandoned due to completion of pond evaluation
BECY-5	Camp St. Mary's M2 Regional Retrofit	Monthly Grab after 0.1 inches/hour of rainfall	Trend Analysis and Future BMP Evaluation	Abandoned due to low variability and high salinity
BECY-4r	Okatie East Tributary	Monthly Grab after 0.1 inches/hour of rainfall	Trend Analysis and BMP Evaluation	Active
BECY-16	Okatie West Tributary	Monthly Grab after 0.1 inches/hour of rainfall	Trend Analysis and BMP Evaluation	Active

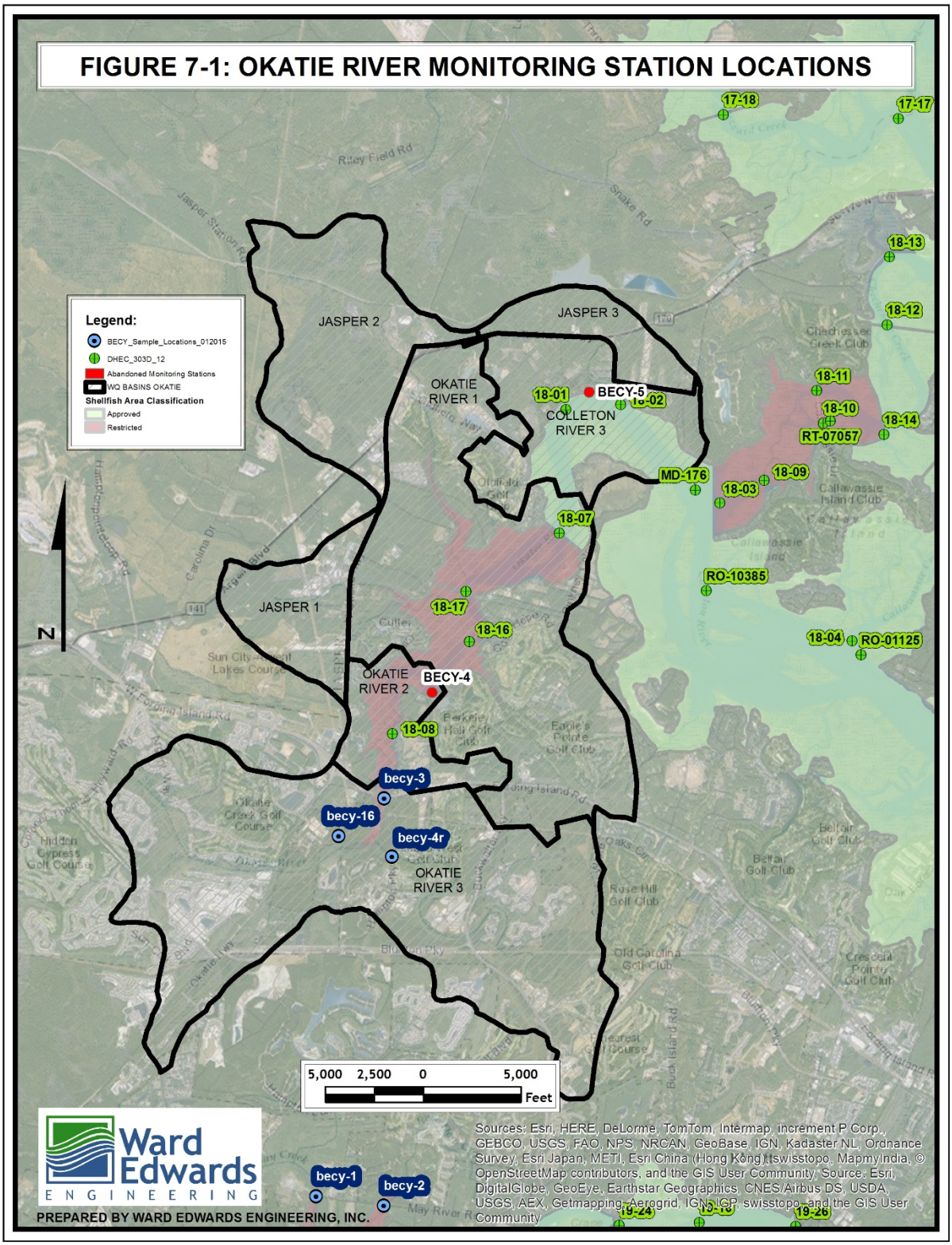

Figure 7-1 – Past, Present, and Future Beaufort County Water Quality Monitoring Stations

List of References:

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- *Beaufort County Special Area Management Plan,* SCDHEC – 2002
- *A Blueprint for Clean Water,* Beaufort County Clean Water Taskforce, 1997
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- *City of Hardeeville Comprehensive Plan 2009 Update* – 2010
- *Eagle's Point PUD Stormwater Water Quality Monitoring & Testing Summary,* Camp Dresser McKee, Inc. – 2006 Camp Dresser McKee, Inc. – 2009
- *Okatie River 319 Grant Project Closeout Report,* LOCOG - 2014
- *Okatie River Watershed Management Plan,* Applied Technology and Management Inc. – 2002
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