Long Creek General Permit

Annual Report 2021

LONG CREEK
WATERSHED MANAGEMENT DISTRICT

Long Creek Watershed Management District
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Introduction and Background

This report has been prepared in fulfillment of Part IV.A of the Maine Department of Environmental Protection's ("Maine DEP") *General Permit — Post-Construction Discharge of Stormwater in the Long Creek Watershed*, Waste Discharge License #W-9052-5Y-B-N, dated April 15, 2015 (hereinafter referred to as the "Long Creek General Permit"), which states as follows:

> *"Annual progress reports shall be submitted by the permittee no later than May 31st of each calendar year and will include activities of the previous calendar year. The Long Creek Watershed Management District may submit an annual report on behalf of all permittees participating in the Plan."*

Where is Long Creek?

Long Creek is a meandering urban stream system with four primary branches that converge before flowing into Clark's Pond in South Portland, Maine. The Long Creek Watershed encompasses 3.5 square miles in a commercial, residential, retail, and recently, increasingly residential, district located in four municipalities: Portland, Scarborough, South Portland, and Westbrook. The watershed with respective landmarks is illustrated in **Figure 1**.

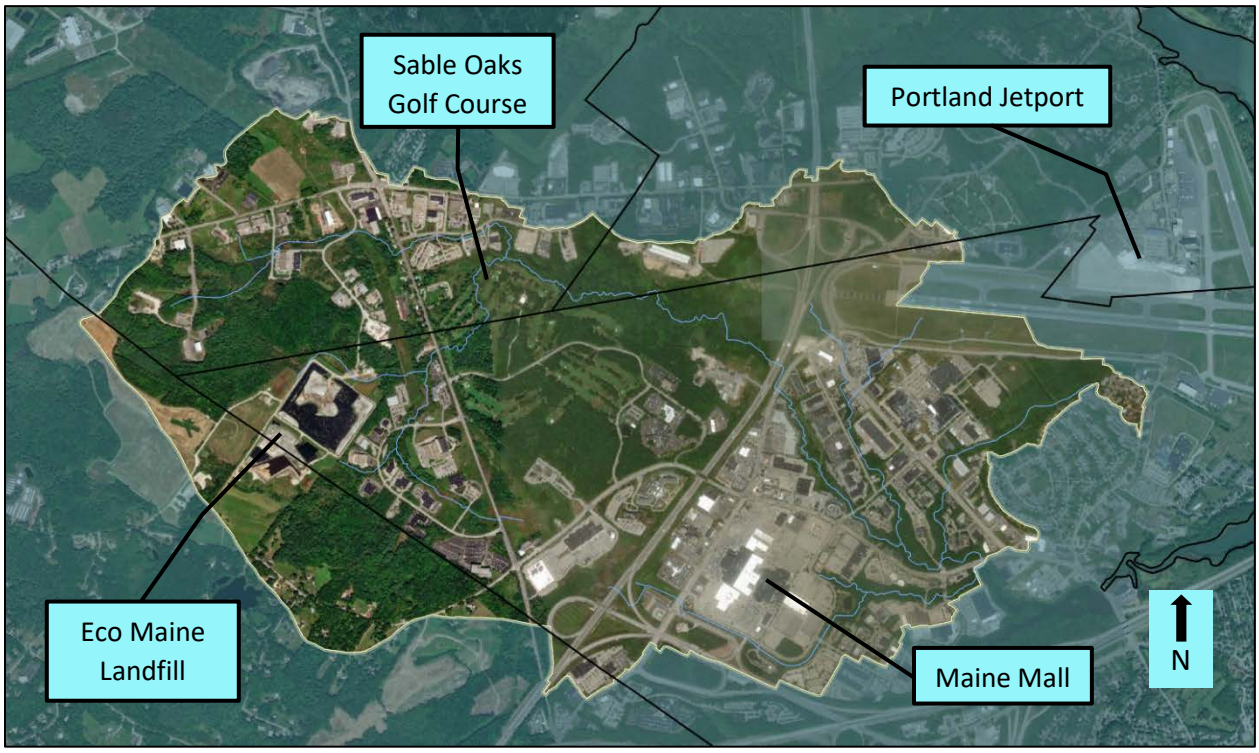

Figure 1 *Long Creek Watershed Overview Map*

Why is Long Creek Regulated?

Long Creek is an urban stream system that is classified by the Maine Water Classification Program as partially a Class B, and primarily a Class C, stream. Portions of Long Creek currently do not meet state water quality standards established for Class B streams which,

> *"must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; navigation; and as habitat for fish and other aquatic life. The habitat must be characterized as unimpaired"*

and Class C Streams, which,

> *"must be of such quality that they are suitable for the designated uses of drinking water supply after treatment; fishing; agriculture; recreation in and on the water; industrial process and cooling water supply; hydroelectric power generation, except as prohibited under Title 12, section 403; navigation; and as a habitat for fish and other aquatic life"*

as provided for in Maine law, 38 M.R.S.A § 465(3)(A) & (4)(A).

Long Creek has been the subject of many studies and reports. What the data suggests is twofold:

1. As stated in the Long Creek Restoration Project Executive Summary, *"[y]ears of urbanization have significantly impaired the stream's health, as well as its ability to support recreation and wildlife, such as brook trout."*
2. The Long Creek Watershed Management Plan ("LCWMP") identified that water quality impairments are a result of increased concentrations of metals, chloride, phosphorus, nitrogen, polycyclic aromatic hydrocarbons, and reduced dissolved oxygen concentrations.

Historically, there have been very few regulated point source discharges and stormwater controls (*i.e.*, water quantity and quality) in the watershed. Over the years, increasing stormwater discharges from the built environment have contributed to degraded water quality. Increased water temperatures from lack of shading in certain areas and altered hydrological conditions have also adversely affected stream health and water quality.

In 2009, the U.S. Environmental Protection Agency ("EPA") exercised its authority under a provision in the Clean Water Act, known as Residual Designation Authority ("RDA"), requiring a permit for the discharge of stormwater for designated discharges in the Long Creek Watershed. The EPA's designation requires permits for *"[s]torm water discharges from properties on which there are impervious surfaces or areas equal to or greater than one acre in the Long Creek watershed."* This precedent-setting use of the RDA provision led to the establishment of the Long Creek Watershed Management District ("LCWMD") to implement the LCWMP and to a corresponding annual fee paid by permittees to fund implementation of the plan.

Impervious Cover

As defined in EPA's designation, "impervious surface" or "impervious area" (hereinafter collectively referred to as "Impervious Cover" or "IC") means:

"the total area of a parcel or right-of-way that consists of building and associated constructed facilities; areas that are covered with a low-permeability material such as asphalt or concrete; or areas such as gravel roads and unpaved parking areas that are compacted through design or use to reduce their permeability. Common impervious areas include, but are not limited to, roads, rooftops, walkways, patios, driveways, parking lots or storage areas, concrete or asphalt paving, packed earthen materials, and macadam or other surfaces which similarly impede the natural infiltration of storm water."

In the Long Creek Watershed, the amount of IC on a property is used to determine whether a discharge of stormwater is regulated and, if so, to assess annual fees for implementation of the LCWMP under the Long Creek General Permit. In general, IC is also used as a measure of watershed and stream health. Key figures for the watershed are as follows:

- Watershed size is 2,305 acres (3.5 square miles)
- Length of stream is approximately 10 miles
- Total IC is 736 acres (32% of watershed)
- Regulated IC is 615 acres (84% of IC in watershed)[1]

Regulated IC includes parcels with one acre or more of IC. Parcels with less than 1 acre of IC are not required to obtain a permit.

