

Project: Yarmouth Comprehensive Stormwater Management Assessment
Municipality: Town of Yarmouth

Project Contact

Amanda Lima, Town Engineer
Department of Public Works
508-398-2231 Ext. 1253
Alima@yarmouth.ma.us

Partners: Association to Preserve Cape Cod (APCC) and Horsley Witten Group (HW)
Other Funding: USDA Natural Resources Conservation Service (NRCS) Cape Cod Water Resources Restoration Program funding supported construction at Standish Way
Project Webpage: <https://apcc.org/our-work/science/stormwater-management/yarmouth-stormwater/>

Completed Tasks & Lessons Learned

Task 1 Project Kickoff Meeting

A virtual meeting was held via Zoom in November 2023 with CZM, APCC, HW, and the Town of Yarmouth to discuss the project tasks, deliverables, and due dates. During the meeting, the role of the town, CZM, and project partners were identified.

Task 2 Site Survey and Existing Site Conditions

Horsley Witten Group completed site assessments at five priority retrofit sites throughout the fall and winter with Existing Condition Plans completed in February 2024 for: Baker Ave, Curve Hill Rd, Grove St, Lake Road West, and Standish Way. Soil test pits were conducted at each of the 5 sites, and the data is included in the stamped existing conditions plans. HW completed the wetland report for these top five sites in May 2024.

Task 3 25% Design Plans and Public Meeting

HW developed 25% design plans including drainage area maps, preliminary sizing, and hydrologic models for existing and proposed conditions for the five priority retrofit sites from March through June of 2024. APCC coordinated meetings with the project team including review of the first three sites in April, and the last two sites in May followed by an additional meeting with partners at the Cape Cod Conservation District (CCCD) for Standish Way, and a public meeting in June 2024 to gather input on all five priority sites and designs.

Task 4 75% Design

Incorporating input from the 25% design plans, project team feedback, and the public meeting, the project team selected the top two ranking sites (Curve Hill Road and Standish Way) for advancing. Both sites were advanced through design and permitting with CZM funding with Standish Way proposed for final construction supported by the CCCD and NRCS. HW completed the 75% designs in September 2024. The 75% designs included construction cost estimates and draft O&M plans for both Curve Hill Rd and Standish Way sites.

Additional scope was added in 2025 through amendment of agreements to spend down remaining funds including advancing the Grove Street site to 75% design. Horsley Witten provided draft revised design in September and final 75% design in October 2025.

Task 5 Permitting

APCC coordinated a meeting with the project team to review the 75% designs to prepare for permit applications in September 2024. Horsley Witten developed permit applications for Curve Hill Rd and Standish Way sites to submit as separate filings to the Yarmouth Conservation Commission. Horsley Witten sent notifications to property abutters as required and the town provided additional outreach to property abutters. Order of Conditions were received in October 2024.

As part of close-out of the project to spend down remaining funds, HW drafted permit application materials for Grove St in October 2025 and APCC coordinated a meeting for review with the project team along with 75% design plans.

Task 6 Final Design and Bid Documents

Horsley Witten prepared 95% design plans for review by the project team and incorporated edits into 100% designs including construction cost estimates, bid specification documents, and bid packages for the two priority sites at Curve Hill Road and Standish Way. Final design was completed for Curve Hill in November 2024 with the project put out to bid in January 2025. The 95% design for Standish Way was completed in December reviewed with project team in early 2026 and finalized in February 2025 for bidding. Construction for Curve Hill was aligned for funding with the CZM grant and Standish Way for funding by USDA Natural Resources Conservation Service (NRCS) so the two project were bid separately with additional design review by the CCCD and NRCS for Standish Way.

Task 7 Construction

The town of Yarmouth selected C.C. Construction as the contractor for Curve Hill Road and Dubis as the contractor for Standish Way. APCC, Horsley Witten, and the town of Yarmouth prepared for and participated in a pre-construction meeting for the sites, Curve Hill Rd in February 2025, and Standish Way in March 2025 (along with CCCD and NRCS). Construction for Curve Hill Road extended into July of 2025 and Standish Way was completed in June of 2025.

Additional scope of work was identified at Curve Hill Road during construction warranting replacement of existing drainage pipes and structures to connect flow from Great Western to the proposed constructed wetland at Curve Hill Road. Additional design work for Great Western was completed in June of 2025 and the project put out to bid in July. Following a bid protest and rebidding of the project Dubis was selected as contractor for the Great Western Road scope and a pre-construction meeting held in September 2025. Construction was completed over a three week period in October 2025.

The project team met for separate biweekly calls during construction for each of these three contracted projects. The town and Horsley Witten provided site management and construction oversight. Horsley Witten prepared eight inspection reports for Standish Way, five inspection reports for Curve Hill Rd, and two for Great Western Rd. Horsley Witten also provided a punch

list of remaining items, and as-built designs. As-builts and O&M plans were finalized in October 2025 with a final O&M training held on site on October 29, 2025.

