Improving Water Quality for an Island Community

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As development and tourism showed a steady increase in the last decade—barring the global stand-still due to the COVID-19 pandemic—the challenges facing Florida's coastal communities became more apparent and increasingly troublesome. Not only does the increasing interest in visiting and living in an "island paradise" lead policymakers to take a hard look at how to best handle the influx of people, but the increase in residents and visitors results in additional water quality issues that must be addressed.

As quaint beach communities become more developed and populated, stormwater systems are prone to be impacted and harmful pollutants are more likely to enter recreational and environmentally sensitive waters. In Florida the annual rainfall averages approximately 54 in., and rainfall is commonly highest from June through September. Rainfalls of more than 8 in. may occur during hurricanes and other naturally occurring events. Hurricane season starts in June, although recent trends have it starting in May and lasting until the end of October, overlapping the rainy season. The risk of severe coastal surge events further complicates coastal community concerns.

Many factors limit the ability to apply a wide-sweeping water quality approach that will address all the issues presented by increases in stormwater pollutants, such as nutrients, sediment, litter, and other waste. Opportunities to provide water quality treatment within public spaces can be extremely limited; these locations typically include parks, rights-of-way, or other municipal-owned properties. The topography of these communities, especially barrier islands, is low and flat and provides little to no relief for drainage. Additionally, the cost of property in these communities inhibits the purchase of repetitive-loss properties, and shallow ever-present groundwater inhibits these properties for usage as stormwater storage and treatment facilities.

Infrastructure in Fort Myers Beach

The town of Fort Myers Beach (town) is a prime example of one of these communities, being a barrier island located in southwest Florida on the Gulf of Mexico. See Figure 1 for a map showing the location of the town.

The existing stormwater infrastructure is typical for a coastal community first developed in the mid-20th century: no master planning of the area, limited drainage inlets, shallow swales, piped outfalls through private property, and narrow roadways with no crown or longitudinal slope. In many instances, the outfalls are historic and not located within recorded drainage easements. Consistent tidal backflow into the right-of-way slowly degrades the roadways and limits access to private property. Typical water quality treatment facilities, such as retention ponds, are few within the town's system.

The town was incorporated in 1995, and at that time, Lee County (county) transferred

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Figure 1. Location map of Fort Myers Beach.

Figure 2. The reFRESH Estero Boulevard project limits.

Figure 3. Outfall locations maintained by Fort Myers Beach.

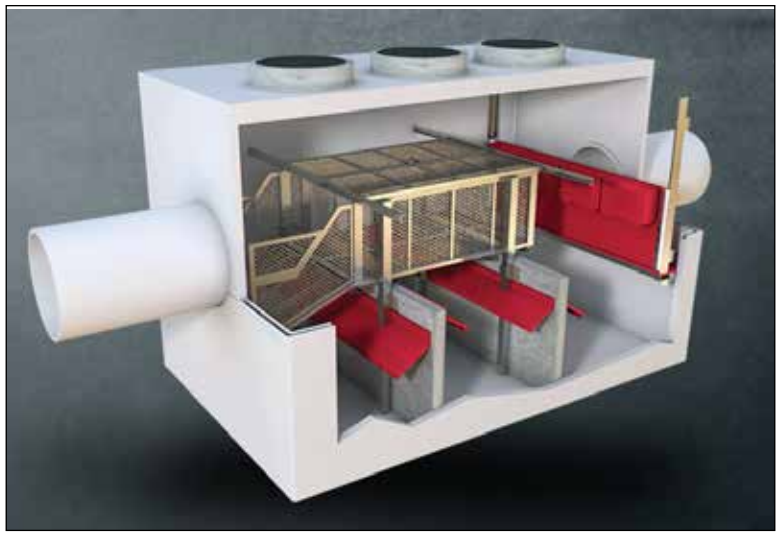

Figure 4. Nutrient-separating baffle box cross section.

Table 1. Treatment Flow Rates Provided by Oldcastle Nutrient-Separating Baffle Box

MODEL	SIZE (FT X FT)	MIN RIM TO INVERT DEPTH (FT)	MAX PIPE SIZE (IN)	TREATMENT FLOW RATES (CFS)		
				80% REMOVAL, 150 MICRON	50% REMOVAL, 75 MICRON NJCAT	TRASH CAPTURE
NSBB-4-8	4 x 8	4.5	24	4.60	2.49	28.80
NSBB-5-10	5 x 10	5.0	30	8.03	3.89	-
NSBB-6-12	6 x 12	5.5	36	12.70	5.60	42.80
NSBB-8-16	8 x 16	7.25	48	26.00	9.95	72.00
NSBB-10-20	10 x 20	8.0	60	45.40	15.56	197.20
NSBB-12-24	12 x 24	Varies	72	71.70	22.40	286.30

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the maintenance responsibility of the publicly maintained residential streets (side streets), downtown district, north segment of Estero Boulevard, and public drainage easements adjacent to these rights-of-way to the town. The county retained maintenance responsibility of Estero Boulevard (from San Carlos Boulevard to the south end of the island), and Amberjack Drive, the main thoroughfare of the island and a historic island ingress and egress roadway.