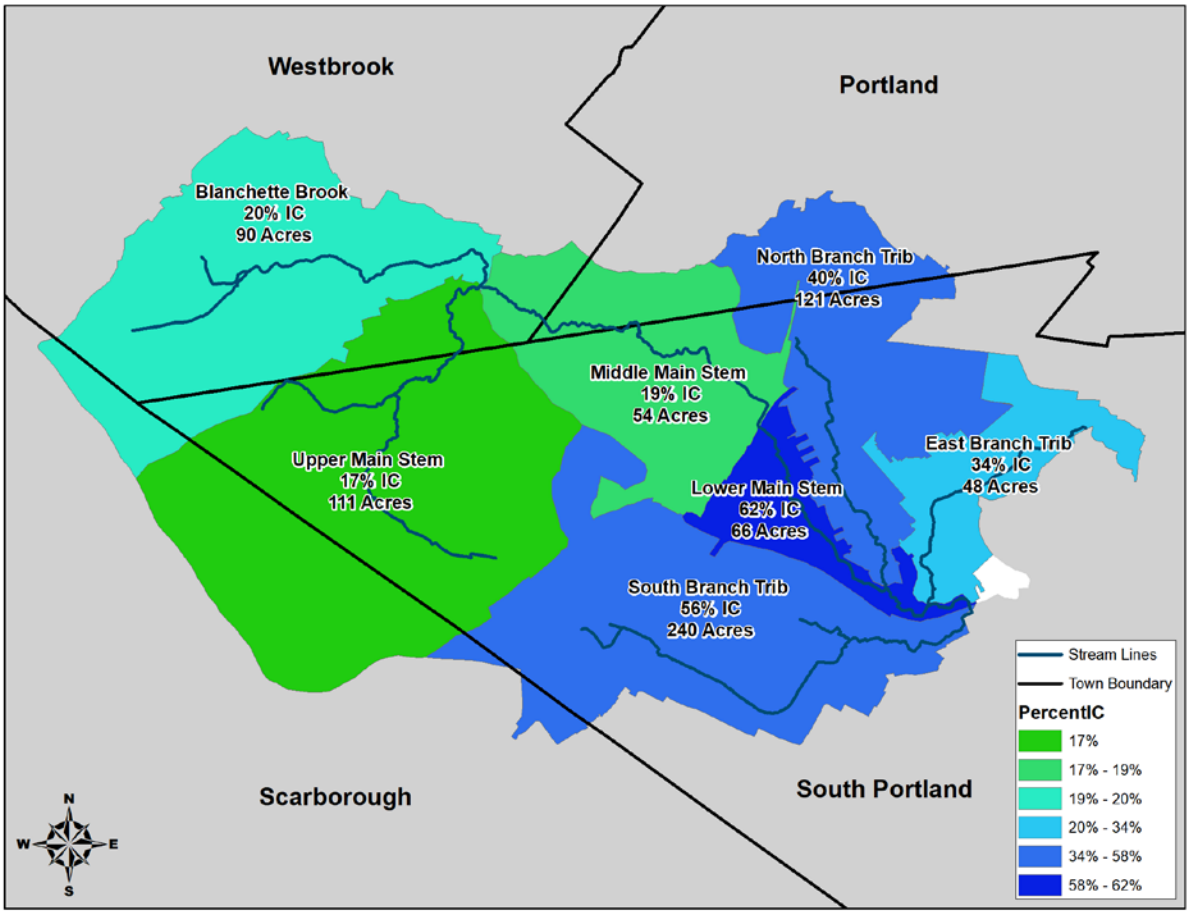

Figure 2 *Impervious Cover by Subwatershed*

[1] There is a discrepancy in in the amount of regulated IC identified through permits and the amount of regulated IC determined using GIS methods. The regulated IC figures used in this report is the amount identified using GIS methods. In anticipation of the third permit cycle of the Long Creek General Permit, LCWMD is working on reconciling different methods of determining IC.

General or Individual Permit Requirement

Following EPA's designation, affected landowners and operators in the Long Creek Watershed had two permitting options: (1) participate in implementation of the LCWMP being managed by LCWMD via the filing of Notice of Intent to Comply with the Long Creek General Permit or (2) obtain an individual permit. Individual permit holders are required to meet current stormwater management law requirements for development, as well as waste discharge requirements (*i.e.*, Maine DEP, Chapter 500 and Chapter 523, standards). Six landowners or operators within the universe of owners and operators of regulated IC do not participate in implementation of the LCWMP through the Long Creek General Permit and, therefore, are subject to individual permit requirements. Approximately 22 acres (4%), out of a total of 615 acres of regulated IC, are managed outside of the Long Creek General Permit under individual permits.

Long Creek Watershed Management Plan

Operators of properties who file a notice of intent to comply with the Long Creek General Permit are required to demonstrate that they have entered into a binding agreement with LCWMD which provides for participation in the implementation of the LCWMP. Operators that obtain permit coverage under the Long Creek General Permit are referred to as "Participating Landowners" and the agreements they enter into with LCWMD are referred to as "Participating Landowner Agreements." As stated in the Long Creek General Permit, the LCWMP was:

> *". . . developed jointly by the municipalities of South Portland, Portland, Westbrook and Scarborough, along with other entities, and approved by the Maine Department of Environmental Protection, for the purpose of restoring the water quality of Long Creek . . ."*

As stated in Participating Landowner Agreements:

> *". . . cooperative implementation of the Long Creek Watershed Management Plan, which includes but is not limited to design, engineering, construction, reconstruction, installation, operation, modification, alteration, use, maintenance, repair, replacement, inspection and monitoring of public and private stormwater management structures, facilities and improvements and in-stream and riparian restoration in and along Long Creek and within the Long Creek Watershed, is likely to reduce the cost and time for Long Creek to comply with Water Quality Standards . . ."*

Participating Landowners

LCWMD implements the LCWMP on behalf of 95 Participating Landowners. Approximately 84% of the watershed's total IC, and approximately 96% of the regulated IC in the watershed, is managed under the LCWMP. The Participating Landowner's include:

- 89 private landowners, primarily commercial and retail properties with IC from rooftops, driveways, sidewalks, and parking lots.
- Three municipal entities, whose IC primarily consists of roads and sidewalks.
- Two state entities, which are both transportation agencies:
    - the Maine Department of Transportation ("Maine DOT"), and
    - the Maine Turnpike Authority ("MTA").

- One quasi-municipal entity, Eco Maine — a regional waste management facility providing recycling and waste-to-energy services to a number of southern Maine municipalities.

Administration

LCWMD was established by "Interlocal Agreement" among the municipalities of Portland, Scarborough, South Portland, and Westbrook, of which portions of each lie within the Long Creek Watershed, to oversee LCWMD activities. In accordance with the Interlocal Agreement and Participating Landowner Agreements, implementation of the LCWMP has been primarily delegated to LCWMD. LCWMD's Executive Director manages the day-to-day implementation of the LCWMP. LCWMD maintains a broad-based Services Agreement with the Cumberland County Soil & Water Conservation District ("CCSWCD") to provide administrative and technical support services to LCWMD concerning implementation of the LCWMP.

LCWMD Board of Directors

The Interlocal Agreement provides for up to sixteen Board members, which were apportioned in the Interlocal Agreement to represent private and public stakeholders relative to their respective amount of IC in the watershed. The landowners and organizations represented on the LCWMD Board of Directors in 2021 are shown in **Table 1**.

Table 1 *LCWMD Board of Directors in 2021*

ORGANIZATIONAL REPRESENTATION		BOARD MEMBER
Portland	1 municipal representative	**Doug Roncarati**, City of Portland, Vice Chair
Portland	1 private Participating Landowner or non-profit representative	**Curtis Bohlen**, Treasurer, Casco Bay Estuary Partnership
Scarborough	1 municipal representative	**Angela Blanchette**, Town of Scarborough
Scarborough	1 public or private Participating Landowner	**Arthur Colvin**, Eco Maine
South Portland	2 municipal representatives	**Fred Dillon**, Chair, City of South Portland **Susan Henderson**, City of South Portland
South Portland	4 private Participating Landowners	**Brian Goldberg**, Secretary, The Bramlie Corporation **Craig Gorris**, GGP-Maine Mall L.L.C. **Ed Palmer**, Portland Marriott at Sable Oaks (1) Vacant
South Portland	1 non-profit representative	**Will Haskell**, Gorrill-Palmer Consulting Engineers, Inc., on behalf of the South Portland/Cape Elizabeth Community Chamber of Commerce
Westbrook	1 municipal representative	**Eric Dudley**, City of Westbrook
Westbrook	2 private Participating Landowners	(2) Vacant
State	1 Maine DOT representative	**Kerem Gungor**
State	1 MTA representative	**Sean Donohue**

More information on Board members and Board activities are posted on LCWMD's website under "District Management."

Board Meetings

LCWMD's Board of Directors met on the following dates in 2021. Minutes and other information are available on the Long Creek website.[2] Board meetings are open to attendance and public comment by Participating Landowners and the general public.

- January 26, 2021
- April 14, 2021
- May 26, 2021
- June 24, 2020
- August 25, 2021
- October 6, 2021

Fiscal Summary

LCWMD maintains its accounting on a fiscal year basis that runs from July 1 to June 30 each year. An estimated budget for the subsequent fiscal year is provided to Participating Landowners in February and the Board must adopt a final budget for the ensuing fiscal year no later than July 1 of each year. LCWMD's revenue generated from fees paid by Participating Landowners is approximately $1.5 million annually. Due to the financial impacts of COVID-19 on Participating Landowners, the Board voted to "forgive" first half of fiscal year 2021 assessments. Therefore, fiscal year 2021 Operating Revenue was $717,590.