Task 8 Grant Administration and Reporting

The town of Yarmouth provided administrative services, including review of contractor invoices, contractor payment, compilation of staff time and match contribution. APCC supported submission of all deliverables including the final project report. Horsley Witten Group was contracted with remaining funds in 2025 to update the CZM23 funded stormwater retrofit assessment with progress to date, additional stormwater concepts for sites identified in a Town Ways to Water Project, and revised the ranking of sites. APCC provided monthly invoices throughout the duration of the project timeline for APCC and Horsley Witten expense.

Lessons Learned

Due to an initial delay in the timing of the award notification and contracting between the town of Yarmouth, CZM, APCC and Horsley Witten Group the project schedule was adjusted at the time of project kick off in November 2023. The project team remained relatively on track with this revised schedule through permitting and design with only slight variations in actual date of some team and public review. With slight delays in the start of the project and complexity with multiple sites it was agreed that at various stages of design the development deliverables and review with the project team would be staggered. This was done for the five sites advanced through 25% design as well as the two priority sites selected for final implementation. Additional meetings and time were required in particular for review of the Standish Way site with partners at the CCCD and NRCS along with separate documents for permitting, final design and bidding due to the separate funding sources for construction. To keep the project on track and provide enough capacity to advance two sites through construction in the spring of 2025 the final design review and bidding was completed sequentially rather than as one project. For future projects with additional partners and funding sources, the team will need to anticipate these additional documents and time for technical review.

The final bids for both sites came in under the estimated construction cost which allowed for a surplus of funding in the CZM grant. The project team met with CZM and provided an amended scope and budget in the spring and fall of 2025 to adjust for this projected underspend. The project was able to utilize the remaining CZM funds to complete additional design and construction at Great Western Road, 75% designs and draft permit documents for Grove Street, and an update the Yarmouth Stormwater Report. However, to complete this additional scope and complete the construction of new drainage along Great Western connecting into the Curve Hill Road constructed wetland the grant required an extension through October of 2025. This extension was needed largely due to the prohibition of construction on roadways during the summer months. Despite a bid protest received for Great Western Road in the summer, the project team was able to rebid the project and work with the selected contractor to still complete the project on schedule.

Curve Hill Road BMP Summary

Location: Curve Hill Road, Yarmouth, MA (41.685778, -70.168468)

The main water quality BMPs constructed at Curve Hill Road include a water quality unit and constructed stormwater wetland to treat and manage runoff from a total drainage area of 13 acres, including 32% impervious surface (4.15 acres). The drainage area encompasses Curve Hill Road, as well as drainage captured through a series of catchbasins along Great Western Road. The water quality unit removes the majority of the sediment before the pretreated stormwater discharges to the constructed wetland. The constructed wetland is designed with three deep pools, connected by a series of micropools, with areas of low and high marsh. Excess stormwater that enters the constructed wetland overflows via a spillway. The design life of the constructed wetland is 20 years.

This project also included the construction of new drainage infrastructure to connect existing Great Western Road drainage to the water quality unit on Curve Hill Road underneath the roadway. This was done to abandon the existing 18" corrugated metal pipe located on private property with no Town easement for maintenance, which had conveyed the Great Western Road runoff to the area where the constructed wetland was built. The drainage infrastructure included three new manholes, the replacement of an existing manhole, and installation of 24" drainage pipe.

This constructed stormwater wetland system was built to treat the 1-inch storm, equal to 15,065 cf of runoff. Based on performance curves treating the 1 inch of runoff for the constructed stormwater wetland,¹ this system will remove 32% of the nitrogen², 53% of phosphorus³, 65% of bacteria⁴, and 80% of sediment⁵ for an estimated removal of 25.2 lbs of nitrogen, 6.0 lbs of phosphorus, 777 billion colonies of bacteria, and 2,997 lbs of sediment on an annual basis⁶.

Cost Summary

The total construction cost for the Curve Hill Road project was \$462,220. The cost for the constructed wetland without the drainage infrastructure for Great Western Road was \$299,000. The cost per unit pollutant removal each year calculated based on the constructed wetland cost alone is \$11,878/lb of nitrogen, \$50,200/lb of phosphorus, \$385/billion colonies of bacteria, and \$100/lb of sediment⁷.

Standish Way BMP Summary

Location: End of Standish Way, Yarmouth, MA 02673 (41.64734, -70.25586)

The green stormwater infrastructure (GSI) BMPs constructed at Standish Way include a water quality unit (for pretreatment), infiltration trench, and bioretention to address a total drainage

¹ It is important to note that these curves have a crosswalk to help users determine which specific curve to reference: for the constructed wetland, the appropriate curve is the Wet Pond Performance Curve.

² Estimates for nitrogen removal were sourced from the MS4 NPDES General Permit (USEPA, 2021).

³ Estimates for phosphorus removal were sourced from the MS4 NPDES General Permit (USEPA, 2021).

⁴ Estimates for bacteria removal were sourced from Paradigm Environmental (2019).

⁵ Estimates for TSS removal were sourced from the Massachusetts Stormwater Management Standards (MADEP, 2008).

⁶ Pollutant load reduction estimates were calculated using the Simple method, assuming a residential land use.

