THREE BAYS STORMWATER MANAGEMENT PROJECT REPORT

EXECUTIVE SUMMARY

Association to Preserve Cape Cod, Horsley Witten Group and Town of Barnstable

June 2022

EXECUTIVE SUMMARY

The Three Bays stormwater management project was a six-year, $2 million project that supported planning, assessment, design, permitting, construction, and maintenance of green infrastructure best management practices (BMPs) within the watershed. The project completed a watershed scale assessment to identify and prioritize potential stormwater retrofits and provide a comprehensive stormwater management plan including 10% concept designs for 71 sites. This plan (with ranked and prioritized sites), along with community input, was used to inform selection of 10 sites for further survey work, development of existing conditions plans and initial design. Of these ten sites, seven were funded through to completion with a total of nine BMPs constructed including three bioretentions, a sand filter, a gravel wetland, and four dry swales (Table 1 and Figure 1).

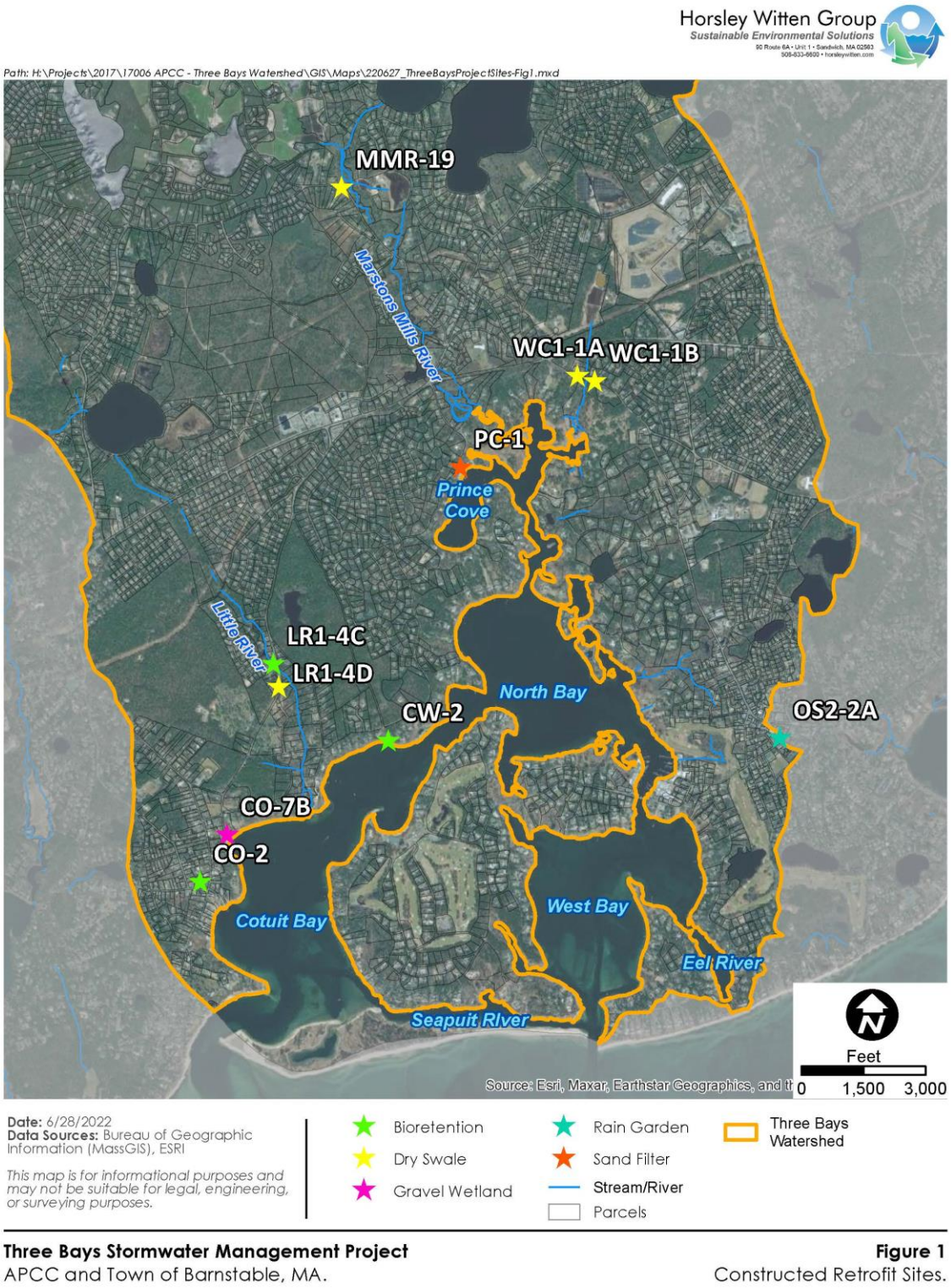
Table 1. Summary of Three Bays stormwater constructed BMPs sites and practices (2018-2022).