As of the end of December 2021, LCWMD had current assets of approximately $3.39 million and was carrying approximately $4.70 million worth of fixed assets (primarily LCWMD-constructed BMPs) on its books. The $3.39 million in current assets includes approximately $1.4 million that is budgeted for design and construction of a gravel wetland BMP project. Long-term liabilities were approximately $0.76 million and are related to LCWMD's Maine Municipal Bond Bank loan.

Structural Management Opportunities

Implementation of the structural aspects of the LCWMP includes, but is not limited to, design, engineering, construction, and reconstruction of public and private stormwater management structures. Section 5.2 of the LCWMP identifies and recommends "structural management opportunities for the built environment" which are prioritized by catchment area. The goal of the structural management opportunities is to provide treatment for up to 150 acres of IC within the Long Creek Watershed, of which approximately 102 acres has been addressed by structural management projects to date.

Completed Projects

A summary of the structural management projects completed in the watershed to date is identified in **Table 2.**

[2] Board agendas and minutes are available on LCWMD's website at: https://www.restorelongcreek.org/documents.

Table 2 *Summary of Structural Project Construction to Date*[3]

Branch	Date	Catchment	Best Management Practice(s) Installed	Acres IC Treated	Other Total	LCWMD Total	Total Cost
South Branch	2009	E-07, 14, 16, 18, 20, 22, 24 (Philbrook Avenue)	Filterra tree box filters, Stormtreat filter units, and Stormtech storage chambers	2.12	$445,324[4]	0	$445,324
South Branch	2009	E-02 (Maine Mall Road)	Credits to Maine DOT for pervious asphalt project	2.95		$368,112	$368,112
North Branch	2010	C-03, 05, 07, 11 (Darling Ave I &II)	Filterra tree box filters, soil media filters, landscaped media filters	7.21	$596,387[4]		$596,387
Lower Main Stem	2010	A1-05, 06 (Mall Plaza Phase I & II)	Multi-cell soil media filter to collect and distribute stormwater to seven treatment cells, underground Stormtech chambers installed to store runoff, Stormtreat systems installed to treat runoff	16.41	$995,906[4]	$257,617	$1,253,523
Blanchette Brook	2012	B-21, 22 (Colonel Westbrook)	Gravel wetland, soil media filters, Stormtech chambers, and Brentwood Units	16.39		$615,796	$615,796
Upper Main Stem	2012	Port Resources	Installation of bioretention cells as part of a grandfathered addition to an industrial park	1.97	$57,145	0	$57,145

[3] Additional details on each construction project are available on LCWMD's website at: https://www.restorelongcreek.org/plan-implementation.

[4] American Recovery & Reinvestment Act Funds; 0% Interest loan, 27.7% principal forgiveness.

North Branch	2013	C-08 (Fairchild and Texas Instruments facilities)	Fairchild: basin retrofitted as a gravel wetland, removed IC and installed nine tree islands. Texas Instruments: installed one wet pond, one wet vegetated treatment system, and three bioretention cells	17.47	$200,000[5]	$323,484	$523,484
Lower Main Stem	2014	Gorham Road	Redesign of medians to provide shade, aesthetics, and treatment where the road drains to median	1.06	$150,000[6]	$476,348	$626,348
Lower Main Stem	2014	A1-03, 14 (Maine Mall Road, Western Avenue to Gorham Road)	Redesign and treatment of road segment	8.42		$682,564	$682,564
South Branch	2015	E-24 (Maine Mall)	Detention basin retrofitted to a gravel wetland	28.29		$651,373	$651,373
South Branch	2020	E-02 (Maine Mall Road)	Credits to Maine DOT for repaving of pervious asphalt project	2.95		$112,062	$112,062
Totals				**102.29**	**$2,444,762**	**$3,119,244.00**	**$5,932,118.00**

Current Project

South Branch BMP Retrofits

The LCWMP identified expansion and enhancement of the *"Hannaford Shopping Plaza's existing stormwater detention basin to provide improved water quality treatment"* as a structural management opportunity. Design of this project is complete, and construction is anticipated to take place in 2022. This project was originally scheduled to be constructed in 2020, however, geotechnical slope stability concerns raised by one of the landowners has delayed the project so that a geotechnical analysis could be performed.

[5] Estimated costs of retrofits installed and paid for by Texas Instruments.

[6] City of South Portland contribution to the project.

The project's primary objective is to implement stormwater BMP retrofits within a 48-acre catchment in order to address water quality concerns in Long Creek including temperature, dissolved oxygen, chlorides, nutrient levels, metal concentrations, and runoff volume. The project will retrofit an existing stormwater detention area with the construction of a new gravel wetland stormwater BMP. In addition to the gravel wetland, the project includes the construction of modular wetland BMP units which will allow stormwater from approximately 3.3 acres of impervious surface within the 48-acre catchment area to be redirected from the gravel wetland to these proprietary systems. The modular wetlands will provide water quality treatment for the smaller subcatchment area and will allow the gravel wetland to achieve a higher level of water quality treatment.

A summary of current structural management projects identified to be completed in the watershed is identified in **Table 3.**

Table 3 *Current Structural Projects Estimated Timeline*

Branch	Date	Catchment	Best Management Practice(s) Proposed	Acres IC Treated	Estimated LCWMD Total	Total Cost
South Branch	2021	E-24	Gravel Wetland; Modular Wetland System	47.4	$1,391,000 (based on 30% design)	$1,391,000
Totals				**47.4**	**$1,391,000**	**$1,391,000**

Structural BMP Inspection and Maintenance

Inspection and maintenance of structural BMPs continues to be a substantial ongoing effort and cost. LCWMD presently inspects and maintains 96 LCWMD-owned-or-operated structural BMPs in the Long Creek Watershed. Inspections and routine maintenance of structural BMP are completed throughout the year. Inspection and maintenance reports are reviewed by CCSWCD's District Engineer who assigns non-routine maintenance for structural BMPs.

Each BMP has been assigned an individual BMP number to allow for the inspection and maintenance costs of individual BMPs to be tracked. This information is used to project future inspection and maintenance schedules and budgets and guides LCWMD's decision-making process should additional structural BMPs be considered. In addition to BMP inspection and maintenance, landscaping services for constructed BMPs requires significant ongoing effort and financial resources. Landscaping includes services such as mowing, mulching, weeding, trash removal, seeding, and cutting of vegetation for winter dormancy.

During 2021, 85 BMPs were inspected and routine maintenance was performed on 84 BMPs. In addition, non-routine maintenance was performed on the Maine Mall Gravel Wetland, all Filterra units, and the underdrained soil filter and bioretention units on Darling Avenue and Gorham Road. Excess sediment and vegetation were removed from the forebay for the Maine Mall Gravel Wetland. The forebay periodically experiences a heavy accumulation of sand which, it is speculated, may be from sand fill infiltrating into the subsurface stormwater collection system that discharges into the gravel wetland. The filter media was removed and replaced in all 22 Filterra units managed by LCWMD at an approximate cost of $110,000. Following laboratory analysis of the existing media by Contech, the manufacturer of the Filterra units, it was determined that fine particulate had infiltrated the media layer reducing the media's effective. During this process, any necessary repairs were made, and mulch and

plant materials were also replaced. In addition, underdrained soil filters and bioretention systems on Darling Avenue and Gorham Road were rehabilitated to remove accumulated sediment and mulch down to the media layer and remulch with coarse cedar mulch. The underdrained soil filters and bioretention units on Gorham Road are particularly impacted by sand and other sediment during the course of each winter.

Restoration Opportunities for the Aquatic Environment

In addition to the structural management activities implemented to treat pollution for improved stormwater quality, the LCWMP calls for restoration measures to improve the aquatic environment. Section 5.4 of the LCWMP identifies in-stream habitat, riparian habitat, and floodplain restoration recommendations. These projects include improvements to riparian and in-stream habitats to mitigate damage that has been caused to aquatic habitats over time. As identified in the LCWMP, undertaking these projects will encourage the habitat conditions needed for the re-colonization of Long Creek by aquatic species more indicative of a healthy stream such as pollution-sensitive macroinvertebrates and brook trout.