Generally, the island water quality design was intended to be swale drainage along the side streets, with intermittent connections to dredged canals. The town continues to experience flooding in many areas of the island. Existing storm drainage was either nonexistent or nonfunctional and lacked both drainage inlets and outfall connections, with little to no water quality treatment. Additional issues to the system were caused by tidal backflow (surges) and saltwater intrusion. Less than 30 percent of the town's roadways were maintained for stormwater and over 80 percent of the existing outfalls were undersized and failing. Additionally, private property owners' encroachments into the right-of-way further reduced the effectiveness of the swales and culverts. The shallow swales that were intended for stormwater capture/conveyance were filled in or disconnected from the out-falls.

With this information, the town updated its stormwater management plan. Along with the apparent need of stormwater improvements on the island, the state of Florida mandates that water quality improvements be made where possible.

The town recognized the problems that development and tourism present to water quality management and began taking measures in the late 2000s to address these issues within the right-of-way and existing easements, where possible, to develop cost-effective solutions, utilize proven technology, and secure the funding necessary to provide effective and environmentally beneficial water quality enhancement. The North Estero Improvement, constructed in 2009, included a slot drain system along the curb line and provided treatment via exfiltration chambers located within portions of the undeveloped right-of-way, the town-owned potable water storage, and the pumping site adjacent to the project limits.

ReFRESH Fort Myers Beach

In 2013, the town and the county commenced coordinated projects, dubbed reFRESH Estero Boulevard, to revitalize the infrastructure within the Estero Boulevard right-of-way from San Carlos Boulevard to the south end of the island.

This project includes potable water improvements performed by the town and sanitary and roadway improvements performed by the county. In conjunction with the county roadway revitalization, stormwater management facilities discharging to Estero Bay were provided by an enhanced town system.

This coordinated effort between the town and the county has provided an opportunity for improved water quality within the town through a wet exfiltration system constructed by the county and pollutant collection through sumped inlets and nutrient-separating baffle boxes. The town has undertaken the responsibility to provide an improved stormwater management system throughout the island, looking at each outfall individually, and determined what can be done to provide at least some level of pollutant removal prior to discharge into the bay. See Figure 2 for an illustration of the reFRESH project limits.

Where's the Money?

At the commencement of the reFRESH project, the town opted to utilize the funding mechanism provided through the Florida Department of Environmental Protection

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(FDEP) State Revolving Fund (SRF), with payback provided through a stormwater utility established by the town through resolution. As part of the SRF process, a facilities plan was developed to determine the scope, cost, and preferred design alternative for a townwide system. The town has also secured grant funding through other programs administered by state and federal governments, which includes a FDEP total maximum daily load (TMDL) grant, and multiple Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program (HMGP) grants.

In total, the town identified over $30 million in potential stormwater improvements, including swale reclamation, establishment of proper roadway grading, installation of collection and conveyance facilities to meet level of service goals, installation of water quality devices, and tidal backflow prevention measures to help reduce salt intrusion.

Treatment and Discharge

For the Estero Boulevard improvements, engineers for the county and the town worked together to determine effective outfall locations. The county performed modeling to determine the number and spacing of outfalls, while the town modeled basins and conveyance to determine pipe sizing. Locations were selected based on the Estero Boulevard improvements modeling results, with input from the town's engineers and staff to determine the feasibility of the joint system. Existing water and stormwater issues reported by the town were additional factors in selecting streets for infrastructure improvements. The facilities plan also considered three options for providing improvements to the remaining town to maintain right-of-way that had not been constructed.

Within the limits of the planning area for the facilities plan, the town is responsible for the maintenance of 132 acres of right-of-way. The combined residential and town right-of-way runoff area, which is a drainage basin area included in the plan, is approximately 409 acres; of this, approximately 10 acres have been identified as having no infrastructure. Fifty-nine basins, with a total area of 200 acres, contain a minimal amount of infrastructure (along 25 percent or less of the roadways); 18 basins, with a total area of 65 acres, contain a medium amount of infrastructure (along 25 to 75 percent of the roadways); and 29 basins, with a total area of 134 acres, contain the largest amount of infrastructure (along greater than 75 percent of the roadways). Private commercial development accounts for 320 acres of basin area and is responsible for its own stormwater management.

A majority of these developments drain to the bay and do not contribute runoff to the town's stormwater management system. The county right-of-way within the town totals 57 acres, which is solely Estero Boulevard right-of-way, and the total basin area that contributes to this area comprises 236 acres.