Retrofit ID	Site Name	Practice Type	Location (Address)
CW-1	Cordwood Landing	Bioretention	590 Cordwood Road, Cotuit, MA 02635
PC-1	Prince Cove	Sand Filter	0 Prince Avenue, Marstons Mills, MA 02648
CO-7	Ropes Beach	Gravel Wetland	85 Old Shore Road, Cotuit, MA 02635
LR1-4C	Putnam Avenue	Bioretention	16-52 Captain Isaiah Road, Cotuit, MA 02635
LR1-4D	Putnam Avenue	Dry Swale	325-451 Putnam Avenue, Cotuit, MA 02635
CO-2	Cotuit Library	Bioretention	871 Main Street, Cotuit, MA 02635
WC1-1C	South County Road	Water Quality Unit	1774-1812 South County Road, Osterville, MA 02655
WC1-1A&B	South County Road	Dry Swales	1774-1812 South County Road, Osterville, MA 02655
MMR-19	River Road	Dry Swales	465 River Road at Rosa Lane, Marstons Mills, MA 02648

The project was managed by the Association to Preserve Cape Cod (APCC) working in close coordination with the Town of Barnstable (Town). APCC managed project scope, schedule, and administration including grant expense and match reporting. APCC provided review of all technical documents and managed ongoing education and outreach throughout the project. The Horsley Witten Group (HW) was hired and managed by APCC as the stormwater engineer and completed all design, permitting, maintenance trainings, and joint construction oversight with the Town. HW put all sites out to bid and held the construction subcontracts. Both HW and the Town supported grant administration and reporting along with public meetings and outreach. Town staff provided technical review of all plans, permits, and bid specifications and assisted with coordination of local permitting as well as construction oversight.

The project was funded jointly by EPA Southeast New England Program (SNEP) Grants, Office of Coastal Zone Management (CZM) Coastal Pollutant Remediation (CPR) Grants and in-kind contributions from the project team and partners. The total project cost was $2,205,470 including $1,905,470 in grant expense and $300,000 in tracked in-kind match. Total in-kind contributions far exceeded this amount, but to limit the administrative burden on town staff, the bulk of their time and contributions were not tracked beyond the first two years of the project when complimentary SNEP and CPR grants were available for match. A total of three SNEP grants (FY16, FY18, FY19) were awarded to APCC and five CPR grants (FY18-FY22) were awarded

to the Town in support of this work. Table 2 provides a summary of constructed BMPs including year of construction, total drainage area addressed and estimated pollutant removal.



Three Bays Stormwater Management Project
APCC and Town of Barnstable, MA.

Figure 1
Constructed Retrofit Sites.

Table 2. Summary of the pollutant removal and construction expense for the Three Bays stormwater constructed BMPs (2018-2022).