Completed Projects

The stream restoration projects identified in the LCWMP, as amended, have been constructed. A summary of in-stream and riparian projects completed in the watershed to date is identified in **Table 4.**

Table 4 *Summary of Restoration Projects to Date*[7]

Branch	Date	Catchment	Restoration Project Implemented	Other Total	LCWMD Total	Total Cost
South Branch	2009	Upper South Branch	Vegetation	Included as part of 2009 Philbrook Avenue Structural BMP Project		Included as part of 2009 Philbrook Avenue Structural BMP Project
Blanchette Brook	2011	B-21 (Colonel Westbrook)	In-stream and riparian enhancement	$29,480[4]	$163,735	$193,215
Main Stem	2014	Lower Main Stem	In-stream and stream bank stabilization		$39,258	$39,258
Main Stem	2019	Middle Main Stem	In-stream structures to improve aquatic habitat, floodplain restoration, bank stabilization, replant floodplain with native plants		$981,425.13	$981,425.13
Totals				**$29,480**	**$1,184,418**	**$1,213,898**

[7] Additional details on each restoration project are available on LCWMD's website at: https://www.restorelongcreek.org/plan-implementation.

Nonstructural Management Opportunities

Implementation of the non-structural aspects of the LCWMP include but are not limited to *"stormwater runoff management techniques that do not require extensive construction efforts and either limit the generation of stormwater runoff or reduce the amount of pollutants contained in the runoff."* In 2021, LCWMD implemented its standard operating procedure that applies to LCWMD's nonstructural obligations including pavement sweeping on Participating Landowner parcels, annual inspection and maintenance of LCWMD-owned-or-operated BMPs, annual inspection of Participating Landowner parcels as related to "pollution prevention" and "good housekeeping," and annual catch basin cleaning on Participating Landowners parcels.

Pollution Prevention

As identified in the LCWMP, pollution prevention is aimed at reducing or eliminating waste at the source, promoting the use of non-toxic or less-toxic substances, implementing conservation techniques, and re-using materials rather than putting them into the waste stream. Pollution prevention includes activities such as pavement sweeping, catch basin cleaning, parcel inspections, and education and outreach.

Pavement Sweeping

Pavement sweeping was completed by LCWMD on private parking lots and roads by a third-party contractor for most properties managed under the Long Creek General Permit. Solids collected through sweeping are designated for disposal at an identified solid waste handling facility.

In addition to general parcel sweeping, "hot spots" are identified on a site-specific basis based on known high-traffic areas (high-turnover [8]parking lots, drive-thru windows, and other high usage areas) and observations of areas where street dust tends to accumulate. Specifics pertaining to sweeping in 2021 include the following:

- Spring cleanup, large particle collection, approximately **261 acres swept**
- Spring cleanup, collection of fines, approximately **259 acres swept**
- Hotspot sweeping completed one time, approximately **53 acres swept**[9]
- Fall sweep, collection of fines, approximately **236 acres swept**[10]

In addition, Participating Landowners will receive credits against their annual assessments for sweeping approximately **118 acres of additional impervious area**.

A total of **93.33 tons of sweepings** were collected by LCWMD's contractor in 2021. **Figure 3** shows the total acreage and total tons of sweeping collected by LCWMD's annual sweeping events from 2015 to 2021.

[9] Typically, two Hot Spot sweeping are conducted annually. However, due to a contractor equipment failure and supply chains issues in acquiring replacement parts, the Hot Spot sweeping could not be performed prior to the Fall Sweep.

[10] The Hot Spot #3 sweeping event was converted to a full sweep in calendar year 2018 and is now referred to as the "fall sweep."

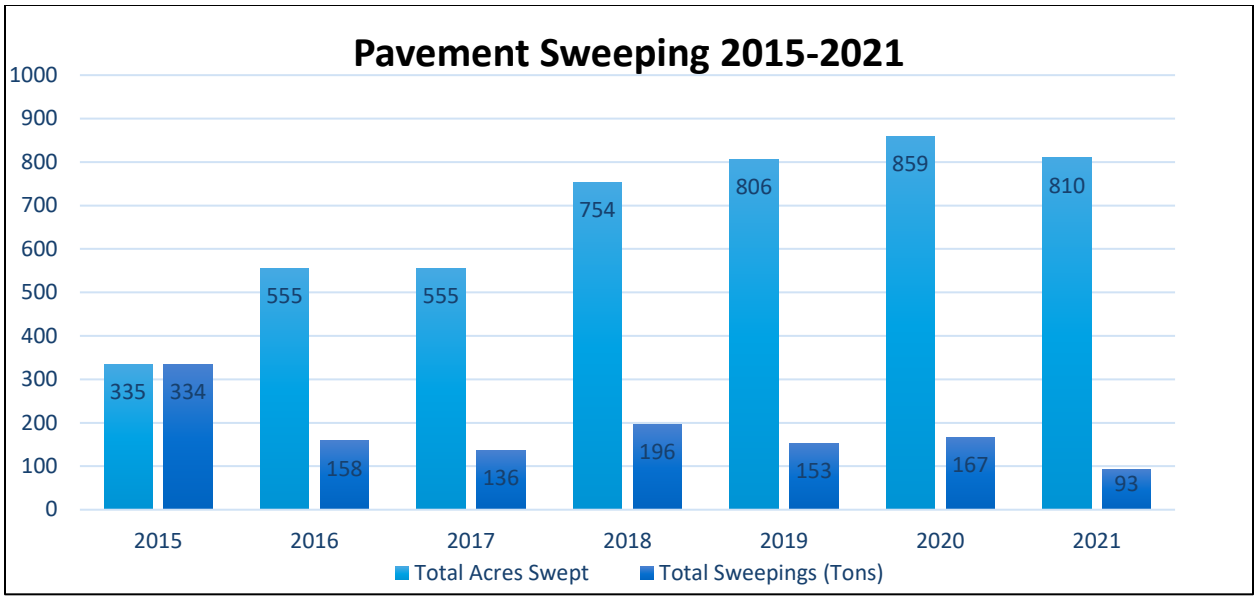

Figure 3 *Tons of Sweepings Collected by Year*

Catch Basin Cleaning

Catch basin maintenance including inspection and/or cleaning was completed by a third-party contractor for properties managed under the Long Creek General Permit. Solids collected through catch basin cleaning are designated for disposal at an identified solid waste handling facility.

In 2021, **695 catch basins were inspected and/or cleaned** which is an increase from 668 in 2020. Approximately **23.79 tons of catch basin grit was collected**, a decrease from 43.44 tons in 2020. In addition, Participating Landowners received credits against their annual assessments for cleaning an **additional 259 catch basins**.

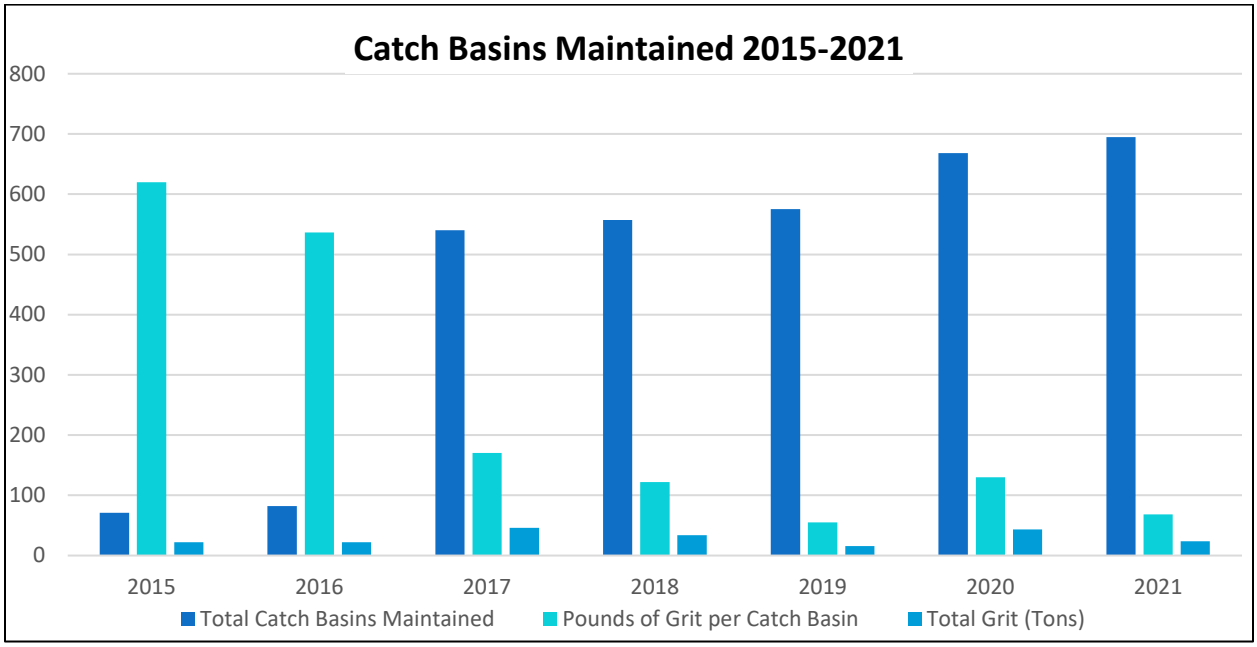

Figure 4 *Catch Basins Maintained by Year*

Sustainable Winter Management (SWiM®)

The water quality monitoring program for Long Creek implemented by LCWMD has identified chlorides from the application of winter dicing salt as a significant impairment of water quality in Long Creek. Elevated chloride levels are known to impact the growth and reproduction of aquatic organisms. As a result, LCWMD has identified the reduction in the use of chlorides as a necessary element to meeting water quality standards in Long Creek.