To provide the most-economical solutions to the deficiencies identified, alternatives were evaluated that would help reduce the cost of the project. Although the stormwater issues being experienced within the town are primarily caused by a lack of conveyance infrastructure within the system, the town continually desires to provide water quality treatment as a part of its overall plan; therefore, the alternatives explored in the plan had, as one of its main objectives, a means of treating the quality of the stormwater prior to discharge into the bay. In addition to improvement alternatives, a "no action" alternative was developed to determine the baseline costs of operating and maintaining the existing system.

Treatment Alternatives

The first of the improvement alternatives explored consists of the installation of nutrient-separating baffle boxes, or sediment boxes. These units are installed immediately upstream of basin outfalls with the purpose of collecting sediment, suspended solids, floating debris, and other pollutants prior to discharging to open water. Basins exceeding 3 acres in runoff area are proposed for installation of these devices.

The second alternative proposed in the plan involved the installation of exfiltration chambers within the town's right-of-way to impound stormwater runoff, provide water quality treatment, and reduce the peak flows into the receiving water body. In order to minimize the cost associated with this system, only areas with available right-of-way, but limited green space, as well as larger basins with peak flows above 13 cu ft per second (cfs), were selected as suitable for exfiltration chambers. See Figure 3 for a map of the outfall locations within the town.

Based on the life cycle analysis, the cost differential between the two alternatives was negligible; therefore, the sediment basin alternative was chosen due to its lack of recurring capital costs that would require additional construction, roadway closures, pavement replacement, and long-term maintenance/replacement of the system. Each street, however, is evaluated at the time of design and the most-appropriate method of improvement is made on a street-by-street basis.

For water quality improvements, 46 nutrient-separating baffle boxes, 11 grate inlet skimmers, and over 250 sumped inlets were proposed for treatment of stormwater runoff. As of the end of 2020, the town has completed the joint outfall phases of the reFRESH project, which includes retrofit stormwater improvements on nearly 30 side streets. These joint outfall drainage improvements provided upgraded infrastructure for 23 streets within the town, including over 20,000 lin ft of storm

Figure 5. Lower half of nutrient-separating baffle box.

Figure 6. Pollutants collected by a nutrient-separating baffle box.

pipe, 219 drainage structures, 23 nutrient-separating baffle boxes, and 26 tidal backflow devices.

The crux of the water quality treatment comes via nutrient-separating baffle boxes. These precast structures are fitted with the latest technology to separate and clean pollutants from runoff prior to discharge into the receiving waterbody. A study performed in 2010 entitled, "Final Report Baffle Box Effectiveness Monitoring Project DEP Contract NO. S0236," states that nutrient-separating baffle boxes averaged 67.2 percent total suspended solids (TSS) removal, 19 percent total nitrogen (TN) removal, and 15.5 percent total phosphorus (TP) removal. Table 1 provides treatment flow rate data for removal efficiencies of the Oldcastle Nutrient-Separating Baffle Box®, or Nutrient-Separating Baffle Box (NSBB™).

Figure 4 shows a cross section of the device illustrating the multiple treatment technologies included in the design. The NSBB technology was selected due to its low head/high flow application. Multiple technologies are included within the box that aid in the treatment of stormwater flows, which includes internal concrete baffles, turbulence deflectors, centrally located screen system, and Bold and Gold Media chamber and floating skimmers. Turbulence deflectors slow water down to enhance sediment capture and resistance to scouring.

The screen system is designed to rest above the static water column, which prevents any organic matter from leaching nutrients back into the water. Additionally, the screen system is centrally located, providing a significant amount of area for the water to bypass around to the sides or above the screen system so as not to cause flooding during large rain events. The media chambers contain a biosorption activated media that treats for TSS, TN, and TP. Additionally, floating skimmers are able to retain most, if not all, of the debris as their skimmer floats up and down with the water table.

Figure 5 shows the lower half of a baffle box prior to installation on Lazy Way in the town. Figure 6 shows the amount of pollutants that can be collected within the NSBB.

Summary

The town has seen tremendous growth and buildout over the past 50 years. Upon incorporation as a town, it inherited a stormwater management system that performed to bare minimum standards and provided little to no water quality treatment to stormwater runoff. As the town and the county have worked together to provide the residents and visitors with upgraded utilities, roadway, and stormwater infrastructure, it became paramount that water quality be included in the design to improve the ecosystem and meet the desires of the public and government regulation. Due to limited space to provide conventional stormwater treatment ponds, swales and sediment boxes have been installed to increase the level of benefit provided by the stormwater management system.

These improvements will not solve all of the flooding issues within the town, but major strides have been taken to improve the water quality and reduce the recovery time after storm events.