⁷ The cost per unit pollutant removal each year calculated based on the total project cost (\$462,220) is \$18,362/lb of nitrogen, \$77,604/lb of phosphorus, \$595/billion colonies of bacteria, and \$154/lb of sediment.

area of 0.98 acres, including 39% impervious surface (0.38 acres). In addition, the project removed 1,750 sf of impervious pavement (sidewalk) and replaced it with porous pavement.

A water quality unit with an open grate captures stormwater as it flows down the road, providing pretreatment to remove the majority of the sediment and oil and grease. The pretreated stormwater then discharges into an infiltration trench filled with stone and planted with native shrubs where it is filtered and infiltrated into native soils. The downgradient road runoff flows along the berm into a paved flume and sediment forebay for pretreatment, and then into a bioretention. The bioretention removes pollutants as stormwater filters through the bioretention soil and is taken up by the native plants. Overflows from these systems during larger storm events will continue down the road as they did in preconstruction conditions. The design life of the water quality unit, infiltration trench, bioretention, and porous pavement is approximately 20 years.

This system was constructed so that the infiltration trench would treat a 1-inch storm equal to 1,027 cf of runoff, and the bioretention was constructed to treat a 1-inch storm equal to 363 cf of runoff. Based on performance curves treating the 1 inch of runoff⁸, this system will remove 100% of the nitrogen⁹, 98% of phosphorus¹⁰, 100% of bacteria¹¹, and 85% of sediment¹² for an estimated 7.1 lbs of nitrogen, 1 lb of phosphorus, 107 billion colonies of bacteria, and 278 lbs of sediment annual loading¹³.

Cost Summary

The total cost of construction for the Standish Way Retrofit was \$131,301. The cost per unit pollutant removal each year is \$18,597/lb of nitrogen, \$132,837/lb of phosphorus, \$1,224/billion colonies of bacteria, and \$472/lb of sediment.

References:

Massachusetts Department of Environmental Protection (MADEP). 2008. Massachusetts Stormwater Standards Manual.

Paradigm Environmental. 2019. USEPA Memo. Tisbury MA Impervious Cover Disconnection (ICD) Project: An Integrated Stormwater Management Approach for Promoting Urban Community Sustainability and Resilience - Task 4D. Develop Planning Level GI SCM Performance Curves for Estimating Cumulative Reductions in SW-Related Indicator Bacteria.

USEPA. 2021. National Pollutant Discharge Elimination System (NPDES)-General Permits for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems in Massachusetts (as modified).

⁸ It is important to note that these curves have a crosswalk to help users determine which specific curve to reference: for the infiltration trench, the appropriate curve is Infiltration Trench with 2.41 in/hr infiltration rate; and for the bioretention, the appropriate curve is the Infiltration Basin Performance Curve with 2.41 in/hr infiltration rate.

⁹ Estimates for nitrogen removal were sourced from the MS4 NPDES General Permit (USEPA, 2021).

¹⁰ Estimates for phosphorus removal were sourced from the MS4 NPDES General Permit (USEPA, 2021).

¹¹ Estimates for bacteria removal were sourced from Paradigm Environmental (2019).

¹² Estimates for TSS removal were sourced from the Massachusetts Stormwater Management Standards (MADEP, 2008).

¹³ Pollutant load reduction estimates were calculated using the Simple method, assuming a residential land use.

Curve Hill Road Constructed Wetland



Before: Curve Hill Road site before construction showing large overgrowth of brush and invasive vegetation. Credit: Gerry Beetham for the Association to Preserve Cape Cod.



During: Curve Hill Rd after clearing of existing vegetation (left) and following construction of wetland pools during planting (right). Credit: Gerry Beetham



After: Curve Hill Rd following construction completion. Credit: Gerry Beetham

Great Western Road – Infrastructure Improvement and Replacement to Direct Drainage to Curve Hill Road Constructed Wetland



Before: Site assessment showing intersection of Great Western Road (at right) draining down gradient to Curve Hill Road (left) and the proposed location of the constructed wetland to the far left outside of the image. Credit: Gerry Beetham



During: Installation of new infrastructure at Great Western Road including deep manholes and piping (left – Credit: Horsley Witten Group) and repaving of the area from Great Western down Curve Hill Road (right – Credit: Gerry Beetham) to connect to the constructed wetland.



After: Underground drainage indicated by newly paved area to replace failed pipe connection from Great Western (right of image) to Curve Hill Road (left side of image). Credit: Gerry Beetham

Standish Way “Tree” Trench and Bioretention Construction



Before: Standish Way before construction looking toward Lewis Bay at location of proposed tree trench (left) and upgradient away from Lewis Bay at the proposed location of the bioretention (right). Credit: Gerry Beetham



During: Underground pipes being installed at Standish Way to connect the catch basin and water quality unit to the tree trench (left) and planting of the bioretention (right). Credit: Gerry Beetham



After: The final porous pavement sidewalk, established plantings and grass, the tree trench planted with shrubs connected to the storm drain shown in the foreground (left) and the bioretention planted with grass behind the stone edging to the roadway (right). Credit: Gerry Beetham