In 2021, LCWMD continued working with its chloride reduction consultant, WIT Advisers, to develop a local program for adopting Sustainable Winter Management (SWiM®) guidelines throughout the Long Creek Watershed. As the initial phase of implementing the program for the 2021-2022 winter season, key stakeholders and property owners withing the watershed were identified as potential participants for this program, which begins with a broad stakeholder engagement process followed by a future needs assessment process that helps participants to identify opportunities to save money, manage risk, and reduce de-icing salt outputs entering the watershed.

Work during the 2021-2022 winter season included engaging with snow removal operators and others responsible for winter snow and ice management operations on participating properties. Engagement with participants included gathering information related to budgets, operational logistics, and landowner constraints.

Parcel Inspections

During 2021, LCWMD's parcel inspection program was carried out by staff from CCSWCD who conducted 105 inspections of Participating Landowner properties in the watershed. The parcel inspection program is the primary means for LCWMD to conduct outreach with Participating Landowners. CCSWCD staff makes a concerted effort to engage Participating Landowners in the inspection process to ensure that landowners are aware of site-specific operation and maintenance plans and to accomplish timely resolution of issues identified during inspections.

Subsequent to parcel inspections, Participating Landowners were sent annual inspection reports detailing follow-up actions requested by inspection staff. **Table 5** illustrates the relative frequency of the common issues identified during parcel inspections as needing corrective actions. Outreach to landowners was conducted to follow up on corrective actions and to provide technical assistance. LCWMD works with municipalities, and sometimes Maine DEP, to rectify issues identified during parcel inspections.

Table 5 *Common Issues Identified During Parcel Inspections as Needing Corrective Action*

Operation and Maintenance Inspection Element	Corrective Action Needed
Swales or Ditches in Poor Condition	17
Poor Outfall Stability	14
Dumpster Management	13
Poorly Vegetated or Bare Areas (Grass or Landscaped)	12

Culverts in Poor Condition	11
Catch Basin Structural Maintenance Needed	11
Trash/Litter	8
Hazardous Materials Storage or Oil Spill or Leak	7
Pavement in Poor Condition	5
Snow Storage Area in Poor Condition	3
Fats, Oils, Grease	2

Education and Outreach

Fact Sheets

A primary focus of LCWMD's pollution prevention initiatives is distribution of fact sheets to Participating Landowners, all of which are available on LCWMD's website.[11] Distribution of these fact sheets allows LCWMD to efficiently address the most commonly encountered issues in the Long Creek Watershed. Several of the most popular fact sheets are available in Spanish and Mandarin as the result of requests from Participating Landowners, or their tenants. During 2021, fact sheets were simplified to rely less on text and more on simple infographics.

Communications with Participating Landowners

Specific outreach communications to update Long Creek Participating Landowners and subscribers to the Long Creek list serve included the following:

- **January 11, 2021 – Currents: LCWMD Board of Director's Meeting.** The next Long Creek Watershed Management District Board of Directors' Meeting is scheduled for January 26, 2021 at 9:00a.m.
- **February 5, 2021 – Currents: LCWMD Funds Available to Participating Landowners for Water Quality Projects.** The Long Creek Watershed Management District (LCWMD) is excited to announce a new BMP Incentive Program for participating landowners. Interested parties may apply for funds for new projects or to retrofit existing projects that will improve Long Creek water quality. LCWMD currently has $295,000 allocated to this program. Awards are for up to 75% of project costs, with a cap of $50,000, so funding can be allocated to as many projects within the watershed as possible.
- **April 1, 2021 – Currents: Spring Cleanup Starts Today.** Spring has arrived early so the Long Creek Watershed Management District is excited to start the spring cleanup on April 1st. Our pavement sweeping contractor, Maritime Farms and Land Management, LLC will begin sweeping roadways and parking lots on April 1st.
- **April 27, 2021 – Currents: Catch Basin Cleaning.** The Long Creek Watershed Management District's (LCWMD) catch basin cleaning contractor, Clean Venture, Inc./ACV Enviro, will start cleaning catch basins on April 28, 2021.

[11] Fact sheets are available on LCWMD's website at: https://www.restorelongcreek.org/landowners.

- **May 24, 2021 – Currents: Board of Directors Meeting.** The next Long Creek Watershed Management District Board of Directors' Meeting is scheduled for May 26, 2021 at 9:00a.m.
- **June 2, 2021 – Currents: 2020 Annual Report Available.** Due to COVID-19 restrictions, the Long Creek Watershed Management District (LCWMD) was not able to hold its Annual Participating Landowner Meeting in May 2021. Although we are not able to provide an-in person update, we recently submitted the 2020 Annual Report to the Maine Department of Environmental Protection highlighting activities conducted during 2020.
- **June 14, 2021 – Currents: Board of Directors Meeting.** The next Long Creek Watershed Management District Board of Directors' Meeting is scheduled for June 24, 2021 at 9:00 a.m.
- **June 22, 2021 – Currents: RFP Financial Audit Services.** The Long Creek Watershed Management District ("LCWMD") is seeking proposals from qualified service providers to perform annual financial and compliance audits of LCWMD's financial statements. The scope of services is for LCWMD's 2021, 2022, and 2023 fiscal years, with possible extensions for fiscal years 2024 and 2025.
- **June 30, 2021 – Currents: Fiscal Year 2022 Budget.** At its June 24, 2021 meeting the Long Creek Watershed Management District's Board of Directors approved the District's final budget for Fiscal Year 2022 (July 1, 2021 to June 30, 2022).
- **July 21, 2021 – Currents: Funds Available to Participating Landowners for Water Quality Projects.** The Long Creek Watershed Management District (LCWMD) is excited to announce a new round of funding for the Private BMP Incentive Program.
- **August 20, 2021 – Currents: Board of Directors Meeting.** The next Long Creek Watershed Management District Board of Directors Meeting is scheduled for August 25, 2021 from 9:00a.m. to 10:00a.m. at the Portland Sheraton at Sable Oaks (outdoor gazebo), 200 Sable Oaks Drive, South Portland, Maine.
- **October 1, 2021 – Currents: Board of Directors Meeting.** The next Long Creek Watershed Management District Board of Directors' Meeting is scheduled for October 6, 2021 at 9:00a.m.
- **December 20, 2021 – Currents: Board of Directors Meeting.** The next Long Creek Watershed Management District Board of Directors' Meeting is scheduled for January 19, 2022, at 9:00a.m.

Conferences, Meetings, and Events

- **South Portland Land Trust, West End Trails Committee: January 20, February 17, March 17, April 21, June 16, July 21, September 16, October 21, November 18, and December 16, 2021.** Stakeholder on the West End Trails Committee of the South Portland Land Trust. The West End Trails Committee provides input to the South Portland Land Trust on the implementation of their plans to make the west end of the city (the Maine Mall area) more pedestrian friendly and help protect pockets of natural areas. Particular attention was paid to the potential redevelopment of the Sable Oaks Golf Course.
- **Interlocal Stormwater Work Group, Ordinance Committee: October 20, 2021, and December 17, 2021.**
  Working as a partner to the Interlocal Stormwater Work Group on the development of model Erosion and Sedimentation Control and Low Impact Development model ordinance for adoption by Maine MS4 communities.

Monitoring

LCWMD has been implementing the *Long Creek Monitoring Plan*[12] ("Monitoring Plan") and associated *Long Creek Quality Assurance Project Plan*[13] ("QAPP") since late summer 2010. Detailed information about the various aspects of the Long Creek monitoring program is provided in the Monitoring Plan and QAPP.

Monitoring Locations

The monitoring locations for 2021 are identified in **Figure 5**, which are consistent with prior years.

Goals of Monitoring

Monitoring of conditions in the Long Creek Watershed reflects specific regulatory and management needs. These are: to determine whether or not Long Creek meets applicable water quality standards; to gather information to improve management of Long Creek; and, to document effectiveness of restoration programs and progress towards meeting standards. The Monitoring Plan was developed in order to evaluate baseline chemistry and flow conditions and monitor stream recovery at predetermined points across the watershed. The Monitoring Plan is focused on gathering the information needed to monitor Long Creek restoration efforts.