Retrofit ID	Site Name	Practice Type	Construction Year	Drainage Area	Impervious Surface	Nitrogen Removal		Bacteria Removal		TSS Removal		Construction Cost	Construction Grant Funder(s)
				(ac)	*%*	*%*	*lbs*	*%*	*billion colonies*	*%*	*lbs*		
CW-1	Cordwood Landing	Bioretention	2019	1.4*	32	100%	13.1	100%	126.5	100%	398	$106,835	SNEP16
PC-1	Prince Cove	Sand Filter	2019	1.8	38	70%	14	86%	164	90%	539	$105,415	SNEP16
CO-7	Ropes Beach	Gravel Wetland	2020	0.25*	50	68%	2.2	76%	23.8	90%	88	$132,000**	SNEP16/18, CPR19/20
LR1-4C	Putnam Avenue	Bioretention	2020	0.3	56	32%	1.5	55%	25	90%	128	$65,250	CPR20/SNEP19
LR1-4D	Putnam Avenue	Dry Swale	2020	3.8	18	100%	23	100%	219	100%	685	$122,750	CPR20/SNEP19
CO-2	Cotuit Library	Bioretention	2020	0.17	96	100%	4.4	100%	42.3	100%	133	$179,000	SNEP18/19
WC1-1C	South County Road	Water Quality Unit	2020	4.7***	27	0%	0	0%	0	80%	687	$22,000	SNEP19
WC1-1A&B	South County Road	Dry Swales	2021	2.6	24	100%	12	100%	182	100%	513	$157,808	CPR21/SNEP19
MMR-19	River Road	Dry Swales	2022	1.1	32	100%	6.3	100%	96.4	100%	302	$148,659	CPR22/SNEP19
						Totals:	**76.5**		**879**		**3473**	**$1,039,717**	

**Drainage area quantity does not include the drainage area to an existing stormwater BMP that was retrofit during this project.*
***The amount listed is the cost of the BMP. The total project amount including additional demobilization/remobilization and wall repair costs was $214,263.15.*
****Total drainage area includes the 2.6 acres from WC1-1A&B. However, the TSS removal for the Water Quality Unit was calculated separate from WC1-1A&B.*

Education and Outreach

APCC managed education and outreach for the project, working closely with the Town and HW. The project was highlighted in APCC quarterly and annual reports, and APCC maintained an project webpage (www.apcc.org/threebays) which was updated in the spring of 2023 with final project materials and videos. The Town of Barnstable has also created a stormwater management webpage with links to the APCC Three Bays stormwater management project page and the Stormwater 101 video (https://barnstablewaterresources.com/stormwater/).

APCC worked with the Town of Barnstable Channel 18TV to outline and produce two educational videos geared toward the public: stormwater 101 and residential stormwater management. These two videos were in addition to an existing video created in 2018 documenting the Cordwood Landing BMP construction. In 2020, a fourth video, "Creatively Managing Stormwater," was completed with an APCC volunteer to promote the project and work at the Cotuit Library in particular, and HW produced the following video highlighting their work and several BMPs constructed with the Three Bays project: "Nature Based Solutions: An Introduction to Green Infrastructure."

The success of education and outreach to date can be measured in output of materials produced and estimated number of community members and individuals reached with public engagement. The following tables summarize the outreach materials produced, events hosted as well as estimated attendance and reach of in-person, print and online outreach to the public (Tables 3 and 4).

Table 3. Summary of outreach activities, events and videos along with estimated or actual number of individuals reached from 2018-2022. Activities highlighted in green involved direct outreach to homeowners to encourage eco-landscaping practices and reduction in fertilizer and other chemical applications.

Activity, Event or Material	Date	Estimated or Actual Attendance for Events	
Presentation of the Project at the Cape Coastal Conference	December of 2018	50	estimated total in attendance
Presentation of the project at the Restore America's Estuaries Summit	December of 2018	50	estimated total in attendance
Presentation to the Barnstable Association of Recreational Shellfishermen	February of 2019	25	estimated total members in attendance
Public meetings to review watershed assessment and "top 10" list of priority sites	February of 2019	30	estimated total members in attendance
Presentation at the Cape Cod Natural History Conference	March of 2019	300	total estimated in attendance
Eco-Landscape Lecture Series (3 lectures)	May, June, July 2019	160	total in attendance at in-person lectures
Presentation of the project and proposed 25% designs at the Cotuit Civic Association	August of 2019	30	total estimated in attendance
Cordwood Landing Construction, Stormwater 101 and Residential Stormwater Videos produced by Town of Barnstable CH18 TV	Released 2018, 2019, 2021	663	total views of videos to date as shared by APCC and Town on Vimeo and YouTube
Creatively Managing Stormwater Video produced by APCC volunteer	2020	171	views from APCC vimeo page