Figure 5 *Long Creek Monitoring Locations*

[12] The Monitoring Plan is available on LCWMD's website at: https://www.restorelongcreek.org/documents.

[13] The QAPP is available on LCWMD's website at: https://www.restorelongcreek.org/documents.

Monitoring Plan and Quality Assurance Project Plan

The Monitoring Plan requires water quality monitoring, biological monitoring, habitat assessment, and physical (geomorphic) assessment to determine the effectiveness of stormwater BMPs and watershed restoration projects on water quality, habitat, and the health of biological communities.

Monitoring Plan Implementation

The Monitoring Plan and QAPP were implemented in 2021 by LCWMD's monitoring contractor with support provided by CCSWCD and oversight provided by LCWMD. Long Creek's monitoring program includes primarily continuous monitoring, collection of grab samples, hydrologic monitoring, and biomonitoring. LCWMD's monitoring contractor provided a monitoring services summary report to LCWMD for the 2021 calendar year on January 31, 2022.[14]

Water Quality Monitoring Data Summary

LCWMD has identified water quality criteria for general water chemistry in Long Creek based on Maine DEP and U.S. Environmental Protection Agency water quality standards and recommendations for freshwater or urban streams. Specific conductance (used as a proxy for chloride), dissolved oxygen ("DO"), and temperature are measured nearly continuously with water quality data loggers. Phosphorus, metals (cadmium, copper, lead, nickel, and zinc), chloride, and Polycyclic Aromatic Hydrocarbon levels are measured periodically by in-stream grab sampling. These water quality parameters are monitored as ongoing indicators of water quality in Long Creek and its ability to support aquatic life. Long Creek's ability to support aquatic life, such as macroinvertebrates and fish, is ultimately determined through periodic biomonitoring (described below).

LCWMD uses the Criteria Continuous Concentration ("CCC") and Criteria Maximum Concentration ("CMC") as comparative criteria for contaminant concentrations in surface water. The CCC, or chronic criterion, is the highest in-stream concentration to which organisms can be exposed indefinitely without causing unacceptable effect (typically the four-day average concentration that should not be exceeded more than once every three years on the average), and the CMC, or acute criterion, is the highest concentration to which organisms can be exposed for a brief period of time without causing an acute effect (typically the one-hour average concentration that should not be exceeded more than once every 3 years on the average). LCWMD has developed a color-coded screening system to track each stream reaches' conformity with quality criteria referred to as "stoplights." **Table 6** reflects the structure of the stoplights system. The subsequent tables are the outcomes of the stoplights at the identified monitoring locations.

Table 6 *Monitoring Criteria for Ranking*

Color Codes	Dissolved Oxygen	Chloride	Metals	Nutrients	Calculated Chloride
RED	Failed for more than 21 days	CMC exceeded or CCC exceeded for >50% samples			
ORANGE	Failed for 7-21 days	CCC exceeded for 30-50% of samples			
YELLOW	Failed for 1-6 days	CCC exceeded for 25% of samples (and not during baseflow)			
GREEN	Meets classification				

[14] *See* GZA GeoEnvironmental, Inc. January 2022. 2021 Annual Monitoring Services Summary Report— Long Creek Watershed — Portland, South Portland, Westbrook, and Scarborough, Maine. Edited portions reproduced for this report.

Blanchette Brook

Blanchette Brook Monitoring Summary (Secondary)

Location	Year	Calculated Chloride	Chloride	Dissolved Oxygen	Metals	Nutrients
S12	2011	GREEN	—	YELLOW	—	ORANGE
S12	2012	GREEN	—	YELLOW	—	RED
S12	2013	GREEN	GREEN	YELLOW	RED	RED
S12	2014	YELLOW	GREEN	YELLOW	RED	RED
S12	2015	GREEN	GREEN	YELLOW	RED	RED
S12	2016	GREEN	GREEN	YELLOW	RED	RED
S12	2017	GREEN	GREEN	YELLOW	RED	RED
S12	2018	ORANGE	ORANGE	YELLOW	RED	RED
S12	2019	GREEN	GREEN	GREEN	RED	RED
S12	2020	GREEN	GREEN	YELLOW	RED	RED
S12	2021	GREEN	GREEN	YELLOW	ORANGE	RED

Blanchette Brook Monitoring Summary (Primary)

Location	Year	Calculated Chloride	Chloride	Dissolved Oxygen	Metals	Nutrients
S07	2010	ORANGE	RED	RED	RED	RED
S07	2011	ORANGE	GREEN	RED	RED	RED
S07	2012	ORANGE	ORANGE	RED	RED	RED
S07	2013	YELLOW	GREEN	RED	RED	RED
S07	2014	YELLOW	ORANGE	RED	RED	RED
S07	2015	RED	ORANGE	RED	RED	RED
S07	2016	RED	RED	RED	RED	RED
S07	2017	RED	RED	RED	RED	RED
S07	2018	RED	RED	RED	RED	RED
S07	2019	ORANGE	RED	RED	RED	RED
S07	2020	RED	RED	RED	RED	RED
S07	2021	RED	RED	RED	ORANGE	RED

Main Stem

Upper Main Stem Monitoring Summary (Secondary)

Location	Year	Calculated Chloride	Chloride	Dissolved Oxygen	Metals	Nutrients
S11	2011	ORANGE	—	YELLOW	—	ORANGE
S11	2012	GREEN	—	YELLOW	—	ORANGE
S11	2013	GREEN	GREEN	YELLOW	RED	RED
S11	2014	ORANGE	YELLOW	YELLOW	RED	RED
S11	2015	ORANGE	ORANGE	YELLOW	RED	RED

S11	2016	ORANGE	RED	YELLOW	RED	YELLOW
S11	2017	ORANGE	ORANGE	YELLOW	ORANGE	RED
S11	2018	ORANGE	ORANGE	YELLOW	RED	RED
S11	2019	RED	GREEN	YELLOW	RED	RED
S11	2020	GREEN	GREEN	YELLOW	ORANGE	RED
S11	2021	ORANGE	ORANGE	YELLOW	ORANGE	RED

Upper Main Stem Monitoring Summary (Primary)

Location	Year	Calculated Chloride	Chloride	Dissolved Oxygen	Metals	Nutrients
S06	2010	GREEN	GREEN	RED	RED	RED
S06	2011	ORANGE	GREEN	RED	RED	RED
S06	2012	YELLOW	GREEN	RED	ORANGE	RED
S06B	2013	YELLOW	GREEN	RED	RED	RED
S06B	2014	ORANGE	YELLOW	RED	RED	RED
S06B	2015	ORANGE	ORANGE	RED	RED	RED
S06B	2016	ORANGE	ORANGE	RED	RED	RED
S06B	2017	ORANGE	ORANGE	RED	ORANGE	RED
S06B	2018	ORANGE	ORANGE	RED	RED	RED
S06B	2019	ORANGE	ORANGE	RED	RED	RED
S06B	2020	YELLOW	YELLOW	RED	ORANGE	RED
S06B	2021	ORANGE	ORANGE	RED	GREEN	RED

Middle Main Stem Monitoring Summary (Primary)

Location	Year	Calculated Chloride	Chloride	Dissolved Oxygen	Metals	Nutrients
S05	2010	GREEN	GREEN	RED	RED	RED
S05	2011	YELLOW	GREEN	RED	RED	RED
S05	2012	GREEN	GREEN	YELLOW	RED	RED
S05	2013	GREEN	GREEN	RED	RED	RED
S05	2014	YELLOW	YELLOW	RED	RED	RED
S05	2015	ORANGE	GREEN	YELLOW	RED	RED
S05	2016	RED	GREEN	YELLOW	RED	RED
S05	2017	ORANGE	ORANGE	YELLOW	RED	RED
S05	2018	ORANGE	ORANGE	YELLOW	RED	RED
S05	2019	ORANGE	YELLOW	YELLOW	RED	RED
S05	2020	ORANGE	YELLOW	YELLOW	ORANGE	RED
S05	2021	ORANGE	YELLOW	YELLOW	RED	RED

Lower Main Stem Monitoring Summary (Primary)