Presentation of project update at the Cotuit Civic Association	September of 2020	30	estimated in attendance for this virtual zoom meeting
Presentation at the Restore America's Estuaries Virtual Summit	October of 2020	50	estimated in attendance
Horsley Witten Group Video, Nature Based Solutions: An Introduction to Green Stormwater Infrastructure highlighting this project	November of 202	425	total views of video to date
Cotuit Library Garden Tour	June of 2021	100	or more in attendance that toured the Cotuit Library bioretention garden
Cape Cod Native Garden Lectures for the Cotuit and Sturgis Libraries	July of 2021	35	estimated in attendance for two virtual lectures by Kristen Andres of APCC
Five Year Project Celebration Event Hosted at the Cotuit Library with Tours of Installed BMPs	July of 2021	30	estimated in attendance at this small in-person invite only outdoor event
Rain Garden Workshop for homeowners at the Cotuit Library	August of 2021	8	total in attendance for this small format in-person outdoor workshop
Presentation of the Project and Lessons Learned for EPA Soak Up the Rain Webinar	April of 2022	174	total in attendance for this virtual webinar
TOTAL ESTIMATED REACH		**2,331**	
SUBTOTAL HOMEOWNER OUTREACH ON ECO-LANDSCAPING PRACTICES		**966**	

Table 4. Total outreach to members and followers from print and online outreach.

News and Online Outreach	Date	Total Numbers as of June 2022	
APCC membership	2018-2022	5,000	total reached with print and e-newsletters
APCC Facebook	2018-2022	4,341	total followers
APCC Instagram	2018-2022	1,303	total followers
Horsley Witten Facebook	2018-2022	402	total followers
Horsley Witten Instagram	2018-2022	392	total followers
Horsley Witten Newsletters	2018-2022	2,500	total reached with e-newsletters
Town of Barnstable Facebook	2018-2022	11,000	total followers
Town of Barnstable Instagram	2018-2022	1,466	total followers
Cotuit Library Facebook	2020-2022	1,523	total followers
	TOTAL	**27,927**	

Increasing Municipal Capacity

One of the objectives of this project was to increase municipal capacity to better address stormwater management in the Three Bays watershed, the town of Barnstable, and across the region.

Prior to the implementation of these systems, stormwater runoff in the Three Bays project area was largely untreated or minimally treated with catch basins. The addition of these BMP stormwater systems to the existing stormwater infrastructure has greatly increased the amount of TSS, bacteria, and nutrient removal before discharge to a river or estuary. The process has also heightened the Town's awareness of measures necessary to maintain BMP stormwater infrastructure since these systems are not what the highway division staff were previously

accustomed to maintaining. After these systems were constructed, it was apparent that the Town needed education, training, and communication to ensure adequate upkeep of these systems.

APCC and HW provided the Town with Operation and Maintenance Plans and hands-on trainings to help educate the Town staff on maintenance of these systems. However, staffing turnovers often resulted in the loss of maintenance reminders and maintenance of these systems would default to local notification that the system needed attention. Ultimately, the Town decided to create a reoccurring work order in the highway division's work order system that would occur at the various maintenance intervals, grouping similar maintenance needs at multiple systems. This work order process has helped the Town become more proactive and less reactive in maintaining these stormwater systems.

In addition, the Town also initiated an annual capital funding project for developing and implementing stormwater improvements at impaired ponds. This program seeks to implement low impact development and nature-based solutions where possible and provides a funding source that is able to help leverage grant requests. As a result of this funding and the Three Bays stormwater assessment and management plan, completed with this project, the Town will be advancing three additional sites through permitting, design, and construction.

As an outgrowth of regional maintenance trainings, the town of Eastham reached out to APCC with interest in support for stormwater management in their town. The Town of Eastham subsequently contracted with APCC and HW to assist with planning and design for stormwater BMPs to address runoff to Schoolhouse Ministers Pond. That collaboration is ongoing with 25% design plans completed for two proposed BMPs along Route 6 and construction of a smaller BMP at the town-owned Fisherman's Landing planned for 2022.