Location	Year	Calculated Chloride	Chloride	Dissolved Oxygen	Metals	Nutrients

S02	2010	YELLOW	GREEN	RED	RED	RED
S02	2011	ORANGE	GREEN	RED	RED	RED
S02	2012	ORANGE	ORANGE	RED	RED	RED
S02	2013	ORANGE	GREEN	RED	RED	RED
S02	2014	ORANGE	RED	RED	RED	RED
S17	2015	RED	ORANGE	RED	RED	RED
S17	2016	RED	RED	RED	RED	RED
S17	2017	ORANGE	RED	RED	RED	RED
S17	2018	RED	RED	RED	RED	RED
S17	2019	ORANGE	RED	RED	RED	RED
S17	2020	RED	YELLOW	RED	RED	RED
S17	2021	RED	ORANGE	RED	RED	RED

South Branch

Middle South Branch Monitoring Summary (Secondary)

Location	Year	Calculated Chloride	Chloride	Dissolved Oxygen	Metals	Nutrients
S04	2010	RED	RED	ORANGE	RED	RED
S04	2011	RED	RED	RED	RED	ORANGE
S04	2012	RED	RED	YELLOW	RED	ORANGE
S04	2013	RED	RED	YELLOW	RED	YELLOW
S04	2014	RED	RED	YELLOW	RED	RED
S04	2015	RED	RED	YELLOW	RED	ORANGE
S04	2016	RED	RED	YELLOW	RED	ORANGE
S04	2017	RED	RED	YELLOW	RED	RED
S04	2018	RED	RED	YELLOW	RED	ORANGE
S04	2019	RED	RED	YELLOW	RED	ORANGE
S04	2020	RED	RED	YELLOW	RED	RED
S04	2021	RED	RED	YELLOW	RED	RED

Lower South Branch Monitoring Summary (Primary)

Location	Year	Calculated Chloride	Chloride	Dissolved Oxygen	Metals	Nutrients
S01	2010	RED	RED	RED	RED	RED
S01	2011	RED	RED	RED	RED	RED
S01	2012	RED	RED	RED	RED	RED
S01	2013	RED	RED	RED	RED	ORANGE
S01	2014	RED	RED	RED	RED	ORANGE
S01	2015	RED	RED	RED	RED	RED
S01	2016	RED	RED	RED	RED	RED
S01	2017	RED	RED	RED	RED	ORANGE
S01	2018	RED	RED	RED	RED	RED
S01	2019	RED	RED	RED	ORANGE	GREEN

S01	2020	RED	RED	RED	GREEN	ORANGE
S01	2021	RED	RED	RED	GREEN	GREEN

North Branch

North Branch Monitoring Summary (Primary)

Location	Year	Calculated Chloride	Chloride	Dissolved Oxygen	Metals	Nutrients
S03	2010	RED	RED	RED	RED	ORANGE
S03	2011	RED	RED	RED	RED	ORANGE
S03	2012	RED	RED	RED	ORANGE	ORANGE
S03	2013	RED	RED	RED	RED	ORANGE
S03	2014	RED	RED	RED	RED	RED
S03	2015	ORANGE	ORANGE	RED	RED	RED
S03	2016	RED	ORANGE	RED	RED	RED
S03	2017	RED	RED	RED	RED	RED
S03	2018	RED	RED	RED	ORANGE	RED
S03	2019	RED	RED	RED	GREEN	GREEN
S03	2020	RED	RED	RED	GREEN	RED
S03	2021	RED	RED	RED	GREEN	GREEN

Biomonitoring

Pursuant to the Monitoring Plan, invertebrate monitoring utilizing rock bags is performed at primary monitoring locations twice in every five-year period (*e.g.,* 2010, 2013, 2015, 2018). In 2021, off-cycle invertebrate evaluations were completed at two long-term monitoring stations; S05 in the upper Main Stem of Long Creek, and S17 in the middle Main Stem of Long Creek. To supplement rock bag sampling data to document the effectiveness of the Main Stem Restoration Project, which was completed in 2019, D-frame sampling and habitat assessments were also performed in 2021 in the "reference" and "restoration" reaches.

Rock Bags

The macroinvertebrate community is sampled by deploying standardized sampling devices (rock bags or rock baskets) on the stream bottom for a period of four weeks and collecting the organisms that colonize the bags. The collected organisms are identified and quantified. The resulting data is used to calculate 23 variables that are used in linear discriminant models which predict the probability that the community will meet the aquatic life criteria for a given stream classification (A, B, C, or Nonattainment). **Table 7** summarizes biomonitoring outcomes based on Maine DEP evaluations of rock bag data. Rock bags are deployed twice in every five-year period, with the work alternatingly being performed by Maine DEP or LCWMD.

Maine DEP was scheduled to deploy rock bags in 2020, however, due to the monitoring season being limited in 2020 due to COVID-19, deployment of rock bags was deferred to 2021. In 2021, Maine DEP determined that rather than deploying rock bags at the traditional primary monitoring locations, biomonitoring should focus on documenting the effectiveness of the Main Stem Restoration Project. As a result, biomonitoring was limited to the "reference" and "restoration" reaches. Maine DEP deployed one set of rock bags at monitoring station S05, the "reference" reach, and three sets of rock bags in the

"restoration" reach, with one set being deployed at monitoring station S17, and two addition sets being deployed, one upstream of S17 and one downstream of S17, both in the "restoration" reach.

Table 7 *Summary of Aquatic Life Classification Attainment Reports*

Date	Biomonitoring Station	Monitoring Station	Statutory Class	Determination
8/18/2010	S-409	**S07** (Blanchette Brook)	B	NA
8/18/2010	S-411	**S06A** (Main Stem just above Blanchette)	B	NA
8/18/2010	S-570	**S05** (Main Stem above Turnpike)	C	C
8/16/2010	S-414	**S03** (North Branch)	C	NA
8/16/2010	S-752	**S17** (Main Stem just above Foden Road)	C	NA
8/13/2010	S-415	**S02** (Main Stem below Foden Road)	C	NA
8/13/2010	S-753	**S01** (South Branch above Clark's Pond)	C	NA
9/9/2013	S-409	**S07** (Blanchette Brook)	B	C
9/9/2013	S-1015	**S06B** (Main Stem Sable Oaks just below Cummings)	C	NA
9/9/2013	S-570	**S05** (Main Stem above Turnpike)	C	C
9/9/2013	S-414	**S03** (North Branch)	C	I
9/9/2013	S-581	**NONE** (South Branch below S-408)	C	NA
9/9/2013	S-415	**S02** (Main Stem below Foden Road)	C	NA
8/27/2015	S-411	**S06A** (Main Stem just above Blanchette)	B	C
8/27/2015	S-414	**S03** (North Branch)	C	NA
8/27/2015	S-408	**NONE (**South Branch above S-581)	C	NA
8/27/2015	S-752	**S17** (Main Stem just above Foden Road)	C	NA
8/1/2018	S-409	**S07** (Blanchette Brook)	B	NA
8/1/2018	S-1015	**S06B** (Main Stem Sable Oaks just below Cummings)	C	NA
8/1/2018	S-411	**S06A** (Main Stem just above Blanchette)	B	NA
8/1/2018	S-570	**S05** (Main Stem above Turnpike)	C	NA
8/1/2018	S-414	**S03** (North Branch)	C	NA
8/1/2018	S-752	**S17** (Main Stem just above Foden Road)	C	NA
8/1/2018	S-415	**S02** (Main Stem below Foden Road)	C	NA
8/1/2018	S-753	**S01** (South Branch above Clark's Pond)	C	NA
8/13/2019	S-409	**S07** (Blanchette Brook)	B	NA
8/13/2019	S-570	**S05** (Main Stem above Turnpike)	C	NA
8/13/2019	S-752	**S17** (Main Stem just above Foden Road)	C	NA
9/3/2021	S-570	**S05** (Main Stem above Turnpike)	C	Pending
9/3/2021	S-1196	**NONE** Close to S-410	C	Pending
9/3/2021	S-1197	**NONE** Upstream of S-752 (adjacent to **S17**)	C	Pending
9/3/2021	S-752	**S17** (Main Stem just above Foden Road)	C	Pending

D-Frame Sampling

In 2019, the Main Stem riparian habitat restoration project was completed. The primary objective of this project was to restore the corridor of the Main Stem of Long Creek in the project area to enhance habitat conditions for macroinvertebrates and restore floodplain functions. To document the effectiveness of the project, d-frame macroinvertebrate sampling and habitat assessments are being utilized to supplement rock bag data.

During the 2021 monitoring season, one round of benthic macroinvertebrate assessments with d-frame net sampling was performed in the main stem of Long Creek in the general areas of Long Creek Monitoring Station S17 (the "restoration reach") and Long Creek Monitoring Station S05 (the "reference reach"). The assessment was conducted in accordance with Section 7.2 of EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. Following EPA protocols, each monitoring station composite sample consisted of d-frame net 'dips' taken within each reach, within representative micro-habitats.