Growing interest to address stormwater, not only in coastal embayments but in freshwater ponds as well, along with a large inventory of stormwater project needs across the Cape, led APCC to pursue a new project to address stormwater runoff at priority public boat ramps across the region. Building on the successful model from the Three Bays stormwater project, APCC proposed to manage the project, hire the engineering consultant, and partner with town and state staff. This project, currently funded with a SNEP22 grant, has identified an initial set of 20 priority sites for field assessment in July of 2022. As was done with the Three Bays project, concept (10%) designs will be developed and all sites ranked, prioritized, and reviewed with the public and project team to inform final selection of up to five BMPs for development of permit-ready designs. APCC has also applied to CZM for FY23 funds to supplement this scope of work and include additional priority BMPs for design with the goal of replicating the successful funding approach from the Three Bays project. The long-term goal is to continue to partner with the towns to secure funding to advance sites through to construction.

Cordwood Landing Bioretention

Prior to construction the dirt landing frequently eroded, pushing sediment and bacteria into the bays contaminating nearby shellfishing areas. The existing space was dominated by invasive plants.

Improvements were made to an existing stormwater system upgradient adding concrete inverted dips to direct more flow from the road into the system and permeable paver forebays for easier maintenance.

An inverted directed flow to the new bioretention at the end of the landing, and porous pavers installed down to the water to reduce erosion and improve water access.

Construction was completed in spring of 2019. Invasives were removed, the parking space shifted over, and the bioretention garden planted out with native vegetation.

CORDWOOD LANDING BIORETENTION IMPACT REPORT

Receiving Water: Cotuit Bay
Total Drainage Area: 1.4 Acres
32% Impervious Surface
Estimated Pollutant Removal:
100% Nitrogen Removal
99.8% Bacteria Removal

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Prince Cove Sand Filter

Located adjacent to the Prince Cove Marina, land owned by the Barnstable Land Trust offered an opportunity to address a problem of sediment buildup and treat polluted runoff from the marina parking and roadway.

A sand filter with underdrain was constructed in early 2019 as part of the first round of construction projects completed.

A large forebay lined with porous pavers was installed to capture sediment for easy removal with the sand filter constructed behind the fence for treatment of stormwater.

The final landscaping transformed the area from a bare fertilized lawn to a colorful meadow helping to treat stormwater and support our local pollinators.

PRINCE COVE SAND FILTER IMPACT REPORT

Receiving Water: Prince Cove
Total Drainage Area: 1.8 Acres
39% Impervious Surface
Estimated Pollutant Removal:
70% Nitrogen Removal
85.7% Bacteria Removal

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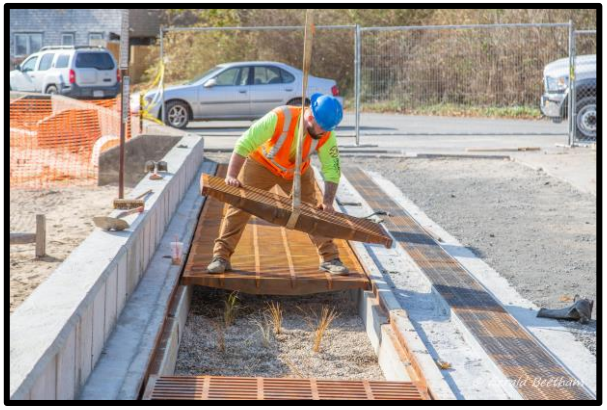
Ropes Beach Gravel Wetland

In 2019, a gravel wetland was constructed with a series of pre-cast concrete chambers installed below ground to minimize the space used for this system.



Salt marsh grasses were planted and protected with an overlaid grate to allow the public to walk directly over the system to the beach without damaging the plants.

Overflow from big storms flows to a series of infiltrating steps that also serve to improve pedestrian access down to the water.

This beach is popular for swimming and boating. The system was designed to preserve parking spaces, direct access, and unobstructed ocean views.