Total taxa richness in d-frame net samples was 22 at Station S05 (the reference reach) and 30 at Station S17 (restoration reach). In general, the 2021 d-frame net samples were dominated by pollution-and-condition-tolerant taxa. However, d-frame net sampling in 2021 did detect caddisflies (Order Trichoptera) and mayflies (Order Ephemperoptera), which are pollution-sensitive taxa and, therefore, important indicators of higher aquatic life use criteria.

Caddisflies (Order Trichoptera) were only present in the reference reach (S05) based on the 2021 data. Given that restoration was completed in 2019, it is possible that additional time (*i.e.* growing seasons) are required to detect positive increases in caddisflies in the restoration reach. In addition, it is also possible that weather conditions and ongoing drought also influenced dispersal of caddisflies from nearby areas. The d-frame net sampling method detected individuals of Order Ephemperoptera (mayflies) along the reference reach (S05) and the restoration reach (S17).

No individuals of Order Plecoptera (stoneflies) were captured in 2021, which is similar to the 2020 results but contrary to previous data collected in Long Creek in 2013 (*i.e.* see S05 data).

In summary, the d-frame net sampling method seems to be a useful method to gather a more complete list of taxa from the Long Creek streambed than sampling with rock bas.

Habitat Assessment

In addition to d-frame sampling, one round of instream habitat assessments was performed in 2021 in the Main Stem of Long Creek in the reference reach and the restoration reach where the Main Stem Restoration Project was implemented. The characterization of stream bottom substrate size was conducted in accordance with Section 5 of EPA's *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition*. As part of the assessment, general land use, stream origin, vegetation features, and instream features including substrate and stream depth are characterized. Ten parameters are assessed on a scale of one to 20 for each of ten habitat parameter categories as part of assigning four habitat condition categories (*i.e.* optimal, suboptimal, marginal, and poor, see **Table 8**).

Table 8 *Summary of Habitat Scoring associated with the EPA Rapid Bioassessment Protocols (Source: GZA GeoEnvironmental, Inc.)*

Scoring	Poor	Marginal	Suboptimal	Optimal
Score for each Habitat Parameter	0 - 5	6 - 10	11 - 15	16 - 20
Total Score (sum of all parameters)	< 50	51 - 100	101 - 160	161 – 200

During 2021, habitat scores ranged from 136 to 139 (compared to 102 to 139 in 2020, 94 to 131 in 2019, and 90 to 137 in 2018) at the monitoring stations, with no scores in the lowest (< 50) or highest (>160) habitat assessment categories. Based on the scores, the stations are rated as having suboptimal habitat conditions, with neither of the stations rated as having marginal or optimal conditions.

Table 9 *Summary of Habitat Scoring associated with the EPA Rapid Bioassessment Protocols (Source: GZA GeoEnvironmental, Inc.)*

HABITAT PARAMETER	STATION S05	STATION S17
	Reference Reach	**Restoration Area**
Epifaunal Substrate	12	15
Pool Substrate Characterization	14	15
Pool Variability	13	17
Sediment Deposition	15	14
Channel Flow Status	10	18
Channel Alteration	14	15
Channel Sinuosity	13	4
Bank Stability (left bank)	8	3
Bank Stability (right bank)	7	4
Vegetative Protection (left bank)	7	2
Vegetative Protection (right bank)	8	9
Riparian Vegetative Zone Width (left bank)	9	10
Riparian Vegetation Zone Width (right bank)	9	10
TOTAL SCORE	**139**	**136**
Overall Habitat Condition Category	**Suboptimal**	**Suboptimal**

Station S17 (the restoration area) improved from a marginal rating (score of 94) in 2019 to a suboptimal rating (score of 102) in 2020 and maintained a suboptimal rating (score of 136) in 2021. Specifically, the pool variability and channel flow status categories for Station 17 improved from marginal (2019) to optimal (2021). Station S05 (the reference reach) received a consistent score within the suboptimal rating between 2020 and 2021. **Table 10** below shows the overall habitat scores from 2018 to 2021.

These scores highlight the importance and success of the Main Stem Restoration Project, as scores improved in the restoration area after restoration work was complete.

Table 10 *Overall habitat parameter scores at each assessed monitoring station from 2018 to 2021 utilizing the EPA Rapid Bioassessment Protocols (Source: GZA GeoEnvironmental, Inc.)*

STATION	2018	2019	2020	2021
S05 (Reference Reach)	137	131	139	139
S17 (Restoration Area)	90	94	102	136

Notably, the overall habitat scores for the reference and restoration reaches were similar in 2021. Although habitat scores have improved in the Restoration Reach and are now similar to habitat conditions in the Reference Reach, it is noteworthy that neither of the assessed stations are considered optimal habitat. This is important to note considering that impairment in the watershed is measured on macroinvertebrate health, which is in part, directly tied to habitat conditions such as channel characteristics and flow regime. Although instream habitat improved in the restoration reach, habitat conditions in the buffer have remained similar between years. Additional habitat restoration measures may be necessary to improve habitat conditions above the suboptimal category.

Woody Debris

Data for woody debris was also collected in the reference reach (S05) and the restoration reach (S17), as they are expected to correlate with flow conditions. The sample size in 2021 was approximately half of that in 2020, for both reaches. Small, narrow sticks are more mobile in faster velocities, and offer less than optimal habitat. Larger woody debris typically offers better cover as habitat. The same two sample t-tests (as those performed for the various habitat types) were performed for the collected size parameters, length, width (*e.g.*, approximate diameter), and overall size (length times width). The null hypothesis H0 is the sample mean of the reference reach is less than or equal to the sample mean of the restoration reach (M1 <= M2). Confidence coefficient of 95% (*i.e.*, significant level of 0.1) was used.

Based on the sampling results, there was no statistically significant difference in the length, width or overall size of the submerged woody debris between the reference and restoration reaches based on the data collected in 2021. In 2020, the woody debris were found to be slightly longer in the restoration reach (S17) than those in the reference reach (S05). **Table 11** (below) summarizes the statistical analysis results on woody debris per GZA's 2021 data.

Table 11 *Comparison of 2021 Woody Debris Assessment Results Between Reference Reach and Restoration Reach*

Wood Debris Size Parameter	Reference Reach (S05)				Restoration Reach (S17)				t-test value	Critical t (0.05)	Pvalue	Hypothesis Accepted
	Sample size	Avg (M1) (%)	Med (%)	StDev (%)	Sample size	Avg (M2) (%)	Med (%)	StDev (%)				
Length (L, in)	63	14	12	5	46	14	12	5	-0.44	1.66	0.67	H0
Width (W, in)	63	1.4	1.0	1.3	46	1.3	1	1.1	0.49	1.66	0.32	H0

Overall Size L*W (in^2)	63	20	11	23	46	19	11	19	0.32	1.66	0.38	H0

The same two sample t-tests were performed on the woody debris data from 2019 and 2021 to evaluate effects from the 2019 restoration effort for the restoration reach (S17). The null hypothesis H0 is the sample mean of the 2019 dataset is less than or equal to the sample mean of the 2021 dataset (M1 <= M2). Confidence coefficient of 95% (*i.e.*, significant level of 0.1) was used. Based on the sampling results, there was no statistically significant difference in the length, width, or overall size of the woody debris between the reference and restoration reaches based on the data collected in 2021. **Table 12** (below) summarizes the statistical test results on woody debris comparing 2019 and 2021 data.

Table 12 *Comparison of Woody Debris Assessment Results for the Restoration Reach Between 2019 and 2021 (Source: GZA GeoEnvironmental, Inc.)*

Wood Debris Size Parameter	**2019 Restoration Reach (S17)**				**2021 Restoration Reach (S17)**				**t-test value**	**Critical t (0.05)**	**Pvalue**	**Hypothesis Accepted**
	Sample size	**Avg (M1) (%)**	**Med (%)**	**StDev (%)**	**Sample size**	**Avg (M2) (%)**	**Med (%)**	**StDev (%)**				
Length (L, in)	87	12	12	5	37	14	15	5	-2.82	1.66	1.00	H0
Width (W, in)	87	1.2	1.0	0.9	37	1.3	1.0	1.0	-0.46	1.66	0.68	H0
Overall Size L*W (in^2)	87	14	10	13	37	20	12	19	-1.93	1.66	0.97	H0

Based on the sampling results, it was concluded that the length and in-turn overall size were statistically significantly longer and larger in 2021 than those in 2019, which can be mostly likely attributed to the restoration effort. The results also indicate that there was no statistically significant increase in width, which remained fairly similar between 2019 and 2021.