ROPES BEACH GRAVEL WETLAND IMPACT REPORT

Receiving Waters: Cotuit Bay
Total Drainage Area: 0.23 Acres
50% Impervious Surface
Estimated Pollutant Removal Swale:
68% Nitrogen Removal
76% Bacteria Removal

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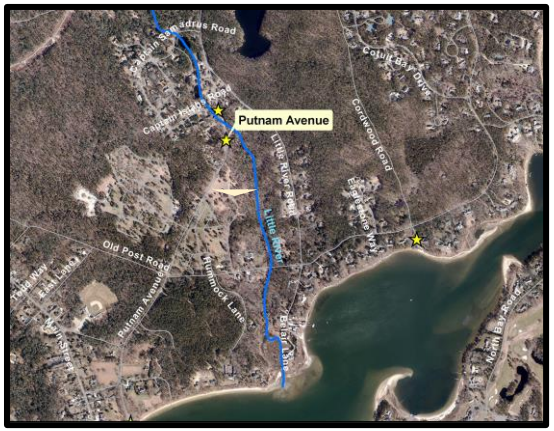
Putnam Avenue Dry Swale and Bioretention

In 2020, a dry swale was installed along Putnam Avenue to address road runoff flowing into Little River and Cotuit Bay.

Designed for low maintenance mowing, this swale was planted primarily with grasses and was showing off its colorful blooms one year later.



A smaller bioretention garden was installed along with the swale at the next intersection to treat additional runoff entering the river at this location.

The system was planted with grasses and other native plants. The rock monument was relocated to allow for access and maintenance by the neighborhood association.

PUTNAM AVENUE BMP IMPACT REPORT

Receiving Waters: Little River to Cotuit Bay

Total Drainage Area: 4.1 Acres

21% Impervious Surface

Estimated Pollutant Removal Swale:

100% Nitrogen Removal

100% Bacteria Removal

Estimated Pollutant Removal Bioretention:

32% Nitrogen Removal

55% Bacteria Removal

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Cotuit Library Bioretention

Constructed in 2020, this bioretention captures and removes pollution from stormwater runoff from the parking lot and portions of the library roof.

The design of this garden includes stepping stones and logs to allow people to interact with and explore the garden.

The diverse set of shade tolerant plants was paired with unique design features like decorative manhole covers to demonstrate how stormwater systems can be both functional and beautiful.

The final garden provides opportunities for ongoing outreach and education including tours for the public, rain garden workshops for homeowners, and story time with the library.

COTUIT LIBRARY BIORETENTION IMPACT REPORT

Receiving Waters: Cotuit Bay
Total Drainage Area: 0.17 Acres
96% Impervious Surface
Estimated Pollutant Removal Swale:
100% Nitrogen Removal
100% Bacteria Removal

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South County Road Water Quality Unit and Dry Swales

A water quality unit was installed in 2020 to remove sediment, trash, and other debris from road runoff before discharging to the stream.

Two dry swales with a series of check dams and basins designed for the slope of the land were constructed in 2021.

Additional stormwater runoff was directed into the swales through connection to existing catch basins across the road.

Final planting was completed in May of 2021 with grass and other native plantings for low maintenance.

SOUTH COUNTY ROAD DRY SWALE IMPACT REPORT

Receiving Water: Stream to Warren's Cove

Total Drainage Area: 2.6 Acres

23% Impervious Surface

Estimated Pollutant Removal:

100% Nitrogen Removal

100% Bacteria Removal

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River Road Dry Swales

A series of three small swales were constructed in the narrow right-of-way to capture and treat runoff before flowing into the Marstons Mills River.

An infiltration basin was installed along with the swales to provide additional treatment and a new manhole installed in the roadway to connect to existing stormwater infrastructure (see inset photo to the right).

Concrete curbing lines both sides of the swales, an innovative design component to fit within the limited space between the hill and underground utilities.

Final planting was completed in June of 2022 with native grasses and wildflowers for a low maintenance landscape.

RIVER ROAD DRY SWALES IMPACT REPORT

Receiving Water: Marstons Mills River to North Bay

Total Drainage Area: 1.1 Acres

30% Impervious Surface

Estimated Pollutant Removal:

100% Nitrogen Removal

100% Bacteria Removal

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